

Import multiplier in input - output analysis

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Received 5 April 2009

Abstract. In this research paper, the Keynesian, Leontief's and Miyazawa's multiplier concepts are extended in order to decompose the factors that propagate to total import requirements on such variables as domestic intermediate consumption, domestic final consumption, domestic investment and export. From these extended concepts, we are able to quantify the direct and indirect import requirements and determine the decomposition factors that induce total import requirements. Along with domestic output multipliers, policy makers would be able to look into and consider the import multiplier as a key determinant in sectoral economic planning and policy formulation.

1. Introduction

Imported intermediate inputs are shown in the usual Keynesian foreign trade multiplier analysis as $Y + M = C + I + E$. That is, the external sector is combined consistently with the domestic sector in the circular flow. Y stands for net national product (or net final demand) that excludes intermediate product demand, while M stands for imported products that include imports of intermediate products. On the other hand, Leontief's matrix multiplier is devoted entirely to the analysis of intermediate products in the circular flow. Additionally, the Leontief system can regard the household sector as industry whose output is labor income and inputs are consumption products.

In this paper, we try to estimate import requirements consistently between Leontief system and Keynesian model based on Vietnam

time series IO tables (1989, 1996, 2000 and 2005).

2. Foreign trade multiplier

Based on the traditional Keynesian multiplier on income, the equation is given as:

$$a + a^2 + a^3 + \dots + a^n = a \cdot (1 + a + a^2 + a^3 + \dots + a^n) = a/(1 - a) \quad (n = 1, \infty) \quad (1)$$

Where a is ratio of intermediate input and $(1 - a)$ is value added ratio:

In the usual Keynesian procedure, the imported intermediate products required for production of investment goods (or export products) are treated as an exogenous factor in the multiplier process. Logically, however, we should treat the imported intermediate products as an endogenous factor induced by the initial injection. Let $\lambda = D/T$; in which D is the demand for domestic intermediate product and T is total intermediate products. Then we can rewrite the above sub-multiplier process increase R as follows:

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$$a \cdot (\lambda^0 + \lambda^1 + a\lambda + a^2\lambda^2 + a^3\lambda^3 + \dots + a^n\lambda^n) = a / (1 - a \cdot \lambda) \quad (2)$$

This foreign trade multiplier takes into account the intermediate products in the circular flow. Of course, the usual Keynesian foreign trade multiplier generally does take into account the import of intermediate products required for the production of consumption, but this is done inadequately. Nevertheless, the intermediate products required for the production of consumption goods and services, as well as those required for the production of investment (or export) products, are not imported at the expenditure level, but in the sub-multiplier process. In that multiplier, the import of intermediate products is taken into account at the proper place, namely, in the circular flow of intermediate products.

In order to express our multiplier in a form comparable with the orthodox Keynesian multiplier, we let $X = T + V$ to denote gross output where V denotes value added. Then $(1 - a) = V/X$ is the value added ratio.

Letting $\delta = T/V$, we have $\delta = (T/X) / (V/X) = a/(1 - a)$

So that:

$$h = (1 - a) / (1 - \lambda a) = (1 - a) / (1 - a + a - \lambda a) = \{(1 - a)/(1 - a)\} / \{1 + a \cdot (1 - \lambda)/(1 - a)\} = 1 / [1 + \delta \cdot (1 - \lambda)] \quad (3)$$

Based on the Miyazawa concept, we call p as the marginal propensity to consume domestic products. Since similar sub-multiplier processes precede all the other secondary increases in income (due to additional consumption expenditure), the whole income-generating process can be given as:

$$h + ph^2 + \dots + p^{n-1}h^n = h/(1 - ph) \quad (4)$$

This is called foreign trade multiplier that takes into account the intermediate products in the circular flow.

From equation (3) and (4), the *foreign trade multiplier* becomes:

$$h/(1 - ph) = 1 / [(1 - p) + \delta \cdot (1 - \lambda)] \quad (5)$$

We call m as the marginal propensity to import finished products and c as the marginal propensity to consume. Letting $p=c-m$, equation (5) becomes:

$$h/(1 - ph) = 1 / [(1 - (c - m) + \delta \cdot (1 - \lambda))] \quad (5')$$

3. The revised multiplier

The multiplier in equation (5) or (5') has different values since the interindustrial average values of δ and λ differ with each pattern of propagation. That is a characteristic which is not found in the Keynesian foreign trade multiplier.

If we put $\lambda = 1$, equation (5) or (5') becomes: $1/1 - p$ or $1/[1 - (c - m)]$. It therefore coincides with the Keynesian multiplier in the case where induced imports are restricted to finished products only.

The multiplier can also be derived from a revised fundamental equation for an open economy. Based on Keynesian and Leontief equations, we can rewrite as follows:

$$X - A \cdot X = C + I + E - M \quad (6)$$

Where: X , C , I , E and M are vectors of gross output, consumption, investment, export and import, respectively.

We can rewrite equation (6) as follows:

$$X - A \cdot X = C + I + E - M^p - M^c \quad (7)$$

Where M^p = the imports of intermediate products, M^c = the imports of finished products, i.e. $M = M^p + M^c$.

We can then expand equation (7) to be:

$$X - A^d \cdot X - A^m \cdot X = C^d + I^d + E + C^m + I^m - M \quad (8)$$

Where $A \cdot X = A^d \cdot X + A^m \cdot X$ where $A^m \cdot X = M^p$ and $M^c = C^m + I^m$. A^d is vector of intermediate consumption of domestic products, while C^d and I^d are final consumption and investment vectors of domestic products, respectively.

Putting $Y^d = C^d + I^d + E$, where Y^d denotes final demand of domestic products vector, we can rewrite equation (8) as:

$$X = (I - A^d)^{-1} \cdot Y^d = (1 + A + A^2 + A^3 + \dots) \cdot Y^d \tag{9}$$

Where $(I - A^d)^{-1}$ is the Leontief matrix multiplier that shows domestic product requirements for a unit increase in domestic final demand.

On the other hand, equation (8) can be derived as follows:

$$X - A^m \cdot X = A^d \cdot X + C^d + I^d + E + C^m + I^m - M = TDD - M^P$$

We put total domestic demand $TDD = A^d \cdot X + C^d + I^d + E$. It includes intermediate demand (production), consumption demand, investment demand and export. Then we have:

$$X = (I - A^m)^{-1} \cdot (TDD - M^P) \tag{10}$$

Or:
$$X = (I - A^m)^{-1} \cdot (TDD + C^m + I^m - M^P) \tag{11}$$

Matrix $(I - A^m)^{-1}$ is import matrix multiplier. Equations (10) and (11) show the import requirements induced by intermediate imported products requirement as well as final demand's domestic and imported products.

In the case where input-output tables are available only in competitive-import types such as in the case of Vietnam's, we can estimate A^m and A^d as follows:

Let import coefficient $m_i = M_i / TDD_i$ where M_i is import of product i and TDD_i is total domestic demand of product i , where TDD_i excludes export. Note that $m_i < (or =) 1$. So we have:

$$A^m X = \Phi \cdot A \cdot X \text{ and } A^d X = (I - \Phi) \cdot A \cdot X \tag{12}$$

Where Φ is a diagonal matrix of import coefficients (m_i).

4. Case study

Table 1. Direct and indirect import requirements: 1989 - 2005

		1989		1996		2000		2005	
		Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
01	Agricultural crops, livestock & poultry: agricultural services	0.077	1.030	0.109	1.038	0.097	1.046	0.090	1.055
02	Fishery	0.202	1.081	0.105	1.047	0.182	1.094	0.166	1.116
03	Forestry	0.087	1.036	0.072	1.027	0.076	1.034	0.054	1.036
04	Mining and quarrying	0.197	1.082	0.145	1.056	0.069	1.032	0.090	1.056
05	Food, beverage & tobacco manufactures	0.131	1.041	0.096	1.021	0.105	1.038	0.131	1.058
06	Other consumer goods	0.244	1.087	0.243	1.087	0.325	1.146	0.378	1.244
07	Industrial materials	0.288	1.112	0.260	1.096	0.353	1.176	0.430	1.295
08	Capital goods	0.343	1.145	0.468	1.274	0.441	1.274	0.463	1.359
09	Electricity, gas & water	0.248	1.109	0.230	1.155	0.138	1.076	0.164	1.120
10	Construction	0.315	1.125	0.311	1.121	0.386	1.206	0.424	1.304
11	Wholesale and retail trade	0.046	1.016	0.086	1.040	0.196	1.109	0.175	1.128
12	Transport services	0.306	1.131	0.254	1.130	0.213	1.111	0.228	1.163
13	Post and telecommunication	0.167	1.077	0.145	1.077	0.133	1.063	0.124	1.087

14	Finance, insurance & real estate & business services	0.175	1.069	0.105	1.032	0.130	1.050	0.117	1.070
15	Other private services	0.118	1.050	0.096	1.042	0.132	1.061	0.148	1.094
16	Government services	0.078	1.029	0.097	1.039	0.140	1.067	0.145	1.093

This case study is based on the IO tables for Vietnam that have been compiled for benchmark years: 1989, 1996, 2000 and 2005. For the purpose of this study, the IO tables were collapsed following a uniform 16-sector classification of the Vietnamese economy.

Table 1 presents the direct and indirect import requirements per unit increases in final demands during the periods under consideration. We can observe that some sectors such as other consumer goods (06), industrial materials (07), capital goods (08) and construction (10) have exhibited significantly heavy increases in their import requirements through the years. For example, in the capital goods sector (sector 08) which is traditionally an import-dependent industry, its total direct and indirect import requirements in 1989 amounting to 1.488 (0.343 + 1.145) units per unit of final demand rose to 1.822 (0.463 + 1.359) units or a hefty increase of about 22%, way above the national average of approximately 7%. Indirect import requirements account of 1.145 units per unit increase in final demand rose to 1.359 units in 2005 or a hefty increase of about 19%.

Table 2 shows the import requirements being decomposed into its component of demand as induced by domestic final demand (consumption domestic demand (C^d),

investment domestic demand (I^d) and Export (E^d), imports of finished products for consumption (C^m) and investment (I^m), and imports of intermediate products (A^d.X). Results in table 2 were calculated by the following formula:

$$(I - A^m)^{-1} \cdot (TDD + C^m + I^m) \div I \cdot K$$

Where: I is row unit vector of n order; K is matrix with dimension (n x 6), and (÷) means each elementary of this matrix divided by consistent elementary of other matrix.

Table 2 shows that induced import requirements in 2005 appeared to be relatively higher than in previous years except for domestic consumption demand (C^d). Most notable is consumption of one unit of imported finished products in 2005 further induces 2.204 units of imports. Imports by domestic investment (I^d) exhibited the largest effect of 1.639 units of imports required for every one unit of domestic investment.

Table 2' shows a percentage time-series index of Table 2, with 1989 as the base year. It can be observed that, in 2005, total import requirements were induced by almost (except C^d) factors of demand. Domestic investment demand (I^d) and final consumption of imported products (C^m) registered the higher percentage increases.

Table 2. Total import requirements induced by total domestic demand: 1989-2005

	C ^m	I ^m	C ^d	I ^d	E ^d	A ^d .X
1989	1.687	1.528	1.321	1.385	1.212	1.231
1996	1.948	1.666	1.312	1.404	1.220	1.242
2000	1.999	1.639	1.389	1.463	1.282	1.321
2005	2.204	1.741	1.264	1.639	1.405	1.435

Table 3. Percentage increase of total import requirements induced by factors of demand

	C^m	I^m	C^d	I^d	E^d	$A^d.X$
1989	100.00	100.00	100.00	100.00	100.00	100.00
1996	115.47	109.03	99.32	101.37	100.66	100.89
2000	102.62	98.38	105.87	104.20	105.08	106.36
2005	110.26	106.22	91.00	112.03	109.59	108.63

5. Concluding remarks

- Table 1 and annex A shows the sector Food, Beverage & Tobacco manufactures is best significant preparation to economic activities.

- In period 2001 - 2006, domestic investment, export and domestic intermediate demand increase had led to strong stimulated of imported intermediate products and total imported requirement.

- The total imported requirement of stage 2001 - 2006 induced by domestic consumption lower than prior stages.

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