HUMAN CAPITAL APPROACH TO ECONOMIC GROWTH IN TURKEY

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF SOCIAL SCIENCES
OF
THE MIDDLE EAST TECHNICAL UNIVERSITY

BY

HÜSEYİN ERGEN

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF SCIENCE
IN
THE DEPARTMENT OF ECONOMICS

SEPTEMBER 1996

Approval of the Graduate School of Social Sciences.

Prof. Dr. Bahattin AKŞİT
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

Assoc. Prof. Dr. Nazım EKİNCİ
Head of the Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science in Economics.

Prof. Dr. Zehra KASNAKOĞLU
Supervisor

Examining Committee Members

Assoc. Prof. Dr. Erol ÇAKMAK

Dr. Erdal ÖZMEN

ABSTRACT

HUMAN CAPITAL APPROACH TO ECONOMIC GROTWH IN TURKEY

Ergen, Hüseyin

M.S., Department of Economics

Supervisor: Prof.Dr. Zehra Kasnakoğlu

September 1996, 89 pages.

In this study the contribution of education to economic growth in Turkey, between 1980 and 1990, is analyzed by means of estimating production function relationships. Firstly, Cobb-Douglas production functions are estimated by OLS, for single year cross-sectional and panel data. Secondly, a difference model considering also the province-specific differences is estimated. Finally, more flexible functional forms of CES and translog functions are considered. It is concluded that the effect of education on output growth is positive, but not increasing during the decade, and also unchanging across regions. Output elasticity of the capital increases over time and gets lower for underdeveloped regions, while the reverse is true for the output elasticity of labor. It is observed that the assumption of constant returns to scale, which is assumed for Cobb-Douglas production function holds for the Turkish economy within the decade. The claims of the difference forms are not supported for Cobb-Douglas Production function. CES and Translog Functions are found to be advantageous over Cobb-Douglas production function.

Key words: Human capital, education, economic growth, production function analysis, Cobb-Douglas production function.

ÖZ

TÜRKİYE'DE EKONOMİK BÜYÜMEYE İNSAN SERMAYESİ YAKLAŞIMI

Ergen, Hüseyin
Yüksek Lisans, İktisat Bölümü
Tez Yöneticisi: Prof.Dr. Zehra Kasnakoğlu
Eylül 1996, 89 sayfa

Bu çalışmada, Türkiye'de, 1980 ile 1990 arasında, eğitimin büyümeye olan katkısı üretim fonksiyonu ilişkilerinin tahmin edilmesi yoluyla çözümlenmektedir. İlk olarak, tek tek yıllara ait çaprazlama data ile panel data için Cobb-Douglas üretim fonksiyonu en küçük kareler yöntemiyle tahmin edilmiştir. Daha sonra, illere ait değişik özellikleri de içeren bir fark modeli sınanmıştır. Son olarak, daha esnek biçimlere sahip CES ve translog fonksiyonları denenmiştir. Sonuç olarak onyıl boyunca eğitimin büyümeye olumlu, fakat artmayan bir katkısı olduğu saptanmış olup, bu katkının bölgeler arasında da farklılık göstermediği gözlenmiştir. On yıl boyunca, sermayenin üretim esnekliği zaman içinde artış gösterir ve az gelişmiş bölgelerde daha düşük olurken, emeğin üretim esnekliği için bunun tersinin doğru olduğu saptanmıştır. Cobb-Douglas üretim fonksiyonu için yapmış olduğumuz ölçeğe göre sabit getiri sayıltısının dönem içinde geçerli olduğu gözlenmiştir. Cobb-Douglas üretim fonksiyonu için fark modellerinin iddialarını destekleyen bulgular elde edilmemiştir. CES ve Translog üretim fonksiyonlarının Cobb-Douglas üretim fonksiyonuna üstünlüğü bulunduğu saptanmıştır.

Anahtar sözcükler: İnsan sermayesi, eğitim, ekonomik büyüme, üretim fonksiyonu analizi, Cobb-Douglas üretim fonksiyonu.

To Umut

ACKNOWLEDGEMENTS

My thanks are due to, first of all, Zehra Kasnakoğlu who supervised this thesis with a very generous care. I am also indebted to Erdal Özmen for his advises throughout the study and Erol Çakmak who has carefully read and corrected the text. I am very grateful to Erol Taymaz who particularly made helpful comments on more flexible functional forms and corrected some errors. I appreciate the support given to me by Feyyat Gökçe who eagerly provided his help and comments on Turkish education system. My thanks also go to C. Ergin Ekinci for editing the English of the text. As usual, the remaining mistakes are mine.

TABLE OF CONTENTS

LIST OF TABLES

TABLE

LIST OF FIGURES

FIGURE

CHAPTER 1
INTRODUCTION

It is widely believed that all the changes and the structural relations in a society can solely be attributed to some deterministic economic relationships. However, institutional factors may also be effective in explaining the changes and/or *status quo*. An example to this may be revealed by the idea that educational changes in a society can affect the economic growth significantly.

Despite the fact that economic development, to a certain extent, depends on the acceleration of capital accumulation, the provision of greater increases in commodity production depends on how productive the labor power, the current capital stock operates together, is, and how knowledge and abilities of labor power can be improved by means of education. The problem of increasing the productivity of labor power is analyzed within the human capital context in the economics literature, and basically constitutes the scope of health and education economics. When approached to the human capital from the point of view of education, it is generally recognized that education can affect the production processes in two ways: formal education and on-the-job training. This study aims at analyzing the contribution of formal education to Turkey's economic growth within the period of 1980-1990.

In Turkey, this period is frequently specified as the decade of rapid economic change and growth. A great deal of analyses have been carried out on the nature and causes of these changes and growth. In this study we also want to bring forward the effect of the educational changes on the output growth, within this period. This effect comes into mind due to the fact that the same decade is also a period of rapid changes in education.

Although qualitative and quantitative aspects of education have been widely and severely criticized at many platforms, it is observed that many structural changes were experienced during the decade. Some important changes are discussed below.

In 1983, preliminary education is defined as "the basic education" by the Law no:2843 amending the Law of Basic implemented in 1973. And the process of the formation of new schools, which primary schools and junior high schools participate in under the new title of 'the basic-education schools' has been started.

With the 1980 military government a literacy campaign has been started. This extensive and continuous campaign has involved a great deal of Turkish citizens, also by the utilization of the mass-media.

In 1982, Law of Higher Education no:2547 was introduced. This act has enabled the teacher trainining institutions to be brought under the same structure. Before this integration, there were some important restrictions concerning the qualities and quantities of the newly beginnig teachers. This system has produced an important number of new teachers to the educational system, although their qualifications are criticized.

What's more, one of the most discussed issues has been the quality aspects of the newly founded universities. Despite many difficulties, insufficiencies and lack of resources, school enrollment ratio at higher education level has increased.

The open university practices started in the mid-1970's, in order to generate a supply response to high demand for higher education and thus to provide medium level manpower to the economy, has become an institution providing the qualitative improvements for those already employed, rather than concealing the demand for higher education.

By the Law of Apprenticeship and Vocational Education some steps have been taken towards increasing the educational levels and occupational skills of those working as apprentices within the small scale enterprises, by training them in the apprenticeship centers in certain days of the week.

Private schools have grown enormously both in quantity and quality. The number of students in the Turkish private schools have more than doubled merely during the second half of the decade (Z. Baloğlu, 1990:220). As a reason for this we may recognize the increase in demand for higher quality education.

The number of schools for realizing the distinguishing function of education has rapidly increased and the student equipped with higher ability to comprehend have started to be determined more extensively before they go into the labor force.

The rates of schooling at different levels of the educational system have shown increase mainly during the second half of the decade. During the first half they were rather stable and an outstanding decrease has been observed comparing with the previous decade particularly at higher education level (Table 1.1).

The shares of public educational expenditures in the consolidated budgets and the GNP (provided on the Table 1.2) in general show a declining trend until 1987 and then a slight increase which is unable to recover the loss that occurred during the decade. Kasnakoğlu (1988) concludes that "the same trends are observed in the shares of consolidated budget to GNP and total public and Ministry of Education expenditures to GNP. [thus] Declines in the shares of consolidated budget to GNP are immediately reflected to the budget share of education"(Kasnakoğlu, 1988:4). However, increases in the shares of consolidated budget to GNP are not reflected to the budget shares of education.

This fact brings out questions such as: What must be the relation between the national output growth of a country and the investments in human capital? If these investments do not increase when the output is increasing, then which inferences are acquired from this scheme concerning the development policies of this country?

Table 1.1: Schooling rates.

Education year	*Primary school level*	*Junior high school level*	*High school level*	*Higher education*
1979-80	88.5	44.1	17.8	7.3
1980-81	87.3	43.5	17.7	6.2
1981-82	87.6	46.9	18.0	6.2
1982-83	88.3	49.9	17.2	7.1
1983-84	88.7	51.9	17.6	8.2
1984-85	90.5	52.2	17.8	9.8
1985-86	92.5	54.6	18.9	10.8
1986-87	91.5	57.4	20.1	11.2
1987-88	107.0	60.1	20.1	11.2
1988-89	105.6	57.1	19.6	12.6

Source: Z. Baloğlu(1990).

Note: 1. The generation ages are 7-12 for primary schools, 13-15 for junior high schools, 16-18 for high schools and 19-22 for higher education.

2. Concerning the primary level the percentages over 100% are related to the rate of failure and targeted to be lower than 5%.

It can be stated that developing countries have adopted a planned development understanding, because of the positive evidence from the experiences of the countries which had applied successful development plans such as France, Israel, Japan etc. The plans are applied long-term, medium-term or short-term. Turkey has preferred to realize the development by means of medium-term (5 years) plans. Plan targets for school enrollment ratios are excerpted from the fifth five years development plan and supplied on the Table 1.3. Comparing with the Table 1.1, it is evident that except for the higher education, the plan targets could not achieved during the decade.

When it is viewed from the macro scale, education was a part of the development plans. The problem from the viewpoint of education was, on the other hand, arising from the micro-planning of the education, i.e. the allocation of resources to education according to types and levels of education and the components of the educational expenditures. In 1980's and particularly in the vocational and technical education the plan targets were not reached. The main reason for this situation the system which brings about higher unemployment rates for pre-university level educated people.

Table 1.2: Shares of Educational Expenditures.

Years	*Share of the budget of the Ministry of Education in consolidated budget*	*Share of the budget of the Ministry of Education in GNP*	*Share of the budgets of the higher education institutions in consolidated budget*	*The ratio of the investment allowances of Ministry of education to General budget investment allowances*
1980	11.46	1.20	3.8	9.6
1981	9.44	2.24	3.0	11.2
1982	10.39	2.14	3.0	12.3
1983	.11.02	2.48	3.7	11.8
1984	10.39	1.85	3.6	12.2
1985	8.60	1.67	2.7	15.3
1986	8.52	1.57	3.1	16.1
1987	8.40	1.59	2.9	18.4
1988	8.62	1.74	2.9	23.8
1989	9.00	1.83	3.2	27.6

Source : Z. Baloğlu (1990).

If the problem had been solved by better macro planning approaches, then it would have been convenient to model the relationships between the growth and education by means of the macro planning models. Indeed such models planning the requirements for education for economic development are available in the literature.

Tinbergen and Boss (1964) have developed such a model which aims at the "description of the 'free' development of the educational system under the forces of supply and demand, and, therefore, at forecasting such a development." and aims at describing "the demand flows for various types of qualified manpower to be expected from the organizers of production and of education..."(Tinbergen and Boss, 1964:126). The model does not analyze the contribution of education to growth. Instead a *balanced growth rate* is determined and then adapting the model to this growth rate, the model estimates the required rates of some selected educational indicators.

According to their understanding; if the dimensions and the composition of the education system is changed in accordance with the growth of the economy then the qualitative aspects of the educational development will be obvious.

Table 1.3: Plan Targets for Schooling rates.

Education year	***Primary school level***	***Junior high school level***	***High school level***	***Higher education***
1984-85	100.0	50.8	31.9	9.0
1985-86	100.0	55.8	33.4	9.5
1986-87	100.0	61.2	35.5	10.0
1987-88	100.0	68.0	37.3	11.0
1988-89	100.0	75.0	39.4	12.0

Source: SPO (1985).

An extension of this model is applied for Turkey (Blum, 1965). In this study three planning models are applied and the results reached are that the simple basic model he firstly used would not be a practical planning instrument; and the other more complicated models' results are more acceptable. However these models assumed a simple proportional relationship between educational labor power stocks and volume of output and existing stock are optional. Blum concluded that these relationships would not be valid in the long run.

Also Sen (1964) criticized the model concluding that "it is in analyzing minimum education requirements, rather than in clarifying optimum educational planning." And regarding the educational policy and economic growth context he offers an approach involving in the analysis of production function relationships, which is the subject matter of this study.

The following chapter presents a brief review of the system and problems in education in Turkey. The third chapter examines the contribution of education to economic growth in Turkey by means of production function analyses.

CHAPTER 2
EDUCATION IN TURKEY

2.1. The System of Education

In Turkey, according to Basic Law of Education No.1739 implemented in 1973, the system of education is structured in two main parts: formal and non-formal. Formal education comprises the levels of education while non-formal education comprises education, teaching, guidance and implementations, taking place alongside formal education or outside it (Figure 2.1).

The general aim of the Law on Turkish National Education encompasses;

a) Citizens are to be brought up in a spirit true to Turkish nationalism and Atatürk's reforms and principles, dedicated to preserving and developing the national, moral, humane and cultural values of the Turkish nation, with a deep love for family, homeland and nation and fully responsible with respect to duties and responsibilities towards the republic of Turkey, which is a state governed by the rule of law, based on human rights and the basic principles as outlined in the Constitution.

b) To develop interest, ability and talent in citizens by supplying the required knowledge, thereby preparing them for life and offering them a profession to enable them to lead a happy life and contribute to the welfare of the society.

c) All this is directed towards raising Turkish citizens with a high level of prosperity leading happy lives and supporting social and cultural development in national unity, and making the Turkish nation positive, distinguished and creative partner in contemporary civilization.

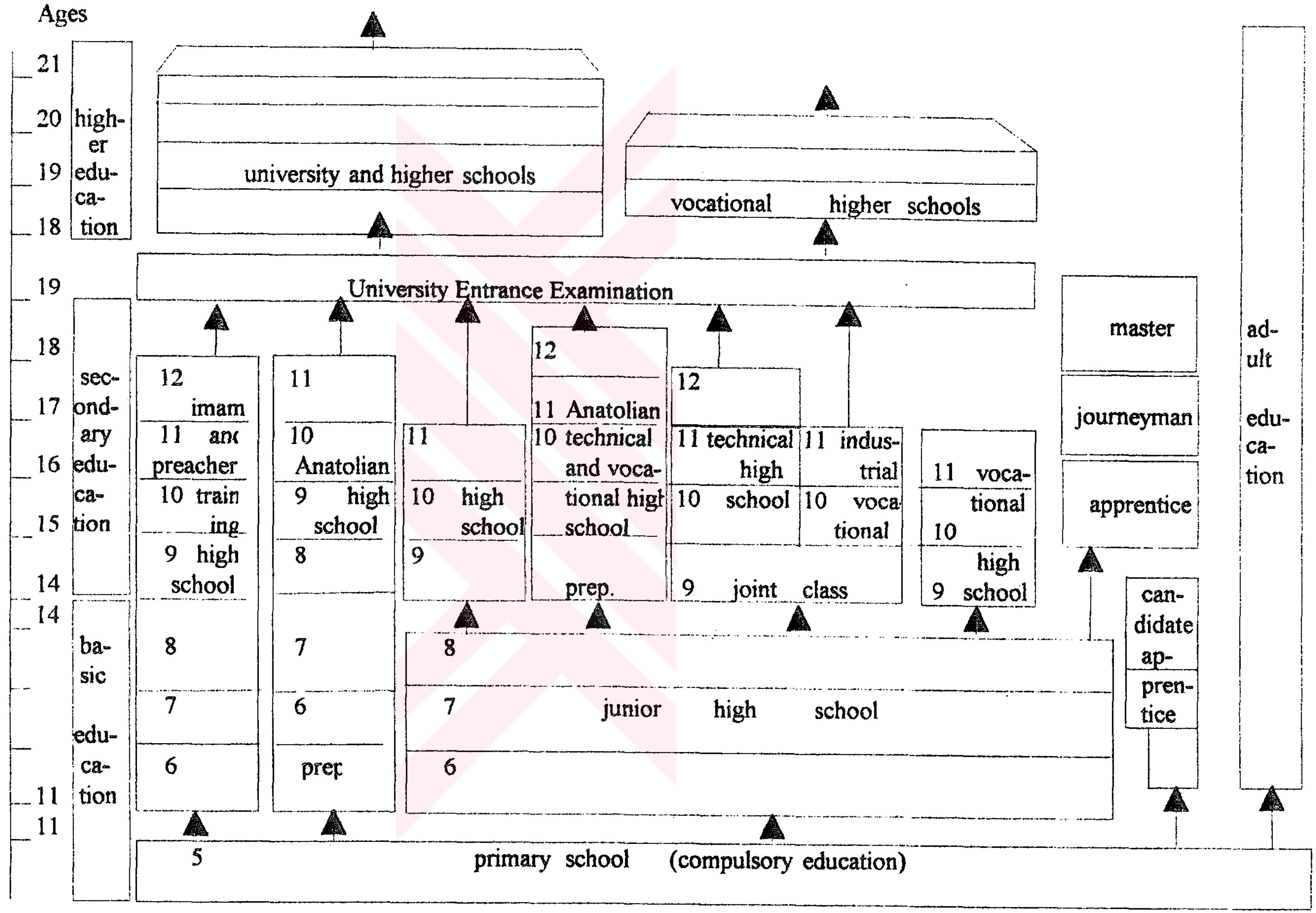

Figure 2.1. Turkish Education System (Source: Z.Baloğlu, 1990:198).

2.1.1. Formal Education

Formal education includes pre-school education, basic education, secondary education and higher education institutions.

2.1.1.1. Pre-School Education

Pre-school education is optional and aims at developing physical, mental and emotional abilities of children; helping them acquire good habits; preparing them for basic education; providing an atmosphere of growing together for children coming from poor areas; and helping them acquire an adequate knowledge of Turkish language. School enrollment rate at this level was 4.6% in 1990.

2.1.1.2. Basic Education

Basic education comprises the education of children in the 6-14 year age group. The basic education forms the basis of the National Education System and is compulsory. In accordance with the general aims and basic principles of the National Education, basic education aims at providing every Turkish child with basic knowledge, abilities, behaviors and habits which are required to be a good human being and good citizen; preparing them for higher levels of education and growing them up in line with their interests and abilities.

Although in 1973, in the Basic Law of National Education, it is stated that the basic education includes 5 years of primary school education and 3 years of junior high school education, the unification of these two levels couldn't have been realized up today. Of the students graduated from the preliminary schools, only 57% in 1987-88 and 70 % in 1993-94 are enrolled to the second stage of the basic education (MEB, 1996:4). This is mainly due to the problems in training the adequate and sufficient teachers, buildings, renovation of the curriculum and the demographic movements. Because the administration of schools is highly centralized and structured uniformly, they couldn't have operate independently as to respond the different regional conditions and requirements. In addition, the existence of junior high schools within the structure of religious schools and their different education program are another obstacle for the unification of the basic education system.

The number of student leaving the educational system after the junior high school is very low. It was 3% in 1988-89 and 8.7% in 1993-94. The rest continued to upper levels of the system.

2.1.1.3. Post-Basic Education

The post-basic education or as commonly named secondary education, encompasses general, vocational and technical education institutions. In these institutions a minimum of three years of schooling is implemented.

In the Basic Law of National Education it is indicated that the post-basic education is so arranged in the various programs or schools named high school, within an integrated system that has vertical and horizontal transitions, And the aims are to provide students with a knowledge of general culture; to acquaint them with problems of individual and communal nature and to motivate them for finding respective solutions; to instill them the strength and knowledge to participate in the economic, social and cultural development of the country and to prepare them in line with their interest and talents, for institutions of higher education. In particular three different objectives of post-basic education is specified in 1973;

a) to prepare students for institutions of higher education. This is for the general high schools with 3-year program over and above junior school education for 15-17 year age group,
b) to prepare students both for professions and for higher education institutions. This is for technical high schools with 4-year program,
c) to prepare students for active life in different occupations. And this is for the vocational high schools with a 3-year program.

The rate of enrollment of the high school graduates to a higher education institution was 23% in 1989. Entrance to a higher education institution is the only objective of a high school student, due to whether occupational or other reasons. Even the vocational high school students have been directed to this objective. In 1989, the composition of candidates applying for the university entrance examinations was as follows: 36% of them were new high school graduates, 42% of them were those who graduated from high schools previously but could not enter a higher education institution, 11% of them were those who enrolled in higher education institutions and 11% of them were others (Z. Baloğlu, 1990:122-123).

The ratio of enrollments in higher education institutions to the number of applicants of the university entrance examinations were 8.9% in 1980, 32.5% in 1985, 23.5% in 1989 and 25.5% in 1994 (MEB, 1996:4)[1]. 59% of those who couldn't pass the examinations is constituted by the general high school graduates who are not prepared for any profession (Baloğlu, 1990:124).

The difficulties in entrance in a higher education institution have led to emergence of two special institutions: one is privileged high schools and the other is private preparatory education institutions.

The privileged high schools are public or private schools which were appeared because of the demand of parents for the education of their children, to allow them to learn a foreign language and have greater chances to enter a proper higher education institution. In these schools, it's well-known that student/classroom and student/teacher ratios are kept at rational and scientific levels; adequate and qualified teachers are appointed; and attention is paid to the choice of qualified educational instruments.

Private preparatory education institutions function in two ways: first, to prepare high school graduates for university entrance examinations; and second, to prepare primary

[1] Open university is included in 1990 and 1994 ratios.

school graduates for privileged schools. Parents aiming at providing their children with a good occupation and thus a good future, are zealous to thrust their children into a pitiless race.

Emergence of these two kinds of institutions indicates that the general high schools whose aim was to prepare the students for higher education institutions have not reached their aims.

Occupational high school (except religious schools) have the junior high school graduates as inputs. There are two kinds of them; (a) those preparing for professions, i.e. vocational high schools, (b) technical high schools preparing both for professions and higher education, and the religious schools (Imam and preacher training high schools). Within these schools there were 531 thousands students in 1989, while the total number of students at post-basic education level was 1246.5 thousands.

2.1.1.4. Higher Education Institutions

Higher education institutions are arranged in accordance with the Higher Education Law No.2547 in 1981, restructuring the higher education institutions within a university framework. In accordance with Higher Education Law, a Council of Higher Education was established with the prime duty of planning, coordinating and controlling higher education. On the basis of this Law, and in accordance with the proposal submitted by the Council of Higher Education, the presidents of universities are appointed by the President of the Republic.

The aim of higher education is to educate individuals to meet the demands of the country at various levels, and in science, individuals able to raise the general level of the community and enlighten public opinion by spreading educational service orally and in writing.

Higher education includes two kinds of institutions: one is vocational higher education institutions with a two year education, and the others include graduate, bachelor and masters' degrees with at least 4 year programs. The latter comprise faculties, institutes, higher schools, conservatories, and practice and research centers.

In 1990 there were 29 universities. Today, in 1996, this number is 57. Within the same period the number of faculties rose from 212 to 422 and the number of higher schools from 219 to 481 (MEB, 1996:15). It is declared by the Ministry of National Education that the schooling rate at universities intended to rise over 30% in the year 2000. This rate was 12.6% in 1989, and 13.6% in 1994 and this 13.6% increases to 27.1% when the open university is included (MEB, 1996:2 and 15).

On the other hand, the newly founded universities are operating in great difficulties and insufficiencies concerning teaching staff, buildings, laboratories and the other education instruments. In 1990, in 29 universities of Turkey there were 408,752 students[2], and 10,273 professors (meaning 39.8 students per professor) and at total 20,272 teaching personnel (meaning 20.2 students per teaching personnel). These rates are not higher than 15% in European universities.

2.1.2. Non-formal Education

Non-formal education's goal is to reach people between 12-65 years of age and outside the school system. The purposes of the non-formal education are to teach citizens to read and write and continuously prepare opportunities to enable them to complete their incomplete education; to prepare training possibilities with the aim of acquainting persons with contemporary scientific, technological, economic, social and cultural developments; to provide education with the aim of preserving and promoting national and cultural values; to encourage behavior of understanding towards cooperation, solidarity and communal living and the adoption of a life style directed towards increasing economic strength, and to allow for correct use of leisure time.

---

[2] Those who are in open university amounted 228,000 are not included.

The non-formal education comprises three kinds of educational programs:

a) General education programs: These include literacy courses and social-cultural courses.

b) Vocational and technical education programs: These are courses open to persons with no formal education or vocational training for the purpose of teaching them a trade. These courses are offered at adult education centers.

c) Programs for apprentices, assistant masters and masters: This comprises training for persons in the 12-18 year age group who have completed their primary education but have not attended junior high schools and have not had a formal education. This training includes one day of theory in schools and 4 days of on-the job training a week.

Open University which was aiming at servicing vocational education to people by means of radio and TV, in practice, has turned out to have a function of serving the aims of those who already have a job, to ameliorate in their profession. The reason for this situation is basically some statements in the Personnel Laws, amongst the others.

2.2. Education and the Development Problem

Turkey, although, it has taken important steps on the way to industrialization, could not have reached the stage to realize the transformations for being an industrialized country, yet (F. Şenses, 1989:103). Indeed, Turkey has been called a semi-industrialized country which has come to this stage of industrialization process by importing the necessary technology for industry, and could not produce it. Turkey imports information technology, too. However in order to be an industrialized society or an information society, one has to produce the technology belonging to these societies (H.Erkan, 1994:214). Industrialization is not only an economic but also a socio-cultural phenomenon, therefore this technological lag can be attributed to a cultural lag.

During this industrialization process, while the agriculture based traditional social structure has been dissolute, the norms, values, rolls and behavior patterns of industrialized and/or information society couldn't have been established. in 1980 43.9% of the population were living in urban areas, and in 1985 this rate became 53.03%, and 59.01% in 1990 (SIS, 1992a:36). While the average annual rate of growth of population is 2.48% between 1980 and 1985 and 2.17% between 1985 and 1990 (SIS, 1992a:34), the difference is an indicator of the size of migration and social, cultural and economic problems intensified by the migration. The industrialization has brought about urbanization, but couldn't have brought about citification, because it is a mainly socio-cultural process.

The contribution of total factor productivity to growth of output is computed as 34.8%; and the compounded contribution of inputs is 65.2%. The average of industrialized countries for the contribution of total factor productivity is 50% (F. Şenses, 1989:71).

In 1988 the rate of unemployment was 8.3%; this rate has fallen down to 7.4% in 1990 (SIS, 1992b:227), and risen to 8.4 in 1991 (SIS, 1996:252). This rate was 12.3% in urban areas in 1991. Indeed these are long-term unemployment rates and the concealed unemployment is of severe dimensions. Furthermore the share of economically active population in the total population was 42.9% in 1980 % (SIS, 1992a:58) and rose to 52.2% (SIS, 1996a:253). These rates are close to those of developing countries. For example, the proportion of economically active population to the whole population is 45.6% in Uganda, 42.3% in Brazil, 55% in Thailand, and 46.1% in Jamaica. Furthermore this rate was lower in urban areas in Turkey, for example in 1991 42.2% of urban population and 65.3% of rural population were economically active (SIS, 1996a:252-253).

Concerning the distribution of income the picture was of no better quality either. The share of the highest 20% of the population from the national income was 49.9% and that of lowest 20% was 5.2% in 1987 (SIS, 1996a:635). The national income shares of the highest and lowest 20% of the population were 62.6% and 2.4% in Brazil in 1983, 39.5% and 5.8% in England in 1979, and 41.0% and 6.8% in Italy in 1986 (SIS, 1996a:635).

The social and economic structure of Turkey very briefly presented above may be an indicator emphasizing that she is a developing country. In this part of our study, briefly discussed the importance of amelioration in education to and with the development policies formed and/or to be formed in Turkey.

In order to further development, in other words to reach the optimum rate of growth and change a particular change in the structure and occupational composition of the manpower is required. And the technology in the country must change and develop in line with the changing occupational qualifications and requirements. For this reason the need for manpower that have knowledge, ability and formation to use the developing technology is very strong in Turkey. Growing up such a manpower is recognized to be possible only by means of the adaptation of education to changing requirements of the production processes. For the direction and quality of education to adapt the economic requirements there is need to an equilibrium between the economic and social development objectives and the educational policies. Taken into consideration that there are two purposes of education from the viewpoint of economics, of which the first is to prepare people to be more productive producers, and the second is to prepare them to be rational consumers. Therefore, the necessity of a consensus among the aims of education and the social-economic changes that economic development brings about appears to be a more compelling fact.

However, in Turkey, although the necessity that for the requirements of economic development the national education policy must be redefined or revised is recognized clearly, any action towards an educational policy in line with the economic development purposes cannot be seen (TED, 1978:45).

In Turkey, the necessity of national education to develop in conformity with the economic development plans takes place among the principles of national education. In the article 14th of Basic Law of Education No.1739 which implemented in 1973 it is stated that: "The development of National Education is planned and realized in accordance with economic, social and cultural development goals, considering also the education-manpower-employment relationships and in a way emphasizing the vocational and technical education required for providing necessary technological progressions in industry and in agriculture."

Since 1963, the beginning of the planned development period, the basic problems and the proposals for their solutions have been reflected to the development plans and National Education Councils. The scope of our study comprising the years 1980-1990, is the periods of two plans. The Fourth Five Years Development Plan encompasses the years 1973-1983, and the Fifth Five Years Development Plan Encompasses the years 1985-1989.

In the Fourth Five Years Development Plan, the problems of education system that were on the agenda is summarized as follows: The education possibilities have not been generalized to individuals in an efficient, and egalitarian way. Education system has fallen short of conforming with the changing social conditions. Insufficient buildings and educational instruments have caused the quality of education to decrease. Concerning secondary education targeted improvements couldn't have been reached in vocational and technical schools.

In the fourth plan, it is stated that the educational system within an integration together with the other systems, will be institutionally structured consistent with the technological and economical structure. In this plan, for the secondary education the vocational and technical education is emphasized and in all the levels of education, the non-functional contents of education is suggested to be altered.

During the fourth plan, in 1981 the 10th National Education Council have met. In the 10th Council it is stressed that the educational system brought by the Basic Law of National Education and the principles on the flow of students and vertical and horizontal transitions couldn't have been realized. In the 10th Council the education system was taken into consideration and analyzed in their totality. The proposed model aimed at administrating and integrating the compulsory 8 years basic education and the 3 years secondary education. The secondary education is proposed to be a framework composed of a uniform, multifunctional general high schools with varying programs and vocational and technical schools (N.Tural, 1988:259).

In 1982, 11th National Education Council have met and in this Council the conditions and problems of teachers and educational staff within the educational system are discussed.

The Fifth Five Years Development Plan comprises the period between 1985 and 1989. In this plan it is emphasized that: during the previous plan period although there were some quantitative increases in the education system, the same result haven't been reached in terms of qualitative aspects. The system could not succeded sufficiently in bringing up good human beings, good citizens and good professionals.

In the fifth plan, education is taken into consideration as a lifetime process and in the all levels and kinds of education a qualitative increase together with quantitative increases is aimed at. In the plan it is targeted that the vocational and technical education would be structured so as to be preferred to general high schools.

In the development plans, in general, realization of three basic goals for the system of education is emphasized (N. Tural, 1988:261):

a) to bring up labor power having the quality and quantity that society needs,

b) to provide all the citizens with at least basic education to grow up good human beings and good citizens,

c) to provide social justice and opportunity egality in the system of education.

A great deal of educational goals proposed within the development plans couldn't have been put into practice. Although there are quantitative increases in the system, the quality of it has not been dealt with as much.

The basic education which is compulsory and took place in the development plans as a social strategy could not have been extended to the corresponding age group. In terms of basic education and literacy ratios, the regional differences are at significant levels.

For instance, in 1985 while 82.1% of the total female population was literate, in Hakkari 23.4% of the female population was literate (M. Adem, 1993:47).

Despite the importance attached to the vocational and technical education in the development plans, in the 1990s Turkey is , in proportions, below the level reached in 1950-51. Between 1970 and 1990, while the rate of increase of enrollments in the vocational and technical high schools is 376%, this rate is 1246% for Imam and preacher training high schools. The aggregate average increase in the secondary school level during the same period is 267.8% (Z. Baloğlu, 1990:133). In the commercial and tourism education, the student share increased to 19% in 1990, but the same ratio is decreased to 0.2% for the agricultural vocational high schools (M.Adem, 1993:49).

While Turkey was spending effort to be industrialized by means of these development plans, the Western industrialized countries have passed the stage of being an industrialized society and advanced towards the information society. The problem before Turkey is now, to be able to move towards industrialized and information societies simultaneously. According to Hüsnü Erkan (1994:229) an education system which is restraining rather than inducing the abilities of individuals is dominant. An educational and cultural policy providing the society with the basic values and motives of a society depending on achieving competition, innovation and creativeness, and institutional policies inducing achieving abilities in the society are needed. Without establishing these policies, without improving the type of entrepreneur and informatic individuals, it is hard to build the information society.

CHAPTER 3

CONTRIBUTION OF EDUCATION TO ECONOMIC GROWTH

3.1. A Review of the Literature

The contribution of education to economic growth can be measured directly through growth accounting. Economic growth is measured by changes in national income at full employment and constant prices. The traditional theory of economic growth naively views the output growth as a product of the accumulation of the physical capital (investment) and the productivity of capital, that is

$$\Delta I/I = \Delta S/S \quad \text{and} \quad I/Y = S/Y = s$$

in full employment equilibrium, where I is investments, S is savings, Y is output and s is savings ratio. Average and marginal propensities are assumed to be equal and constant: $\Delta Y/\Delta K = Y/K = \sigma$. The change in the output capacity (ΔY_c) is equal to the change in the capital stock due to current investment (I) multiplied by the productivity of capital (σ). Full employment growth requires the change in output capacity to be equal to the change in demand for output (ΔY_d). In fact, ΔY_d is the product of the multiplier and the net increments to current investment, i.e.

$$\Delta Y_c = \Delta Y_d = (1/s)\,\Delta I.$$

$$\Rightarrow I\sigma = (1/s)\Delta I \;\Rightarrow\; \sigma s = \Delta I/I \;\Rightarrow\; \sigma s = \Delta K/K$$

which is the full employment growth rate. In other words,

$$Y_g = (I\sigma)/Y \;\Rightarrow\; (sY\sigma)/Y = s\sigma.$$

This scheme suggests that the formation of physical capital through savings and net investments plays the dominant role in the growth of the output. Similar results can be obtained from production functions by employing the growth accounting. Production function approach considers the output to be produced by a series of inputs (or factors of production) by means of an aggregate production function like

$$Y = f(K, L, D).$$

where K is physical capital, L is labor force and D is the arable land. The total differential of this function with respect to time (t) is

$$\frac{dY}{dt} = \frac{dK}{dt}\frac{\partial f}{\partial K} + \frac{dL}{dt}\frac{\partial f}{\partial L} + \frac{dD}{dt}\frac{\partial f}{\partial D}, \qquad \text{and}$$

$$\frac{dY}{dt} = \frac{dK}{dt} f_K + \frac{dL}{dt} f_L + \frac{dD}{dt} f_D,$$

where f_i is the marginal product of the i[th] factor. Assuming that the arable land is fixed and dividing both sides by Y, we obtain the rate of growth of output in terms of the rates of growth of capital and labor:

$$\frac{1}{Y}\frac{dY}{dt} = \frac{dK}{dt}\frac{f_K}{Y} + \frac{dL}{dt}\frac{f_L}{Y}.$$

By definition, dK/dt is equal to invesment rate. When we first divide and then multiply the last term on the right hand side by L, we obtain the product of rate of growth of labor and the share of labor in total output:

$$g_y = \frac{I}{Y} f_K + \frac{1}{L}\frac{dL}{dt}\frac{f_L L}{Y}.$$

Noting that g_i are the rates of growth of output and labor and k is the investment-output ratio, we conclude with growth accounting scheme:

$$g_y = k f_K + g_L s_L.$$

However, empirical evidence shows that this proclamation is not valid. Results of several attempts to estimate these production function relationships indicate that the increases in the conventional factors of production do not explain all the increases in output. In other words, the sum of the terms on the right hand side is generally less than the rate of growth in output. The rest of the output increase was attributed to a *residual factor.* This residual is presumed to be the technological change. R. M. Solow (1956) observed that technology was possibly embodied in new physical investment;

i.e. the quantity of the physical capital stock changes with both replacement investment and net capital formation. K. J. Arrow (1961) noted that technological change was a function of learning by doing and thus embodied in qualitative changes in factors of production. N. Kaldor and J. Robinson tend to emphasize the effects of income distribution and stress lifetime consumption and savings patterns.

From the point of view of residual factor approach, technological change means that more amount of output can be produced by the same amount of factors as a result of the technical progress in the inputs and in the production process. Technical changes are of two kinds: embodied and disembodied. Disembodied technical changes are those which are not preserved within the production factors and which are not influencing the qualities of the production factors. The availability of better infrastructural facilities and better reallocation of resources are examples for this kind of technical changes. Embodied technical change, on the other hand, explains the improvements in the quality of factors. Better educated labor force is an example of the technical changes embodied within the labor; and better machinery and equipment is an example of technological changes embodied within the physical capital.

Thus, technical changes embodied within the labor are considered to be an investment in human capital. Investment in human capital can take place in the above growth accounting scheme in alternative ways. One is the exposition of T. W. Schultz (1961), and the other is that of E. F. Denison (1962).

First, Schultz's exposition involves in distinguishing two kinds of capital: Physical capital (K) and human capital (H). The human capital figure enters into the growth accounting scheme as investment in education:

$$g_Y = \frac{I_K}{Y} r_K + \frac{I_H}{Y} r_H + g_L s_L.$$

where I_H/Y is the educational investment-output ratio interpreted as the proportion of national income devoted to education in a given year; and r_H is the social rate of return of education. The contribution of education term can be disaggregated into the contribution of particular educational levels. For example if one is interested in primary (p), secondary (s) and higher (h) levels of education:

$$g_Y = \frac{I_K}{Y} r_K + \frac{I_p}{Y} r_p + \frac{I_s}{Y} r_s + \frac{I_h}{Y} r_h + g_L s_l$$

Secondly, Denison's exposition involves in distinguishing several nonhomogenous labor inputs based on the educational level, which implies a growth accounting scheme as:

$$g_y = kf_K + g_p s_p + g_l s_l + g_h s_h.$$

In Denison-type calculation, we multiply the rate of growth of a given educational input by the income share of attendants in the labor force having the same educational qualification. On the other hand, in Schultz-type calculation, the contribution of education to growth is derived from the measures of factor rentals.

The standard growth accounting methodology with human capital specifies an aggregate production function of Cobb-Douglas type :

$$Y_t = A_t K_t^{\alpha} L_t^{\beta} H_t^{\gamma} e^{\varepsilon_t}.$$

Taking the natural logarithms and first differences the above Cobb-Douglas aggregate production function becomes:

$$\begin{aligned}(\ln Y_T - \ln Y_0) = (\ln A_T - \ln A_0) + \alpha(\ln K_T - \ln K_0) + \beta(\ln L_T - \ln L_0) \\ + \gamma(\ln H_T - \ln H_0) + (\varepsilon_T - \varepsilon_0).\end{aligned}$$

The empirical analyses of this aggregate production function can be utilized in order to attribute the input changes over time to output changes. However, many difficulties appear in trying to realize this analysis. The difficulties to a large extent emerge from the use of a single production function for the whole economy, whilst in fact, there are many differences among regions concerning the production techniques and these differences in most cases are not separately identifiable. Another source of the difficulties is the variation in data: it is possible that because physical and human capital are accumulated factors, they will be correlated with the error term.

Earlier cross sectional analyses such as Hayami and Ruttan (1976), Yamada and Ruttan (1980), Arrow, Chenery, Minhas and Solow (1961), Antle (1980), Evenson and Kisley (1975), Nguyen (1979) which are all within the scope of testing the agricultural productivity differences on cross-country data basically assumed the homogeneity of the production function across countries. The authors within the framework of education's contribution to economic growth including the progenitors Denison (1971) and Schultz (1971) and the others such as Psacharopoulos (1973), Selowsky (1969) and Griliches (1970) also considered a common underlying aggregate production function. They assumed that all producers from every region of the different countries had access to same technology.

Mundlak and Hellinghausen (1982) provided a variable coefficient model with heteroscedastic error components. They defined the technology as a collection of techniques represented by different microproduction functions. Then they defined a vector of state variables expressing the choice of a technique. After the elimination of the non-significant variables from regression they used a method based on combination of multiple comparisons and principal components analyses. At the end, they obtained the estimates of the total contribution of all components "under the premise that various forms of human capital are capital items and their expansion is constrained by the amount of capital in the economy."(Mundlak and Hellinghausen, 1982:671).

Hayami and Ruttan attributed a special notion to aggregate production function: It must be the envelope of the all neo-classical production functions because of its reference to very long run. Lau and Yotopoulos (1989) extended Hayami and Ruttan's model to capture the country specific aspects and this model constitutes the subject of the section 3.2.2.

3.2. The Model

The approach used in this study involves the estimation of a cross-sectional Cobb-Douglas production function for sixty-seven provinces of Turkey. This is actually Hayami and Ruttan's (1970) definition of "meta-production function". They utilized a Cobb-Douglas function because of its 'ease of manipulation and interpretation'. They also tried a more complicated function of the CES type, but the results show that CES type production functions do not necessarily yield better results than the conventional form.

For a single province, i, the production function is generally defined as different from that of all other provinces, i.e.,

$$(1) \qquad Y_{it} = f_{it}(K_{it}, L_{it}, ED_{it}, t) \qquad i = 1, \dots, 67$$

where the Y_{it} is the GDP produced in province i, during the year t; K_{it} is the observation on the physical capital stock for i th province and t th year; L_{it} is the number of persons attaining in the production activities at t th year, in i th province; ED_{it} is the measured value for the human capital for province i for year t; and t is a time index taking place for the technical change.

However, in many times due to lack of sufficient data to carry out the estimation of the individual production functions on time series data; and due to well-known difficulties concerning the estimation of such functions including the insufficient variation in the data which results in unreliability and underidentification of the estimated coefficients and the difficulties concerning the identification of the technological differences within the production functions of the individual provinces, the equation (1) is not utilisable. This issue leads to the basic assumption underlying the meta-production function concept, i.e.; the assumption of lumping into a unitary production function the provinces which indeed differ in their individual production functions because of the differences in the technological standards. This assumption claims that regardless of provinces in which producers are located, they all have potential access to the same technology, but each may choose to operate on different parts of it, depending on specific circumstances determined by the environment. In other words, the full ranges of technological alternatives described by the meta-production function are only partially available to individual producers in a particular province at a particular period of time. Therefore, the production functions showing common underlying peculiarities across provinces are:

$$(2) \qquad Y_{it} = f_t(K_{it}, L_{it}, ED_{it}, t) \qquad i = 1, \ldots, 67.$$

Hayami and Ruttan defended the meta-production function by specifying that this function relates to the secular period. In a two factors world, capital is fixed in the short run and the labor is the only variable factor. In the long run, capital is released, but the potentially available technology constraints the production activities. In the secular period technology is also released to admit producers to have access to potentially discoverable knowledge.

In fact, the assumption of a common production function across provinces is a testable hypothesis. In order to test this hypothesis, the production function may be estimated separately for different groups of the provinces. The grouping may involve in specifying a level of national income per capita or a level of agricultural/industrial output measure. Another criterion may be generated by means of socio-economical index that is considered to be developed for the generation of an alternative proxy for physical capital measure by the use of principal components analysis. Another way to test this hypothesis may be the introduction of intercept and slope dummies for the regional differences and to test the joint significance of them; and in our study we choose this way to test for the structural changes.

3.2.1. Hayami and Ruttan Meta-Production Function

Hayami and Ruttan meta-production function approach (Hayami and Ruttan, 1970) to the estimation of equation (2) involves two steps. Firstly, this approach considers the estimation of,

$$\ln Y_{it} = \beta_0 + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 ED_{it} + u_{it}. \qquad (3)$$

$\beta_0 = \ln A$[3] and stands for the technical change. β_i, $i = 1,2,3$, is interpreted in two ways: (a) as the output elasticity of i th factor and (b) as the share of income earned by i th factor. For example β_2 is the (a) output elasticity of labor, i.e. $(\%\Delta Y)/(\%\Delta L)$ or $(\Delta Y/\Delta L)(L/Y)$ the marginal products times the inverse of average products, (b) share of real national income earned by labor, wL/pY, (from $\Delta Y/\Delta L = w/p$, where w:wages and p:aggregate price level). In a two-factor world, β_1 and β_2 are assumed to sum up to unity, which we assumed as an underlying assumption of Cobb-Douglas production function, and which indicates the first degree homogeneity, namely constant returns to scale. u_{it} is a stochastic disturbance term. In Hayami and Ruttan model, human capital is treated as the third factor entering in the production function. Therefore, the intercept term mainly explains the technological change, under the assumption that the above equation is correctly specified. The other factors that may be explained in this term are the natural resources, the degree of competition, cultural incentives, socioeconomic structure of the institutions etc. Technical change embodied in the capital, discussed earlier, is also omitted in this model due to data inavailability and we assumed that its effect is not significant, which is a testable hypothesis. The disturbance term is assumed to have the following properties:

$$\begin{aligned}
&E(u_{it}) = 0 && \forall i, \\
&V(u_{it}) = \sigma^2 && \forall i, \\
&C(u_{it}, u_{i't'}) = 0 && \forall i, i', t, t'; i \neq i', t \neq t'.
\end{aligned}$$

and it is assumed that the stochastic disturbance term is uncorrelated with the independent variables of (3), so that the OLS estimator is BLUE.

---

[3] A comes from the conventional Cobb-Douglas production function. See the discussion on section 3.1 on page 22.

The equation (3) can be extended to test the differences among groups of provinces differing in the level of development. In accordance with the criterion discussed above, a related grouping can be performed. In order to explain the effects of these differences across provinces, the equation (3) takes the form of;

$$(4) \qquad \ln Y_{it} = \beta_0 + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 ED_{it} + \beta_4 PD_{it} + u_{it},$$

where PD_{it} is a dummy variable for the level of underdevelopment and takes the value 1 for less developed provinces and 0 for developed provinces. The choice of the proper dummy is discussed in Appendix A.

Here we assume that there is no interprovincial difference other than that represented by PD_{it}. Even though the measurements, definitions and quantities of inputs across provinces are completely same in our model, the actual efficiencies of the inputs may differ because of the existence of interprovincial differences in the basic economic environment (climate, topography, infrastructure, etc.). Also, they may differ in accordance with the differences in the levels of the technical efficiency (the ability of producing outputs from given quantities of inputs). If these differences are ignored, the resulting estimated production function is likely to be biased.

By means of structural difference analysis, we may test the equation (3) whether it is homogeous across provinces or not. In particular, we may extend equation (4) so as to include slope dummies as well. And equation (4) becomes,

$$(4a) \qquad \begin{aligned} \ln Y_{it} = {} & \beta_0 + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 ED_{it} \\ & + \beta_4 PD_{it} + \beta_5 PD_{it} \ln K_{it} + \beta_6 PD_{it} \ln L_{it} + \beta_7 PD_{it} ED_{it} + u_{it}. \end{aligned}$$

Now equation (4a) is our unrestricted model for the test of the joint significance of the intercept and slope dummies; and if we reject the null hypothesis of no interprovincial difference, we may conclude that the production functions differ between developed and underdeveloped regions.

A further extension of equation (3) is the test of the stability of the meta production function over time. To do this, the data are pooled. In this model, the slope coefficients are assumed to be fixed over time and provinces; and the intercept terms are changing over time and across provinces. The disturbance term is assumed to access the same properties with the previous models. In fact, this extension enables us to test for the technical change by means of the year dummies. Then equation (4) becomes;

(5) $$\ln Y_{it} = \beta_0 + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 ED_{it} + \beta_4 PD_{it} + \beta_5 T_{i1} + \beta_6 T_{i2} + u_{it}.$$

where T_{i1} and T_{i2} are time dummies. T_{i1} takes the value 1 for the the observations related to 1985 and 0 otherwise and T_{i2} for 1990 accordingly. We may introduce two kinds of panel data: one for pooling only 1980 and 1990 observations and the other for pooling 1980, 1985 and 1990 observations. We again extend the equation so as to include the slope dummies and we obtained the unrestricted model for the estimations on panel data for 1980 and 1990.

(5a) $$\begin{aligned} \ln Y_{it} &= \beta_0 + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 ED_{it} \\ &+ \beta_4 PD_{it} + \beta_5 PD_{it} \ln K_{it} + \beta_6 PD_{it} \ln L_{it} + \beta_7 PD_{it} ED_{it} \\ &+ \beta_8 T_{i2} + \beta_9 T_{i2} \ln K_{it} + \beta_{10} T_{i2} \ln L_{it} + \beta_{11} T_{i2} ED_{it} + u_{it}. \end{aligned}$$

For the estimations on panel data for 1980, 1985 and 1990, we make use of a more extended version of eq.(5):

(5b) $$\begin{aligned} \ln Y_{it} &= \beta_0 + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 ED_{it} \\ &+ \beta_4 PD_{it} + \beta_5 PD_{it} \ln K_{it} + \beta_6 PD_{it} \ln L_{it} + \beta_7 PD_{it} ED_{it} \\ &+ \beta_8 T_{i1} + \beta_9 T_{i1} \ln K_{it} + \beta_{10} T_{i1} \ln L_{it} + \beta_{11} T_{i1} ED_{it} \\ &+ \beta_{12} T_{i2} + \beta_{13} T_{i2} \ln K_{it} + \beta_{14} T_{i2} \ln L_{it} + \beta_{15} T_{i2} ED_{it} + u_{it}. \end{aligned}$$

Equation (5b) is the unrestricted model for the estimations of panel data obtained by pooling 1980, 1985 and 1990 observations. By testing the joint significance of intercept and slope time dummies, we may observe the structural change in the production function between years.

3.2.2. Lau and Yotopoulos Approach to Meta-Production Function

Lau and Yotopoulos approach to the meta-production function is to generalize Hayami and Ruttan approach by allowing the specific effects pertaining to different provinces (Lau and Yotopoulos, 1989). They point out firstly that even if the quantities of all inputs are the same, the quantities of outputs may differ due to differences in the levels of technical efficiency across provinces.

Secondly, they assume that independent variables are not directly comparable, or *efficiency equivalent* across provinces. They are comparable only after the multiplication of the quantity of each factor by a constant province and factor specific scalar conversion factor, i.e. efficiency factor. Therefore, the efficiency equivalent input is given by

(6) $$X^*_{ijt} = A_{ijt}(t)X_{ijt}.$$

$i=1,...,67;$ $X_j=K,L,ED;$ $t=1980,1985,1990.$ A_{ijt} are unknown and unobserved constant efficiency factors. X_{ijt} are the measured quantities of independent variables of the i th province in the t th year. The time index indicating the technical change is now embodied in the augmentation factors. One implication of the assumptions of the model is that the measured inputs in a province may be converted into equivalent units of measured inputs in another province. Another is that the meta-production function is assumed to apply to all provinces only in terms of efficiency equivalent quantities of outputs and inputs, i.e.

$$(7) \qquad Y_{it}^{*} = A_{i0}(t)^{-1} f(K_{it}^{*}, L_{it}^{*}, ED_{it}^{*})$$

$$\text{where} \quad \begin{aligned} Y_{it}^{*} &= A_{i0}(t) Y_{it}, \\ K_{it}^{*} &= A_{iK}(t) K_{it}, \\ L_{it}^{*} &= A_{iL}(t) L_{it}, \\ ED_{it}^{*} &= ED_{it} + A_{iE}(t). \\ i &= 1, \ldots, 67. \end{aligned} ,$$

A_{i0} indicating the efficiency of the i th province in terms of measured quantities of output and is the possibly time varying level of the technical efficiency of production. Also, labeled as the output efficiency in the i th province at time t. The efficiency equivalent measure of the human capital variable is assumed to be obtained through addition, whilst the other variables are converted through multiplication. Furthermore, the augmentation factors for output, physical capital and labor are assumed to have constant exponential form with respect to time and for human capital, assumed to have linear form with respect to time.

$$(8) \qquad \begin{aligned} A_{i0}(t) &= A_{i0} e^{c_{i0} t}, \\ A_{iK}(t) &= A_{iK} e^{c_{iK} t}, \\ A_{iL}(t) &= A_{iL} e^{c_{iL} t}, \\ A_{iE}(t) &= A_{iE} + c_{iE} t. \end{aligned}$$

The right hand side terms are constant. So, the efficiency equivalent meta- production function in Cobb-Douglas form for empirical estimation in loglinear form (Lau et al., 1993) is;

$$(9) \qquad \ln Y_{it} = -\ln A_{i0}(t) + \ln Y_0 + \beta_K \ln K_{it}^{*} + \beta_L \ln L_{it}^{*} + \beta_E ED_{it}^{*} + u_{it}.$$

Substituting the definitions in (7) and (8) into (9) yields,

$$\ln Y_{it} = \ln\left(A_{i0}e^{c_{i0}t}\right)^{-1} + \ln Y_0 + \beta_K \ln\left(A_{iK}e^{c_{iK}t}\right) + \beta_K \ln K_{it}$$
$$+ \beta_L \ln\left(A_{iL}e^{c_{iL}t}\right) + \beta_L \ln L_{it}$$
$$+ \beta_E\left(ED_{it} + A_{iE} + c_{iE}t\right) + u_{it}.$$

rearranging

$$\ln Y_{it} = \ln Y_0 - \ln A_{i0} - c_{i0}t + \beta_K \ln A_{iK} + \beta_K c_{iK}t + \beta_K \ln K_{it}$$
$$+ \beta_L \ln A_{iL} + \beta_L c_{iL}t + \beta_L \ln L_{it}$$
$$+ \beta_E A_{iE} + \beta_E c_{iE}t + \beta_E ED_{it} + u_{it}.$$

and further

$$\ln Y_{it} = \ln Y_0 + \left(-\ln A_{i0} + \beta_K \ln A_{iK} + \beta_L \ln A_{iL} + \beta_E A_{iE}\right)$$
$$+ \left(-c_{i0}t + \beta_K c_{iK}t + \beta_L c_{iL}t + \beta_E c_{iE}t\right)$$
$$+ \beta_K \ln K_{it} + \beta_L \ln L_{it} + \beta_E ED_{it} + u_{it}.$$

defining A_{i0}^* and c_{i0}^* from the last equation

(10) $$\ln Y_{it} = \ln Y_0 + \ln A_{i0}^* + c_{i0}^*t + \beta_K \ln K_{it} + \beta_L \ln L_{it} + \beta_E ED_{it} + u_{it}.$$

by taking the first differences of equation (10) we obtain

$$\ln Y_{it} - \ln Y_{it-1} = (\ln Y_0 - \ln Y_0) + (\ln A_{i0}^* - \ln A_{i0}^*) + \left[c_{i0}^*t - c_{i0}^*(t-1)\right]$$
$$+ \beta_K \ln K_{it} - \beta_K \ln K_{it-1} + \beta_L \ln L_{it} - \beta_L \ln L_{it-1}$$
$$+ \beta_E ED_{it} - \beta_E ED_{it-1} + u_{it} - u_{it-1}$$

which yields in

(11) $$\ln Y_{it} - \ln Y_{it-1} = c_{i0}^* + \beta_K\left(\ln K_{it} - \ln K_{it-1}\right) + \beta_L\left(\ln L_{it} - \ln L_{it-1}\right)$$
$$+ \beta_E\left(ED_{it} - ED_{it-1}\right) + \left(u_{it} - u_{it-1}\right).$$

and by taking the first difference of (11) we obtain the second difference of (10),

$$
\begin{aligned}
(12)\quad [(\ln Y_{it} - \ln Y_{it-1}) - (\ln Y_{it-1} - \ln Y_{it-2})] = \beta_K [(\ln K_{it} - \ln K_{it-1}) - (\ln K_{it-1} - \ln K_{it-2})] \\
+ \beta_L [(\ln L_{it} - \ln L_{it-1}) - (\ln L_{it-1} \ln L_{it-2})] \\
+ \beta_E [(ED_{it} - ED_{it-1}) - (ED_{it-1} - ED_{it-2})] \\
+ [(u_{it} - u_{it-1}) - (u_{it-1} - u_{it-2})].
\end{aligned}
$$

We introduce stochastic disturbance terms ε_{it} into the second difference form of the natural logarithms of the aggregate production function. It is assumed that ε_{it} have the following properties

$$
\begin{aligned}
&\varepsilon_{it} = [(u_{it} - u_{it-1}) - (u_{it-1} - u_{it-2})], && \\
&E(\varepsilon_{it}) = 0 && \forall i,t, \\
&V(\varepsilon_{it}) = \sigma^2 && \forall i,t, \\
&C(\varepsilon_{it}, \varepsilon_{i't'}) = 0 && \forall i,t, \quad i \neq i', \quad t \neq t'.
\end{aligned}
$$

the stochastic disturbance terms ε_{it} have identical variances and are uncorrelated across provinces. However, if we make the Gauss-Markov assumptions on equation (3), the variance of the equation (11) is not equal to σ^2,

$$
\mathrm{E}(u_{it} - u_{it-1})^2 = \mathrm{E}(u_{it})^2 + \mathrm{E}(u_{it-1})^2 + 2\mathrm{E}(u_{it}u_{it-1}) = 2\sigma^2.
$$

and accordingly,

$$
\mathrm{E}(\varepsilon_{it})^2 = \mathrm{E}[(u_{it} - u_{it-1}) - (u_{it-1} - u_{it-2})]^2 = 2\sigma^2.
$$

Thus, the variance of our new disturbance term is still assumed to be homoscedastic. In fact, all the standard errors must be calculated on the basis of the heteroscedasticity-consistent covariance matrix estimators introduced by H.White (1980), in case the presence of heteroscedasticity causes the OLS estimator not to be BLUE. By means of heteroscedasticity consistent standard errors, OLS estimators are still 'Linear Unbiased' but no longer BLUE.

3.3. Variables and Data

In this section we provide detailed information on the collection and provision of the data and the variables used in the estimations presented in the section 3.4 and in the Appendices B and C. The data are presented in Appendix A.

3.3.1. Output

The real output corresponds to the Gross Domestic Product (GDP) at 1987 constant purchaser prices. The data for 1990 are obtained from State Institute of Statistics (SIS) (1996b). The data for the years 1980 and 1985 are computed by multiplying the shares of provinces in GDP, which are available in Özötün (1988), by the GDP values discounted for 1987 prices, which are available from SIS publications (1994). Indeed Özötün (1988) calculates the GDP for provinces the years 1978 through 1986 and the method of calculation is consistent with the SIS observations, because Özötün uses exactly the same techniques as that of SIS. The method briefly involves in finding out the value added by provinces, created by sectors and subsectors and aggregating them for each province. So that GDP at current prices is obtained. Then an implicit GDP deflator is created from the value addeds by sectors, provided by SIS at current and constant prices every year. However, the composition of GDP differs in Özötün (1988) and SIS (1996b); for example, the value addeds for non-profit organisations are absent in the GDP definitions of the former. Therefore, the aggregates obtained from Özötün (1988) do not coincide with the values from SIS (1994), while aggregates obtained from SIS (1996b) do.

For 1990, observations for the newly founded provinces must be added to the provinces from which they were separated, in order to make the data comparable. For this purpose, we added the 1990 observations of newly founded provinces Aksaray, Bayburt, Karaman and Kırıkkale to those of Niğde, Gümüşhane, Konya and Ankara respectively. In SIS (1996b) the observations of Şırnak and Batman are not separately presented for 1990 and are included in those of Hakkari, Mardin and Siirt, thus we did not need to adjust them. The observations obtained are presented at Table A.1.

3.3.2. Physical Capital

Due to the unavailability of direct observations on the physical capital a proxy was used. In the literature many different proxies are tried. Psacharopoulos (1973) estimates incremental capital output ratios (ICOR) and multiplies them by gross national products in order to reach the physical capital. Hayami and Ruttan (1970) use livestock and machinery without labeling them as the physical capital. Lau et al.(1993) use industrial electricity consumption. Benhabib and Spiegel (1994) use the investment flow data to obtain the estimates of capital stock.

For cross-province analyses, the capital stock data are not available for all cases in Turkey. However, the industrial electricity consumption data (measured in Mwh) are available by province from the Turkish Electricity Institution (TEK) publications (presented at Table A.2. For the present, we have these data for the use as a proxy for physical capital. To develop an alternative for this proxy, we have considered a social development index for Turkey by provinces. Such an index can be computed by the method of principal components analysis. Such a study in fact was performed by Ö.Kulakoğlu (1995). For this analysis we must use data related to physical capital such as number of plants in manufacturing industry, value added per capita in manufacturing industry, number of construction licenses and electricity consumption in industry. However, we tried the index computed by Ö.Kulakoğlu (1995) for Turkey, for 1990, in single year estimations (in models 3a,.3, 4 and 4a), but could not find a plausible result.

3.3.3. Labor Force

The data on the labor force are obtained from the censuses of population and refer to employed population (The employed part of the economically active population) by

Table 3.1: Weights of Distribution of the Observations Belonging to Newly Founded Provinces.

	Batman	*Şırnak*
Hakkari	_	0.180675
Mardin	0.129666	0.590200
Siirt	0.870334	0.180675

12 years of age and over. For 1990 the observations for the newly founded provinces Aksaray, Bayburt, Karaman and Kırıkkale are added to that of Niğde, Gümüşhane, Konya and Ankara respectively. The observations for Şırnak and Batman are distributed between Hakkari, Mardin and Siirt by means of the population weights of the districts which were tied to these provinces before separation. These weights are given on the Table 3.1. The data on the employed population are presented at Table A.3.

3.3.4. Human Capital

The proxy used for the human capital input is the average education year per person in labor force. Average education years are computed from the population data by provinces, by employed population and by the graduation status. Number of people with primary education is multiplied by 5, number of people with junior high school education is multiplied by 8, number of people with high school education is multiplied by 11 and the number of people with university education is multiplied by 15; the aggregations of all divided by labor force for that province. The result is average education years for labor force for provinces, and presented at Table A.4. The average education years for whole population are also computed and provided at Table A.4a, for the purposes of comparison.

In literature, human capital has been approximated generally by enrollment ratios representing the investment levels in human capital, and the literacy rates which is a stock variable. Hayami and Ruttan (1970) use school enrollment ratio and the rate of literacy alternatively as data for general education and the data for technical education pertaining the agricultural labor force. Psacharopoulos (1973) uses the average education years multiplied by the yearly social cost of schooling. Lau et al. (1993) use the average education years for labor force. Benhabib and Spiegel (1994) estimate the relationship between average years of schooling in the labor force and past enrollment ratios. Islam (1995) considers two different proxies, one is the average schooling years in the total population over age 25, and the other is based on secondary schooling information only.

3.3.5. Dummy Variables

We made use of two kinds of dummy variables. First, we tested the structural change in terms of time. For this purpose, we introduce 'T1' taking the value 1 if the corresponding year is 1985 and 0 otherwise, and 'T2' taking the value 1 if the year is 1990 and 0 if otherwise. We have also introduced slope dummies with the above variables.

The second kind of dummy variables considers the regional differences. We named this dummy as the 'underdevelopment dummy' indicating that it takes value 1 if the province is not developed and 0 if the province is developed. To define this underdevelopment dummy, we considered three alternatives. First is the provincial per capita GDP (PD), taking value 1 if the per capita GDP is less then the country average, and 0 if otherwise. The second is the industrial/agricultural GDP ratio (DD), taking the value 1 if the ratio is less than 1, and 0 if the ratio is greater than 1. The last is the social development index computed by Ö. Kulakoğlu (1995) for Turkey for 1990 (SD), taking the value 1 if the index is less then 0, and 0 if the index is greater than 0. We have tried these three alternatives of regional dummies in the estimations and chosen the one with the highest t-ratio in almost all cases. This was PD. PD, DD, and SD are presented at Table A.5.

3.4. Estimation Results

3.4.1. Estimation Results of Hayami and Ruttan Meta-Production Function

We have estimated Hayami and Ruttan Meta-Production function by two methods. First, we made use of single year observations by using the equations (3), (4) and (4a). In equation (3), we include a human capital proxy i.e. education variable into the conventional two-inputs Cobb-Douglas production function. In equations (4) and (4a), we extend the model for regional differences. Secondly, we tried two definitions of panel data: one obtained by pooling 1980 and 1990 observations and the other obtained by pooling 1980, 1985 and 1990 observations. For the former definition of panel data estimations, we made use of equations (3), (4), (4a), (5) and (5a). For the latter definition of the estimation of panel data we additionally made use of equation (5b). In equations (5), (5a) and (5b), we further extend the model to observe the changes over time.

For Hayami and Ruttan meta-production function we have tried a variety of combinations and found that the best models are the unrestricted models: equation (4a) for the single year estimations, equation (5a) for the former definition of panel data estimations, and equation (5b) for the latter definition of panel data estimations. We have tested models above for model selection by two methods: first, by making use of RESET-test and second, by testing the joint significance of regional and time differences.[4]

[4] In almost all models, we found that intercept terms are not individually significant. We presented the estimation results of models without an intercept term in Appendix B.

We concluded from the Hayami and Ruttan estimations that there was a possible need to employ an additional variable indicating the embodied technical change in capital, namely the capital jelly. However, observations for such a variable are not available for cross-provincial data. It is recomended that the models considering the capital as an endogenous variable must be tried[5]. However, one again faces the data problem in attempting such models.

3.4.1.1. Single Year Estimations

Firstly, we have seperately estimated equation (3) for years 1980, 1985 and 1990. The results are at Table 3.2. In the first columns of each part, we presented the conventional Cobb-Douglas (Model (3a)), and in the second columns we allowed the education variable to enter (Model (3)). We observed from the RESET test that the models are not correct except Model (3) for 1990. This means that there is either an omitted variable case or a wrong functional form. Throughout the text we try to get an answer to this question.

The estimated coefficients of labor are between 0.77 and 0.92 (Table 3.2). The output elasticity of labor is highest in 1980, gets lower in 1985 and increases slightly in 1990 where it is over 0.8. On the other hand, the output elasticity of capital increases as the time passes. Concerning the model (3) coefficient of capital is 0.12 in 1980, 0.2 in 1985 and 0.24 in 1990, indicating that the output elasticity of capital is doubled during the decade. In other words, in 1990 capital's share of gross domestic product (GDP) has doubled since 1980. This may be partially because of the relative decrease in labor's share in GDP which was 0.89 in 1980 and decreased to 0.82 in 1990, and partially because of relatively capital using techniques in the production processes. Our results show that the intercept term is not significant in all cases. This means that

[5] See Benhabib and Spiegel (1994) and Islam (1995).

Table 3.2: Estimation Results for Equation (3). (Single years) N=67

GDP=ln of (Gross Domestic Product)	GDP80 Model(3a)	GDP80 Model(3)	GDP85 Model(3a)	GDP85 Model(3)	GDP90 Model(3a)	GDP90 Model(3)
constant	-.483	-.243	.047	-.273	-.594	-.594
	(-.526)	(-.364)	(.052)	(-.453)	(-.796)	(-1.44)
capital (in ln)	.201	.116	.309	.195	.326	.241
	(7.439)	(5.138)	(8.903)	(7.503)	(10.05)	(8.520)
labor (in ln)	.915	.888	.770	.796	.807	.819
	(10.19)	(13.60)	(8.145)	(12.72)	(9.627)	(12.62)
education	_	.286	_	.312	_	.251
		(7.633)		(9.126)		(6.622)
R-square	.898(.894)	.947(.944)	.905(.903)	.959(.957)	.927(.924)	.957(.955)
F-statistic	280.66	373.92	306.59	494.93	404.87	465.24
st.error of model	.305	.221	.309	.204	.295	.228
SSR	5.948	3.090	6.097	2.626	5.579	3.289
Q(RESET)	F(1,63)	F(1,62)	F(1,63)	F(1,62)	F(1,63)	F(1,62)
functional form	22.649	5.054	14.851	2.737	5.877	.192
[probability]	[.000]	[.028]	[.000]	[.103]	[.018]	[.662]
Q(WHITE)	F(1,65)	F(1,65)	F(1,65)	F(1,65)	F(1,65)	F(1,65)
heteroscedasticity	2.381	.349	3.110	.884	3.513	.188
[probability]	[.128]	[.557]	[.082]	[.351]	[.065]	[.666]

Note: 1. Estimations are carried out by MFIT286.

2. Numbers in parentheses below the coefficients of independent variables are corresponding t-ratio

3. Numbers in brackets below the diagnostic test statistics are corresponding F-probabilities.

4. Numbers in parentheses next to R-squares are adjusted R-squares.

5. The dependent variable GDP, and capital and labor enter to the regression loglinearly, while education enters linearly.

technical changes disembodied in inputs like better reallocation of resources and improvements in organizations, affect the production processes neither positively nor negatively. This shows that -because the intercept term corresponds to ln*A* in Cobb-Douglass production function- the effect of what *A* indicates is unitary[6]. The inclusion of human capital proxy increases the goodness of fit parameter. The coefficient of education is between 0.25 and 0.31. This, for 1990,

---

[6] The insignificance of the intercept implies that lnA is 0. Then A is 1. If a is above 1, the production function curve shifts upward; and if it's below 1, the production function curve shifts downward (in a two dimensional, one factor world. Concerning the isocosts, the production function shifts inward and outward if *A* is greater and smaller than 1, respectively.

Table 3.3: Wald Tests of Restrictions of $\hat{\beta}_1 + \hat{\beta}_2 = 1$. on Hayami and Ruttan Meta-Production Function.

year	test statistic	
	Conventional Cobb-Douglas (Model (3a))	*Cobb-Douglas with Education (Model (3))*
1980	2.530 [.112]	0.004 [.947]
1985	1.202 [.273]	0.289 [.865]
1990	4.522 [.033]	1.431 [.232]
1980/1985	0.540 [.463]	0.140 [.708]
1980/1985/1990	3.170 [.075]	0.034 [.853]

Note: Test statistics has $X^2(1)$ distribution and number in brackets are corresponding probabilities.

means that if the average education years of employed population increases by 1 year, this increases the GDP by 25%. Another important result is that the models with the education variable have homoscedastic standard errors, which is in accordance with our Gauss-Markov assumptions. On the other hand, the conventional Cobb-Douglas functions suffer from heteroscedasticity, thus their OLS estimators are biased. Because the extended models are homoscedastic we do not need to calculate the White's heteroscedasticity-consistent standard errors. From the estimation of the single year Cobb-Douglas functions we conclude that the inclusion of the education variable is necessary and the effect of education is positive.

One of the basic assumptions of the model is related to conventional inputs: whether the model shows constant returns to scale. To test the hypothesis of constant returns to scale, we used the Wald-statistic which has a X^2 distribution and the results are shown at the Table 3.3. The test results indicates that the assumption of first degree homogeneity holds for the conventional Cobb-Douglas function at 5% significance level, except for 1990. For the extended model for education, we conclude that the output elasticities of conventional inputs also sum up to unity.

In order to test the hypothesis of no separate production functions among the developed and under developed provinces we may run equations in two groups. However, in order not to complicate the tables, we may do the same test by using the dummy variables and test the joint significance of them. In particular, we estimate equation (4), and (4a) in which we include slope dummies as well. Here we restate the equation (4a).

$$\text{(4a)} \qquad \begin{aligned} \ln Y_{it} &= \beta_0 + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 ED_{it} \\ &\quad + \beta_4 PD_{it} + \beta_5 PD_{it} \ln K_{it} + \beta_6 PD_{it} \ln L_{it} + \beta_7 PD_{it} ED_{it} + u_{it}. \end{aligned}$$

where PD is an underdevelopment dummy taking the value 1 if the per capita GDP is below the country average and 0 if otherwise. The estimation results of equations (4) and (4a) are given at Table 3.4. Now, equation (4a) is our unrestricted model and we tested the joint significance of the intercept and slope dummies and we cannot accept the null hypothesis, i.e., the production functions differ between developed and underdeveloped regions. The test results are presented at Table 3.5. The test results indicate that slope terms are not significantly different for 1985 and 1990 while we cannot reject the effect of these terms for 1980. However, we cannot reject the structural regional differences indicated by the intercept dummies in all separate year estimations. This is an expected result, because the Hayami and Ruttan Meta-Production Function does not consider the provincial or regional differences as it is assumed to be the 'envelope' of the all Cobb-Douglas production function. We have shown that this assumption does not hold for Turkey for 1980, 1985 and 1990.

Concerning the models (4) and (4a)[7], the intercept dummy is significant when the slope terms are not included. Its sign is negative as expected and indicating that the production activities are "less" efficient in less developed regions. Another important result related to this unfavorable effect for underdeveloped regions is that this effect

---

[7] Concerning the estimation of equations (4) and (4a), we again observed no heteroscedastic standard errors. The functional forms are all correct except for the equation (4) of 1980.

gets greater by time: it's 0.19 in 1980, 0.22 in 1985, and 0.24 in 1990. This indicates

Table 3.4: Estimation Results for Equation (4). (Single years) N=67

GDP=ln of (Gross Domestic Product)	*GDP80 Model(4)*	*GDP80 Model(4a)*	*GDP85 Model(4)*	*GDP85 Model(4a)*	*GDP90 Model(4)*	*GDP90 Model(4a)*
constant	.157	-.322	.216	-.173	-.313	-.740
	(.238)	(-.378)	(.372)	(-.229)	(-.511)	(-.904)
capital (in ln)	.117	.293	.187	.247	.229	.219
	(5.387)	(4.362)	(7.678)	(3.968)	(8.531)	(3.162)
labor (in ln)	.882	.757	.797	.758	.820	.859
	(14.06)	(7.767)	(13.679)	(8.469)	(13.434)	(9.268)
education	.230	.208	.252	.277	.190	.199
	(5.432)	(2.600)	(6.898)	(3.505)	(4.643)	(2.224)
PD	-.189	1.005	-.221	.752	-.236	.943
	(-2.518)	(.765)	(-3.274)	(.626)	(-3.044)	(.729)
*PD*capital*	_	-.174	_	-.054	_	.029
		(-2.417)		(-.777)		(.368)
*PD*labor*	_	.072	_	-.007	_	-.111
		(.534)		(-.053)		(-.817)
*PD*education*	_	-.008	_	-.047	_	-.028
		(-.089)		(-.516)		(-.271)
R-square	.952(.949)	.959(.954)	.965(.963)	.967(.963)	.962(.960)	.963(.959)
F-statistic	305.801	195.705	431.147	245.069	397.045	219.279
st.error of model	.213	.202	.190	.191	.215	.219
SSR	2.803	2.399	2.239	2.145	2.861	2.819
Q(RESET)	F(1,61)	F(1,58)	F(1,61)	F(1,58)	F(1,61)	F(1,58)
functional form	5.003	1.520	1.827	.212	.016	.497
[probability]	[.029]	[.223]	[.181]	[.647]	[.901]	[.484]
Q(WHITE)	F(1,65)	F(1,65)	F(1,65)	F(1,65)	F(1,65)	F(1,58)
heteroscedasticity	.452	.051	1.120	.191	.001	.005
[probability]	[.504]	[.822]	[.294]	[.664]	[.974]	[.945]

Note: 1. Estimations are carried out by MFIT286.

2. Numbers in parentheses below the coefficients of independent variables are corresponding t-ratio

3. Numbers in brackets below the diagnostic test statistics are corresponding F-probabilities.

4. Numbers in parentheses next to R-squares are adjusted R-squares.

5. The dependent variable GDP, and capital and labor enter to the regression loglinearly, while education enters linearly.

Table 3.5: Tests of Joint Significance for Structural Change.

restriction (Variables deleted from the equation)	**the test statistic**				
	1980 (The unrestricted model is eq.(4a))	**1985** (The unrestricted model is eq.(4a))	**1990** (The unrestricted model is eq.(4a))	**1980/90** (The unrestricted model is eq.(5a))	**1980/85/90** (The unrestricted model is eq.(5b))
PD, PDK, PDL, PDED	F(4, 59)=4.246 [.004]	F(4, 59)=3.307 [.016]	F(4, 59)=2.460 [.055]	F(4, 122)=9.066 [.000]	F(4, 185)=10.871 [.000]
PDK, PDL, PDED	F(3, 59)=3.311 [.026]	F(3, 59)=0.860 [.467]	F(3, 59)=0.296 [.828]	F(3, 122)=8.654 [.000]	F(3, 185)= 10.177 [.000]
T2, T2K, T2L, T2ED	–	–	–	F(4, 122)=6.565 [.000]	F(4, 185)=5.200 [.001]
T2K, T2 L, T2ED	–	–	–	F(3, 122)=3.091 [.030]	F(3, 185)= 3.226 [.024]
PDK, PDL, PDED, T2K, T2L, T2ED	–	–	–	F(6, 122)=6.676 [.000]	F(6, 185)= 7.957 [.000]
PD, PDK, PDL, PDED, T2, T2K, T2L, T2ED	–	–	–	F(8, 122)=10.750 [.000]	F(8, 185)=10.332 [.000]
T1, T1K, T1L, T1ED	–	–	–	–	F(4, 185)=6.275 [.000]
T1K, T1L, T1ED	–	–	–	–	F(3, 185)= 3.486 [.017]
PDK, PDL, PDED, T1K, T1L, T1ED	–	–	–	–	F(6, 185)= 7.739 [.000]
PD, PDK, PDL, PDED, T1, T1K, T1L, T1ED	–	–	–	–	F(8, 185)=9.935 [.000]
T1, T1K, T1L, T1ED, T2, T2K, T2L, T2ED	–	–	–	–	F(8, 185)=4.755 [.000]
PD, PDK, PDL, PDED, T1, T1K, T1L, T1ED T2, T2K, T2L, T2ED	–	–	–	–	F(12, 185)=8.811 [.000]
PDK, PDL, PDED, T1K, T1L, T1ED, T2K, T2L, T2ED	–	–	–	–	F(9, 185)=8.329 [.000]

Note: 1. PD is regional dummy and PDX is related slope dummy. T2 is time dummy for 1990 and T1 is time dummy for 1985, and T1X and T2X are slope dummies. K stands for capital, L for labor and ED for education.

2. Numbers in brackets below the test statistics are corresponding F-probabilities.

that infrastructural and conjectural changes are getting unfavorable in underdeveloped regions. In other words, the effect of disembodied technical changes to the growth of GDP gets lower by 0.19 in 1980, by 0.21 in 1985, and by 0.24 in 1990 in underdeveloped provinces[8]. The output elasticity of capital is between 0.12 and 0.23 for model (4) and between 0.22 and 0.29 for model (4a), for developed regions. For underdeveloped regions, in 1980, the output elasticity of capital decreases by 0.17. On the other hand the output elasticity of labor does not change significantly when the dummy variables are included. The effect of education is again significant and positive, and between 0.19 and 0.28, and does not show difference between regions. We obtained the smallest effect of education when the effects of capital and regional differences are highest -in 1990 (4) and (4a). Except that of capital in 1980, the slope terms are individually insignificant and we have rejected their joint significance as well. To conclude from the single year estimations, we observed that there is no significant difference in output elasticities of labor and capital and the effect of education, and that there is significant differences in disembodied technical change between developed and underdeveloped regions.

3.4.1.2. Estimation of Panel Data

Use of panel data enables us to introduce time dummies. We made use of two kinds of panel data: the first is obtained by pooling the observations related to 1980 and 1990, and the second is obtained by pooling the observations related to 1980, 1985 and 1990. For the former definition of panel data we made use of equations (5) and (5a). For the latter definition of panel data we further extended the model to equation (5b).

The estimation results for the panel data including 1980 and 1990 observations are presented at Table 3.6. Concerning the equation (3), the results are quite similar: the intercept term is not significant, the output elasticity of capital decreases when the education variable is included. Lau et al. (1993) findings for Brazil show a significant intercept term indicating the effect of the technological change shifts the production function inward and when the education variable is included the effect of technological

[8] The production function curve shifts downward, or isocosts shift outward for underdeveloped regions, indicating less amounts of production at a given income level.

Table 3.6: Estimation Results for Panel Data. T=1980,1990, N=134

GDP 1980/90 (in ln)	*GDP Model(3a)*	*GDP Model (3)*	*GDP Model(4)*	*GDP Model(4a)*	*GDP Mod(5.1)*	*GDP Model(5)*	*GDP Mod(5a.1)*	*GDP Model(5a)*
constant	.529	.277	.974	-.676	.136	.656	1.568	1.283
	(.700)	(.423)	(1.555)	(-.865)	(.226)	(1.083)	(1.733)	(1.305)
capital	.291	.198	.190	.378	.183	.183	.157	.344
(in ln)	(12.050)	(7.768)	(8.165)	(6.404)	(8.216)	(8.216)	(5.351)	(5.947)
labor	.753	.782	.773	.589	.782	.782	.684	.530
(in ln)	(10.073)	(12.092)	(12.836)	(7.560)	(13.570)	(13.570)	(7.958)	(5.789)
education	–	.231	.169	.216	.311	.248	.364	.358
		(6.774)	(4.891)	(3.124)	(8.836)	(6.267)	(7.463)	(4.573)
PD	–	–	-.322	-.224	–	-.224	–	-.242
(intercept dummy)			(-4.600)	(-.187)		(-3.106)		(-.217)
*PD*capital*	–	–	–	-.211	–	–	–	-.210
(slope dummy)				(-3.256)				(-3.481)
*PD*labor*	–	–	–	.234	–	–	–	.238
(slope dummy)				(2.005)				(2.185)
*PD*education*	–	–	–	-.094	–	–	–	-.080
(slope dummy)				(-1.186)				(-1.067)
T2 (time)(1990=1)	–	–	–	–	-.296	-.224	-2.459	-1.677
(intercept dummy)					(-4.997)	(-3.625)	(-2.066)	(-1.553)
*T2*capital*	–	–	–	–	–	–	.084	.060
(slope dummy)							(1.821)	(1.459)
*T2*labor*	–	–	–	–	–	–	.135	.106
(slope dummy)							(1.143)	(1.002)
*T2*education*	–	–	–	–	–	–	-.113	-.137
(slope dummy)							(-1.666)	(-2.190)
R-square	.869 (.867)	.903 (.901)	.917 (.914)	.931 (.927)	.919 (.916)	.924 (.921)	.926 (.922)	.943 (.938)
F-statistic	433.224	403.088	354.476	242.158	364.298	312.902	225.710	183.712
st.error of model	.374	.322	.300	.277	.296	.287	.286	.255
SSR	18.291	13.519	11.614	9.636	11.327	10.533	10.286	7.929
Q(RESET)	F(1,130)	F(1,129)	F(1,128)	F(1,125)	F(1,128)	F(1,127)	F(1,125)	F(1,121)
functional form	27.363	13.071	9.396	1.681	9.731	7.898	4.866	.329
[probability]	[.000]	[.000]	[.003]	[.197]	[.002]	[.006]	[.029]	[.567]
Q(WHITE)	F(1,132)	F(1,132)	F(1,132)	F(1,132)	F(1,132)	F(1,132)	F(1,132)	F(1,132)
heteroscedasticity	.441	.048	.106	.533	.385	.384	1.038	1.416
[probability]	[.508]	[.828]	[.745]	[.467]	[.536]	[.536]	[.310]	[.236]

Note: 1. Estimations are carried out by MFIT286.

2. Numbers in parentheses below the coefficients of independent variables are corresponding t-ratios.

3. Numbers in brackets below the diagnostic test statistics are corresponding F-probabilities.

4. Numbers in parentheses next to R-squares are adjusted R-squares.

5. The dependent variable GDP, and capital and labor enter to the regression loglinearly while education enters linearly.

change decreases, and capital and labor are not influenced by this inclusion. Our findings, however, indicate a relationship between the education (i.e. embodied technical change in labor) and capital. It is strongly possible that a variable indicating the embodied technical change in capital called as *capital jelly* in literature, is missed in the model (William H. Branson, 1979:540-542). Concerning the equation (4), we again found similar results to those obtained from the single year estimations. When the underdevelopment dummy enters to the model the coefficient of education gets lower a little bit, from .23 in (3) to .22 in (4a). However, for eq.(4a), the slope dummies for capital and labor, this time, are significant. The output is more elastic to capital in developed provinces indicating a relatively capital saving technology in underdeveloped provinces, and this affects the production in underdeveloped provinces unfavorably: the output elasticity of capital is .167 in underdeveloped provinces (.378-.211=.167, where .211 is the coefficient of the slope dummy for capital). The coefficient of slope dummy for labor is positive, indicating that the output elasticity of labor is higher in underdeveloped regions, namely a labor using production technology. The effect of education on production does not differ between regions[9].

To test the structural change between 1980 and 1990 we estimated the equation (5) which introduces a time dummy. We extended the equation (5) so as to include the slope dummies and we obtained the unrestricted model for the estimations on panel data for 1980 and 1990, namely the model (5a). Here we again restate equation (5a):

$$\text{(5a)} \qquad \begin{aligned} \ln Y_{it} &= \beta_0 + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 ED_{it} \\ &+ \beta_4 PD_{it} + \beta_5 PD_{it} \ln K_{it} + \beta_6 PD_{it} \ln L_{it} + \beta_7 PD_{it} ED_{it} \\ &+ \beta_8 T_{i2} + \beta_9 T_{i2} \ln K_{it} + \beta_{10} T_{i2} \ln L_{it} + \beta_{11} T_{i2} ED_{it} + u_{it}. \end{aligned}$$

Estimations of equations (5) and (5a) with and without underdevelopment dummies are at the last part of the Table 3.6. Concerning the last column -herein we presented the unrestricted model (5a), we conclude, comparing with model (4a), that the inclusion of time dummies lowers the output elasticity of labor and that of capital while raises the effect of education, and does not influence the coefficients of underdevelopment dummies. When only the intercept time dummy is included (models (5) and (5.1)) we observed that during the decade there is a technical technical regress, which is evident from the negative and significant coefficient of that dummy. When the

[9] From the Model (4a) at Table 3.5 we observed that when the slope dummies are suppressed (Model (4)) the functional form is no longer correct.

slope dummies are also included (model (5a)) the intercept dummy is no longer significant, whereas the time effect of education is negative and significant. This means that concerning the production activities, increases in average education years of employed population was more effective in 1980 comparing to 1990. In the seventh column, model (5a.1), we observed a significant intercept term, but there may be a functional form misspecification. The joint significance of time and underdevelopment dummies are also tested and listed at Table 3.5. In each case we again reject the null hypothesis of no structural change over time and no structural difference across regions. The joint significance tests suggest that Hayami and Ruttan Meta-Production Function is not homogenous across provinces in Turkey between 1980 and 1990. Because the assumption of homogeneity across provinces is not verified, one needs to use a more intrinsic model which also considers the provincial differences. This is the matter of Lau and Yotopoulos approach to Meta-Production Function and constitutes the subject of the next section.

Secondly we have estimated the panel data by pooling 1980, 1985 and 1990 observations. Results are shown at the Table 3.7. Concerning the equation (3), the results are quite similar to the former estimation results of panel data (given at Table 3.6) except that here the residuals are heteroscedastic if the education variable is not included as was the case when the function is estimated separately by year. Again we conclude that the effect of education is significant and positive, and 1 year increase in the level of formal education causes 23% in GDP (model (3)). Concerning eq.(4), we found a significant intercept term, at 10% level of significance. In the model (4a) the coefficient of slope dummy for capital is negative indicating relatively capital saving production techniques in underdeveloped regions; and the coefficient of slope dummy for labor is positive indicating a relatively labor using production technics in those provinces. The inclusion of underdevelopment dummies lowers the output elasticity of labor and effect of education and raises the output elasticity of capital. This is a clue for the source of the difference between two regions. The contribution of education to growth of GDP does not differ between developed and underdeveloped provinces. The overall effect of education is .18 when the underdevelopment dummies are included. This is probably due to the functional form misspecification observed at first 12 columns of the Table 3.7. This problem has been eliminated in the unrestricted model which is the extended version of equation (5).

Table 3.7: Estimation Results for panel data. *T=1980,1985,1990,* N=201

GDP 1980/85/90 (in ln)	*GDP Model(3a)*	*GDP Model (3)*	*GDP Model (4)*	*GDP Model(4a)*	*GDP Mod.(5.2)*	*GDP Mod.(5.1)*	*GDP Mod.(5.3)*	*GDP Mod.(5.4)*
constant	.098	.079	.727	.068	.104	.128	.238	.700
	(.185)	(.179)	(1.644)	(.121)	(.237)	(.295)	(.566)	(1.627)
capital	.280	.197	.193	.376	.197	.196	.196	.194
(in ln)	(15.178)	(11.085)	(11.44)	(9.220)	(11.190)	(11.165)	(11.622)	(11.802)
labor	.794	.778	.778	.648	.796	.790	.781	.770
(in ln)	(14.951)	(18.337)	(18.337)	(11.683)	(18.068)	(18.028)	(18.469)	(18.661)
education	_	.228	.178	.176	.228	.249	.270	.221
		(9.363)	(6.951)	(3.392)	(9.424)	(9.789)	(10.763)	(7.799)
PD	_	_	-.235	.489	_	_	_	-.180
(intercept dummy)			(-4.609)	(.568)				(-3.452)
*PD*capital*	_	_	_	-.204	_	_	_	_
(slope dummy)				(-4.492)				
*PD*labor*	_	_	_	.151	_	_	_	_
(slope dummy)				(1.792)				
*PD*education*	_	_	_	-.023	_	_	_	_
(slope dummy)				(-.389)				
T1 (time) (1985=1)	_	_	_	_	-.075	_	-.185	-.154
(intercept dummy)					(-1.828)		(-3.976)	(-3.325)
T2 (time) (1990=1)	_	_	_	_	_	-.109	-.218	-.161
(intercept dummy)						(-2.514)	(-4.353)	(-3.136)
R-square	.895 (.894)	.927 (.926)	.934 (.933)	.944 (.942)	.928 (.927)	.929 (.928)	.935 (.933)	.938 (.937)
F-statistic	842.282	836.498	697.078	466.183	635.669	645.894	558.905	493.820
st.error of model	.329	.274	.261	.243	.273	.271	.261	.254
SSR	21.435	14.834	13.385	11.380	14.585	14.371	13.293	12.524
Q(RESET)	F(1,197)	F(1,196)	F(1,195)	F(1,192)	F(1,195)	F(1,195)	F(1,194)	F(1,193)
functional form	53.745	24.202	20.599	6.025	23.512	21.640	18.768	17.306
[probability]	[.000]	[.000]	[.000]	[.015]	[.000]	[.000]	[.000]	[.000]
Q(WHITE)	F(1,199)	F(1,199)	F(1,199)	F(1,199)	F(1,199)	F(1,199)	F(1,199)	F(1,199)
heteroscedasticity	4.538	.606	.968	.013	.657	.859	1.128	1.305
[probability]	[.034]	[.437]	[.326]	[.908]	[.419]	[.355]	[.290]	[.255]

Note: 1. Estimations are carried out by MFIT286

2. Numbers in parentheses below the coefficients of independent variables are corresponding t-ratio

3. Numbers in brackets below the diagnostic test statistics are corresponding F-probabilities.

4. Numbers in parentheses next to R-squares are adjusted R-squares.

5. The dependent variable GDP, and capital and labor enter to the regression loglinearly, while education enters linearly.

Concerning the equation (5) we have estimated a variety of models, because one more time dummy is needed and the combinations for the estimations increase. We make use of a more extended version of eq.(5), again restated here:

Table 3.7 Estimation Results for panel data (continued). *T=1980,1985,1990,* *N=201*

GDP 1980/85/90 (in ln)	GDP Mod(5b.1)	GDP Mod(5a.1)	GDP Mod(5b.2)	GDP Mod(5b.3)	GDP Mod(5b.4)	GDP Mod(5b.5)	GDP Mod(5b.)
constant	-.615	.749	.176	-.620	.582	.206	-.150
	(-1.163)	(1.415)	(.239)	(-1.010)	(.931)	(.534)	(-.191)
capital	.173	.181	.133	.347	.361	.325	.313
(in ln)	(8.414)	(9.005)	(5.349)	(8.304)	(8.769)	(8.437)	(7.271)
labor	.882	.752	.840	.735	.615	.678	.710
(in ln)	(16.689)	(14.322)	(11.694)	(11.858)	(10.03)	(14.688)	(9.230)
education	.211	.251	.277	.167	.196	.212	.234
	(7.523)	(8.327)	(6.580)	(3.212)	(3.460)	(8.318)	(3.718)
PD	_	_	_	.628	.356	_	.468
(intercept dummy)				(.750)	(.420)		(.579)
*PD*capital*	_	_	_	-.191	-.204	-.202	-.193
(slope dummy)				(-4.297)	(-4.536)	(-5.514)	(-4.493)
*PD*labor*	_	_	_	.130	.156	.184	.141
(slope dummy)				(1.579)	(1.867)	(5.109)	(1.757)
*PD*education*	_	_	_	-.029	-.004	_	-.007
(slope dummy)				(-.512)	(-.063)		(-.119)
T1 (time)(1985=1)	2.063	_	1.271	1.877	_	_	1.303
(intercept dummy)	(2.305)		(1.271)	(2.360)			(1.428)
*T1*capital*	.087	_	.127	.069	_	.077	.103
(slope dummy)	(2.303)		(3.292)	(2.053)		(2.818)	(2.911)
*T1*labor*	-.274	_	-.232	-.241	_	-.082	-.210
(slope dummy)	(-3.002)		(-2.324)	(-2.964)		(-3.282)	(-2.302)
*T1*education*	.066	_	.0004	.062	_	_	-.005
(slope dummy)	(1.276)		(.007)	(1.343)			(-.090)
T2 (time)(1990=1)	_	-1.639	-1.067	_	-1.337	_	-.718
(intercept dummy)		(1.841)	(-1.067)		(-1.661)		(-.786)
*T2*capital*	_	.060	.108	_	.045	.086	.087
(slope dummy)		(1.559)	(2.744)		(1.286)	(3.087)	(2.406)
*T2*labor*	_	.066	-.022	_	.070	-.092	-.017
(slope dummy)		(.725)	(-.214)		(.842)	(-3.565)	(-.186)
*T2*education*	_	.0004	-.026	_	-.030	_	-.056
(slope dummy)		(.007)	(-.440)		(-.618)		(-1.016)
R-square	.933 (.931)	.934 (.931)	.943 (.942)	.948 (.945)	.947 (.944)	.952 (.950)	.954 (.950)
F-statistic	383.878	388.822	283.186	316.292	309.471	419.457	253.954
st.error	.266	.264	.248	.236	.238	.227	.226
SSR	13.657	13.495	11.658	10.501	10.720	9.815	9.439
Q(RESET)	F(1,192)	F(1,192)	F(1,188)	F(1,188)	F(1,188)	F(1,190)	F(1,184)
functional form	23.170	12.765	10.977	4.705	1.973	1.740	1.031
[probability]	[.000]	[.000]	[.001]	[.031]	[.162]	[.189]	[.311]
Q(WHITE)	F(1,199)	F(1,192)	F(1,199)	F(1,199)	F(1,199)	F(1,199)	F(1,199)
heteroscedasticity	.471	2.122	3.267	.131	.255	.542	.372
[probability]	[.493]	[.147]	[.072]	[.718]	[.614]	[.462]	[.543]

$$
\begin{aligned}
\ln Y_{it} = {} & \beta_0 + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 ED_{it} \\
& + \beta_4 PD_{it} + \beta_5 PD_{it} \ln K_{it} + \beta_6 PD_{it} \ln L_{it} + \beta_7 PD_{it} ED_{it} \\
& + \beta_8 T1_{it} + \beta_9 T1_{it} \ln K_{it} + \beta_{10} T1_{it} \ln L_{it} + \beta_{11} T1_{it} ED_{it} \\
& + \beta_{12} T2_{it} + \beta_{13} T2_{it} \ln K_{it} + \beta_{14} T2_{it} \ln L_{it} + \beta_{15} T2_{it} ED_{it} + u_{it}.
\end{aligned} \tag{5b}
$$

Equation (5b) is the unrestricted model for the estimations of panel data obtained by pooling 1980, 1985 and 1990 observations[10]. The estimation results for eqs.(5) and (5b) are presented at the last part of the first page and the second page of Table 3.7. In the first page we have shown the effect of the intercept time dummies. Their effect is significant and signs are negative, which is a surprising finding indicating technical regress meaning that technical change affected the production efficiency unfavorably during the decade. The inclusion of intercept time dummies does not influence the coefficients of the labor, capital and education considerably. Model (4) on the third column of Table 3.7 has a significant intercept term, indicating .73 contribution of technical change to growth of GDP. However, this model is rejected by the test of functional form.

In the second page of the Table 3.7, we also included the slope time dummies into the model within several combinations. In models (5b.1) and (5b.3) we have positive and significant coefficients for the intercept dummy of 1985. This implies a significant advance in efficiency of production in 1985. In model (5b) (and also in (5b.1), (5b.2) and (5b.3)) we observed a significant and positive coefficient for 'T1*capital' and significant and negative coefficient for 'T1*labor'. This means that the technical change is capital using and labor saving. That is, during the first half of the decade the capital inputs are entered into production processes relatively intensively (output share of capital increased by 10%) and the output share of labor inputs decreased by 21%. Changes in the level of education from 1980 to 1985 did not differ in terms of output increase, which is evident from the insignificant coefficient of 'T1*education'. The effect of education remains same during the decade. In contrast to that for 1985, the coefficient of intercept dummy for 1990 is negative in all cases but insignificant in most cases including the unrestricted model which supplies the best fit among all. While it is not significant in model (5b), it is significant in models (5a.1) and (5b.4) at

[10] For detailed explanation see section 3.2.1.

5% level of significance. The output share of capital input is again advanced by 8.7%. The output shares of labor and education are not influenced by the technical change in 1990.

The output shares of inputs differ from developed to underdeveloped provinces. We observed that the capital is used more intensively in developed regions and the labor is used more intensively in underdeveloped regions.

Comparing models (5.4) and (5b) we observed that when the slope dummies included, the intercept dummies are no longer statistically significant. Knowing the fact that model (5.4) is not a correct model (implied by Q-RESET), we turned back to our unrestricted model and deleted the variables with insignificant coefficients, namely the intercept dummies PD, T1 and T2 and the slope terms for education (PD*education, T1*education, and T2*education). Joint significance of deleted variables are rejected[11]. We have obtained the model (5b.5) in which all the variables entered in the regression have significant coefficients. The differences in output shares of inputs calculated from model (5b.5) are shown at Table 3.8. In the Table it is shown that the output share of capital increases over time from .325 to .411, meaning that while 1 % increase in capital increases GDP by .325 in 1980, the same amount increase in capital increases GDP by .411 in 1990. The output share of labor, on the other hand, decreased by .092. When the interprovincial differences are considered, labor's share increases while capital's share decreases in underdeveloped regions. The contribution of education, which is found 21.1% increase in GDP as a result of 1 year increase in average formal education years of labor force, remains unchanged over time and across provinces.

To test the assumption of the constant returns to scale which we have assumed for the Cobb-Douglas production functions, we performed the tests of necessary restrictions on the coefficients of capital and labor. The results are shown at Table 3.3 and are similar to our findings from the estimation of separate production functions by year: We cannot reject the hypothesis that the coefficients of two conventional inputs sum

---

[11] Q-statistic F(6, 185) is 1.226 which is significant at 29.5% level.

up to unity. These results are interpreted as a strong evidence for constant returns to scale. In Lau et al. (1993) the hypothesis of constant returns to scale is rejected for Brazil. The results of our study strongly supports the assumption of constant returns to scale in capital and labor for Turkey.

Table 3.8 The output shares of inputs.

years	*provinces*	*technical change*	*physical capit*	*labor*	*education*
1980	*developed*	1.0	.325	.678	.212
	underdeveloped	1.0	.123	.862	.212
1985	*developed*	1.0	.402	.596	.212
	underdeveloped	1.0	.200	.780	.212
1990	*developed*	1.0	.419	.586	.212
	underdeveloped	1.0	.209	.770	.212

Note: Figures are calculated from the estimated coefficients of model (5b.5).

For the panel data estimations we have all jointly significant models, but the unrestricted models in two cases give the best fits. The unrestricted models have both correct functional form and homoscedastic residuals. The test of joint significance of excluding the time and regional dummies are performed and presented at Table 3.5. In all cases again we reject the deletion of them. This means that concerning the Cobb-Douglas production function there are technical changes over time and technical differences across regions. These findings comply with the Lau and Yotopoulos exposition of the Hayami and Ruttan Meta-Production Function. Lau and Yotopoulos (1989) estimated the Hayami and Ruttan Meta-Production Function for the world agriculture and concluded that there is a possible existence of inter-country differences. Then they offer an extended version of this function which considers the inter-country differences as well. In the following section we test their model.

3.4.2 Estimation of Lau and Yotopoulos Meta-Production Function

The Lau and Yotopoulos Meta Production Function has been tried by making use of the first differenced form (eq.11), which collects the regional differences in the constant term by assumption[12]. The estimation results for the first differenced form are presented at Table 3.9. The model is estimated also for no intercept case and the results are in the second part of the Table. All of the estimated equations are jointly significant. The results show that the estimated effect of education is not significant if the intercept term is not suppressed and increases when the regional dummies are included. When the dummies are not included at all (model (11'), it is near to 0.17, indicating that a one year level increase[13] in education raises the rate of growth of GDP by 17%. In the no intercept case (models (11a') and (11b') in the Table 3.8) the effect of education is also positive and significant: it is .31 and .38 respectively. The intercept term which indicates the estimated rate of technical progress is significant in the conventional Cobb-Douglas Function (the model (11.1) in the first column of the Table 3.8).

When the intercept term is suppressed and the education variable included (model (11') in the sixth column of the Table 3.9), we see how sensitive are the effects of education and technical progress to inclusion and the exclusion of each other. Their estimated effects are nearly equal when the other is absent: that of technical change is .19 and that of education is .17. Nevertheless, When we include both of them neither of them is significant[14].

---

[12] The second differenced form (equation 12) is also tried. However the results are not significant, thus not included and interpreted within the text. For the estimation results of second differenced form see Appendix C. For the definition of the constant term see section 3.2.2.

[13] See Appendix A. $\Delta ED = 1.124$.

[14] We tried logarithmic first differences for education variable. In this case the coefficient of education indicates the output elasticity of education, i.e. percentage increase in the rate of growth of output when education years of labor force increases by 1%. However we couldn't find a more plausible result, therefore we did not need to present these results here.

Table 3.9: Estimation Results for the First Differenced Form (Equation 11). N=67

rate of change GDP	*GDP M(11.1)*	*GDP M(11)*	*GDP M(11a)*	*GDP M(11b)*	*GDP M(11.1')*	*GDP M(11')*	*GDP M(11a')*	*GDP M(11b')*
constant	.189	.032	.144	-.066	_	_	_	_
	(3.396)	(.170)	(.796)	(-.161)				
capital (rate	.016	.011	..014	.096	.084	.012	.015	.082
of change)	(.422)	(.296)	(.393)	(.606)	(2.427)	(.303)	(.410)	(.623)
labor (rate	.998	1.019	.833	.546	1.418	1.029	.887	.510
of change)	(4.700)	(4.761)	(3.941)	(1.242)	(7.630)	(5.044)	(4.447)	(1.360)
education	_	.147	.192	.386	_	.174	.307	.345
(level change)		(.879)	(1.215)	(1.255)		(3.525)	(4.657)	(2.024)
PD	_	_	-.181	.076	_	_	-.171	.011
(intercept dummy)			(-.2.959)	(.167)			(-2.864)	(.051)
PD capital	_	_	_	-.096	_	_	_	-.083
(slope dummy)				(-.592)				(-.602)
PD labor	_	_	_	.473	_	_	_	.509
(slope dummy.)				(.929)				(1.122)
PD education	_	_	_	-.251	_	_	_	-.210
(slope dummy)				(-.699)				(-.836)
R-square	.270 (.248)	.279 (.245)	.368 (.328)	.393 (.321)	.139 (.126)	.279 (.256)	.362 (.332)	.393 (.332)
F-statistic	11.857	8.134	9.041	5.464	10.482	12.375	11.913	6.475
st.error of model	.226	.226	.214	.215	.244	.225	.213	.213
SSR	3.269	3.229	2.829	2.718	3.858	3.230	2.858	2.719
Q(RESET)	F(1,63)	F(1,62)	F(1,61)	F(1,58)	F(1,64)	F(1,63)	F(1,62)	F(1,59)
functional form	.027	.357	.006	2.835	5.657	.244	.021	1.352
[prob.]	[.869]	[.552]	[.936]	[.098]	[.020]	[.623]	[.886]	[.250]
Q(WHITE)	F(1,65)	F(1,65)	F(1,65)	F(1,65)	F(1,65)	F(1,65)	F(1,65)	F(1,65)
heteroscedasticity	.493	.077	.001	.007	1.346	.053	.002	.017
[prob.]	[.485]	[.782]	[.980]	[.936]	[.250]	[.818]	[.968]	[.897]

Note: 1. Estimations are carried out by MFIT286.

2. The numbers in parentheses below the coefficients are corresponding t-ratios.

3. R-squares computed correspond to Rm-squares. MFIT286 computes Rm-squares also for no intercept cases but not Rr-squares. Therefore the diagnostic test statistics may be wrong for no intercept cases.

4. The expressions in parentheses next to R-squares are adjusted R-squares.

5. The numbers in brackets below the diagnostic test statistics are corresponding F-probabilities.

The output elasticity of labor is significant in all but the unrestricted model (the models (11b) and (11b')in the fourth and eight columns of the Table 3.9). In addition, the magnitude of this elasticity is quite high: around 1.0 in model (11) and 0.83 in model (11a). The production elasticity of labor is founded around 0.4 in Lau et al. (1993:57) for Brazil, 1970-1980.

The other surprising result is that the output elasticity of capital is significant only when the both education and technical progress variables are suppressed (model 11.1') and its value is very low (near to 0.1 which is the case in Lau et al.(1993) for Brazil)[15]. The insignificance of capital input in model(11)[16] is another important problem we faced in the attempt to test the claims of Lau and Yotopoulos (1989). This problem arises because we used a proxy for capital stock, the industrial electricity consumption which is a flow variable. Another proxy might have been generated. We tried a Social Development Index computed for Turkey for 1990 by Ö. Kulakoğlu (1995). We ran regression on single year observations of 1990 and we could not find a plausible result. Our conclusion from the Hayami and Ruttan Meta-Production Function was on the basis of a need to employ a probably omitted variable indicating the embodied technical change in capital. Here we additionally conclude that the capital proxy is not relevant for the first differenced equation. And we need to restate that simultaneous equations models considering the capital as an endogenous variable should have been tried.

To test for the regional differences we again introduce the underdevelopment dummy, PD. The joint test of significance of intercept and slope dummies is tested and null hypothesis of no regional difference is rejected. The effect of the relative efficiency of the production activities is negative (in favor of developed provinces) and near to 0.2, which are both in line with our earlier findings. However when the slope dummies are included none of the variables are significant except the coefficient of education in no intercept case. The test results are given at Table 3.10. The results indicate that we can reject null hypothesis of no inter-regional difference, i.e. the model (11) is not homogenous across provinces. This is an important finding because Lau and Yotopoulos (1989) introduced this differenced forms into the context of meta-production functions in order to include the inter-provincial (or inter-country)

---

[15] Lau et al. (1993) also found a very low production elasticity of capital for Brazil in 1970-1980. In general this elasticity is found around 0.2 in the studies for developing countries.

[16] Lau et al. (1993) decompose the economic growth into its sources by means of the estimated coefficients obtained from the estimation of equation (11). This corresponds to the second column of the Table 3.9 in our case. Nevertheless, in our case there is only one significant coefficient in this equation and we cannot determine the sources of economic growth from that equation.

Table 3.10: Test of joint significance for first differences for Lau and Yotopoulos Meta-Production Function.

Variables deleted from the model	*First differences with intercept Unrestricted model is (11b)*	*First differences without intercept Unrestricted model is (11b')*
PDK, PDL, PDED	F(3, 59) = 0.807 [.495]	F(3, 60) = 1.024 [.389]
PD, PDK, PDL, PDED	F(4, 59) = 2.774 [.035]	F(4, 60) = 2.821 [.033]

Note: 1. Numbers in brackets next to the test statistics are corresponding F-probabilities.

2. PD is intercept dummy for regional differences, PDK, PDL, PDED are slope dummies for capital, labor and education respectively.

differences. However the deficiency, as they state, of Hayami and Ruttan Meta-Production Function remains in the first differenced form for Turkey in 1980-1990. This might partially be due to insufficient variation in data and partially to the insignificance of intercept term in which they collected the inter-provincial differences by means of several transformations. We observed from our findings that what would the necessary but unobservable inter-provincially different inputs have given us is not given when they are simply lumped in the constant term.

From the test results for the joint significance of regional dummies we concluded that our best models for first differenced Cobb-Douglas production function are the ones include the intercept dummy for regional differences, i.e. the models (11a), and (11a') for no intercept case, in the third and seventh columns of the Table 3.9.

3.4.3. Test of Functional Form

Concerning the estimations on Hayami and Ruttan Meta-Production Function, we concluded that there is a possible omitted variable case, although the RESET-test for the unrestricted model gives (5b) positive result. Additionally we rejected the hypothesis of homogeneity of Cobb-Douglas production function across provinces. Lau and Yotopoulos approach to Cobb-Douglas production function did not give more plausible results either. In order to test whether our unrestricted model (5b) is the most plausible result that we could obtain from the available data, we need to try some other functional forms.

In this section we estimated more complicated functional forms and tried to find an answer to the question whether CES and/or Translog functional forms have an advantage over the Cobb-Douglas production function.

3.4.3.1. CES Production Function:

We firstly estimated the CES (Constant Elasticity of Substitution) production function. The conventional form of the CES production function is

$$Y_{it} = \gamma\left[\delta K_{it}^{-\rho} + (1-\delta)L_{it}^{-\rho}\right]^{-v/\rho} e^{\varepsilon_{it}}. \qquad (\gamma > 0;\ 1 > \delta > 0;\ v > 0;\ \rho \geq -1),$$

where γ is the efficiency parameter, δ is the distribution parameter, v is the returns-to-scale parameter, and ρ is the substitution parameter. Note that the CES production function takes the Cobb-Douglas function as a special case: When there assumed no substitution between capital and labor, i.e. ρ=1, the CES production function reduces to Cobb-Douglas production function. Jan Kmenta (1986:514-515) generates a model for the estimation of the parameters of the CES production function by using Taylor series. We extended his model to include the education input:

(13)

$$\begin{aligned}\ln y_{it} &= \alpha_0 + \alpha_1 \ln k_{it} + \alpha_2 \ln l_{it} + \alpha_3 ed_{it} \\ &+ \alpha_4(\ln k_{it} - \ln l_{it})^2 + \alpha_5(\ln k_{it} - ed_{it})^2 + \alpha_6(\ln l_{it} - ed_{it})^2 + \varepsilon_{it}.\end{aligned}$$

where $x_{it} = X_{it} - \overline{X}$, and α_1, α_2 and α_3 are output shares of inputs at average input levels, and α_4, α_5 and α_6 are coefficients of interaction terms.

We see that the first part of the equation (13) on the right hand side is nothing but the Cobb-Douglas production function. If the estimated coefficients of the second part are not jointly significant we reject the CES function in favor of Cobb-Douglas function.

Considering the above equation as the unrestricted model, we present joint tests of significance together with the estimation results at Tables 3.11 and 3.12.

For the single year estimations (Table 3.11) coefficients of interaction terms are jointly significant for 1980 (model MC.1), and insignificant for 1985 and 1990 (model MC.3 and MC.2). Therefore we may conclude that no advantage of CES production function is observed over Cobb-Douglas production function in 1980 and 1985, and the reverse is true in 1990. Comparing CES and Cobb-Douglas functions we observed that the output shares of the inputs are not considerably different for the single year estimations. However, for 1980 and 1985 we have significant intercept terms unlikely to the results of Cobb-Douglas function presented at Table 3.2. The negative sign of the intercept term indicates that the efficiency parameter is smaller than 1, which in turn, indicates an outward shift for the production function. Concerning the interaction variables, we have a significant capital-labor interaction coefficient which shows a "technical complementarity"[17] between two inputs.

The additional variables are jointly significant for the estimated models of the panel data (models MC.4 and MC.5 in Table 3.12), which is an evident that CES function is advantageous over Cobb-Douglas function for Turkey between 1980 and 1990. In these models we observed significant and negative intercept terms, again indicating unfavorable technical change. For model (4) the output elasticity of capital and labor at average input levels are higher than the output elasticities obtained from Cobb-Douglas production function (model 3 at Table 3.6). The effect of education is, however, slightly lowered from .23 to .21 (compare MC.4 with M.3 at Table 3.6). The interaction variables are all significant. The coefficient of interaction variables show the increase in one of two inputs, if the other is increased by 1%. We observed that capital and education are in inverse relation with each other, while the relationship of labor with capital and education are both positively shaped. The sharp change in the test statistic of functional form is interpreted as a strong evidence for the necessity of education variable to be included in the models. Concerning model MC.5 we observed

---

[17] Note that "technical complementarity" or "substitubility" does not show that these inputs are complements or substitutes concerning the production processes.

Table 3.11: Estimation Results of CES Production Function for Single Year Data.

	GDP80 MC.1	GDP80 MC.1a	GDP85 MC.2	GDP85 MC.2a	GDP90 MC.3	GDP90 MC.3a
constant	-.069	-.081	-.075	-.048	-.027	-.021
	(-1.732)	(-1.954)	(-1.970)	(-1.064)	(-.606)	(-.456)
capital (in ln)	.154	.251	.201	.329	.232	.335
	(6.298)	(8.742)	(7.343)	(9.178)	(7.337)	(9.736)
labor (in ln)	.877	.888	.833	.768	.848	.805
	(14.212)	(10.691)	(12.944)	(8.269)	(11.999)	(9.574)
education	.264	_	.312	_	.254	_
	(7.470)		(9.334)		(6.550)	
$(lncap-lnlab)^2$	.036	.031	.023	.030	.010	.013
	(3.139)	(3.507)	(1.610)	(1.826)	(.600)	(.777)
$(lncap-edu)^2$	-.018	_	-.0007	_	-.009	_
	(-1.415)		(-.053)		(-.618)	
$(lnlab-edu)^2$	.026	_	.055	_	.039	_
	(.759)		(1.809)		(1.125)	
R-square	.957 (.953)	.914 (.910)	.964 (.960)	.910 (.906)	.958 (.954)	.927 (.924)
F-statistic	223.124	224.237	264.351	212.950	227.655	268.447
st. error of model	.204	.281	.198	.303	.231	.296
SSR	2.493	4.976	2.352	5.791	3.205	5.526
Q(RESET)	F(1,59)	F(1,62)	F(1,59)	F(1,62)	F(1,59)	F(1,62)
functional form	.858	10.521	.124	14.280	.213	6.373
[probability]	[.358]	[.002]	[.726]	[.000]	[.646]	[.014]
Q(WHITE)	F(1,65)	F(1,65)	F(1,65)	F(1,65)	F(1,65)	F(1,65)
heteroscedasticity	.415	2.537	.114	3.599	2.306	.156
[probability]	[.522]	[.116]	[.734]	[.062]	[.134]	[.694]
Q	F(3, 60)	F(3, 63)	F(3, 60)	F(3, 63)	F(3, 60)	F(3, 63)
joint significance	4.793	12.299	2.334	3.332	.528	.604
[probability]	[.005]	[.001]	[.083]	[.073]	[.665]	[.440]

Note: 1. Estimations are carried out by MFIT286 and MFIT386.

2. Numbers in parentheses below the coefficients of independent variables are corresponding t-ratios.

3. Numbers in brackets below the diagnostic test statistics are corresponding F-probabilities.

4. Numbers in parentheses next to R-squares are adjusted R-squares.

5. The dependent variable GDP, and capital and labor enter to the regression loglinearly while education enters linearly.

quite similar results to those obtained from model MC.4, except that interaction variables with education are no longer significant this time. Although the estimation results of CES production function for single year data do not as a whole allow us, we may conclude from the joint tests of significance for panel data estimations that

Table 3.12: Estimation Results of CES Production Function for Panel Data and First Differences.

	90/80 MC.4	90/80 MC.4a	90/85/80 MC.5	90/85/80 MC.5a	First Diff. MC.6	First Diff. MC.6a
constant	-.112	-.110	-.070	-.067	.087	.063
	(-3.273)	(-3.324)	(-2.593)	(-2.235)	(2.454)	(1.954)
capital	.231	.348	.232	.396	.089	.097
	(9.884)	(15.160)	(12.471)	(14.291)	(2.103)	(2.253)
labor	.814	.739	.785	.696	1.095	1.020
	(14.514)	(11.286)	(18.230)	(13.117)	(5.458)	(5.152)
education	.206	_	.215	_	.132	_
	(7.175)		(9.370)		(.822)	
(lncap-lnlab)²	.055	.047	.037	.035	-.164	-.118
	(6.501)	(6.386)	(4.821)	(5.376)	(-2.024)	(-3.266)
(lncap-edu)²	-.034	_	-.014	_	.057	_
	(-3.134)		(-1.540)		(.789)	
(lnlab-edu)²	.054	_	.023	_	-.627	_
	(2.667)		(1.326)		(-1.539)	
R-square	.935 (.932)	.900 (.898)	.938 (.936)	.908 (.906)	.430 (.373)	.376 (.346)
F-statistic	306.610	390.125	484.998	650.289	7536	12.653
st. error of model	.266	.327	.256	.308	.206	.211
SSR	8.994	13.923	12.738	18.692	2.555	2.795
Q(RESET)	F(1,126)	F(1,129)	F(1,193)	F(1,196)	F(1, 56)	F(1,62)
functional form	2.215	3.300	4.827	20.077	.544	.016
[probability]	[.139]	[.072]	[.029]	[.000]	[.464]	[.901]
Q(WHITE)	F(1,132)	F(1,132)	F(1,199)	F(1,199)	F(1, 65)	F(1,65)
heteroscedasticity	.618	1.775	.480	9.449	.009	2.800
[probability]	[.433]	[.185]	[.489]	[.002]	[.926]	[.009]
Q	F(3, 127)	F(3, 130)	F(3, 194)	F(1, 197)	F(3, 60)	F(1, 63)
joint significance	21.300	40.785	10.644	28.906	5.280	10.665
[probability]	[.000]	[.000]	[.000]	[.000]	[.003]	[.002]

Note: 1. Estimations are carried out by MFIT286 and MFIT386.

2. Numbers in parentheses below the coefficients of independent variables are corresponding t-ratios.

3. Numbers in brackets below the diagnostic test statistics are corresponding F-probabilities.

4. Numbers in parentheses next to R-squares are adjusted R-squares.

5. The dependent variable GDP, and capital and labor enter to the regression loglinearly while education enters linearly.

concerning the Hayami and Ruttan Meta-Production Function the CES production function is advantageous over Cobb-Douglas production function. For the Lau and Yotopoulos model, we cannot reject the CES production function in favor of Cobb-Douglas production function for the first differenced form, the CES production function fits better[18]. The coefficient of technical progress is significant and positive, indicating efficient production methods during the decade. The output elasticity of labor at average input level is over 1, indicating elastic production activities to labor. That of capital is also significant and again at a very low level as was the case for the Cobb-Douglas production function (Table 3.9). The coefficient of education is not significant, which may be interpreted as being in line with our earlier findings for the Hayami and Ruttan estimates of panel data, where we have concluded that the effect of the education does not change during the decade although the level of education increases. Capital-labor interaction variable shows, in this case, that the increases in two inputs are inversely related. We conclude that Lau and Yotopoulos Meta-Production function is better explained by CES production function comparing to Cobb-Douglas production function hold for Turkey in 1980-1990.

3.4.3.2. Transcendental Logarithmic Form:

The transcendental logarithmic (or translog) production function is of the most flexible form in the context of the production functions (Kmenta, 1986:517). In our case the translog function becomes

$$\begin{aligned}
\ln y_{it} &= \alpha_0 + \alpha_1 \ln k_{it} + \alpha_2 \ln l_{it} + \alpha_3 ed_{it} \\
&+ \alpha_4 (\ln k_{it})^2 + \alpha_5 (\ln l_{it})^2 + \alpha_6 (ed_{it})^2 \qquad (14) \\
&+ \alpha_7 (\ln k_{it})(\ln l_{it}) + \alpha_8 (\ln l_{it})(ed_{it}) + \alpha_9 (\ln l_{it})(ed_{it}) + \varepsilon_{it}.
\end{aligned}$$

where, again, lowercase letters indicates the variables obtained by calculating the deviations from means. Therefore coefficients of input show the input shares at average input levels. The disturbance term is again assumed to hold Gauss-Markov assumptions. Equation (14) is estimated with single years and panel data in order to see if the translog production function has any advantage over Cobb-Douglas production function in Hayami and Ruttan meta-production function model.

---

[18] The second differenced form is again insignificant and presented in Appendix C.

Table 3.13: Estimation Results of Translog Production Function for Single Year Data.

	GDP80 MT.1	GDP80 MT.1a	GDP85 MT.2	GDP85 MT.2a	GDP90 MT.3	GDP90 MT.3a
constant	-.069	-.127	-.071	-.091	-.027	-.061
	(-1.641)	(-2.942)	(-1.824)	(-2.018)	(-.589)	(-1.350)
capital	.167	.255	.214	.346	.239	.331
	(6.008)	(8.712)	(6.696)	(9.366)	(6.616)	(9.103)
labor	.835	.785	.799	.628	.828	.745
	(10.296)	(8.519)	(9.263)	(6.190)	(8.630)	(7.961)
education	.265	_	.324	_	.248	_
	(6.232)		(7.749)		(5.346)	
(lncap)²	-.003	.023	-.006	.0001	-.015	.0007
	(-.183)	(1.537)	(-.265)	(.006)	(-.553)	(.034)
(lnlab)²	-.093	.244	-.098	.176	.023	.185
	(-.715)	(1.746)	(-865)	(1.281)	(.211)	(1.682)
(edu)²	.029	_	.075	_	.026	_
	(.682)		(2.121)		(.630)	
*(lncap*lnlab)*	.056	-.058	.096	.030	.034	-.026
	(.631)	(-.624)	(1.036)	(.279)	(.362)	(-.284)
*(lncap*edu)*	.059	_	.033	_	.043	_
	(1.802)		(.860)		(.864)	
*(lnlab*edu)*	-.122	_	-.183	_	-.116	_
	(-1.072)		(-1.800)		(-.998)	
R-square	.959 (.952)	.926 (.920)	.965 (.960)	.926 (.920)	.958 (.952)	.936 (.931)
F-statistic	147.239	153.641	176.628	153.485	145.342	179.284
st.error of model	.205	.265	.198	.280	.236	.282
SSR	.938	4.275	2.233	4.779	3.180	4.852
Q(RESET)	F(1, 56)	F(1, 60)	F(1, 56)	F(1, 60)	F(1, 56)	F(1, 60)
functional form	4.808	.928	3.979	.162	1.627	.463
[probability]	[.033]	[.339]	[.051]	[.689]	[.207]	[.449]
Q(WHITE)	F(1, 65)	F(1, 65)	F(1, 65)	F(1, 65)	F(1, 65)	F(1, 65)
heteroscedasticity	1.021	.414	.233	.346	2.112	.563
[probability]	[.316]	[.522]	[.631]	[.559]	[.151]	[.456]
Q	F(6, 57)	F(3, 61)	F(6, 57)	F(3, 61)	F(6, 57)	F(3, 61)
joint significance	2.749	7.956	1.671	5.607	.326	3.043
[probability]	[.020]	[.000]	[.145]	[.002]	[.921]	[.036]

Note: 1. Estimations are carried out by MFIT286 and MFIT386.

2. Numbers in parentheses below the coefficients of independent variables are corresponding t-ratios.

3. Numbers in brackets below the diagnostic test statistics are corresponding F-probabilities.

4. Numbers in parentheses next to R-squares are adjusted R-squares.

5. The dependent variable GDP, and capital and labor enter to the regression loglinearly while education enters linearly.

The test results of joint significance are presented at Table 3.13 for single year estimations and at Table 3.14 for panel data and first differences.

The estimations results for single year production functions (models (MT.1), (MT.2) and (MT.3)) appear to be successful in 1980 comparing to results obtained from the estimation of Cobb-Douglas production function: Test of joint significance of interaction variables indicates that translog function is advantageous over Cobb-Douglas in 1980, while there is no a priori evidence for the advantageousness of it in 1985 and 1990. Concerning the interaction variables, we observed that the capital and labor are not sensitive to any increase in each other. In 1980 a technical complementarity is observed between physical and human capital. In 1985 the second order own effect of education is significant, and education and labor are inversely related to each other. Test of functional form implies that models including education variable are not preferred for translog function containing only the conventional inputs.

For panel data estimations (models MT.4, MT.5 and MT.6) we cannot reject the translog form. However, the estimation with the former definition of the panel data (MT.4) fails in the RESET test. For the model MT.5 we have a negative and significant intercept term, indicating technical inefficiency of production methods. the output elasticity of capital in average input level is greater than the output efficiency of capital observed from model (3) of Table 3.7, while the reverse is true for that of labor. The output share of education is lower (by .016) at average input levels comparing the model (3) of Table 3.7. Second order cross interaction effects are all significant indicating directly related capital-labor and capital-education and inversely related capital-education.

Now we turn to Lau and Yotopoulos case in order to test the joint significance of translog form over the Cobb-Douglas form in differenced models[19]. For the first differenced form we make use of Christensen type of the translog production function (see Lau et al.(1993):63). Here we combine the equations (11) and (14) together:

---

[19] For the second differences of translog production function see Appendix C.

Table 3.14: Estimation Results of Translog Production Function for Panel Data and First Differences.

	90/80 MT.4	90/80 MT.4a	90/85/80 MT.5	90/85/80 MT.5a	First Diff. MT.6	First Diff. MT.6a
constant	-.116	-.157	-.095	-.119	.065	.066
	(-3.262)	(-4.613)	(-2.449)	(-2.524)	(1.675)	(1.820)
capital	.231	.318	.253	.268	.087	.098
	(8.875)	(12.878)	(13.340)	(15.370)	(2.020)	(2.278)
labor	.814	.767	.710	.693	1.085	.970
	(11.360)	(10.579)	(14.227)	(12.742)	(5.334)	(4.866)
education	.199	_	.212	_	.168	_
	(6.096)		(8.428)		(1.026)	
(lncap)²	.023	.060	-.018	.012	-.128	-.140
	(1.497)	(6.032)	(1.619)	(1.337)	(-2.988)	(-3.665)
(lnlab)²	.157	.397	-.163	.040	.299	-.088
	(1.708)	(4.395)	(-2.707)	(.615)	(.270)	(-.083)
(edu)²	.015	_	.025	_	-.120	_
	(.548)		(1.214)		(-.138)	
*(lncap*lnlab)*	-.128	-.252	.127	.051	5295	.719
	(-1.877)	(-4.243)	(2.831)	(1.093)	(1.631)	(2.463)
*(lncap*edu)*	.068	_	.074	_	-.069	_
	(2.214)		(3.249)		(-.368)	
*(lnlab*edu)*	-.107	_	-.111	_	2.073	_
	(-1.482)		(-1.997)		(2.013)	
R-square	.936 (.931)	.911 (.908)	.945 (.942)	.918 (.916)	.462 (.377)	.404 (.356)
F-statistic	200.150	262.150	365.171	434.744	5.433	8.283
st. error of model	.269	.311	.242	.293	.206	.209
SSR	8.970	12.391	11.194	16.778	2.411	2.668
Q(RESET)	F(1,123)	F(1,127)	F(1,190)	F(1,194)	F(1,56)	F(1,60)
functional form	10.375	6.810	.793	.503	.052	.0007
[*probability*]	[.002]	[.010]	[.374]	[.479]	[.821]	[.979]
Q(WHITE)	F(1,132)	F(1,132)	F(1,199)	F(1,199)	F(1,65)	F(1,65)
heteroscedasticity	.502	.386	.015	.774	.784	.646
[*probability*]	[.480]	[.535]	[.902]	[.353]	[.379]	[.424]
Q	F(6, 124)	F(3, 128)	F(6, 191)	F(3, 195)	F(6, 57)	F(3, 61)
joint significance	10.482	20.320	10.354	18.044	3.221	4.575
[*probability*]	[.000]	[.000]	[.000]	[.000]	[.009]	[.006]

Note: 1. Estimations are carried out by MFIT286 and MFIT386.

2. Numbers in parentheses below the coefficients of independent variables are corresponding t-ratios.

3. Numbers in brackets below the diagnostic test statistics are corresponding F-probabilities.

4. Numbers in parentheses next to R-squares are adjusted R-squares.

5. The dependent variable GDP, and capital and labor enter to the regression loglinearly while education enters linearly.

$$
\begin{aligned}
\ln y_{it} - \ln y_{it-1} &= \alpha_0 + \alpha_1(\ln k_{it} - \ln k_{it-1}) + \alpha_2(\ln l_{it} - \ln l_{it-1}) + \alpha_3(ed_{it} - ed_{it-1}) \\
&+ \alpha_4\left((\ln k_{it})^2 - (\ln k_{it-1})^2\right)/2 + \alpha_5\left((\ln l_{it})^2 - (\ln l_{it-1})^2\right)/2 \\
&+ \alpha_6\left((ed_{it})^2 - (ed_{it-1})^2\right)/2 + \alpha_7(\ln k_{it}\ln l_{it} - \ln k_{it-1}\ln l_{it-1}) \\
&+ \alpha_8(\ln k_{it}ed_{it} - \ln k_{it-1}ed_{it-1}) + \alpha_9(\ln l_{it}ed_{it} - \ln l_{it-1}ed_{it-1}) + \varepsilon_{it}.
\end{aligned} \tag{14a}
$$

The estimation result for equation (14a) is presented at the last two columns of the Table 3.14. Test statistics calculated for the estimated model show that the best fit is obtained for the first differenced form by means of translog production function. Concerning the first-order coefficients for the inputs, we observed quite similar results to those obtained from the CES function estimates (Table 3.12). Concerning second order own coefficients only that of capital is significant and has a positive sign, and concerning second order cross interaction coefficients only that for capital-labor technical substitutability is significant, which is on the contrary to our findings for Hayami and Ruttan case where this variable has a positive sign. The test of joint significance of the translog functional form indicates that we cannot reject the translog production function in favor of Cobb-Douglas production function for the first differences. Therefore we conclude from our estimations on translog production function that we have obtained a result supporting the Lau and Yotopoulos's claims on the meta-production functions, as was the case for the CES production function estimates.

CHAPTER 4
CONCLUDING REMARKS

We found a positive relationship between education and output growth in Turkish economy during 1980's. In particular, we specified the contribution of general education from the Table 3.8 that a one year increase in the average education year of labor force causes a 0.21 unit change in the rate of Gross Domestic Product. However such a relationship is not an indicator of the quality increase in the labor force through investments in human capital namely education, the increase is due only to the level increase in education. We found such a positive relationship in spite of the deteriorating quality indicators in the public education discussed in the second chapter, because of the quantitative increases in the enrollments. On the other hand, while the average education years of employed population increases, the effect of education does not change. Furthermore the effect of education does not change between the developed and underdeveloped regions either. This is interpreted as follows: If the quality of education does not increases, only quantity increases do not raise the efficiency of education in production; and the uniform and centralized structure of the formal education does not allow for efficiency changes among regions.

We also found for the Cobb-Douglas production function estimates that production methods are not technically efficient during the decade.

For the conventional inputs of the Cobb-Douglas production function we concluded that the output elasticity has increased during the period from .325 to .411; and that of labor has decreased from .678 to .596 for developed regions. The output shares of capital and labor show differences between the developed and underdeveloped regions. The output share of capital reduces by half, and the output share of labor increases by one third in the underdeveloped areas (see Table 3.7). This is an expected result because of the anticipated differences among the structure of production processes of provinces. This means that the Hayami and Ruttan Meta-Production function is not homogeneous across provinces in Turkey between 1980 and 1990.

Another important result concerning the conventional inputs of the Cobb-Douglas production function is that we found strong evidence in favor of constant returns to scale during the period.

The trial of more flexible functional forms shows that we cannot reject the advantages of CES and translog production functions over the Cobb-Douglas production function. We have obtained the estimation results at average input levels, so that the coefficients of input show output shares. As a suggestion for further studies we conclude that the flexible forms may be dealt in much detail so as to take the provincial differences and changes over time into account.

Lau and Yotopoulos (1989) have claimed that the difference forms of Cobb-Douglas function includes the province specific differences and their effects can be lumped into a constant term. Our findings do not support this claim. For the first difference form we cannot reject the regional differences. This is partially due to the insignificance of constant term, partially to insufficient variation in data and partially to the utilization of a possibly inappropriate proxy for physical capital. And the second difference models are jointly insignificant. On the other hand, we obtained reasonable results from the first differences of CES and translog production functions, whereas the second difference form of them are still jointly insignificant.

Our discussion on the physical capital variable revealed that models considering the capital as an endogenous variable are needed to try. However, available data does not allow us to carry out such studies. With the available capital data, on the other hand, some more extensions of the model can be suggested. The aggregate output may be divided into agricultural and industrial outputs, so that the contribution of education in different sectors can be analyzed. Furthermore labor force may be decomposed into male and female counterparts, so that the different education levels of labor force belonging to either sex can be observed. Finally the effects of education years pertaining to primary secondary and higher levels may be taken into account.

REFERENCES

Adem, M., (1993), Ulusal Eğitim Politikamız ve Finansmanı, A.Ü. Basımevi, Ankara.

Arrow, K. J., et al., (1961), "Capital-Labor Substitution and Economic Efficiency", Review of Economics and Statistics, 43: 225-250.

Baloğlu, Z., (1990), Türkiye'de Eğitim: Sorunlar ve Değişime Yapısal Uyum Önerileri, İkinci Baskı, TÜSİAD Yayını, İstanbul.

Benhabib J., and M. M. Spiegel, (1994), "The Role of Human Capital in Economic Development: Evidence from Aggregate Cross-Country Data", Journal of Monetary Economics, 34: 143-173.

Blum. J., (1965), "Planning Models for the Calculation Educational Requirements for Economic Development: Turkey", in J. Tinbergen and H. C. Boss (eds.), Econometric Models of Education: Some Applications, OECD Education and Development: Paris.

Branson, W. H., (1979), Macroeconomic Theory and Policy, Second Edition, Harper and Row: New York.

Denison, E. F., (1962), The Sources of Economic Growth in the United States and the Alternatives Before Us, Committee for Economic Development: New York.

Denison, E. F., (1971), "Education, Economic Growth and Gaps in Information." In R. A. Wykstra (ed.) Education and Economics of Human Capital, The Free Press,

Erkan, H., (1994), Bilgi Toplumu ve Ekonomik Gelişme, İkinci Basım, Türkiye İş Bankası Kültür Yayınları, Doğuş Matbaası, Ankara.

Griliches, Z., (1970), "Notes on the role of education in production functions and growth accounting." Education, Income and Human Capital, W. L. Hansen, New York: NBER.

Hayami, Y., and V. W. Ruttan, (1970), "Agricultural Productivity Changes Among Countries", American Economic Review, 60: 895-911.

Hicks, N. L., (1987), "Education and Economic Growth". G. Psacharopoulos (ed.) Economics of Education: Researches and Studies. Pergamon Press, pp:101-107.

Islam, N., (1995), "Growth Empirics: A Panel Data Approach" The Quarterly Journal of Economics, November 1995, pp.112-1170.

Judge, G. G., et al., (1982), Introduction to the Theory and Practice of Econometrics, John Wiley & Sons, Inc.:New York.

Kasnakoğlu, Z., (1988), "Costs and Financing of Education in Turkey: 1977-1987" EMENA Working Paper, The World Bank, Washington D.C., October.

Kasnakoğlu, Z., and E. Erdil, (1994), Trends in Education Expenditures in Turkey: 1975-91", METU Studies in Development, 21(4): 521-542.

Kmenta, J., (1986), Elements of Econometrics. Macmillan Publishing Co. New York.

Kulakoğlu, Ö., (1995), İllerin Sosyo-Ekonomik Gelişmişlik Düzeyinin Temel BileşenlerAnalizi ile Saptanması. DİE Uzmanlık Tezi, Ankara, Mart 1995.

Lau, L. J., and P. A. Yotopoulos, (1989), "The Meta-Production Function Approach to Technological Change in World Agriculture", Journal of Development Economics, 31: 241-269. North-Holland.

Lau, L. J., et al., (1993), "Education and Economic Growth: Some Cross-Sectional Evidence from Brazil." Journal of Development Economics, 41:45-70.

Milli Eğitim Bakanlığı, (1995), Milli Eğitim Temel Kanunu, İlköğretim Kanunu, Milli Eğitim Bakanlığı Teşkilat ve Görevleri Hakkında Kanun, Özel Eğitim Kurumları Kanunu, Milli Eğitim Basımevi, Ankara.

Milli Eğitim Bakanlığı, (1996), Milli Eğitimde Sorunlar, Reformlar, Hedefler, Projeler, Yasal Düzenlemeler, Personel Durumu, Milli Eğitim Basımevi, Ankara.

Mundlak, Y., (1978), "On the Pooling of Time Series and Cross Section Data". Econometrica, Vol.46, no.1, pp: 69-85.

Mundlak, Y., and R. Hellinghausen, (1982), "The Intercountry Agricultural Production Function: Another View", American Journal of Agricultural Economics, 64: 664- 672. New York.

Nguyen, D., (1979), "On Agricultural Productivity Differences Among Countries", American Journal of Agricultural Economics, 61: 565-570.

Özötün, E., (1988), Türkiye Gayri Safi Yurtiçi Hasılasının İller İtibariyle Dağılımı: 1978-1986, ISO Araştırma Dairesi, Yayın no. 1988/8. İstanbul.

Psacharopoulos, G., (1973), Returns to Education: An International Comparison, Elsevier Scientific Publishing Company: Amsterdam.

Sarıaslan, H., (1978), "Ekonomik Büyüme ve Eğitim", A.Ü. Eğitim Fakültesi Dergisi, 10: 215-222.

Schultz, T. W., (1961), "Education and Economic Growth", Social Forces Influencing American Education, Chicago:NSSE.

Schultz, T. W., (1971), "Investment in Human Capital". In R. A. Wykstra (ed.) Education and the Economics of Human Capital, The Free Press: New York.

Selowsky, M. C., (1969), "On the Measurement of Education's Contribution To Growth", Quarterly Journal of Economics, (August).

Sen, A. K., (1964), "Comments on the Tinbergen-Boss Model". OECD Study Group in the Economics of Education, The Residual Factor and Economic Growth, OECD;Paris, pp.188-197.

SIS, (1992a), Statistical Yearbook of Turkey: 1990, SIS Printing Division, Ankara.

SIS, (1992b), Statistical Yearbook of Turkey: 1991, SIS Printing Division, Ankara.

SIS, (1993), Provincial and Regional Statistics, DİE Matbaası, Ankara.

SIS, (several years), Censuses of Population: Social and Economic Characteristics of Population, 1980,1985,1990, DİE Matbaası, Ankara.

SIS, (1996a), İller İtibariyle Gayri Safi Yurtiçi Hasıla Sonuçları: 1987-1994, Haber Bülteni, 08.04.1996 Ankara.

SIS, (1996b), Statistical Yearbook of Turkey:1995, SIS Printing Division, Ankara.

SIS, (1994), Gross National Product: Concepts, Methods, and Sources, SIS Publication-No: 1710, DİE Matbaası, Kasım 1994:Ankara.

SPO, (1979), Fourth Five Years Development Plan (1979-1983), Başbakanlık Devlet Matbaası, Ankara.

SPO, (1985), Fifth Five Years Development Plan (1985-1989), Başbakanlık Devlet Matbaası, Ankara.

Şenses, F., (1989), 1980 Sonrası Ekonomi Politikaları Işığında Türkiye'de Sanayileşme, Verso Yayıncılık, Ankara.

TEK, (several years), Türkiye Elektrik Enerjisi Tüketim Analizi, TEK Matbaası, Ankara.

Tinbergen, J. and H. C. Boss (1964), "A Planning Model of the Educational Requirements of Economic Growth". OECD Study Group in the Economics of

Education, The Residual Factor and Economic Growth, OECD. Paris, pp.147-169.

Tural, N., (1988), Planlı Dönemde Temel Eğitim ve Lise Seviyeli Eğitimin Yeniden Düzenlenmesiyle İlgili Politikalar ve Uygulamalar, DPT Matbaası, Ankara.

Türk Eğitim Derneği, (1979), Ulusal Eğitim Politikamız, II. Eğitim Toplantısı: 25-26 Ekim1978, Şafak Matbaası, Ankara.

White, H., (1980), "A Heteroscedasticity-Consistent Covariance Matrix Estimator and a Direct Test For Heteroscedasticity", Econometrica, Vol.48, No.4, pp.817-838.

Yamada, S. and V. W. Ruttan, (1980), "International Comparisons of Productivity in Agriculture". In W. Kendrick and N. Vaccara (eds.), New Developments in Productivity Measurement and Analysis, pp.509-585. University of Chicago Press: Chicago.

APPENDIX A: DATA

Table A.1: Gross Domestic Product. *million TL*

province	1980	1985	1990	province	1980	1985	1990
Adana	15541	20472	30165	İzmir	40085	51276	63382
Adıyaman	1911	2168	5267	Kars	2665	3443	2805
Afyon	4627	5676	6203	Kastamonu	3772	3826	3956
Ağrı	1257	1339	1269	Kayseri	6387	7844	9263
Amasya	2816	2869	3263	Kırklareli	3118	4719	7908
Ankara	37369	46429	70658	Kırşehir	1911	2232	2427
Antalya	8449	10012	19023	Kocaeli	19766	29464	36439
Artvin	1860	1913	3252	Konya	15189	17410	22015
Aydın	7292	9885	13112	Kütahya	5733	7270	6712
Balıkesir	9858	11415	14521	Malatya	4023	6441	7070
Bilecik	1961	2678	3775	Manisa	10511	14158	22472
Bingöl	855	829	854	K.Maraş	5733	6186	9105
Bitlis	955	1020	1384	Mardin	2967	3699	4100
Bolu	4426	4783	7670	Muğla	5180	7334	11149
Burdur	2565	3188	2979	Muş	1307	1466	1469
Bursa	15792	22704	33228	Nevşehir	2715	4273	4288
Çanakkale	5381	6313	7989	Niğde	4224	4528	5449
Çankırı	2112	2040	2061	Ordu	4325	4336	5669
Çorum	3721	4464	6333	Rize	3319	3826	4117
Denizli	7192	8864	11592	Sakarya	5934	5867	8564
Diyarbakır	4426	5867	11188	Samsun	9053	10459	14264
Edirne	4526	5739	4988	Siirt	2565	2869	3567
Elazığ	4526	5165	6530	Sinop	1760	1977	2126
Erzincan	2011	2232	2264	Sivas	4023	4528	5564
Erzurum	4426	4783	5147	Tekirdağ	5431	6951	8930
Eskişehir	7494	8673	9913	Tokat	3872	4400	5645
Gaziantep	6236	7653	15049	Trabzon	5230	6122	7810
Giresun	3068	3443	3646	Tunceli	754	829	722
Gümüşhane	1257	1594	1326	Ş.Urfa	3068	5357	5966
Hakkari	553	510	534	Uşak	2213	2806	3085
Hatay	7695	8099	14292	Van	1860	1977	3168
Isparta	3269	4273	4373	Yozgat	2967	3507	3668
İçel	15994	16581	23486	Zonguldak	12473	13966	12204
İstanbul	97322	138649	173339	TOTAL	502959	637761	835784

Note: 1. The values are deflated at 1987 constant purchaser prices.

2. Observations for 1990 are obtained from SIS (1996a).

3. Observations for 1980 and 1985 are caculated by multiplying the province shares obtained from Özötün (1988) by aggregate GDP from SIS (1994).

4. For the newly founded provinces 1990 observations are added to that of provinces that they were were previously belonged. Therefore 1990 observations for Aksaray, Bayburt, Karaman and Kırıkkale are added to those for Niğde, Gümüşhane, Konya and Aksaray respectively. Those for Şırnak and Batman are not seperately presented in SIS (1996a).

Table A.2: Industrial Electricity Consumption *Mwh*

province	1980	1985	1990	province	1980	1985	1990
Adana	6791	10179	13009	İzmir	8830	18883	39711
Adıyaman	84	915	1327	Kars	250	321	240
Afyon	1386	1506	2018	Kastamonu	431	638	1157
Ağrı	19	119	125	Kayseri	2030	3332	3822
Amasya	404	460	368	Kırklareli	723	1066	2718
Ankara	3810	6253	9397	Kırşehir	54	188	414
Antalya	2329	3420	4431	Kocaeli	10846	15933	26971
Artvin	605	731	1217	Konya	9182	9624	15258
Aydın	990	1302	1875	Kütahya	3833	3423	3525
Balıkesir	1474	4958	5905	Malatya	605	871	1007
Bilecik	740	1769	3781	Manisa	1001	1781	3234
Bingöl	7	13	18	K.Maraş	752	2338	3609
Bitlis	25	32	41	Mardin	1031	2920	2349
Bolu	877	1551	2034	Muğla	1880	1931	2709
Burdur	304	299	410	Muş	6	89	118
Bursa	4921	9266	16652	Nevşehir	172	280	408
Çanakkale	863	1682	3209	Niğde	530	1010	1458
Çankırı	25	81	164	Ordu	460	938	998
Çorum	323	1054	1214	Rize	350	574	659
Denizli	712	1238	2554	Sakarya	826	1212	1258
Diyarbakır	117	689	1174	Samsun	1027	1839	2588
Edirne	998	1658	2536	Siirt	586	686	1711
Elazığ	2237	3270	3535	Sinop	105	122	213
Erzincan	354	267	225	Sivas	645	727	1743
Erzurum	512	593	829	Tekirdağ	1569	2977	4926
Eskişehir	1373	1740	2448	Tokat	548	618	693
Gaziantep	1639	2857	4950	Trabzon	532	739	597
Giresun	1795	1436	1756	Tunceli	3	18	29
Gümüşhane	10	42	39	Ş.Urfa	104	1004	1764
Hakkari		9	16	Uşak	432	590	1097
Hatay	5604	8242	13148	Van	338	185	317
Isparta	891	1147	1591	Yozgat	583	654	992
İçel	3485	6124	6927	Zonguldak	13498	12833	14828
İstanbul	20567	30840	39998	TOTAL	130066	196116	292072

Note: 1. Observations are obtained from the Electricity Energy Consumption Analyses published by Turkish Electricity Institution (TEK).

2. 1990 observations are not seperately presented by TEK for newly founded provinces.

Table A.3: Labor Force.

province	1980	1985	1990	province	1980	1985	1990
Adana	5516	5897	6808	İzmir	8089	9029	10803
Adıyaman	1437	1722	2026	Kars	3258	3412	3182
Afyon	2701	3104	3428	Kastamonu	2404	2284	2293
Ağrı	1560	1701	1770	Kayseri	2738	3120	3375
Amasya	1589	1633	1663	Kırklareli	1547	1551	1636
Ankara	9842	10903	12190	Kırşehir	943	1024	1048
Antalya	3515	4340	5558	Kocaeli	2175	2635	3467
Artvin	1156	1129	1094	Konya	6491	7322	8261
Aydın	3123	3562	4058	Kütahya	2435	2587	2800
Balıkesir	4100	4376	4666	Malatya	2384	2639	2758
Bilecik	755	796	850	Manisa	4716	5221	5897
Bingöl	942	1037	1078	K.Maraş	2874	3387	3699
Bitlis	987	1124	1244	Mardin	2160	2472	2722
Bolu	2311	2499	2793	Muğla	2232	2521	3083
Burdur	1139	1218	1266	Muş	1245	1426	1581
Bursa	4958	5414	6625	Nevşehir	1167	1300	1395
Çanakkale	2091	2227	2488	Niğde	2176	2326	2832
Çankırı	1260	1246	1313	Ordu	3435	3572	3940
Çorum	2646	2804	2842	Rize	1629	1750	1622
Denizli	2742	3122	3674	Sakarya	2487	2686	3221
Diyarbakır	2702	3264	3650	Samsun	4684	4962	5295
Edirne	1972	2061	2187	Siirt	1637	1778	2085
Elazığ	1628	1797	1824	Sinop	1394	1396	1333
Erzincan	1250	1350	1356	Sivas	3073	3237	3209
Erzurum	3522	3625	3550	Tekirdağ	1929	2057	2383
Eskişehir	2140	2216	2384	Tokat	2864	3115	3342
Gaziantep	2769	3165	3820	Trabzon	3240	3417	3731
Giresun	2205	2323	2360	Tunceli	691	678	606
Gümüşhane	1298	1338	1302	Ş.Urfa	2140	2874	3498
Hakkari	680	810	898	Uşak	1124	1223	1336
Hatay	3172	3787	4462	Van	1888	2080	2322
Isparta	1613	1722	1988	Yozgat	2278	2550	2707
İçel	3426	4158	5048	Zonguldak	3279	3699	4659
İstanbul	15639	18735	25399	TOTAL	185223	205567	233818

Note: 1. Observations are obtained from the data on economically active population published by SIS in censuses of population.

2. The economically active population is accounted as the number of persons who are over 12 years age by last week's economic activity.

3. For 1990, observations of Aksaray, Bayburt, Karaman and Kırıkkale are added to those of Niğde, Gümüşhane, Konya and Ankara respectively. 1990 observations of Batman and Şırnak are distributed to those of Hakkari, Mardin and Siirt by means of the weights presented at Table 3.1.

Table A.4 :Average Education Years for Labor Force.

province	1980	1985	1990	province	1980	1985	1990
Adana	4.207	4.889	5.311	İzmir	5.215	5.731	6.170
Adıyaman	2.189	3.016	3.549	Kars	2.996	3.658	4.029
Afyon	3.725	4.341	4.817	Kastamonu	2.945	3.470	3.698
Ağrı	2.206	2.827	3.074	Kayseri	4.210	4.732	5.319
Amasya	3.744	4.392	4.757	Kırklareli	4.480	5.125	5.495
Ankara	6.572	6.776	7.356	Kırşehir	3.752	4.453	4.942
Antalya	3.979	4.658	5.398	Kocaeli	5.080	5.563	6.039
Artvin	4.011	4.427	4.700	Konya	4.136	4.608	5.035
Aydın	3.928	4.515	4.898	Kütahya	3.485	4.216	4.269
Balıkesir	3.944	4.407	4.953	Malatya	3.431	4.132	4.789
Bilecik	4.164	4.918	5.434	Manisa	3.657	4.187	4.596
Bingöl	2.292	2.742	3.351	K.Maraş	3.040	3.650	4.186
Bitlis	1.972	2.640	3.198	Mardin	1.903	2.278	2.961
Bolu	3.576	4.181	4.637	Muğla	4.123	4.788	5.303
Burdur	4.124	4.844	5.288	Muş	2.106	2.686	2.930
Bursa	4.532	5.045	5.691	Nevşehir	3.732	4.463	4.908
Çanakkale	3.845	4.459	4.751	Niğde	3.151	3.845	4.309
Çankırı	3.366	4.116	4.628	Ordu	2.842	3.468	4.069
Çorum	2.964	3.482	3.972	Rize	3.435	4.266	4.694
Denizli	4.098	4.618	5.077	Sakarya	4.048	4.493	4.932
Diyarbakır	2.404	2.856	3.346	Samsun	3.259	3.908	4.349
Edirne	4.145	4.757	5.126	Siirt	1.925	2.533	3.104
Elazığ	3.409	3.976	4.585	Sinop	3.003	3.510	3.995
Erzincan	3.820	4.427	4.945	Sivas	3.159	3.860	4.508
Erzurum	3.189	3.777	4.244	Tekirdağ	4.403	4.995	5.580
Eskişehir	5.159	5.717	6.267	Tokat	2.976	3.658	4.204
Gaziantep	3.408	4.092	4.525	Trabzon	3.498	4.168	4.702
Giresun	3.011	3.657	4.203	Tunceli	3.282	3.896	4.497
Gümüşhane	3.182	3.849	4.376	Ş.Urfa	2.148	2.638	3.145
Hakkari	1.681	2.550	3.090	Uşak	3.684	4.245	4.827
Hatay	3.681	4.412	4.675	Van	1.929	2.442	2.988
Isparta	4.389	5.059	5.591	Yozgat	3.043	3.611	4.136
İçel	4.642	4.970	5.485	Zonguldak	4.147	4.663	4.812
İstanbul	6.288	6.727	7.082	TURKEY	3.993	4.582	5.112

Note: 1. The observations are calculated from the data for population for 12 year of age and over, by last week's economic activity and the level of formal education completed, which is available in censuses of population published by SIS seperately for each province. To obtain average years of labor force, number of persons who had been economically active in last week when the census was taken in each province is multiplied by the formal education year they have completed at that time, and then the result is divided by the labor force in that province.

2. For the 1990 observations of newly founded provinces same method is applied with that we calculated the labor force. See notes below Table A.3.

Table A.4a :Average Education Years for Total Population..

province	1980	1985	1990	province	1980	1985	1990
Adana	3.227	3.686	4.099	İzmir	4.255	4.661	5.059
Adıyaman	1.713	2.357	2.835	Kars	2.400	2.948	3.308
Afyon	3.041	3.625	4.046	Kastamonu	2.498	2.951	3.427
Ağrı	1.606	2.080	2.301	Kayseri	3.087	3.687	4.165
Amasya	3.088	3.623	4.037	Kırklareli	3.841	4.345	4.777
Ankara	4.631	5.147	5.605	Kırşehir	3.057	3.597	4.116
Antalya	3.315	3.971	4.605	Kocaeli	3.854	4.300	4.726
Artvin	3.328	3.703	4.093	Konya	3.263	3.729	4.159
Aydın	3.290	3.792	4.180	Kütahya	2.964	3.600	4.004
Balıkesir	3.425	3.877	4.386	Malatya	2.774	3.343	3.979
Bilecik	3.529	4.099	4.572	Manisa	3.106	3.554	3.925
Bingöl	1.774	2.156	2.617	K.Maraş	2.347	2.859	3.375
Bitlis	1.550	2.076	2.486	Mardin	1.439	1.852	2.219
Bolu	2.996	3.558	4.086	Muğla	3.459	4.055	4.605
Burdur	3.396	4.021	4.477	Muş	1.648	2.079	2.286
Bursa	3.683	4.137	4.638	Nevşehir	3.034	3.625	4.110
Çanakkale	3.556	3.867	4.283	Niğde	2.508	3.009	3.549
Çankırı	2.890	3.517	4.050	Ordu	2.436	2.976	3.606
Çorum	2.436	2.924	3.378	Rize	2.769	3.491	3.924
Denizli	3.276	3.747	4.234	Sakarya	3.298	3.726	4.194
Diyarbakır	1.817	2.220	2.567	Samsun	2.729	3.309	3.764
Edirne	3.566	4.085	4.556	Siirt	1.490	1.935	2.318
Elazığ	2.701	3.234	3.752	Sinop	2.531	2.961	3.416
Erzincan	3.030	3.623	4.172	Sivas	2.621	3.207	3.856
Erzurum	2.572	2.350	3.568	Tekirdağ	3.721	4.228	4.721
Eskişehir	4.151	4.641	5.122	Tokat	2.510	3.053	3.570
Gaziantep	2.410	2.901	3.346	Trabzon	2.952	3.574	4.201
Giresun	2.555	3.125	3.731	Tunceli	2.616	3.118	3.719
Gümüşhane	2.571	3.163	3.720	Ş.Urfa	1.571	1.946	2.347
Hakkari	1.318	1.940	2.265	Uşak	3.080	3.535	4.043
Hatay	2.792	3.361	3.742	Van	1.517	1.944	2.291
Isparta	3.644	4.207	4.703	Yozgat	2.526	3.019	3.497
İçel	3.567	3.916	4.413	Zonguldak	3.066	3.532	4.012
İstanbul	4.681	5.035	5.390	TURKEY	3.244	3.746	4.222

Note: Same technic is used with the calculations of average education years of economically active population, but this time the data for whole population whether or not economically active by the last week at time the census is performed are used. See notes below the Table A.4.

Table A.5 : Alternative Underdevelopment Dummies.

province	PD	DD	SD	province	PD	DD	SD
Adana	0	0	0	İzmir	0	0	0
Adıyaman	1	1	1	Kars	1	1	1
Afyon	1	1	1	Kastamonu	1	1	1
Ağrı	1	1	1	Kayseri	1	0	0
Amasya	1	1	1	Kırklareli	0	1	0
Ankara	0	0	0	Kırşehir	1	1	1
Antalya	0	1	0	Kocaeli	0	0	0
Artvin	1	1	1	Konya	1	1	0
Aydın	0	1	0	Kütahya	1	0	1
Balıkesir	0	1	0	Malatya	1	0	1
Bilecik	0	0	0	Manisa	0	1	0
Bingöl	1	1	1	K.Maraş	1	1	1
Bitlis	1	1	1	Mardin	1	1	1
Bolu	1	1	0	Muğla	0	1	0
Burdur	1	1	0	Muş	1	1	1
Bursa	0	0	0	Nevşehir	0	1	0
Çanakkale	0	1	0	Niğde	1	1	1
Çankırı	1	1	1	Ordu	1	1	1
Çorum	1	1	1	Rize	1	1	1
Denizli	1	1	0	Sakarya	1	1	0
Diyarbakır	1	1	1	Samsun	1	1	1
Edirne	0	1	0	Siirt	1	1	1
Elazığ	1	0	0	Sinop	1	1	1
Erzincan	1	1	1	Sivas	1	1	1
Erzurum	1	1	1	Tekirdağ	0	0	0
Eskişehir	0	0	0	Tokat	1	1	1
Gaziantep	1	1	0	Trabzon	1	1	1
Giresun	1	1	1	Tunceli	1	1	1
Gümüşhane	1	1	1	Ş.Urfa	1	1	1
Hakkari	1	1	1	Uşak	1	1	0
Hatay	1	1	0	Van	1	1	1
Isparta	1	1	0	Yozgat	1	1	1
İçel	0	0	0	Zonguldak	1	0	1
İstanbul	0	0	0	TOTAL	48	52	37

Note: 1. PD takes the value 1 if the per capita GDP in that province is less than the country average in 1990, and 0 if otherwise. The data for calculation of PD is obtained from SIS (1996a).

2. DD takes the value 1 if the proportion of industrial GDP to agricultural GDP in that province is below 1 in 1985, and 0 if otherwise. The data for calculation of DD is obtained from Özötün(1988).

3. SD takes value 1 if social development index calculated by Kulakoğlu(1995) for 1990 is less than 0 for that province, and 0 if otherwise.

APPENDIX B: ESTIMATION RESULTS OF HAYAMI AND RUTTAN META-PRODUCTION FUNCTION FOR THE MODELS WITHOUT AN INTERCEPT TERM

One important result we observed from the estimation of Hayami and Ruttan meta-production function is that the intercept term is not significant in all cases. This means there is no effect of technological change for the growth of GDP. In this appendix we present the no intercept cases for the sake of making comparisons.

Table B.1: Estimation Results for Equation (3).

Single Year Data for no Intercept Case N=67

GDP = ln of Gross Domestic Product	*GDP80 Model(3a')*	*GDP80 Model(3')*	*GDP85 Model(3a')*	*GDP85 Model(3')*	*GDP90 Model(3a')*	*GDP90 Model(3')*
capital (in ln)	.239	.120	.308	.201	.339	.261
	(9.306)	(5.997)	(10.69)	(9.040)	(12.25)	(10.52)
labor (in ln)	.869	.865	.775	.769	.748	.730
	(43.25)	(59.28)	(28.85)	(43.20)	(28.31)	(35.01)
education	–	.287	–	..311	–	.247
		(7.711)		(9.172)		(6.481)
R-square	.897 (.896)	.947 (.945)	.905 (.904)	.959 (.958)	.926 (.925)	.955 (.954)
F-statistic	567..35	568.52	622.73	751.62	814.76	685.34
st. error of model	.303	.220	.306	.203	.294	.230
SSR	5.974	3.097	6.097	2.635	5.627	3.397
Q(RESET)	F(1,64)	F(1,63)	F(1,64)	F(1,63)	F(1,64)	F(1,63)
functional form	1.318	.472	.279	.516	1.279	2.230
[*probability*]	[.255]	[.494]	[.599]	[.475]	[.262]	[.140]
Q(WHITE)	F(1,65)	F(1,65)	F(1,65)	F(1,65)	F(1,65)	F(1,65)
heteroscedasticity	3.716	.387	2.959	1.040	6.297	.425
[*probability*]	[.058]	[.536]	[.090]	[.312]	[.015]	[.517]

Note: 1. Estimations are carried out by MFIT286.

2. Numbers in parentheses below the coefficients of independent variables are corresponding t-ratios.

3. Numbers in brackets below the diagnostic test statistics are corresponding F-probabilities.

4. Numbers in parentheses next to R-squares are adjusted R-squares.

5. The R-squares listed are Rm-squares. MFIT286 does not compute Rr-squares for no intercept cases. There fore the diagnostic statistics may be wrong.

6. The dependent variable GDP, and capital and labor enter to the regression loglinearly while education enters linearly.

Table B.2: Estimation Results for Equation (4).

Single Years for no Intercept Case. N=67

GDP = ln of Gross Domestic Product	*GDP80 Model(4')*	*GDP80 Model(4a')*	*GDP85 Model(4')*	*GDP85 Model(4a')*	*GDP90 Model(4')*	*GDP90 Model(4a')*
capital (in ln)	.114	.294	.183	.248	.235	.216
	(5.941)	(4.412)	(8.524)	(4.032)	(9.691)	(3.123)
labor (in ln)	.896	.728	.817	.743	.792	.802
	(48.068)	(12.465)	(37.104)	(12.723)	(29.852)	(11.87)
education	.231	.217	.225	.279	.186	.208
	(5.516)	(2.843)	(7.124)	(3.580)	(4.668)	(2.332)
PD (regional	-.185	.682	-.214	.579	-.248	.203
intercept dummy)	(-2.555)	(.687)	(-3.312)	(.625)	(-3.389)	(.203)
*PD*capital*	_	-.175	_	-.055	_	.032
(slope dummy)		(-2.450)		(-.802)		(.412)
*PD*labor*	_	.102	_	.009	_	-.053
(slope dummy)		(.925)		(.079)		(-.447)
*PD*education*	_	-.017	_	-.049	_	-.036
(slope dummy)		(-.186)		(-.545)		(-.354)
R-square	.952 (.949)	.957 (.954)	.965 (.964)	.967 (.963)	.962 (.960)	.962 (.959)
F-statistic	413.914	231.606	582.784	290.492	535.589	256.474
st.error of model	.211	.200	.189	.189	.214	.218
SSR	2.806	2.405	2.244	2.147	2.874	2.858
Q(RESET)	F(1,62)	F(1,59)	F(1,62)	F(1,59)	F(1,62)	F(1,59)
functional form	.007	.292	.021	.080	.275	.645
[probability]	[.932]	[.591]	[.885]	[.778]	[.602]	[.425]
Q(WHITE)	F(1,65)	F(1,65)	F(1,65)	F(1,65)	F(1,65)	F(1,65)
heteroscedasticity	.419	.054	.988	.213	.0002	.00007
[probability]	[.520]	[.817]	[.324]	[.646]	[.989]	[.993]

Note: 1. Estimations are carried out by MFIT286.

2. Numbers in parentheses below the coefficients of independent variables are corresponding t-ratios.

3. Numbers in brackets below the diagnostic test statistics are corresponding F-probabilities.

4. Numbers in parentheses next to R-squares are adjusted R-squares.

5.The R-squares listed are Rm-squares. MFIT286 does not compute Rr-squares for no intercept cases. Therefore the diagnostic statistics may be wrong.

6.The dependent variable GDP, and capital and labor enter to the regression loglinearly while education enters linearly.

Table B.3: Estimation Results for Panel Data for no Intercept Case. *T=1980,1990,* *N=134*

	GDP M.(3a')	GDP M.(3')	GDP M.(4')	GDP M.(4a')	GDP M.(5.1')	GDP M.(5')	GDP M.(5a.1')	GDP M.(5a')
capital	.282	.194	.174	.383	.184	.173	.133	.342
(in ln)	(13.681)	(8.797)	(8.254)	(6.512)	(9.056)	(8.593)	(5.103)	(5.903)
labor	.804	.808	.861	.642	.803	.840	.830	.632
(in ln)	(42.005)	(48.973)	(43.674)	(13.327)	(52.852)	(43.021)	(44.725)	(13.336)
education	_	.232	.177	.205	.311	.257	.375	.362
		(6.831)	(5.146)	(3.019)	(8.908)	(6.614)	(7.695)	(4.611)
PD (regional	_	_	-.295	.453	_	-.202	_	.527
intercept dummy)			(-4.329)	(.502)		(-2.918)		(.555)
PD*capital	_	_	_	-.216	_	_	_	-.216
(slope dummy)				(-3.340)				(-3.584)
PD*labor	_	_	_	.181	_	_	_	.183
(slope dummy)				(1.823)				(1.815)
PD*education	_	_	_	-.083	_	_	_	-.078
(slope dummy)				(-1.060)				(-1.034)
T2 (time)(1990=1)	_	_	_	_	-.297	-.234	-.891	-.735
(intercept dummy)					(-5.031)	(-3.820)	(-1.143)	(-.913)
T2*capital	_	_	_	_	_	_	.108	.076
(slope dummy)							(2.442)	(1.928)
T2*labor	_	_	_	_	_	_	-.010	.019
(slope dummy)							(-.124)	(.235)
T2*education	_	_	_	_	_	_	-.124	-.149
(slope dummy)							(-1.822)	(-2.420)
R-square	.868(.867)	.903(.901)	.915(.913)	.930(.927)	.919(.917)	.924(.921)	.924(.921)	.942(.938)
F-statistic	869.316	608.354	466.738	282.955	489.284	390.309	258.744	200.765
st. error of model	.373	.321	.302	.276	.295	.287	.288	.256
SSR	18.360	13.538	11.832	9.693	11.331	10.629	10.532	8.040
Q(RESET)	F(1, 131)	F(1, 130)	F(1, 129)	F(1, 126)	F(1, 129)	F(1, 128)	F(1, 126)	F(1. 122)
functional form	.021	.022	1.116	.456	.074	.390	1.337	1.421
[probability]	[.886]	[.883]	[.293]	[.501]	[.787]	[.533]	[.250]	[.236]
Q(WHITE)	F(1, 132)	F(1, 132)	F(1, 132)	F(1, 132)	F(1, 132)	F(1, 132)	F(1, 132)	F(1, 132)
heteroscedasticity	.235	.037	.061	.516	.381	.367	1.031	1.663
[probability]	[.629]	[.849]	[.806]	[.474]	[.538]	[.546]	[.312]	[.199]

Note: 1. Estimations are carried out by MFIT286.

2. Numbers in parentheses below the coefficients of independent variables are corresponding t-ratios.

3. Numbers in brackets below the diagnostic test statistics are corresponding F-probabilities.

4. Numbers in parentheses next to R-squares are adjusted R-squares.

5. The R-squares listed are Rm-squares. MFIT286 does not compute Rr-squares for no intercept cases. Therefore the diagnostic statistics may be wrong.

6. The dependent variable GDP, and capital and labor enter to the regression loglinearly while education enters linearly

Table B.4: Estimation Results for Panel Data for no intercept case.   T=1980,1985,1990,   N=201

	GDP M.(3a')	GDP M.(3')	GDP M.(4')	GDP M.(4a')	GDP M.(5.1')	GDP M.(5')	GDP M.(5a.1')	GDP M.(5a')
capital	.278	.195	.182	.377	.196	.193	.192	.183
(in ln)	(17.659)	(12.351)	(11.77)	(9.326)	(12.442)	(12.370)	(12.738)	(12.17)
labor	.804	.804	.843	.654	.806	.802	.804	.833
(in ln)	(55.085)	(66.087)	(57.193)	(18.914)	(66.427)	(66.629)	(69.166)	(56.510)
education	_	.228	.184	.175	.228	.249	.270	.227
		(9.386)	(7.218)	(3.466)	(9.448)	(9.809)	(10.77)	(8.066)
PD (regional	_	_	-.208	.556	_	_	_	-.154
intercept dummy)			(-4.289)	(.855)				(-3.087)
PD*capital	_	_	_	-.205	_	_	_	_
(slope dummy)				(-4.542)				
PD*labor	_	_	_	.146	_	_	_	_
(slope dummy)				(2.023)				
PD*education	_	_	_	-.022	_	_	_	_
(slope dummy)				(-.374)				
T2(time) 1985=1	_	_	_	_	-.074	_	-.184	-.154
(intercept dummy)					(-1.826)		(-3.954)	(-3.311)
T1(time) 1990=1	_	_	_	_	_	-.109	-.216	-.164
(intercept dummy)						(-2.509)	(-4.331)	(-3.179)
R-square	.895(.894)	.927(.926)	.933(.932)	.944(.942)	.928(.927)	.929(.928)	.935(.933)	.938(.936)
F-statistic	1692.7	1260.9	920.585	546.654	851.622	865.174	700.983	587.093
st. error of model	.328	..274	.262	.242	.272	.270	.261	.255
SSR	21.439	14.837	13.570	11.381	14.590	14.377	13.315	13.166
Q(RESET)	F(1, 198)	F(1, 197)	F(1,196)	F(1, 193)	F(1, 196)	F(1, 196)	F(1, 195)	F(1, 194)
functional form	.820	.318	.838	.045	.249	.170	.011	.900
[probability]	[.366]	[.574]	[.361]	[.833]	[.618]	[.680]	[.917]	[.344]
Q(WHITE)	F(1, 199)	F(1, 199)	F(1,199)	F(1, 199)	F(1, 199)	F(1, 199)	F(1, 199)	F(1, 199)
heteroscedasticity	4.159	.599	.901	.014	.643	.856	1.120	1.270
[probability]	[.043]	[.440]	[.344]	[.907]	[.424]	[.356]	[.291]	[.261]

Note: 1. Estimations are carried out by MFIT286.

2. Numbers in parentheses below the coefficients of independent variables are corresponding t-ratios.

3. Numbers in brackets below the diagnostic test statistics are corresponding F-probabilities.

4. Numbers in parentheses next to R-squares are adjusted R-squares.

5. The R-squares listed are Rm-squares. MFIT286 does not compute Rr-squares for no intercept cases. Therefore the diagnostic statistics may be wrong.

6. The dependent variable GDP, and capital and labor enter to the regression loglinearly while education enters linearly

Table B.4: Estimation Results for panel data (continued). *T=1980,1985,1990,* *N=201*

	GDP M.(5b.1')	GDP M.(5a')	GDP M.(5b.2')	GDP M.(5b.3')	GDP M.(5b.4')	GDP M.(5b.5')	GDP M.(5b')
capital	.184	.169	.130	.347	.365	.325	.314
(in ln)	(10.056)	(9.273)	(5.820)	(8.286)	(8.872)	(8.467)	(7.315)
labor	.823	.824	.857	.683	.662	.693	.698
(in ln)	(59.653)	(59.775)	(52.534)	(19.408)	(18.355)	(18.984)	(18.694)
education	.211	.249	.277	.177	.186	.214	.235
	(7.507)	(8.260)	(6.595)	(3.469)	(3.347)	(8.482)	(3.782)
PD (regional	_	_	_	.125	.814	_	.395
intercept dummy)				(.186)	(1.179)		(.557)
PD*capital	_	_	_	-.188	-.208	-.205	-.192
(slope dummy)				(-4.241)	(-4.682)	(-5.735)	(-4.502)
PD*labor	_	_	_	.170	.122	.188	.146
(slope dummy)				(2.364)	(1.623)	(5.368)	(1.967)
PD*education	_	_	_	-.040	.005	_	-.008
(slope dummy)				(-.696)	(.089)		(-.139)
T1 (time) (1985=1)	1.448	_	1.448	1.505	_	_	1.189
(intercept dummy)	(2.044)		(2.154)	(2.135)			(1.726)
T1*capital	.076	_	.130	.062	_	.076	.102
(slope dummy)	(2.077)		(3.501)	(1.880)		(2.796)	(2.975)
T1*labor	-.215	_	-.249	-.204	_	-.081	-.199
(slope dummy)	(-2.835)		-3.499	-2.808		(-3.265)	(-2.802)
T1*education	.067	_	.001	.063	_	_	-.005
(slope dummy)	(1.280)		(.019)	(1.356)			(-.095)
T2 (time) (1990=1)	_	-.890	-.890	_	-.979	_	-.833
(intercept dummy)		(-1.241)	(-1.328)		(-1.384)		(-1.219)
T2*capital	_	.072	.111	_	.051	.084	.085
(slope dummy)		(-.005)	(2.923)		(1.515)	(3.058)	(2.451)
T2*labor	_	-.005	-.038	_	.035	-.092	-.006
(slope dummy)		(-.069)	(-529)		(.470)	(-3.544)	(-.085)
T2*education	_	.002	-.025	_	-.030	_	-.056
(slope dummy)		(.036)	-.430		(-.614)		(-1.023)
R-square	.933 (.930)	.933 (.931)	.943 (.940)	.948 (.945)	.947 (.944)	.952 (.950)	.954 (.950)
F-statistic	446.823	450.961	313.053	347.784	340.571	473.618	273.507
st.error of model	.266	.265	.247	.236	.238	.226	.225
SSR	13.752	13.166	13.166	10.557	10.769	9.829	9.441
Q(RESET)	F(1, 193)	F(1, 193)	F(1, 189)	F(1, 189)	F(1, 189)	F(1, 191)	F(1, 185)
functional form	4.183	.501	.510	1.767	.492	.111	.157
[probability]	[.724]	[.480]	[.476]	[.185]	[.484]	[.739]	[.692]
Q(WHITE)	F(1, 199)	F(1, 199)	F(1, 199)	F(1, 199)	F(1, 199)	F(1, 199)	F(1, 199)
heteroscedasticity	.724	2.058	3.209	.067	.260	.481	.386
[probability]	[.396]	[.153]	[.075]	[.796]	[.610]	[.489]	[.535]

APPENDIX C: ESTIMATION RESULTS FOR SECOND DIFFERENCE FORM OF LAU AND YOTOPOULOS META-PRODUCTION FUNCTION

The results for the second difference form are not significant. We present them at Table C.1. Although the original form of the equation (12) does not have an intercept, we tried also the intercept case. However we could not obtain an interpretable estimation result. We conclude that the Lau and Yotopoulos exposition of meta-production function for second differences is not verified for Turkey between 1980 and 1990.

The estimated models for the second difference form of CES are also jointly insignificant. Results are at Table C.2.

The second difference form of translog production function is obtained by extending the equation (14a) for second differences. Indeed, here we combine equations (14) and (12):

(14b)

$$
\begin{aligned}
\left[(\ln y_{it} - \ln y_{it-1}) - (\ln y_{it-1} - \ln y_{it-2})\right] = {} & \alpha_1\left[(\ln k_{it} - \ln k_{it-1}) - (\ln k_{it-1} - \ln k_{it-2})\right] \\
& + \alpha_2\left[(\ln l_{it} - \ln l_{it-1}) - (\ln l_{it-1} \ln l_{it-2})\right] \\
& + \alpha_3\left[(ed_{it} - ed_{it-1}) - (ed_{it-1} - ed_{it-2})\right] \\
& + \alpha_4\left[\left((\ln k_{it})^2 - (\ln k_{it-1})^2\right) - \left((\ln k_{it-1})^2 - (\ln k_{it-2})\right)\right]/4 \\
& + \alpha_5\left[\left((\ln l_{it})^2 - (\ln l_{it-1})^2\right) - \left((\ln l_{it-1})^2 - (\ln l_{it-2})\right)\right]/4 \\
& + \alpha_6\left[\left((ed_{it})^2 - (ed_{it-1})^2\right) - \left(ed^2 - (ed_{it-2})\right)\right]/4 \\
+ \alpha_7\left[\left((\ln l_{it})(\ln l_{it}) - (\ln k_{it-1})(\ln l_{it-1})\right) - \left((\ln k_{it-1})(\ln l_{it-1}) - (\ln k_{it-2})(\ln l_{it-2})\right)\right] & \\
+ \alpha_8\left[\left((\ln k_{it})(ed_{it}) - (\ln k_{it-1})(ed_{it-1})\right) - \left((\ln k_{it-1})(ed_{it-1}) - (\ln k_{it-2})(ed_{it-2})\right)\right] & \\
+ \alpha_9\left[\left((\ln l_{it})(ed_{it}) - (\ln l_{it-1})(ed_{it-1})\right) - \left((\ln l_{it-1})(ed_{it-1}) - (\ln l_{it-2})(ed_{it-2})\right)\right] & \\
+ \varepsilon_{it}\,. &
\end{aligned}
$$

The equation (14b) estimated and the estimation result shown at the last column of the Table C.2. However the second difference form is still jointly insignificant. Therefore we conclude that second difference form does not fit for Turkey during the decade.

Table C.1: Estimation Results for Equation (12) (Second Differences). N=67

	GDP M.(12.1)	GDP M.(12)	GDP M.(12a)	GDP M.(12b)	GDP M.(12.1')	GDP M.(12')	GDP M.(12a')	GDP M.(12b')
constant	.031	.054	-.012	.068	_	_	_	_
	(.933)	(1.393)	(-.186)	(.682)				
capital (rate	-.018	-.022	-.021	.038	-.035	-.041	-.019	-.036
of change)	(-.385)	(-.448)	(-.434)	(.170)	(-.790)	(-.879)	(-.412)	(-.186)
labor (rate	.878	.899	1.212	-.024	.943	.967	1.171	.720
of change)	(1.662)	(1.703)	(2.099)	(-.016)	(1.801)	(1.828)	(2.212)	(.725)
education	_	.198	.241	.543	_	.071	.247	.437
(level change)		(1.137)	(1.366)	(1.547)		(.472)	(1.427)	(1.395)
PD(int.dummy	_	_	.100	.008	_	_	.089	.077
for underdevelop			(1.302)	(.072)			(1.918)	(1.532)
PD capital	_	_	_	-.056	_	_	_	.017
(slope dum.)				(-.247)				(.087)
PD labor	_	_	_	1.383	_	_	_	.639
(slope dum.)				(.857)				(.540)
PD education	_	_	_	-.408	_	_	_	-.302
(slope dum.)				(-.988)				(-.793)
R-square	.042 (.012	.061 (.017	.086 (.027	.111 (.006	.029 (.014	.032 (.002	.086 (042	.104 (.015
F-statistic	1.402 (.25	1.370	1.463	1.057	1.938 (.17	1.069 (.35	1.969 (.13	1.166 (.34
st.error of model	.253	.252	.251	.254	.253	.254	.249	.254
SSR	4.093	4.011	3.904	3.797	4.149	4.135	3.907	3.827
Q(RESET)	F(1,63)	F(1,62)	F(1,61)	F(1,59)	F(1,64)	F(1,63)	F(1,62)	F(1,59)
func. form	2.965	1.059	1.319	.612	.160	.021	1.353	.670
[probability]	[.090]	[.307]	[.255]	[.437]	[.691]	[.884]	[.249]	[.416]
Q(WHITE)	F(1,65)	F(1,65)	F(1,65)	F(1,65)	F(1,65)	F(1,65)	F(1,65)	F(1,65)
(heterosced.)	.594	.975	.483	.465	1.020	.880	.538	.344
[probability]	[.444]	[.327]	[.489]	[.498]	[.316]	[.352]	[.466]	[.560]

Note: 1. Estimations are carried out by MFIT286.

2. Numbers in parentheses below the coefficients of independent variables are corresponding t-ratios.

3. Numbers in brackets below the diagnostic test statistics are corresponding F-probabilities.

4. Numbers in parentheses next to R-squares are adjusted R-squares.

5. The R-squares listed are Rm-squares. MFIT286 does not compute Rr-squares for no intercept cases. Therefore the diagnostic statistics may be wrong.

6. The dependent variable GDP, and capital and labor enter to the regression loglinearly while education enters linearly

Table C.2: Estimation Results for Second Differenced Forms of CES and Translog Production Functions.

CES	*MC.7*	*MC.7a*	*Translog*	*MT.7*	*MT.7a*
capital	-.009	.005	***capital***	-.548	-.033
	(-.168)	(.082)		(-.337)	(-.566)
labor	.905	.914	***labor***	1.364	1.129
	(1.725)	(1.733)		(.609)	(2.188)
education	.248	–	***education***	1.699	–
	(1.418)			(.503)	
(lncap-lnlab)^2	.234	.033	***(lncap)^2***	-.112	.087
	(1.671)	(.839)		(-1.087)	(1.957)
(lncap-edu)^2	-.223	–	***(lnlab)^2***	-.026	-5.856
	(-1.402)			(-1.069)	(-1.032)
(lnlap-edu)^2	.273	–	***(edu)^2***	.872	–
	(.427)			(2.496)	
R-square	.112 (.039)	.052 (.023)	***(lncap*lnlab)***	.090	-2.217
F-statistic	1.535	1.769		(.545)	(-1.790)
st. error	.249	.252	***(lncap*edu)***	.033	–
SSR	3.795	4.049		(.505)	
Q(RESET)	F(1, 60)	F(1, 63)	***(lnlab*edu)***	.-.304	–
func. form	.375	1.573		(-.982)	
[probability]	[.542]	[.214]	***R-square***	.172(.058)	.144(.089)
Q(WHITE)	F(1, 65)	F(1, 65)	***F-statistic***	1.509	2.615
heterosced.	1.510	.001	***st. error***	.247	.243
[probability]	[.224]	[.974]	***SSR***	3.537	3.656
Q (joint	F(3, 61)	F(1, 64)	***Q(RESET)***	F(1,57)	F(1,61)
significance)	1.157	.704	***func. form***	1.683	1.694
[probability]	[.334]	[.404]	***[probability]***	[.200]	[.198]
			Q(WHITE)	F(1,65)	F(1,65)
			heterosced.	1.597	2.424
			[probability]	[.211]	[.124]
			Q (joint	F(6, 58)	F(3, 62)
			significance)	1.298	2.473
			[probability]	[.275]	[.070]

Note: 1. Estimations are carried out by MFIT286.

2. Numbers in parentheses below the coefficients of independent variables are corresponding t-ratios.

3. Numbers in brackets below the diagnostic test statistics are corresponding F-probabilities.

4. Numbers in parentheses next to R-squares are adjusted R-squares.

5 The dependent variable GDP, and capital and labor enter to the regression loglinearly while education enters linearly

6. The R-squares listed are Rm-squares. MFIT286 does not compute Rr-squares for no intercept cases. Therefore the diagnostic statistics may be wrong.