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ANALYZING THE EFFECTS OF EXOGENOUS PRICE ADJUSTMENTS IN ENERGY MARKETS USING AN INPUT-OUTPUT MODEL: THE CASE OF TURKEY

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Introduction

Energy commodities play a key role in all economies not only because of their absolute volume but also because of their backward and forward linkages to other sectors of the economy. Accordingly, prices of all other sectors depend on price changes in the main energy goods. The I-O model provides an appropriate tool to analyze the results of these interactions both in the form of volume and price changes in all sectors of the economy.

Total energy consumption in Turkey has increased from 74 Mtoe in 2002 to 131.3 Mtoe in 2015, growing at 4.1 percent annually. Nearly 90 percent of the total energy supply in Turkey is provided by the three primary energy sources: natural gas (30.7 %), coal (29 %), and petrol (28.1 %). The remaining 10 percent come from renewable energy sources, mainly from hydroelectric power stations. Moreover, in 2016, 99.5 percent of natural gas, 89 percent of petrol, 60 percent of lignite, and 97 percent of hard coal were imported (BOTAS, 2016). As a result, nearly 78 percent of the total energy supply is met by imports. Clearly, on the supply side the Turkish economy is heavily dependent on foreign resources. It is also expected that this energy problem will not change significantly in the foreseeable future (OME, 2014). This situation implies that Turkey has very limited bargaining power in the pricing process administered mainly by the suppliers operating in non-competitive international market structures such as oligopolies, cartels, or a few dominant state-owned companies. Natural gas mainly comes from Russia, Iran, Azerbaijan, Algeria, and Nigeria. Petrol is imported mainly from Iraq, Iran, and Russia (BOTAS, 2017).

Domestic prices paid by final consumers and manufacturing companies are set by another chain of oligopoly firms. The Energy Market Regulatory Board (EMRB, EPDK) sits at the top of the pyramid of the domestic distribution process and regulates the market. Using the standard I-O price model, this paper analyzes a one-time effect of an exogenous price increase in imported energy commodities on domestic production sectors.

The study is based on the 64-sector 2012 I-O table published by TurkStat. It is used within the I-O modeling framework and two scenarios are designed for computations: a low inflation scenario and a high inflation scenario. In each scenario import data are grouped into three categories: crude petroleum and natural gas imports, imports of refined petroleum products, and all other imports.

1. Data Sources

The data for this study come mainly from two sources. The first one is the TurkStat sources. Towards the end of 2016 TurkStat published a set of I-O tables for the year 2012, three of which constitute the basic data structure of this paper. These are the Domestic Input-Output Table, the Import Input-Output Table, and the [Total] Input-Output Table. As will be explained in Section 2, in order to apply the I-O price model, the domestic I-O table is used. The data in the import matrix are then aggregated into three rows and added to the primary input block of the domestic table. An abridged version of the I-O table is presented in the Appendix (Table A1).

For the purpose of price analysis, along with the other primary inputs or value added rows, import data are grouped into three following categories:

- imports of crude petroleum and natural gas;
- imports of refined petroleum products;
- all other imports.

These three lines are appended into the value added block of the domestic I-O table. All the values are expressed in millions of TRY in current prices.

The second set of data is related to the domestic energy price formation process. These data were obtained from the regular annual reports of EPDK. Since the analysis in this paper is related to only one-year price change in energy products, the data obtained from the 2016 Annual Report were sufficient (EPDK, 2017).

2. Methodology

2.1. The I-O production model

The standard I-O production model is given by

$$q = Aq + f \tag{1}$$

where q is output column vector; A is matrix of input coefficients; and f is final demand column vector.

The solution to Equation (1) is

$$q = (I - A)^{-1} f = Lf \tag{2}$$

where $L = (I - A)^{-1}$ is called the Leontief inverse.

The I-O production model given in Equations (1) and (2) is known as the demand-driven I-O model. In this model the fixed technical coefficient matrix A, output levels of each industry depend entirely on the exogenously determined final demand vector f.

To explore the I-O production model further, three new coefficient matrices should be defined. These are given in Table 1.

Here the A matrix is obtained in the usual way by dividing each element of the interindustry flow matrix by the column totals or output levels in each industry. Matrix C is defined by dividing each element of primary input rows by their column (output) totals. In Table A1 (see Appendix) six primary inputs are included. Three of them show imported inputs into domestic production and the remaining three are for value added rows in the form of net indirect taxes, wages, and gross profits. Matrix B shows the sectoral input composition of final demand vectors obtained by dividing column elements of the final demand block in

Table 1

Tableau of Direct Input Coefficients (Schematic)

A	B
C	D

In Table 1 the four coefficient matrices are:

A – input-output coefficient matrix as in Equation (1);

B – final demand coefficient matrix;

C – primary input coefficient matrix;

D – coefficient matrix defined for primary inputs into final demand categories.

Table A1 (see Appendix) into their respective column totals. In the original form of the I-O table five final demand categories are defined: private household consumption, government consumption, gross fixed capital formation, changes in stocks, and exports. Finally, matrix D is obtained by dividing primary input components of final demand vectors into their total as in matrix B. From these definitions it can be shown that the column totals of A and C, and the column totals of B and D, respectively add up to unity.

For a full description of the I-O production model a set of the balancing equations should be defined using the four coefficient matrices. The first one is related to the total income for six primary input categories given in Equation (3).

Let y denote the column vector of total incomes of primary inputs:

$$y = Cq + \mathrm{h} \tag{3}$$

where h is a column vector of direct uses of the primary inputs by the final demand categories. Inserting q from Equation (2) into the first component of y in Equation (3) the following equation can be obtained:

$$Cq = C(I - A)^{-1}f. \tag{4}$$

Equation (4) ties the income of primary input categories or payments sector to exogenously determined final demand vector f.

Now, let g denote the sum of column elements of all final demand categories expressed in the form of a column vector. Then, with the help of matrix B the row sums of the final demand categories in the I-O table (Table A1, see Appendix) gives column vector f as in Equation (5):

$$f = Bg. \tag{5}$$

Finally, direct use of the primary inputs by the final demand vectors can be expressed as in Equation (6):

$$h = Dg. \tag{6}$$

From the last three Equations (4)–(6) the vector of primary input income categories can be expressed as in Equation (7):

$$y = C(I - A)^{-1}Bg + Dg \tag{7}$$

or as in Equation (8):

$$y = [C(I - A)^{-1}B + D]g \tag{8}$$

Now a new matrix can be defined as in Table 2.

This new matrix is known as the tableau of cumulative I-O coefficients (Heesterman, 1979). In the I-O production model the Leontief inverse $(I - A)^{-1}$ plays a crucial role. The elements of $(I - A)^{-1}$ are very useful and important numbers. Each captures, in a single number, the direct and indirect effects of a change in the final demand vectors (Miller & Blair, 2009). Accordingly, the solution to the production model given in Equation (4) for any sector i can be expressed as in Equation (9):

$$q_i = l_{i1}f_1 + \cdots + l_{ij}f_j + \cdots + l_{in}f_n. \tag{9}$$

Table 2

Tableau of Cumulative I-O Coefficients (Schematic)

$(I - A)^{-1}$	$(I - A)^{-1}B$
$C(I - A)^{-1}$	$C(I - A)^{-1}B + D$

It is easy to show that l_{ij} is the partial derivative of q_i with respect to f_j, that is $\partial q_i/\partial f_j = l_{ij}$. Therefore, it measures the direct and indirect effects of one unit increase in the final demand of sector j on the output of sector i.

2.2. The I-O price model

The I-O price model states that the unit price of any sector is equal to the sum of the unit cost of physical inputs evaluated in their respective prices plus value added per unit produced in that sector. Accordingly, the basic I-O price model can be expressed as in Equation (10). In this model it is useful to place a row vector to the left of a matrix:

$$p = pA + rC + p^* \qquad (10)$$

where

p – sectoral price index vector in row form;
A – domestic inputs coefficient matrix;
r – price index vector for primary inputs in row form;
C – coefficient matrix of primary inputs (including imports);
p^* – excess (arbitrary) price increases in some sectors, if any.

When we assume that both A and C matrices are constant, then the increase in the domestic output price in each sector depends on the increase in prices of intermediate inputs plus the increase in prices of primary inputs. In Equation (10) the first component on the right hand side, vector pA, captures the total intermediate cost of one unit of output in each sector expressed in monetary units. The second component, vector rC, captures the total cost of the primary inputs (imports and factors of production) of one unit of output in each sector. For that reason the price model is also called the I-O costing model. In any specific sector there may be some arbitrary price increase. This last component is shown in the row vector p^*, which does not depend directly on any structural matrix in the I-O framework.

If each row of the primary inputs coefficient matrix C is treated as a row vector, and taking the sum of these vectors – a process which makes sense if all the rows are measured in monetary values in the prices of the year of the table – row vector v of value-added per unit of output can be obtained (Almon, 2016). Omitting p^* for simplicity, at least for the base year (2012 in the present model), Equation (10) can be expressed as follows:

$$p = pA + v. \tag{11}$$

In Equation (11) it is implicit that vector rC is replaced by vector v. This final equation can answer the question of how prices p would change if v changes while A remains constant. To answer these types of questions in a broader context, three rows of imported energy items are included in matrix C.

The solution to Equation (10) is given in Equation (12):

$$p = rC(I - A)^{-1} + p^*(I - A)^{-1}. \tag{12}$$

In the present model, p is a row vector of 64 elements.

2.3 Deflator computations

The deflator d is defined as the price index numbers for all final demand categories. Given the assumption of fixed coefficients for all elements of B and D, as for A and C, d is given by:

$$d = pB + rD \tag{13}$$

where d is deflator, a row vector in the form of index numbers; B and D are defined in Section 2.1; and p is computed in Equation (12).

The first component on the right side of Equation (13), pB, measures the unit cost of domestic sector outputs consumed by final demand categories. The second component, rD, measures the unit cost of primary inputs in the form of imports or factor payments going directly into the final demand sectors.

Substituting the solution to the output price vector p from Equation (12) into Equation (13), we obtain the solution to domestic deflators as follows:

$$d = r[C(I - A)^{-1}B + D] + p^*(I - A)^{-1}B. \tag{14}$$

It is now clear that the cumulative I-O coefficients presented in Table 2 are fully utilised in the computational process of the deflators for final demand categories. The next section will demonstrate the model applications with actual I-O data for the Turkish economy.

3. Application

The I-O price model is not as widely known as the production model, though it was also formulated by Leontief as early as in 1947. Using the 1939 I-O table of the US, in 1947 and 1951 Leontief himself calculated the effects of a 10 percent increase in (the price of) indirect taxes and wages on the prices of all sectors of the economy (Leontief, 1986). Similar computations were performed for the Norwegian economy by (Bjerkholt, 1983). For 1980, Bjerkholt calculated that a 10 percent increase in the price of imports resulted in a 2.9 percent inflation in consumer price index, CPI.

Using Equation (11) as stated above, a more comprehensive approach has been adopted in the INFORUM modeling systems for a long time. However, the INFORUM modeling group does not calculate the Leontief inverse very often in their applications. Instead, in the Interdyme modeling software applied by the INFORUM group, vector p is calculated in a dynamic process for many years without calculating the Leontief inverse. This method is called the Gauss-Seidel algorithm for the production model and the PSeidel algorithm for the price model (Almon, 2016; Meade, 2010). In this paper, since it is a comparative static analysis for one year (2012), the Leontief inverse is calculated and all other matrix computations are done in Excel.

3.1 Price Formation in Domestic Energy Markets

Before moving to the model calculations with actual data, the price formation process in the domestic markets needs to be explained. The prices of energy items in Turkey are determined and administered by the Energy Market Regulatory Board (EMRB or EPDK as its Turkish acronym). After receiving imported energy items at CIF prices, the Board follows a mark-up procedure to determine the actual market prices that consumers and enterprises pay. Table 8 shows the price composition and changes in the fuel markets in Istanbul from January 2016 to January 2017.

The first item in Table 3, "product price", shows the CIF price determined in the world market, generally in Europe. Over the course of the last 12 months the share of this basic price in the final market price increased to 30.1 percent from 22.1 percent. This high rise was mainly caused by the depreciation of the Turkish lira against the US dollar. The main component of the final fuel price is the total tax. It was 66.4 percent in January 2016 but fell to about 60 percent in January 2017. The main reason for this decline is the fact that the original import price of oil increased by more than 70 percent. As a result, the overall price increase was about 25 percent in one year, from January 2016 to January 2017.

Figure 1 shows the total energy import value of Turkey in billions of dollars from 2002 to 2016. There has been a sustained growth in the total cost of energy imports from 2002 to 2012, except for 2009 and 2010. After 2012, it started to fall mainly because of the

Table 3

Unleaded Fuel Price Formation in Istanbul, TRY Per Liter

Price components	Jan 2016	%	Nov 2016	%	Jan 2017	%	y/y, %
Product price	0.94	22.1	1.18	24.4	1.60	30.1	70.2
Wholesale margin	0.05	1.2	0.06	1.2	0.06	1.1	20.0
Income contribution	0.00	0.1	0.00	0.1	0.00	0.1	4.1
Distributor margin	0.44	10.3	0.47	9.7	0.47	8.8	6.8
Total tax	2.83	66.4	3.12	64.6	3.19	59.9	12.7
Sale price	4.26	100.0	4.83	100.0	5.32	100.0	24.9
Price increase (%)		10-month: 13.4		2-month: 10.1		12-month: 24.9	

(Source: Own elaboration based on EPDK (2017))

falling petrol prices. A further point to note in Fig. 1 is that the share of imported energy in GDP has followed a similar path as shown on the second y-axis.

An international comparison of relative energy prices reveals that Turkish consumers pay the eighth highest relative price for petrol in the world. In this comparison the relative price is defined as the ratio of the average daily wage to the nominal (absolute) price of a gallon of petrol expressed in percentage terms. Using this definition of relative price, Table 4 shows the 10 least affordable countries for oil consumption in 2015. India ranks as the most expensive country in the world in terms of the relative price of oil. Indian consumers pay nearly 80 % of their average daily wage to buy a gallon of petrol. Among these 10 countries Turkish consumers pay the highest price ($ 5.8) for a gallon of petrol. However, the average daily wage in Turkey is also the highest among these countries ($ 26.1). Accordingly, Turkish consumers pay only 22.1 % of their average daily wage to buy a gallon of petrol. In this regard they are also better off than consumers in Nigeria, which is a major oil producer in the world. Nigerians pay the lowest prices ($ 1.94) but coupled with an $ 8 average daily wage Nigeria's gas becomes the sixth least affordable in the world.

The statistics presented thus far emphasize the high cost of imported energy items and the importance of the price formation process in this sector for the Turkish economy.

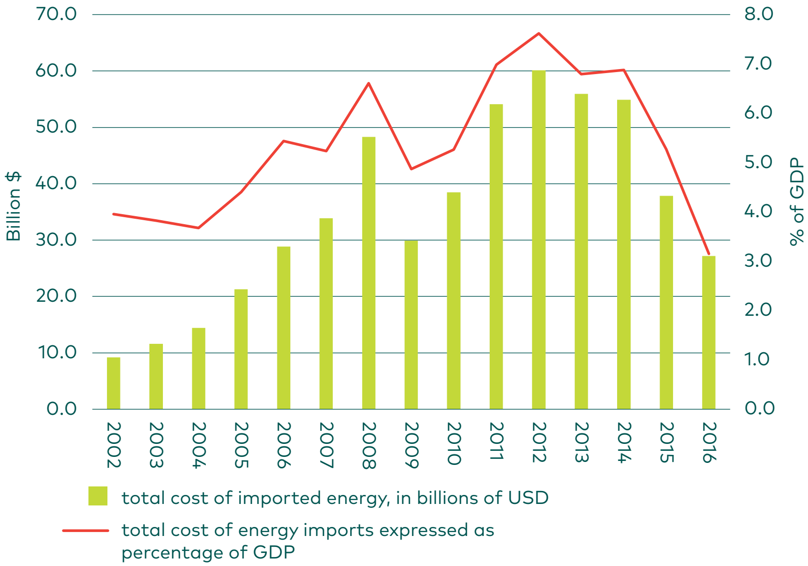

Fig. 1. Total energy import value, in billions of USD, and as percentage of GDP. (Source: Own elaboration based on BOTAS (2017))
Note: The values of 2016 are for nine months only.

Table 4

Least Affordable 10 Countries for Oil Consumption, 2015

		Price per gallon, $	Average daily wage, $	Wage paid for a gallon of petrol, %
1	India	3.75	4.77	78.62
2	Pakistan	2.32	3.97	58.44
3	Philippines	3.17	8.14	38.94
4	Egypt	2.66	10.25	25.95
5	South Africa	3.19	13.03	24.48
6	Nigeria	1.94	8.00	24.25
7	Indonesia	2.23	9.89	22.55
8	Turkey	5.77	26.13	22.08
9	Bulgaria	4.05	18.93	21.39
10	Thailand	3.44	16.23	21.20

(Source: www.oilprice.com (2017))

3.2. Price increase scenarios

Equations (12) and (14) together are used in calculations of the I-O price model. If it can be assumed that there is no increase in the profit margin along with an increase in the price of imported energy items, the final term in these two equations will disappear, i.e. the v^* vector will be zero. Under this assumption sectoral price indexes will depend only on an initial increase in the price of import items, wage rates, or profit rates. As will be clear from the calculations below, even if there is an increase in the profit margin in any sector, its effect on the other sectors will be negligible. Therefore, only two scenarios are included in this paper. The first one is the low price increase scenario called Scenario A, and the second one is the high price increase scenario called Scenario B.

Scenario A: Low price increase scenario

In this scenario, relatively low initial price increases are assumed for three import rows in the C matrix. In this matrix, the first row shows imports in the mining and quarrying sector, as a share of total domestic output in each sector. By definition, among all other mining products this sector also covers the imports of crude petroleum and natural gas. The second row shows coke and refined petroleum products expressed as a percentage of total domestic output of all sectors. Finally, row 3 contains imports from all other 62 sectors expressed as percentages of total domestic output of each sector.

Based on the information given in Table 3, an overall price increase of imported crude oil and natural gas by 25 percent can be assumed a “normal” or “relatively low” rate. Besides the demand and supply conditions, in international practice natural gas prices follow the path of the petroleum prices. For that reason in this scenario natural gas prices are allowed to increase by the same rate as in Table 3, which is 25 percent. Refined petroleum prices are assumed to grow only by 15 percent, as prices of domestically produced refined petroleum products usually increase less than the price of raw materials (petrol and natural gas). Finally, prices of all other imports are allowed to increase by 20 percent, which is a simple arithmetic mean of the previously mentioned price increase rates. The reason for this is the fact that the increase in prices of petroleum products and natural gas depends to a large extent on the appreciation of the US dollar against the Turkish lira. As a result of the exchange rate depreciation of Turkish lira it is normal to assume that the domestic prices of all other imports should go up.

Table 5 shows these three price changes. Since the present model considers only one-step price effects of energy prices, there are no

Table 5

Initial Price Increase in Energy Import Items: Scenario A

	Primary inputs, vector r	New index	Increase, %
1	Crude petroleum and natural gas imports	1.25	25.0
2	Refined petroleum products imports	1.15	15.0
3	Other imports	1.20	20.0
4	Net indirect taxes	1.0	0.0
5	Wages	1.0	0.0
6	Capital income	1.0	0.0

changes in the prices of the other three primary inputs – taxes, wages, and profits. To reflect this fact, the last three items in vector *r* are presented with index number 1.

As stated at the beginning of this section, in the low price increase scenario it is assumed that all the elements of vector p^* are zeros. Thus the last term in Equation (12) cancels out, and the solution to the price model becomes as in Equation (15):

$$p = rC(I - A)^{-1}. \quad (15)$$

Now, a new price vector *p* is obtained by premultiplying the bottom left block of the cumulative I-O table by the new level of vector *r*. After this computation the top 10 sectors showing the highest price rises are given in Table 6.

Table 6 shows that the highest price increase occurs in coke and refined petroleum products (by 17.4 percent). This rate is only 2.4 percentage points higher than the initial increase in the price of refined petroleum imports but much lower than the increase in the price of crude petroleum and natural gas imports. The second highest increase is seen in the electricity and gas utility sector with a relatively low rate of 11.4 percent. Inflation rates in all other sectors are much smaller than the initial increase in the prices of imported energy items and all other imports.

The deflators in the I-O price model are summary measures. They can reflect the economy-wide price changes in a few numbers instead of 64 sectors. With the assumption of zero exogenous domestic price increase (or without an additional profit margin) in any sector of the economy, i.e. when p^* is a zero vector, the deflators are calculated as in Equation (16):

$$d = r[C(I - A)^{-1}B + D]. \quad (16)$$

Equation (16) makes use of all the coefficient matrices in the I-O coefficients table, which are collected in the bottom-right corner of

Table 6

Top 10 Highest Price Changes: Scenario A

	I-O No.	Sector	Price index	Price increase, %
1	10	Coke and refined petroleum products	1.174	17.4
2	24	Electricity, gas, steam and air conditioning	1.114	11.4
3	15	Basic metals	1.094	9.4
4	20	Motor vehicles, trailers and semi-trailers	1.089	8.9
5	11	Chemicals and chemical products	1.087	8.7
6	13	Rubber and plastic products	1.083	8.3
7	18	Electrical equipment	1.081	8.1
8	8	Paper and paper products	1.076	7.6
9	17	Computer, electronic and optical products	1.070	7.0
10	19	Machinery and equipment n.e.c.	1.069	6.9

the tableau of the cumulative I-O coefficients (Table 2). The resulting d vector is given in Table 7.

Table 7 shows that even though a 15 percent increase is assumed for the price of imported commodities, the overall general price increase reflected in the GDP deflator is only 4.5 percent. In Table 7 the GDP deflator is a weighted arithmetic mean of the five deflators of the final demand categories. The highest increase is observed in the exports of goods and services at a rate of 6.8 percent. The second highest number

Table 7

Deflators in Scenario A

	Deflator	Index number	Increase, %
1	C: Household consumption of final goods	1.036	3.6
2	G: Government final consumption	1.022	2.2
3	I: Gross fixed capital formation	1.060	6.0
4	dS: Changes in stocks	1.049	4.9
5	X: Exports of goods and services	1.068	6.8
	GDP: Gross domestic product (GDP deflator)	1.045	4.5

Note: GDP deflator is computed as weighted arithmetic mean of the five components.

is 6 percent, which is observed in gross fixed investment. The increase in prices of private household consumer goods is 3.6 percent. The reason for the relatively low level of price increase in consumer goods is the relatively lower rate of direct import content in their composition, which is reflected in matrix D. In matrix D the highest rate is 0.134, which belongs to the investment column and in the row of the other imports.

Scenario B: High price increase scenario

Scenario B is the same as the low price increase scenario but with an extra price increase in the land transportation and transportation via pipeline sector. The second assumption implies that the last item on the right side of Equation (12) is not zero. Whenever the Turkish lira depreciates against the dollar and other major currencies at a significant rate coupled with a rise in the prices of imported energy items, business associations in the transportation sector claim an immediate price increase for their services. When the Turkish lira depreciates against the US dollar by about 10 percent, the next day petrol prices at gas stations may go up by about 20 percent, and taxi drivers in Istanbul or Ankara can shock their customers showing the new rate at their meters, which can be about 25 percent higher than the day before. This practice is reflected in the last item in Equation (12), with $p^*_{31} = 0.25$. Here the index number 31 is the sector number of land transportation and transportation via pipelines in the I-O table. Therefore, in the high price increase scenario, the I-O price model is fully applicable.

With all these assumptions vector r will look like the one given in Table 5. However, the last item will be placed in a different vector called *p**, which has 0.25 for its 31st element and zeros for all of the other 63 elements.

Upon applying Equation (12) with all its components, the price indices and rates of increases are computed for all 64 sectors of the economy. The top ten sectors showing the highest price increases are listed in Table 8.

Table 8 shows that the highest price increase is in land transport services and transport services via pipelines. This sector shows a 33.3 percent price increase rate of which 25 percent comes from the initial price rise defined in Scenario B. The remaining 8.3 percentage points come from the indirect effects of the increase in imported energy prices due to the I-O relations. The second highest increase is seen in the coke and refined petroleum products sector with a relatively lower rate (18 percent). As in Scenario A, price rises in all the other sectors are much smaller than the initial price increases in imported energy items and all other imports.

Table 8

Top 10 Highest Price Changes: Scenario B

	I-O No.	Sector	Price index	Price increase, %
1	31	Land transportation services, transportation services via pipelines	1.333	33.3
2	10	Coke and refined petroleum products	1.180	18.0
3	24	Electricity, gas, steam and air conditioning	1.117	11.7
4	15	Basic metals	1.112	11.2
5	20	Motor vehicles, trailers and semi-trailers	1.106	10.6
6	11	Chemicals and chemical products	1.099	9.9
7	18	Electrical equipment	1.098	9.8
8	13	Rubber and plastic products	1.096	9.6
9	8	Paper and paper products	1.093	9.3
10	19	Machinery and equipment n.e.c.	1.086	8.6

With the assumption of the exogenously determined price rise in land transportation and transportation via pipelines, Equation (14) is fully applicable for the computation of deflators in Scenario B. The resulting deflators in Scenario B are given in Table 9.

Table 9 shows that even though at least a 15 percent increase is allowed in the price of import items and an additional increase in the price of land transportation and transportation via pipelines sector (31), the overall general price increase reflected in the GDP deflator is only 5.8 percent. As in Scenario A, the highest price increase is observed in the exports of goods and services at a rate of 8.3 percent. The second highest number – 6.4 percent – is observed in the gross fixed investment column. The increase in the prices of private household consumer goods is only 5.5 percent.

A final comment regarding the deflators is related to two numbers taken from the TurkStat and the UN Statistical Division websites (TurkStat, 2017b; United Nations, 2017). For 2012, in the former the consumer price index is 1.062, and in the latter the GDP deflator is 1.069. Thus, somewhat hypothetical model solutions in the high inflation scenario presented in this paper produced almost identical indices for both indicators: 1.055 and 1.058, respectively.

However, compared with a 9.2 percent increase in the actual CPI for 2016 (TurkStat, 2017b) the model solution underestimates this result. The difference then can only be attributed to other determinants, such as changes in monetary variables, wages, profits, or demand conditions.

Table 9

Deflators in Scenario B

	Deflator	Index number	Increase, %
1	C: Household consumption of final goods	1.055	5.5
2	G: Government final consumption	1.023	2.3
3	I: Gross fixed capital formation	1.064	6.4
4	dS: Changes in stocks	1.049	4.9
5	X: Exports of goods and services	1.083	8.3
	GDP: Gross domestic product (GDP deflator)	1.058	5.8

Note: GDP deflator is computed as weighted arithmetic mean of the five components.

Summary and conclusions

Traditional price index methods cannot answer the question: what happens to the consumer price index if the price of imported oil increases exogenously, say, by 10 percent. In this regard, the standard I-O price model is a powerful tool with a strong theoretical base. The model presented in this paper has produced not only six deflators for all final demand categories but also inflation rates for all 64 domestic production sectors. Accordingly, the decision makers in regulatory government authorities in energy markets would be able to test the effects of their pricing policy on individual sectors of the domestic economy using the I-O price model.

The Turkish economy is heavily dependent on imports of all the types of energy items – crude oil, refined petroleum products, and natural gas. The present form of the international energy market structure makes Turkey a price taker. That is, Turkey has limited bargaining power in energy markets. Therefore, to reduce the degree of its dependence of the supply of basic fuel items on foreign players, Turkey should boost investment activities in domestic renewable and clean energy sources.

In the process of the domestic price formation, after an increase in the price of imported energy items, additional arbitrary and unjustified price increases in domestically produced goods and services should be avoided.

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APPENDIX

Table A1

Domestic I-O Table of Turkey, 2012, Current Prices, in Millions of TRY (Abridged)

		1	5	6	10	1	2	3	
		Agricul.	Food, beverage, tobacco	Textile	Coke and refined petrol	Consum. (h/holds and gov.)	Gross invest. (inc. stock changes)	Exports	Total q
1	Agriculture	28 934	47 390	4 384		61 781	14 511	9 099	170 616
5	Food, beverage, tobacco	6 067	19 064	471	8	95 192	630	31 452	173 280
6	Textile	76	249	47 312	3	38 882	–2 361	60 774	152 189
10	Coke and refined petrol	2 065	315	190	433	1 958	89	12 169	43 695
31	Land transport	2 295	6 684	2 729	635	77 173	5 946	22 420	198 182
44	Real estate activities	42	669	2 195	100	125 992		695	172 460
55	Public services	10	34	12	2	89 038			91 379
56	Education		38	12	6	68 618		207	72 260

		1	5	6	10	1	2	3	
		Agricul.	Food, beverage, tobacco	Textile	Coke and refined petrol	Consum. (h/holds and gov.)	Gross invest. (inc. stock changes)	Exports	Total q
57	Health			2		61 894		1 318	67 703
64	Paid household services					782			782
	Other sectors	12 081	28 704	23 735	4 562	503 909	347 907	211 574	1 881 920
	Total intermediate input	51 569	103 146	81 041	5 749	1 063 324	366 723	348 391	2 956 762
1	Crude petroleum and natural gas imports	3	559	975	29 268	3 614	1 471	362	76 127
2	Refined petroleum imports	2 210	341	204	464	5 872	27	72	37 425
3	Other imports	6 569	17 283	17 341	80	47 218	57 324	20 096	335 027
4	Net indirect taxes	–532	1 465	2 564	5 347	82 441	18 737	2 580	189 146

		1	5	6	10	1	2	3	
		Agricul.	Food, beverage, tobacco	Textile	Coke and refined petrol	Consum. (h/holds and gov.)	Gross invest. (inc. stock changes)	Exports	Total q
5	Labor income	2 490	13 409	19 660	490				438 578
6	Gross capital income	108 308	37 076	30 403	2 297				941 948
	Total primary inputs	119 048	70 134	71 148	37 946	139 146	77 559	23 109	2 018 252
	Total output q	170 616	173 280	152 189	43 695	1 202 470	444 282	371 500	

(Source: Own elaboration based on TurkStat (2017a))