AGRICULTURAL INPUT-OUTPUT MODEL

ENERGY MODULE

***

1. Disaggregation of input-output table

To rearrange the I-O table of 1998[1] to obtain an agriculture focused one, two sources of data were used; I-O table[2] for the year 1998 prepared by Turkish Statistics Institute and commodity balance tables[3] in Turkey. The sector number 01, namely growing of cereals and other crops (GCC), was disaggregated further into wheat, maize, sunflower, and cotton by using commodity balance tables which provides information about total domestic demand, total production (excluding waste and loss), final consumption (private and public), gross fixed capital formation (private and public), stock change, exports, and imports of the products, as well as their distribution to feed and seed use.

Disaggregation has been done systematically, firstly, in domestic transactions component of the I-O table and then in imports component, lastly they were added together horizontally. In order to find out the use/sales of wheat, maize, cotton and sunflower by/to different sectors (intermediate demand for these products), equation 1 was employed and to find out the inputs used by wheat, maize, cotton and sunflower equation 2 was utilized.

$$us_{ij} = (tind_i - usse_i - usfe_i - fd_i)\gamma_{GCCj} \quad (1)$$

$$us_{ik} = \left(\frac{qp_k}{qp_{GCC} - m_{GCC}}\right)\chi_{iGCC} \quad (2)$$

where;
fd_i: final demand for the $_i^{th}$ sector
$_k$: wheat, maize, cotton, sunflower
m_{GCC}: imports of GCC

---

[1] Recent available I-O table in Turkey. However, since Turkey has suffered from two major earthquakes in 1999 and from two severe economic crises since 1998, radical changes are not expected in the interindustry transactions of the new I-O table (2002) that will be available in early 2008.
[2] Covers the I-O table for domestic output and for imports, TURKSTAT (2004).
[3] See Akyil (1999), Aydogus et al. (1998), Dellal and Ege (2000) and Dolekoglu (2001) for further information.

qp_k: output of $_k^{th}$ sector
qp_{GCC}: total output of GCC ($qp_{GCC} - m_{GCC}$: domestic output of GCC)
$tind_i$: total intermediate demand for $_i^{th}$ sector
us_{ij}: use/sales of $_i^{th}$ sector by/to $_j^{th}$ sector
us_{ik}: use/sales of $_i^{th}$ sector by/to $_k^{th}$ sector
$usfe_i$: demand/use for/of $_i^{th}$ sector for feed
$usse_i$: demand/use for/of $_i^{th}$ sector for seed
χ_{iGCC}: use/sales of $_i^{th}$ sector by/to GCC
γ_{GCCj}: inter-industry demand coefficients

where; $\gamma_{GCCj} = \dfrac{\chi_{GCCj}}{tind_{GCC} - usse_{GCC} - usfe_{GCC}}$

and χ_{GCCJ} is the use/sales of GCC by/to sector $_j$ and $tind_{GCC}$ is the intermediate demand, $usse_{GCC}$ is the sales for seed and $usfe_{GCC}$ is the sales for feed use of GCC. It is assumed here that γ_{GCCj} is same for wheat, maize, cotton and sunflower to the sales of $_i^{th}$ sector[4]. Above methodology was used to disaggregate the imports component also. Finally, domestic and imports components were added horizontally to get total agriculture focused I-O table at basic prices for the year 1998 for Turkey.

2. Solution procedure

The I-O analysis simply measures the magnitudes of direct and indirect variation in total production caused by changes in the final demand. The solution procedure of the model is summarized through the equations 3 to 7. Given X as the vector of total production (equation 3), it is equal to sum of Ax and Y (final demand vector), where Ax represents the matrix of intermediate demand and A is the matrix of technical coefficients $[a_{ij}]$ found as in equation 4. In equation 4, x_{ij} is the sale of $_i^{th}$ sector to sector $_j$ and X_j is the total outlay of sector $_j$.

$$X = Ax + Y \tag{3}$$

$$a_{ij} = \frac{x_{ij}}{X_j} \tag{4}$$

Rearranging equation (3) and simplifying it results in equation 6, in which $(I - A)$ is required to be a non-singular matrix in order to find a solution for X. Then by using the Leontief inverse, $(I - A)^{-1}$, total industrial output can be obtained by solving equation 7 with respect to exogenous changes in Y by calculating both direct and indirect effects in the chain of inter-industries linkages.

$$X - Ax = Y \tag{5}$$

$$X(I - A) = Y \tag{6}$$

$$X = (I - A)^{-1} Y \tag{7}$$

[4] Although this may seem to be a rough estmate, no other data is available which show the relative shares of wheat, maize, cotton and sunflower in the sales of GCC sector to the $_j$ sector. In addition not enough time series data do exist to estimate the shares econometrically.

3. Industry specification in the aggregated agricultural I-O table

Aggregated version of agricultural focused input-output table

1 Growing of cereals and other crops n.e.c.
2 Wheat
3 Maize
4 Sunflower
5 Cotton
6 Growing of vegetables, horticultural specialties and nursery products
7 Growing of fruit, nuts, beverage and spice crops
8 Farming of animals
9 Agricultural and animal husbandry service activities, except veterinary activities
10 Forestry, logging and related service activities
11 Fishing
12 Mining and quarrying [08-12]
13 Production, processing and preserving of meat and meat products
14 Processing and preserving of fish and fish products
15 Processing and preserving of fruit and vegetables
16 Manufacture of vegetable and animal oils and fats
17 Manufacture of dairy products
18 Manufacture of grain mill products, starches and starch products
19 Manufacture of prepared animal feeds
20 Manufacture of bakery products
21 Manufacture of sugar
22 Manufacture of cocoa, chocolate, sugar confert. & other food products n.e.c.
23 Manufacture of alcoholic, soft drinks and mineral waters [23-24]
24 Manufacture of tobacco products
25 Manufacture of textiles [26-32]
26 Wood, furniture, paper, publishing [33-37, 67]
27 Manufacture of fertilizers, pesticides, other agro-chemicals, paints, and varnishes [40-41]
28 Manufacture of coke, refined petroleum prod., basic chemicals, rubber, plastics, glass, ceramic prod., non-metallic minerals, etc. [38-39, 42-49]
29 Manufacture of ferrous, non-ferrous metals, various machinery, vehicles, etc. [50-66, 68]
30 Energy production and distribution [69-70]
31 Water and Construction [71-72]
32 Transport [73, 78-81]
33 Services [74-77, 82-97]

4. Industry specification in the disaggregated agricultural I-O table

Disaggregated version of agriculture focused input-output tables

01 Growing of cereals and other crops n.e.c.
011 Wheat
012 Maize
013 Sunflower
014 Cotton
02 Growing of vegetables, horticultural specialties and nursery products
03 Growing of fruit, nuts, beverage and spice crops
04 Farming of animals
05 Agricultural and animal husbandry service activities, except veterinary activities
06 Forestry, logging and related service activities
07 Fishing
08 Mining of coal and lignite
09 Extraction of crude petroleum and natural gas
10 Mining of metal ores
11 Quarrying of stone, sand and clay

12 Mining and quarrying n.e.c.
13 Production, processing and preserving of meat and meat products
14 Processing and preserving of fish and fish products
15 Processing and preserving of fruit and vegetables
16 Manufacture of vegetable and animal oils and fats
17 Manufacture of dairy products
18 Manufacture of grain mill products, starches and starch products
19 Manufacture of prepared animal feeds
20 Manufacture of bakery products
21 Manufacture of sugar
22 Manufacture of cocoa, chocolate, sugar confert. & other food products n.e.c.
23 Manufacture of alcoholic beverages
24 Manufacture of soft drinks; production of mineral waters
25 Manufacture of tobacco products
26 Manufacture of textiles
27 Manufacture of other textiles
28 Manufacture of knitted and crocheted fabrics and articles
29 Manufacture of wearing apparel, except fur apparel
30 Dressing and dyeing of fur; manufacture of articles of fur
31 Tanning and dressing of leather; man.of luggage, handbags, saddlery and harness
32 Manufacture of footwear
33 Sawmilling and planning of wood
34 Manufacture of wood and of products of wood and cork
35 Manufacture of paper and paper products
36 Publishing
37 Printing and service activities related to printing
38 Manufacture of coke, refined petroleum products
39 Manufacture of basic chemicals, plastics & synthetics rubber
40 Manufacture of fertilizers and nitrogen compounds
41 Manufacture of pesticides, other agro-chemicals and paints, varnishes
42 Manufacture of pharmaceuticals, medicinal chemicals &botanical products
43 Manufacture of cleaning materials, cosmetics & man-made fibers
44 Manufacture of rubber products
45 Manufacture of plastic products
46 Manufacture of glass and glass products
47 Manufacture of ceramic products
48 Manufacture of cement, lime and plaster related articles these items
49 Cutting and finishing of stone and man. of non-metallic mineral products n.e.c.
50 Manufacture of basic iron and steel
51 Manufacture of basic precious and non-ferrous metals
52 Casting of metals
53 Manufacture of fabricated metal products, tanks, reservoirs &steam generators
54 Manufacture of other fabricated metal products; metal working service activities
55 Manufacture of general purpose machinery
56 Manufacture of special purpose machinery
57 Manufacture of domestic appliances n.e.c.
58 Manufacture of office, accounting and computing machinery
59 Manufacture of electrical machinery and apparatus n.e.c.
60 Manufacture of radio, television and communication equipment and apparatus
61 Manufacture of medical, precision and optical instruments, watches and clocks
62 Manufacture of motor vehicles, trailers and semi-trailers
63 Building and repairing of ships, pleasure and sporting boats
64 Manufacture of railway and tramway locomotives and rolling stock
65 Manufacture of aircraft and spacecraft
66 Manufacture of transport equipment n.e.c.
67 Manufacture of furniture
68 Manufacturing n.e.c.
69 Production, collection and distribution of electricity

70 Manufacture of gas; distribution of gaseous fuels through mains
71 Collection, purification and distribution of water
72 Construction
73 Sale, maintenance and repair of motor vehicles, motorcycles; retail sale of fuel
74 Wholesale trade and commission trade, except of motor vehicles and motorcycles
75 Retail trade, except of motor vehicles and motorcycles; repair of personnel &household goods
76 Hotels; camping sites and other provision of short-stay accommodation
77 Restaurants, bars and canteens
78 Transport via railways
79 Land transport; transport via pipelines
80 Water transport
81 Air transport
82 Supporting and auxiliary transport activities; activities of travel agencies
83 Post and telecommnications
84 Financial intermediation, except insurance and pension funding
85 Insurance and pension funding, except compulsory social security
86 Real estate activities
87 Renting of machinery and equip. without operator and of personal & household goods
88 Computer and related activities
89 Research and development
90 Other business activities
91 Education
92 Health and social work
93 Activities of membership organizations n.e.c
94 Recreational, cultural and sporting activities
95 Other service activities
96 Public services
97 Ownership of dwelling

5. Multipliers

6. Backward Linkages

7. Forward Linkages

8. Incorporating energy component to I-O model

The I-O model can be used to trace the environmental discharges in an economy, as firstly introduced and used in Leontief (1970). To incorporate environment into input-output analysis equation 8 is introduced.

$$EB_i = eb_i X \qquad (8)$$

where EB_i is the vector of environmental burden of sector $_i$ and eb_i is the vector of environmental discharges of type $_i$ per monetary unit of sector's output. In order to solve for EB_i, simply X in equation 7 is substituted into equation 8. As a result, economic data can be linked with resource use (such as energy and ore consumption) and/or environmental impact categories (such as greenhouse gas emissions, toxic discharges, ozone depletion potential, hazardous or non-hazardous waste), as in equation 9.

$$EB_i = eb_i \left(I - A\right)^{-1} Y \qquad (9)$$

8.1. Identifying the environmental pollution caused by fossil fuel consumption

In order to get emissions data for each sector of agriculture focused input-output table of Turkey for the year 1998, this study requires fossil fuel consumption (coal, crude oil and natural gas) for each sector. There is no source which provides the data about the consumption of fossil fuel for each sector of agriculture focused input-output table. The only source that gives the data of fossil fuel consumption for the manufacturing sector is prepared by Turkish Institute of Statistics with the title, "Energy Consumption in the Manufacturing Industry" for the year 1998. In order to achieve concordance between sources, agriculture focused input-output table is reaggregated accordingly with the classification in TURKSTAT 2001.

Data for total consumption of coal (lignite and hard coal), petroleum and natural gas is obtained from the Ministry of Energy given on its web page.[5] Here we assume that petroleum is equal to crude oil, so that information given in the agriculture focused input-output table for the sectors of mining of coal and lignite, and extraction of crude petroleum and natural gas can be used to distribute the coal, petroleum and natural gas in remaining sectors (intermediate and final users).

The quantity of coal (hard coal and lignite) and coal products (coking coal and coke powder); petroleum products (residual fuel oil, diesel oil, gasoline, LPG, and petroleum coke etc.) and natural gas consumed in manufacturing industry is subtracted from the total consumption so that the remaining can be distributed in all other sectors (intermediate and final users) accordingly their shares obtained from the sales of mining of coal and lignite, and extraction of crude petroleum and natural gas sectors given to them, without counting the shares of manufacturing in above both sectors in their total value. Mathematically:

$$\beta_{ej} = \frac{s_{ej}}{S_e - s_{em}} \qquad (10)$$

where

β_{ej} : share of *j*th sector from energy type sector.

s_{ej} : sales of energy type sector to *j* sector.

S_e : total sales of energy type sector

s_{em} : sales of energy type sector to manufacturing sector

(here e: type of energy sector-mining of coal and lignite or extraction of crude petroleum and natural gas sector).

In the agriculture focused input-output table, manufacture of coke and refined petroleum products sector and manufacture of gas; distribution of gaseous fuels through mains sector get inputs from mining of coal and lignite, and extraction of crude petroleum and natural gas significantly. From the above mentioned methodology we get

[5] www.enerji.gov.tr

their shares from the mining of coal and lignite sector, and extraction of crude petroleum and natural gas sectors. Here, it is assumed further whatever they produce is equal to the inputs they get from above sectors as the outputs of these sectors are the processed forms of the mining of coal and lignite, and extraction of crude petroleum and natural gas sectors. Again these processed coke, petroleum and natural gas outputs are distributed in all other sectors (intermediate and final users) in the similar fashion as mentioned in the above equation.

8.2. Methodology for estimation of GHGs from fossil fuel consumption

Turkish economy is mostly driven by fossil fuel consumption for energy systems like most economies and fossil fuel consumption is the major source of GHGs emissions in the country. To estimate GHGs emissions from fossil fuel consumption IPCC and EPA-USA guidelines were used (IPCC, 2006 and 1996, EPA, 1985)[6].

There are three tiers mentioned in both IPCC guidelines to estimate GHGs emissions from fossil fuel consumption: tier 1 approach uses average emission factors (default emission factors); in tier 2 method, country specific emission factors are used for different fuels; and in tier 3 method for energy, detailed emission models, plant combustion technologies for industries are used and different emission factors are available for different combustion and efficiency technologies. In this study tier 1 approach was used, as the required data for tier 2 and 3 approaches is not available.

Tier 1 emission estimate approach requires the following steps for each fuel type:
1. Converting Fuel Data into a Common Energy Unit: Firstly fuel data must be converted into 1000 tones; then to convert 1000 tones into terajoules net calorific values (NCVs) must be used.
2. Identifying a default emission factor: Default emission factor of a given GHG by type of fuel (kg /TJ).
GHGs emissions from fossil fuel consumption then can be estimated by the following equation:

$$Emissions_{GHGi,Fi} = Fi\ Consumption\ in\ TJ \times EF_{GHGi,Fi} \quad (11)$$

GHGi: type of GHG
Fi: type of fuel
EF: emission factor Kg/TJ

From the above equation, all types of GHGs can be calculated from fossil fuel consumption by simply multiplying the fuel type consumption expressed in energy units (TJ) with its emission factor.[7] For example, diesel oil consumption of textile industries is 8.037 thousand tones for the year 1998. To estimate CO2 emissions for textile

[6] 2006 IPCC Guidelines for National Greenhouse Gas Inventories methodology has been used for CO2, CH4 and N2O, Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories has been used for CO, NOx, and NMVOC and for SOx, AP-42 EPA USA guideline has been used.
[7] The details of net calorific values (default values) of fuel types and emission factors for fuel and GHG types are given in the "2006 IPCC Guidelines for National Greenhouse Gas Inventories", "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories" and EPA-USA guideline.

industries from diesel oil consumption, the diesel consumption (1000 tones) is converted into energy units by simply multiplying its net calorific value which is 43 TJ/1000 tones. The result is 345.591 TJ; multiplying this result with the emission factor of CO2 for diesel oil which is 74100 Kg/TJ, CO2 emissions from diesel oil consumption for textile industries will be 25608293.1 Kg (25608.3 tones).

Average emission factor and average NCV was used for petroleum products in other sectors to estimate GHGs emissions because information for each petroleum product consumption is not available for other sectors; such information is available only for manufacturing sectors.

Empirical Findings

Table 1. GHG emissions in 1998 (1000 tones)

Sectors	CO2	N2O	CH4	CO	SOx	NOx	NMVOC
Growing of cereals and other crops n.e.c.	3345.56	0.0235	0.1222	23.9775	30.578	30.559	4.819
Wheat	660.17	0.0046	0.0241	4.7314	6.034	6.030	0.951
Maize	115.34	0.0008	0.0042	0.8266	1.054	1.054	0.166
Sunflower	145.43	0.0010	0.0053	1.0423	1.329	1.328	0.209
Cotton	89.94	0.0006	0.0033	0.6446	0.822	0.822	0.130
Growing of vegetables, horticultural specialties and nursery products	122.29	0.0009	0.0045	0.8764	1.118	1.117	0.176
Growing of fruit, nuts, beverage and spice crops	130.20	0.0009	0.0048	0.9331	1.190	1.189	0.188
Farming of animals	41.87	0.0003	0.0015	0.3007	0.382	0.382	0.060
Agricultural and animal husbandry service activities, except veterinary activities	11.50	0.0001	0.0004	0.0824	0.105	0.105	0.017
Forestry, logging and related service activities	174.87	0.0019	0.0042	2.2715	2.227	0.946	0.295
Fishing	369.01	0.0027	0.0131	2.8221	3.483	3.257	0.539
Mining and quarrying [08-12]	970.81	0.0069	0.0351	0.1527	8.943	2.730	0.070
Production, processing and preserving of meat and meat products	74.55	0.0007	0.0015	0.0658	1.020	0.205	0.010
Processing and preserving of fish and fish products	7.97	0.0000	0.0001	0.0037	0.076	0.019	0.001
Processing and preserving of fruit and vegetables	143.85	0.0011	0.0054	0.0216	1.277	0.372	0.009
Manufacture of vegetable and animal oils and fats	324.34	0.0034	0.0068	0.2830	4.064	0.907	0.044
Manufacture of dairy products	57.55	0.0005	0.0021	0.0140	0.563	0.150	0.004
Manufacture of grain mill products, starches and starch products	5.22	0.0000	0.0002	0.0007	0.047	0.014	0.000
Manufacture of prepared animal feeds	5.25	0.0001	0.0001	0.0069	0.092	0.015	0.001
Manufacture of bakery products	86.27	0.0003	0.0020	0.0366	0.565	0.221	0.007
Manufacture of sugar	2444.74	0.0316	0.0363	2.9900	36.032	7.120	0.419
Manufacture of cocoa, chocolate, sugar confert.& other food products n.e.c.	643.48	0.0065	0.0154	0.4985	5.977	1.798	0.082
Manufacture of alcoholic, soft drinks and mineral waters[23-24]	144.37	0.0010	0.0049	0.0332	1.136	0.376	0.010
Manufacture of tobacco products	41.84	0.0003	0.0014	0.0117	0.303	0.112	0.003
Manufacture of textiles [26-32]	2334.60	0.0135	0.0584	1.1464	15.256	6.212	0.216
Wood, furniture, paper, publishing [33-37, 67]	2569.66	0.0192	0.0916	0.6293	22.285	6.868	0.193
Manufacture of fertilizers, pesticides, other agro-chemicals, paints, and varnishes [40-41]	2001.75	0.0083	0.0488	0.8817	7.234	5.355	0.171
Manufacture of coke, refined petroleum prod, basic chemicals, rubber, plastics, glass, ceramic prod., non-metallic minerals, etc. [38-39, 42-49]	19053.87	0.1719	0.4730	12.0256	196.546	50.024	2.095
Manufacture of ferrous, non-ferrous metals, various machinery, vehicles, etc. [50-66, 68]	18983.49	0.2302	0.3072	21.6770	180.115	55.079	3.094
Energy production and distribution [69-70]	84171.95	0.9904	1.5016	18.0471	1144.228	245.396	4.917
Water and Construction [71-72]	3156.53	0.0210	0.1090	0.7926	26.633	8.762	0.250
Transport [73, 78-81]	32764.54	0.2334	1.1729	1851.8286	301.267	331.402	347.603
Services [74-77, 82-97]	11249.75	0.1082	0.2485	99.7687	125.134	12.903	10.171
PrC	41683.77	0.5028	0.7200	569.4289	580.912	45.603	57.393
Pb C	6768.60	0.0501	0.1995	22.9420	60.226	8.532	2.490
Goods and services exports	5189.82	0.0365	0.1886	1.9379	47.424	7.272	0.411
Total	240084.75	2.4753	5.4182	2643.7328	2815.676	844.237	437.213

Source: Author's Calculations

Table 2. GHG emissions in 1998 (%)

Sectors	CO2	N2O	CH4	CO	SOx	NOx	NMVOC
Growing of cereals and other crops n.e.c.	1.39	0.95	2.26	0.91	1.09	3.62	1.10
Wheat	0.27	0.19	0.45	0.18	0.21	0.71	0.22
Maize	0.05	0.03	0.08	0.03	0.04	0.12	0.04
Sunflower	0.06	0.04	0.10	0.04	0.05	0.16	0.05
Cotton	0.04	0.03	0.06	0.02	0.03	0.10	0.03
Growing of vegetables, horticultural specialties and nursery products	0.05	0.03	0.08	0.03	0.04	0.13	0.04
Growing of fruit, nuts, beverage and spice crops	0.05	0.04	0.09	0.04	0.04	0.14	0.04
Farming of animals	0.02	0.01	0.03	0.01	0.01	0.05	0.01
Agricultural and animal husbandry service activities, except veterinary activities	0.00	0.00	0.01	0.00	0.00	0.01	0.00
Forestry, logging and related service activities	0.07	0.08	0.08	0.09	0.08	0.11	0.07
Fishing	0.15	0.11	0.24	0.11	0.12	0.39	0.12
Mining and quarrying [08-12]	0.40	0.28	0.65	0.01	0.32	0.32	0.02
Production, processing and preserving of meat and meat products	0.03	0.03	0.03	0.00	0.04	0.02	0.00
Processing and preserving of fish and fish products	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Processing and preserving of fruit and vegetables	0.06	0.04	0.10	0.00	0.05	0.04	0.00
Manufacture of vegetable and animal oils and fats	0.14	0.14	0.13	0.01	0.14	0.11	0.01
Manufacture of dairy products	0.02	0.02	0.04	0.00	0.02	0.02	0.00
Manufacture of grain mill products, starches and starch products	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Manufacture of prepared animal feeds	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Manufacture of bakery products	0.04	0.01	0.04	0.00	0.02	0.03	0.00
Manufacture of sugar	1.02	1.28	0.67	0.11	1.28	0.84	0.10
Manufacture of cocoa, chocolate, sugar confert.& other food products n.e.c.	0.27	0.26	0.28	0.02	0.21	0.21	0.02
Manufacture of alcoholic, soft drinks and mineral waters[23-24]	0.06	0.04	0.09	0.00	0.04	0.04	0.00
Manufacture of tobacco products	0.02	0.01	0.03	0.00	0.01	0.01	0.00
Manufacture of textiles [26-32]	0.97	0.55	1.08	0.04	0.54	0.74	0.05
Wood, furniture, paper, publishing [33-37, 67]	1.07	0.77	1.69	0.02	0.79	0.81	0.04
Manufacture of fertilizers, pesticides, other agro-chemicals, paints, and varnishes [40-41]	0.83	0.33	0.90	0.03	0.26	0.63	0.04
Manufacture of coke, refined petroleum prod, basic chemicals, rubber, plastics, glass, ceramic prod., non-metallic minerals, etc. [38-39, 42-49]	7.94	6.94	8.73	0.45	6.98	5.93	0.48
Manufacture of ferrous, non-ferrous metals, various machinery, vehicles, etc. [50-66, 68]	7.91	9.30	5.67	0.82	6.40	6.52	0.71
Energy production and distribution [69-70]	35.06	40.01	27.71	0.68	40.64	29.07	1.12
Water and Construction [71-72]	1.31	0.85	2.01	0.03	0.95	1.04	0.06
Transport [73, 78-81]	13.65	9.43	21.65	70.05	10.70	39.25	79.50
Services [74-77, 82-97]	4.69	4.37	4.59	3.77	4.44	1.53	2.33
PrC	17.36	20.31	13.29	21.54	20.63	5.40	13.13
Pb C	2.82	2.02	3.68	0.87	2.14	1.01	0.57
Goods and services exports	2.16	1.48	3.48	0.07	1.68	0.86	0.09
Total	100	100	100	100	100	100	100

Source: Author's Calculations

Table 3. Prices and net calorific values of fuels

Fuel Type	Prices Millions TL per Tone	NCVs TJ/Gg
Lignite	10.90	11.9
Sulphur	12.00	40.2
Coke powder	13.72	25.0
Hard coal	14.16	26.7
Petroleum coke	16.62	32.5
Coking coal	21.23	28.2
Fuel oil	31.64	40.4
Natural gas	40.83	48.0
LPG	88.36	47.3
Diesel oil	129.54	43.0
Kerosene	151.20	43.8
Gasoline	202.66	44.3

Source: (TURKSTAT, 2001) and (IPCC, 2006)

Table 4. Rankings of emissions in ascending order for three GHG

Fuel Type	CO2 Emissions Kgs per Tone	Fuel Type	CH4 Emissions Kgs per Tone	Fuel Type	N2O Emissions Kgs per Tone
Lignite	1201.9	Lignite	0.0119	LPG	0.00473
Coke powder	2449.165	Coke powder	0.025	Natural gas	0.0048
Hard coal	2624.61	Hard coal	0.0267	Lignite	0.01785
Coking coal	2667.72	Coking coal	0.0282	Petroleum coke	0.0195
Natural gas	2692.8	LPG	0.0473	Sulphur	0.02412
Sulphur	2946.66	Natural gas	0.048	Fuel oil	0.02424
LPG	2984.63	Petroleum coke	0.0975	Diesel oil	0.0258
Gasoline	3069.99	Sulphur	0.1206	Kerosene	0.02628
Fuel oil	3126.96	Fuel oil	0.1212	Gasoline	0.02658
Kerosene	3149.22	Diesel oil	0.129	Coke powder	0.0375
Petroleum coke	3168.75	Kerosene	0.1314	Hard coal	0.04005
Diesel oil	3186.3	Gasoline	0.1329	Coking coal	0.0423

Source: Author's Calculations

Table 5. Conversion of fuel types into natural gas in manufacturing industries

Energy Type	Quantity in 1000 Tones	NCVs TJ/Gg	Energy Type in TJ	NG Equivalent in 1000 Tones
Natural gas	2667.632	48.0	128046.30	2667.632
Fuel oil	3780.943	40.4	152750.10	3182.294
LPG	362.545	47.3	17148.38	357.258
Kerosene	6.866	43.8	300.73	6.265
Sulphur	144.705	40.2	5817.14	121.190
Diesel oil	129.533	43.0	5569.92	116.040
Gasoline	18.634	44.3	825.49	17.198
Petroleum coke	1443.449	32.5	46912.09	977.335
Coking Coal	828.289	28.2	23357.75	486.619
Coke Powder	419.814	25.0	10495.35	218.653
Hard coal	4891.877	26.7	130613.10	2721.107
Lignite	5050.529	11.9	58081.08	1210.023

Source: Author's Calculations

References

Akyil, N., 1999. Pamuk Tahmin: 1998/99 *(in Turkish)*. Agricultural Economics Research Institute, Research Paper No. 16, Ankara.

Aydogus, O., Ege, H. and Erturk, Y.E., 1998. Bugday Tahmin: 1998/99 *(in Turkish)*. Agricultural Economics Research Institute, Research Paper No. 12, Ankara.

Dellal, I. and Ege, H., 2000. Yemlik Tahillar: Durum ve Tahmin, 2000/01 *(in Turkish)*. Agricultural Economics Research Institute, Research Paper No. 48, Ankara.

Dolekoglu, T., 2001. Yagli Tohumlar ve Bitkisel Yaglar: Durum ve Tahmin, 2001/2002 *(in Turkish)*. Agricultural Economics Research Institute, Research Paper No. 73, Ankara.

IPCC, 2006. "2006 IPCC Guidelines for National Greenhouse Gas Inventories." Available at: http://www.ipcc-nggip.iges.or.jp

IPCC, 1996. "1996 IPCC Guidelines for National Greenhouse Gas Inventories." Available at: http://www.ipcc-nggip.iges.or.jp

IPCC, 1996. "Climate Change 1995: The Science of Climate Change." Cambridge University Press. Cambridge, UK.

Koc A., A. Bayaner, S. Tan, Y.E. Erturk and F. Fuller, 2000. "Analyses of the Impact of Support Policies and Programs on Animal Resources Development in Turkey." Ministry of Agriculture and Rural Affairs, Agricultural Economics Research Institute, November.

Leontief W., 1970. "The Dynamic Inverse." In Contributions to Input-Output Analysis, edited by Carter A. P. and A. Brody, 17-46, Amsterdam: North-Holland.

Magdoff F. and V. E. Harold, 2000. "Building Soils for Better Crops." 2nd Edition, Sustainable Agriculture Network Handbook Series.

Mosier, A. R., J. K. Syers and J.R. Freney, (Eds.), 2004. Agriculture and the Nitrogen Cycle. Island Press, Washington, D.C.

OECD, 2001. "Environmental Indicators for Agriculture." Volume 3 Methods and Results, Paris.

Turkish Institute of Statistics (TURKSTAT), 2004. Turkish Institute of Statistics, Input Output Table for 1998 (electronic publication), Ankara.

Turkish Institute of Statistics (TURKSTAT), 2001. "Energy Consumption in the Manufacturing Industry (Establishments with 500 Tones of Oil Equivalent or More Energy Consumption) 1998." Ankara.

Turkish Ministry of Energy. http://www.enerji.gov.tr

UNFCCC. Available at: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/3734.php