SCIENCE AND TECHNOLOGY POLICIES IN THE ADJUSTMENT PROCESS WITH EUROPEAN UNION

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This paper focuses on technology and competition policies in the emerging countries. We present an analysis of interrelationship between technology and competition within evolutionary approach in three dimensions: (1) International Division of Labor, (2) Global Market System, (3) Dependency. Government intervention in the technology and competition processes is vital for developing countries. Moreover, national policies are not adequate, common acts applied by inter and supra national institutions are necessary. Through this aspect, documenting the common science and technology policies applied and results achieved in European Union and Turkey, we compare Turkey with new member states of EU.

Key Words: Technology, International Division of Labor, Competition Policies.

JEL: O34, O38,

1. INTRODUCTION

In today’s globally integrated world, technological capabilities –consequently competitive power– is the key factor determining the position of a country in the international division of labor. The present level of technological accumulation and creativity makes it impossible to think of technology as an exogenous variable. From an evolutionary aspect, the interaction between competition and technological progress secures the permanence of the market system. On the other hand, because technological capabilities are determined by existing accumulation of knowledge; the more technological power a country has, the more creative a country is. This implies that countries lacking knowledge assets depend on those generating technologies. Growing dependency gradually deteriorates the income distribution of the world; in other words, divergence emerges. Also, it is observable that when an industry intensifies technology or information, the tendency at monopolization in markets increases, which conflicts with the essence of the market system.

In this study we propose to explore the present situation of Turkey in global markets and to discuss technology and competition policies. First, a brief review of relations between competition and technology is presented in three dimensions within a global perspective: the international division of labor, the global market system, and dependency. A Balassa export specialization index is calculated to interpret the positions of countries. We examine the

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technology system and policies of the European Union in order to understand Turkey’s level in the adjustment process with the EU. In place of conclusion, we suggest a technology system based on process management.

2. INTER-RELATIONSHIP BETWEEN COMPETITION AND TECHNOLOGY

Modern capitalism is built on the market system which can be likened to the atomic particles. The market system includes a collection of economic agents -individuals, firms, governments, nations, etc- that interact with each other in the exchange of goods and services. The core of the system is competition. It can be defined as an organizer –the invisible hand of Adam Smith–, or an adjuster –the auctioneer of Walras–; however it is defined, competition process determines the relationship between economic actors.

Technology is the process by which humans modify nature to meet their needs and wants. The production possibility frontier changes by every attempt to satisfy a new want. The struggle with environment makes humanity more connected and more integrated, which refers that division of labor to become more varied. Technology has always been the main determinant of how people live and how related they are. As technological progress takes more control on nature, people’s ability to work and efficiency improves, and also life styles change. Nevertheless; technology designates the interactions between the economic actors. If competition is the core of the system, technology should be the orbit.

Like variety of factors determining the interactions between the economic agents, the international trade function is consist of a number of variables besides technology; like geographical position, population, natural resources, etc. After the industrial revolution technological capabilities of the countries became dominant over the positions of nations within the world economy. For two centuries world has witnessed a rapid improvement in production and polarization of international division of labor. The industrialized countries compelled others to trade on comparative advantages in natural resources or production factors. Although improving technology increased the sum of the game, exchange of low value added labor-intensive goods from the developing countries with more value added capital-intensive goods from the developed countries distorted income distribution among the nations. This flow (transfer) of resources made it more difficult to break the chains for the less developed countries. By the eighties, the process including enormous improvements in the information technologies and financial liberalization, globalization, strengthen the bounds between technological capabilities and competitive power of a nation in global markets.
International Division of Labor

The relation between technological level and the position in the international division of labor of countries is presented using plot diagrams in the Appendix A. The data representing the technological capabilities, on the horizontal axis, is gathered from ArCo Technology Index. On the vertical axis, there are balassa export specialization index values for different groups of goods.

The ArCo Technology Index (Archibugi and Coco, 2004) is consist of three dimensions: a) the creation of technology, b) the technological infrastructures, c) the development of human skills; and eight sub-dimensions; a1) patents, a2) scientific articles, b1) Internet penetration, b2) telephone penetration, b3) electricity consumption, c1) tertiary science & engineering enrolment, c2) mean years of schooling, c3) literacy rate. It is useful as a proxy of a nation’s technological capabilities. In the index a country gets a score between 0 and 1.

We have calculated Balassa (Balassa, 1965) indexes of specialization in exports for raw material intensifies, labor intensive, capital intensive, easy imitable research-oriented, and difficultly imitable research-oriented goods. Detailed decomposition based on the study of Yılmaz (2003) is represented in the Appendix B. The data set contains the values of 152 countries and is taken from UNCTAD’s Handbook of Statistics online (www.unctad.org). The index score of a country for a class of good is calculated as follows:

\[
B_{ij} = \frac{\sum_i EX_{ij}}{\sum_j \sum_i EX_{ij}}
\]

i: good;  
j: country;  
\(EX_{ij}\): Export value of j country for i type good;  
\(B_{ij}\): index score of j country for i type good.

On the plot diagrams it is obviously seen that the technological capability of a country is in direct proportion to the export specialization in capital intensive, easy and difficult imitable research-oriented goods; while it is inversely proportional to that in low value added products. Another observation is that the relationship gets clearer by the time, meaning that polarization emerges. This deduction is not surprising due to the mutual characteristic of the relationship. Possessing a high technological level allows countries –as well as firms- to add more value on products. More value added provides necessary support to technology system
that includes research and development studies, innovations, diffusion, and etc. Therefore, the gap, by all means, between developed and non-developed countries grows.

**Global Market System**

While technology designates the international division of labor, it also affects mechanism of the market system through different aspects. Schumpeter (1947) summarized capitalistic world in an evolutionist manner as “creative destruction”. Creative destruction is vital because without innovations, entrepreneurial profits, which are the basic motive of the system, vanish. Technological improvements shorten product life cycles; therefore, it is getting difficult to close the gap; in other words, as creative power increases, *creativity destructs* more.

On the other side, technology strengthens the tendency of markets to monopolize. This tendency that refers that all imperfect markets are apt to become a monopoly is a controversial argument; however, we will take issue within the context of the diffusion of technological improvements. Developing technology makes production processes more integrated. As a result; countries, which invest on research and development studies and develop basic devices or software programmes, gain monopolistic power in the production technologies market in two ways. Firstly; patents and license agreements provide monopolistic power. Secondly; the followers who try to intervene the market have to create their inventions, convenient to basic ones. Accordingly; producers who want to use complementary or related devices are compelled to use the basic ones inevitably. Another aspect of this monopolistic situation is especially valid for the high technology products because of their special demand function. These products have a positive sloping demand curve; because the value of these increases as the number of users increases. Telecommunication industry is a good example: a consumer deciding which operator to choose will ask how many customers the operator has. Naturally, if he is a rational customer, he will choose the operator that has more users. This kind of network externality enables market leader to become a monopoly.

**Dependency**

Although knowledge, defined as a pure common good, is non-competitive; but diffusion is not. Patents and license agreements are protection tools for intellectual property rights which are thought to be an essential concept of the market system; nevertheless, they restrict the diffusion of knowledge. It is a fact that most of the common innovations emerge from developed countries. The creator of technologies also determines the production
standards; therefore, unless products satisfy these, a country is not able to export. There are
two related result of the situation for non-developed countries; (1) technological dependency,
and (2) financial dependency. Technological dependency brings import dependency which is
the reason of extreme foreign trade deficits generally seen in non-developed countries. International dept applied for deficits become structural problem of financial dependency.

3. COMMON SCIENCE AND TECHNOLOGY POLICY OF EU

Technology Policy

Technology policy is, briefly, a set of policies including government intervention to
economy in the aim of affecting technological change process (Stoneman and Vickers, 1988). In a broader sense, technology policy can be defined as "a set of principles which guide the
generation of, or contribution to general scientific knowledge and which governs the
acquisition, utilization adaptation and further development of technology for the purpose of
achieving development objectives". Defined in this way it includes; science, engineering and
technology education or human resource development; the research and development system;
production system; the consequences of technological change; the regional development of S
& T; international aspects of science and technology (Adeboye, 1996).

In the past three decades trade and financial liberalization has been the dominant trend
in the world, which implies restriction of share and activity of government in the economy. Yet, it is a fact that even the most liberal countries have national science and technology
policies, meaning that governments have active role in development and diffusion of
technologies. Governments apply technology policies for several reasons (Taymaz, 1993)

First reason is about the function of governments to designate legal and institutional
measures that secure market system. Capitalist system is built on property rights, which not
only include physical goods but also intellectual products. In this sense, governments
need/have technology policies in order to define and protect intellectual property rights.

Another reason is that technological improvement of some of the common goods like
medicine or military defense cannot be realized within the market system. Therefore,
governments take the responsibility and obligation to regulate technological process in these
fields.
Market failure due to lack of investment in new technology, co-ordination of market agents, and speed of diffusion of new technology is another reason. Inadequate investment on technology in market economies is mostly related with the diffusion of knowledge. Potential users cannot know how much beneficial the knowledge/technology is so that they cannot set a value. And when they learn the knowledge, they do not need to buy it. Also, risk in knowledge market is higher than other markets because of the uncertain environment. Another aspect of market failure is that firms work on same kind of projects, intently (patent race) or not (uncertainty), bearing the same huge costs. Discoordination of researchers reduces the market efficiency. Hence, governments apply technology policies to promote and coordinate the knowledge market.

**Joint Technology Policies of EU**

States attach more importance to science and technology policies in order to reach to the goals of social and economic development. Competitive power of a country depends on capability of producing new technologies and ability of applying these technologies through the production processes. Countries that have national science and technology programmes parallel with their economic and political objectives are the ones that prevailed in global economy. However, it must be recognized that present level of globalization obligates national policy makers to consider global aspects. For this reason, the concept of joint act includes science and technology policies.

Being more effective in global markets; the European Union (EU) began to seriously study on science, technology and competition policies by 1970s. At the beginning, EU countries aimed to have more competitive power in global markets with their national policies. However; the national policies were not sufficient solely to struggle with tough global competition, so that EU members decided to generate a common policy and carry out this policy within the borders of the European Union.

The most important reason canalized EU to apply a joint policy is the desire of finding rational and permanent solutions to EU citizens’ common problems. Furthermore, in today’s integrated world all problems are absolutely global. Anything happened in a country directly or indirectly affects others. It is obvious that multinational studies are more beneficial in such global issues. Joint act enables researchers and policy makers from different countries think collectively. Another benefit is reducing costs, and also facilitating complexity of high-level researches.

The initial steps of European co-operative research and technology activities begin with the establishment of the European Economic Community and the European Atomic
Energy Community (EUROTOM). But the first institutional act emerged in 1970s. Decisions taken in the Paris Summit (1972) and the Copenhagen Summit (1973) were admitted as an action plan by EU members. Later on, this action plan was turned into the most important instrument of the Common Science and Technology Policies which is called as the First Framework Programme.

In 1986, with the Single European Act, science and technology started to be considered as a community responsibility. The direction of the Single European Act was to expand scientific and technologic foundations in order to better off competitive power of the Union. The Maastricht Treaty in 1993 emphasized the importance of common policy and obligated the Commission to present annual reports to the European Parliament and Council.

In March 2000, the Lisbon European Council set a strategic goal for the European Union: “to become the most competitive and dynamic knowledge based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion by 2010” (Tüsiad, 2003).

The Lisbon Strategy can be divided into eight dimensions which considered to be crucial for national competitiveness: (1) creating an information society for all, (2) developing a European area for innovation, research and development, (3) completing the single market and state aid and competition policy, (4) building network industries in telecommunications and in utilities and transportation, (5) creating efficient and integrated financial services, (6) improving the enterprise environment for business start-ups and in the regulatory framework, (7) increasing social inclusion by returning people to the workforce, upgrading skills and modernizing social protection, and (8) enhancing sustainable development (Lizbon Review 2004).

Taking up this challenge, the European Commission, Member States and the European Parliament, the scientific community and industry committed to work together towards the creation of a “European Research Area” (www.europe.eu/scadplus/leg/en/lvb/i23000.htm).

**Science and Technology Programmes of Europe**

Over the years the European Union has applied various science and technology programmes to get more share of the global value added. The most considerable programmes are ESPRIT (The European Strategic Programme for Research and Development in Information Technology), EUREKA (European Research Coordination Agency) and the Framework Programmes. In 1984 all of them compounded under the name of the Framework Programmes. The objectives of the first five years for the Framework Programmes were
similar to Lisbon Strategy: (1) supporting projects that provide economical and social benefits to Union members, (2) giving priority to the integrated projects, managing R&D activities efficiently, (3) facilitating free movement of researches within the Europe borders, (4) determining prior research areas which are suitable for objectives, (5) constituting an integrated European Research Area (IKV, 2004).

EU allocates a significant budget for the Framework Programmes. The budgets have increased gradually, from 3.27 billion Euros for the First Framework Programme (1984-1997) to 17.5 billion Euros for the Sixth Framework Programme (2002-2006).

**Graphic 1. The Budgets of Framework Programmes**

![Graphic 1. The Budgets of Framework Programmes](image)

**Source: TÜBİTAK, 2006**

The main objective of the Sixth Framework Programme (6FP) is to contribute to the creation of the European Research Area by improving integration and co-ordination of research in Europe. The 6FP is different from the others in terms of two new instruments: (1) “Integrated Projects” that aims efficiency in R&D management and productivity in usage of resources and (2) “Excellence Networks” that purpose cooperation of universities and research institutions (Tübitak, 2004). This Framework also highlights for stimulating and supporting collaboration between European researchers and aims to provide mobility of researchers.

In order to meet the objectives of the renewed Lisbon Strategy, the Competitiveness and Innovation Framework Programme (CIP) is proposed for the period 2007-2013. The major objectives are to improve competitiveness capability of small and medium sized enterprises (SMEs), to support innovation, to accelerate the improvement of information society and to encourage the usage of renewable energy resources. (Tübitak, 2006)

CIP is made up of three specific sub-programmes: (a) The Entrepreneurship and Innovation Programme, (b) The ICT Policy Support Programme, and (c) The Intelligent
Energy - Europe Programme. The Action Plans will be prepared and published for each of the sub-programmes by the European Commission.

<table>
<thead>
<tr>
<th>Total R&amp;D personnel and researchers as % of labour force</th>
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<tr>
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<tr>
<td>EU 25</td>
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<td>EU 15</td>
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<tr>
<td>Czech Republic</td>
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<tr>
<td>Hungary</td>
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<td>Poland</td>
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<tr>
<td>Turkey</td>
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Patent applications to the EPO by priority year at the national level

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<td>40935</td>
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<td>100</td>
<td>108</td>
<td>107</td>
<td>116</td>
<td>122</td>
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<td>81</td>
<td>97</td>
<td>106</td>
<td>123</td>
<td>120</td>
<td>173</td>
<td>205</td>
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<td>23</td>
<td>27</td>
<td>39</td>
<td>55</td>
<td>60</td>
<td>80</td>
<td>121</td>
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<td>25</td>
<td>30</td>
<td>53</td>
<td>67</td>
<td>88</td>
<td>88</td>
<td>118</td>
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Gross domestic expenditure on R&D as a percentage of GDP

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<td>EU 15</td>
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<td>1.87</td>
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<td>0.95</td>
<td>0.98</td>
<td>1.09</td>
<td>1.17</td>
<td>1.16</td>
<td>1.23</td>
<td>1.22</td>
<td>1.22</td>
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<td>Hungary</td>
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<td>0.65</td>
<td>0.72</td>
<td>0.68</td>
<td>0.69</td>
<td>0.8</td>
<td>0.95</td>
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<td>0.67</td>
<td>0.68</td>
<td>0.7</td>
<td>0.66</td>
<td>0.64</td>
<td>0.58</td>
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<tr>
<td>Turkey</td>
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<td>0.38</td>
<td>0.45</td>
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<td>0.49</td>
<td>0.5</td>
<td>0.63</td>
<td>0.64</td>
<td>0.72</td>
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</table>

Data is gathered from Eurostat and OECD

**Relative Level of Turkey in EU**

Success of Common Science and Technology Policy is essential for the EU to become the most competitive economy in the world, as articulated by the Lisbon Declaration. To evaluate the position of Turkey relatively to EU and new member states it must be known that where Europe stands on the Lisbon goals. In the table 1 we present a brief summary of major science and technology indicators.

EU gets along well in the basis of technological performance. One of the major indicators of technological performance is the percentage of total R&D personnel and researchers in the labor force. Since 1994, performance of EU15 in this field has increased slightly. Despite the increasing number of R&D personnel in the total employment in Turkey, the effort of Turkey is not enough for catching up the level of EU15.

Another important indicator of technological performance is patent applications. Patent indicators are commonly constructed on the basis of information from single patent
office. There are three patent families which are European Patent Office (EPO), the Japanese Patent Office (IPO) and the US Patent & Trademark Office (USPTO). EU15’s patent applications to USPTO have almost doubled since 1994. Especially, performances of Germany, United Kingdom, Austria, and Ireland are spectacular. Total patents applications from EU members to EPO have also doubled in 10 years. Turkey’s improvement is impressive but still is far back from average.

Although candidate and member countries of Union improved their performance over the years, EU is still behind the goals of Lisbon Strategy and also its rivals. EU’s R&D expenditure relative to GDP is far behind the OECD and US. According to OECD Scoreboard the annual difference between R&D expenditures of EU and R&D expenditures of US is approximately 120 billion Euros. Turkey presents a persistent work on R&D activities. In spite of the financial crisis in 2000 and 2001, R&D share in GDP has increased.

Within the framework of common policy, EU 15 has performed well in the field of scientific researches. The volume of articles published is a key indicator of the output of scientific researches. With regard to OECD Main, Science and Technology Indicators; EU 15 is still lagging behind OECD countries (OECD, 2005).

**Lisbon Criteria**

On 1 May 2004, European Union experienced with the Fifth Enlargement wave. The European Council decided to welcome ten new countries to join the Union. To evaluate the position of Turkey in EU, three countries - Czech Republic, Hungary and Poland-, which are similar to Turkey in terms of macro economic variables and adjustment process, were chosen among the new member countries.

**Czech Republic:** Since 1999, the Czech Republic is a part of the Fifth Framework Programme. The main development in Research and Technological Development Area in 2002 concerns the Act on State Support to Research and Technological Development which provides for the allocation of public funds to research and development, outlines the rights and duties of private and legal entities dealing with research and development, establishes an evaluation system, and lays down the tasks and obligations of the relevant government bodies. (www.europe.eu/scadplus.htm). At the fifth place, scores of Czech Republic very close to EU average, especially those of the network. However, total number of research and development personnel and researchers in Czech Republic is below the average of EU15. Also, with regard to patent applications, the country falls behind the EU15. On the other hand; country is one of the three best accession performers in the Social Inclusion and Sustainable Development sub index.
Hungary: Like Czech Republic, Hungary has been associated with the Fifth Framework Programme since 1999. Although Hungary is ranked sixth among the accession countries according to Lisbon Criteria, she manages to be the one of the best performers in the sub index of Efficient and Integrated Financial Services and Enterprise Environment. However, the gross domestic expenditure on R&D is still relatively low and needs to be increased. Hungary has better performance than Czech Republic in patent applications and also has better position in terms of percentage of R&D personnel and researchers.

Poland: Poland is the worst performer among the new member states according to Lisbon Scores. The gross domestic expenditure on Research and Development has begun to slow down since 2000. So the most serious problem of this country is financing R&D activities. Poland’s relatively strongest point seems to be liberalization, which is due to the successful specializations.

Turkey: At the 10th level, scores of Turkey are below EU, but better than those of Romania and Bulgaria which are going to join to EU in 2007. Participating to 6FP, Turkey is the first candidate country to participate a framework programme fully. The weakest side of Turkey is that she is far away to be an information society.

<p>| Table 2. Ranking and Scores of Potential Accession and New Member Countries |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Country</th>
<th>Rank</th>
<th>Final Index</th>
<th>Information society</th>
<th>Innovation and R&amp;D</th>
<th>Liberalization</th>
<th>Network Industries</th>
<th>Financial services</th>
<th>Enterprise</th>
<th>Social Inclusion</th>
<th>Sustainable development</th>
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<td>Estonia</td>
<td>1</td>
<td>4.64</td>
<td>4.92</td>
<td>3.82</td>
<td>4.40</td>
<td>4.98</td>
<td>5.43</td>
<td>4.90</td>
<td>4.20</td>
<td>4.44</td>
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<tr>
<td>Slovenia</td>
<td>2</td>
<td>4.36</td>
<td>4.38</td>
<td>3.92</td>
<td>4.06</td>
<td>5.21</td>
<td>5.69</td>
<td>3.76</td>
<td>4.24</td>
<td>4.60</td>
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<tr>
<td>Latvia</td>
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<td>12</td>
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<td>2.66</td>
<td>2.94</td>
<td>3.26</td>
<td>3.54</td>
<td>3.64</td>
<td>3.81</td>
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<td>EU Average</td>
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<td>4.97</td>
<td>4.61</td>
<td>4.41</td>
<td>4.69</td>
<td>5.81</td>
<td>5.52</td>
<td>4.74</td>
<td>4.81</td>
<td>5.16</td>
</tr>
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<td>Source: Lisbon Review 2004</td>
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CONCLUSION

Technology indexes clearly show that; Turkey improves over the time, but still remains ranked among countries of average level. In the ArCo Technology Index 2003, Turkey is evaluated as a latecomer, whereas European countries are considered to be leaders or potential leaders, at 65th place which is 10 positions above ArCo 1997. At 73rd position, Turkey comes after the EU countries in the ICT (Information and Communication Technologies) Diffusion Index of OECD which measures the average achievements of countries in connectivity and access dimensions.

This picture of Turkey is mainly due to the lack of technology policy. There have been some attempts, but legislation and regulations in the extent of these policies have been insufficient and inadequate. A policy has to include well-defined legislations and regulations, institutions, and coordinators, which form a system as a whole. In the case of Turkey, especially after 1990s, even though policy makers build institutions; there is a permanent coordination problem.

The world becomes more integrated; so that the coordination of actors gets more difficult. For this reason, policies need to be perceived differently from those that aim solely increasing the scores of the related indicators. According to the definitions of the concepts in an economy, which treat them as processes, policies must be considered through process management.

Technology policy cannot be separated from competition policy and industry policy. In this extent, the policies of development should be considered as joint acts that bring policies together. The coordination of the policies is essential not only because processes are complicated but also because results and aims of one is tightly coupled with those of another. For example; rapid diffusion of knowledge, one of the major aims of technology policy, is related with competition policy and industry policy. Legislation on property rights is an important determinant of speed of diffusion, which is a heading of competition policy. Besides; speed of knowledge diffusion is a useful measure of industry policy in deciding which industry to and how much to support.
BIBLIOGRAPHY


Lisbon Review 2004


APPENDIX A. THE RELATION BETWEEN TECHNOLOGICAL CAPABILITIES AND FACTOR INTENSIFIY
APPENDIX B. SITC CLASSIFICATION

Raw material intensifies goods:
- SITC 0 food and live animals
- SITC 2 crude materials excl. fuels
- SITC 3 mineral fuels etc.
- SITC 4 animal vegetable oil fat

Labor intensive goods:
- SITC 26 textile fibres and waste
- SITC 6 basic manufactures
- SITC 8 misc manufactured goods

Capital intensive goods:
- SITC 1 beverages and tobacco
- SITC 35 electrical energy
- SITC 53 dyes, tanning, color production
- SITC 55 perfume, cleaning etc production
- SITC 62 rubber manufactures nes
- SITC 67 iron and steel
- SITC 68 non-ferrous metals
- SITC 78 road vehicles

Easy imitable research oriented goods:
- SITC 51 organic chemicals
- SITC 52 inorganic chemicals
- SITC 54.1 medical pharm products
- SITC 58 plastic materials etc.
- SITC 59 chemical materials nes
- SITC 75 office machines and adapt equipment

Difficultly imitable research oriented goods:
- SITC 7 machines, transport equipment
- SITC 87 precision instrument
- SITC 88 photo equipment, optical gods etc