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The historical background of scientific research in Turkey

From 1280 to 1566, at the height of the Ottoman Empire, the multiethnic state that preceded the Turkish nation state, science was based on the received tradition of Greek and Arab scholarship, as it was in Europe. Ottoman and European physicians, for example, studied and practised under the guidance of the works of Ibn Sina/Avicenna of Isfahan (908_1037). Arabic was the language of science among the Ottomans, and the medieval European scientists also had to learn Arabic in order to gain access to the Greek scientific legacy in some aspects of logic, physics, mathematics, metaphysics, astronomy and medicine¹.

When the European economy began to take shape in the 15th century, the Ottoman Empire, having developed a powerful centralised structure under Sultan Süleyman the Magnificent (1520_1566), was not able to initiate comparable changes in its closed economy.

A decline in the traditional administrative system of the Empire and military setbacks after 1683 forced the Sultans and the Ottoman ruling class to undertake reforms, but the Empire had lost touch with the scientific and technological progress that was leading to the Industrial Revolution in Europe².

In the 19th century a constitutional monarchy took the place of the traditional autocratic government and the predominantly Islamic legal system was partly replaced by a secular legislation. Between 1839_1923, new legal and administrative practices as well as modern military techniques were introduced, a new relationship between citizen and state emerged, and the ideologies of the civil states of Europe were widely discussed and reformulated to suit Turkish conditions.

In this context new schools were created to train and educate the recruits needed in a modern civil service and army.

Under French Austrian and, in the late 19th century, increasingly German influence, a new secular education system grew up alongside the traditional Islamic schools. A constitutive element in the reform process was science and technology transfer from

Europe, carried out by foreign military experts, scientists and teachers working for the Turkish government and by Turkish scientists and administrators who had studied abroad.

In an effort to combine theoretical with practical learning and to serve public needs, institutes of applied science were often attached to the new schools. These became the cells of modern Turkish research. For instance, at the Military Academy of Medicine (*Mekteb-i Tibbiye-Adliye-Sahane*) a bacteriological laboratory (*Bakteriolojihane-i Sahane Osmani*) was established in 1894 to fight epidemics. There Turkish bacteriologists identified a new type of influenza-causing bacterium and developed methods for the diagnosis of rinderpest³.

In general, the reform concepts of the Empire did not go beyond the perspective of strengthening the power of the central government and were thus confined to modernizing the military and the administration. Most importantly, they left untouched the key task of restructuring the traditional system of agrarian economy⁴. Thus, within such a restrictive framework, the establishment of a new educational system remained fragmentary. Despite several attempts, the founding of a university (*Darülfünun*)⁵, as an institution of academic teaching and research in all scientific fields had to wait until 1908, and here too the new university remained isolated from other educational institutions.

The whole situation changed with the founding of the Turkish Republic in 1923. The founder Mustafa Kemal (later called Kemal Atatürk) and the Republican People's Party introduced a complete social transformation by means of radical reforms from above. The ruling elite, which had graduated from the new schools of the old Empire, made use of their modern education. Their broad development concept for Turkey encompassed all fields of government action and public life, beginning with the introduction of a modern constitution, European laws and jurisprudence, a thorough secularization and modernization of education, through to industrialization strategies based on import substitution and the founding of state enterprises and state banks. In 1932, when the political leaders finally got around to re-establishing the university, higher education expansion was pursued as an integral part of a general plan. In the first years of the republican period (1923_1950) of recent Turkish history, a nation-wide primary and secondary school system was built up, guaranteeing sufficient educational preparation of students prior to academic studies. With time, a professional sphere based on academic and higher technical qualifications emerged within the new social infrastructure, ensuring employment opportunities for new university graduates. Along with the closure of the old-style university (the *Darülfünun*) in 1933, the Turkish state once again embarked on a large-scale programme of science transfer from Europe. In 1933 the model University of Istanbul was opened. From 1933 on, German and Austrian scientists, whom the National Socialist regime in Germany had considered 'racially' or politically undesirable, were appointed to the chairs of Istanbul University and to all model institutes of the young Turkish Republic, building the nucleus of science as a modern institution in contemporary Turkish society.

These emigrants, supported by an experienced Turkish administration and assisted by young Turkish academics who had studied in Germany in the 1920s, succeeded in breaking Turkey's traditional dependency on the transfer of science and technology by foreign experts which had characterised science in the Ottoman Empire. The Turkish successors of the emigrants built up the classical research institutes and universities of Turkey today (see below)⁶.

The institutional system of science in Turkey

Turkey today combines a highly centralized state with a mixed economy. Since the early 1980s, the Turkish economy has been undergoing a structural transformation, moving away from direct government regulation and control towards greater reliance on market forces. Recent measures have brought about the privatization of some state enterprises and the first steps towards more decentralized administration⁷. On the other hand, the Turkish state is trying to achieve more efficiency of state action by tightening the organisation of its apparatus.

In view of the centralism of the Turkish state, we shall first consider those R&D organisations which operate under state directories or cooperate with the government. In many cases, these public-sector institutions of science policy and research combine the functions of planning and science policy with implementation in research centres. They can be divided into three groups: government bodies responsible for policy, coordination and management; the ministries; and the universities.

The first group is organized through two different sections of the administrative system: the section embracing boards or commissions (*kurul*) and the section including institutes or societies (*kurum, kurulus, enstitü*), as well as organisations or offices (*teskilat, baskanlik*). These bodies are, on a varying legal basis, attached to the Prime Minister's Office (*basbakanlik*)⁸.

Institutions linked with the Prime Minister's Office

Since the sixties, the national economy and research and development (R&D) have been subject to the policies contained in the government's Five Year Development Plans. In Turkey, the link between these plans and the relevant institutions is not forged by a specific ministry but by a council of relevant officials. Under the Sixth Development Plan (1990_94) the existing Supreme Council for Science and Technology (*BTYK - Bilim ve Teknoloji Yüksek Kurulu*) was turned into the supreme policy-making body for science and research in Turkey. The Council is chaired by the Prime Minister. Its members include representatives of :

the State Planning Organisation (*DPT -Devlet Planlama Teskilati*)

the Scientific and Technical Research Council of Turkey (*TÜBİTAK - Türkiye Bilimsel ve Teknik Arastırma Kurumu*)

the ministries involved in science and technology (S&D)

the Higher Education Council (*YÖK - Yüksek Öğretim Kurulu*)

the Turkish Atomic Energy Authority (*TAEK - Türkiye Atom Enerjisi Kurumu*)

The State Planning Organisation (DPT) was founded in 1960 with the aim of providing systematic and realistic plans for economic investment and development in Turkey, and with the stress on incentive rather than strict regulation. As a part of central administration, it has an advisory function for the government's economic strategy and an evaluative function for the implementation of the Five Year Development Plans, which are ratified by parliament. In general, the Five Year Development Plan is imperative for the state sector and indicative for the private sector, but it has lost some of its directive function since the fourth planning period, in the context of the Turkish government's economic policy changes.

Universities and public R&D establishments requiring support for infrastructure investment and expensive scientific equipment apply directly to the DPT, which is responsible for allocating funds for technical research facilities.

The body which provides the necessary data for governmental planning is the State Institute of Statistics (*DİE - Devlet İstatistik Enstitüsü*). The *DİE* is a long-standing

institution of the Turkish state, and in recent years it has acquired more and more importance in view of the diversification of Turkish society and Turkey's increasing integration into international economic networks.

Among bodies subordinated to or associated with, the Prime Minister's office a crucial position in the R&D field has been occupied by the Scientific and Technical Research Council of Turkey (*TÜBİTAK - Türkiye Bilimsel ve Teknik Arastırma Kurumu*) ever since its foundation in 1963. Although *TÜBİTAK* gets its main financial support from the government, it enjoys financial and administrative autonomy. It was the first Turkish body to coordinate, organise, promote and develop basic and applied research. A revision of the status of the Supreme Council in 1993, formally changed *TÜBİTAK* from the head body of R&D in Turkey to more of an executive organ. However, it still holds its two main functions of designing Turkish R&D policies and applying them in several areas of activity.

As far as planning functions are concerned, *TÜBİTAK* has - since the Second Development Plan - determined Turkey's R&D priorities in accordance with the economic and social targets of successive Development Plans, together with the *DPT*. Within a changed institutional R&D setting after 1993, it drew up and further developed a National Research Plan for discussion and approval by *BTYK* and prepared draft legislation to create a Science and Technology Fund. *TÜBİTAK* also retains its science policy functions in its role as secretariat of *BTYK*.

TÜBİTAK and *TÜBA* (cf. below) are the only horizontal funding agencies in Turkey. According to priority areas defined by the governing Science Board of *TÜBİTAK*, its grant committees distribute funds in a broad range of scientific fields. Besides providing grants for research and fellowships at different educational levels, they also organise and promote symposia, seminars and congresses. This contribution to Turkish and international scientific dialogue and public information is complemented by information and documentation services and the publication of scientific journals in various fields. *TÜBİTAK* also has three research institutions of its own:

the Marmara Research Centre, which conducts basic and applied industry-oriented research projects, especially into new technologies;

the Defence Industries Research and Development Institute, which develops arms-related technologies and assists the Turkish Armed Forces in selecting, inspecting and utilizing imported arms and weapons systems;

and the Electronics Research and Development Institute, whose duties are to perform R&D activities (including prototype and initial production stages), technically assist public or private institutions during product development and production, and provide assistance in problems related to design, selection and use of electronic systems.

Another institution involved in R&D planning and pursuing comprehensive goals is the newly founded (1993) Turkish Academy of Science (*TÜBA - Türkiye Bilimler Akademisi*).

Like *TÜBİTAK*, it enjoys financial and administrative autonomy. *TÜBA*'s mission is to encourage and promote research activities in all fields of science, to raise the social status of scientists and to raise Turkish science to international standards. As it has not yet been possible to create a special institution to fund research and communication in the social sciences, *TÜBA* plays - in addition to its general functions - a special role in supporting the humanities and social sciences by running a scholarship programme, issuing internationally recognised scientific publications, and sponsoring international conferences. In this way, *TÜBA* is filling a gap in the spectrum of R&D activities left open by *TÜBİTAK*.

Two other institutes in the public sector, the Turkish Atomic Energy Authority (TAEK - *Türkiye Atom Enerjisi Kurumu*) and the Turkish Standards Institute (TSE - *Türk Standartları Enstitüsü*), are not concerned with general R&D planning but pursue specific scientific and technical research goals.

In 1994, a separate and autonomous Patent Institute was established, operating under the provisions of the Paris Convention.

TAEK advises the government on nuclear policy and conducts research on nuclear energy in three centres in Çekmece, Ankara and Lalahan, which carry out research on different aspects of nuclear technology.

TSE is mainly a technical services provider. Besides theoretical and practical work on standards, metrology and calibration, and the dissemination of its results, the institute also performs technical studies at the request of the public or private sector.

The traditional state enterprises, which have in fact been partly privatized within the last years, are Sümer Bank, the Turkish Cement Works and the Turkish Glassworks.

They maintain large R&D and education centres, like the Sümer Bank Research, Development and Education Establishment (SAGE), the Cement R&D Centre of the Cement Manufacturers' Association and the R&D Centre of the Turkish Glassworks.

In the area of culture and the humanities, public institutions are required by the constitution to act in accordance with the State's cultural mission. To this end, several institutions cultivate and develop the idea of Kemalism as expressed in Kemal Atatürk's reforms, which followed the birth of the Turkish nation state in 1923. The Atatürk Higher Council for Culture, Language and History (*Atatürk Kültür, Dil ve Tarih Yüksek Kurumu*) oversees work in this field. In terms of research, work on Turkish history is carried out by the Society for Turkish History TTK (*Türk Tarih Kurumu*), while linguistic studies come under the auspices of the Society for Turkish Language, TDK (*Türk Dil Kurumu*).

The ministries

Direct sectoral government funding is mainly the responsibility of those ministries which maintain research and education centres in their areas of competence. The most important centres operate under the following ministries: Agricultural and Rural Affairs, Forestry, Industry and Trade, Defence, Energy and Natural Resources, and Health and Public Welfare. In particular, agricultural and veterinary research receives high priority in Turkey. The Ministry of Agriculture and Rural Affairs has two general directorates with 55 affiliated research institutes and centres, while two research institutes operate under the Ministry of Forestry.

Chaired by the Ministry of Industry and Trade, the Small and Medium Industry Development Organisation (KOSGEB) brings together the Union of Chambers of Commerce and Industry, an umbrella association for trades and professions, and several governmental bodies, as well as TÜBİTAK, in order to improve the effectiveness and expand the role of SMEs (Small and medium enterprises). KOSGEB's legal status is defined by a special law and its international activities include development projects in the new Central Asian Republics (mediated by TICA, the Turkish International Cooperation Agency). It offers services such as training programmes and market research.

The trade and industry portfolio also includes responsibility for the Sugar Institute, which has an Agricultural and a Technological Research Division concerned with Turkish sugar production, and the Machinery and Chemical Industries Council, whose nine companies produce machinery, chemicals, weapons and ammunition primarily for

the Turkish armed forces. The Council's R&D Department was founded 1979 and has performed joint projects with TÜBİTAK and several universities.

Defence research is carried out in units under the Ministry of Defence. The ministry is responsible for sponsoring and managing defence-related applied research projects carried out by government and/or industrial institutions.

The Ministry of Energy and Natural Resources has several research institutions, the largest of which is the General Directorate of Mineral Research and Exploration (*Maden Tetkik ve Arama Enstitüsü*). Its objectives are to carry out basic geological studies, to perform geological research, to carry out all kinds of exploration and research in mining and industrial raw materials, and to determine existing economic potential. Part of the Ministry of Health and Public Welfare is the Refik Saydam Institute, which is responsible for all matters of hygiene and disease control within the country's public health system. It also provides pharmaceutical control services.

The universities

From 1946 to 1955, three other universities were founded alongside the University of Istanbul (1933) and the Istanbul Teknik Üniversitesi (1944). From 1955 to 1967 the original university system declined and a search for new models began. Finally, the American university system replaced the continental academic order, as seen in the founding of Hacettepe University and the Middle East Technical University. 1967 to 1975 were formative years in which the new model was put into practice. In that period, a rapid increase took place in the number of universities, accompanied by an expansion of graduate studies. In the 1970s, several new universities were created in Istanbul, Ankara and Izmir, some of them offering a variety of degrees on a non-standardised basis. There were 19 universities by 1981⁹.

In the decades before 1981 the Turkish higher education system consisted of three different sectors:

autonomous universities;

academies specialising in engineering and economic studies and administratively attached to the Ministry of Education, though with academic authority to grant degrees;

and vocational schools including teacher training colleges affiliated to the Ministry of Education.

In the 1970s, this tripartite system showed many signs of failure and degeneration. The problems largely stemmed from the lack of efficient, coordinated central planning for all levels of higher education and from the rapid growth in student demand, particularly during the 1960s and 1970s. The political, social and economic problems of the two preceding decades also contributed to the deterioration of Turkish higher education. With the implementation of the new Higher Education Law in 1981, the Turkish system of higher education underwent a major academic, institutional and administrative shake-up. According to the provisions of this law, and Articles 130 and 131 of the Constitution, the Higher Education Council (*YÖK - Yüksek Öğretim Kurulu*) was established as the supreme authority for higher education. The Council is a fully autonomous national board of trustees vested with the powers and responsibilities to govern all Turkish universities.

Since the reforms went into effect, all the academies, teacher training colleges, and vocational colleges have been integrated into the university system. They have either been amalgamated to form new universities or transformed into new faculties. The total number of universities in Turkey increased from 19 in 1981 to 57 in 1994, of which

53 are state universities. These universities comprise 422 faculties, 110 research and post-graduate institutes, 371 colleges and a number of special research centres. The numbers of students and of university teachers have also increased. From 1982 to 1995 the figures for students rose from 240,403 to 1,336,952, and for teaching staff, from 22,223 to 49,052. 16,035 members of the teaching staff are professors, associate professors, and assistant professors¹⁰. These numbers show the immense effort the Turkish state has made to overcome the problems posed by the old higher education system with its inadequate capacity.

Within the framework of the law and also of institutional statutes, the universities enjoy administrative autonomy. The whole system is based on the principle of accountability according to which every administrator is answerable to his immediate superior and faculty members periodically have to report on their academic work. The Higher Education Inspection Board of the Higher Education Council supervises and controls the universities, the units attached to them, and the teaching staff and their activities. The Council itself consists of 25 members, seven representing the universities, seven representing the office of the President of the Republic, seven representing the government, two representing the Ministry of National Education, with one member representing the General Staff¹¹.

The Higher Education Law was amended 19 times from 1982 to 1993, with a great deal of debate focusing on academic freedom in research and teaching. Turkish criticism has also centred on the appointment procedures for rectors and deans of faculties. Holders of these posts are no longer elected by the teaching staff, but chosen by YÖK. The main problem of Turkish higher education is to combine qualitatively high standards of study and research, and, at the same time promote quantitative expansion of the universities¹².

Non-governmental organisations (NGOs)

The Turkish state lacks the resources to respond to all of the demands of the rapidly growing and changing Turkish society. The vacuum caused by the retreat of the state from many of its traditional functions, has been filled for the last fifteen years, non-governmental organizations by reacting to the new social challenges of today's Turkey¹³. In 1996 there were an estimated 2,700 foundations, 50,000 associations and 1200 trade unions, cooperatives and professional chambers. In the last five years, significant increases have also occurred in the membership of NGOs, especially of those, which were already large and effective.

Donations are the primary income source for foundations, while the work of associations is primarily financed by membership fees. Revenues from financial investments and immovable property constitute a third income source of foundations, cooperatives and trade unions. Associations often benefit from publications and like income of cultural activities.

The term 'non-governmental' is not very clear, as organizations like TÜBİTAK or TTGV which despite their formal independence from state action, have a close relationship with the government or at least enjoy tax exemption, while others, which are less important in terms of financial power, which do not interfere with governmental interests, or which represent pressure groups, act at a greater distance from the government or within other systems of interplay between state and society. Irrespective of all these differences, the Turkish constitution does not allow the NGOs to act politically.

As to the NGOs concerned with science, they support and promote a particular scientific field or a group of fields, or they represent the professional interests of scientists, technicians and other staff scientific institutions.

From the variety of the numerous NGOs - differing in respect to goals, objectives, status and structure, number of members, financial resources and other characteristics, it is useful to give some examples of small or large organisations.

Among the NGOs in the field of science or of applied sciences the medical sciences are the best organized. Their objectives range from medical research on special diseases and their therapy (like the Leprosy Association) to the numerous medical organisations representing special fields (from the Turkish Society of Algology or the Society of Andrology to the Turkish Society for Surgery and Reconstruction).

Some of these NGOs have predecessor institutes whose founding dates back to Ottoman times. To give an example of these traditions, there is the Turkish Pharmacists, Association (*TEB-Türk Eczacılar Birliği*), which has existed under modern legal conditions since 1956. But already in 1909, there was a "Devlet-i Osmaniye Eczacılar Cemiyeti" with Turkish and a "Société des Pharmaciens de l'Empire Ottoman" with foreign pharmacists, founded to provide adequate working conditions for pharmacists, to standardise pharmaceutical products, to communicate scientific data, and to regulate the education of pharmacists¹⁴.

Some other organizations maintain the old tradition of a school, like the Mülkiyeliler Union (*Mülkiyeliler Birliği*), founded in 1946 for the graduates of the Faculty of Political Science of the University of Ankara. It considers itself as a continuation of the "mülkiye mektebi", a school for civil administrators, already famous for modern thought in the Ottoman Empire. The *Mülkiyeliler Birliği*, with 7650 members in 1995, provides scholarships, publishes a periodical and organizes conferences on subjects such as privatization or the administrative and bureaucratic problems of the state towards the year 2000.

Important scientific research in the fields of social sciences and humanities is initiated and carried out by organizations like the Economic and Social History Foundation of Turkey (*Türk Tarih Vakfı*) or the Turkish Social Sciences Association (*Türk Sosyal Bilimler Derneği*, founded in 1967), both dealing with phenomena of modern life and consequences of change in Turkish society. Both are publishing scientific periodicals. These organisations are examples of Turkish NGOs participating in the international network of scientific organisations : The Tarih Vakfı (founded in 1991) is member of the IFLA and FID - The Hague, Netherlands; the Société Asiatique and the ICA - Paris, France; the International Council of Archives - Koblenz, Germany; the International Conference of Labour Movement Historians - Linz, Austria.

Other NGOs focus on research subjects concerning national, cultural, ethnic or religious entities. Serious scientific work is, for example, done by an organisation which concentrates activities on the history of Turkish sciences and technology, the Turkish Scientific History Institute (*Türk Bilim Tarihi Kurumu*) founded in 1983.

The Eurasia Foundation (*Avrasya Vakfı*, 1993), to give another example, concentrates on countries 'sharing the life and fate of Turkey in the motherland of Eurasia'¹⁵.

Islamic history is the major field of study of the Islamic History, Art Culture and Research Foundation (1990). The Service to Science Foundation (1975) seems to identify the Koran with science in general, as its main activity is to teach the recitation of the Koran.

Often NGOs inspired by a particular ideology, belief or the memory of a person's life and works mention research activities among their main objectives. There is the case, for example, with the Ugur Mumcu Research and Journalism Foundation (1994) which, besides evaluating the works of this well-known Turkish journalist, wants to contribute to the development of modern scientific methods and techniques and to carry out research in the field of investigative journalism which had been Ugur Mumcu's professional field.

Other NGOs aim at the development and support of specific structural key institutions of Turkish science, such as the Science Centre Foundation (1995) which is dedicated to the establishment of Science, Technology and Industry Centres (the centres of excellence, see below), or the Higher Education Research Foundation (1983), which contributes to university education and research services in universities.

Until recently, records of Turkish NGOs have been kept only by government offices for monitoring purposes. Since 1995 research on NGOs has been carried out by the *Türk Tarih Vakfı*, which is to publish data on the structures and activities of Turkish NGOs - their development being an important indicator of democratization in Turkey.

Turkey and international science

Data on the financial framework of state and industry-financed science in Turkey, and on the personnel resources available to science, are given below in comparison with other OECD and EU member countries.

Table 1: Selected indicators of R&D intensity in Turkey, OECD-countries and in EU-countries in 1993¹

	GERD millions \$ PPPs ²	GERD as a % of GDP	GERD financed by industry	GERD financed by govern- ment	Total R&D personnel FTE ³ in thou- sands	Total R&D research- er FTE in thou- sands	Total R&D personnel per 10000 labour force
Total OECD	385 495.1	2.24	58.8	36.2	..	2 362.84	..
EU-15	123 056.3	1.96	53.25	39.75	1 559.05	744.84	93
Turkey	1 465.2	0.46	31.8	62.2	16.17	13.6	87

(Source: OECD, STIU databases (DSTI Division) November 95)

1 includes some provisional and/or Secretariat estimates

2 purchasing power parities

3 full-time equivalent

Turkey is among the lowest third of OECD member states, in terms of both absolute numbers and the share of R&D expenditure in gross domestic expenditure (GERD).

Industry's contribution is correspondingly low in Turkey, with more than two thirds of R&D expenditure financed by the government. Only in Greece, Iceland, Mexico and Portugal is private enterprise S&T contribution lower.

As far as R&D personnel is concerned, Turkey also ranks among the lowest third in terms of absolute numbers and share of the working population. Indeed, in terms of the

share of R&D personnel in the total labour force, only Mexico's scientists and support staff constitute a lower percentage.

Turkish science in international publications

Although Turkish R&D institutions are not very well equipped in comparison with other OECD countries and member countries of the EU, they have a relatively high level of publication activity. Within 50 countries with more than 1,000 publications over a five-year period¹⁶, Turkey has advanced from 42nd place between 1985 and 1989 to 36th place in the period between 1989_93, leaving Ireland, Hong Kong, Chile, Saudi Arabia and Nigeria behind.

Progress continued from 1994 to 1995: Turkish publication productivity in 1994 lifted Turkey to 34th place in a table based on national publication output in the sphere of basic sciences, engineering and health sciences. In terms of the publication rate, behind the ten world leaders of scientific research and publications - the USA, UK, Japan, Germany, France, Canada, Italy, Russia, Holland, and Australia-, Turkey is to be found in the mid_field among other NICs (newly industrialized countries)¹⁷.

The fact that 1995 again saw a record 30% leap over the previous year's output may be due to the TÜBİTAK programme, launched in 1993, to provide grants for internationally accepted Turkish publications¹⁸.

However, if we consider different scientific fields, it becomes apparent that the social sciences, arts and humanities are relatively under-represented. Very few Turkish publications in these fields reach an international audience. This may partly be due to the fact that topics of social research, often have only a national interest. Another cause may be the relatively low support given in the fields of humanities, arts and social sciences by Turkish funding organizations¹⁹.

If output in the social sciences, arts and humanities is negligible in terms of international recognition, a closer look at publication data on the individual medical and natural science disciplines reveals the topography of the internationally best-represented and also the best-accepted areas of research.

Measured against Turkey's average share of scientific publications in the international arena, particular fields demonstrate greater or lesser performance on the international publication scene. By applying the parameters of the international citation frequency of Turkish publications, we can also evaluate the international impact of Turkish research work on world science. As international performance does not automatically mean international reception of scientific results of a country's research, the citation impact shows, how well a country's research in a specific field is accepted by the international scientific community²⁰.

Table 2: International Turkish publication performance and citation impact from 1983_1993 (natural sciences, medical sciences)

Scientific Field	Im- Perfor- pact* mance+	Scientific Field	Im- Perfor- pact* mance+
Mathematics	0.68 0.94	Other fields of physics	0.86 0.88
Geology	1.47 0.97	Microbiology	0.88 0.59
Pharmacology	0.90 1.88	Nutrition and Agronomy	0.49 0.87
Organic Chemistry	1.32 1.82	Public Health	0.46 2.19

Inorg. Chemistry and Chemical Engineering	0.95 1.60	Gerontology	0.42 1.19
Solid-State Physics	1.57 1.00	Immunology	0.97 1.06
Ecology	0.88 1.24	Analytical Chemistry	0.76 1.49
Biotechnology	0.89 0.42	Internal Medicine	0.54 1.20
General Biology	0.89 0.46	Physical Chemistry	0.81 0.55
Nuclear Sciences	0.62 0.62	Material Sciences	0.38 0.96
Applied Medicine	0.64 0.64	General Medicine	0.73 0.45
Electronic Engineering	0.55 0.55	Pathology	0.19 0.46
Applied Physics	0.90 0.90	Neurological Sciences	1.23 1.18
Other fields of engineering	0.62 0.62		

Source: İlhan, M. *Cumhuriyet Bilim ve Teknik* 1996/478)

* measured by the citation frequency of a given publication within a certain period.

+ a ratio of the overall Turkish share of world publications to the Turkish share of world publications in a specific field.

It is apparent from Table 2 that Neurological Sciences, Internal Medicine, Gerontology, Public Health and Applied Medicine, i.e. the medical sciences, have an above-average international performance, as do Pharmacology, Organic Chemistry, various fields of Engineering, Nuclear Sciences and Analytical Chemistry among the natural sciences. As table 2 also shows, Turkish publications achieve low impact scores in Geology, Solid-State Physics and Neurological Sciences. The reason for this is *inter alia* the fact that the emphasis of Turkey's scientific activity is not on basic research but on the development of applied sciences. As a result, much of the published material takes the form of case studies and technical reports, whose conclusions cannot be generalised.

It should be mentioned at this point that such scientometric descriptions raise serious methodological problems by leaving out the conditions under which research is done and publications are produced. In particular, they ignore the barriers faced by scientists in Turkey and other NICs on the periphery²¹ in their search for recognition by the world's research centres and their publications²².

International relations

Another aspect of Turkey's participation in international scientific dialogue is joint authorship of Turkish scientists with partners from other countries.

The table below indicates Turkey's scientific relations not only with European countries, the USA, Canada and Japan, but also with Russia and two of the CIS-countries.

Table 3: Turkish joint publications by countries of co_authors in 1995

Country	Number of publications	Country	Number or publications
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US	314	Israel	12
Germany	124	Bulgaria	9
UK	105	Denmark	7
Italy	82	Sweden	7
Japan	47	Pakistan	6
France	32	Yugoslavia	6
Azerbaijan	28	Syria	5
Switzerland	26	Egypt	5
Holland	23	Greece	5
Canada	22	Malaysia	4
Russia	17	Czechoslovakia	3
Belgium	14	Poland	3
Spain	14	Norway	2
Ukraine	14	Austria	2

(Source: Çakir, S./*Cumhuriyet Bilim ve Teknik* 1996/478)

Science and technology cooperation is also a matter of intergovernmental agreements and inter-institutional arrangements, often within the framework of foreign aid for Turkey, or aid given by Turkey to developing countries, especially the newly-founded CIS states.

On the bilateral level, Turkey has signed intergovernmental agreements with Albania, Azerbaijan, Hungary, Kazakhstan, Pakistan, the Russian Federation and the United States. Inter-institutional arrangements include cooperation with the German DFG, the Italian CNR, the French CNRS, the Indian CSIR, the Egyptian ASRT and the Chinese SSTCC.

Inter-institutional cooperation includes, for example, the scientific relations of 47 German universities or faculties with Turkish universities in the fields of engineering and natural sciences²³.

On the multilateral level, Turkey takes part in scientific and technological cooperation as a member of NATO, the OECD, the United Nations, the Organisation of the Islamic Conference (OIC), the European Science Foundation (ESF), the International Council of Scientific Unions (ICSU), the World Association of Industrial and Technological Research Organisations (WAITRO), the International Institute of Refrigeration (IIR), the European Molecular Biology Organisation (EMBL/EMBO), and the European Communities' EUREKA programme.

An example of cooperation at this level is a project within the Science for Stability (SFS) NATO programme. The project's goal is to develop ecosystem models as a management tool and to coordinate measurements of the Black Sea's coastal states for the protection of the ecosystem of the Black Sea²⁴.

One example of the numerous forms of Turkish cooperation with the European Union is the programme of European Cooperation in Scientific and Technological Research (COST). COST projects have generated considerable benefits for Turkey, as seen in the case of the Veterinary Faculty of the Ankara University and 13 other projects at

universities and S&T institutions, 7 of which deal with telecommunication, two with food technology and the remainder with other subjects. Turkey also participates in other specific programmes such as AVICENNE and MED_CAMPUS. The AVICENNE projects concern environmental protection and health²⁵.

There are also several cooperation arrangements at the regional level, especially with the CIS countries (ECO- Economic Co-operation Organisation), and with the Black Sea coastal states (BSEC- Black Sea Economic Co-operation).

To give an example of such regional cooperation, the ministers representing the eleven countries of the BSCE decided in 1995 to establish a Centre for Black Sea Studies, which will have affiliates in all the 11 participating countries²⁶.

Turkish science within the national framework

Turkey is at a turning point with regard to R&D policy. Instead of direct government input and output, the public sector is now to play a supporting role in creating the conditions for technological progress to secure Turkey's integration in the world market. This change of direction is also shaping the country's science policy²⁷.

Financial and personnel situation

The following tables provide a general overview of trends in R&D resourcing and staffing as well as a sectoral breakdown based on OECD statistics.

Table 4: Total resources devoted to R&D 1983_1992

R & D ex- penditure	R & D personel				
Year	PPP \$ mil1	GERD	Number	Number FTE	Number FTE2 personel per 10 000 of labour force
1983	240.9	0.20	29,908	12,004	4,0
1990	855.6	0.33	36,376	13 ,951	6.7
1992	1,514.5	0.50	39,817	15,701	7.5

Source: OECD 1 purchasing power parity; 2 full-time equivalent

There was a modest but steady growth of financial resources invested in R&D activities from 1983_1992. In 1993 the Supreme Council of Science and Technology drew up a master plan for Turkish science policy for 1993_2003 which provides for accelerated growth so that GERD will double to 1% of GDP by 2003. Moreover, the number of researchers is planned to increase to 15 per 10,000 persons in the labour force by that year.

Table 5: R&D expenditure by sector

Sector	1990		1992	
	PPP\$ mil	%	PPP\$ mil	%
Higher Education	597,2	70	1,026,3	68
Public	84,2	10	124,4	8
Business Enterprise	174,2	20	363,8	24

Total	855,0	100	1,514,5	100
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Source: OECD

In 1993 the Supreme Council also planned to initiate a change in the distribution of sectoral R&D funding, hoping to increase the private sector's share of R&D expenditure to 30%²⁸.

Table 6: R&D personnel* by sector of employment

	1990	%	1992	%
Higher Education	28,214	78	30,172	76
Public	9,933	13	5,463	14
Business Enterprise	2,182	9	4,182	10
Total	29,908	100	36,376	100

Source: OECD

* excluding technicians and auxiliary personnel in the higher education sector

As the main performer of R&D in Turkey, the universities employ most of the R&D personnel (see table 6). According to the figures issued by the Statistical Institute for 1994, 23.2% of all R&D staff have graduated from secondary schools, 49.9% are graduates of higher education institutions with intermediate (ön lisans) or full degrees (lisans) (four years' study), and 26.9% have postgraduate (lisans üstü) qualifications.

Table 7: R&D expenditure in the higher education sector by scientific field

Scientific field	1990	1992		
	PPP \$ mil	%	PPP \$ mil	%
Basic sciences	31.6	5	55.2	5
Engineering	96.6	16	131.0	13
Health sciences	321.8	54	641.5	63
Agricultural sciences	48.4	8	52.2	5
Social sciences and humanities	98.4	17	146.3	14
Total	597.2	100	1026.2	100

Source OECD

Health sciences received the major share of R&D expenditure from 1990 to 1992. This share also showed the largest increase among all scientific fields over that period. Growth of R&D expenditure does not necessarily mean solving problems. Science policy-makers are aware of the challenges of a changing economy, including the privatization of state enterprises, the new market conditions facing national entrepreneurs within the European Customs Union and also Turkey's special role as a bridge between Europe and the CIS countries. Together with representatives of the science community, policy-makers are engaged in defining the tasks of an adequate R&D policy in order to overcome shortcomings and develop a joint support strategy²⁹.

Developments in policy planning

The overriding goal of government science policy is to lift applied science research to a higher level, thereby making medium-term technology transfer superfluous. To this end, technical education is to be improved, the role of university research strengthened, and industry encouraged to make use of university research and also contribute towards national R&D costs.

This programme is being implemented at different levels. Thus, on the level of general *organization*, it is essential that spheres of competence that evolved organically are made to act as part of a coordinated whole. This imperative lay behind the creation of the Supreme Council for Science and Technology (see above). Several ministries have also set up new R&D sections. But the foundation of a special Ministry for S&T is still under discussion. Furthermore, legal frameworks need to be established to govern combined R&D activities between private enterprises and universities, primarily in the form of patent and intellectual property protection laws. Having established a new Patent Institute, the next step in this direction is to implement the new patent law of June 1995, which replaces an old law dating from 1871. Finally, the system of R&D funding, in general, and the system of tax incentives for company R&D, in particular, have to be overhauled in order to achieve long-term R&D goals. A decree was enacted in 1995 which established a Science and Technology Fund and gave TÜBİTAK, as a central R&D body, powers to decide on the distribution of R&D support to industry.

The low salaries of university staff, their heavy teaching loads and, not least, the cumbersome bureaucratic procedures for providing research funds, as well as the often unsatisfactory facilities in laboratories and libraries, are responsible for the low research productivity of Turkish science. These factors have led, on the one hand, to an internal brain drain from the newly established universities in poor regions to relatively better equipped universities in the industrial centres of Turkey, and, on the other, to an international brain drain from Turkey to world-class research centres in Europe and the USA. Another problem is the low qualification of technicians³⁰.

At the level of *practical measures*, the education and working conditions of R&D personnel are to be improved. To improve the training of technical personnel, a Model Curriculum for Laboratory Schools was developed by the Ministry of Education and introduced in 1992. It is a secondary-level initiative designed to qualify future technicians in accordance with OECD standards. From 1992 to 1994, this curriculum was applied in 208 Laboratory Schools in 7 different regions of the country³¹.

As to standards in higher education and research, discussion is taking place on the best way to channel financial support and improve university systems in view of the gap in the quality of research and teaching that exists between the older universities in the industrial centres and the new higher education institutions recently created in less developed regions of Turkey. Attention has focused on proposals to build up "centres of excellence", concentrating research on the already best equipped research institutions, and to require other institutions to focus on the teaching and the training of technicians.

Another important tool for promoting technological change is the establishment of technoparks, two of which are run by KOSGEB together with the Istanbul Technical University and the Middle East Technical University in Ankara (see above). Both are concerned with electronics and computer-aided design/manufacturing. Another technopark, the Marmara Research Centre, was founded in 1990 in Gebze (see above).

One of the measures designed to initiate new research projects is an award programme run by TÜBİTAK for internationally accepted publications of universities and public sector institutions. The distribution of awards in 1994, shown in table 8, made under this scheme, known as UBYT (*Uluslararası Bilimsel Yayınları Tesvik Programı*), provides an insight into the most productive universities.

Table 8: Universities and researchers receiving awards from TÜBİTAK in 1994

Universities	Number of Researchers receiving awards
Hacettepe Üniversitesi (A)(1967)	828
Orta Dogu Teknik Üniversitesi (A)(1959)	512
Ankara Üniversitesi (A)(1946)	472
Istanbul Teknik Üniversitesi (I)(1944)	438
Gazi Üniversitesi (A)(1982)	302
Ege Üniversitesi (IZ) (1955)	300
Istanbul Üniversitesi (1933)	296
Çukurova Üniversitesi (Adana)(1973)	211
Bogazici Üniversitesi (I)(1971)	183
Marmara Üniversitesi (I)(1982)	143
Dokuz Eylül Üniversitesi (IZ)(1982)	142
Erciyes Üniversitesi (Kayseri)(1978)	132
Bilkent Üniversitesi (A)(1986)	128
Karadeniz Teknik Üniversitesi (Trabzon) 1958/1963	114
Ondokuz Mayıs Üniversitesi (Samsun)(1975)	101

Source: Atamer, H./*Cumhuriyet Bilim ve Teknik* 1996/473).

The author has added their location - (A) Ankara, (I) Istanbul, (IZ) Izmir - and foundation dates.

TÜBİTAK spent TL 14 billion on awards in 1994 for publications in the fields of basic sciences, health sciences and engineering sciences. Researchers from 29 universities received this financial support. The first six universities received 49% of the whole funding. Since researchers in the health sciences were most active and thus best supported, four universities with faculties of medicine (Hacettepe, Ankara, Gazi, Istanbul Üniversitesi) were awarded the highest sums.

The 15 establishments listed above (out of the 30 universities which received awards) are, with four exceptions, older universities. The four universities established in the 1980s are, like most of the older institutions, based in the three most highly developed regions - Ankara, Istanbul and Izmir. Among these four new universities one is private, the Bilkent University³². In the public sector, researchers at TÜBİTAK institutes, the Turkish Atom Energy Authority, and GATA (Military School of Medicine) also received publication awards³³.

Similar to the TÜBİTAK scheme, the newly established TÜBA also started an award programme in 1994, spending 290,600,000 TL in grants to authors of social science publications in 1994 and 1995.

TÜBA has also started a scholarship programme (Yurtiçi yurtdışı bütümleştirilmisi doktora burs program or BDBP) which is to provide scholarships for post-graduates. It is similar to the TÜBİTAK scholarship scheme, which supported 12,000 doctoral students from 1968 to 1992, of whom 550 studied abroad. Since 1993, TÜBİTAK has also provided research grants (DOPROG) for scientific collaboration with scientists of partner countries. Up to 1995, 14 research projects had been approved³⁴.

Cooperation between industry and science

Officials of Turkey's industrial associations and representatives of the universities admit that the university-enterprise relationship is, with few exceptions, not very satisfactory. Only the large state-owned companies (see above) and a few private companies perform their own technology development and R&D. The mass of SMEs import their technology and are more interested in improving production processes than in developing new products³⁵. This may have been viable in the past, but under changing market conditions technological dependency could be a major obstacle to further competitiveness. Smaller companies, which have so far shied away from making long-term R&D investment commitments, should be attracted to the opportunities for university research cooperation being supported by the government. An example of how university research is increasingly linking up with government institutions, TÜBİTAK, Turkey's private enterprises and foreign organizations, is provided by the Orta Dogu Teknik Üniversitesi (ODTÜ), i.e. the Middle East Technical University. ODTÜ cooperates with Turkish enterprises such as Akelsan, Roketsan, TAI, MKE_Mechanical and Chemical Industries and TPAO (the Turkish Petroleum Corporation). Out of the total expenditure on research in 1995, US \$ 1,360,000 were spent on contract research projects. Total funding for international projects was US \$ 6.4 million in the same year³⁶.

Joint efforts to develop private and public sector collaboration in the field of R&D lay behind the creation of the Technology Development Foundation of Turkey (TTGV - Türkiye Teknoloji Gelistirme Vakfi) in 1991. Its 40 member organizations donated TL 1.5 billion to build up the Foundation's assets and another US \$ 43.3 million were obtained through a loan agreement signed between the World Bank and the Republic of Turkey. The Foundation is an NGO (non-governmental organisation) aiming at the stimulation and encouragement of Turkish industry's investment activity in R&D. Acting either on its own or under contract, the TTGV carries out research projects in areas likely to improve the country's economic structure in line with the R&D priority areas defined by the Supreme Council for Science and Technology. Those projects are also intended to bridge technology gaps between Turkey and other nations in certain sectors of trade. The Foundation also works to strengthen the ties between Turkish industry and higher education institutions, TÜBİTAK, and other public and private research organisations. By the end of 1995, 82 industrial projects had been selected for promotion, of which over 50% dealt with information technologies and material technologies, followed by projects on biotechnology³⁷.

Research information

An indicator of the effectiveness of the different institutions of science and development is the information provision of the respective institutions.

The table below shows the distribution of information centres in the different R&D establishments in Turkey.

Table 9: Sectoral distribution of information centres 1993

Universities	38%
Public sector	31%
Private sector	16%
Foreign organisations	4%
International organisations	4%
Non-profit organisations	2%
others	5%

Source: OECD

Universities and the public sector run almost 70% of all facilities providing and processing information, half of which define themselves as information and/or documentation centres. 10% of all these units gather and handle numerical data, 5% collect, analyse and disseminate data, 15% are capable of producing their own data base. Only TÜBİTAK's bibliographic National Scientific and Technical Databases are accessible on_line. TÜBİTAK's National Scientific and Technical Databases cover 300 national periodicals published in Turkey and 3,000 scientific and technical reports of TÜBİTAK projects. The NSTD records reached 20,000 in December 1994. Turkish and English are the database languages. The other databases are used for inter_institutional or in_house information.

As far as all centres open to the public are concerned, 30% use the various databases of 30 different international information centres. DIALOG is the most used database, followed by STN International. The most widely used source of information among 50 different CD_ROM databases is MEDLINE and the Science Citation Index. Approx. 75% of the units have libraries and 22% of them have subscriptions to more than 1,000 periodicals and series³⁸.

Since 1993, access to the Internet by Turkish users has expanded rapidly. With rapidly increasing numbers of users, including scientists and scholars, Turkey is now in 30th position among the 120 participating countries in terms of internet traffic. Turkey is a member of the EUREKA project EuroCAIRN (European Cooperation for Academic and Industrial Research Networking), working on the improvement of pan_European data communication and on widening the network to countries like Canada and Japan, as well as to Central and Eastern Europe.

Within the NATO Science for Stability Programme, TÜBİTAK is carrying out a project to facilitate communication, data transfer and access to international network resources and databases in the marine institutes of the Black Sea coastal countries : Bulgaria, Georgia, Romania, Russia, Turkey and Ukraine. A long-term objective is to extend the network to include Azerbaijan, Iran, Kazakhstan, Kyrgyzstan, Pakistan and Turkmenistan³⁹.

NOTES

1. To give an example of Greek traditions in the scientific discussions of medieval east and west : the commentary of the Arabic philosopher and physician *Ibn Rüşd/Averroes* (1126_1198) on *Aristotles'* philosophy earned him the name of "the Commentator" among medieval European scholars. In his discussion of the works of the philosopher and mystic *Gazali/Algazel* (1059_1111), he defends the compatibility of the Islamic religion with Aristotelian philosophy. His ideas on the relationship between philosophy and religion led to the founding of the Paris school of Averroism (in about 1250), whose representatives expounded, at that stage of Christian religious thinking, the revolutionary thesis that something could be philosophically right even though it was theologically wrong. In the Islamic world the Ottoman Sultan *Mehmet II* (1451_ 1481), the conqueror of Constantinople, who was said to "believe in nothing", took a keen interest in questions which were also stirring Christian thinkers. He ordered that the debate on those issues be continued among Islamic scholars, the *ulema*, at the *medrese* (Islamic college) of *Aya Sofya*. For Sultan Mehmet's attitudes towards religion cf. Babinger, F.: *Mehmed der Erober und seine Zeit. Weltenstürmer einer Zeitenwende*. Munich 1953, p.452.
2. Cf. Shaw, S.: *History of the Ottoman Empire and Modern Turkey*. Cambridge 1976, p.169f.
3. Cf. Unat, E.K.: *Osmanli Imparatorlugunda bakteriyoloji ve viroloji* [Bacteriology and Virology in the Ottoman Empire]. Istanbul 1970, pp.128_129.
4. On this period cf. Berkes, N.: *Development of Secularism in Turkey*. Montreal 1964, p.93f.
5. On the *Darülfünun*: Kreiser, K.: *Deutsche Professoren am Istanbuler Darülfünun <1915-1918>*. XXIII Deutscher Orientalistentag vom 16. bis 20. September 1985 in Würzburg. In: *Zeitschrift der Deutschen Morgenländischen Gesellschaft*; Suppl. 7/1989, p. 211-218.
6. On the influence of German scientists working in Turkey cf. Erichsen, R.: *Die Emigration deutschsprachiger Naturwissenschaftler von 1933 bis 1945 in ihrem sozial- und wissenschaftshistorischen Wirkungszusammenhang*. In: Strauss, H.A et al.: *Die Emigration der Wissenschaft nach 1933*. Munich 1991, pp.73_105.
7. For a Turkish discussion of the subject cf. Boratav, K./Türkcan, E.: *Türkiye'de sanayiesmenin yeni boyutlari ve KITler* [New Dimensions of Industrialization and the State Enterprises (KIT)]. Istanbul 1993.
8. On the general structure of the Turkish administration system cf. Sencer, M: *Türkiye'nin yönetim yapisi* [The structure of Turkish administration]. Istanbul 1986; On the present position regarding individual institutions: OECD (ed.) *Reviews of National Science and Technology Policy _ Turkey*. Paris 1995. For TÜBİTAK cf. Turkey, in: *EUROscience*. Stuttgart 1995; for the development of TÜBA cf. the first numbers of the periodical *TÜBA bülteni* (December 1995 and April 1996). An example of R&D activities of traditional state-owned research institutes, such as the Sugar Institute is given in a letter of the institute's research director Nazim Taygun in *Cumhuriyet Bilim ve Teknik* (1996)510, p.4.
9. Cf. Uzun,A./Özel, M.E./Yalçın, C.: *Main trends in graduate study in basic sciences in Turkish universities: a quantitative overview*. In: *Higher Education* 20 (1990) 4, pp.485_ 497.
10. Cf. Sağlam, M.: *Intermediary Bodies and Universities: Autonomy in Turkey*. In: *Higher Education Policy* 8(1995)3, p.40_42, here p.40. Women constitute 32.2% of all university

- teachers, showing a remarkably high participation rate of women in academic professions, even in comparison with Western industrialized countries. Cf. Açar, F.: *Women and University*. In: *Education in Europe*, XVIII(1993)4, pp.65-76, here p.67.
11. Sağlam, M., op.cit., p.41.
 12. For the Turkish discussion on YÖK and the University Law cf. TÜBA (ed.): *Üniversite Yasası* [The University Law]. *Bilimsel toplantı serileri* 3. Ankara 1995.
 13. Information on the NGOs in: History Foundation of Turkey (Türk Tarih Vakfı) (ed.): *Non-Governmental Organizations Guide (Main Establishments)*. Istanbul 1996.
 14. Cf. Baytop, T. *Türk Eczacılık Tarihi* [History of Pharmacy in Turkey]. Istanbul 1985, pp. 268-272.
 15. Cf. Avrasya Vakfı Resmi Senedi. Kurulus Hükümleri [Public register of the Avrasya Foundation. Foundation principles]. 23.2.1993.
 16. Cf. İlhan, M./Türker, K.: *Dünya biliminde Türkiye'nin yeri. Türkiye'nin 1989_1993 döneminde bilimsel yayın sayısı bakımından dünya sıralamasındaki yeri* [Turkey's Place in world science in terms of publication statistics from 1989_1993. In: *Cumhuriyet Bilim ve Teknik*(1996)462, p.7. İlhan/Türker refer to: Braun,T./Glanzel, W.,/Grupp.H.: *The scientometric weight of 50 nations in 27 science areas, 1989_1993* Part I.
 17. Cf. Gakir, S.: *Türkiye: Bilimsel makale sayısında %30 sıçrama!* [Turkey: A jump of 30% in the number of publications!]. In: *Cumhuriyet Bilim ve Teknik* (1996)478, p.6_7 Gakir refers to the CD_ROM version of the SCI_data_basis. In the 1995 language table Turkey is preceded (in places 11 to 33) by : Spain, Sweden, Switzerland, India, China, Israel, Belgium, Denmark, Poland, Taiwan, Finland, Brazil, Austria, South Korea, Norway, Ukraine, South Africa, New Zealand, Greece, Hungary, Czechoslovakia, Argentina and Mexico.
 18. Cf. Atamer, H.: *TÜBİTAK, araştırmacılara 1 y ilda 14 milyar TL ödedi* [TÜBİTAK, paid 14 billion TL to researchers in one year]. In: *Cumhuriyet Bilim ve Teknik* (1996)472, pp.8_9.
 19. Cf. Pak, N.K.: *Üniversitelerde akademik yükseltmeler* [Academic careers at the universities] In: *Academic Careers at the Universities*. TÜBA Bilimsel Toplantı Serileri 4. Ankara 1996, p.9_24, here p.18; as Denkeli, Kagitçibasi Pak and Pamuk point out, the low citation rate of Turkish social science research does not automatically measure the scientific value of Turkish social science. For their arguments see Denkeli, A., Kagitçibasi C.; Pak, N., Pamuk, S.: *Sosyal bilimcilerimiz, fencilerimizden geri degil* [Our social scientists do not take second place after our natural scientists]. In: *Cumhuriyet Bilim ve Teknik* (1997)487, p.8.
 20. İlhan, M.: *Bilimde kalite degerlenmesi* [Quality measurement in science]. In: *Cumhuriyet Bilim ve Teknik*. (1996)478, p.7.
 21. For an observation of the scientific centre_periphery relationship from the aspect of a sociology of science cf. Gibbs, W.: *Lost Science in the Third World*. In: *Scientific American Research*, August 1995, pp.76-83.
 22. For a qualitative evaluation of science and education in Turkey see: Batuhan, H.: *Kann man von einer Wissenschaftspolitik der Türkei sprechen?* In Senocak, Z. (ed.): *Der gebrochene Blick nach Westen*. Berlin 1994, pp.95_137.
 23. Cf. Bundesministerium für Bildung, Wissenschaft, Forschung und Technologie (ed.): *Deutsch-türkische Hochschulkooperationen*. Koblenz 1995, here p.42.
 24. For a description of the present state of this project cf. Besiktepe, S.T.: *TÜBİTAK ve NATO Karadeniz için el ele* [TÜBİTAK and NATO hand in hand in the Black Sea]. In: *Cumhuriyet Bilim ve Teknik* (1997)501, p.10.
 25. Cf. OECD, op.cit fn. 8, pp.73_76.

26. Demirsar, M: *BSEC reviews telecommunications, transport, and energy projects*. *Turkish Daily News*, December 25, 1995.
27. Cf. Türkcan, E.: *Dünya'da ve Türkiye'de bilim ve teknoloji politikasının evrimi* [The development of science policy in the world and in Turkey]. Paper, presented at a conference of the Friedrich Ebert Stiftung, Ankara 30.3.1996, p.27.
28. Cf. TÜBİTAK (ed.): *Türk Bilim ve Teknoloji Politikası 1993_ 2003* [Turkish Science Policy from 1983_2003]. Ankara 1993, pp.5_7.
29. Cf. Türkcan, E.: *Türkiye'de bilim politikası sisteminin evrimi* [The development of Turkish science policy]. Paper, presented at the 4th National Congress on Social Sciences from 1_3 October 1995, organised by the Association of Turkish Social Sciences (Sosyal Bilimler Derneği) in Ankara.
30. Cf. for the Turkish discussion TÜBA (ed.): *Dünya'da ve Türkiye'de bilim, etik ve üniversite*. [Science, Ethics and the University in the World and in Turkey]. *Bilimsel toplantı serileri 1*. Ankara 1994.
31. Cf. The Turkish Republic _ The Ministry of National Education (ed.): *Developments in National Education/Turkey*. *International Conference of Education, 44th Session*. Geneva 1994. Ankara 1994, pp.49, 50.
32. The department of physics of Bilkent University is, measured by the number of publications in international periodicals, the most active institute after the Orta Dogu Teknik Üniversitesi. Cf. the letter of Prof. Dr. Elerman and Prof. Dr. Sultansoy to *Cumhuriyet Bilim ve Teknik*, (1996)462, p.4.
33. Cf. Atamer, H.: *Bilime 14 milyarlık tesvik*. [TL 14 billion to Turkish Science]. In: *Cumhuriyet Bilim ve Teknik* (1996)473, p.6; also Çakır, S.: *Türkiye'de 1995 bilim haritaları* [Landscape of Turkish Science in 1995]. In *Cumhuriyet Bilim ve Teknik* (1996)481, p.6.
34. Cf. TÜBA (ed.): *Türkiye Bilimler Akademisi faaliyet raporu 1 Ocak 1995_ 31 Aralık 1995*. [Activity Report of the Turkish Academy of Science 1st October _ 31st December 1995], Ankara 1996.
35. For the Turkish discussion cf. the report of a study in 1995 carried out by *Türkiye Genç İşadamlar Derneği/Young Businessmen's Association of Turkey (TÜGIAD)* (ed.): *2000'li yıllara doğru Türkiye'nin önde gelen sorunlarına yaklaşımlar. XIV _ Üniversite-sanayi işbirliği ve Arastırma_ Gelistirme*. [University-industry cooperation and Research and Development]. January 1996.
36. Information paper on the University sent to the author by Prof. Dr. Aybar **Erreur! Signet non défini.** Ertepinar, Deputy Rector of the Middle East Technical University, 5.4.96.
37. Cf. Ger, M.: *A Descriptive Analysis of R&D Activities in Turkey, (the) TTGV Experience*. Contribution to a conference on 'University, Industry and Governmental Collaboration', sent to the author by Prof. Dr. Metin Ger.
38. OECD, op. cit. fn.8, pp.63, 64 and p.125.
39. Cf. OECD, op. cit. fn.8 , pp.83_87.