

**DETERMINATION OF KEY SECTORS IN TURKISH ECONOMY BY  
USING INPUT-OUTPUT ANALYSIS**

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**Abstract:**

*The purpose of this study is to determine the key economic sectors by using Leontief input-output analysis in the deriving backward and forward linkages for all sectors in the Turkish economy for the year 2011. It is important to contribute to public policies aimed at development of the national economy according to the results reached in our study.*

*The key economic sectors, according to their direct or indirect forward and backward linkage indices, are Textiles and Textile Products, Chemicals and Chemical Products, Basic Metals and Fabricated Metal, Electricity, Gas and Water Supply, Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies. Investments primarily in these sectors may increase economic mobility.*

**Keywords:** *Leontief Input-Output Analysis, Key Sectors, Forward-Backward Linkages Coefficients.*

**JEL Classification:** *C67, D57, O11.*

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## **1. Introduction**

Input-output analysis investigates the input transactions between sectors. To do this, it utilizes input-output tables that show the transactions between sectors. Input-output tables can be used in many fields such as structural analyses and planning of the economy, calculation of national income and analyses of production, demand, price, cost, investment, productivity and sensitivity (Özdemir, Yüksek, 2006).

The fundamental purpose of our study is to investigate the productive structure of the Turkish economy taking all sectors into consideration. The results obtained will help us to determine investment priorities by identifying key sectors in the economy. Despite the fact that the economic structure of sectors is comparable through descriptive statistics, due to inter sector effects, the interactive economic structure of sectors can be investigated through the input-output analysis approach. Thus, we conducted an input-output analysis using data from the Turkey by World Input Output Database (WIOD) for 2011.

The paper consists of 3 sections. Section 1 presents the empirical literature related to input-output analysis. Section 2 presents the input-output analysis method and input-output analysis results for 2011. Finally several conclusions are presented in Section 3.

## **2. Literature Review**

In the empirical literature, input-output analysis is done benefiting from various organizations input-output tables. In generally the studies analyzed in Turkey case are used Input-Output Tables of Turkish Statistical Institute's (TurkStat) for some years. The 2002 Input-Output data is the latest ones published by TurkStat.

Our study is different from other studies in empirical literature in terms of using the latest data source to determine key sectors in Turkish economy. We have analyzed all of the sectors. In other hand we have calculated the relationship of all the sectors with other sectors by using WIOD with Input-Output Table of 2011 for 35 sectors. We have used Leontief Method to determine forward and backward linkage effects of all the sectors.

There are many studies available in the empirical literature. In Turkey and other countries case, some of them are as follows:

Tunç (2004) examines the main source of structural transformation in the Turkish economy for the aggregated 25 sectors by using TurkStat (Turkish Statistical Institute) Input-Output Tables for the years 1985, 1990 and 1996. According to the study results domestic final demand, export growth, import substitution of final demand, import substitution of intermediate goods demand and technological changes have been identified as the main source of country.

Çondur and Evlimoğlu (2007) analyze the mining sector in Turkey by using Leontief Input-Output Method for the year 1996. The coke oven and refined petroleum products manufacturing sectors have the highest value and they are the key sectors both in terms of forward and backward linkages. However, the effects of the backward linkages of the crude oil and natural gas extraction sectors are low while the effects of the forward linkages are high.

Ayaş (2011) determines the strategic sectors of Turkish manufacturing industry by using TurkStat 2002 Input-Output Table. In this study strategic sectors are food-beverage, textile, garment, chemical products and machinery products. The sectors which have strong forward linkage are non-metallic mineral products and the basic metal industry.

Tekin and Evcim (2011) analyze input-output relations between agricultural and other sectors of national economy, consisting of 59 sectors with TurkStat 2002 Input-Output Table data, in order to determine input structure of the production and, backward-forward dependency of the sectors in Turkish economy. According to the study results agricultural activities sector is the largest contributor to the Turkish economy.

Kelek and Gökçalp (2012) examine iron and steel industry and basic metal industry's location and importance in Turkish economy. The relationship with other sectors has been calculated with Input-Output Tables of TurkStat 1990, 1998 and 2002 years. The iron and steel industry plays a substantial role in the country's economic development and is recognized as an important indicator for classification of economic development level.

Atan and Arslantürk (2012) analyze the tourism and economic growth nexus by means of input-output analysis, covering forward and backward linkage effects, based on the 2002 TurkStat Input-Output Table in Turkey. The analysis results show that, tourism is growing very fast and its contribution to the economy is very significant.

Taşcı (2013) analyze how Information and Communication Technologies (ICT) industry's structure and magnitude in Turkish economy as benefitting

from two Input-Output Tables (1998 and 2002) for Turkey prepared by OECD. Analysis results show that The ICT industry has been growing rapidly, diffusing to other industries and has been able to create a significant amount of new jobs in spite of financial crises.

Meng, Zhou, Zhou et al. (2014) search the input-output relationship of the electrical industry by using China Input-Output Table (2007) in economy. Their empirical results show that the mechanical industry, construction industry and chemical industry have the largest electricity-saving potential.

Chang, Shin and Lee (2014) present an input-output analysis on how the port sectors impact a concerned economy using South Africa Supply and Use Tables (2006). The demand-driven, supply-driven and price models, were derived for the estimation. According to the study results, the overall forward linkage effect of the port sector is 0.97 and the backward one is 0.48.

Chun, Woo, Seo et al. (2014) investigate the effect of hydrogen energy technology investment on the Korean economy for the period 2020-2040. The study results show that the hydrogen sector can be characterized as intermediate primary production owing to its high backward and forward linkage effects.

Aydoğuş, Değer, Çalışkan et al. (2015) examines the intermediate inputs import dependency of Turkish economy with input-output model by using TurkStat 2008 Input-Output Table data. The analysis reveals dependency of Turkish economy on especially raw material inputs obtained from abroad. Analysis results shows that import dependency in Turkey is a matter of raw material imports, mostly fuels.

### **3. Empirical Results**

#### **3.1. Methodology**

The Leontief input coefficients matrix shows the transaction relationship of goods and services between industries. Due to its complex structure, it is not good for direct use in analyses. Therefore, it is better to convert it into the matrix of technical coefficients (A) (Matrix of Indirect Input Coefficients) in order to have analytical and practical benefits. The input coefficient in input-output models is the rate of output amount of a specific sector to its input amount which it has to get from other sectors in order to produce one unit of output. This can be formulated as follows:

$$a_{ij} = X_{ij} / X_j \quad (1)$$

$X_{ij}$ :  $j$  represents the amount demanded by the sector and  $i$  represents the amount of demand from other sectors. Coefficient  $a_{ij}$  represents the intermediate input required to produce product  $j$ . When the matrix of the input coefficients ( $A$ ) is subtracted from the unit matrix and multiplied by the matrix of intersector output ( $X$ ), we derive the final demand vector ( $Y$ ) as follows:

$$Y = (I - A)X \quad (2)$$

That is:

$$X = (I - A)^{-1}Y \quad (3)$$

The matrix of  $(I - A)^{-1}$  in equation 3 is called the Leontief Inverse Matrix. The sum of values in  $i$  lines and  $j$  column are as in equations 4 and 5;

$$R_{i=} = \sum_{i=1}^n r_{ij} \quad (i = 1, 2, \dots, n) \quad (4)$$

$$R_{j=} = \sum_{j=1}^n r_{ij} \quad (j = 1, 2, \dots, n) \quad (5)$$

What is meant by the sum of values of  $i$  units is the required speed up by any  $i$  sector due to any one unit of speed up in the final demands of all sectors in the economy (Özdil, Turdalieva and Ganiyev 2011, 357).

Similarly, the total of  $j$  values represents the required speed up by all sectors in the economy in order to respond to the unit demand increase in sector  $j$ . In this sense, the relationship chain in the economy is made visible by this inverse matrix (Kepenek, 1977, 20-25).

For example, when there is a demand increase in the construction industry, there must be a higher amount of iron production. Therefore, this increase in the main metal production sector means more energy consumption. In this way, sectors affect each other as a chain reaction (Türker, 1999).

The highest values of the sums of elements in the Leontief matrix represent sectors which activate other sectors and, thus, affect the economy. By calculating the forward and backward linkage coefficients of the rows and columns of the matrix, one can determine the leading or key sectors where the effect is strong in terms of linkage coefficients. Key sectors that are used in the formation of economic plans are the most important outcomes of input-output analysis. In this way, we can define their level of significance in production.

The service and goods transaction of the sector may be defined as the goods and services that the sector demands from others (input demand) and that the sector offers to other sectors (input offer) for production. The input demands of the sector from other sectors for production are called backward linkage coefficients, while the input offers of the sector to other sectors for production are called forward linkage coefficients (Özdil, Turdalieva and Ganiyev 2011, 358).

Forward ( $B_i$ ) and backward ( $B_j$ ) direct linkage coefficients are calculated as given in equations 6 and 7 below:

$$B_i = \sum_{i=1}^n \frac{X_{ij}}{X_i} \quad (6)$$

$$B_j = \sum_{j=1}^n \frac{X_{ij}}{X_j} \quad (7)$$

Here, one calculates  $X_{ij}$  production,  $X_i$  use of intermediate inputs and  $X_j$  demand of intermediate inputs. These coefficients represent the level of direct contribution to production. A sector's having a high coefficient of backward linkage means that the production of other sectors will be affected by any one unit of increase in the production of the sector as much as by the level of the calculated coefficient. If the level of the forward linkage coefficient is high, it may be assumed that any one unit increase in the production of the sector means an increase in intermediate input offer to other sectors. Those sectors having high level are called "key sectors" (Öney, 1983, 99).

When defining intersectoral relationships, backward and forward linkage indices are determined. The inverse matrix is represented by  $r_{ij}$  and the total indirect forward linkage index for any  $i$ . sector is (TFI $_i$ ) as in equation 8, while the total backward linkage index (TBI $_j$ ) is given in equation 9 (Aydoğuş, 1999, 96);

$$TFI_i = \frac{\sum_j r_{ij}}{\left( \frac{\sum_i \sum_j r_{ij}}{N} \right)} \quad (8)$$

$$TBI_j = \frac{\sum_i r_{ij}}{\left( \frac{\sum_j \sum_i r_{ij}}{N} \right)} \quad (9)$$

Backward and forward measures of dispersion can be calculated by using total linkage indices. These measures are given as follows (Aydoğuş, 1999, 97):

$$DF_i = \frac{\left\{ (1/N - 1) \left[ \sum_j r_{ij} - (1/N) \sum_j r_{ij} \right]^2 \right\}^{1/2}}{\left( (1/N) \sum_j r_{ij} \right)} \quad (10)$$

$$DB_j = \frac{\left\{ (1/N - 1) \left[ \sum_i r_{ij} - (1/N) \sum_i r_{ij} \right]^2 \right\}^{1/2}}{\left( (1/N) \sum_i r_{ij} \right)} \quad (11)$$

Consequently, Hirschman classified sectors in four categories in terms of their sectoral investment priorities 8 (in 1958). The categories of this classification can be summarized as follows (Aydoğuş, 1999, 100-101):

**Category 1:** Sectors with high forward and backward linkage effects.

**Category 2:** Sectors with high backward but low forward linkage effects.

**Category 3:** Sectors with high forward but low backward linkage effects.

**Category 4:** Sectors with low forward and backward linkage effects

Sectoral investment priorities are listed from the highest to the lowest above. According to this, sectors in category 1 are key sectors with the highest investment priority. Current scarce resources will be assigned to these sectors. Later, if there is any amount of unassigned resource, this amount must be assigned to sectors in category 2. Sectors in categories 3 and 4 are of the lowest priority. In other words, these sectors are expected to be stimulated by key sectors. It is easy for sectors with high backward linkage to activate the economy they are in. Therefore, it is seen that sectors in category are more important as they have a higher backward linkage effect compared to that of sectors in category 3.

### 3.2. Data and Empirical Findings

The input-output table for data relating to Turkey was obtained from the WIOD (World Input-Output Database). Analyses were done on data of 35 sectors for the year 2011. As the result of analyses, the direct forward linkage effects (Bi) and direct backward linkage effects (Bj) showing the direct interactions of a sector to other sectors are given in Table 2. Ranks show the order of the direct backward and forward linkage coefficients of the sectors.

According to Table 2, the total increase in production due to 1 unit increase in demand by Inland Transport, sector code number c23, is 3,266 units. Each 1 unit increase in demand by all sectors caused 2,330 units of production increase in the Inland Transport sector.

Considering the direct forward and backward linkage effects of sectors, the top 5 sectors with the highest forward linkage are 1) Inland Transport, 2) Construction, 3) Food, Beverages and Tobacco, 4) Textiles and Textile Products, 5) Public Admin and Defense; Compulsory Social Security, respectively. The top 5 sectors with the highest backward linkage are 1) Inland Transport, 2) Renting of M&Eq and Other Business Activities, 3) Wholesale Trade and Commission Trade, Except for Motor Vehicles and Motorcycles, 4) Electricity, Gas and Water Supply and 5) Retail Trade, Except for Motor Vehicles and Motorcycles; Repair of Household Goods, respectively.

**Table 1. Direct Forward and Backward Linkage Indices of Turkish Economy (2011)**

SECTORS	Code	Manufacturing			
		Bi	Rank	Bj	Rank
<b>Agriculture, Hunting, Forestry and Fishing</b>	c1	1,206	<b>8</b>	1,508	<b>9</b>
Mining and Quarrying	c2	0,427	32	0,884	17
Food, Beverages and Tobacco	c3	2,163	<b>3</b>	0,884	16
<b>Textiles and Textile Products</b>	c4	2,154	<b>4</b>	1,749	<b>7</b>
Leather, Leather and Footwear	c5	0,700	24	0,469	24
Wood and Products of Wood and Cork	c6	0,316	33	0,383	26
Pulp, Paper, Paper, Printing and Publishing	c7	0,653	26	1,039	13
Coke, Refined Petroleum and Nuclear Fuel	c8	0,707	22	0,615	22
Chemicals and Chemical Products	c9	1,117	11	1,387	10
Rubber and Plastics	c10	0,572	29	0,645	20

Other Non-Metallic Minerals	c11	0,666	25	1,028	14
<b>Basic Metals and Fabricated Metal</b>	c12	1,193	<b>9</b>	1,222	<b>11</b>
Machinery, Nec	c13	0,790	20	0,258	28
Electrical and Optical Equipment	c14	1,027	14	0,511	23
Transport Equipment	c15	0,729	21	0,161	30
Manufacturing, Nec; Recycling	c16	0,631	27	0,115	33
Electricity, Gas and Water Supply	c17	1,030	13	1,985	<b>4</b>
Construction	c18	2,297	<b>2</b>	0,282	27
Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	c19	0,630	28	1,027	15
<b>Wholesale Trade and Commission Trade, Except for Motor Vehicles and Motorcycles</b>	c20	1,447	<b>6</b>	2,308	<b>3</b>
Retail Trade, Except for Motor Vehicles and Motorcycles; Repair of Household Goods	c21	0,842	17	1,760	<b>5</b>
Hotels and Restaurants	c22	0,818	19	0,462	25
<b>Inland Transport</b>	c23	2,330	<b>1</b>	3,266	<b>1</b>
Water Transport	c24	0,285	34	0,636	21
Air Transport	c25	0,432	31	0,257	29
Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	c26	0,826	18	1,527	<b>8</b>
Post and Telecommunications	c27	0,701	23	0,819	18
Financial Intermediation	c28	0,872	16	1,756	<b>6</b>
Real Estate Activities	c29	1,043	12	1,212	12
Renting of M&Eq and Other Business Activities	c30	0,945	15	2,895	<b>2</b>
Public Admin and Defense; Compulsory Social Security	c31	1,593	<b>5</b>	0,041	34
Education	c32	0,480	30	0,126	32
Health and Social Work	c33	1,168	<b>10</b>	0,136	31
Other Community, Social and Personal Services	c34	1,213	<b>7</b>	0,647	19
Private Households with Employed Persons	c35	0	35	0	35

**Source:** Authors' Calculations

According to Table 1, the top 5 sectors with the highest backward and forward linkage are 1) Inland Transport, 2) Textiles and Textile Products, 3) Wholesale Trade and Commission Trade, Except for Motor Vehicles and Motorcycles, 4) Agriculture, Hunting, Forestry and Fishing, and 5) Basic Metals and Fabricated Metal. Both the forward and backward linkage coefficients of these sectors are higher than 1. These sectors are key sectors, or leading sectors, in terms of their direct forward and backward linkage effects

The indirect forward and backward linkage effects presenting the chain interactions between a sector and the others are given in Table 2.

When we analyze Table 2, the total increase in production due to 1 unit increase in demand by Inland Transport, sector code number c23, is 2,014 units according to indirect backward linkage effect. Each 1 unit increase in demand by all sectors caused 0,882 units of production increase in the Inland Transport sector according to the indirect forward linkage effect.

When the indirect backward and forward linkage effects are analyzed, the top 5 sectors with the highest forward linkage are 1) Leather, Leather and Footwear, 2) Electricity, Gas and Water Supply, 3) Wood and Products of Wood and Cork, 4) Rubber and Plastics and 5) Textiles and Textile Products, respectively. The top 5 sectors with the highest backward linkage are 1) Inland Transport, 2) Electricity, Gas and Water Supply, 3) Renting of M&Eq and Other Business Activities, 4) Textiles and Textile Products and 5) Wholesale Trade and Commission Trade, Except for Motor Vehicles and Motorcycles, respectively.

Considering the backward and forward linkage indices in accordance with the Hirschman index, the sectors with high forward and backward linkage effects are Gas and Water Supply, Textiles and Textile Products, Chemicals and Chemical Products, Pulp, Paper, Paper, Printing and Publishing, Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies and Basic Metals and Fabricated Metal, respectively. These sectors in category 1 are key sectors, or leading sectors, in terms of indirect forward and backward linkage effects.

Sectors with a high backward but low forward linkage effect are Inland Transport, Renting of M&Eq and Other Business Activities, Wholesale Trade and Commission Trade, Except for Motor Vehicles and Motorcycles, Retail Trade, Except for Motor Vehicles and Motorcycles; Repair of Household Goods, Agriculture, Hunting, Forestry and Fishing, Financial

Intermediation, Mining and Quarrying, Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel, and Real Estate Activities. These sectors have vital importance for activating the production of other sectors.

**Table 2: Indirect Forward and Backward Linkage Indices and Key Sectors of Turkish Economy**

SECTORS	Code	Manufacturing		
		TFI	TBI	Hirschman Category
Agriculture, Hunting, Forestry and Fishing	c1	0,853	1,313	2
Mining and Quarrying	c2	0,893	1,061	2
Food, Beverages and Tobacco	c3	1,190	0,968	3
<b>Textiles and Textile Products</b>	c4	<b>1,199</b>	<b>1,582</b>	<b>1</b>
Leather, Leather and Footwear	c5	1,282	0,817	3
Wood and Products of Wood and Cork	c6	1,223	0,738	3
<b>Pulp, Paper, Paper, Printing and Publishing</b>	c7	<b>1,198</b>	<b>1,071</b>	<b>1</b>
Coke, Refined Petroleum and Nuclear Fuel	c8	1,186	0,842	3
<b>Chemicals and Chemical Products</b>	c9	<b>1,180</b>	<b>1,266</b>	<b>1</b>
Rubber and Plastics	c10	1,200	0,836	3
Other Non-Metallic Minerals	c11	1,086	0,906	3
<b>Basic Metals and Fabricated Metal</b>	c12	<b>1,054</b>	<b>1,025</b>	<b>1</b>
Machinery, Nec	c13	1,013	0,671	3
Electrical and Optical Equipment	c14	1,143	0,785	3
Transport Equipment	c15	0,949	0,633	4
Manufacturing, Nec; Recycling	c16	1,111	0,627	3
<b>Electricity, Gas and Water Supply</b>	c17	<b>1,255</b>	<b>1,787</b>	<b>1</b>
Construction	c18	0,990	0,648	4
Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	c19	0,910	1,023	2
Wholesale Trade and Commission Trade, Except for Motor Vehicles and Motorcycles	c20	0,887	1,563	2
Retail Trade, Except for Motor Vehicles and Motorcycles; Repair of Household Goods	c21	0,775	1,338	2
Hotels and Restaurants	c22	1,028	0,769	3
Inland Transport	c23	0,882	2,014	2
Water Transport	c24	0,850	0,793	4
Air Transport	c25	1,058	0,672	3

<b>Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies</b>	c26	<b>1,007</b>	<b>1,223</b>	<b>1</b>
Post and Telecommunications	c27	0,949	0,891	4
Financial Intermediation	c28	0,874	1,264	2
Real Estate Activities	c29	0,708	1,015	2
Renting of M&Eq and Other Business Activities	c30	0,875	1,643	2
Public Admin and Defense; Compulsory Social Security	c31	0,896	0,595	4
Education	c32	0,755	0,617	4
Health and Social Work	c33	0,992	0,625	4
Other Community, Social and Personal Services	c34	0,971	0,798	4
Private Households with Employed Persons	c35	0,581	0,581	4

**Source:** Authors' Calculations

According to Table 2, sectors with a low backward and high forward linkage effect are Food, Beverages and Tobacco, Other Non-Metallic Minerals, Coke, Refined Petroleum and Nuclear Fuel, Rubber and Plastics, Leather, Leather and Footwear, Electrical and Optical Equipment, Hotels and Restaurants, Wood and Products of Wood and Cork, Air Transport, Machinery, Manufacturing, and Recycling.

Sectors with low forward and backward linkages are Post and Telecommunications, Other Community, Social and Personal Services, Water Transport, Construction, Transport Equipment, Health and Social Work, Education, Public Admin and Defence; Compulsory Social Security, and Private Households with Employed Persons.

#### **4. Conclusion**

In this paper, we investigated the key industries within the input-output framework and used input output data obtained from the input-output table by preparing WIOD Project for Turkey in 2011. Beside, data which was arranged in 2002, used in many previous and latest studies, but we used data which was arranged in 2011 and included 35 sectors. Thus; we obtained key industries for Turkey by using the latest data. In this study, the key sectors of the Turkish economy were determined through the Leontief input-output analysis method. The backward and forward linkage coefficients were derived by using direct and indirect methods to determine the key sectors.

The key sectors we determined as a result of our study are Textiles and Textile Products, Chemicals and Chemical Products, Basic Metals and Fabricated Metal, Electricity, Gas and Water Supply, Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies. These sectors are in category 1 of the Hirschman index. The investment priority is with sectors in category 1 followed by those in category 2. In this way, it will be possible to activate other sectors. Thus, we can contribute to economic development and growth by using current resources effectively.

Göktolga and Akgül (2011) determined the key sectors of Turkish economy by 2002 input output data. According to study results, Public Utilities, Services and Other Activities, Inland Transport, Textiles and Textile Products, Leather, Leather and Footwear identified as key sectors. Our study shows that Inland Transport and Textiles and Textile Products sectors are still key sectors in Turkish economy for the year 2011. Results of analysis are generally consistent with the study of Göktolga and Akgül (2011).

This study is a guide for future researches on the use of input-output analysis in sector and inter sectoral industries studies in other countries case. Our analysis results can be used as a decision making problems in industry and development planning of related sectors. Especially, these results can be an important tool for the future possible investment plans.

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