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THE EARLY IMPACTS OF COVID-19 ON PRODUCTION THROUGH TRADE SHOCKS IN TÜRKIYE:

AN ANALYSIS OF INTERNATIONAL PRODUCTION CHAINS

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Abstract

The study analyzes the early impact of the Covid-19 crisis on the production of sectors through trade shocks in Türkiye by considering the international production chains. To investigate this, we employ a two-tier strategy. In the first step, we calculate the shock values of trade variables by subtracting realized values from estimated values. The realized values are taken from International Trade Center (INTRACEN, 2021) database. In the second step, the last available EORA26 Multi-Regional Input-Output (MRIO) table (Lenzen et al., 2012, 2013), the year 2015, is utilized to decide the change in the production of each sector as a result of trade-induced demand and supply shocks, separately. The I-O analysis indicates that there is approximately a 23 billion USD loss in production and almost half a million decreases in employment owing to the trade shocks (8% reduction in production/employment). Investigating the effect in the framework of production chains with the inter-country input-output tables enables researchers and policymakers to understand the dynamics of potential shocks so that they can take the necessary precautions to ensure the stability of supply chains, the availability of products, and the well-being of individuals. As far as we know, there is no study analyzing the effect of Covid-19 through trade-induced demand and supply shocks in the framework of international production chains for Türkiye.

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Hence, our study carries a crucial understanding and provides solid policy recommendations to be well-prepared for possible external shocks.

Keywords: International production chains, Input-Output tables, Covid-19, Türkiye

JEL Classification: F10, F16, F17

COVİD-19'UN TİCARET ŞOKLARI BAĞLAMINDA TÜRKİYE'DEKİ ÜRETİM ÜZERİNDEKİ ERKEN ETKİLERİ: ULUSLARARASI ÜRETİM ZİNCİRLERİ ÇERÇEVESİNDE BİR ANALİZ

Öz

Bu çalışma, uluslararası üretim zincirleri bağlamında, Covid-19 krizinin Türkiye'deki sektörlerin üretimi üzerindeki erken etkisini ticaret şokları üzerinden analiz etmektedir. Bunu araştırmak için iki aşamalı bir strateji kullanılmaktadır. İlk adımda, Covid-19 öncesi değerlerden hareketle Covid-19 dönemi için tahmini değerler hesaplanmakta ve bu değerlerden gerçekleşen değerler çıkarılarak ticari değişkenler için şok değerleri hesaplanmaktadır. Gerçekleşen değerler Uluslararası Ticaret Merkezi tarafından yayınlanan verilerden alınmıştır (INTRACEN, 2021). İkinci adımda, ticaret kaynaklı talep ve arz şokları sonucunda her bir sektörün üretimindeki değişim ayrı ayrı hesaplanmaktadır. Bu hesaplamalar için EORA26 Çok Bölgeli Girdi-Çıktı (MRIO) Tablosunun (Lenzen vd., 2012, 2013) 2015 yılı verileri kullanılmıştır. Hesaplamalarımız ticaret şoklarının üretimde yaklaşık olarak 23 milyar ABD doları kayba ve istihdamda yaklaşık yarım milyon azalmaya neden olduğunu göstermektedir (üretim/istihdamda %8 azalma). Ülkeler arası girdi-çıktı tabloları ile şokların etkilerinin üretim zincirleri çerçevesinde incelenmesi, araştırmacıların ve politika yapıcıların potansiyel şokların dinamiklerini anlamaları ve böylece tedarik zincirlerinin istikrarını, ürünlerin bulunabilirliğini ve bireylerin refahını sağlamak noktasında gerekli önlemleri alabilmeleri çerçevesinde katkı sağlayacaktır. Bildiğimiz kadarıyla Türkiye için uluslararası üretim zincirleri çerçevesinde Covid-19'un ticaret kaynaklı talep ve arz şokları üzerinden etkisini inceleyen bir çalışma bulunmamaktadır. Bu nedenle, çalışmamız çok önemli bir bakış açısı taşımakta ve olası dış şoklara karşı iyi hazırlıklı olmak için de sağlam politika önerileri sunmaktadır.

Anahtar Kelimeler: Uluslararası üretim zincirleri, Girdi- Çıktı tabloları, Covid-19, Türkiye

JEL Sınıflandırması: F10, F16, F17

I. INTRODUCTION

The Covid-19 pandemic has spread over the world from the East Asia region, one of the biggest production and trading hubs (Baldwin and Tomiura, 2020). On March 11, the Turkish government announced the first patient (Worldometers, 2020). The pandemic causes serious economic turmoil across the world through simultaneous shocks such as decreases in both domestic and foreign demand, disrupting global value chain activities, and tightening

financial conditions. The main aim of the research is to analyze the early impact of the Covid-19 crisis on the production of sectors through trade shocks in Türkiye by considering the international production chains. Investigating the early effect in the framework of production chains with the inter-country input-output tables enables researchers and policymakers to understand the dynamics of potential external shocks so that they can take the necessary precautions to ensure the stability of supply chains, availability of products, and the well-being of individuals.

The effects of the Covid-19 crisis on various sectors are realized through two-side of the economy; demand and supply. Regarding the demand side, a possible direct impact is more likely a decrease in the purchasing power of people working at factories, hotels, restaurants, and transportation sectors that stopped their operations during the first wave of the pandemic. While this negative effect may not be seen in food products due to their low-income elasticity, it can be observed in other products such as electronics and automobiles. Due to increased income uncertainties and instability in the economy, both domestic and foreign households and firms delay their consumption and investments for precautionary purposes.

Regarding the supply side, the outbreak of the Covid-19 crisis in the harvest months/spring period for most countries has been one of the important reasons for the decrease in agricultural production across countries. The pandemic and serious lockdown conditions made labor mobility impossible which many countries need to harvest crops. This shortage brought many trade restrictions on many agricultural goods and food/beverages sectors. Similarly, many firms in manufacturing industries kept closed during the initial wave of the pandemic because the working condition of factories is not suitable to protect social distancing among workers. Also, many workers were infected, and this created absenteeism in the workplace. The crisis has an impact not only on the final products and labor market but also on the intermediate goods and services market. For instance, agricultural products, mostly dependent on foreign seeds, animal feed, fertilizers, or pesticides, have been affected by the closure of the borders, as well as the exchange rate volatility in this period. Due to the increasing airway transportation costs and the difficulty in the supply of pesticides in East Africa; the fields in Kenya, Ethiopia, and Somalia encountered grasshopper invasions, which seriously endangered food safety (Tamru et al., 2020). Similarly, many manufacturing sectors have fallen in a difficulty to find intermediates owing to the increase in transportation costs, reduction of the number of officers working at customs, and subsequent delays in

transactions. Disruptions in global supply chains directly or indirectly hinder the production of the world's manufacturing products because the epidemy has spread from one of the largest production and trade hubs, that is East Asia, to all over the world (Baldwin and Tomiura, 2020). Overwhelmingly integrated world economies amplify the contagiousness of this economic crisis and almost all producers could not find necessary and cheap inputs to produce (UNCTAD, 2020). For instance, the MENA region experiences the highest loss in the extractions and manufacturing sectors (Zeshan, 2020). All these negative demand and supply shocks on production inevitably have a negative influence on employment. According to the estimates of the International Labor Organization (ILO), approximately six million workers lost their jobs in this region in the second quarter of 2020 (ILO, 2020).

Given this conceptual discussion, we ask the following question: "What are the production and employment effects of the trade-induced demand and supply shocks caused by Covid-19 on Turkish sectors?"

Figure I represents the real GDP over 1998-Q1- 2020-Q4. Our initial observation regarding real GDP in Türkiye reveals that there are approximately 30 billion Turkish Lira losses in real GDP starting from March when the crisis hits.

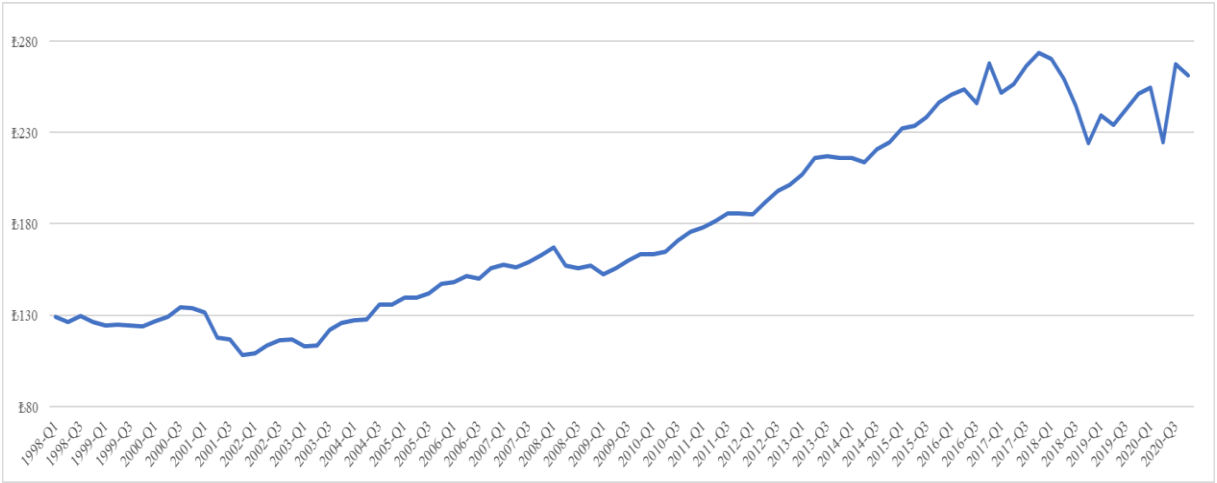

Figure I: Real GDP over 1998-Q1- 2020-Q4 (in billion TL)

Source: Central Bank of the Republic of Türkiye (CBRT) (2021a)

Figure II represents the employment over 2004-01 - 2021-01. There are nearly 2 million decreases in employment starting from March 2020.

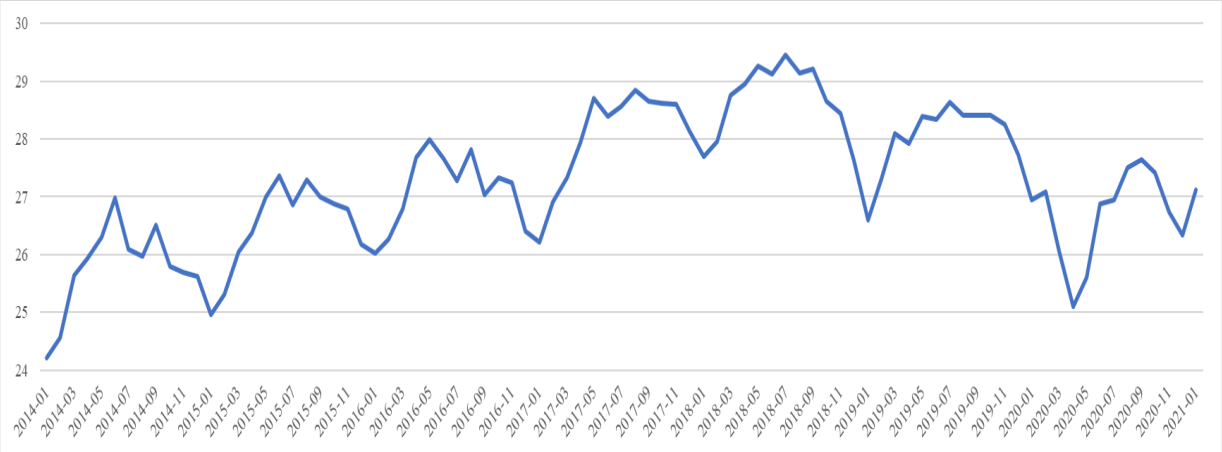

Figure II: Employment over 2004-01 - 2021-01 (in million)

Source: Central Bank of the Republic of Türkiye (CBRT) (2021b)

Therefore, understanding the dynamics of potential shocks through the I-O framework is quite important to take necessary precautions, to sustain the stability of supply chains, availability of products across countries, and ultimately to protect the well-being of individuals.

In the Covid-19 literature, some studies focus on Türkiye (Cakmakli et al., 2020; Voyvoda and Yeldan, 2020; Sayan and Alkan, 2021). However, our study differs from these studies in terms of its approach. We first define the change in the export of intermediates and final products as a demand shock and the change in the import of intermediates as a supply shock. We then calculate the shock values by predicting the counterfactual values of these trade statistics. After, we analyze the effects of these shocks on the sectoral performance of Türkiye in the framework of I-O simulation. Overall, as far as we know, there is no study analyzing the effect of Covid-19 through trade-induced demand and supply shocks in the framework of international production chains for Türkiye. Hence, our study carries a crucial understanding and provides solid policy recommendations to be well-prepared for possible external shocks.

The I-O analysis indicates that there is approximately a 23 billion USD loss in production and almost half a million decreases in employment owing to the trade shocks (8% reduction in production/employment). Although the production and employment of the agriculture sector are severely affected by the trade-induced supply-side shock, at the end of the year, we observe a positive effect of all types of shocks on the agriculture sector. We observe the largest hit in manufacturing sectors, especially for transport equipment, metal

products, and other manufacturing. When we just think of the effects of shock separately, we notice that the three industries and the utility sector are much more affected by the trade-induced demand-side shock.

II. DATA

To answer the question asked in the previous part, we utilize different databases. The trade values are taken from International Trade Center (INTRACEN, 2021) database which provides monthly trade statistics at the product level from 2004 to 2020. This product-level data enables us to differentiate products as intermediate (INT) and final (FIN) by employing the broad economic category codes (BEC). We then aggregate this product-level data set to construct sectoral-level trade values by utilizing the concordance table provided by the Organization for Economic Co-operation and Development (OECD, 2017) (HS6-BEC-ISIC Rev. 3). These nominal trade values are deflated by employing the sectoral monthly price from the U.S. Bureau of Labor Statistics (2021).

Via our second main database, the EORA26 MRIO database, we understand the sectoral dynamics and relationships of sectors across countries. Employment statistics come from the International Labor Organization (ILO, 2019) and the production index comes from Turkish Statistical Institute (TURKSTAT, 2021).

Before we continue with the methodological part, we want to represent the general characteristics of sectors in our sample. After reducing product-level trade statistics into the sectoral aggregates, we end up with 12 sectors mainly composed of manufacturing industries. Table I shows that sectors in our simulation constitute nearly half of the total economy but capture whole manufacturing sectors. We calculate the export and import values as a share of sectoral output in the year 2015. This is the latest available I-O table provided by EORA. As you can notice manufacturing sectors engage in trade activities relatively more than agriculture and utility service.

Table I: Integration of sectors - 2015 I-O table

Sectors\GVCs	Intermediate Export /Output	Final Export /Output	Intermediate Import /Output	Trade /Output
Transport Equipment	17%	26%	30%	72%
Metal Products	25%	3%	43%	71%
Other Manufacturing	3%	10%	50%	63%
Petroleum, Chemical and Non-Metallic Mineral Products	20%	4%	37%	61%
Textiles and Wearing Apparel	12%	24%	24%	60%
Electrical and Machinery	13%	14%	29%	57%
Wood and Paper	9%	2%	33%	43%
Mining and Quarrying	34%	0.3%	8%	43%
Electricity, Gas and Water	0.1%	0.04%	21%	21%
Food & Beverages	4%	4%	8%	15%
Agriculture	8%	4%	4%	15%
Post and Telecommunications	5%	1%	6%	11%

Note: Sectors in this simulation constitute 44% of the total economy.

Source: Authors' own calculations based on EORA MRIO

III. METHODOLOGY

To investigate our research question, we employ a three-tier strategy. *In the first step*, we calculate the shock values of trade variables (both import and export of intermediates and final products) by subtracting the actual values from the predicted values. The realized values are taken from International Trade Center (INTRACEN, 2021) database which provides monthly trade statistics at sectoral and product levels. We are mainly interested in the period 2017-2020. The predicted trade series that would have been realized if the pandemic had not occurred are calculated by using several time series forecasting techniques such as ARIMA, exponential smoothing, and seasonal naive method (Hyndman and Athanasopoulos, 2018). Among these forecasting models, we chose the model with the lowest residual standard deviation. We also check for autocorrelation of the models (ACF test). We continue with the ARIMA model because it catches the data more properly. We then calculate the shock values for each sector and for a specific flow such as the import and export of intermediate and final products by subtracting the actual values from the estimated values (see Figures A1-A3 in the Appendix).

In the second step, the last available EORA26 Multi-Regional Input-Output (MRIO) table (Lenzen et al., 2012, 2013), the year 2015, is utilized to decide the change in the production of each sector as a result of trade-induced demand and supply shocks, separately.

We assume that the coefficients of the domestic transaction matrix have not changed over time. In other words, we assume that there is not a structural change in the economy. We reduce this I-O table that includes 189 countries to the table that includes just Türkiye and the rest of the world. In this reduced form of the I-O table, we have 26 sub-sectors[4] for Türkiye and all other countries aggregated and titled as the rest of the world (see Table A1 in Appendix). Utilizing matrixes in the 2015 I-O table and reinterpreting the basic equation of Acemoglu et al. (2016) and using the calculation methods of Yanikkaya and Altun (2020), we can analyze trade-induced demand and supply shocks.

In the third step, assuming that the output-employment ratio has not changed over time, we just divide the loss value in production by the related output-employment ratio to get the approximate effects of Covid on employment. Because sectoral employment statistics are available until 2019, the 2019 value of the output-employment ratio is utilized. TURKSTAT does not provide information on the output of sub-manufacturing sectors but provides the information on sectoral production index (TURKSTAT, 2021). So, we extrapolate the 2015 sectoral output in EORA utilizing the growth rate of the production index.

Demand Shock:

$$y_i = \sum_{j=1}^{26} x_{i,j} + ID_i^{WORLD} + FD_i^{TR} + FD_i^{WORLD} \qquad (1)$$

Equation (1) enables us to assess the magnitude of a demand shock. The equation is represented for Türkiye. Sub-indices i and j represent exporter and importer sectors, respectively. y_i represents sectoral output. $x_{i,j}$ represents domestic transactions. ID_i^{WORLD} represents exported intermediates of each country in Türkiye. FD_i^{TR} stands for the final demand of Türkiye. FD_i^{WORLD} stands for the final demand of the rest of the world.

Domestic intermediate goods and services transactions of each country in Türkiye can be expressed as the multiplication of the coefficient matrix and the output matrix vector:

$$\sum_{j=1}^{26} x_{i,j} = \sum_{j=1}^{26} a_{i,j}\,(y_i) \qquad (2)$$

[4] Agriculture; Fishing; Mining and Quarrying; Food & Beverages; Textiles and Wearing Apparel; Wood and Paper; Petroleum, Chemical and Non-Metallic Mineral Products; Metal Products; Electrical and Machinery; Transport Equipment; Other Manufacturing; Recycling; Electricity, Gas and Water; Construction; Maintenance and Repair; Wholesale Trade; Retail Trade; Hotels and Restaurants; Transport; Post and Telecommunications; Financial Intermediation and Business Activities; Public Administration; Education, Health and Other Services; Private Households; Others; Re-export & Re-import.

When we plug equation (2) into equation (1), we get the following equation:

$$y_i = (I - \sum_{j=1}^{26} a_{i,j})^{-1}((ID_i^{WORLD}) + (FD_i^{TR}) + (FD_i^{WORLD})) \quad (3)$$

where $(I - \sum_{j=1}^{26} a_{i,j})^{-1}$ is the inverse of the Leontief matrix. The Leontief inverse matrix expresses the effect of a unit change in exported intermediates/final demand on the change in output.

Supply Shock:

$$y_j = \sum_{j=1}^{26} x_{j,i} + ID_j^{TR} + VA_j^{TR} \quad (4)$$

Equation (4) enables us to assess the magnitude of an external supply shock. y_j represents sectoral output. $x_{i,j}$ represents domestic transactions. ID_j^{TR} represents imported intermediates of Türkiye. VA_j^{TR} represents the value added of sectors in Türkiye.

After some arrangements, we end up with the following equation:

$$y_j = \left(I - \sum_{j=1}^{26} a_{j,i}\right)^{-1} \left((ID_j^{TR}) + (VA_j^{TR})\right) \quad (5)$$

where $(I - \sum_{j=1}^{26} a_{j,i})^{-1}$ is the inverse of the Ghosh matrix. The Ghosh inverse matrix expresses the effect of a unit change in foreign intermediate goods and services/sectoral value added on the change in output.

IV. RESULTS

This part provides the I-O simulation results. The graphs of the twelve sectors are represented in the main sectoral categories: agriculture, manufacturing, and utilities (Figures III-V). The first blue and second dark blue columns represent employment changes due to the change in intermediate exports and final exports over the ten months after the crisis hits. The last green column represents employment changes due to the intermediate imports. The light blue, dark blue, and green lines indicate losses in production owing to the change in intermediate exports, final exports, and intermediate imports, respectively.

Figure III depicts the simulation results for the agriculture sector. There is a relatively fluctuating trend of production and employment in agriculture. The sector is much more

affected by the trade-induced supply shock, which is observed via intermediate imports compared to trade-induced demand shocks through intermediate and final exports. The sector faces the largest hit in July with an almost 200 million USD loss in production and 3,000 losses in employment, then the adverse impact gradually disappears at the end of the year. Still, agriculture is one of the two sectors we observe a positive aggregate effect of all types of shocks at the end of 2020.

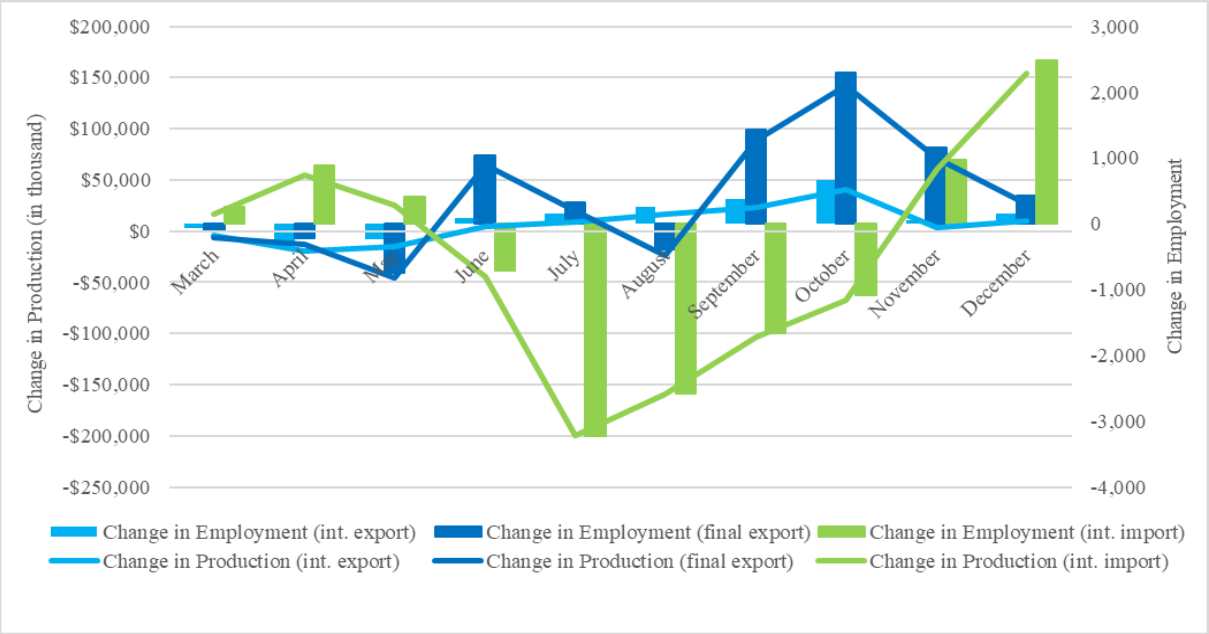

Figure III: Change in production (in thousand) and employment – Agriculture

Source: Authors' own calculations based on EORA MRIO

Figure IV represents the simulation results for the manufacturing sector. We find out the most dramatic declines in terms of magnitude in manufacturing industries regardless of the types of trade flows. As shown in Table I, the trade openness of manufacturing sectors is relatively higher than other sectors. While the trade share in output is 54% for manufacturing sectors on average, the trade ratios of agriculture and utilities are 15% and 16%, respectively. This inevitably leads to amplifying the magnitudes of trade-induced demand and supply-side shocks in manufacturing industries. The effects of shocks persist until October. Through this time, the Turkish manufacturing industry experiences a nearly 24 billion USD loss in production and 460,000 losses in employment.

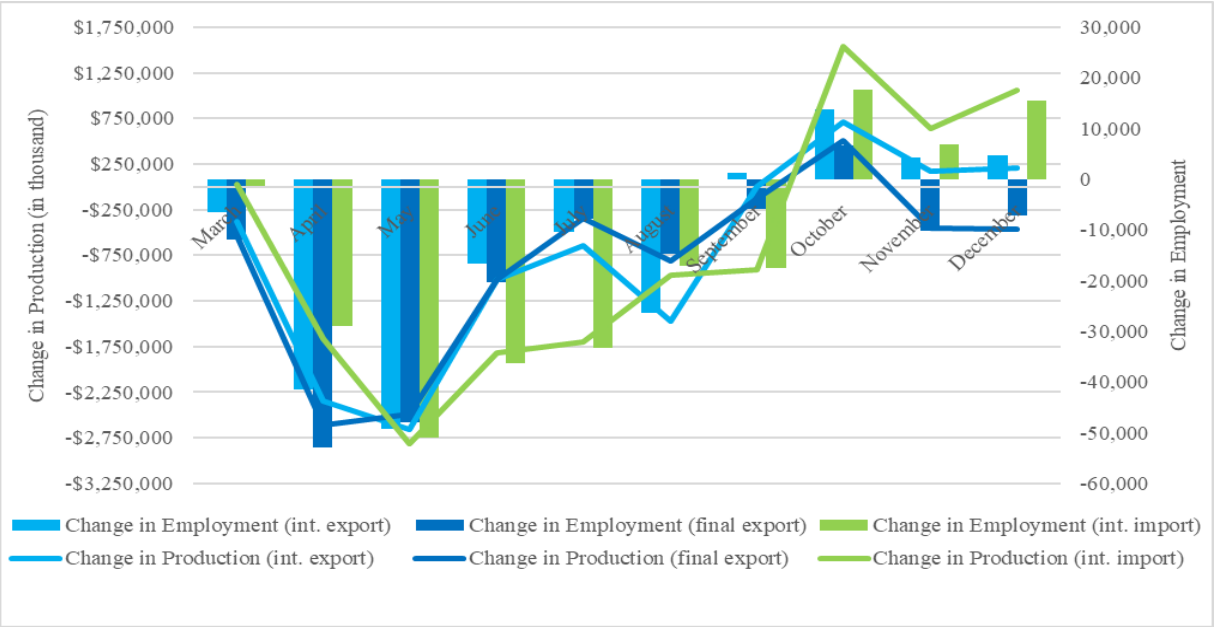

Figure IV: Change in production (in thousand) and employment – Manufacturing

Source: Authors' own calculations based on EORA MRIO

Figure V presents the simulation results for the utility sector. Even though we see a decreasing trend starting from March, utility sectors including post and telecommunication and electricity, gas, and water show positive progress over consecutive months. Indeed, this huge effect comes from electricity, gas, and water. The negativity is closely related to the sectoral lockdowns, especially in manufacturing sectors which highly depend on utilities.

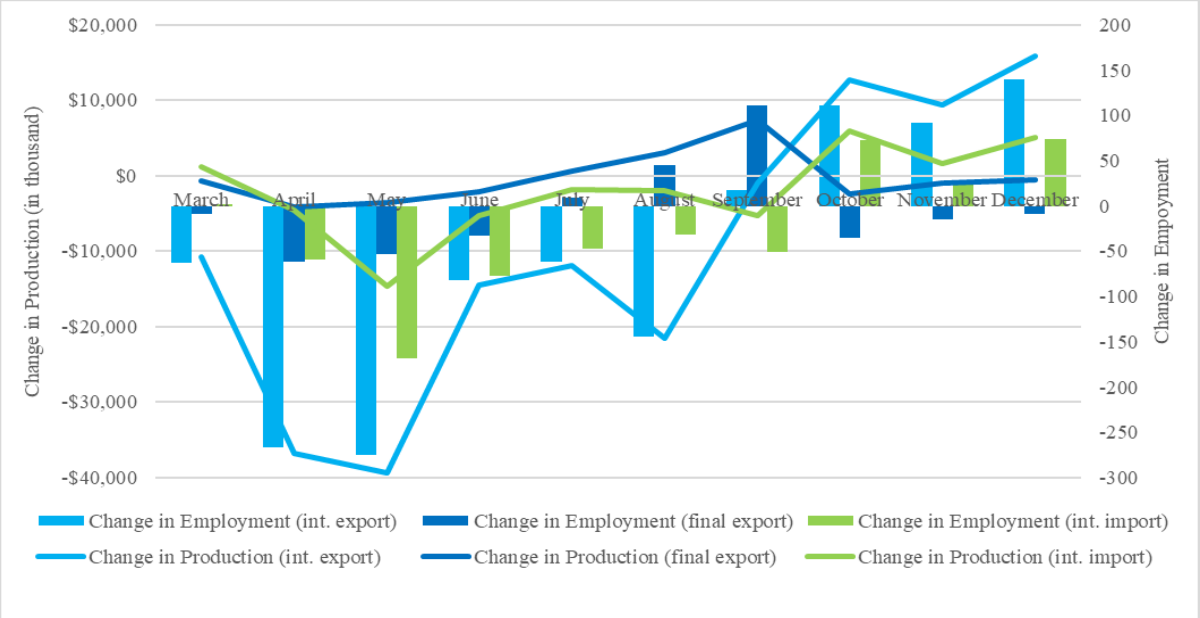

Figure V: Change in production (in thousand) and employment – Utilities

Source: Authors' own calculations based on EORA MRIO

We sum up all types of shock and compose Table II to see the relative Covid-19-related damage of sectors in Türkiye. Overall, the crisis leads Turkish production to shrink by approximately 23 billion USD. The ratios show that the shares of production decrease. We detect the most severe production and thereby employment losses ins transport equipment, metal products, and other manufacturing sectors. Food and beverages may be the least affected manufacturing sector compared to others. Overall, we notice that the agriculture and post and communication sectors continue to operate even in the first wave of the pandemic.

Table III presents employment effects by sectors and months. Overall, 445,900 people lose their job during this period. To reiterate, these effects are just related to the trade shocks and reflect mainly manufacturing industries and agriculture. The actual values can be much higher or just different from these values. Indeed, the government provides financial support to firms and applies bans on the dismissal of employees (Demir Seker et al., 2020). This may lead to our estimates being overestimated.

Table II: Overall production effects of Covid-19 across sectors (in thousand)

Sectors\Months	March	April	May	June	July	August	September	October	November	December	Total	Ratio
Transport Equipment	$125,849	-$2,195,199	-$2,019,616	-$1,023,871	-$614,119	-$1,326,673	-$352,348	$1,564,326	$302,527	$73,826	-$5,465,298	-20%
Metal Products	-$30,672	-$844,914	-$1,082,715	-$502,502	-$422,766	-$405,773	-$225,892	$136,487	-$38,294	$395,243	-$3,021,797	-20%
Other Manufacturing	-$177,979	-$441,363	-$499,154	-$324,336	-$206,030	-$221,657	-$90,000	-$3,902	$24,378	-$30,892	-$1,970,934	-20%
Petroleum, Chemical and Non-Metallic Mineral Products	-$122,606	-$535,193	-$906,920	-$560,454	-$566,653	-$421,848	-$230,329	$123,858	-$72,897	$123,096	-$3,169,946	-11%
Electrical and Machinery	-$201,786	-$904,568	-$1,562,668	-$680,432	-$511,870	-$420,100	$20,763	$699,128	$442,088	$752,070	-$2,367,376	-11%
Textiles and Wearing Apparel	-$502,962	-$1,683,292	-$1,614,721	-$679,507	-$171,438	-$243,861	-$101,948	$149,513	-$261,918	-$583,713	-$5,693,846	-8%
Wood and Paper	-$26,461	-$22,692	-$98,522	-$43,278	-$85,707	-$132,056	-$101,566	-$28,025	-$37,950	-$4,311	-$580,568	-5%
Mining and Quarrying	$31,626	-$405	-$43,822	-$16,262	-$32,332	-$42,762	-$34,417	$14,709	-$5,053	$29,333	-$99,385	-2%
Electricity, Gas and Water	-$10,203	-$36,838	-$45,659	-$16,930	-$12,104	-$22,037	-$7,276	$11,909	$5,590	$12,421	-$121,126	-0.3%
Food & Beverages	$42,217	$2,380	-$185,481	-$39,899	-$100,784	-$79,357	$54,816	$115,556	-$9,559	$79,689	-$120,422	-0.2%
Post and Telecommunications	$81	-$8,746	-$11,931	-$4,944	-$954	$1,562	$8,546	$4,364	$4,420	$7,936	$334	0.002%
Agriculture	$6,297	$21,676	-$35,311	$25,180	-$170,320	-$167,168	$8,293	$116,013	$135,386	$191,063	$131,108	0.4%
Total	-$872,896	-$6,670,830	-$8,071,209	-$3,892,416	-$2,724,755	-$3,314,563	-$1,059,650	$2,787,923	$353,334	$854,698	**-$22,479,255**	**-8%**
Ratio	-4%	-30%	-36%	-17%	-12%	-15%	-5%	12%	2%	4%	100%	-10%

Source: Authors' own calculations based on EORA MRIO

Table III: Overall employment effects of Covid-19 across sectors

Sectors\Months	March	April	May	June	July	August	September	October	November	December	Total	Ratio
Transport Equipment	1,554	-27,101	-24,934	-12,640	-7,582	-16,379	-4,350	19,313	3,735	911	-67,473	-20%
Other Manufacturing	-5,393	-13,375	-15,126	-9,828	-6,243	-6,717	-2,727	-118	739	-936	-59,725	-20%
Metal Products	-958	-26,404	-33,835	-15,703	-13,211	-12,680	-7,059	4,265	-1,197	12,351	-94,431	-20%
Petroleum, Chemical and Non-Metallic Mineral Products	-2,665	-11,635	-19,716	-12,184	-12,319	-9,171	-5,007	2,693	-1,585	2,676	-68,912	-11%
Textiles and Wearing Apparel	-10,059	-33,666	-32,294	-13,590	-3,429	-4,877	-2,039	2,990	-5,238	-11,674	-113,877	-8%
Wood and Paper	-473	-405	-1,759	-773	-1,530	-2,358	-1,814	-500	-678	-77	-10,367	-5%
Electrical and Machinery	-2,402	-10,769	-18,603	-8,100	-6,094	-5,001	247	8,323	5,263	8,953	-28,183	-5%
Mining and Quarrying	930	-12	-1,289	-478	-951	-1,258	-1,012	433	-149	863	-2,923	-2%
Electricity, Gas and Water	-71	-258	-319	-118	-85	-154	-51	83	39	87	-847	-0.6%
Food & Beverages	449	25	-1,973	-424	-1,072	-844	583	1,229	-102	848	-1,281	-0.2%
Post and Telecommunications	1	-131	-178	-74	-14	23	128	65	66	118	5	0.002%
Agriculture	102	350	-570	406	-2,747	-2,696	134	1,871	2,184	3,082	2,115	0.4%
Total	-18,987	-123,379	-150,596	-73,508	-55,277	-62,112	-22,968	40,647	3,078	17,202	**-445,900**	**-8%**
Ratio	-4%	-28%	-34%	-16%	-12%	-14%	-5%	9%	1%	4%	100%	-10%

Source: Authors' own calculations based on EORA MRIO

V. CONCLUSION

This study investigates the early impacts of the Covid-19 pandemic on Turkish sectors by employing the I-O methodology. The first possible effect of the pandemic is a decrease in domestic and foreign demand caused by a loss in household income and sudden shutdowns of many working places or sectors such as factories, hotels, and the transportation sector. The second one is disruptions of global and domestic value chains because of social distancing and lockdown conditions, which directly and especially affect whole manufacturing sectors owing to their higher dependency on domestic and foreign intermediates in their production processes.

In light of this motivation, this research aims to investigate the production effects of the Covid-19 crisis on Turkish industries by utilizing the most current I-O table. Specifically, we ask the following questions: What are the production and employment impacts of the trade-induced demand and supply shocks resulting from Covid-19?

Our simulation results indicate that there is an approximately 23 billion USD loss in production and almost half a million decreases in employment owing to the trade shocks (8% reduction in production/employment). Although production and employment are severely affected by the trade-induced supply-side shock, at the end of the year, we observe a positive effect of all types of shocks on the agriculture sector. We observe the largest hit in manufacturing sectors, especially for transport equipment, metal products, and other manufacturing. When we just think of the effects of shock separately, we notice that the three industries and the utility sector are much more affected by the trade-induced demand-side shock.

Our conclusion points out the importance of sector-specific recovery programs. The second thing we observe is the amplified effect of the Covid-19 shock on sectors with higher trade openness which clearly emphasizes the importance of improvement of supply chain resilience and a more diversified set of trade partners. Future research can address this issue by doing further robustness checks for predicted monthly trade values, enlarging country coverage, and considering also domestic demand and supply shocks. Moreover, this approach may be beneficial for making further scenario-based simulations for predicting possible impacts of various alternative prospective regional and global occasions.

APPENDIX

The next three figures are related to the first step of the analysis. This figure represents the actual and predicted values of intermediate export. As you can see, there is a sharp decrease in intermediate export starting from March. The predicted values are represented with a blue line. We then calculate the shock values by subtracting the actual values from the predicted ones. To check the accuracy of our predicted values, we randomly select a one-time point over years and then forecast the trade values for a later 10 months period like in the current analysis. When we repeat these trials many times, we also calculate the standard deviation from actual values each time. The standard deviations range from 9% to 12%. Therefore, we can say that the ability of ARIMA to capture real data is well enough and we can continue to calculate the shock values with ARIMA (After May 2019 with 10 months forecasting period).

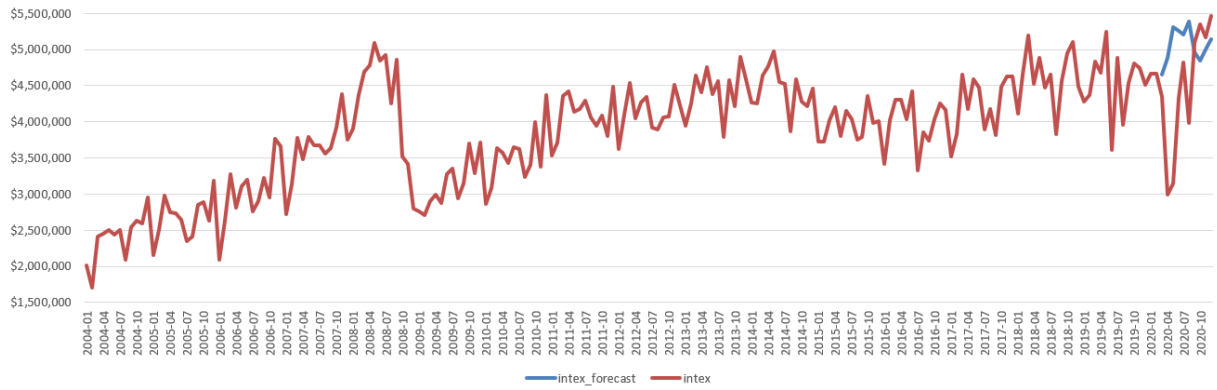

Figure A1. Actual and predicted values of intermediate export (in thousand), 2004-01-2020-12

Source: INTRACEN (2021) and authors' own calculations

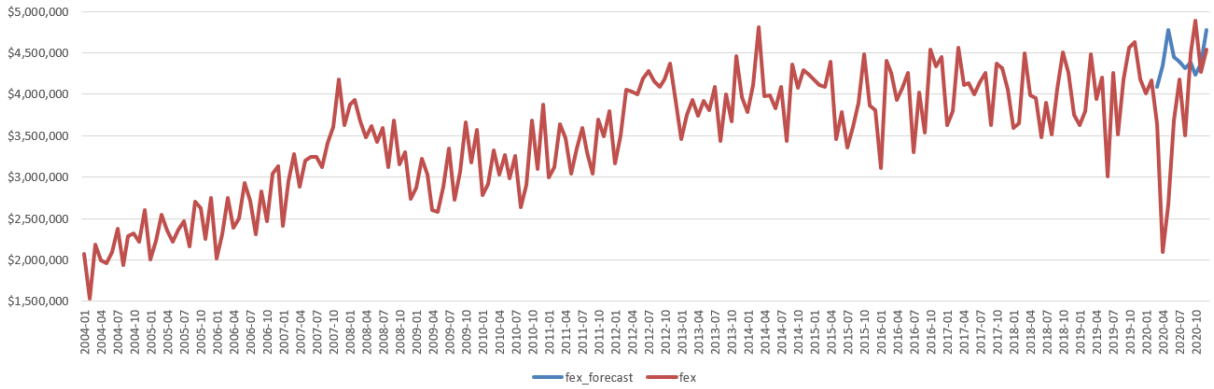

Figure A2. Actual and predicted values of final export (in thousand), 2004-01-2020-12

Source: INTRACEN (2021) and authors' own calculations

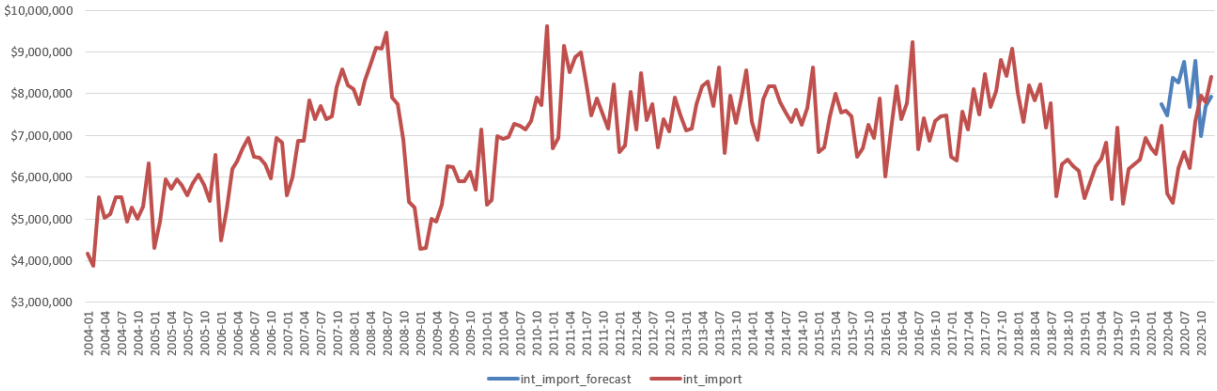

Figure A3. Actual and predicted values of intermediate import (in thousand), 2004-01 - 2020-12

Source: INTRACEN (2021) and authors' own calculations

Table A1 shows the construction of I-O tables. Zone (I) shows the intermediate transactions from the Turkish industries in rows to Turkish industries in columns, (II) shows the intermediate transactions from Turkish industries to abroad, (III) shows the intermediate transactions from abroad to Turkish industries, (IV) shows the intermediate transaction from the world (except Türkiye) to the world (except Türkiye), (V) shows the transactions from Turkish industries for final demand of Türkiye, (VI) shows the transactions from Turkish industries for final demand of world (except Türkiye), (VII) shows the transactions from world industries (except Turkish industries) for final demand of Türkiye, (VIII) shows the transactions from world industries (except Turkish industries) for final demand of world (except Türkiye), (IX) shows the Turkish sectoral value added and (X) shows the world sectoral value added (except Turkish sectors).

Table A1. Reduced matrices: 2 countries - 26 sectors

	Importers			
Exporters	$T^{TR,TR}$ (26x26) **(I)**	$T^{TR,WORLD}$ (26x26) **(II)**	$FD^{TR,TR}$ (26x1) **(V)**	$FD^{TR,WORLD}$ (26x1) **(VI)**
	$T^{WORLD,TR}$ (26x26) **(III)**	$T^{WORLD,WORLD}$ (26x26) **(IV)**	$FD^{WORLD,TR}$ (26x1) **(VII)**	$FD^{WORLD,WORLD}$ (26x1) **(VIII)**
	VA^{TR} (1x26) **(IX)**	VA^{WORLD} (1x26) **(X)**		

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