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INPUT - OUTPUT INDICATORS OF KNOWLEDGE-BASED ECONOMY AND TURKEY

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ABSTRACT

This paper aims to present a new and more effective approach to examine statistical picture of Knowledge Based Economy. Reviewing and criticizing the methodologies presented by international economic organizations, we have classified relevant statistics under the components of "input" and "output" indicators. Such a classification setting up "causal connection" among the indicators will enable us to analyze the dynamic of new economy in more effective manner. Furthermore, this kind of classification shed light on the economic policies towards Knowledge-Based Economy much more. In order to find out it's placement in New Economy according to classification of indicators presented in this study, Turkish Economy has also been examined by comparison with the cases of European Union (EU 15) and OECD countries.

1. INTRODUCTION

Review of economic history illustrates a number of transformations in economic source of production. Lately, the concept of "knowledge" as an engine of economic development has gained huge significance. This emerging economic system due to its reliance on knowledge is generally defined as "Knowledge Based Economy" (KBE). Wealth creating assets shift from physical things to intangible resources based on knowledge. New Economy results from a fuller recognition of the importance of knowledge in all aspects of the economy. OECD also defined KBE as "the economies which are directly based on the production, distribution and use of knowledge and information" (OECD, 1996: 3). Thus, it is indicated that generation and the exploitation of knowledge have come to play the predominant part in the creation of wealth in KBE.

However, knowledge has always been understood to contribute to economic growth. Indeed, the economy has always been driven by knowledge leading to innovation and technical change. And knowledge-based institutions have helped store and share knowledge for centuries. But in recent times the significance attributed to knowledge in economic development has markedly increased. What we see today is essentially more of the same but operating on a bigger scale and at a faster pace. "Economy is more strongly and more directly rooted in the production, distribution and using of knowledge than even before" (Foray and Lundwall, 1996: 27). Therefore the knowledge-based economies today complement efforts to improve economy-wide productivity through enhancement Total Factor Productivity. The studies on analyzing the performance of industries show that knowledge-intensive industries have a higher value-added multiplier and higher productivity compared with traditional or non-knowledge intensive industries much more (Lee and Gibson, 2002: 306).

Accordingly analytical approaches now are being developed so that knowledge can be included more directly in production functions of growth theories. Investment in knowledge can increase the productive capacity of the other factors of production as well as transform them into new products and process. And since these knowledge investments are characterized by increasing returns, they are the key to long-term economic growth (OECD, 1996: 11). Recently there has been a growing interest in the contribution of knowledge to total factor productivity growth. Economists have already developed new growth theories to explain the forces which drive long-term economic growth (Romer, 1994).

However, the concept of knowledge is generally complicated and hard to quantify. Because of this reason our understanding of what is knowledge-based economy is constrained by the extent and quality of the available knowledge-related indicators. Indeed, one can no longer assume that the overwhelmingly available information would answer the research questions precisely since the observations and indicators of KBE are knowledge intensive. The knowledge economy may remain a vague concept without measurable definitions or effective classification of indicators. It might be hard or impossible to offer a set of practical evidence based policy recommendations to policy makers. For all that we need to measure and classify the indicators of the knowledge economy in a better way. In other words, improvement of measures or classifying methods for knowledge-based economy is crucial to understand its dynamics and produce more effective policies.

Accordingly, this study aims to present a suite of statistical indicators which capture the essence of a KBE. Before statistical indicators can be developed, a framework on the subject (dimensions) is needed. These dimensions would enable relevant statistical indicators to be grouped, organized and thus analyzed in a logical manner. For this aim, first section reviews the existing frameworks on KBE presented by different international economic organization to draw up an appropriate framework. Later, we will develop main thematic areas in relation to indicators of KBE. In this section, the indicators of a knowledge-based economy are examined in terms of inputs and outputs, Themes can be used to classify existing indicators and improve our understanding and appraisal of the knowledge economy. Finally, using this analysis we will try to find out Turkey's placement in knowledge-based economy by comparison with the cases of European Union countries.

2. REVIEW OF INTERNATIONAL INSTITUTIONS' METHODOLOGIES

The powerful argument of a transition to a "knowledge-based economy" implies a systems transformation at the structural level across nations. Following this lead the focus of the efforts at the international economic organizations has been to develop indicators of the relative knowledge-intensity of new economies. Therefore, there have been a lot of discussions on the determining the indicators of KBE at the international level. However, there is still no internationally agreed framework for measuring KBE. Different frameworks have been developed by international organizations, including World Bank (WB), Organization for Economic Co-operation and Development (OECD), European Union (EU), and Asia Pacific Economic Cooperation (APEC). This section reviews the frameworks or methodologies asserted by different international economic organizations.

World Bank Institute's Knowledge for Development (K4D) Program has developed the *Knowledge Assessment Methodology* (KAM) in 1999 with the object of measuring and analyzing the knowledge economy. This methodology is based on the supposition that the knowledge economy comprises four pillars: Economic Incentive and Institutional Regime, Education and Human Resources, Innovation System and Information and Communication Technology (World Bank Institute, 2007: 1). Four knowledge economy pillars are necessary for sustained creation, adoption, adaptation and use of knowledge in domestic economic production, which will consequently result in higher value added goods and services. KAM is based on 83 structural and qualitative variables that serves as proxies for the four knowledge economy pillars: Overall Economic Performance (9), Economic Incentive and Institutional Regime Index (19), Innovation System Index (24), Education and Human Resources Index (19) and ICT Index (12). There are two frequently used modes of the KAM: The Basic Scorecard and Knowledge-based Economy Index.

Table 1: World Bank Knowledge Economy Indicators (Basic Scorecards)

1. Performance 1.1 Average annual GDP growth (%) 1.2 Human Development Index
2. Economic Incentive and Institutional Regime 2.1 Tariff and non-tariff barriers 2.2 Regulatory Quality 2.3 Rule of Law
3. Education and Human Resources 3.1 Adult Literacy rate (%age 15 and above) 3.2 Secondary Enrolment 3.3 Tertiary Enrolment
4. Innovation System 4.1 Researchers in R-D, per million populations 4.2 Patent Applications granted by the USPTO, per million populations 4.3 Scientific and technical journal articles, per million populations
5. Information Infrastructure 5.1 Telephones per 1000 persons, (telephone mainlines + mobile phones) 5.2 Computers per 1000 persons 5.3 Internet Users per 10000 persons

Source: World Bank Database, The Knowledge Assessment Methodology (KAM), website (www.worldbank.org/kam)

The *KAM Basic Scorecard* provides an overview of the performance of a country in terms of the pillars of the knowledge economy under 5 sub-titles. It includes 14 standard variables: two performance variables and 12 knowledge variables, with 3 variables representing each of the 4 pillars of knowledge economy. The Table-1 shows these indicators. The knowledge economy can also be quantified by means of a numerical index known as the *Knowledge Economy Index (KEI).* This calculated from the data of twelve indicators, three of which form a single pillar. The KAM Knowledge Economy Index (KEI) is an aggregate index that represents the overall level of development of a country or region in the Knowledge Economy. It summarizes performance of the four Knowledge Economy pillars and is constructed as the simple average of the normalized values of the 12 knowledge indicators of the basic scorecard. The basic scorecard can be thus seen as a disaggregated representation of the Knowledge Economy Index.

Another comprehensive analysis for KBE came from Organization for Economic Co-operation and Development (OECD). The concept of knowledge-based economy was firstly used in a document written for the meeting of the Committee on Science and Technology Policy in 1995. This paper discussed two themes: new growth theory and innovation performance in the framework of knowledge-based economy (OECD, 1995: 3). In 1996, after defining the knowledge economy as "economies which are directly based on the production, distribution and use of knowledge and information", it was suggested that improved indicators for the KBE are needed for the following tasks (OECD, 1996: 20); Measuring knowledge inputs, Measuring knowledge stocks and flows, Measuring knowledge outputs, Measuring knowledge networks, Measuring knowledge and learning.

Thus, OECD attempted to measure knowledge directly. However there are a lot of challenges in order to measure KBE with this way because of systematic obstacles to the creation of intellectual capital accounts to parallel all accounts of conventional fixed capital. Although it is at the heart of the KBE, knowledge itself is particularly hard to quantify and also price. To overcome the challenges, firstly indicators of knowledge creation and distribution at the firm level were suggested to be collected through innovation surveys. Later indicators for measuring knowledge and learning are needed to reflect efficiency and equity of education and training. In this regards, OECD developed human capital indicators with the aim of measuring private and social rates of return to investment in education and training (Leung, 2004: 6).

The first measurement exercise of OECD concerning KBE appeared in the form of a scoreboard of indicators in 1999. This document was prepared for the 1999 meeting of the Committee for Scientific and Technological Policy at Ministerial level. In this study nine of the thirty-two indicators were specifically located and analyzed under the concept of knowledge-based economy (OECD, 1999). As can be seen from Table-2, measurement covers the other four dimensions named: Information and Communication Technology, Science and Technology Policies, Globalization, and Output and Impact. Publication noted especially that ICT has been a major foundation of the KBE since its enormous and continuing advances make it possible to store, process and circulate an increasing amount of data rapidly and inexpensively. On the other hand, it argues that science and technology are a major aspect of globalization of the economy. ICT has made possible the globalization all of the form of life including scientific and technological activities. In other words Scientific and Technological activities are also increasingly performed on an international scale. Accordingly, innovation no longer depends solely on how firms, universities, research institutes and regulators perform, but increasingly on how they work together. Thus both development of ICT and globalization process have great importance on the diffusion and use of information and knowledge as well as its creation in the form of scientific and technological. To sum up, as can be also seen from the dimensions and their indicators in Table-2, OECD focus on interaction and positive externalities of this interaction among ICT development, Science and Technology improvement and increasing Globalization while determining the basic facts of KBE.

Beside the publication, concerning to determination of KBE's indicators above, there are also two significant issues: Growth project Reports and Industry and Technology Scoreboard of Industries. OECD's *Growth Project Reports* can probably be described as presenting a policy analysis rather than a statistical framework (OECD, 2001)**.** However, they provide a structure which can be used to describe the dimensions of a statistical framework. Its policy recommendations cover five broad areas; Stable and Open Macro-economic Environment, Diffusion of ICT, Fostering Innovation, Investing in Human Capital, Stimulating Firm Creation. *Industry and Technology Scoreboard of Indicators* are published by OECD every 2 year and includes a series of economic and science and technology indicators. OECD STI Scoreboard consists of 76 indicators under the 5 sub-titles: R&D and Innovation (15), Human Resources in Science and Technology (10), Patents (11), ICT (17), Knowledge Flows and the Global Enterprise (12), The Impact of Knowledge on Productive Activities (11). (OECD, 2005).

Table 2: OECD Knowledge Economy Indicators

1. Knowledge-Based Economy 1.1 Knowledge Investment (education, R&D and software) as % of GDP 1.2 Education of the adult population as % of the population aged 25-64 1.3 R&D expenditure as a percentage of GDP 1.4 Basic research expenditure as a percentage of GDP 1.5 Expenditure of Business R&D in domestic product of industry 1.6 Expenditure of Business R&D in manufacturing 1.7 Share of services in R&D expenditure 1.8 Expenditure on innovation as a share of total sales 1.9 Investment in venture capital as a percentage of GDP
2. Information and Communication Technology 2.1 ICT spending as % of GDP 2.2 PC penetration in households 2.3 Number of internet host per 1000 inhabitants 2.4 Percentage share of ICT industries in GDP 2.5 Share of ICT in patents granted by USPTO
3. Science and Technology Policies 3.1 Publicly funded R&D as % of GDP 3.2 Government R&D expenditure on health-defense-environment 3.3 Government R&D expenditure in total R&D expenditure 3.4 Business R&D expenditure in total R&D expenditure 3.5 Share of Government-Business R&D expenditure financed together 3.6 Tax subsidies rate for R&D
4. Globalization 4.1 Share of foreign affiliates in R&D 4.2 Share of foreign and domestic ownership in total inventions 4.3 Number of international technological alliances 4.4 Percentage of scientific publications with a foreign co-author 4.5 Percentage of patents with a foreign co-investor

5. Output and Impact
5.1 Scientific publications per 100 000 population
5.2 Share of countries in total EPO patent application
5.3 Share of firm creating any innovative output
5.4 GDP per employed person
5.5 Share of knowledge-based industries in total value added
5.6 Share medium-high technology industries in manufacturing export
5.7 Technology balance of payments as a percentage of GDP

Source: OECD, (1999), The Knowledge-Based Economy: A Set of Facts and Figures.

After World Bank and OECD, European Commission also developed a methodology called *European Innovation Scoreboard* as a measurement of new economy. It includes a set of indicators which together give an assessment of Europe's innovation performance. European Innovation Scoreboard focused on Innovation process basically while determines the indicators of knowledge-based economy. The scoreboard is designed to capture the main drivers of a knowledge-based economy plus several measures of innovation outputs. As can be seen from Table-3, European Innovation Scoreboard indicators are distributed among five categories under two sub-titles such as Innovation Input and Innovation Outputs. Dimensions under Innovation Output consist of Innovation Drivers (5), Knowledge Creation (5), and Entrepreneurship (6) while Innovation Inputs covers two dimensions like Application (5) and Intellectual Property Rights (5). This Scoreboard issues for a cross- country comparison of the innovation indicators to help identify national strength of member countries rather than determining the indicators of knowledge-based economy exactly. European Innovation Scoreboard has been published every year since 2001. Besides this scoreboard European Union publish Global Innovation Scoreboard in order to give possibility to member's country for compare their innovation capabilities with other countries in the world. Global Innovation Scoreboard includes only 12 indicators as summary version of European Innovation Scoreboard.

Table 3: European Union Knowledge Economy Indicators

(European Innovation Scoreboard)

1. Innovation Drivers (5) 1.1 New S&E graduates per 1000 population aged 20-29 1.2 Population with tertiary education per 100 population aged 25-64 1.3 Number of broadband lines per 100 population 1.4 Participation in life-long learning per 100 population aged 25-64 1.5 Percentage population age 20-24 completed secondary education
2. Knowledge Creation (5) 2.1 Public R&D expenditures (% of GDP) 2.2 Business R&D expenditures (% of GDP) 2.3 Share of medium high-tech and high-tech R&D 2.4 Share of enterprises receiving public funding for innovation 2.5 Share of University R&D expenditures financed by business sector
3. Innovation and Entrepreneurship (6) 3.1 SMEs innovating in-house (% of SME) 3.2 Innovative SMEs co-operating with others (% of SMEs) 3.2 Innovative expenditures (% of turnover) 3.4 Early-stage venture capital (% of GDP) 3.5 ICT expenditure (% of GDP) 3.6 SMEs using non-technological change (% of SMEs)
4. Application (5) 4.1 Employment in high-tech services (% of total workforce) 4.2 Exports of high technology products as share of total exports 4.3 Sales of new-to-market products (% of turnover) 4.4 Sales of new-to-firm not new-to-market products (% of turnover) 4.5 Employment in medium-high tech manufacturing (% of total)
5. Intellectual Property (5) 5.1 New European Patent Office patents per million 5.2 New United States Patent and Trademark Office per million 5.3 New Triad patents per million population 5.4 New community trademarks per million population 5.5 New community industrial designs per million population

Source: European Innovation Scoreboard, 2010, European Commission

Final comprehensive methodology concerning to indicators of knowledge-based economy was presented by Asia Pacific Economic Cooperation (APEC). The APEC framework was developed as part of a Project, "*Towards Knowledge-based Economies in APEC*", commissioned by the APEC Economic Committee in mid-1999. The aim of the Project was to provide the analytical basis useful for promoting the effective use of knowledge, and the creation and dissemination of knowledge among APEC economies. APEC KBE framework consists of 26 indicators under the four dimensions shown in Table -4.

APEC Economic Committee also analyzed the underpinnings of the knowledge-based economy and the four dimensions deduced that (APEC, 2001: 12-13);

- Pervasive innovation and technological change, supported by an effective national innovation system.
- Pervasive human resource development, in which education and training are of high standard, widespread and continue "throughout a person2s working life".
- Efficient infrastructure, operating particularly in information and communications technology (ICT).
- A business environment supportive of enterprise and innovation.

Table 4: APEC Knowledge Economy Indicators

1. Business Environment 1.1 Knowledge based Industries as % of GDP 1.2 Services Exports as of GDP 1.3 High-Tech Exports as of GDP 1.4 Foreign Direct Investment inward flow as % of GDP 1.5 Government transparency rating by World Competitiveness Yearbook 1.6 Financial transparency rating by World Competitiveness Yearbook 1.7 Competition policy rating by World Competitiveness Yearbook 1.8 Openness rating by World Competitiveness Yearbook
2. ICT Infrastructure 2.1 Number of mobile telephones in use per 1000 inhabitants 2.2 Number of telephone mainlines in use per 1000 inhabitants 2.3 Number of computers per 1000 inhabitants 2.4 Number of internet users as % of population 2.5 Internet hosts per 10000 2.6 Expected e-commerce Revenues, M$US

3. Innovation System
3.1 Scientists Engineers in R&D per million of the population
3.2 Full-time researchers per million of the population
3.3 Gross Expenditure on R&D (% of GDP)
3.4 Business Expenditure on R&D (% of GDP)
3.5 US Patents per annum
3.6 The number of technological cooperation among companies
3.7 The number of technological cooperation between company-university
4. Human Resource Development
4.1 Secondary enrolment (% of age group)
4.2 Natural Sciences Graduates per annum
4.3 Knowledge Workers (% of labor force)
4.4 Newspaper (per 1000 inhabitants)
4.5 Human Development Index

Source: APEC, (2000), "Towards Knowledge-Based Economies in APEC", APEC Economic Committee, p.195.

3. INPUT AND OUTPUT INDICATORS FOR KNOWLEDGE ECONOMY

As seen from previous section, to understand the degree to which an economy is a KBE, relevant statistical indicators have to be considered by different economic organization. The knowledge economy is intensively thought of and sometimes defined in terms of knowledge industries based ICT production or usage and /or high shares of highly educated labor. Each characteristic is populated by several statistical indicators. The methodologies of international organizations can be only viewed as a "descriptive" or "presentation" framework using different statistical indicators rather then trying to view those indicators within context of a statistical framework (Leung, 2004:5). The challenge here is how to combine various measures of the same concept and determine the interaction among them.

We set out a wide range of measures grouped under inputs and outputs in order to overcome these challenges. While different sets of statistical indicators have been selected and grouped according to different aspects in the above frameworks of international organization, they can be grouped into two dimensions: Input Indicators and Output Indicators. In other words, to fully understand the working of the KBE, classification of indicators such as input and output are required beyond the conventional classification of international organization presented in previous section. Input indicators show to investment or capacity building efforts for each dimension towards knowledge-economy transformation. On the other hand, output indicators determine what degree of knowledge economy a country has. Thus, output indicators illustrate the impact of input indicators or performance of a country towards knowledge economy.

Measuring knowledge economy in accordance with the input/output framework has also been need basic dimensions for consideration. Such an approach can aid analysis of basic properties of knowledge-based economy both in general and specific level. If we look at the OECD's definition of knowledge-based economies (economies which are directly based on the production, distribution and use of knowledge), it is clear that basic dimensions should consist of "knowledge production", "knowledge distribution" and "knowledge utilization" (Godin, 2006: 21). We also add "knowledge acquisition" as another dimension, although it is not in OECD's definition of knowledge-based economy, because in the globalization process presents a lot of opportunities to economies for getting the new knowledge from foreign resources. Thus, to get new knowledge, it is not required only to produce them. But also it is possible to acquire new knowledge from abroad in different ways in globalizing world. Finally Table-5 presents the "Input and Output Indicators" of Knowledge-based Economy concerning to four dimensions: "Knowledge Acquisition", "Knowledge Production", "Knowledge Distribution" and "Knowledge Utilization".

In this framework, the accumulation of knowledge, which is the basic dynamic for development in new economy, can be provided by both "Acquisition" and "Production". Acquisition of Knowledge can be perfectly provided by the way of making an economy fully openness to world in trade and Foreign Direct Investment (FDI). Thus openness degree of an economy, as input indicators, depends on the ratios of a country's trade (exports plus imports) and FDI inflows to its GDP. On the other hand, competitiveness level of an economy calculated by World Competitiveness Yearbook is accepted as an output indicator concerning to knowledge acquisition. Production of Knowledge, which is the other part of accumulation of knowledge, is required to invest on Scientific R&D. The share of expenditure on Scientific R&D in GDP and number of scientists are input indicators of the dimension of knowledge production. In this dimension, "scientific publications" is selected as output indicators.

The accumulation of knowledge leads to the creation of wealth only if the knowledge is effectively distributed and utilized. For this reason, distribution and utilization of knowledge are selected as other two basic dimensions. Distribution of Knowledge includes all form of disseminating or diffusion of knowledge by the way of Information and Communication Technologies (ICT) and transmission of knowledge by the way of education. Expenditures on the levels of tertiary and long-life education are input indicators while tertiary education enrolment and participation ratio of life-long learning shows output indicators. ICT spending as % of GDP is input indicators of knowledge distribution dimension while both Personnel Computer (PC) penetration and number of internet hosts per 1000 population indicate the outputs.

Utilization of Knowledge covers absorbing and transferring of knowledge from scientific form to technological form by the way of Technological R&D. OECD defines R&D to "comprise of creative work undertaken on a systemic basis in order to increase the stock of knowledge and the use of this stock of knowledge to devise new applications. In this approach, Scientific and Technological R&D are defined together. However, in our approach, we separates Scientific and Technological R&D each other. "R&D towards increasing the stock of knowledge" means Scientific R&D and this indicator is located in dimension of knowledge production as an input indicator. On the other hand, "R&D towards using of knowledge stock to devise new application" connotes "Technological R&D" and put in the dimension of knowledge utilization as an input indicator with number of engineers in per 1000 000 population. Patent application to European Patent Office (EPO), the shares of production and export of high-tech sectors are output indicators.

Table 5: Input and Output Indicators for Knowledge Economy

INDICATORS **DIMENSIONS**	**Input Indicators**	**Output Indicators**
Knowledge Acquisition	1. Export + Import / GDP 2. Foreign Direct Investment inward flow as % of GDP	1. Competitiveness Rating (World Competitiveness Yearbook)
Knowledge Production	3. Scientific R&D expenditure as a % of GDP 4. Number of Scientists in per 1000 000 population	2. Scientific Publications per 100 000 population
Knowledge Distribution	5. Tertiary Education Expenditure as a % of GDP 6. Long life learning Expenditure as a % of GDP 7. ICT spending as % of GDP	3. Tertiary Education per 1000 pop. 4. Participation life-long learning per 100 population 5. PC penetration per 1000 6. Number of internet host per 1000
Knowledge Utilization	8. Technological R&D expenditure as a % of GDP 9. Number of Engineers in per 1000 000 population	7. Share of patent application to EPO in total 8. Exports of high-tech products as a % of total 9. Production of high-tech sector as a % of total

4. TURKEY AND KNOWLEDGE-BASED ECONOMY

In this section, our aim is to find out Turkey's placement in Knowledge-based Economy using knowledge measurement system developed in previous part. We also analyze the relevant variables in Turkey comparing with the average values in European Countries that is EU 15 and OECD Countries. In this framework, one of the major obstacles in assessing precisely the Turkey's comparative position among other countries in the knowledge based economy is non availability of data on key parameters. Consequently, we have to combine some variables and drop some others because of deficiency of variables especially relating to Turkey. Table-6 and Table-7 present these new formulations of input and output indicators separately. Because of non-availability of variables concerning R&D expenditures on Science and Technology and the number of engineer and scientist separately, R&D Expenditure and Personnel in both side combines under the dimension of Knowledge Production and Utilization. Also tertiary and long-life learning education expenditures are calculated as total education expenditure under the dimension of knowledge distribution.

Looking at the tables, both input and output indicators under the dimension of Knowledge Acquisition show better value compared to other dimensions. The gaps between the variables of Turkey and EU 15 and OECD countries are lower in this dimension compared to other dimensions. Turkey adapts better relatively to the new economy in the form of integrating to international economic system. Turkey has the worst indicators in the field of knowledge production and utilization against other countries both in input-based and especially out-based. Indeed, national patent application per million populations in 2008 and Export of High-tech Products as a % of total in 2008 are 29 and 2 and quite lower than the relevant average values of EU 15 and OECD

countries. The average number of patent application per million populations and export of high-tech products as a % of total export are 201,2 and 13,73 in EU 15 countries while same value equal 328,1 and 13,78 in OECD countries, respectively.. In addition, difference of the values in between Turkey and other countries in output indicators is the much bigger than input indicators. This also shows the low output/input ratio in the dimension of knowledge production and utilization and indicates that Turkey has a low level of productivity or efficiency in using the inputs of knowledge production and utilization. Other trouble value concerning with output-based indicators for Turkey relates to "Life Long Learning per 100 population aged 25-64" in 2010 under the dimension of knowledge distribution. The value of this ratio is only 1, 80 in Turkey while 12,04 and 11,62 in average value of EU 15 and OECD countries, respectively. Industries need flexible worker's ability in modern knowledge economies because of increasing the accelerating speed of production technologies permanently. High ratios of public expenditure and participation of population in life-long learning programs would be the perfect complement to deficiencies in labor market in today. People needs continuously upgrade and adapt their skills to efficiently create and use of knowledge. From this point of view, policy makers in Turkey should give much more importance to life-long learning beside basic and tertiary education for improving human capital.

Table 6: Input Indicators of Knowledge Economy for Turkey and EU

Countries	Knowledge		Knowledge Production		Knowledge	
	Imp.+Exp. /GDP (2008)[a] (%)	FDI inflow / GDP (2009)[b] (%)	RD Expen-Diture/GDP (2008)[c] (%)	RD Workers per million (2008)[d] (%)	Education. Spending % share of GDP (2009)[e]	ICT Spending % share of GDP (2009)[f]
Australia	24,5	2,95	2,35	4259	4,4	n.a
Austria	56,5	3,02	2,67	4141	5,5	2,0
Belgium	85,3	12,89	1,96	3517	6,4	2,4
Canada	34,3	1,68	1,84	4535	4,8	1,7
Chile	34,8	8,00	0,33	355	4,0	0,3
Czech Rep.	74,8	1,51	1,47	2870	4,1	1.4
Denmark	53,7	1,26	2,87	6496	7,7	2,9
Estonia	45,7	8,01	1,29	2695	5,7	1,4
Finland	45,0	2,97	3,72	7689	6,1	2,9
France	27,7	1,32	2,12	3690	5,6	2,5
Germany	44,1	1,18	2,68	3667	4,6	2,6
Greece	28,3	0,75	0,58	1829	2,3	1,2
Hungary	81,7	3,26	1,01	1846	5,1	1,6
Iceland	45,9	0,52	2,64	7428	7,5	2,6
Ireland	78,3	11,90	1,45	3342	5,7	2,4
Israel	45,2	2,27	4,64	1450	5,5	2,7
Italy	29,1	0,78	1,23	1614	4,6	1,9
Japan	17,4	0,24	3,45	5189	3,4	2,8
South Korea	53,5	0,27	3,36	3476	4,8	n.a
Luxemburg	137,8	3,98	1,56	4499	5,7	1,5
Mexico	26,1	1,79	0,37	347	3,1	n.a
Netherlands	64,4	4,63	1,76	3074	5,5	2,8
New Zealand	33,9	4,15	1,02	3452	6,1	n.a
Norway	37,3	1,66	1,73	5643	5,9	n.a
Poland	28,9	3,02	0,60	1618	5,1	1,6
Portugal	33,9	1,15	1,50	3900	4,9	2,1
Slovak Rep.	76,8	0,4	0,47	2313	3,6	1,4
Slovenia	45,8	1,31	1,65	3484	5,2	1,6
Spain	29,8	0,58	1,35	2901	4,6	1,8
Sweden	43,2	2,68	3,30	5320	6,8	2,9
Switzerland	43,5	5,95	3,40	4320	5,24	n.a
U. K.	28,3	3,36	5,40	4112	1,77	3,7
U. S.	11,9	1,13	5,51	4673	2,79	3,3
EU 15	52,36	3,49	2,27	3986,1	5,18	2,37
OECD	46,89	3,04	2,16	3628,6	4,97	2,02
TURKEY	39,7	1,37	0,72	745	2,9	0,9

[a] Calculated by using OECD Database (website: http://stats.oecd.org)

[b] Calculated by using World Bank Database (website: http://data.worldbank.org)

[c, d, e] Obtained from World Bank Database (website: http://data.worldbank.org)

[f] Obtained from Eurostat, European Commission Database, (website: http://epp.eurostat.ec.europea.eu)

Table 7: Output Indicators of Knowledge Economy for Turkey and EU

Countries	Knowledge Acquisition	Knowledge Production and Utilization			Knowledge Distribution			
	Competi-tiveness Rating (2010)[a]	Scientific. Publicatio n per million people (2009)[b]	Patent Application per million people (2008)[c]	High Tech. Export as % of total (2008)[d]	Tertiary Education per 100 aged 25-64 (2007)[e]	Lifelong Learning per 100 aged 25-64 (2010)[f]	PC Using % of as aged 25-64 (2009)[g]	Internet Host % of as aged 25-64 (2009)[h]
Australia	92,17	894	129	12	33,0	na	76,3	74,2
Austria	84,08	602	283	11	17,6	13,2	76,5	73,5
Belgium	73,58	730	66	9	31,8	6,8	77,0	76,2
Canada	90,45	867	153	16	47,0	na	84,2	80,3
Chile	69,66	111	34	3	10,1	na	42,8	38,8
Czech Rep.	65,44	393	79	13	13,5	3,2	67,5	64,4
Denmark	85,58	1060	304	18	34,7	14,3	87,9	86,8
Estonia	62,64	398	58	6	32,4	9,8	72,5	72,4
Finland	80,00	1022	361	14	35,1	23,1	85,3	82,5
France	74,37	515	221	23	26,2	7,2	74,3	71,5
Germany	82,73	547	508	15	23,9	7,9	82,8	79,3
Greece	52,30	495	70	9	22,2	2,9	49,0	44,5
Hungary	54,12	255	76	25	17,7	3,1	64,8	61,8
Iceland	65,06	776	213	31	29,5	25,1	94,0	93,5
Ireland	78,14	565	181	24	30,8	10,2	69,7	67,4
Israel	80,32	851	198	18	24,6	na	67,6	63,1
Italy	56,32	434	147	7	12,9	6,3	51,4	48,8
Japan	72,09	592	2307	19	40,5	na	66,2	78,1
South Korea	76,24	440	2653	24	32,9	na	82,9	81,6
Luxemburg	86,86	222	108	10	24,0	8,5	88,5	87,3
Mexico	51,48	43	31	14	15,4	na	36,2	28,3
Netherlands	85,65	915	151	21	30,3	12,9	90,7	89,6
New Zealand	78,53	808	365	9	38,3	na	82,6	79,7
Norway	89,98	860	252	16	32,9	19,3	92,7	92,1
Poland	64,48	198	76	6	17,9	5,3	62,5	59,1
Portugal	57,09	384	57	4	13,5	4,7	53,9	48,3
Slovak Rep.	51,09	216	32	6	14,2	3,3	78,1	75,2
Slovenia	48,68	652	187	5	15,2	13,9	67,4	64,3
Spain	58,75	478	76	6	28,5	10,4	65,8	62,6
Sweden	90,89	1076	218	13	30,5	32,4	91,8	90,8
Switzerland	96,12	1167	240	26	29,9	26,8	81,3	78,3
U. K.	76,80	772	267	22	30,5	19,9	85,9	83,6
U. S.	99,09	709	725	21	39,5	na	74,3	68,4
EU 15	74,87	654,46	201,2	13,73	26,16	12,04	75,36	72,84
OECD	70,65	607,48	328,1	13,78	26,57	11,62	73,46	71,1
TURKEY	51,11	118	29	2	9,7	1,8	37,9	36,4

[a] The Competitiveness Yearbook 2010, IMD p.19.

[b, c, d] World Bank Database, (website: http://data.worldbank.org)

[e] OECD Database (website: http://stats.oecd.org)

[f] European Innovation Scoreboard 2010, European Commission, p.57

[g, h] International Telecommunication Union, ICT Database, (http://www.itu.int/ITU - /ict/publications/world)

5. CONCLUSION

One of the major obstacles in assessing precisely the level of knowledge-based economy is non availability of agreement on key parameters. There is a huge need for analysis, both in understanding its characteristics and dynamics, and in identifying the most appropriate routes for policy development. The aim of this study is to present a new methodology in order to better capture and measure the KBE.

We draw up a new indicators set for KBE by reviewing the existing frameworks on KBE issued by different international economic organization. We set out a range of inputs and outputs measures grouped under four dimensions. Each dimension is basically derived from based on the acquisition, production, and distribution and utilization of knowledge which is basic engine of development in new economy. These dimensions include relevant statistical indicators in the form of input-based and output-based. Thus nine knowledge leading indicators and nine knowledge driven outcomes are determined to comprehensively define and characterize the knowledge-based economy.

After new analytical framework was presented, Turkish Economy has been analyzed in order to find out its placement in new economy. Figures are much more unfavorable for Turkey concerning to dimension of knowledge production and utilization. Output/input ratio is also quite low in this dimension since output-based indicators are much worse than input-based indicators. Therefore, policy makers should basically focus on the activities increasing the efficiency of knowledge production and utilizing inputs for successful transformation of Turkey towards knowledge-based economy. Beside it seems that life-long learning policies needs special policy interest in Turkey because of relatively its low level value. In period of rapid technological change of new economy, it is essential to increase adult and worker participation in life-long learning beyond basic and tertiary education.

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