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RECONSIDERING IMPORT DEPENDENCY: THE BREAK-DOWN OF SECTORAL DEMANDS WITH RESPECT TO SUPPLIERS

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I. INTRODUCTION

The purpose of this paper is to suggest a modification of the input-output model in studying import dependency to improve the information content and assess its contribution with data for Turkey. In its widely applied form, final demand induced intermediate import requirements, i.e. import backward linkages, are used for detecting most import dependent sectors in terms of suppliers. We suggest a modification to break down these linkages in terms of buyers .

Import dependency has been a topic of interest especially in the context of evaluating the performance of import substitution policies in developing countries. As most of these countries strove for speeded industrialization but faced serious balance of payments deficits problems, assessment of the progress towards the ultimate target also implied assessment of the extent of relief from the foreign exchange bottleneck.

The input-output model has proved useful for studying import dependency mainly because of its interindustrial context. The classification of intermediate inputs used by domestic sectors into domestic and imported components and the mapping of the latter to their sectoral (foreign) origins provide snapshot information which is crucial per se. Besides, as has been widely used, solving for additional (potential) import requirements stimulated by sectoral final demand changes forms the basis of identifying those sectors (domestic) which are leading in import dependency: that is those which in a way deter the

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realization of the development goals. Carrying the exercise in time improves the information content even further: the directions of industrial restructuring could be traced and assessed on the basis of the economic policies implemented.

The backward linkages for imports found by the input-output model serves the above stated purposes by linking sectoral final demand impacts on imports by origin, i.e. by supplying foreign sectors. The purpose of this paper is to improve the information content of this mapping by integrating the dimension of imports by destination, i.e. by demanding domestic sectors.

The paper is organized as follows: we discuss our modification in the next section. In Section III, we compare earlier findings on import dependency for Turkey with findings from our modified model. Section IV comprises a general evaluation.

II. METHODOLOGY

Intermediate imports in the input-output model are defined with respect to two aspects: by origin and by destination. Intermediate imports by origin involve foreign suppliers (sectors, i = 1....,n) and intermediate imports by destination involve domestic buyers (sectors, j = 1....,n). In its widely applied form, final demand induced intermediate input requirements (policy sectors k = 1....., n) are computed in terms of imports by origin (i) only. A version of this form provides information on final demand induced intermediate input requirements in terms of imports by destination (j) only. We propose to reconcile these two aspects and hence define final demand induced intermediate input requirements in terms of imports both by origin and destination thus with respect to k, i and j.

A. Imports by origin

$\mathbf{A^m}$ and $\mathbf{A^d}$ being coefficient matrices, by (n, n), of imported and domestic intermediate inputs, respectively, **A,** intermediate input coefficients matrix, is the combination of the two: $\mathbf{A} = \mathbf{A^d} + \mathbf{A^m}$. Direct intermediate import requirements by origin are given by

$$\mathbf{m} = \mathbf{A^m}\,\mathbf{x} \qquad (1)$$

where **x** is an (n,1) vector of sectoral outputs, Here, the column vector, **m**, captures sectoral totals for intermediate imports by origin (foreign or supplying sectors) and $\Sigma_i\ \mathbf{m}_i = \mathbf{M_{int}}$, total intermediate imports in the economy.

The common practice for finding total (direct+indirect) intermediate import requirements (**m**) in response to domestic final demand ($\mathbf{y^d}$) (a vector by n,1) changes involves the definition

$$\mathbf{m = A^m x = A^m (I-A^d)^{-1} y^d = A^m R y^d = S y^d} \quad (2)$$

$\mathbf{A^m R}$ or **S** in short, is usually referred to as the import dependency matrix. The typical element of **S**, $\mathbf{s_{ik}}$ is interpreted as "imported input requirement from the foreign sector *i*, in response to a say, unit increase in the final demand of sector *k*. Then $\mathbf{\Sigma_i\, s_{ik}}$ shows the total imported input requirement in the economy generated by one unit increase in the final demand of sector *k* or in short backward linkages for imports (see Weisskoff and Wolff (1975) for an early introduction and e.g. Bulmer-Thomas (1982) and (1986), Fujita and James (1991), Sarma (1996), Sarma and Ram (1989) for applications).

As $\mathbf{s_{ik}}$ in fact equals $\mathbf{\Sigma_j\, s_{i,j,k}}$, i.e. the total of imports required from *i* by domestic sectors, *j* = 1,…n, in response to $\mathbf{k^{th}}$ final demand change, a question like "how much imported input is required in response to an increase in the final demand of *k* from foreign sector *i* by the domestic sector *j* ? " can not be answered in the present context. This question, in short, involves finding intermediate import requirements by destination (domestic or buying sectors). This is relevant especially for developing economies which are dependent on imported inputs but are constrained by foreign trade deficits.

B. Imports by destination

The above posed question is partly answered by

$$\mathbf{u = < T > x} \quad (3)$$

where **u**, a vector of (n,1), is the vector of imported intermediate inputs by destination and **T** is a diagonal matrix with its typical element $\mathbf{t_{jj} = \Sigma_i\ a^m{}_{ij}}$ (column totals of $\mathbf{A^m}$). Overall total of **u** is again equal to total intermediate imports in the economy, i.e. $\mathbf{\Sigma_i\ u_i = M_{int} = \Sigma_i\ m_i}$. Relating intermediate imports by destination to final demands involves

$$\mathbf{u = < T > (I-A_d)^{-1} y^d = < T > R y^d = V y^d} \quad (4)$$

The elements of the matrix resulting from $\mathbf{< T > R}$ or **V** in short show the intermediate import demand of the j^{th} domestic sector in response to a unit change in k^{th}

final demand, i.e. associating final demands with imports by destination. The column totals $\Sigma_j v_{jk}$ here are identical to the corresponding $\Sigma_i s_{ik}$, as import backward linkages for sectors *k* and hence $\Sigma_k \Sigma_j v_{jk} = \Sigma_k \Sigma_i s_{ik}$.

With similar insight, v_{jk}, the typical element of **V**, equals $\Sigma_i v_{i,j,k}$, i.e. the total of imports required by the domestic sector, *j*, from *i* = 1,…n, in response to k^{th} final demand change, but disguises information on the supplying foreign sector, *i*, or on the origin sector.

C. Imports by origin and destination

In an attempt to answer the above posed question and thus reconcile the information contents of the two preceding sections, all three dimensions, i.e. *i*, *j* and *k*, of import dependency can be captured in the following way: for any policy or final demand sector *k*, define

$$\mathbf{G^k = A^m < R^{*k} >} \tag{5}$$

where $\mathbf{< R^{*k} >}$ is a diagonal matrix of (n,n), formed by the k^{th} column of **R**, i.e. $\mathbf{(I-A_d)^{-1}}$ diagonalized for sector *k*. Hence for $i = \ell$, $\mathbf{r^{*k}_{i\ell} = r_{ik}}$. $\mathbf{G^k}$ can be regarded a certain way of combining information on direct intermediate import demands by origin (*i*) and by destination (*j*) with information on final demand (*k*) induced intermediate imports (direct+indirect) by origin (*i*). A typical element of $\mathbf{G^k}$, $\mathbf{g^k_{ij}}$, then stands for imported intermediate input requirement (direct+indirect) by the j^{th} (domestic) sector from the i^{th} (foreign) sector induced by one unit increase in the k^{th} sector's final demand.

The row sums of $\mathbf{G^k}$ give $\mathbf{s_{ik}}$, import backward linkages in common practice, i.e.

$$\Sigma_j \mathbf{g^k_{ij}} = \mathbf{s_{ik}} \tag{6}$$

and the column sums of $\mathbf{G^k}$ give $\mathbf{v_{jk}}$, i.e.

$$\Sigma_i \mathbf{g^k_{ij}} = \mathbf{v_{jk}} \tag{7}$$

Also, $\Sigma_i \Sigma_j g^k_{ij} = \Sigma_i s_{ik} = \Sigma_j v_{jk.}$. Thus, with the typical element g^k_{ij}, we are able to answer the posed question above, in coherence with the common usage of **S** and **V** for assessing import dependency.

This approach is rather easy to utilize when the number of sectors, n, is small, as the procedure can be repeated for every policy sector k=1,..n or for policy sectors of choice. However, when n is large, as it would be in reality, repetitions might be frustrating. A simultaneous solution for the whole economy, for **G**, requires multiplication of two block diagonal matrices, each block being of order n by n. The first block diagonal matrix will capture $\mathbf{A}^m$ in all of its n diagonal blocks and the second block diagonal matrix will capture each of $\mathbf{R}^{*k}$, for k = 1,..n. Hence matrices of order n^2 by n^2 are to be multiplied, resulting in the block diagonal matrix of **G**, where any k^{th} block, provides a break down of import dependency in terms of both buying and supplying sectors, in response to a unit change in the k^{th} final demand.

The common methodology outlined in Section II.A was used in several studies on import dependency of Turkey (e.g. Senesen (1990) and (1995), Senesen and Kücükcifci (1991), Yildirim (1978)). The information gain from the proposed methodology in this section will be assessed with Turkish data next.

Input –output tables for the Turkish economy are available in coherent classification for 64 sectors for the years 1973, 1979, 1985 and 1990. Imported intermediate input flow matrices are also available. Since the input-output data for 1996 has not been released yet, we have used the most recent input-output tables for 1990 (SIS, 1994).

III. IMPORT DEPENDENCY OF THE TURKISH ECONOMY IN 1990

Turkey has long suffered from balance of payments deficits which has exerted severe pressure on the functioning of the economy in times of foreign exchange shortages, relieved only with inflow of foreign borrowing. Another noteworthy characteristic of the economy is the drifting away , in 1980 from the import substitution strategy of three decades to the export promotion strategy. In the new era a significant increase in import dependency is observed, as the calculated imports backward linkages of 60 sectors out of 64 rose cosiderably, some of them a few hundred per cent, in 1985 compared with those in 1979. On the whole the import dependency of the economy jumped up by about 60 per cent during 1979-1985 and remained unchanged in 1990, as

indicated by the imports backward linkages in that year (Senesen (1995)). Pamukcu and de Boer (1999) provides an analysis of import patterns in the Turkish manufacturing industries during 1968-1990, in the context of Structural Decomposition Analysis.

One of the main characteristics of the Turkish economy is the crucial dependency on petroleum. Among those sectors with high (imported inputs / intermediate sales) ratios raw petroleum comes first with a value of almost 90% both in 1985 and in 1990. That is, Turkey imports 90 % of its intermediate"raw petroleum"supply in both years. On the other hand, among the major domestic buying sectors, "oil refinery" is the leading one in both 1985 and in 1990. Its (imported inputs / total inputs) ratio was 78% in 1985 and 90% in 1990. The imports backward linkages for "oil refinery" was 0.5170 and 0.4525 in those years respectively (Senesen (1995)).

It is interesting to see that nine of the ten sectors with the highest (imported inputs / total inputs) ratios and with the highest imports backward linkages coincide in 1990, though their orders are slightly different by the two indicators (see Table 1). The only exceptions are "motor vehicles" and "non-ferrous metals" that are listed among the first ten sectors in only one of the two lists. The value of intermediate imports for five of those nine sectors constitute more than half of the total intermediate imports of the whole economy. Therefore it would be both fruitful and rather sufficient to examine those sectors in detail by applying the method proposed in this study. However, two of them (*other* manufacturing and *other* chemicals) are also left out due to difficulties of the interpretation because of their vaguely defined end products.

We summarize the findings with the G^k methodology for these leading sectors in Tables 2-8. For each policy sector, import dependency structure is presented by the entries of the tables with respect to origin and destination. As would be expected, these are the outlying components of the second column of Table 1 and the entries in the right-bottom corner of Tables 2-8 are equal to the values given there. These tables include only those origin (selling) and destination (buying) sectors which have a value of greater than 0.01 at their row or column totals respectively. The outstanding values for each destination (buyer) sector are highlighted by bold typing.

A common finding for these sectors is that, the policy sector coincides with the leading destination sector. In other words, a one unit increase in $\mathbf{y^d}$ of the $\mathbf{k^{th}}$ sector induces imported intermediate input demand mainly by the $\mathbf{k^{th}}$ sector, (i.e. j = k). With the obvious exception of oil refinery, the $\mathbf{k^{th}}$ origin sector, (i.e. i = j = k), ranks high among the origin sectors.

Another common characterictic of these policy sectors is that for all of them oil refinery is an outstanding destination sector and in each case the origin sector is raw petroleum. This again shows the very crucial role raw petroleum has played in the growth performance of Turkey.

It is also interesting to see that the sectoral compositions in Tables 2-8 were already obvious from the imported intermediate inputs coefficients matrix $\mathbf{A^m}$, the related elements of which are extracted inTable 9. Besides, the $\mathbf{a^m_{ij}}$ values are very close (more than 80 %) in magnitude to those highlighted in Tables 2-8. For example, per unit of output, oil refinery sector requires 0.4485 units of (direct) imports from raw petroleum, as seen in Table 9. In Table 2, total direct+indirect import requirement induced by a change of its final demand is 0.4525 (see also Table 1), 0.4507 of which is the (direct+indirect) import demand of oil refinery from raw petroleum.

IV. CONCLUSIONS

The proposed methodology has served the intended purpose with regard to the Turkish economy. It has revealed the interconnections between the origins and destinations of intermediate input import dependency induced by final demands.

Obviously, although the findings revealed that A^m and G values are quite close to each other for the Turkish economy, this might not be necessarily true for other economies. It seems rather safe to guess that the discrepancy between the two coefficents would be higher for more developed economies with more complex interrelations between their sectors. Since Turkish input-output tables are compiled on the basis of a rather high aggregation, 64 sectors, it is highly likely that a commodity based compilation would have outlined more detailed and thus more interesting compositions.

Nevertheless, recalling that the serious foreign exchange bottleneck in 1979 in the aftermath of the OPEC price shock resulted in petroleum shortage and therefore in severe stagnation was only relieved by foreign debt, one can deduce that similar outcomes are to be expected in similar conditions. Combined with the fact that in 1990s, Turkey has failed to generate alternative domestic energy sources and compensating export revenues, the rather shaky route of growth performance determined mainly by the availability of foreign capital inflows seems inevitable.

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Table 1. Sectors with high import dependency in the Turkish economy, 1990

Sector	Imported inputs / total inputs, %	Import backward linkages
Oil refinery	90.0	0.4525
Other manufacturing	66.5	0.5096
Iron & steel	33.0	0.3696
Electrical machinery	30.9	0.2841
Rubber	29.8	0.3042
Medicine	28.9	0.2264
Other chemicals	26.6	0.2838
Fertilizers	24.6	0.2681
Plastics	24.6	0.2752

Table 2. Policy sector: **Oil refinery.** Origin and destination sectors of import dependency

	DESTINATION	
ORIGIN	**Oil refinery**	Total
Raw petroleum	**0.4507**	0.4507
Total	0.4513	**0.4525**

Table 3. Policy sector: **Iron & steel.** Origin and destination sectors of import dependency

	DESTINATION		
ORIGIN	Oil refinery	**Iron & steel**	Totals
Coal		0.0423	0.0423
Raw petroleum	0.0358		0.0358
Ferrous metals		0.0136	0.0136
Iron & steel		**0.2321**	0.2390
Other metals		0.0112	0.0.136
Total	0.0359	0.3187	**0.3696**

Table 4. Policy sector: **Rubber.** Origin and destination sectors of import dependency

	DESTINATION		
ORIGIN	**Rubber**	Oil refinery	Totals
Raw petroleum		0.0387	0.0388

Forestry	**0.0897**		0.0898
Other chemicals	**0.0906**		0.0966
Rubber	**0.0567**		0.0568
Totals	**0.2478**	0.0388	**0.3042**

Table 5. Policy sector: **Electrical machinery.** Origin and destination sectors of import dependency

	DESTINATION				
ORIGIN	**Electrical machinery**	Other metals	Oil refinery	Iron & steel	Totals
Raw petroleum			0.0135		0.0135
Other chemicals	0.0089				0.0187
Iron & steel	0.0085			0.0089	0.0201
Other metals	0.0693	0.0199			0.0903
Electrical machinery	**0.1163**				0.1176
	0.2188	0.0270	0.0135	0.0122	**0.2841**

Table 6. Policy sector: **Plastics.** Origin and destination sectors of import dependency

	DESTINATION			
ORIGIN	**Plastics**	Other chemicals	Oil refinery	Totals
Raw petroleum			0.0271	0.0271
Plastics	0.0516			0.0518
Other chemicals	**0.1220**	0.0401		0.1654
Totals	0.1827	0.0442		**0.2752**

Table 7. Policy sector: **Fertilizers.** Origin and destination sectors of import dependency

	DESTINATION			
ORIGIN	**Fertilizers**	Oil refinery	Other chemicals	Totals
Raw petroleum		0.0302		0.0303
Fertilizers	0.0342			0.0342
Other chemicals	**0.1533**		0.0256	0.1828
Totals	0.1953	0.0303	0.0282	**0.2681**

Table 8. Policy sector: **Medicine.** Origin and destination sectors of import dependency

ORIGIN	DESTINATION **Medicine**	Oil refinery	Totals
Medicine	**0.1803**		0.1804
Other chemicals	0.0121		0.0201
Raw petroleum		0.0127	0.0127
Totals	0.1958	0.0127	**0.2264**

Table 9. Intrmediate import coefficents (A^m) for the entries shown in Tables 2-8

	DESTINATION						
ORIGIN	Oil refinery	Iron & steel	Rubber	Electrical machinery	Plastics	Ferti-lizers	Medicine
Raw petroleum	0.4485						
Coal		0.0346					
Ferrous metals		0.0111					
Iron & steel		0.1898					
Other metals		0.0091					
Forestry			0.0755				
Other chemicals			0.0762		0.1136	0.1417	0.0101
Rubber			0.0477				
Electrical machinery				0.1041			
Plastics					0.0480		
Fertilizers						0.0316	
Medicine							0.1511