Model of a Knowledge-Based Economy for Armenia*

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Abstract

The transformation to postindustrial economy is characterized by new strength and quality of productivity growth over the rising knowledge intensity of the world economy and the increasing abilities to distribute that knowledge. The informational globalization period brings new challenges to Armenia making the country to disclose its comparative advantage in the region and develop dynamically. The economic developments of past established macroeconomic stability, assuring further economic growth in country. Taking into consider the fact, that the existing modern world developments offer new challenges to the countries for adopting flexible economic policies with respect to knowledge, from receiving, adopting, developing to using it in economy in an effort to have a sustained long-run economic growth, we point out the main steps for Armenia towards transformation to a knowledge-based economy model.

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Introduction.

The XX century became significant with its rapid social and civil transformations. For the grasp of all these changes the philosophers, sociologists and economists offer several conceptions that help to explain the logic of social developments and their perspectives. The examples of such conceptions are postindustrial, postmodern, information and other societies. In each one's context, the modern social-economic existence is considered from the point of view of the science and educational prosperity, where during the changes the role of knowledge and information are becoming significant.

The rising knowledge intensity of the world economy and our increasing abilities to distribute that knowledge have increased its value to all participants in the economic system. The implications of this are profound, for the strategies of enterprises, as well as for the institutions and systems used to regulate economic behavior.

Taking into consider the fact, that the existing modern world developments offer new challenges to the countries for adopting flexible economic policies with respect to knowledge, from receiving, adopting, developing to using it in economy in an effort to have a **sustained long-run economic growth**, we point out the following issues in the framework of present research:

- What is new about the 'New Economy' and what is the Knowledge Economy?
- What does it mean for Armenia?
- What might Armenia do to meet the existing challenges for the transition to a knowledge-based economy?

We provide the theoretical review of long-run economic growth models, with the productivity as the central factor for that. Then emphasizing the transformation to a knowledge economy as the main engine for further productivity growth, we discuss the knowledge economy model by its main pillars. The next section provides a description and interpretation of Armenian economic growth in the transitional period within qualitative indicators and TFP growth trend as well. With this as background, we then describe the knowledge economy pillars of Armenia, revealing the strengths and weaknesses the country has in this context and emphasizing the needed directions for policy towards a knowledge-based economy model.

Theoretical review.

The neoclassical school, which formulated in the world economic rapid industrialization period, by using the exogenous production functions, showed that the capital accumulation is needed for exponential and thus long run sustained economic growth and, therefore, productivity growth.

N. Kaldor (1961) empirically revealed that a/ the output per capita increases during the time, and its rate of growth does not decrease, b/ the physical capital per worker increases during the time, c/ the real income level is mainly stabile etc. Overall, they correspond the growth theories of neoclassical school.

The long-run growth issues have again become a modern topic from the middle of 1980's. Now, empirical studies showed distinctions from the previous facts. For instance, P. Romer (1989) empirically showed that a/ the average growth rate may not correlate with the income per capita, b/ the growth rate of international trade positively correlates with the growth rate of the production, c/ the capital growth isn't a sufficient fact for the explaining of production growth. In the result, some countries (Venezuela) of high income level group moved into those with lower or vice versa (Southern Korea, Singapore).

As it became impossible to explain those occurrences with capital accumulation in the framework of neoclassical theories, the modern growth theories tried to explain newly the rapid growth of residual part of production functions in some countries. At that period,

those countries described with the employment rate reaching its possible maximum rate in industry, transformed from industrial economy to postindustrial, characterized with new strength and quality of productivity growth.

In this context, first researches have made P. Romer (1986), R. Lucas (1988). They explained the growth of productivity or unexplained residual with the conception of human capital.

The second wave of growth models got the name «Research and Development, R&D». In order to explain the residual rapid growth, Barro, Sala-I-Martin (1995), Lucas (1993) considered the development and adoption of innovations and new technologies my means of trade among countries[1].

The postindustrial economy is characterized by the rapid advances in information and communication technologies, which enable researchers in different locations to work together, raising their productivity, resulting in rapid advances in research and development and the generation of new knowledge and technologies as well. As a result, over the past quarter century, the knowledge creation and use have increased significantly. Its accumulation results to the improvement of the production factors labor (human capital) and physical capital (technology), thus explaining the high growth rates of residual or total factor productivity (TFP), resulting to sustained long-run economic growth[2].

Consequently, "new growth theory" reflects an attempt to understand the role of ***knowledge*** and ***information*** in driving productivity and economic growth.

The economy, where knowledge is acquired, created, disseminated and used effectively to enhance economic development, is a Knowledge Economy (KE)[3].

The KE framework elements. Knowledge, as the main engine of economic growth and development, is developed in the endogenous R&D growth model of Chen and Kee (2005). Its interest is that it shows that simple neoclassical models with human capital as a factor of production are able to resolve the concerns of scale effects and policy invariance. Chen and Kee consider the steady-state effects of two scenarios that could result from development-oriented policies.

First scenario focuses on human capital accumulation, the increase in which will result in a larger stock of human capital in economy. The increase in human capital in the R&D sector leads to more innovations and discoveries, which results to more technological growth. The last, combined with the human capital stock in the goods-producing sector, leads to an increase in the growth rate of output. According to the model, a fixed

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[1] Paralleled, new group of researchers showed up in 1990's. It is the authors' opinion that the valid explanation of growth is in the institutes. According to them, institutes are a prism in the "investment-output" relations, and their improvements result to the "investment quality improvement or investment productivity growth (which is the output from a unit investment)", and thus "quantitative improvement of growth".
See North, D. (1990), "Institutions, Institutional Change and Economic Performance", Cambridge University Press, Cambridge; Barrow, C. W. "The strategy of selective excellence: Redesigning higher education for global competition in a postindustrial society", Higher Education, 41, 447-469; Robert E. Hall, Charles I. Jones, "Why Do Some Countries Produce So Much More Output Per Worker Than Others?" , The Quarterly Journal of Economics, Vol. 114, No. 1 (Feb., 1999), pp. 83-116; James D. Gwartney, Randall G. Holcombe, Robert A. Lawson, "Institutions and the Impact of Investment on Growth", 9600 Garsington Road, Oxford OX4 cDQ, UK, 2006, pp.259-270.

[2] On the other hand, there are models, in which authors develop an idea that the growth rate of per capita income depends only on exogenous parameters, such as the growth rate of population, and no longer depends on the level of human capital and other R&D resources in the economy (Jones (1995), Kortum (1997)).

[3] See "Korea as a Knowledge Economy", Overview prepared by Joonghae Suh, Jean-Eric Aubert, Do-Geol Ahn, and Derek H. C. Chen, The World Bank, Washingtnon D.C.
URL// http://info.worldbank.org/etools/docs/library/235384/KoreaKE-Overview.pdf (last assessed: 28.04.2008)

proportion of output is invested as new capital, over again increasing the increased rate of output.

Second scenario relates to information and communications technologies (ICT). It is infrastructure in economy, which refers to the accessibility, efficiency of computers, phones, other networks. According to model, the increased flow of information and knowledge, resulting from improvement in the ICT infrastructure, leads to increased innovation, steady-state growth rate of technology, productivity and hence output (for more in detail see annex 1).

As Chen and Kee model shows, even one time improvement of a) education system (therefore, human capital), b) information infrastructure, and hence c) innovation capability will lead to TFP growth and economic growth in long run.

Consequently, we found out, that in current highly competitive and globalized world economy the development-oriented policy should emphasize the knowledge. That will tend to transition into a KE, which is the main engine for TFP growth and hence long-run economic growth. On the other hand, the review of growth models revealed, that the education, innovations, information infrastructure and economic incentive & institutional regime are the main elements or pillars for KE framework.

To facilitate the transition to a Knowledge economy (KE), the World Bank institute's Knowledge for Development (K4D) Program has developed the Knowledge Assessment Methodology (kam-www.worldbank.org/kam). It is an Internet-based tool that provides a basic assessment of countries readiness for the knowledge economy. It includes 80 structural and quality variables for countries and 9 regional groups that serve as proxies for the knowledge economy pillars. The most frequently used mode of KAM is the Knowledge Economy Index (KEI). It provides an overview of the performance of a specific country in terms of all four pillars of the KE[4].

The composition of economic growth of Armenia

The qualitative definition of growth using several substantial indicators.

After the Soviet Union collapse, independent Armenia got into the economic crisis, accompanied with several negative processes (Nagorno Karabagh conflict, earthquake, energetic crisis). The reforms, commenced on 1994, overall settled macroeconomic and institutional steadiness for succeeding years, assuring the endurance of permanent economic growth, described with two figures in last seven years, getting its 1990's level in 2003.

Still, for the qualitative analysis of existing growth, it is useful to emphasize several significant occurrences accompanying it.

1. The transformational period is continually described with structural changes in GDP. Enduring decrease in component part of the goods production and agriculture as well substitutes with the services production. Despite the fact that this appropriates the world's trend, the industrial sector mainly consists of mining, with a large and increasing share of foods' manufacture (including alcoholic beverage, tobacco), chemical industry, metallurgical industry. On the other hand, large share of services goes to the construction. Note, that those are knowledge acquisition fields, but not creation.

Still, the international comparison in this context makes it clear, that the transitional country Armenia with its economic structure, particularly high component part of agricultural sector in output, appropriates to low income countries,.

[4] The index is constructed as a sample average of 14 normalized values: 2 performances, 12 knowledge variables, with 3 variables representing each of 4 pillars of knowledge economy. Source: Derek H.C.Chen and Carl J.Dahiman, "The Knowledge Economy, the KAM Methodology and World Bank Operations", World Bank, Washington DC 20433, October 2005.

Table 1. The structure of Armenian economy in comparison with world country groups (% in total)

	Agriculture		Goods production		Servicies	
	1990	2002	1990	2002	1990	2002
World average	5	4	34	29	60	68
Low income countries	29	24	30	30	41	46
Countries with medium income	14	9	39	34	47	57
Including the transitional countries of Europe and Central Asia	17	9	44	32	39	59
Developed countries	3	2	33	27	64	71
Armenia (2003)	***17.2***	***23,4***	***52***	***39***	***30.8***	***37,6***

Source: 2004 World Development Indicators, World Bank.

2. The economic growth in non-agricultural sector is characterized by labor productivity growth (output per worker). Yet, it is mainly expounded with the permanent decrease of employment rate during the transitional period, which is explained within the following occurrences:

- In early transitional period the employment in non-agricultural sector is defined by a hidden unemployment growth, as well as abrupt decrease of wages. De facto unemployed and for a long time unpaid workers were considered employed. Thus, during the followed privatization period the employment rate constantly reduced mostly at those workers' expense.
- The number of workplaces in new private enterprises was not sufficient to cover the unemployment rate. Therefore, the employment rate decreased year by year, resulting to a labor productivity growth in non-agricultural sector[5]. Nevertheless, this factor's impact weakened from 2000.

3. The poverty rate is comparatively high in the country, although, due to PRSP implantation in 2003, it reduced from almost half of the population to 26,5%.

4. The country is defined by unequal regional developments, mainly concentrated in the capital, where 32,6% of the country's population live (2005). On the other hand, the 47,2% of industry, 81,5% of construction, 80% of transportation and communications and only 1,2% of agricultural sectors are centered here[6].

5. Continuous migration especially among younger population still exists in the country. According to the official data, more that 800 000 citizens have left the country since the independence.

Quality description of Armenian growth in accordance with its knowledge-based rate. For the substantial analysis of the economy, we need to decompose the growth to production factors and TFP[7]. Taking into consider the availability of incomplete and imperfect statistics'; we have limited methodological capabilities for that.

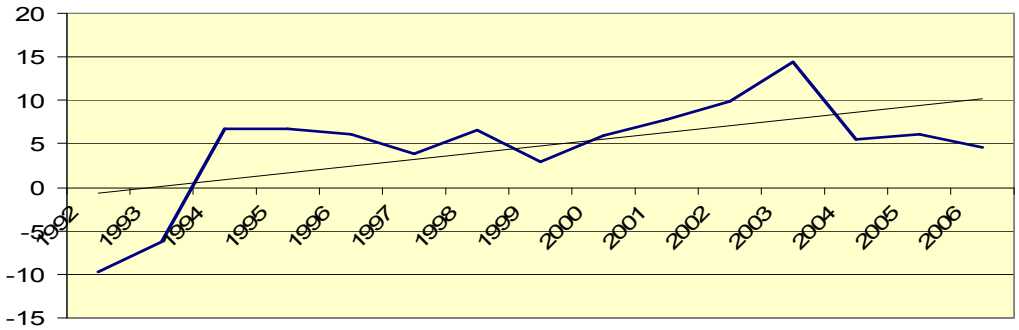
[5] Agricultural sector was described with over employment and thus labor productivity decreasing trends.
[6] Source: NSS, publications, "The Regions of RA with figures, 2002-2005".
URL//www.armstat.am/publications ((last assessed: 20.04.2008).
[7] The first research in this context has been made by H. Manasyan and T. Jrbashyan, see *Gur Ofer and Richard Pomfred*, "The Economic Prospects of the CIS: Sources of Long Term Growth", (Chapter 6, the case of Armenia), Edward Elgar Publishing Ltd, February 2004. Our estimations differ with the considered period of time and emphasize on TFP as an indicator, describing the transformation to a KE.

Using (1) we have calculated the TFP growth rate for the transitional period of Armenian economy. r and w are appropriately capital's and labor's prices or their shares in the total income[8].

$$\Delta A(t)/A(t-1) = \Delta Y(t)/Y(t-1) - a(t)\Delta K(t)/K(t-1) - b(t)\Delta L(t)/L(t-1) \qquad (1)$$

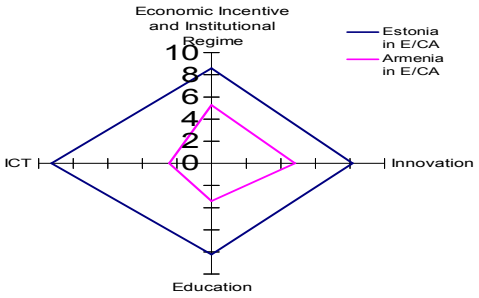
As Picture 1 indicates, the TFP growth rate has been described with: a/ negative values till 1994, as a result of GDP reduction, b/ constant positive values in 1994-2000 years, resulting to a steady economic growth, and c/ growing trend in 2001-2006 years, accompanied with two figure economic growth. Surely, it can be interpreted as if the Armenian economy goes up to a higher level of efficiency and competitiveness after the crisis and stability[9].

Picture 1. The TFP growth rate of RA in the period of 1992-2006



Consequently, TFP growth rate estimates, that Armenian economy has improved its competitiveness. Considering the pillars of a knowledge-based economy with defining indicators, using World Bank's KAM, it would be useful to decompose the estimated TFP growth rate in the context of knowledge-based economy and in comparison to Estonia's model[10].

Picture 2. The KEI of Armenia and Estonia



[8] (r+w)=1, based on the official data, for describing the labor force introduced in the output we chose w=0.4.

[9]

Average annual growth	Armenia	Estonia
1995-2000 years	+2.5	+4.6
2001-2006 years	+8.0	+3.7

Source: IMF Country Report, July 2007 and author's estimates

[10] The two countries are involved into Europe and Central Asia country group (in KAM methodology), are post soviet transitional countries defied with small territory and limited natural recourses.

Table 2. The KEI of Armenia and Estonia

Variable	Armenia (most recent)	Armenia 1995	Estonia (most recent)	Estonia 1995
1 pillar: Economic Incentive and Institutional Regime (average)	*5.26*	*3.52*	*8.60*	*8.75*
2 pillar: Innovation (average)	*4.81*	*4.63*	*8.12*	*7.07*
3 pillar:Education (average)	*3.40*	*2.61*	*8.22*	*7.37*
4 pillar: ICT (average)	*2.44*	*3.71*	*9.24*	*9.17*
Knowledge Economy Index (average)	**4.64**	**3.84**	**8.22**	**7.73**

Source: World Bank, KAM, URL//www.worldbank.org/kam

The picture 1 and 2 interpretations are as follows: in early transformation period, the crisis destroyed Armenian economy so, that the TFP present growth rates, calculated on low basic figures, now do not assure a competitive level of knowledge-based economy.

In this context, the Global Competitiveness Index (GCI) shows the country's competitiveness stage through three levels, revealing the prior directions for raising the existing competitiveness level.

The composition of Armenia's Global Competitiveness Index (GCI) shows, that Armenia drops from first «Factor-driven-economy» stage to the second «efficiency driven» stage:

Table 3. The composition of GCI

Global Competitiveness Index	Rank(out of 125 countries) score (out of 7)	
	Armenia	Estonia
2006-2007	82/3.8	25/5.1
Basic Requirements	**81/42**	**30/5.3**
1st pillar: Institutions	84/3.4	30/4.7
2nd pillar: Infrastructure	92/2.7	30/4.7
3rd pillar: Macroeconomy	71/4.3	16/5.3
4th pillar: Health and primary education	62/6,4	43/6.6
Efficiency Enhancers	**88/3.3**	**19/5.2**
5th pillar: Higher education and training	80/3,6	23/5.3
Tertiary enrollment	*68*	*16*
Quality of the educational system	*88*	
Extent of staff training	*104/1.43*	
Local availability of research and training services	*104*	
6th pillar: Market efficiency	104/3.6	25/5.0
7th pillar: Technological readiness	86/2.8	16/5.3
Cellular telephones (hard data)	*105*	*15*
Internet users (hard data)	*89*	*16*
Technological readiness	*87*	*24*
Laws relating to ICT	*86*	*1*
FDI and technology transfer	*72*	*8*
Innovation Factors	**93/3.2**	**32/4.2**
8th pillar: Business sophistication	104/3.3	35/4.7
9th pillar: Innovation	84/3.0	30/3.8
Company spending on R&D	*100*	*32*
Intellectual property protection	*93*	*32*
Government procurement of technology products	*80*	*33*

Source: The Global Competitiveness Report 2006-2007.

In this context at present phase, Armenia must:

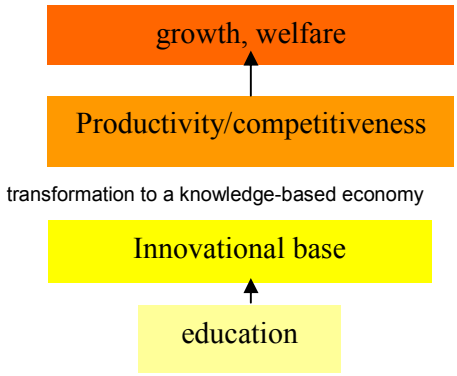
- Adopt new innovative technologies, increasing the knowledge-based potential of its productions and services.

- Improve the education system qualitative and quantitative parameters (indicators).

On the KE transformation at the higher stage of development, the scientific own potential for making innovations is prospective.

Education- the pillar of knowledge-based economy.

The education is a process of creating, developing human being through learning of past experience. It extends body's abilities with an objective of getting knowledge and professionalism, creates human capital, standing the important pillar for a knowledge-based economy and a guarantee for quality life as well.



Armenia inherited almost 99% literal population from the soviet period, more than half with higher education, as well as a quality education system. Since Moscow was the policy-making center at that period, Armenia meets the challenges of carrying out an independent educational policy, creating competitive quality educational system meeting the globalization demands. Quality education means that a country is broadly able to achieve its defined goals[11]. In this context, Armenia has to be consistent in solving the existing problems of the system in order to prevent human capital's moral and physical deterioration in the result.

As indicated GCI and TFP composition, in the objective of getting to a higher competitive level and thus transforming to a KE, Armenian educational system meets new challenges. In this context, the priority has to be given to enrolment in the educational system (especially higher education) and its quality improvements as well.

Table 4 shows the existing main problems of the education system through the main variables (of Knowledge Index) in comparison with the case of Estonia.

Table 4. Education's scores, KI, Armenia and Estonia

Variable	**Armenia**		**Estonia**	
	(Group: Europe and Central Asia)		(Group: Europe and Central Asia)	
	actual	normalized	actual	normalized
Adult Literacy Rate (% age 15 and above), 2004	99.4	5.19	99.8	8.89

[11] Article 35 of Armenia's Constitution (adopted July 5, 1995) guarantees the right to education for every citizen of Armenia:

- Every citizen is entitled to education.
- Education shall be free of charge in state secondary educational institutions.
- Every citizen is entitled to receive higher and other specialized education free of charge and on a competitive basis, in state educational institutions.
- The creation and operation of private educational institutions shall be prescribed by law

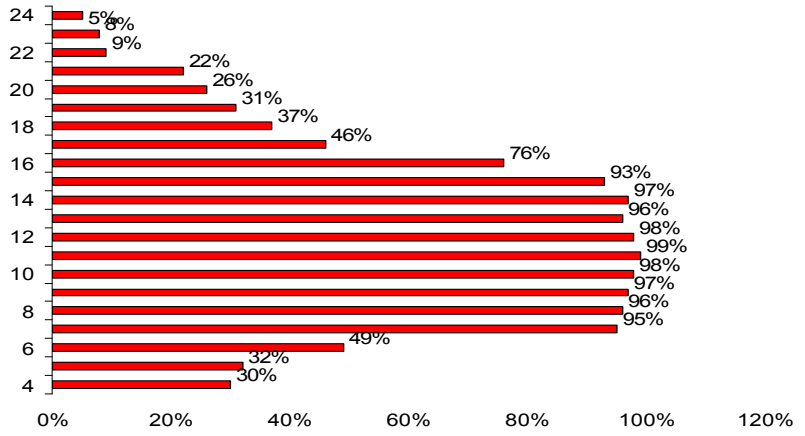
Gross Secondary Enrollment Rate, 2005	88	3.46	98.1	8.08
Gross Tertiary Enrollment Rate, 2005	28	1.54	65.1	7.69
Life Expectancy at Birth,2005	73.3	6.67	72.6	5.19
Internet Access in Schools (1-7), 2006	2.4	0.4	6	9.6
Public Spending on Education as % of GDP, 2005	3.2	1.6	5.7	8
Prof. and Tech. Workers as % of Labor Force, 2004	n/a	n/a	26.43	6.84
8th Grade Achievement in Mathematics, 2003	478	4	531	8.67
8th Grade Achievement in Science, 2003	461	1.33	552	9.33
Quality of Science and Math Education (1-7), 2006	3.8	0.8	5.3	8.4
Extent of Staff Training (1-7), 2006	2.8	2	4.8	9.6
Quality of Management Schools (1-7), 2006	3.1	1.2	4.9	9.2
Brain Drain (1-7), 2006	2.6	4	3.9	8.8

Source: World Bank, KI, KAM, www.worldbank.org/kam (10.03.2008).

The education issues through several substation indicators.

A. Educational system involvements. According to the statistics, the middle school involvement is basically absolute. On the other hand, it differs at the high school and after school systems. Thus, the higher education is rapidly becoming inaccessible for the population (in some cases pupils refuse attending high school, though the education there is free). An argument in favor of this conclusion is the education enrollment for the surveyed age group of 13-33 (i.e. those who enrolled in the educational system in the transition period). It reveals that there is 1.4 times more inequality in education (the Gini coefficient equals 0.21) and 0.4 year less average years of schooling (equals 10.8 years) compared with the calculations for the age group of 10 and above (where the Gini coefficient and average years of schooling are appropriately 0.15 and 11.2, which is largely a result of the practically equal access to all levels of education for various social groups in the Soviet period. Before 1990s, more than half of this age group (52.3 %) was educated. Furthermore, their average age is 21.5 years and 25 % of those aged below 21 and 92 % of those aged 22-33 do not receive any kind of education[12].

Picture 3. Enrollment in education institutions by age



Source: NSS, Education Transitions in Armenia, UNDP, 2006.

B. The quality of Education. The combination of the three components - education inputs, educational process and outputs, is the safeguard of a quality education system.

[12] "Education, Poverty and Economic Activity in Armenia. Situation Analysis Report", UNDP, 2002.

1. *Inputs*. The material (financial, physical environment) and human resources as well (teacher training, professional development) are considered as inputs. Their combination fulfills the education process. Thus, the estimated indicators monitoring could help to reveal the needed policy directed to the inputs improvement.

- *Financing*: State budget expenditures on education amounted 2.74% in 2005 compared to 1.96% in 2003. Despite that increase, it is almost two times less than in OECD countries (4.7%). The primary purpose of the expenditures are the formal basic education system (84.22% in 2005) and increasing salaries of teachers.
- *Internet access at schools:* In academic year 2004-2005 the number of computers in all schools around Armenia was 5 531, from which 279 schools with Internet connection.
- *The quality of teachers:* Within the framework of the survey of "Secondary education in Armenia: problems and perspectives" conducted in 2003, responding to the question on what is necessary to improve in the quality of education, 31.3% of teachers and 29.4% of parents responded "improving the quality of personnel", which had the largest share of responses in both cases[13]. It combines several problems in Armenian educational system:
  - ❖ Higher pedagogical education's quality. It must rather base on practical skills, that theoretical.
  - ❖ Procedure for recruiting teachers. It must be in the framework of a concrete model, such as exams in Korea and France, open competitions in Finland and England etc.
  - ❖ Professional development of teachers. The appropriate courses have started within the framework of the World Bank loan project. In 2004-2006 35 000 teachers were engaged in training programs. These trainings are based on the needs of teachers, with improving learning methods.
- *The selection of lecturers and students*: Permanently updating of teaching structure at higher education institutions, organizing and developing seasonal schools system, international conferences with different thematic focuses, that will enlarge the opportunities for integrating into the international education systems.

2. *Educational process.* The educational process review is held in the basic school and after school levels of the system.

- *Basic education process.* The basic education formally consists of elementary, middle and high schools in Armenia. The second one must determine the pupils in further education, but we may say that there are no significant differences between the content and philosophy of middle and high schools. The last one does not prepare pupils for the admission exams or university education as well. For that reason, education in high school becomes a formality, because according the survey[14], "almost half of secondary school graduates use the service of private tutors for two or more subjects for admission to HEI". Consequently, "there is a gap between supply and demand, which causes demand to be met outside the school". At least three reasons of that are as follows:
  - ❖ The methods of education are not competitive. Due to inadequacy of laboratory equipment and materials in schools, pupils are not able to do the mandatory experiments defined in their science curricula.

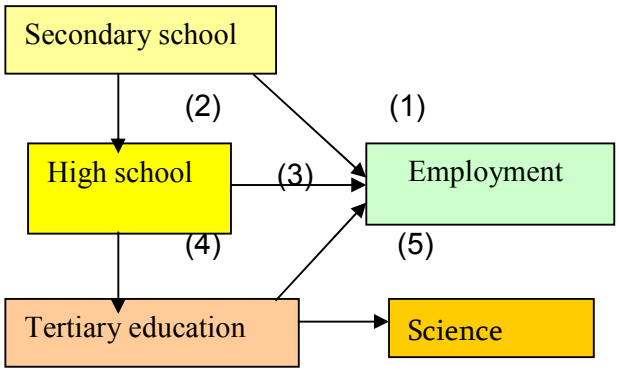
[13] "Educational Transitions in Armenia", National Human Development Report, 2006, UNDP Armenia, 2007, //www.undp.am/publications ((last assessed: 10.01.2008).
[14] Ibid.

- ❖ The volume of materials studied throughout the year is small. For example, a student of grade 8 should learn 2 953 pages, solve 1 936 math problems, 455 geometry problems, 1 402 physics problems in one academic year[15].
- ❖ There is also a chance to continue the learning at secondary vocational institutions. However, students rather prefer to remain in school for ninth and tenth grades, instead of moving there.

- *Tertian education process.* The education process at HEI stimulates the system's competitiveness at most, its integration into the world processes, creating the bases for a knowledge economy. The inherited qualitative education system has had a long-run effect. The primary problems here are the needed rapid reforms, aimed at education's corresponding to international criteria. In this context, Armenia has adopted a policy complying with the signed Lisbon treaty, through which it joined the Bologna Process. In its framework, the country has admitted several principles aimed to increase the quality of higher education process. Those are:
  - ❖ Inputting a multilayer education system (bachelor-master-postgraduate).
  - ❖ Inputting a credit system, such as the European Credits Transfer and Accumulation System (ECTS).
  - ❖ Assisting students', professors', researchers' and administrative workers' with mobility.
  - ❖ Developing and supporting the lifelong learning.

  Though Armenia has commenced on the reforms toward improving the higher education's process, much remains to be done in harmonizing the legal framework with international commitments in order to meet required principles and standards and thus have a competitive educational system.

3. *Outputs.* "The struggle to improve the quality of education has shifted from inputs to outputs" [16]. To assess the outputs of Armenian education system, we need to monitor several substantial indicators that appropriate the logic of the model described below.



(1) Describes how many pupils refuse to continue education at high schools as well as their preparation level for joining the labor market. Picture 3 estimated that there is a trend that the high school enrollment fluctuates around 70 %. Some of the middle school graduates enter the labor market[17]. On the other hand the analysis of 9th and 10th grades' curricula and course plans confirm, that the level of skills and abilities is the same for all schools of Armenia, and does not do much to facilitate the employment of secondary

[15] Ibid, p. 50.
[16] World Bank, "Explaining opportunities and building Competencies for Young People", World Bank, 2005, p. 212.
[17] The 2006-2008 state Medium-Term Expenditure Framework of Republic of Armenia. URL//www.mfe.am ((last assessed: 10.10.2007).

school graduates[18]. According to PRSP, when asked whether they would like their children to learn a craft while at school, 77% of the urban and 85.3% of the rural population responded affirmatively[19].

(2) Describes the preparation level of the students', preferring to continue studying at high schools. According to the figures, during the academic year 2005-2006, 98.2% of the pupils passed the exams[20]. The grades pupils get when taking exams for moving to high schools are a convenient indicator for describing (2), but still not sufficient to present the quality of education's output in Armenia. The main problems here are as follows:

- The schools conduct the exams themselves, so the results are not objective enough for determining the degree to which middle schools are accomplishing their mission.
- Sometimes parents more concentrate on their children's grades instead of the quality of education.
- Often pupils use private tutoring with their teachers in middle school.
- According to National Curriculum of general education, the study of form and substance of middle and high school graduation exams show that «the existing standards, curricula, textbooks and evaluation system only partially meet the requirements of contemporary education. The delivery of information to the learner and learners' memorization of fact is over-emphasized, while insufficient attention is paid to the development of the learners' abilities and skills»[21].

(4) Describes the number of the pupils entering HEI. According the NSS, this figure decreases year by year.

(5) Describes the qualitative and quantitative parameters of those joining the labor market. In 2002 61,1% of graduates from state universities and 55.2% from non-state universities joined the labor force (total 59,5%)[22].

Taking into consider all above, the educational reforms in Armenia should be mainly directed to the improvement of its output parameters, encouraging its quality improvement in this context.

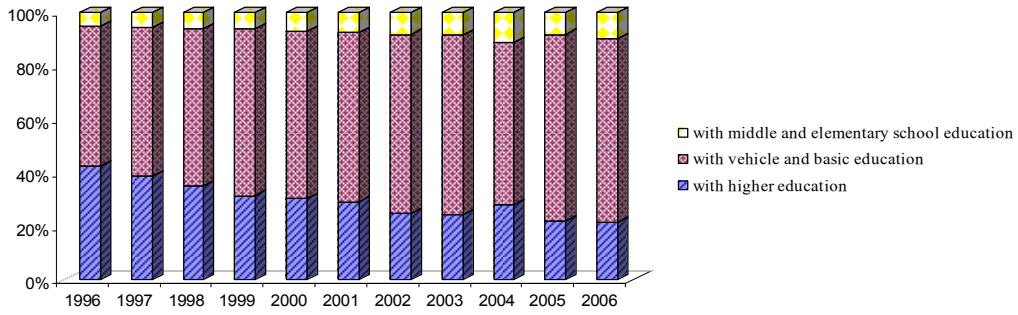
The main issues concerning the labor market may be described as follows:

- There is a surplus in supply because of the structural changes in economy. According the statistics, 17,8% of those graduated from the HEI and joined the labor market in 2002 do not work with their specialty, and 12% of those not working say their inability to find a job due to the absence of jobs matching their professional qualifications in the Armenian labor market.
- According the survey, only 40.2% of employers consider that the knowledge acquired by graduates during their studies is sufficient for finding employment and engaging in professional activities[23].

From overall, the employment structure has changed, thus changing the human capital of the production. Those changes are described with the decrease of the proportion of workers having higher education.

[18] "Educational Transitions in Armenia", Op. Cit., p. 46.
[19] S. Manukyan, PRSP Impact Assessment, p. 129.
[20] "Education in Armenia" yearbook.
[21] "Educational Transitions in Armenia", Op. Cit.
[22] Ibid., p. 84.
[23] Ibid., p. 90.

Picture 4. The employment by education degree



Source: NSS, authors estimates.

From the statistics and trends available in the educational system, we may conclude, that the growth in Armenia is described with worsening human capital. As we estimated the education improvement in the present efficiency stage is an important base toward the sustained knowledge-based economic growth. Thus, the implemented policy shall grasp the following steps:

- To continue the embedding of a flexible system of education loans, giving opportunities to the students for getting the education, needed literature and other tools for the process as well.
- To build career development centers, that will facilitate young graduates' integration into the labor market.
- To continue increasing the expenditures toward the education system, increasing teachers' and lecturers' income as well as better environmental conditions for classes.
- To carry out staff training and re-training programs in all levels of educational institutions.

Innovations- the pillar of knowledge-based economy.

Towards a competitive knowledge-based economy with the objective of having a qualitative growth, Armenia has to provide a basis for transforming to innovation model of economy. That means founding a general system for knowledge development and transfer, by means of integration into the international global scientific innovation system.

Consequently, at the same time the country should a/ fulfill scientific and applied researches in the prior fields of the economy, b/ develop the innovation system within its integration into the economy, c/ correspond the domestic R&D system to the international criteria trough cooperation. In that framework the country will be able to get the scientific products from abroad, master them effectively and have its own inputs there.

Soviet Armenia was classified as a country specialized in high technologies, holding 30% of the previous system's electronic industry as well as the principal portion in military industry, were the main potential of soviet science was concentrated. Science was also one of the advanced Armenian economic fields. Post-soviet Armenia inherited research (and education) institutions, and thus well represented with academic, higher education and scientific institutions.

Still, this system weakened with the Soviet Union collapse. The science and innovation indicators monitoring will help to find out the available problems indicating the needed policy to resolve them as well.

Table 5 displays the state of innovations in the country by means of their main indicators in comparison with the selected country Estonia.

Table 5. Innovation's scores, KI, Armenia and Estonia

Variable	Armenia		Estonia	
	(Group: Europe and Central Asia)		(Group: Europe and Central Asia)	
	actual	normalized	actual	normalized
FDI Outflows as % of GDP, 2000-05	0.1	3.6	2.5	9.2
FDI Inflows as % of GDP, 2000-05	4.9	5.93	10.3	9.26
Royalty and License Fees Payments (US$/pop.), 2005	n/a	n/a	19.2	7.39
Royalty and License Fees Receipts (US$/pop.), 2005	n/a	n/a	4.2	6.96
Royalty Payments and Receipts (US$/pop.) 2005	n/a	n/a	23.4	6.96
Science and Engineering Enrolment Ratio (%), 2005	7.1	0	22.6	4.21
Science Enrolment Ratio (%), 2005	0.3	0	10.4	8.95
Researchers in R&D, 2004	4927	2.17	3369	1.74
Researchers in R&D / Mil. People, 2004	1605.93	6.09	2523	8.7
Total Expenditure for R&D as % of GDP, 2004	0.25	0.87	0.91	6.96
Manuf. Trade as % of GDP, 2005	37.2	2.8	94.8	8.8
University-Company Research Collaboration (1-7), 2006	2.7	2.4	3.9	9.2
Technical Journal Articles, 2003	175	3.7	368	4.81
Technical Journal Articles / Mil. People, 2003	58.3	4.81	262.9	8.89
Availability of Venture Capital (1-7), 2006	2.5	0	4.1	9.6
Patents Granted by USPTO, avg 2001-05	1.2	2.59	3.6	4.81
Patents Granted by USPTO / Mil. People, avg 2001-05	0.4	4.81	2.65	8.52
High-Tech Exports as % of Manuf. Exports, 2005	0.7	0	17.6	8.33
Private Sector Spending on R&D (1-7), 2006	2.7	2	3.8	8.4
Firm-Level Technology Absorption (1-7), 2006	4.9	7.2	5.6	9.6
Value Chain Presence (1-7), 2006	3.4	4.8	4.2	7.6

Source: World Bank, KI, KAM, www.worldbank.org/kam

The innovation issues through several substation indicators.

- *Expenditures on Research & Development.* The total expenditures as percentage of GDP yields to the developed countries in the same parameter, which amounted 3 % in Japan in 1999, 2.8 % in the USA, 2.4 % in Germany. In Armenia in 2003, this figure amounted 0.24 % and continued its decreasing trend later, getting to 0.21 % in 2006. This variable includes internal private, public as well as external sources for financing.

❖ Public expenditures. According to the national statistics the weight of public expenditures on R&D in GDP decreased more than 4.5 times during the 1990-2004 time period. At the same time, the nominal public expenditures on science on the whole have increased 1,3 times during 1998-2004 years.

❖ The national producers' and business environments' interests in the scientific outputs are very low. In the KE the demand increases for the scientific outputs, directing to the private sector's competitiveness growth. It also uses to be the main source for internal R&D financing. Here the mediator enterprises' have the role to transfer the innovation projects to a valid business plan for a potential investor.

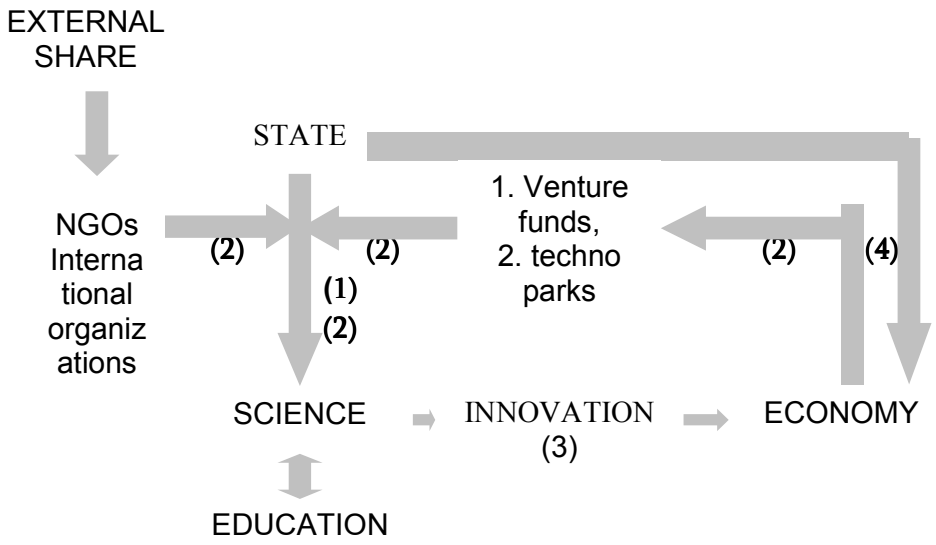
❖ The portion of external R&D financing is as follows: from 2% in 1997 it increased to 9.2% in 2004. This indicator is higher in the dynamically developing countries with knowledge-based economies. For instance, in Korea the 2/3 of total expenditures to R&D are accumulated within the external and internal private financial sources as well.

- *The portion of researchers holding a scientific degree*. Official data shows, that the number of researchers having scientific degree has fallen 3.5 times from 1987. On the other hand, getting its lowest number in 1995, it increased by 40.5 % to 2004.
- *The average age of researchers holding scientific degree* is 60 years in Armenia (the world average is 44 years) tending to increase in the transitional period. Consequently, the country shall decrease this figure by causing the young to get involved into the science.
- *The average age of scientific equipment* is 11-13 years (the world average in 1999 was 5-6 years). The promotion of science development will be accompanied with this figure decease.
- *The expenditures on innovations.* According to the Armenian Innovational Promotion and Development concept (January, 2005) and the Ministry of Education and Science, 80 % of the state financing goes to fundamental research, and only 20 % to the applied researches. At the same time, for instance, in the USA only the 16 % of financing goes to fundamental research, the 26-28 % – to applied researches, and 65 % to the experiments and technological developments as well.
- *The share of innovative enterprises in the industry* was almost 10 % in 2003, which means that we fall behind the developed countries. The comparison with international data shows, that we are falling behind the developed countries. For instance, it amounted 82.5 % in Germany, 75.3 in Switzerland, 60.8 % in Australia in 1999.
- *The portion of innovative output in industry* is 1 % in Armenia (2003). It is 29 % in Germany, 31 % in Australia (in 1999), 3.5 % in Russia (2000).
- *The number of granted patents.* The establishment of the Patent Office and the National Agency of Copyright, and the patent law as well formed intellectual property protection system in Armenia. With the number of its granted patents to every 100 000th inhabitant (2.5) Armenia surpasses Ireland (1.7), New Zeeland (1.7), Spain (0.4), Italy (2.1) and falls behind the rest countries of G7, as well Island (10.2), Finland (4.5) and Southern Korea (4.4). On the other hand, Armenia lags to generate financial resources for using granted patents as well as with having institutions for that purpose. Thus, according to the number of license agreements of the National Agency of Copyright, only two contracts were signed in each of the years 2001 and 2002. As a result, the knowledge goods production is low in Armenian economy.
- *The cooperation of science and HEI.* According to the data, only the 8 % of the lecturers of state universities having scientific degree and 1.1 % of those from private universities are involved in scientific researches. Surely, on the way to a developed educational system its integration to the science and industry are prior.
- *The cooperation of the science and private sector.* The models of technoparks are widely used over the world in the purpose of making and trading R&D. There is one-technopark in Armenia (Viasphere) with 18 enterprises and around 600 specialists. It is implementing projects in the context of high technologies, including information technologies. In addition to that, in the framework of the World Bank Enterprise Incubator project, in spring 2002 the Enterprise Incubator Foundation was established with government support by the local and foreign international Armenian enterprises. At present, almost 180-200 enterprises are doing business in IT sphere, with 3-5 thousands of IT engineers excluding programmers.

Considering the existing problems in the innovation and science systems, we showed Armenia's need in the introduction of «science-innovation-economy» model, corresponding to the international criteria of fundamental and applied R&D.

According to the model (1) represents the following issues:

- Estimating priorities in R&D and innovation. Taking into consider the designed traditions, existing potential, resource on one hand, and the existing developing technological world trends on the other hand, Armenian scientific priorities could make for biotechnologies, medicine, computers etc.
- Improving the system infrastructure, for instance, renewing scientific equipment.
- Improving management of the scientific system within the following linkages:
  - ❖ Encouraging the young scientists for prior fields,
  - ❖ Introducing effective models of R&D and higher educational institutions within structural improvements of the system



(2) represents the expenditures on the science and R&D, including public, external as well as internal private sector resources.
(3) represents the scientific products implantation into production using internationally admitted trade models. For instance, by establishing techno-parks and venture capital.
(4) represents promotion of the knowledge-based fields in economy.

ICT –the pillar of knowledge-based economy.

As a matter of fact ICT is the most important pillar for the knowledge-based economy. As the economic infrastructure, ICT transforms its main cells knowledge and information and thus defines its development. Therefore, ICT development means:

- IT production (chip production, system creation), IT services' (software goods and services) and sub-sectors' development as well (cooperation and feedback approach between R&D and manufacturing infrastructures), increasing IT industry portion of GDP.
- The knowledge and information transformation in the public, corporate and social spheres of life, creating information society - the important precondition for a knowledge-based economy.

During the Soviet period, being closely linked to the Soviet military industry, Armenia produced semiconductors, mainframe computers, hardware and software. As the field with

the destroyed, the significant part of the professionals lost their qualification, the majority emigrated.

Independent Armenia inherited that system elements with long-run effects, assuring the country's comparative advantages in this field, which are:

- The higher education, especially in the fields of applied mathematics, computer engineering.
- ICT R&D sectors inherited from Soviet Union, including infrastructure.
- Significant diaspora resources.

In the transformational period, it is very important not to loose those advantages and promote their continuous developments. Armenian government, realizing that fact, with the support of international organizations developed and in 2001 admitted the ICT industry development master strategy, ICT development program and action plan, that combines the field and infrastructure continuous developments in accordance with international standards.

According to the ICT basic scores, Armenia has a weak position in the Central Asia and Europe country group, falling behind Estonia. Moreover, this pillar is described with the worst values in KEI (see picture 2).

Table 6. ICT scorecard, KI, Armenia and Estonia

Variable	**Armenia**		**Estonia**	
	(Group: Europe and Central Asia)		(Group: Europe and Central Asia)	
	actual	normalized	Actual	normalized
Total Telephones per 1,000 People, 2005	298.6	1.48	1402.1	8.89
Main Telephone Lines per 1000 People, 2005	192.5	2.59	328.4	7.78
Mobile Phones per 1,000 People, 2005	106.1	1.48	1073.7	8.89
Computers per 1,000 People, 2005	66.1	4.35	482.9	9.57
Households with Television (%), 2005	90.6	2.69	93.2	4.62
Daily Newspapers per 1,000 People, 2000	n/a	n/a	192	9.29
International Internet Bandwidth (bits per person), 2005	11.9	1.2	3565.9	9.6
Internet Users per 1,000 People, 2005	53.4	1.48	512.6	9.26
Price Basket for Internet (US$ per month), 2005	52.48	0	10.78	6.67
Availability of e-Government Services (1-7), 2006	1.82	0.83	6.45	9.58
Extent of Business Internet Use (1-7), 2006	3.2	2.4	6	9.6
ICT Expenditure as % of GDP, 2005"	n/a	n/a	n/a	n/a

Source: World Bank, KI, KAM, www.worldbank.org/kam

The ICT issues through several substation indicators.

- *Provision of population with home telephone sets per 100 households* has increased in average 4 % a year from 1999, getting to 68.6% of households in 2006.
- *Number of mobile phones' subscribers per 1000 people* have increased in average 113.7% a year from 1999, getting to 1 185 400 in 2006.
- *Internet users'* number has increased in average 26.1% a year, from 0.1% of the population in 2000 getting to 5.5% in 2006.
- *Total number of ISP providers.* There are 17 providers, with strong competition between in Yerevan, and a few offering services in rural areas (2004).
- *Internet access*. Internet-cafes are a public access point. With foreign support, Internet is also for free available in a few public libraries, mostly in Yerevan and

other big cities. The users in the main are students, university professors and researchers as well.

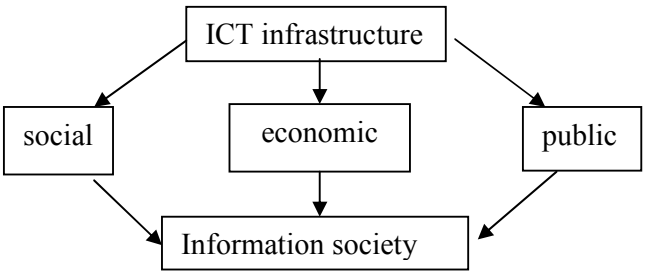
- *Internet prices. U*sually, ISP's combine time and traffic tariffs and offer flexible prices. The average price of dial-up access is almost 3.6 dollars for 100 mgb. The majority of the population cannot afford full time unlimited internet services.
- *Successful calls*. According to non-official statistics, the percentage of successful calls varies from 40% (for analogue-to-analogue line calls) to 80 % (for digital-to-digital line calls)[24].

As the statistical survey shows, the modern ways of communication are integrating into the life of Armenian population. For that purpose, Armenian government has made some steps to decrease the available restrictions. For instance, the cell phones accessibility and qualitative problems were solved with the second mobile phone operator entrance into the market. On the other hand, the problem with the Internet integration into everyday life is still available, especially outside the capital. The vital issues here concern the line phones' quality and the costs as well. On the last, it is necessary to mention, that Armentel provides international leased lines services to local ICPs. In other words, the provision of leased lines for international data transmission services (including international internet access services) is an exclusive right and obligation of Armentel. ISP's can get internet access from foreign internet service providers using Armentel setline infrastructure, thus paying additional contract cost to Armentel. As a result, Armentel continues to be the dominant internet provider for the markets.

- *Access to phones*. Mostly in Armenian enterprises the employees have limited or unlimited access to phones.
- *Internet access from workstation.* Employees of intellectual businesses, banks usually have free access to Internet.
- *The number of computers in businesses or government offices*. There is no official statistics about the computers availability in businesses. However, if there are computers, they can be accessed by the majority of staff members.
- *Electronic commerce.* With support of international organizations and government the following services are set within the ArCa system, but still their practical usage is too low:
  - Electronic Payment system
  - Online shops system
  - Card-to-Card money sent system (c4c)
  - E-banking
  - E-systems for internet auctions
- *Number and quality of government resources online*. The government resources include official web sites, containing general descriptions. For instance, there is no online interaction between the government and public, the enterprises and tax structures etc.
- *E-governance for territorial administration.* This program has been set with the UNDP recourses and Armenian Government cooperation. However, the people are not well acquainted with its advantages and almost do not use it.

As wee saw, the ICT components that are appropriate to the knowledge-based economy in accordance with the quantitative and qualitative indicators are characterized by the following structure.

[24] "Toward a Knowledge-Based Economy, Armenia", Country Readiness Assessment Report, UN, New York and Geneva, 2002.



Here the main problems concern to ICT as the economy infrastructure development, which is too low now.

Conclusions

Soviet Union could create a good model of education and science in Armenia based on the fact, that Armenians are knowledge-loving "Book" society. In fact, the soviet scientific potential was mostly centered in this country. The system collapse and thus the end of previous goals, relationship and financing on one hand, and the world modern postindustrial developments on the other hand, bring new challenges for Armenia in the context of estimating new opportunities for the further development. The main potential we have includes the qualitative human capital, science infrastructure, rich Diaspora, the nation's inclination towards knowledge.

Considering the economic growth with its qualitative indicators, it turned out that through several subjective and objective reasons the economic crash in the beginning became a significant barrier to its further possible development. The economic growth revived from 1994 and described with two figures from the beginning of the century. Meanwhile, considering the knowledge-based economy's pillars as the main qualitative indicators for economic growth (cumulated in TFP) and estimating several indicators for their description, it was clear that the following issues accompanied Armenian economic growth:

1. Human capital physical and moral deterioration because of a/ the migration of young, b/ the quality decrease of the educational system, c/ the inaccessibility of the education in the result of the existing poverty.
2. Continuous renewal of the physical capital in economy by introduction of new infrastructures, technologies, resulting to the TFP growth. Through the last fact, the country dropped to a higher effective stage of the competitiveness. Still, through their implantation, assimilation and use, the country is behind the rest dynamically developing countries.

In this context, the following key policy requirements are met:

- Creating e-society based on book-society within rapid development of ICT infrastructure and its assimilation in the social, public and economic aspects of life, such as e-commerce, e-governance, e-learning etc.
- Encouraging education, science and innovation with new strength and quality within a reconstruction of new "education-innovation-economy" model, that will be a base for passing to the third, innovative level of competitiveness.
- Further institutional reforms in the mid-term period, increasing the economic effectiveness.
- Using Diaspora potential.

- Coordination the activities of different government institutions and donor initiatives.

These steps shall be directed to the creation of a knowledge-based economy model in Armenia, thus increasing the country's economic competitiveness, resulting to a qualitative economic growth, based on TFP.

ANNEXES

Picture 1. The KEI of Armenia and Estonia

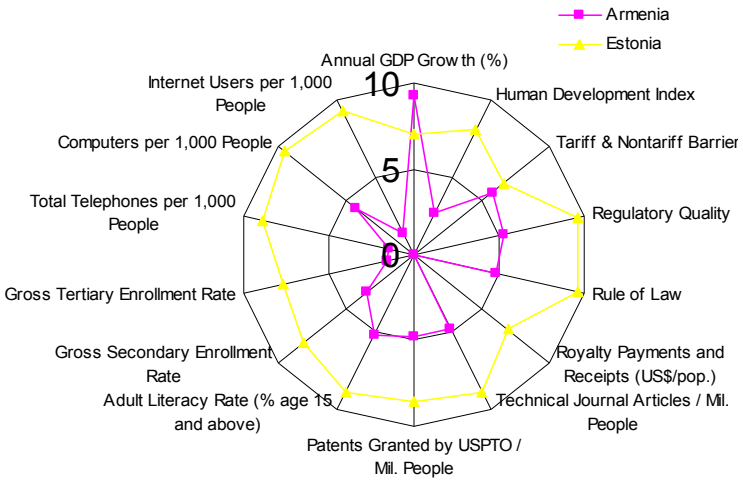


Table 4. The KEI of Armenia and Estonia

Variable	Armenia (most recent)	Armenia 1995	Estonia (most recent)	Estonia 1995
Annual GDP Growth (%)	9.26	6.3	7.04	6.3
Human Development Index	2.69	2.27	8.08	n/a
Tariff & Nontariff Barriers	5.77	n/a	6.54	8.46
Regulatory Quality	5.19	2.59	9.63	9.63
Rule of Law	4.81	4.44	9.63	8.15
1 pillar: Economic Incentive and Institutional Regime (average)	*5.26*	*3.52*	*8.60*	*8.75*
Royalty Payments and Receipts (US$/pop.)	n/a	n/a	6.96	5.29
Technical Journal Articles / Mil. People	4.81	5.19	8.89	7.78
Patents Granted by USPTO / Mil. People	4.81	4.07	8.52	8.15
2 pillar: Innovation (average)	*4.81*	*4.63*	*8.12*	*7.07*
Adult Literacy Rate (% age 15 and above)	5.19	3.6	8.89	4.8
Gross Secondary Enrollment Rate	3.46	3.46	8.08	9.62
Gross Tertiary Enrollment Rate	1.54	0.77	7.69	7.69
3 pillar:Education (average)	*3.40*	*2.61*	*8.22*	*7.37*
Total Telephones per 1,000 People	1.48	5.19	8.89	9.26
Computers per 1,000 People	4.35	1.5	9.57	9
Internet Users per 1,000 People	1.48	4.44	9.26	9.26
4 pillar: ICT (average)	*2.44*	*3.71*	*9.24*	*9.17*
Knowledge Economy Index (average)	**4.64**	**3.84**	**8.22**	**7.73**

Source: World Bank, KAM, (K4D), URL: www.worldbank.org.kam

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E-resourses

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