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Examining the sectoral energy use in Turkish economy (1980–2000) with the help of decomposition analysis

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Abstract

This paper aims to investigate the sectoral energy use in the Turkish economy for the 1980–2000 period when significant changes occurred in the economic and demographic structure of the country. These changes had several impacts on the energy use in the primary sectors such as agriculture, industry and services. Decomposition analysis is conducted on these sectors by using the additive version of the LMDI method due to its advantages over others. Although a close relationship exists between primary energy consumption and GDP, analyses show that significant variations occurred in the sectoral energy use during the 1982, 1988–1989, 1994 and 1998–2000 periods. Such variations are related to the economic policies of the governments. The Turkish economy has undergone a transformation from agricultural to industrial enhanced by rapid urbanization, especially after 1982. However, industrialization has not been completed yet, and the energy demand should be increasing faster than national income until the energy intensity of the country reaches a peak. This study is performed on three basic sectors; however, decomposition into secondary and tertiary sectors will provide detailed information for further investigations.

Keywords: Energy–income relationship; Sectoral energy use; Decomposition; Turkey

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1. Introduction

The structure of the Turkish economy, which is endowed with several resources ranging from geographical to demographic, to cultural and to historical, is that of a rapidly industrializing country [1]. The services sector is one of the major contributors to the national income, followed by industry. These two major sectors contributed almost 87% to Turkey's national income, while the share of agriculture has declined to about 13% in 2000.

The country has experienced three stages of development since 1950: (1) the liberalized foreign trade regime in the 1950s, (2) the import-substitution industrialization in the 1960s and 1970s and (3) the export-oriented industrialization since 1980 [2]. The year 1980 has become a turning point in the philosophy of the Turkish economy, which had been struggling with severe problems caused by the import-substitution industrialization policies coupled with the extensive state intervention of the previous decades [3]. The economic strategy of the 1980s, therefore, aimed at decreasing the scale of the public sector and the degree of state intervention in market operations [3–6].

Although several countries have undergone a similar type of transformation as a part of the restructuring of the world economy during the 1980s, Turkey became one of the pioneer countries that practiced structural transformation effectively [4,6]. However, the present relationship between economy, demography and energy of the country shows that the transformation processes have not yet been completed.

According to IEA (International Energy Agency) data, the GDP of Turkey was 61.655 billion US$ in 1971, 86.999 billion US$ in 1980, 144.565 billion US$ in 1990 and 205.074 billion US$ in 2000, and world's total GDP was 14366.269 billion US$ in 1971, 20053.987 billion US$ in 1980, 26400.942 billion US$ in 1990 and 34037.023 billion US$ in 2000 at 1995 prices and exchange rates. The shares of the Turkish gross domestic product (GDP) and population in the world's totals in 2000 are, respectively, 1.01% and 1.11%, while the share of total primary energy consumption (TPEC) is only 0.77% for the same year. These shares increased during the 1971–2000 period from 0.78% to 1.01% in GDP, from 0.36% to 0.77% in TPEC and from 0.98% to 1.11% in population. This means that the rate of increase has been much higher in energy consumption (296.12%) than in income (232.33%) and in population (82.84%) during the same period. On the per capita basis, the GDP increased from 1687 US$ in 1971 to 3068 US$ in 2000 at 1995 prices and exchange rates.[2] These figures are given as 3462 US$ for 1971 and 6293 US$ for 2000 at 1995 prices adjusted for PPP (purchasing power parity) by the IEA. On the other hand, the TPEC increased from 532 koe (kilogram-of-oil-equivalent) in 1971 to 1154 koe in 2000.

Since the GDP and TPEC in Turkey are still below the world's average, efficient use of energy is suggested to be promoted for the economical and social development of the country [7,8]. In fact, Turkey, as a medium consumer, is among the emerging markets, with a primary energy demand growing more rapidly than most of the other similar countries [9]. The rate of increase in energy demand has always been high, varying from a minimum of −5.73% in 1979 to a maximum of 11.59% in 1972, with an average of 5.12% from 1951 to 1999 [10]. The rate of increase in electricity

[2] According to the 1995 prices and exchange rates, GDP of Turkey is given as 61.655 billion US$ in 1971, 86.999 billion US$ in 1980, 144.565 billion US$ in 1990, and 205.072 billion US$ in 2000 and GDP of the world's total is given as 14366.269 billion US$ in 1971, 20053.987 billion US$ in 1980, 26400.942 billion US$ in 1990, and 34037.023 billion US$ in 2000 by IEA.

demand has been even higher than this with an average of 9.52% from 1970 to 1999. With such growth rates, Turkey is expected to play a significant role in the world's energy sector at least for the first two decades of the 21st century [9].

However, dependency on fossil fuels from foreign sources stands as a significant barrier in front of the sustainable development of the country. Turkey consumed 81.2 million toe (tons-of-oil-equivalent) of primary energy of which only 26.8 million toe has been produced from indigenous resources, consisting of about 33% of the total in 2000.[3] The remaining 67% of Turkey's energy consumption is met by imports, and the import's share is expected to increase rapidly in the future [10,11]. Fossil fuels have the biggest share in overall consumption, reaching almost 87% of which 57% is hydrocarbon (40% oil and 17% natural gas) and 30% is coal (18% lignite, including very small amounts of asphaltite, secondary coal and petro-coke and 12% bituminous coal) in 2000.

The supply security problem of the Turkish energy system can only be solved by policy implications designed by scientific studies specifically on the sectoral use of energy in the Turkish economy. However, this subject has been examined poorly in the previous studies (e.g. [12–15]). The purpose of this study is, therefore, to examine the sectoral energy use in the Turkish economy during 1980–2000 with the help of decomposition analysis. Decomposition analysis is performed on three primary sectors; agriculture, industry and services by using the additive version of the LMDI (Logarithmic Mean Divisia Index) method [16].

Since this is the first study on the subject, only the basic sectors are considered. A special emphasis is given to the agriculture and livestock production sub-sector of the agriculture sector and to the manufacturing sub-sector of the industrial sector. One of the major reasons for this is that the Turkish policy makers have traditionally considered them as the two driving sectors essential for development. However, in practice, these sectors found themselves in a severe competition because one of them is usually neglected while the other is supported [17,18]. Another reason is that the services sector is like a ''wastebasket'', which includes dissimilar activities such as wholesale and retail trade, hotels and restaurants services, transportation and communication, financial institutions, ownership of dwelling, business and personal services, imputed bank service charge, government services, private non-profit institutions and import duties (see also [19]).

The reason to use the LMDI additive method is that this method not only yields perfect decomposition with no residual term but also can accommodate the value zero in the data set [16,20,21]. Additionally, for three of the decomposed sectors, availability of the annual time series data within the study period enabled the decomposition of each successive year. By this way, we have the advantage of evaluating all information in the data set for explaining the pattern of changes in the production, structural and intensity effects.

Unless otherwise indicated, the data used in this study is obtained from the Ministry of Natural Resources and Energy, State Statistics Institute and the Undersecretariat of Treasury of Turkey. GDP is given in TL (Turkish Lira) at 1987 producers' prices, and TPEC is given in toe (tons-of-oil-equivalent).

[3] The difference between the IEA and MENR data are mainly due to the method of calculation. Using one data set for each analysis eliminates the problems of such discrepancies.

2. Energy/economy relationship

A close relationship exists between primary energy consumption (E) and total GDP (Y) of Turkey during 1980–2000 (Table 1). This relationship is almost linear, which is defined by the formula of $E = 707.7 * Y - 5530.1$ with $R^2 = 0.98$.

The historical development of energy consumption and economic production demonstrates frequent fluctuations, evolving in a cyclic pattern (Fig. 1). Two of the four complete increasing cycles, which were previously described by the senior author of this paper in the time series data of additional primary energy consumption (APEC) in Turkey from 1950 to 1999, are also covered within the period under study [10]. They occur between 1979–1988 and 1988–1998 with time durations varying between 9 and 10 years with an average of 9.5 years.

The 20 year average rates of change in GDP and TPEC are close to each other with values of 4.5% and 4.9%, respectively (Fig. 1). GDP increases from 4.9% to 9.5% between 1980 and 1987, reaches a peak of 9.5% in 1987 and then decreases with frequent fluctuations to 7.4% in 2000. Similarly, TPEC increases, starting from 0.2% in 1980 until it reaches a maximum value of 10.4% in 1987 before decreasing to 4.7% in 2000. GDP becomes negative two times: −5.5% in 1994 and −4.7% in 1999, whereas TPEC becomes negative only once: −2.0% in 1994.

The sectoral distributions of GDP from 1980 to 2000 show some significant variations (Fig. 2). During this period, the industrial and services sectors increase from 22.3% to 28.4% and from 52.6% to 58.5%, respectively. On the other hand, the agricultural sector decreases from 25.1%

Table 1
Primary energy consumption (TPEC) and gross domestic product (GDP) of the Turkish economy from 1980 to 2000

Years	TPEC (×1000 toe)				GDP (billion TL)			
	Agriculture	Industry	Services	Total	Agriculture	Industry	Services	Total
1980	963	12947	18003	31913	12636	11197	26463	50296
1981	993	13004	17992	31989	12398	12224	28117	52739
1982	1198	13943	19165	34306	12786	12821	29011	54618
1983	1297	14663	19637	35597	12667	13628	31038	57333
1984	1451	15847	19949	37247	12727	14975	33479	61181
1985	1506	17260	20401	39167	12669	15909	35198	63776
1986	1671	19054	21444	42168	13255	17667	37326	68248
1987	1838	21451	23269	46559	13314	19276	42132	74722
1988	1828	21748	23994	47570	14356	19618	42332	76306
1989	1841	24367	24157	50365	13272	20529	42697	76498
1990	1956	26951	23726	52632	14177	22302	47099	83578
1991	1976	28082	23856	53915	14049	22909	47396	84353
1992	1994	29430	24873	56298	14651	24268	50482	89401
1993	2450	30462	26933	59845	14462	26259	55869	96590
1994	2480	30398	25797	58675	14358	24775	52188	91321
1995	2556	32443	28216	63215	14640	27766	55482	97888
1996	2714	34935	29239	66887	15284	29745	59717	104746
1997	2823	39879	30554	73257	14925	32834	64872	112631
1998	2827	41878	29544	74249	16176	33494	66444	116114
1999	2923	42037	33550	78511	15369	31814	63463	110646
2000	2962	46707	32558	82226	15962	33738	69089	118789

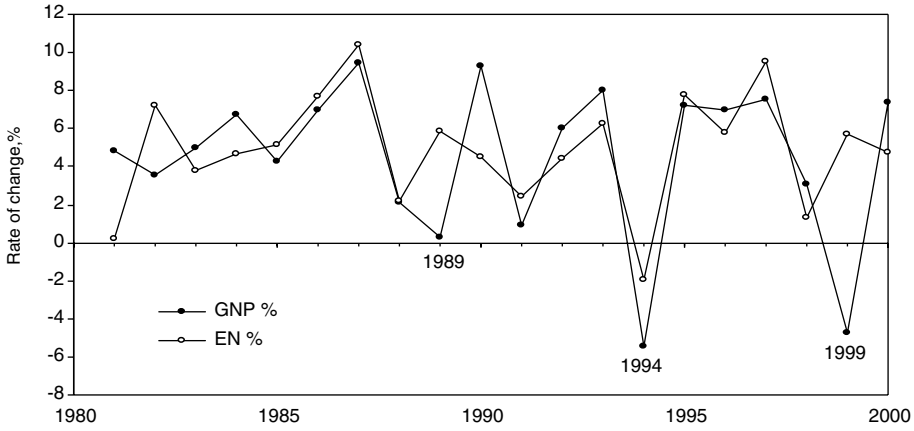

Fig. 1. Rate of change in gross domestic product (GDP) and total primary energy consumption (TPEC) in Turkey from 1980 to 2000.

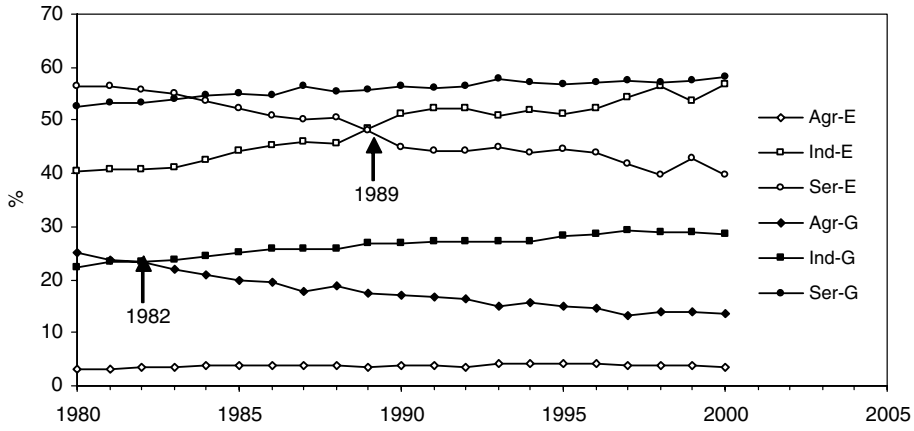

Fig. 2. The sectoral distribution of gross domestic product (GDP) and total primary energy consumption (TPEC) from 1980 to 2000. Agr: Agriculture, Ind: Industry, Ser: Services.

in 1980 to 13.2% in 2000. Although the variations in industry and agriculture are affected by the competition between them, the services sector increases independently. The biggest change occurs at around 23% in 1982, when industry exceeds agriculture.

In spite of services' having the biggest share in GDP, the biggest share in TPEC is allocated to industry with 55.4% in 2000. It is followed by services (40.8%) and agriculture (3.8%). From 1980 to 2000, the total primary energy consumption in industry increases from 40.6% to 55.4% and in agriculture from 3.0% to 3.8%, respectively. On the other hand, services decreased from 56.4% to 40.8% during the same period. Here, industry and services equalize at around 48% in 1989 before industry exceeds services.

Energy intensity values show similar variations (Fig. 3). In 2000, the energy intensity of industry is the highest (1384.4 toe per billion TL at 1987 prices), whereas services (471.2 toe per billion

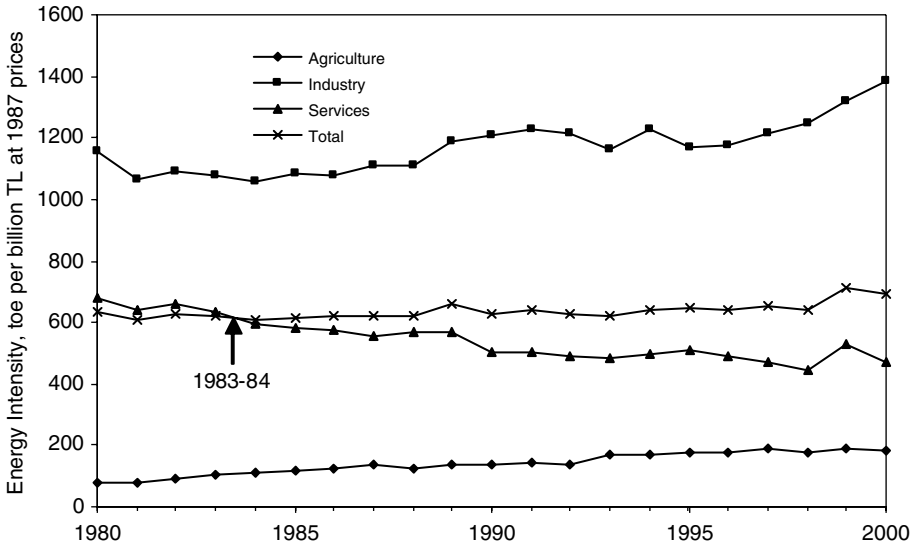

Fig. 3. Energy intensities of the main sectors and of total between 1980 and 2000.

TL) and agriculture (185.6 toe per billion TL) ranked second and third. The total intensity is closer to services than to the other sectors with a value of 692.2 toe per billion TL. During the 1980–2000 period, the energy intensity of industry and agriculture increases, respectively, from 1156.3 to 1384.4 and from 76.2 to 185.6 toe per billion TL, whereas that of services decreases from 680.3 to 471.2 toe per billion TL. The total intensity also increases from 634.5 in 1980 to 692.2 toe per billion TL in 2000.

The sectoral distribution of final energy by fuels from 1980 to 2000 shows that the agricultural sector consumes only oil and electricity, while oil, coal, natural gas, electricity and modern renewables, including geothermal and solar, are consumed by the industrial sector. In the agricultural sector, the share of oil decreases from 98.5% in 1980 to 91.4% in 2000, whereas the share of electricity increases from 1.5% in 1980 to 8.6% in 2000. This clearly shows that oil is replaced by electricity from 1980 to 2000 as the use of modern irrigation systems widens. On the other hand, in the industrial sector, the share of oil decreases from 51.0% in 1980 to 26.2% in 2000, whereas the shares of coal (from 35.0% to 47.4%), natural gas (from 0.3% to 8.9%), electricity (from 13.7% to 17.0%) and modern renewables (from 0% to 0.4%) increased during the same period.

3. Decomposition analysis

Aggregate decomposition analysis assumes that the change in total primary energy consumption from year 0 to year t, also called the total effect (ΔE_{tot}), is formed with the contributions of the production effect (ΔE_{pdn}), structural effect (ΔE_{str}), intensity effect (ΔE_{int}) and residual (ΔE_{rsd}) effect, which is always 0 in this study:

$$\Delta E_{\text{tot}} = \Delta E_{\text{pdn}} + \Delta E_{\text{str}} + \Delta E_{\text{int}} + \Delta E_{\text{rsd}} \quad (1)$$

The three effects in Eq. (1) are calculated for each sector i (agriculture, industry, and services) by using the LMDI method described by Ang et al. in 1998 [16] as follows:

$$\Delta E_{\text{pdn}} = \sum_i L(E_{i,t}, E_{i,0}) \ln(Y_t/Y_0) \tag{2}$$

$$\Delta E_{\text{str}} = \sum_i L(E_{i,t}, E_{i,0}) \ln(S_{i,t}/S_{i,0}) \tag{3}$$

$$\Delta E_{\text{int}} = \sum_i L(E_{i,t}, E_{i,0}) \ln(I_{i,t}/I_{i,0}) \tag{4}$$

where E_i is the primary energy consumption of sector i in toe, Y is the gross national product in TL, S_i is the production share of sector i (Y_i/Y) and I_i is the energy intensity of sector i in toe/TL (E_i/Y_i).

$L(E_{i,t}, E_{i,0})$ in Eqs. 2,3 is calculated as follows:

$$L(E_{i,t}, E_{i,0}) = (E_{i,t} - E_{i,0})/\ln(E_{i,t}/E_{i,0}) \tag{5}$$

where $L(E_{i,t}, E_{i,t}) = E_{i,t}$ is the limit of $L(E_{i,t}, E_{i,0})$ as $E_{i,t} \to E_{i,0}$.

The shares of production, structure and intensity effects for each sector i (agriculture, industry and services) are calculated by using the following equations:

$$\Delta E_{i,\text{pdn}} = L(E_{i,t}, E_{i,0}) \ln(Y_t/Y_0) \tag{6}$$

$$\Delta E_{i,\text{str}} = L(E_{i,t}, E_{i,0}) \ln(S_{i,t}/S_{i,0}) \tag{7}$$

$$\Delta E_{i,\text{int}} = L(E_{i,t}, E_{i,0}) \ln(I_{i,t}/I_{i,0}) \tag{8}$$

Fig. 4 depicts the changes in total primary energy consumption over the previous years (ΔE_{tot}) and the decomposition of these changes into contributions from the production (ΔE_{pdn}), structure (ΔE_{str}) and intensity effects (ΔE_{int}). Aggregate decomposition analysis shows that the major contribution to the total effect is made by the production effect, and the contributions of the other two

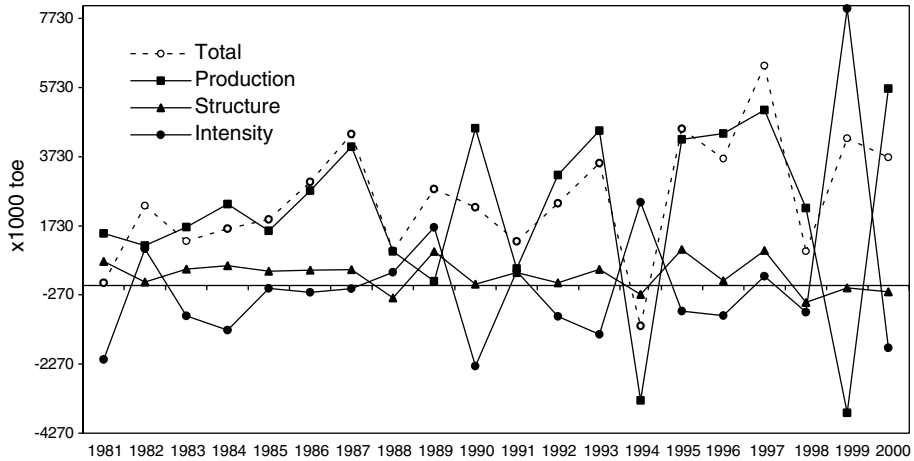

Fig. 4. Aggregate decomposition analysis of total primary energy consumption in Turkish economy from 1980 to 2000.

effects are minimal. We drew the same conclusion from the historical diagram of the rate of changes in GDP and TPEC as shown in Fig. 1. The total and production effects are all positive except for the crises years in 1994 (both are negative) and in 1999 (total is positive but production is negative). On the other hand, the structural effect is positive in 15 years (1981–1987, 1989–1993, 1995–1997), and the intensity effect is positive in 8 years (1982, 1988, 1989, 1991, 1994, 1997, and 1999). The time series graphs of the effects can be separated into three relatively stable segments between 1983–1987, 1990–1993 and 1995–1997, which are punctuated by four breaks in 1982, 1988–1989, 1994 and 1998–2000. The positive total, production and structure effects but negative intensity effect typically characterize each segment, whereas the intensity effect peaks during the breaks.

The shares of the production, structure and intensity effects in the studied sectors are shown for each year in Figs. 5–7. The sectoral decomposition shows that the production effect is more evident in industry and services than in agriculture (Fig. 5). This also is confirmed by the sectoral distribution graphs of GDP and TPEC shown in Fig. 2. The production effects of the sectors are all positive except for the 1994 and 1999 crisis years because of the reasons discussed above. Services are higher than industry before 1989 and are lower than industry after 1989, indicating that the most significant change in the production effect occurs between services and industry in 1989.

The structure effect on industry is the most effective one followed by services and agriculture (Fig. 6). Industry is positive in 12 years (1981–1986, 1989, 1991, 1993 and 1995–1997) and services are positive in 13 years (1981, 1983–1985, 1987, 1989–1990, 1992–1993, 1996–1997, 1999–2000), whereas agriculture is positive only in three years (1990, 1994, 1998). The most consistent structural changes in industry occur positively between 1981 and 1986 and negatively between 1998 and 2000. From 1987 to 1997, it fluctuates between positives and negatives, reaching a maximum at 1995. This indicates that, although insignificant in aggregate decomposition, the most significant

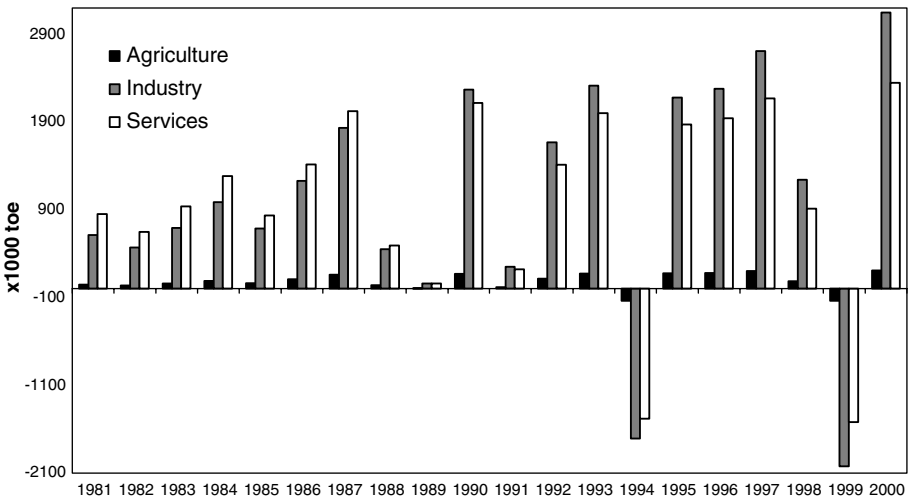

Fig. 5. Decomposition of the production effect into sectors from 1980 to 2000.

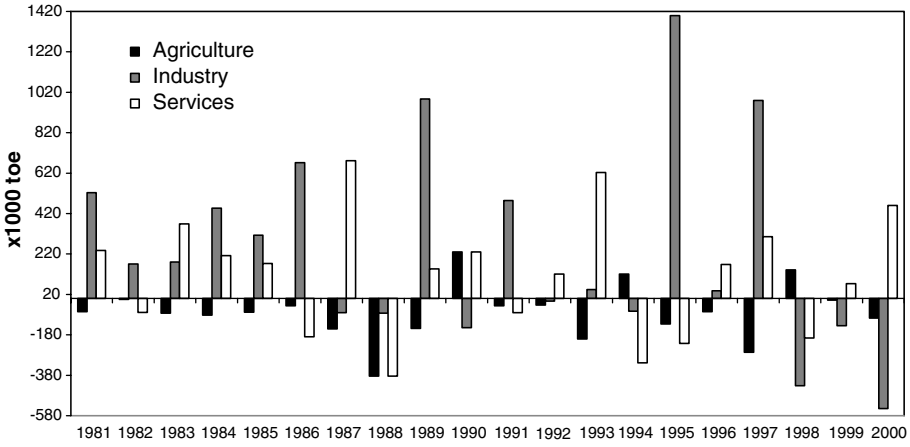

Fig. 6. Decomposition of the structure effect into sectors from 1980 to 2000.

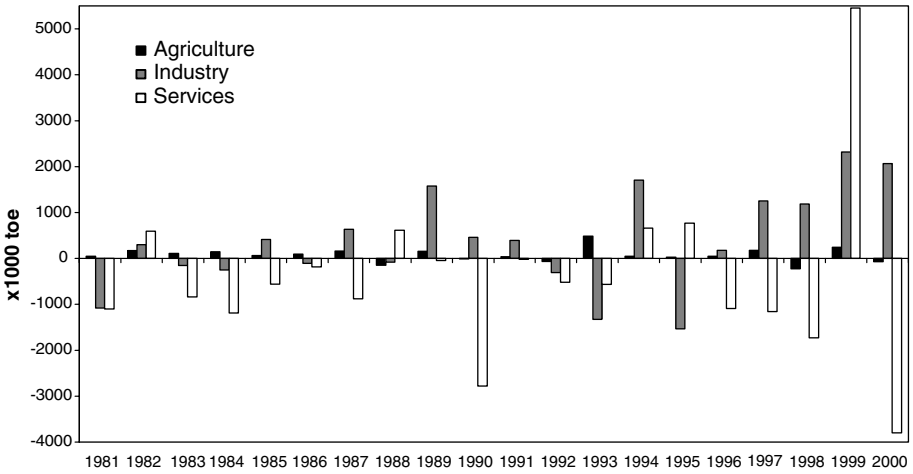

Fig. 7. Decomposition of the intensity effect into sectors from 1980 to 2000.

structural changes in industry occurred during the beginning of the studied period (see also Fig. 4). This is roughly applicable also for services. However, the most significant structural changes in agriculture occurred during 1989–1990. Before these years, they are all negative, but after these years, they are fluctuating between positives and negatives.

In contrast to the structural effect, the sectoral decomposition of the intensity effect shows that services has the biggest positive and negative effects followed by industry and agriculture (Fig. 7). Services are all negative except for the years 1982, 1988, 1994–1995 and 1999, but agriculture is all positive except for the years 1988, 1990, 1992, 1998 and 2000. On the other hand, industry is positive in 12 years (1982, 1985, 1987, 1989–1991, 1994, 1996–2000), resulting in an increasing pattern in intensity values. In the years 1982, 1988–1989, 1994 and 1999, when the intensity effect is positive in the aggregate decomposition (see Fig. 4), all sectors are positive except for the year 1988.

The aggregate and sectoral decomposition analyses can, therefore, be summarized as follows: (1) the major contributing effect of the primary energy consumption in the Turkish economy from 1980 to 2000 is the production effect, and the structure and intensity effects are insignificant; (2) the Turkish economy can be separated into three relatively stable periods between 1983–1987, 1990–1993 and 1995–1997, each one characterizing positive production and structural effects but negative intensity effects; (3) the most prominent changes in the sectoral energy use pattern in the Turkish economy appears to occur during 1982 and 1988–1989 and between these periods, while the 1994 and 1998–2000 breaks are directly related to the economic crises.

4. Policy implications

The results of the decomposition analyses confirm the economic programs of the governments, which are traditionally separated into three periods as 1980–1983, 1983–1987 and 1988 onwards. The Stabilization Program, also called the "24 January Decisions", which was announced during the beginning of the 1980–1983 period, included a series of economic policy changes aimed at stabilization, liberalization and integration into the world's markets [2–4,22,23]. During the 1983–1987 period, the strong inward orientation of Turkey's trade and industrialization changed into an outward orientation coupled with a good integration with the international markets [6,24]. The reason why this period is also known as "the golden years" is related to the outstanding success in export performance, well above the rate of growth of world trade and exports by the newly industrializing countries [4,24].

However, the stability objectives were neglected, especially after 1985 [23], and a "return to conventional populism plus external financial liberalization" started with the mini-crisis of 1987 [4,6,23,25]. This crisis necessitated introducing some austerity measures by the February 4th Program in 1988 [4,23]. However, this program could not prevent oil prices from rising sixfold in a year, resulting in more than a 100% increase in 1988, and the rate of economic growth kept declining until the local elections of March 1989. The initiation of capital market liberalization and declaration of convertibility of the Turkish Lira are other important events in 1989.

During the coalition governments of the 1990s, the economy drifted into financial disorder, instability and recession, especially during the 1994 and 1999 crises years [23]. The GNP growth rates became negative in these years: −5.5% in 1994 and −4.7% in 1999.

The economic policies implemented during the studied period affected the agriculture sector more than the others. Several authors have criticized the policy programs in neglecting the agricultural sector [e.g. 17, 26-30]. In fact, it is not just a coincidence for this sector's losing its reputation of making Turkey one of seven countries in the world to be self sufficient in food and ranking among the largest exporter of agricultural products until 1980 [27]. However, significant improvement has been recorded in urbanization after 1982, when the city population exceeded the village population. This contributed to industrialization by creating a higher demand for manufactured goods and for services than for agricultural products since the consumption capacity of the urban population is larger and more varied than that of the rural population [31].

Aside from 1982, the years 1988–1989 became also an important turning point for the agricultural sector. The 1988–1989 economic depression coupled with the drought in 1989 affected agriculture considerably [17,18]. The crop area increased with a rate of 1.9% from 1980 to 1988 but

decreased with a rate of 0.3% from 1989 to 2000, while the fallow area decreased continuously with a rate of 5.2% from 1980 to 1988 and with a rate of 0.4% from 1988 to 1989. However, the reduction in crop area after 1988–1989 did not negatively affect the yields of wheat and barley, which are the main cereal products. A noteworthy increase is also seen in the yields of various products of the animal husbandry sub-sector of the agriculture sector after 1989.

The increasing trends in the yields of agricultural products are usually attributed to mechanization of the sector [17,18]. In general, the number of modern equipments increases as the number of primitive equipments decrease after 1950, but the biggest changes occurred during 1987–1988, 1990–1991 and 1996–1997. During 1987–1988, wooden plows and animal plows decreased 13.7% and 2.7%, respectively. During 1990–1991, wooden plows (11.7%) and animal plows (7.4%) decreased, but fertilizer distributors increased 5.7%. During 1996–1997, wooden plows (24.8%), animal plows (20.7%) and threshers (7.9%) decreased, while fertilizer distributors (13.5%), four wheel tractors (8.3%) and moldboard plows (5.7%) increased.

The industrial sector has undergone similar changes during the same period. Although substantial increases in the shares of manufactured goods in total exports have been recorded and the manufacturing industry increased their profit margin, little changes have been recorded in the structure of the Turkish manufacturing industry since 1980 [6,22,24,25,28,32].

Among the five biggest manufacturing sub-sectors, whose share in value added total of the manufacturing industry increased gradually to 89% in 2000 from 81.4% in 1980, the biggest changes occurred in sub-sector 135 (chemicals and chemical petroleum, coal, rubber and plastic products) by decreasing its share from 25.3% in 1980 to 6.0% in 2000. During the same period, sub-sector 138 (fabricated metal products, machinery and equipment, transport equipment, professional and scientific measuring and controlling equipment) increased from 19.4% to 32.2%; sub-sector 133 (wood and wood products including furniture) increased from 2.6% to 14.0%; and sub-sector 131 (food, beverages, and tobacco) increased from 18.3% to 24.2%, while sub-sector 132 (textile, wearing apparel and leather industries) decreased from 15.8% to 12.6%.

As a result, sub-sector 135, which used to be the number one manufacturing industry in 1980, became the smallest one in the 1990s, and sub-sector 138 became the dominant manufacturing industry after the period 1993–1996. The capacity utilization and production index data also confirm the value added data.

5. Conclusions and recommendations

This study shows that the sectoral energy use in Turkey from 1980 to 2000 has undergone significant changes owing to the transformation from an agricultural to an industrial economy enhanced by rapid urbanization between 1983 and 1987. However, the country is still in its early stage of development and energy demand should be increasing faster than national income until the energy intensity of the country reaches a peak [33].

The most recent studies examining the relationship between energy demand and economic development showed that as countries develop, the household sector's share of aggregate energy consumption tends to fall with income, the share of transportation tends to rise and the share of industry follows an inverse-U pattern (e.g. [34–36]). At present, Turkey is located in the ''upper middle class'' of the classification of Medlock and Soligo [36]. The per capita income of this class

varies from 3001 to 10,000 US$ at 1985 prices and PPPs, and the shares of energy demand by the services, industry and agriculture sectors in the final demand are 55%, 34% and 11%, respectively. In Turkey, these shares are, respectively, 59%, 36% and 5%, and per capita GDP is 6298 US$ at 1995 prices and PPPs in 2000.

Therefore, the Turkish economy needs some structural changes until the country reaches a per capita income of 9000 US$ (at 1985 prices adjusted for purchasing power parity) as suggested by Judson and others in 1999 [35]. However, it is also shown that, although the worldwide intensity peak occurs around a per capita income of about 14,000 US$ at 1995 prices and PPPs, the peak level of each country varies depending on various inherited characteristics of the economies [33].

The major driving force to improve the energy–economy relationship of the Turkish economy appears to be governmental policies. Single party governments usually have more power to implement development policies than coalition governments. These policies should include changes in the structure of final energy demand, increases in the efficiency of materials and energy use and the substitution of materials and fuels that are more efficient [37].

The energy efficiency in Turkish industry is traditionally low compared to other similar countries [38] but can be increased by some policy implications [14]. Some studies clearly showed that Turkey can reduce emissions considerably without slowing economic growth dramatically [39,40].

Finally, decomposition analyses of total primary energy consumption into production, structure and intensity effects of the Turkish economy from 1980 to 2000 offer useful tools for a better understanding of overall and sectoral changes. However, further decomposition into secondary and tertiary sectors is definitely needed for detailed investigations.

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