Technological Innovation, Competitiveness and Sustainable Development

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Abstract: Science and Technology (S&T) play a fundamental role in finding solutions to many problems of sustainable development. In the framework of this sustainable technology, technological innovation and sustainable development are very interactive with each other. At the same time, innovations lead to a direct reduction in production costs for companies, therefore companies' competitiveness increases in national and international arena.

The purpose of this study is to identify and to present the conditions and situations of technological innovation that foster and promote sustainable development and competitiveness in Turkey. Based on various secondary sources such as activities and annual reports of companies, published articles and deeply interviews and surveys, large companies are investigated for drawing the picture of this sophisticated triangle of technological innovation, competitiveness and sustainable development.

Keywords: Ecological innovation, Competitiveness, Turkey, Sustainable technology

1 Introduction

There is a general opinion on a direct conflict between environmental protection and economic profitability, in other words, it is argued that companies' efforts try to improve environmental protection will probably cause a reduction in companies' competitiveness and profits. Whereas issues and activities related with sustainable technology offer both environmentally friendly world and competitive opportunities for those economic units. Contrary to expectations, environment and profitability are interdependent and both concepts should be in cooperation with the management of companies. Particularly, increasing numbers of companies are influenced by the "being green" argument which improving environmental performance can be a net gain. That means companies now realize that environmental protection are no longer add-on, on the contrary, they understand, this kind of management approach belongs to the whole production process and tries to reduce wastes before they are created, so the result will be profitable. In other words, investing in the environment has the potential to improve economic efficiency, business images and finally their profitableness.

In this study, I want to discuss that to what extent can we say that sustainable technology provide a more competitive atmosphere in Turkey. I will begin to explain with the definition of the two main concepts:

Sustainable Technology

Competitiveness

Then I will try to highlight the existing links between these two concepts in order to explain a company's performance. As it is well known, in our globalizing world, for most companies, the environmental issues are *sine qua non* as a matter of making a good decision. However, it is also argued that those environmentally friendly companies do not always prove to be as profitable as 'dirtier' (or not-environmentally-friendly) companies. Therefore, in some cases, 'bad' driving out the 'good' and competitiveness become tough.

On the other hand, this tough competitiveness drives companies to find low-cost and/or more productive but convenient alternatives. For example when companies face with a shortage of raw materials, they try to find an alternative raw material or create or put a substitution. Similarly, to cope with high land costs, Japanese companies pioneered just-in-time production system and avoided storing inventory on the fac-

tory floor space.[1] These are the different dimensions of competitiveness.[2] Today, using resources productively makes companies more competitive and when these companies become competitive, they have an opportunity to employ advanced technology and methods in using those resources. Therefore, that means, a dynamic competitiveness is mostly characterized by changes in technological means. Particularly, technological competitiveness, which is clearly identified with innovation, is on the agenda of both companies and countries. According to MITI report, over the first half of the 21st century, approximately 40 percent of the world's production of goods and services will be related with environment-linked products and technologies. For example, according to Porter, technological competitiveness is "…the capacity for innovation and improvement that shift the constraints".[3] However, the innovation that we are mentioned in this definition is environmental or green technological innovation and it includes more than simply reducing environmental impacts through waste minimization; it involves completely new products which reduces direct environmental impact or new markets and new production processes. However, since companies do not integrate environmental concerns into their strategies so easily, they embrace technological innovation more comfortably than environmental/green innovation, and this becomes quite strong barrier for the development of environmental/green innovation.

2 Interactions among Environmental Innovations and Technological Competitiveness

As it is mentioned above, technological competitiveness includes environmental/green innovation besides various kinds of environmental technologies. In the short-term, companies mostly deal with environmental technologies, such as

- end-of-pipe technologies, which are managing the final stage of life-cycles of products
- restoring technologies which are helping to regenerate the ecosystem,
- monitoring and observation methods and tools of environmental quality,
- prevention technologies in order to reducing risks,
- lean technologies to prevent resources exhaustion,
- clean technologies which are changing the technological basis of industrial production.

On the other hand, in order to deal with the medium- or long-term environmental issues, companies need to change more structural factors and these structural changes consist of process innovations, product innovations and/or organizational innovations. According to Klemmer definition[4], environmental innovation is a kind of techno-economic, organizational, social and institutional change leading to an improved quality of the environment. In another definition, environmental technology refers to "all techniques, processes and products playing an important role in reducing pressures on scarce natural resources, in reducing pollution flows, and in the prevention and reduction of environmental hazards".[5] The principal competitive advantages of environmental innovation are:

- reducing production costs and increasing productivity
- improving quality
- providing an opportunity to pursue unique and exclusive strategies
- Having social acceptance and legitimacy in the market
- Receiving possibility of influencing legislation to their benefit

1 Porter, M.E. & van der Linde, C. (1995). 'Green and Competitive: Ending the Stalemate', *Harvard Business Review* Vol. 73, No. 5, pp. 120-134.

2 Generally there are four main dimensions: cost, price, structural and technological competitiveness.

3 Porter, M.E. & van der Linde, C. (1995). 'Toward a New Conception of the Environment-Competitiveness Relationship', *Journal of Economic Perspective* Vol. 9, No. 4, pp. 97-118.

4 Triebswetter, U. & Wackerbauer, J. (2007). 'Integrated Environmental Product Innovation in the Region of'.

5 Faucheux et al, S. (1998). 'Globalization, Competitiveness, Governance and Environment: What Prospects for a Sustainable Development?', In: S. Faucheux, J. Gowdy & I. Nicolai (eds) *Sustainability and Firms: Technological Change and the Changing Regulatory Environment* Edward Elgar, Cheltenham, p. 17.

For a long time the prevailing approach to environmental policy of companies remains between environment and the economy. The conventional management emphasize that the benefits from investing environmental technologies are likely to entail serious economic costs. So according to this approach, entering such an environmental policy and making investment on green innovations may constraint the performance of companies and their competitiveness. For example, when companies invest in pollution control and filters, this investment may crowd out other renewal and/or new investments. Pollution control equipments are mostly labor-intensive and that labor has no direct contribution to companies' marketable products. Similarly, compliance with environmental regulations requires specific managerial/administrative skills and this staff has no direct contribution to the final marketable products. On the other side of the coin, the environmental regulations are very effective to move companies (or their investments) from one country to another. For example, according to Lucas, possible cost increase resulting from environmental regulations will move industries to countries, which have less stringent or no environmental regulations.[6]

However, during the nineties, companies started to become familiar with environmental-oriented way of thinking. They started to practice and maintain the good environmental quality, which are increasingly becoming an important component of their economic competitiveness. This modern and more environmentally-friendly approach has facilitated to take the advantage of green innovation and environmental technology. Against reasons for possible cost increases from environmental policy, the new approach cite on different managerial tools such as environmental accounting or eco-efficiency, which have used for increasing competitiveness. Today, we can give many examples of companies which have benefited financially from this environmentally-oriented initiatives.

Particularly in the area of waste management system, there are plenty of innovations, which have become important factor to affect the company's competitiveness. For example, if companies realize that they pay quite a lot of money to the raw materials of waste with the help of using environmental accounting or full cost accounting system, they will think about and revise their purchasing policy or they are going to change their production system. In other words, the waste of resources is equal to the wasted money, because the discharge of wastes during or at the end of a production process means a failure to use productively all the purchased raw materials or inputs. Therefore, in order to increase their competitiveness companies try to minimize waste through reducing production costs, on-site waste monitoring and treatment costs, handling, transport and off-site disposing costs, raw material costs, energy and water costs. For example, textile companies are turning away from traditional waste-treatment processes for cleaner effluent toward efforts that reduce the use of polluting chemicals. They use techniques, which involve re-using the dyebath that color carpets and similar items while cutting pollution. Some studies show that this new techniques (dyebath reuse) cut auxiliary chemical costs by as much as 75 percent. So, this is a typical and basic innovation step and it simply reduces the amount of chemicals used. This means lower inputs in the production process due to improved ecological efficiency lead to an increase in the competitiveness of companies.

Another environmental innovation, which is driven by the need for cost reductions, is the development of an oil-free compressor for brake systems in railway vehicles. Disposal problem of used oil was the main motivation for this innovation. When we make a comparison with the oil-using predecessor product, the new product is light and it works more economically and efficiently. Since this innovation makes the processes, which is related with oil lubrication, unnecessary, some components such as soil filters, oil separators and condensate collectors do not use. With the help of this new product, there is also no need to dispose of used oil and elimination of the condensate. Therefore, due to this innovational step, companies may find to increase their share and competitiveness.

In some cases, innovations are driven by environmental regulations. This kind of innovations addresses the root causes of pollution by improving resource productivity, which defines as the substitution of less

6 Lucas, R., Wheeler, D. & Hettige, H. (1992). 'Economic Development, Environmental Regulation and the International Migration of Toxic Industrial Pollution: 1960-88', In: P. Low (ed.) *International Trade and the Environment* World Bank Discussion Paper, No. 159, World Bank, Washington D.C., pp. 67-86.

costly materials and/or utilization of existing materials. For example, at the end of 1980s environmental regulations in USA called for Dow Chemicals's California complex to close their evaporation ponds. Company used to store the caustic waste and hydrochloric acid waste in those ponds. Instead of closing ponds, the company redesigned production process and also reused waste stream as a raw material in other parts of the production. According to the company's data, this innovative process gave the company an annual savings of $2.4 million.[7] This shows that the company brings two important concepts together on the way of resource productivity: environmental improvement and competitiveness.

Similar example on improving resource productivity comes from 3M Company. Between 1975 and 1992 the company saved more than $530 million from its 3P projects (Pollution Prevention Pays) which was a brilliant idea/innovation. After years, forced to comply with new regulations to reduce solvent emissions by 90 percent, 3M found a way to avoid the use of solvents altogether by coating products with safer, water-based solutions. The company gained an early-mover advantage in product development over competitors, many of whom switched significantly later.[8] I can give one more example on chemical sector, where many believe that the environment-economy trade-off is quite contrary. Because of environmental regulations, Ciba-Geigy Corporation reexamined the wastewater streams at their dye plant and they changed whole their production process. This was the typical example of regulatory pressure on process innovation. However, the result was more than reducing pollution, they also increased process yields by 40 percent and this process innovation gave the company an annual savings of $740,000.[9]

These company examples show that there are considerable opportunities to reduce environmental damages and to catch competitiveness together through innovation of products, processes and methods. Such examples are increasing in spite of some opposition to environmental regulations and in spite of regulatory standards that are becoming barrier to innovative and resource productive solutions.

3 Turkey is on the Way to Sustainable Development

Turkey has applied to join the European Union (EU), which means that it is required to bring its legislation and standards into line with that of EU. Aiming to fasten the harmonization of Turkish technological infrastructure with EU standards, country conducts many EU and/or World Bank projects. Turkey is not a core-innovator country; her share of research and development (R&D) expenditure in GNP is 0.79 percent and the number of scientific article per million person has increased from 21 in 1990 to 252 in 2006. This figure carried the country from the level of 79 to 44th level in the ranking. On the other hand, the share of industry in total R&D expenditures is low (33.4 percent) compared with that of the EU (64.5 percent) figure. All these figures show that Turkey has weak technological activity and research culture. The country depends on imported technology continuously and heavily. In spite of the awareness of the need for stronger national R&D capability, Turkey has still many impediments to establish competitive innovation system.

Before explaining the environmental innovation and competitiveness relation in Turkey, it is worth to mention about Turkish structure of science, technology and innovation system. TUBITAK (The Scientific and Technological Research Council) is the main funding and supporting agency that manage the allocation of government research and development funds to various research projects in both academia and small business firms. TUBITAK, which was found in 1963, funds research in both basic and applied sciences through the following nine research divisions:[10]

1. Basic Sciences
2. Health Sciences

7 Dorfman, H., Warren R.M. & Catherine G.M. (1992). 'Environmental Dividends: Cutting More Chemical Wastes', New York, INFORM.

8 Don L. B. & Betsy C., 'Helping the Planet and the Economy', U.S. News and World Report 110, No. ii, March 25, 1991, p. 46, In: M.E. Porter and Claas van der Linde (1995), Green and Competitive: Ending the Stalemate (1999) *Journal of Business Administration*.

9 Ibid. p. 3.

10 http://www.tubitak.gov.tr.

3. Engineering
4. Electrical, Electronic and Informatics
5. Environmental, Atmospheric and Marine Sciences
6. Agriculture, Veterinary and Forestry Sciences
7. Defense and Security Technologies
8. Social and Behavioral Sciences
9. Public Research Projects

Within the framework of the above research divisions, TUBITAK has several programs:

1. The Support Program for Scientific and Technological Research Projects
2. Short-Term R&D Funding Program
3. Scientific Meeting Support Program
4. Support Program for Research Projects of Public Institutions
5. Global Researcher Program
6. The Participation Program for International Scientific Research Projects
7. The Support Program fort he Initiative to Build Scientific and Technological Cooperation Networks and Platforms
8. National Young Researchers Career Development Program

In connection with Turkey's national innovation system, another important establishment, which was founded in 1991 in accordance with the international loan agreement signed between Turkish Republic and the World Bank, is Technology Development Foundation of Turkey (TTGV). The founders of TTGV consist of public institutions, private sector firms, umbrella organizations and individuals. So that means, this organization represents almost all parts of the society. The foundation has been a key actor for transferring public R&D support to the private sector companies with the available and the most suitable mechanism. With two projects financed by the World Bank, TTGV played an important role in developing and applying new support mechanisms to strengthen the private sector's research, technological development and innovation capabilities.

Apart from TTGV, other agencies directly related with science, technology and innovation are Turkish Atomic Undersecretaries of Foreign Trade (UFT), Turkish Atomic Energy Council (TAEK), Higher Education Council (YOK), and Turkish Academy of Sciences (TUBA). Besides, there are several R&D institutes inside the TUBITAK and two directorates, which are significant for innovation. These institutes are Marmara Research Centre (MAM), Information Technologies Institute (ETE), Food Institute (GE), Genetic Engineering and Biotechnology Institute (GMBE), Chemistry and Environment Institute (KCE), Institute of Materials (ME), Earth and Marine Sciences Institute (YDBE), National Research Institute of Electronics and Cryptology (UEKA), Defense Industries Research and Development Institute (SAGE), Space Technologies Research Institute (UZAY), National Metrology Institute (UME), Research Institute for Basic Sciences (TBAE), Institute for Industrial Management (TUSSIDE), National Academic Network and Information Centre (ULAKBILIM), National Observatory (TUG), Ankara and Bursa Test and Analysis Laboratory (ATAL and BUTAL), and two directorates; one is called as Technology and Innovation Funding Programs Directorate (TEYDEB) and the other one is called as Technology Monitoring and Assessing Directorate (TIDEB). These directorates were established to fund the technological development and innovation activities of the private companies in Turkey. Thus, the directorates' targets are to increase research and technological development capability, innovation culture, and to boost the global competitiveness of Turkish private companies. For example, in TEYDEB, there are currently five technology groups:

1. Machinery and Manufacturing
2. Electrical and Electronics
3. Material, Metallurgical and Chemical

4. Biotechnology, Agricultural, Environmental and Food
5. Information Technologies

On the other hand, in TIDEB, the R&D support program is a non-refundable grant and companies can receive funding of up to 60 percent of their R&D expenses. In this organization, there are six thematic areas, which companies can apply for funding:[11]

1. Information technologies
2. Multifunctional production technologies
3. Enhanced material technologies
4. Genetic engineering and biotechnology
5. Space and aeronautics technologies
6. Technologies for environmental protection

As it is observed from the above information, Turkey seems to have sufficient number of institutions/establishments, which show the institutional infrastructure for her technological activity. However, when we look specifically at the environmental innovation and technology area, we can find few establishments such as Environment, Atmospheric and Marine Sciences division in TUBITAK and two institutions, National Metrology and Biotechnology, Agricultural, Environmental and Food Institutes, which are directly related with the core issues of sustainable development.

Meanwhile, Turkey has undertaken significant steps in terms of technological innovation and the newly established National Innovation System facilitate innovation. The country's Vision *2023 Project*, which began in 2002 under the coordination of TUBITAK, includes eight priority areas and three important sub-projects. These priority areas are:

1. Information Technologies
2. Biotechnology and Gene Technologies
3. Materials
4. Nanotechnology
5. Design Technologies
6. Mechatronics
7. Production Methods and Machinery
8. Energy and Environmental Technologies

In addition, three sub-projects are:

– National Technology Inventory
– Turkish Researchers Inventory
– National R&D Infrastructure

However, in Turkey particularly companies' innovation activities do not depend solely on such supported mechanisms and/or incentives, market discipline is more important. With the help of liberalization attempts, market signals try to be effective in the country's innovation area, but there are still some barriers. For example, market signals should be used to stimulate for and the supply of skills for innovation. However, private sector has still hesitated to enter R&D area, therefore the Scientific and Technological Research Council (TUBITAK) to account for developing a series of competitive funding programs, including research and travel grants, scientific exchange programs and awards that provide scientists throughout Turkey with the opportunity to secure funds and valuable recognition for their work.[12] In spite of these

11 http://alipro.eurescom.de/page/en/tr_tideb (14.01.2008).

12 Cıgdemm K. (2006). 'Science on the Rise in Turkey' www.ictp.trieste.it/~twas/pdf/NL15_2_PDF/06-Turkey_24-27_low.pdf (19.01.2008).

various and different kind of supporting mechanisms, Turkish scientists do not have easily access to every source of financial support due to limited resources. That means public attempts are not sufficient to feed the scientific atmosphere in Turkey. Because of this the country has to apply to the World Bank's financial ability; in fact, the World Bank has supported two large projects related to building innovation system including industrial technology and Science and Technology System. One of them is called as Technology Development Project-I and the other one is Industrial Technology Project. In fact, the share of the business sector in R&D expenditure is around 35 percent and this figure is lower than the 65 percent OECD average. Recently this figure presents an upward trend but this is because of the EU and other international organization's projects. These projects not only provide financial support but also more importantly raise awareness on industrial R&D and innovation in the country. Therefore, the number of companies conducting R&D has increased by nearly 58 percent between 1996 and 2000.[13]

As far as export competitiveness concerned, because of the outward oriented industrialization policy and customs union with EU, particularly large Turkish companies have become more competitive through the last fifteen years. For example, Turkey is at the rank 53rd in the Global Competitiveness Index (GCI) among examined 131 countries. When we look at the country's recent economic history, she has come a long way from the instability and structural weaknesses, which undermined its economy in the 1990s, bringing the country to a virtual halt in 2001 with a violent recession. Indeed, the tough IMF-backed reforms adopted in the aftermath of the collapse, combining tight fiscal and monetary policies with a broad range of reforms aimed at addressing other deep-seated distortions, seem to have set Turkey on a healthier development path, with economic growth rates in the 2002-2005 period averaging 7 percent, and inflation rates falling dramatically to single-digit figures.[14] However, environmental awareness is very low in the industrial and export sector. Actually, environmental-friendly approach comes into reality only as a result of some forcing factor such as strict control and competition created by the EU companies. Environmental measures seem a big burden for most of the Turkish companies; most of them usually prefer to pay the fines and to continue their activities or production without taking any environmental measures. In spite of this attitude, environmental protection specifications, which are requested by international buyers, are becoming effective enforcement in Turkey. For example with the help of these international pressures, Turkish companies have recognized and applied some tools of environmental management such as waste management. Particularly companies, organized in industrial zones, are been supported. This support forces them to take common measures for waste disposal and wastewater treatment. However, this support does not include using environmental innovation or any specific requisites of environmental technology. On the other hand, recently strengthening university-industry cooperation seems to be the ideal business incubator for environmental innovation, which is used by SMEs. To strengthen SMEs' innovation activities, the government tries to find a suitable financial support mechanism.

In spite of these few establishments, particularly the activities of National Metrology Institute were very successful. Institution has met nearly 40 percent of the industry's needs for metrology to international standards and the institute has properly won international recognition and signed several international agreements with many other countries' national institutes and international organizations. However, more important than this, the innovative side of UME has started to develop new standards, equipment and new scientific equipments with the help of its intensive R&D activities. Institution has also provided calibration and testing services to industry and they have been seriously successful in enhancing the range and quality of calibrations. Over the past five years, the number of calibrations performed increased almost 75 percent. An almost 80 percent of these calibrations are comparable to those provided by leading metrology institutes in the world. The competitive advantage of calibration activity in Turkey is the cost of this local calibration is considerably lower than in Europe. With the help of UME, Turkish exporters understand the importance of calibration for export competitiveness.

13 http://www.die.gov.tr/english/SONIST/ARGE/180902/180902.html (14.01.2008).

14 http://www.turkishdailynews.com.tr/article.php?enewsid=55245 (28.09.2006).

In Turkey another innovative attempt come from energy sector. Coal as a fossil fuel is very important in Turkey's energy market. Particularly Afsin-Elbistan region where the largest lignite mines are located in Turkey, including almost half of the entire local proven reserves. Actually, available coal has very poor low calorific value at about average 1150 cal. per kg and 55 percent moisture, 20 percent ash and 1.-4 percent sulphur. Clean coal technology is the recent innovative techniques that Afsin-Elbistan tries to use. With the help of this technological development, available lignite becomes more enriched and this brings in competitiveness.

Turkish scientists, particularly for paper factories, have enhanced innovations in wastewater treatment. The method of electrochemistry, which they use, is cheaper and more efficient than previous ones. For example, with the help of this new method the amount of waste per liter has decreased from 600-700 mg to 350 mg.

Some innovative applications in wastewater treatment come from foreign companies such as Siemens. Siemens has used an innovative and a purely biological process that substantially reduces the quantity of sludge produced by the treatment process in Inegol Organized Industrial District for the first time. This process allows the total amount of sludge to be drastically reduced by 90 to 95 percent compared to conventional methods. At the same time, the cost of sludge handling, transport and disposal has also decreased. Siemens has used TowBro and Cannibal methods for the first time in Turkey, which these methods provide serious energy savings.[15]

4 As a Result...

The strong globalization winds serve to connect competitiveness with environmental innovation and sustainable development. Of course, at the macro and micro level, this is not an easy task. However, for the companies, in addition to cost reduction, pressures from environmental policy can achieve economic benefits by stimulating innovation, which results in new products, new production processes or new organizations. Thus, companies develop new and environmentally-friendly products, the substitutes are mostly less expensive and more manageable than previous ones. Several studies confirm this result.

In Turkey, this kind of awareness is very new. This is not because of the absence of strategy or plans and programs; the reason is the restless of market. In other words, despite some good and successful examples and decisive governmental or non-governmental organizations, the price mechanism, which is the most important component of market, does not work properly. That means companies are attentive to the market prices and they can give considerably healthy signals to consumers. However, these price changes need to be gradual because innovation takes time and sometimes cannot be resulted in proper way.

15 http://w1.siemens.com/innovation/en/publikationen/publications_pof/pof_spring_2005/elements_of_life/wastewater_purification.htm (11.02.2008).

References

ADE (2003). 'Innovation Policy in Seven Candidate Countries: the Challenges', Final Report, v. 2.7 ftp://ftp.cordis.europa.eu/pub/innovation-policy/studies/turkey_final_report_march_2003.pdf (12.01.2008).

http://alipro.eurescom.de/page/en/tr_tideb (14.01.2008).

Barker, T. & Köhler, J. (eds) (1998). 'International Competitiveness and Environmental Policies', Cheltenham, Edward Elgar.

Dorfman, H. Warren R.M. & Catherine, G.M. (1992). 'Environmental Dividends: Cutting More Chemical Wastes', New York, INFORM.

Don, L.B. & Betsy, C., 'Helping the Planet and the Economy', *U.S. News and World Report* 110 No. ii, March 25, 1991, p. 46.

Kagitcibasi , (2006) "Science on the Rise in Turkey" www.ictp.trieste.it/~twas/pdf/NL15_2_PDF/06-Turkey_24-27_low.pdf (19.01.2008).

http://www.die.gov.tr/english/SONIST/ARGE/180902/180902.html (14.01.2008).

Porter, M.E. & van der Linde, C. (1995). 'Toward a New Conception of the Environment-Competitiveness Relationship' *Journal of Economic Perspective* Vol. 9, No. 4, pp. 97-118.

Porter, M.E. & van der Linde, C. (1999). 'Green and Competitive: Ending the Stalemate', *Harvard Business Review* Vol. 73, No.5, pp.120-134.

http://www.turkishdailynews.com.tr/article.php?enewsid=55245 (28.09.2006).

http://w1.siemens.com/innovation/en/publikationen/publications_pof/pof_spring_2005/elements_of_life/wastewater_purification.htm (11.02.2008).

http://www.tubitak.gov.tr.

Taymaz, E. (2006). 'An Assessment of the Idustrial Technology Project', Final Report, http://www.ttgv.org.tr/page.php?id=56 (10.01.208).