

OCCASIONAL MACRO NOTE

July 10, 2008

YKB/OMN/08-07

Author(s)

Eren Ocakverdi (*Economist*)

Phone

+90 (212) 339 71 25

E-mail

eren.ocakverdi@yapikredi.com.tr

Thinking Inside the Box: Input-Output

Anyone who has an interest on the real side of Turkish economy might have encountered the famous sketch of industrial production and exports rising together from 2002 and onwards. The common interpretation of this relationship is that the manufacturing sector is becoming more outward-looking and exports are the main driver behind industrial growth.

Most of the time, no comment is made about imports and are omitted from the analysis, as if everyone has come to an agreement on the fact that an increase in industrial production will inevitably lead to an increase in imports. This is a strong argument since about two out of three dollars of import bill come from intermediate goods.

Very few studies have been conducted to identify and decompose the relationship between production, exports and imports at sector level mainly due to data limitations. Quantitative evidence on the *structural link* between industrial production and foreign trade for each sector would be a substantial policy (*and simulation*) tool for decision makers and analysts.

This study's main objective is to calculate the backward linkages and import dependencies of industrial sectors before and after the crisis in 2001. Input-output tables are used for this purpose due to their usefulness as a "snapshot" of the whole economy. The compilation of IO tables is extremely difficult, since data requirements are enormous. Two recent tables are published for 1998 and 2002, and are appropriate for the aim of this analysis.

An input-output (IO) table provides a complete and consistent picture of the flows of products and services in the economy as a whole for a given year. The table illustrates the relationship between producers and consumers as well as interdependencies between industries (*e.g. exchange of intermediate goods*). One can also find detailed information on input purchases made by each sector in the economy including purchases of imported commodities and their contribution to Gross Domestic Product.

The input-output model of an economy with n sectors can be written in matrix notation as follows:

$${}_{nx1} X^d = {}_{nxn} A \times {}_{nx1} X^d + {}_{nx1} Y$$

$$X_j = X_j^d + M_j \text{ and } Y_j = Y_j^d - \sum_j Z_{ij}^m$$

$$A_{ij} = \frac{Z_{ij}^d}{X_j^d} \Rightarrow X_i^d = \sum_j A_{ij} * X_j^d + Y_i$$

$$Z_{ij} = Z_{ij}^d + Z_{ij}^m$$

In the above model, X , Z and Y vectors/matrices represent total supply, intermediate consumption and final demand, respectively. The M vector refers to imports and superscripts d and m denote the domestic and import components, respectively. The A matrix is defined as the share of intermediate consumption between *sector i* and *sector j* in the total output of *sector j*. The A matrix, is also known as the *technology matrix* and is assumed to be relatively constant over the short term (*e.g. two years*), unless there is a significant shock. These technical coefficients can be further decomposed into domestic and import components:

$$A = A^d + A^m$$

$$A_{ij}^d = \frac{Z_{ij}^d}{X_j^d} \text{ and } A_{ij}^m = \frac{Z_{ij}^m}{X_j^d}$$

Since $M_i = \sum_j Z_{ij}^m + Y_i^m$, we can rewrite total output as:

$$X^d = (I - A)^{-1} \times Y \text{ or } X^d = (I - A^d)^{-1} \times Y^d$$

Here, $R^d = (I - A^d)^{-1}$ is defined as the matrix of *backward linkages*. $\sum_i R_{ij}^d$ represent the total (*direct and indirect*) effect of a *unit increase* in the domestic final demand of *sector j* on the whole economy. From this point, calculating the *import dependency* is straightforward:

$$S = A^m \times R^d$$

$\sum_i S_{ij}$ show the effect on imports of intermediate goods generated by a unit increase in the final demand of *sector j*. For any given year, the equations above are sufficient to calculate the *backward linkages* and the *import dependencies* for each sector.

However, the problem arises when one makes a comparison of these coefficients between two different years. Relative price changes can have significant impact on the *calculated* technical coefficients and might distort the technological relationship between sectors. In order to take into account the varying inflation effects across sectors, technology matrix should be *adjusted (inflated in this case)* according to the base year:

$$A_{\text{new}}^d = (P^d)^{-1} \times A^d \times P^d$$

$$A_{\text{new}}^m = (P^m)^{-1} \times A^m \times P^m$$

Here, P is a diagonal matrix of price changes with respect to the base year (*inflating 1998 figures to 2002 in our case*). Two different indices are used in the analysis in order to separate the impact of the changes in domestic and import prices. Unfortunately, the lack of availability of price indices necessitates aggregation of sectors. We end up with 34 sectors in total; 2 from agriculture, 4 from mining, 22 from manufacturing, 1 from energy and 5 from services (*incl. construction*).

The most striking finding is the nearly 40% increase of the dependency of sectors on imported intermediate goods economy wide. In the meantime, intersectoral dependency (*backward linkages*) rose by only 7% overall. For instance, while petroleum products, non-metallic minerals, communication equipment and construction displayed major increases in their linkages to the rest of the economy, the import content of their production also increased considerably.

An increase in any one of the components of final demand will ultimately stimulate a certain amount of imports of intermediate goods. For instance, if exports of metal products sector increase by *one unit*, it will induce a total amount of *0.296 units* of intermediate goods from abroad. In other words, the sector will have to import nearly 30% of the change in its final demand as raw material for domestic production in order to fully meet the resulting increase.

If final demand of each sector were to increase by one unit (*i.e. 34 units as a whole*) in 2002, then the total effect on domestic output would be 60.9 units and accompanied by 8.2 units increase in imports of intermediate goods. This accounts for 24% of change in the final demand.

Another venue whereby these coefficients could be made use of is the estimation of import content of exports for each sector. In 2002, total exports and imports of machinery and equipment sector were USD 2.1 billions and USD 6.5 billions, respectively. Using these coefficients we can roughly estimate that USD 0.6 billions of total imports were intermediate goods induced by exports. The remaining part of imported intermediate goods (*which is not an officially published figure*) might

have been triggered by other components of final demand (*e.g. consumption*).

On aggregate, total amount of imported intermediate goods in the manufacturing sector induced by exports was estimated around USD 10 billion. As a comparison, we would like to remind you that in 2002 total imports of intermediate goods for Turkey were USD 38 billion whereas total imports of manufacturing sector were USD 41 billion.

How this picture might have changed from 2002 to 2007 will be analyzed in another piece as the change in relationships between sectors has to be estimated rather than derived. Nevertheless, these coefficients can still be used (*provided that they are inflated*), since technological relationships are not supposed to change dramatically over the short/medium term.

<i>Output effect of a unit change in sector's domestic final demand</i>	Backward Linkages		Import Dependency	
	1998	2002	1998	2002
Agriculture	1.486	1.512	0.063	0.064
Fishery	1.162	1.333	0.023	0.070
Coal Mining	1.605	1.483	0.060	0.119
Crude Petr. & Nat. Gas	1.303	1.374	0.040	0.060
Metallic Ore	1.527	1.775	0.068	0.160
Other Mining	1.269	1.663	0.045	0.125
Food	2.038	2.247	0.110	0.120
Tobacco	2.696	1.934	0.180	0.225
Textile	1.965	2.115	0.203	0.276
Clothing	2.442	2.265	0.225	0.236
Leather	2.002	1.908	0.262	0.370
Wood	2.100	2.010	0.143	0.279
Paper	1.858	1.979	0.203	0.297
Publishing	1.430	1.868	0.187	0.222
Petroleum Products	1.161	1.464	0.199	0.570
Chemicals	1.738	1.893	0.303	0.287
Rubber&Plastics	1.924	1.895	0.296	0.335
Non-Metallic Minerals	1.656	1.965	0.115	0.174
Basic Metal	1.932	1.979	0.347	0.366
Metal Products	1.638	2.012	0.259	0.296
Machinery&Equipment	1.793	1.832	0.236	0.279
Office Equipment	1.480	1.412	0.221	0.388
Electrical Machinery	1.822	1.964	0.283	0.310
Radio, TV & Commun.	1.517	1.745	0.289	0.475
Medical Equipment	1.619	1.774	0.286	0.365
Motor Vehicles	1.945	2.071	0.261	0.336
Other Transport	1.855	1.703	0.194	0.210
Furniture&other manuf.	1.746	1.793	0.302	0.416
Energy	1.365	1.856	0.109	0.279
Construction	1.502	1.871	0.126	0.172
Trade	1.407	1.586	0.047	0.082
Transport&Commun.	1.388	1.652	0.087	0.105
Financial Intermediary	1.233	1.538	0.050	0.049
Other Services	1.290	1.471	0.043	0.072
TOTAL	56.894	60.942	5.865	8.189

Strategic Planning and Research		
Section	Phone:	E-mail:
Cevdet Akcay Chief Economist of KFS	90.212 - 319 84 30	cevdet.akcay@yapikredi.com.tr
Ahmet Cimenoglu Head of Section	90.212 - 339 71 28	ahmet.cimenoglu@yapikredi.com.tr
Yelda Yucel Senior Economist	90.212 - 339 71 23	yelda.yucel@yapikredi.com.tr
Muhammet Mercan Senior Economist	90.212 - 339 70 32	muhammet.mercan@yapikredi.com.tr
Cenk Tarhan Senior Economist	90.212 - 339 74 91	cenk.tarhan@yapikredi.com.tr
Eren Ocakverdi Economist	90.212 - 339 71 25	eren.ocakverdi@yapikredi.com.tr
Can Aslak Economist	90.212 - 339 71 22	can.aslak@yapikredi.com.tr

This document is prepared by the Strategic Planning and Research Section of Yapi ve Kredi Bankası A.Ş. solely for information purposes by using official data and is not in any way intended as a professional advice related to subject thereof. Although utmost care has been taken in their compilation and processing, no responsibility is assumed or no warranties, explicit or implicit, are made for the accuracy or completeness of the information provided in the document, no liability and/or indemnification obligation shall be borne by Yapi ve Kredi Bankası A.Ş. vis-à-vis any recipient of the present document or any third party as to the accuracy, completeness and/or correctness of any information covered in the document or as to the usage of the information for commercial purposes. Yapi ve Kredi Bankası A.Ş. accept no responsibility also for the damages or loss to be incurred as a consequence of an investment made relying on the information in the present document. There may also appear opinions, which are of non-factual nature and subject to change without notice for which Yapi ve Kredi Bankası A.Ş. can in no circumstances be held responsible.