Investigation of the Production Structure of the Food Industry with Input-Output Analysis: An Empirical Application on Turkey

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Abstract

Recently, the rising food prices have contributed to inflation in Turkey. It has been crucial to analyze the interconnections between the food sector and other sectors of the economy to understand these price dynamics. The aim of this study is to determine the production structure and linkages of the Turkish food sector with other sectors utilizing input-output analysis. The input-output table for the study has provided by the World Input-Output Database. The findings indicate that the food sector requires 0.6477 units of input from other sectors to produce one unit of output. The direct forward linkage coefficient, which measures the input required by other sectors from the food sector, is estimated at 0.4385. The "hosting and catering service activities" sector is identified as the most demanding sector for the food sector's output, after its own sector, with a share of 0.1267. This finding demonstrates a significant input flow from the food sector to the "accommodation and food service" sector. The total backward and forward linkages for the food sector are computed as 2.0381 and 1.6833 respectively. Therefore, indicating changes in food sector production has significantly influenced other sectors. Both the total backward linkage index value (1.3409) and the total forward linkage index value (1.1075) exceed a certain threshold. This result reveals that the food sector key role in the Turkish economy with push and pull effect on other sectors. It is recommended that prioritize incentive policies that have strong linkages with the food sector and evaluate investment decisions accordingly.

1 Introduction

The analysis of interrelationships among sectors in an economy requires the application of diverse methodologies. One of these methodology is input and output analysis, which allows for the evaluation of the effectiveness of economic policies at both national and regional levels, as well as the forecasting of future trends. This analytical approach relies on the utilization of input and output tables, also referred to as inter-industrial operations tables, which provide a comprehensive framework for examining the interconnections between different sectors. Various statistical methods can asses the specific structural characteristics of the economy within a certain period through an approach that studies the relationships between sectors with the help of a mathematical model. One of the most significant advantages of the analysis is that it can be modeled with numerical data of asset sales at the sectoral level in empirical applications. Moreover, it enables the determination of production structures, interdependencies among all economic sectors, and priorities in development plans. Particularly in the input-output analysis, which demonstrates the mutual relationships throughout industries, it becomes possible to identify key sectors that have a significant influence on other sectors when there is an increase in demand within a particular industry. Thus, investors can make decisions about investments wisely. (Hirschman, 1958; Dasgupta and Chakraborty, 2005). Severe inflation has considerably impacted food costs in Turkey in recent years. It has been critical to employ numerical methods to investigate the food sector's relationship with other sectors in order to comprehend the structural causes of rising food prices. The objective of this study is to assess the analytical methodology by examining the interconnections between the Turkish food industry and other industries. For this purpose, it has been utilized input-output table to determine direct and total linkage coefficients, total linkage index values, and rates of the intermediate input for food industry. Consequently, the study evaluates the role and importance of the food industry in the Turkish economy, including its production structure and structural connections to other sectors. Based on our current understanding, it appears that Turkey has not undertaken any studies to determine the extent relationship between the food sector and other sectors. Therefore, this research fills a significant gap in the existing literature. The study divide into five main parts. Following the introduction, the second section provides a comprehensive review of the relevant literature. The third section presents detailed information about the methodological structure and the dataset used for the input-output analysis. In the fourth section, the findings of the analysis are discussed. The final section of the study focuses on the application of the input-output analysis method to the food sector in Turkey and presents the obtained results, along with policy recommendations for further consideration.

2 Literature Review

It has been recognized that inter-industry relationships are increasing significantly. In this regard, researchers frequently employ input-output analysis as a method to analyze individual sectors and identify interrelationships between them.The resarch completed on input-output analysis in Turkey can be categorized into three main groups: (1)studies conducted for the entire country, (2)specific sub-sectors, regions, and (3)other selected countries. Researchers have shown a strong demand for comprehensive studies utilizing published input-output tables. Due to the comprehensive nature of analyzing the published input-output tables, there are considerable time intervals

between publication times. Studies that utilizing the input-output tables for Turkey reveals a prevalent focus on sectors such as tourism, manufacturing, industry and services, energy, transportation, automotive, and environment. These studies can be regarded as investigations into the interrelations between particular sectors. For instance, Kula (2008) emphasized the importance of studying 12 key sectors employing input-output tables from 2002. Atan (2011) found that the significant sectors vary in each category (general, domestic, import) based on output tables from the same year. Altan et al. (2015) utilized the input-output analysis approach in conjunction with the data envelope method to assess the performance and efficiency of specific sectors in their studies. Some of the studies have focused on computing the forward and backward linkages of the tourism sector with other industries, aiming to determine its economic significance. These studies include the impact of the tourism sector on economic activities in terms of providing foreign exchange input, its effects on the balance of payments, the significant number of backward linkages, and the sector's high potential for income and employment. Studies conducted in this sector have performed structural analyses using input and output data from TURKSTAT for the years 1990, 1998, 2002, and 2012. Based on the findings of the preliminary period study utilizing input-output tables from 1990, it has been determined that the tourism sector received input from 37 sectors, with a significant portion of these sectors belonging to the manufacturing industry (Egeli, 1997). Another investigation focused on the periods of 1990-1995 and observed intermittent changes in the sectors utilized by the tourism sector. The classification of manufacturing, trade, and agriculture shifted to manufacturing, farming, and services (Çakır and Bostan, 2000). Analyzing input and output tables from 2002, a study involving 16 industries revealed a strong impact between the tourism sector and manufacturing industry (Atan and Aslantürk, 2012). Further research investigated the links between the tourism sector and all other sectors employing input and output tables from 2012. Result of the study the backward linkage indices have been estimated as 0.53 and 0.52, respectively (Canlı and Kaya, 2012). An additional investigation emphasized the tourism sector's higher employment and revenue impact values compared to other industries, highlighting its close relationship with food manufacturing, other services, and trade sectors through aggregated input and output tables (Bölük and Karkacıer, 2019). Besides the tourism sector, numerous studies have been conducted to investigate the role and significance of the manufacturing industry in the Turkish economy. Akbulut (2019) conducted a study examining the manufacturing industry's contribution to the Turkish economy in terms of total production, labor, capital, and total added value. The results varied depending on the stimulating effects of demand, leading to different outcomes for the elements examined. Göktolga and Ozkan(2011) examined trends in the transportation industry using input and output tables provided by TURKSTAT in 1998 and 2002. According to studies obtained in 1998, "maritime transportation", which was placed first in the significant sector ranking in 1998, declined to second position in 2002. They also assessed that growth in the transportation sector has been imbalanced. The need for energy has increased in parallel with the development of Turkey's manufacturing industry in recent years. Other studies based on input and output tables from 2002 found a high input-output relationship between the energy sector and its sub-sectors, as well as the main metal industry, transportation sector, manufacturing sector, and construction sector (Özdemir and Mercan, 2012).

Ugurlu and Tuncer (2017) investigated the economic structure of 35 sectors, including tourism, using aggregated input and output tables. They found that sectors with a higher share of exports were more dependent on imports, and the industrial sector's impact on growth was limited to the service sector. Alp et al. (2017) analyzed input and output tables from two distinct time periods to determine the leading industries in the Turkish economy. The study revealed that the number of leading sectors, which was ten in 2002, lost 40% of their leading characteristics by 2012. Moreover, only six out of the eleven leading sectors in 2012 remained as leading sectors in the previous period. Turker et al. (2017) assessed the furniture sector's position within the country's economy using input and output tables from 59 sectors. According to the production and income mültiplier coefficients, the furniture sector has been rated 22nd and 8th, respectively. Erkök et al. (2018) evaluated the production structure of the automotive sector, its dependence on imports, and the interaction between sectors based on the 2002 input and output figures. The result of the study reveal that the automotive industry ranked second and 26th among 59 industries in terms of backward and forward linkage effects, respectively. Additionally, the industry ranked fifth in terms of importing intermediate inputs. Pehlivanoğlu and İnce (2020) studied the changes in the economic structure over time for ten selected sectors between 1970 and 2012. The study concluded that the Turkish economy shifted from an agriculture-based industry to an industry with intensive energy usage. Conducting a study to identify key industries in a specific region is crucial for the development of regional development programs. In addition to comparing different sub-sector comparisons in the literature, output analysis is commonly used in Turkey to examine economic activity on a regional level. Özyurt (1982) determined that in a notable analysis for the Trabzon subregion, which includes 64 sectors, established a static model through input coefficient matrix and identified critical industries in the economy. The Western Black Sea Development Agency performed an investigation that utilized calculations related to sectoral production structure, interconnection effects, impact analysis, factor intensities, concentration levels, and aggregation to evaluate regional competitiveness (Bakka, 2014). Another study which includes four different branches in the TR83 region analyzed investment decisions by grouping employing output analysis and aggregation analysis approaches to establish sector interaction (Özcan, 2014). Topçuoğlu and Ersungur (2016) utilized a questionnaire method and input-output tables to estimate the socioeconomic structure of Iğdır province and assess the impact of sectoral links. The analysis identified important

sectors as employment drivers and selected the top five sectors with the highest employment and income generation to contribute to regional growth objectives. The Izmir Development Agency (2021) conducted an assessment to identify critical industries in the Izmir sub-region. The research classified steam coal, refined petroleum product and nuclear fuel production, chemical and product manufacturing, and the primary metal industry as priority sectors for investment decisions. Studies that employ literature and output analysis to compare nations often focus on identifying specific sectors. For instance, Ersungur and Ekinci (2015) investigated Turkey's foreign trade relationship with four East Asian countries and found that the important industries varied across countries based on input and output tables from different time periods. Yıldız and Akduğan (2014) examined sector-to-sector relationships among the G-7 and emerging countries using data published by the Organization for Economic Development and Cooperation (OECD). The study revealed that the manufacturing industry was the primary sector in the developing country group of the G-7 countries, while other sectors emerged as key sectors. Özdil and Turdalieva (2014) investigated the effectiveness of Turkey-Kazakh economic cooperation through an analysis of the production structures of the two countries. The estimated link effects and index values showed differences in the production processes of the two countries. Turkey was found to have an advantage in the manufacturing sector compared to Kazakhstan, while Kazakhstan excelled in raw material and intermediate product exports. Ersungur et.al, (2017) highlighted major industries in an analysis of Turkish-BRICS trade. The findings indicated that the major industries varied across countries, and the country increased its dependence on energy and industrial items to spur economic development. Topcuoğlu (2019) computed the external trade relations between Turkey and the G-4 countries and the forward and backward effects to identify key sectors in each country. As a result of the study, it was noted that the main sectors show similarities between Turkey and the developed countries. Additionally, Turkey was found to have reduced its energy and industrial sector use and became dependent on imports, particularly from India and Brazil. Topcuoğlu and Ayyıldız (2020) evaluated major sectors in the 56-sector structures of E-7 countries, which are identified as having a high rate of development. The study estimated forward and backward effects and highlighted manufacturing industries as essential sectors across all country groups.

3 Data and Econometric Model

Input-output tables have been developed with various organizations, such as the Organization for Economic Cooperation and Development (OECD) and the World Input Output Database (WIOD). Also, the latest data related to input and output tables in Turkey has been established by the Turkish Statistical Authority (TURKSTAT) in 2012. However, the World Input Output Database published the most comprehensive version of the national input-output table for Turkey in 2016, which includes data at current prices. In order to ensure that the linkages between sectors are preserved and allow for comprehensive analysis. A total of 56 industrial transaction sectors have been selected without aggregation. In this study, the most recent updated input-output table published by WIOD has been utilized. The NACE classification codes and names can be found in Appendix 1. The input and output analysis approach, which allows for the utilization of the output of each sector as an input by itself and other sectors, takes the form of a matrix with rows and columns. This matrix enables the analysis of how the production and usage values of participating sectors in the economy are distributed among sectors over time, as well as the interdependence among industries (Yılmaz, 1985; Miernyk, 1966). Within this matrix, the sales related to the output reveal the extent to which a sector's production value is utilized by other sectors, along with the aggregate demand for the sector's products. The column values within the context of input and output analysis represent the comprehensive supply amount of a given sector, which includes the inflow of inputs from other sectors, as well as the total production value and total import value of that sector (Aydouş, 2010). By subtracting the intermediate consumption value from the total production value of a sector, it is possible to obtain additional value. The summation of the row values of a sector with the final demand is equivalent to the total of the column values, which is known as the added value. This equation has been recognized as an essential prerequisite for achieving a state of general equilibrium in the output tables (Kepenek, 1977). The supply of each sector is equal to the demand of that same sector according to the output model presented in equation 1, (Aydouş, 2010).

$$X_i = \sum_{j=1}^{n} X_{ij} + Y_i \quad (1) \qquad a_{ij} = \frac{X_{ij}}{X_J} \quad (2)$$

In equation 2, input coefficient (a_{ij}) has been computed by dividing the input variable (Xij) to the output quantity of sector i. And also input coefficient (aij) has been defined the technology matrix [A]. The input coefficient included in the technology matrix is the ratio of the value of the input received from other sectors to the output of the relevant sector in order to produce an output in any sector's unit value (Bocutoğlu, 1990). The direct backward linkage coefficient is derived from equation 3, which involves adding the values of the line elements in each sector of the technology matrix [A]. Similarly, the direct forward linkage coefficient computed in equation 4 is computed by adding the values pertaining to the column components in the technology matrix [A].

$$BL_j = \sum_{i=1}^{n} \left(\frac{X_{ij}}{X_j}\right) \quad (3) \qquad FL_i = \sum_{j=1}^{n} \left(\frac{X_{ij}}{X_i}\right) \quad (4)$$

Moreover, change in output of any industry have an enormous effect on those sectors which enable it to enter that sector. To accomplish this objective, the Leontief inverse matrix has to be determined in equations 1 and 2 to yield the reverse Leontief matrix [I-A]-1, which is given in equation 5.

$$X_i = \sum_{j=1}^{n} a_{ij} X_{ij} + Y_i \quad (5)$$

The total backward linkage (TBL_j) and total forward linkage (TFL_i) effects are demonstrated in equations 6 and 7, which is computed by the Leontief reverse matrix $[I\text{-}A]^{-1}$. The sum of row values for any sector in the Leontief reverse matrix indicates the total forward linkage effect, while the sum of column values represents the entire backward linkage effect.

$$TBL_j = \sum_{i=1}^{n} (\, r_{ij} \,) \quad (6) \qquad TFL_i = \sum_{j=1}^{n} (\, r_{ij} \,) \quad (7)$$

The total backward linkage coefficient determines how much a unit increase in the final demand of any sector induces an increase in total production in other sectors. Similarly, the total forward linkage coefficient defines the extent to which an increase in the final demand of all sectors operating in the economy leads to an increase in production for a specific sector. Sectors with a high total backward linkage coefficient have strong demand power, while sectors with a high total forward linkage coefficient exhibit significant production capacity (Aydouş, 2010).

		Direct or Total Forward Linkage Effect	
		Lower < 1	Higher > 1
Direct or Total Backward Linkage Effect	Lower < 1	Category (4)	Category (3)
	Higher > 1	Category (2)	Category (1)

Table 1. *Classification of Sectors by Connection Effects* ***Source:*** *Miller and Blair, 2009.*

Sectoral interdependence has been defined as the utilization of commodities and services produced by any sector as intermediate inputs. In other words, the proportion of intermediate inputs received and provided by a sector from other sectors is included in the total sector production. Setting development plans and making investment decisions between sectors has been critical in considering their ability to exert push and pull effects on each other. For this purpose, the estimation of forward and backward linkage effects has been employed as a powerful decision-making tool (Özdemir and Mercan, 2012; Aydouş, 2010). The classification of sectors based on linkage effects is presented in Table 1. The degree of interconnectivity among sectors reflects their significance in the economy. Sectors that exhibit both forward and backward linkage effects surpassing a specific threshold are classified as key sectors and placed in Category 1. Sectors in Category 1 hold the highest priority for investment, and it is recommended that the limited resources of the country be primarily directed towards these sectors (Foreign, 1983). Sectors exhibiting a high backward linkage effect but a low forward linkage effect are classified under Category 2. In terms of resource allocation, priority should be given to this category. Categories 3 and 4, on the other hand, encompass sectors involved in intermediate production and sectors with the potential to increase output when stimulated by key sectors, respectively (Aydoğuş, 2010).

$$BLI_j = \left(\frac{\sum_{i=1}^{n} r_{ij}}{\frac{1}{N}\sum_{j=1}^{n}\sum_{i=1}^{n} r_{ij}} \right) \quad (8) \qquad TFI_i = \left(\frac{\sum_{j=1}^{n} r_{ij}}{\frac{1}{N}\sum_{i=1}^{n}\sum_{j=1}^{n} r_{ij}} \right) \quad (9)$$

Total backward linkage effect index and total forward linkage effect index have been determined by equations 8 and 9 (Aydouş, 2010). Forward and backward linkage have been used to analyze sector-to-sector interactions and evaluate their economic significance. Also, the index values can be used to identify both the relationship between sectors and the sector's strategic importance to the country's economy (Kıvrak, 2018). If both index values are greater than a value, the sector is classified as a key sector with a high link effect (Temurshoev, 2004).

4 Findings and Duscussions

The backward linkage effect of the food sector must be examined to determine the extent to which it receives inputs from other industries. The direct linkage effects have been calculated by constructing a matrix (technology matrix) utilizing equations 3 and 4. The food industry's direct backward linkage effect coefficient has been found to 0.6477 among the 56 sectors in Table 2. This means that the food industry requires a total of 64.77 units of input from itself and other sectors to produce 100 units. This result suggests that the food sector has a significant impact on economic production. However, in order to assess the distribution of these inputs and identify the sectors with the greatest direct linkage effect on the food industry, sub-sector backward linkage effects have been determined.

Table 2 reveals that the food industry exhibits the highest direct backward linkage effect. Specifically, in order to produce one unit of output, the food sector requires 0.2869 units from the "crop and animal production, hunting and related service activities" sector; 0.1307 units from its own sector; and 0.055 units from the "land transport and transport via pipelines" sector. It can be observed that the "crop and animal production, hunting and related service activities" sectors play a significant role in supplying inputs to the food industry for output production. Specifically, the "crop and animal production, hunting and related service activities" sector exhibits the highest

direct linkage ratio, as it provides essential resources to the food sector. The food industry relies on input from the ground vehicle and motor vehicle sectors for logistics, transportation, and processing activities. The total amount of intermediate input required by the food industry from the transportation and industrial production sectors is 0.1419 units, with logistics activities accounting for (3-4-5). Approximately 14% of food production disruptions are attributed to logistics and transportation sectors. The top 20 sectors with the largest direct linkage effect contribute to over half (approximately 63.50%) of the total input needed for food sector production. Consequently, it is reasonable to argue that the food industry's production structure has the potential to influence the structure of many other industries. By utilizing inputs from various sectors, the food industry also contributes to their development by supplying goods.

No	Sector Name	Direct Backward Linkage
1	Crop and animal production, hunting and related service activities	0.2869
2	Manufacture of food products, beverages and tobacco products	0.1307
3	Land transport and transport via pipelines	0.0550
4	Retail trade, except of motor vehicles and motorcycles	0.0468
5	Wholesale trade, except of motor vehicles and motorcycles	0.0401
6	Manufacture of paper and paper products	0.0098
7	Other professional, scientific and technical activities; veterinary activities	0.0095
8	Administrative and support service activities	0.0088
9	Manufacture of rubber and plastic products	0.0084
10	Manufacture of chemicals and chemical products	0.0064
11	Electricity, gas, steam and air conditioning supply	0.0060
12	Manufacture of textiles, wearing apparel and leather products	0.0056
13	Manufacture of other non-metallic mineral products	0.0049
14	Financial service activities, except insurance and pension funding	0.0030
15	Wholesale and retail trade and repair of motor vehicles and motorcycles	0.0027
16	Water transport	0.0027
17	Warehousing and support activities for transportation	0.0026
18	Manufacture of coke and refined petroleum products	0.0020
19	Manufacture of fabricated metal products, except machinery and equipment	0.0016
20	Telecommunications	0.0015

Table 2. *Ranking of the 20 Sectors That Provide the Most Intermediate Inputs to the Food Sector*
Source*: WIOD Input-Output Table for 2014 and the Author's Own Calculations.*

No	Sector Name	Direct Forward Linkage
1	Manufacture of food products, beverages and tobacco products	0.1307
2	Accommodation and food service activities	0.1267
3	Fishing and aquaculture	0.0288
4	Crop and animal production, hunting and related service activities	0.0259
5	Scientific research and development	0.0191
6	Human health and social work activities	0.0116
7	Manufacture of chemicals and chemical products	0.0093
8	Manufacture of textiles, wearing apparel and leather products	0.0091
9	Public administration and defence; compulsory social security	0.0079
10	Manufacture of paper and paper products	0.0073
11	Water transport	0.0063
12	Other professional, scientific and technical activities; veterinary activities	0.0060
13	Manufacture of computer, electronic and optical products	0.0042
14	Manufacture of machinery and equipment n.e.c.	0.0030
15	Mining and quarrying	0.0028
16	Manufacture of rubber and plastic products	0.0025
17	Other service activities	0.0022
18	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	0.0022
19	Administrative and support service activities	0.0021
20	Education	0.0020

Table 3. *Ranking of the 20 Sectors That Use the Most Intermediate Inputs from the Food Sector (at Current Prices)*
Source: *WIOD Input-Output Table for 2014 and the Author's Own Calculations.*

Table 3 demonstrates the column values for the highest direct forward linkage effect, which can be used to estimate the input requirements of other sectors from the food industry. Upon examining the direct forward linkage coefficients in table 3, it is evident that the food sector provides the most substantial amount of input to its own sector, with a value of 0.1307 units. The most dependent sectors on the food sector are the "accommodation and food service activities" sector with a coefficient of 0.1267, the "fishing and aquaculture" sector with a coefficient of 0.0288, and the "crop and animal production, hunting and related service activities" sector with a coefficient of 0.0259, respectively. The "accommodation and food service activities" sector follows the food sector itself in terms of forward linkage connection effect, indicating a strong interdependency between the two sectors. Additionally, the total impact of the top 20 sectors with the highest forward linkage effect is 0.4097 units, indicating that these sectors utilize 40.97% of the food sector's output. Based on the input matrix (technology matrix) data, the food industry's direct forward linkage coefficient is identified as 0.4385, ranking 16th out of 56 sectors in terms of the magnitude of this ratio. This finding suggests that 43.85 units of the food industry's 100 unit output are utilized as input by other sectors.

Table 4 indicate that the total backward linkage effect coefficients for the 20 sectors having the highest total connection effect. The total backward linkage effect of the food sector is demonstrated by the 1 unit final increase in demand for the food sector, along with the total production growth in food sector production. According to the size of the total backward linkage coefficiency, the food sector ranks second out of 56 industries. The total backward linkage effect coefficient for the "manufacture of food products, beverages, and tobacco products" sector has been calculated as 2.0381. This finding demonstrates that a one-unit increase in final demand for the food sector results in a total production increase of 2.0381 units in the overall economy.

No	Sector Name	Total Backward Linkage Effect	Total Backward Linkage Index
1	Manufacture of textiles, wearing apparel and leather products	2.1246	1.3979
2	Manufacture of food products, beverages and tobacco products	2.0381	1.3409
3	Manufacture of coke and refined petroleum products	1.9356	1.2735
4	Manufacture of paper and paper products	1.9113	1.2575
5	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	1.8543	1.2200
6	Manufacture of other non-metallic mineral products	1.8249	1.2007
7	Printing and reproduction of recorded media	1.8005	1.1846
8	Manufacture of chemicals and chemical products	1.6560	1.0895
9	Manufacture of electrical equipment	1.6517	1.0867
10	Manufacture of computer, electronic and optical products	1.6422	1.0805
11	Manufacture of rubber and plastic products	1.6393	1.0785
12	Manufacture of basic metals	1.6300	1.0724
13	Manufacture of motor vehicles, trailers and semi-trailers	1.6286	1.0715
14	Manufacture of fabricated metal products, except machinery and equipment	1.5466	1.0176
15	Manufacture of machinery and equipment n.e.c.	1.5241	1.0027
16	Mining and quarrying	1.4898	0.9802
17	Crop and animal production, hunting and related service activities	1.3969	0.9191
18	Fishing and aquaculture	1.2996	0.855
19	Forestry and logging	1.1971	0.7876
20	Manufacture of basic pharmaceutical products and pharmaceutical preparations	1.0000	0.6579

Table 4. *Total Backward Linkage Effects and Index of 20 Sectors with the Highest Linkage Effect for all Sectors, Index Values (At Current Prices)* ***Source****: WIOD Input-Output Table for 2014 and own calculations.*

When index values are calculated, the total linkage effect for each sector is proportional to the average linkage effect for all sectors. The significant increase in index values computed in this manner shows that the sector concerned has strong linkage effects. According to the table 3 and table 4; the total backward and forward linkage effects of the food sector have been estimated as index values 1.3409 and 1.1075, respectively. In terms of index values, the fact that both linkage effects are more than a value of the index values supports the conclusion that the food industry is a key sector with a high linkage effect that should be examined in category 1. On the other hand,

the increase in production resulting from a unit increase in the final demand of each sector in the food sector production additionally reveals the food sector's total forward linkage effect.

No	Sector Name	Total Forward Linkage Effect	Total Forward Linkage Index
1	Land transport and transport via pipelines	4.0057	2.6355
2	Electricity, gas, steam and air conditioning supply	3.4250	2.2534
3	Other professional, scientific and technical activities; veterinary activities	3.0835	2.0287
4	Wholesale trade, except of motor vehicles and motorcycles	2.8947	1.9045
5	Financial service activities, except insurance and pension funding	2.5587	1.6835
6	Warehousing and support activities for transportation	2.4310	1.5994
7	Retail trade, except of motor vehicles and motorcycles	2.3572	1.5509
8	Manufacture of textiles, wearing apparel and leather products	2.2682	1.4924
9	Administrative and support service activities	2.1153	1.3917
10	Real estate activities	2.0136	1.3248
11	Mining and quarrying	1.9756	1.2998
12	Wholesale and retail trade and repair of motor vehicles and motorcycles	1.9207	1.2637
13	Crop and animal production, hunting and related service activities	1.8957	1.2473
14	Telekomünikasyon	1.8016	1.1854
15	Manufacture of chemicals and chemical products	1.6988	1.1177
16	Manufacture of food products, beverages and tobacco products	1.6833	1.1075
17	Manufacture of paper and paper products	1.6575	1.0905
18	Manufacture of other non-metallic mineral products	1.5464	1.0174
19	Manufacture of coke and refined petroleum products	1.5196	0.9998
20	Accommodation and food service activities	1.5188	0.9993

Table 5: *Total Forward Linkage Effects and Index of 20 Sectors with the Highest Linkage Effect for all Sectors, Index Values (At Current Prices)* ***Source:*** *WIOD input-Output Table for 2014 and the Author's Own Calculations*

Table 5 indicate that the total backward linkage effect coefficients for the 20 sectors having the highest total connection effect. When the greatest total forward linkage effects has been investigated, the food industry ranked 16th with a linkage ratio of 1.6833. Based on this conclusion, it is assumed that a unit increase in the final demand of all sectors of the economy would increase food sector production by 1.6833 units. Sectors that exhibit both significant total backward linkage and total forward linkage effects are classified as critical sectors, as described in the "econometric model" section.

5 Conlusion

The input-output method has been used to analyze the food sector's interaction with other sectors in Turkey. Direct linkage effects, total linkage effects, and index values have been determined to evaluate the location and significance of the food sector in the Turkish economy. Comprehensive studies are needed to examine the causes of the rise in food prices and examine the sectoral implications in Turkey adequately. The research findings, which assess the forward and backward linkage effects of the food sector and the sub-sector related to the food industry, besides the index values, fill a vacancy in the literature.

The direct linkage coefficient has been established at 0.6477 to determine the degree to which the food sector's production impacts the production of other sectors. This findings denote that the food industry requires 0.6477 units of input from other sectors to achieve one unit of output. Approximately, the food industry requires 65 units of input from both its own sector and other sectors per 100 units of production. Additionally, food sector has a close link to "crop and animal production, hunting and related service activities" sector, with the maximum input of 0.2869 units. This finding is important to show how integrated the food sector is with the agricultural sector. The direct-forward linkage coefficient has been computed as 0.4385 to determine how much input other sectors of the economy require from the food industry. Both the food industry and other sectors used 43.85 units of the food industry's 100 units of output as input. The output of the food industry, the most demanding sector after its own, is the "accommodation and food service activities" sector, which has a quota of 0.1267. Therefore, the food sector has made substantial inroads into the housing and food service industries. According to the total backward linkage coefficient, the food sector ranked second out of 56 sectors, and the total forward linkage coefficient ranked 16th. The total backward and forward linkage coefficients for the food industry have been computed with the values 2.0381 and 1.6833, respectively. This finding demonstrates that the total backward linkage effect is greater than the total forward linkage effect. Thus, growth in food production has been shown to have a considerable impact on production in other areas. Both the total backward linkage index value (1.3409) and the total forward linkage

index value (1.1075) for the food industry have a high index value. The food sector has been classified as category 1 because of the index value of both linkage effects. Also, this conclusion demonstrates that the food sector is a critical sector with its potential to push effect and pull effect the economy. Even so, it is feasible to say that the food sector is an effective sector in the revival of the economy, with substantial demand from other sectors. As a result of the study's findings, it is believed that promotion strategies focused at sectors with significant linkages to the food sector should be prioritized, and investment decisions made in this direction.

References

- Akbulut, 2019. "Türkiye'de İmalat Sanayi Sektörünün Ekonomik Etkileri: Girdi-Çıktı Modeli Analizi", *Sosyoekonomi*, 27(42), p.251.
- Albert, 1958. **The Strategy of Economic Development.** Yale University Press, New Haven and London.
- Alp et. al, 2017. "Türkiye Ekonomisinde Sürükleyici Endüstri Analizi: 2002-2012 Karşılaştırması", *KAÜİİBFD,* 8(16):2, p. 236.
- Altan, et. al, 2015. "Sektörel Etkinlik Ölçümü: Girdi Çıktı Tablosu ve Veri Zarflama Analizi ile Bir Uygulama", *Journal of Business Research Turk*, 7(2), p. 228.
- Atan and Arslantürk, 2012. "Tourism and Economic Growth Nexus: An Input-Output Analysis In Turkey", *Procedia - Social and Behavioral Sciences*, 62, p. 955.
- Atan, 2011. "Türkiye'deki Sektörel Bağlantı Yapısının Girdi-Çıktı Yaklaşımı İle İncelenmesi: Yurtiçi Üretim Ve İthal Ara Girdi Ayrıştırması", *Ekonomik Yaklaşım*, 22(80), p. 75.
- Aydoğuş, 2010. **Girdi-Çıktı Modellerine Giriş**. Efil Yayınevi, Ankara.
- Batı Karadeniz Kalkınma Ajansı (BAKKA), 2014. "TR81 Düzey 2 Bölgesinin Sektörel Yapı ve Rekabet Gücünün Girdi Çıktı Modeli İle Analizi (Zonguldak, Karabük, Bartın)", Buluş Tasarım ve Matbaacılık Hizmetleri, Ankara, p. 13.
- Bocutoğlu, 1990. **Endüstrilerarası İktisat, Teori ve Türkiye Uygulamaları**, Karadeniz Teknik Üniversitesi Basımevi, Trabzon.
- Bölük and Karkacıer, 2019. "Türkiye'de Turizm Sektörünün Enerji ve Toplulaştırılmış Diğer Sektörler İle Yapısal Analizi: Girdi-Çıktı Modeli", *Uluslararası Yönetim İktisat ve İşletme Dergisi*, 15(2), p. 404.
- Çakır and Bostan, 2000. "Turizm Sektörünün Ekonominin Diğer Sektörleri Bağlantılarının Girdi-Çıktı Analizi İle Değerlendirilmesi" *Anatolia: Turizm Araştırmaları Dergisi*, 11(2), p. 43.
- Canlı and Kaya, 2012. "Türk Turizm Sektörünün Ekonomik Etkilerinin Girdi-Çıktı Yaklaşımıyla Ölçülmesi", *Anadolu Üniversitesi Sosyal Bilimler Dergisi*, 1(12), p. 7.
- Dasgupta and Chakraborty, 2005. "The Structure of The İndian Economy", in Proceedings of 15th International Input-Output Conference, Meeting, p. 6.
- Egeli, 1997. "Türk Turizminin Dış Ticaret ve Sektörlerarası Bağlantılar Açısından Değerlendirilmesi", *Ankara Üniversitesi SBF Dergisi*, 52(1), p. 245.
- Erkök, 2018. "Girdi Çıktı Analizi ile Otomotiv Sektörünün Konumu", *Finans Politik & Ekonomik Yorumlar*, 9, p. 29.
- Ersungur and Ekinci, 2015. "Türkiye ve Doğu Asya Ülkeleri Arasındaki Dış Ticaret İlişkileri: Girdi-Çıktı Yöntemi ile Bir Analiz", *İktisadi ve İdari Bilimler Dergisi*, 29(4), p. 746.
- Ersungur, et. al, 2017. "Türkiye İle BRICS Ülkeleri Arasındaki Dış Ticaret İlişkileri: Girdi-Çıktı Yöntemi İle Bir Analiz", *Business and Economics Research Journal* , 8(39), p. 395.
- Göktolga and Özkan, 2011. "1998-2002 Yılları Türkiye Taşımacılık Sektörü Kilit Sektörlerinin Girdi-Çıktı Analizi", *Sosyal Bilimler Araştırmaları Dergisi*, 11(2), p. 80.
- Hirschman, 1958. **The Strategy of Economic Development**, Yale University Press, New Haven and London, p.100
- İzmir Kalkınma Ajansı İZKA, 2021. **İzmir Bölgesi Girdi-Çıktı Analizi**. İzmir Kalkınma Ajansı Yayını.
- Kepenek, 1977. **Türkiye İmalat Sanayiinin Üretim Yapısı (1963-1973),** Ankara, ODTÜ Yayınları.
- Kıvrak, 2018. Dünyada Bölgelerarasi Kilit Sektörlerdeki Değişimin Girdi-Çikti Yöntemiyle Analizi, Yayınlanmamış Yüksek Lisans Tezi, Ege Üniversitesi Sosyal Bilimler Enstitüsü, İzmir, p. 38.
- Kula, 2008. "Supply-Use and Input-Output Tables, Backward and Forward Linkages of The Turkish Economy", in Proceedings of the 16th Inforum World Conference in Northern Cyprus, Meeting, p. 9.
- Miernyk, 1966. **The Elements of Input-Output Analysis**. WVU Research Repository.
- Miller and Blair, 2009. **Input-Output Analysis: Foundations and Extensions**. Cambridge University Press, Cambridge.

- Öney, 1980. **İktisadi Planlama**, Sevinç Matbaası, Ankara.
- Özcan, 2015. "Gıda Ürünleri ve İçecek İmalatı Sektörel Analiz Raporu" Çukurova Kalkınma Ajansı Yayınları, Adan, p. 60.
- Özdemir and Mercan, 2012. "Türkiye'de Enerji Sektöründe Yapısal Bağınlaşma: Girdi-Çıktı Analizi", *Business and Economics Research Journal*, 3(2), p. 118.
- Özdil and Turdalieva, 2014. "Comparing the Economies of Turkey and Kazakhstan by Input-Output Analysis", *Ege Academic Review,*14(3), p. 18.
- Özyurt, 1982. "Trabzon Alt Bölgesi Girdi –Çıktı Modeli ve Alt Bölge Planlamasında Kullanılması", Yayımlanmamış Doçentlik Tezi, Trabzon: K.T.Ü. Temel Bilimler Fakültesi.
- Pehlivanoğlu and İnce, 2020. "Girdi-Çıktı Analizi Yaklaşımıyla Türkiye Ekonomisinde Sektörlerarası Bağınlaşmanın Uzun Dönemli Analizi", *Sosyoekonomi*, 28(44), p. 185.
- Rasmussen, 1957. **Studies In Intersectorel Relations**. Amsterdam, Nourth- Holland.
- Temurshoev, 2004. "Key Sectors in the Kyrgystan Economy " Discussion Paper, No. 2004 135, p. 10.
- Topçuoğlu and Ayyıldız, 2020. "E7 Ülkelerinde Kilit Sektör Analizi", *MANAS Sosyal Araştırmalar Dergisi*, 9(2), p. 829.
- Topçuoğlu and Ersungur, 2016. "Iğdır İlinin Yapısal Analizi: Statik Girdi - Çıktı Modeli ile Bir Uygulama", *Uluslararası Yönetim İktisat ve İşletme Dergisi,* 15(2), p. 319.
- Topcuoğlu, 2019. "Türkiye'nin G4 Ülkeleri ile Dış Ticaret İlişkilerinin Girdi-Çıktı Modeliyle Analizi", *Anadolu Üniversitesi Sosyal Bilimler Dergisi*, 20(1), p. 117.
- Türker, et. al, 2017. "Girdi-Çıktı Çözümlemesi Yardımıyla Mobilya İmalatı Sektörünün Türkiye Ekonomisi İçerisindeki Yerinin Ve Öneminin Belirlenmesi", *İleri Teknoloji Bilimleri Dergisi*, 6(39), p. 921.
- Uğurlu ve Tuncer, 2017. "Türkiye'de Sanayi ve Hizmet Sektörlerinin Büyüme ve İstihdama Katkıları: Girdi-Çıktı Analizi" *Dokuz Eylül Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 32(1), p.162.
- Yıldız ve Akduğan, 2014. "Girdi-Çıktı Tabloları ile Sektörler Arası İlişkilerin Analizi: Seçilmiş Ülke Örnekleri" *Akademik Bakış Dergisi*, 44, p. 18.
- Yılmaz, 1985. **Yönetim Ekonomisi**, Erciyes Üniversitesi Matbaası, Kayseri.

Appendix

No	Nace Code	Sector Name
1	A01	Crop and animal production, hunting and related service activities
2	A02	Forestry and logging
3	A03	Fishing and aquaculture
4	B	Mining and quarrying
5	C10-C12	Manufacture of food products, beverages and tobacco products
6	C13-C15	Manufacture of textiles, wearing apparel and leather products
7	C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
8	C17	Manufacture of paper and paper products
9	C18	Printing and reproduction of recorded media
10	C19	Manufacture of coke and refined petroleum products
11	C20	Manufacture of chemicals and chemical products
12	C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
13	C22	Manufacture of rubber and plastic products
14	C23	Manufacture of other non-metallic mineral products
15	C24	Manufacture of basic metals
16	C25	Manufacture of fabricated metal products, except machinery and equipment
17	C26	Manufacture of computer, electronic and optical products
18	C27	Manufacture of electrical equipment
19	C28	Manufacture of machinery and equipment n.e.c.
20	C29	Manufacture of motor vehicles, trailers and semi-trailers
21	C30	Manufacture of other transport equipment
22	C31-C32	Manufacture of furniture; other manufacturing
23	C33	Repair and installation of machinery and equipment
24	D35	Electricity, gas, steam and air conditioning supply
25	E36	Water collection, treatment and supply
26	E37-E39	Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services
27	F	Construction
28	G45	Wholesale and retail trade and repair of motor vehicles and motorcycles
29	G46	Wholesale trade, except of motor vehicles and motorcycles
30	G47	Retail trade, except of motor vehicles and motorcycles
31	H49	Land transport and transport via pipelines
32	H50	Water transport
33	H51	Air transport
34	H52	Warehousing and support activities for transportation
35	H53	Postal and courier activities
36	I	Accommodation and food service activities
37	J58	Publishing activities
38	J59-J60	Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities
39	J61	Telecommunications
40	J62-J63	Computer programming, consultancy and related activities; information service activities
41	K64	Financial service activities, except insurance and pension funding
42	K65	Insurance, reinsurance and pension funding, except compulsory social security
43	K66	Activities auxiliary to financial services and insurance activities
44	L68	Real estate activities
45	M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities
46	M71	Architectural and engineering activities; technical testing and analysis
47	M72	Scientific research and development
48	M73	Advertising and market research
49	M74-M75	Other professional, scientific and technical activities; veterinary activities
50	N	Administrative and support service activities
51	O84	Public administration and defence; compulsory social security
52	P85	Education
53	Q	Human health and social work activities
54	R-S	Other service activities
55	T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
56	U	Activities of extraterritorial organizations and bodies

Appendix 1: *Sectors and Codes in The Input Output Table* ***Source:*** *WIOD Input-Output Table for 2014*