Cote d'Ivoire

Youssouf Kone and Daillo Souleymane Sadio

1. Introduction

Input-output analysis can be used to evaluate the impact of different policies on macroeconomic variables such as gross domestic product, employment, consumption, productivity, etc, as well as on the environment. Indeed many economic models in applied research are based on Input-Output (I-O) tables. Basically, there are two kinds of I-O models. In the system of national accounts (SNA), the Make-USE model allows industries to produce more than one commodity[1]. In contrast, in the symmetric Input-Output table (SIOT) each industry produces only one commodity an each commodity is produced by only one industry. Furthermore, SIOTs can be divided into two groups[2]. They can either be defined as Industry-by-industry or commodity-by-commodity tables.

A commodity-by-commodity table describes the technological relations between products. The intermediate part describes for each product the amounts of products that were use to produce it, irrespective of the producing industry.

An industry-by-industry table describes interindustry relations. However, the first-cited is generally more homogenous in its description of transaction than Industry-by industry tables. In the system of national account introduced by the United Nations, there are two alternative technology assumptions to be used in converting SIOTs from, the Use and Make tables. These were the Industry technology assumption (ITA) and the commodity technology assumption (CTA).

The main input-output data improvement project that is currently under way at the Centre for Global Trade Analysis aims at the development of software tools for policies analysis completed with a global data base for many countries around the world including the African region. The GTAP 7 Data Base, which is due to be released in 2008 is based on the year 2004 and is expected to have more than 105 countries/regions, plus new trade data. In addition, the Center is being working on a special African GTAP Data Base which will include 31 African countries. This new African data base should be very beneficial to those working on African issues.

In the next section we present the Ivorian 1998 I-O table, while the third section introduces the theoretical framework for the derivation of SIOTs. Section 4 presents the methodological approach of the conversion of Ivorian I-O table into a symmetric commodity-by commodity table. Finally, section 5 provides some concluding remarks.

[1] This model was introduced by the United Nations in 1968.
[2] Bohlin, L. and L. M. Widell, Forthcoming in Economic systems research, 2006.

2. *Description of the Ivorian 1998 Input-Output Table*

The 1998 I-O table for the Ivorian economy is grouped commodity-by-industry and is 43*43 dimensions. It highlights the structure of the different sectors of the economy and their interrelationships. Distinction is made between commodities and industries and we have two intermediate tables: the **Supply** table and the **USE** table.

Industries and commodities are grouped into a disaggregated 43 sectors except the "correction territoriale" which is a fictional sector. There is no data for land and we have only one column vector of Imports.

Generally speaking, an I-O framework centres on the so-called supply and Use tables. The present I-O system includes an integrated set of supply and Use matrixes, which represent an intermediate stage between the basic statistics and the symmetric I-O table which is more useful in economic analysis and modelling.

2.1 The Supply Table

The Supply table shows the commodities (goods and services) produced by each industry and illustrates the relationships between the output of products and the output of industries.
It consists in an intermediate matrix of products produced by industries, plus additional column vectors comprising **Imports** and several valuation adjustment items to convert total supply of products from basic prices into purchaser's prices, namely **distribution margins (trade and transport)** and **net taxes on products**.

The main points from the table were:

- Total supply of Ivorian industries in 1998 at basic prices (i.e excluding product taxes and distributors trading margins) was F CFA **14 632 198** millions.

Total supply is equal to total supply of industries plus import cif.

- Total import is FCA **2 534 116** millions and
- Total import taxes was FCFA **217 093** millions while Total taxes on exports was FCFA **289 600 millions.**

Finally, the row total is industry output, while the Column total is commodity output.

2.2 The Use Table

The Use table represents domestically produced intermediate and final consumption, both at basic and purchaser's prices. The USE matrix provides information on the use of goods and services, and on the cost structure of industries, and therefore presents a comprehensive description of the domestic production functions of Ivorian industries.

Additional columns vectors are shown regarding standard final demand, i.e. **final consumptions by Households, Government, Investment and Exports,** additional rows finally represent different components of value added i.e. **labour cost, capital use**, **and other net taxes on production.**

The main points in 1998 were:

- Gross Value Added at current basic prices was FCA **7 457 508 millions,** of this the Whole sale and retails trade ("commerce en gros et en détail) accounted the most (12.26%), followed by the food crops sector "Agriculture Vivrière" (11.63%) and the Industrial or Export agriculture (9.7%).

- Gross Value Added is made up of employee costs, taxes less subsidies on production and Net Operating surplus. Compensation of employees forms the largest contribution to the GVA, but the proportion varies across industries.

- Total use of products at purchaser's prices for 1998 was **15 412 996 millions** of this 20% (FCFA **3 080 096 millions**) was exported, while 31.37% (**FCFA 4 836 548 millions)** was consumed by households and 6.60% (**FCFA 1018653 millions**) was consumed by government.

- Finally, total use of products at purchaser's prices (**FCFA 15 412 996**) matches the final supply of products (FCFA **15 364 154**) at the same valuation prices.

(See tables 1 and 2 in Appendix)

In the next section we briefly describe two of the most common technology assumptions in compiling SIOTs from Use and make tables.

3. *Theoretical Framework for Derivation of SIOTs*

3.1 *The Commodity Technology Assumption*

The theoretically superior method for the construction of symmetric Input-Output tables is the so-called Commodity Technology assumption (CTA), but it is plagued by the problem that it generates negative results.

According to the CTA, **the same mix of inputs is used for producing a specific product in all industries that are producing that product**. In other words, each product is produced in it own specific way, irrespective of the industry where it is produced[3].
The CTA seems to the most applicable to cases of subsidiary production, since in those cases the technology of primary and secondary product is independent. However the CTA does not

[3] Braibant, M (2002) Transformation of Supply and Use tables to symmetric I-O table. Paper presented at the XIVth international conference on I-O Techniques, Montréal, Canada.

exclude cases where two or more products are produced in the same process (i.e. joint production).

Following the United Nations system of National accounts (1968) consider a Use matrix $U = (U_{ij})_{i, j = 1, 2 \ldots n}$ comprising commodities i consumed by industries j, and a Make matrix $V = (V_{ij})_{i, j = 1 \ldots n}$ showing the produce of sectors i in terms of commodities j.

Notice that we consider square tables, with the same number of commodities as of industries. We can derive an Input-output coefficient (a_{ij}). The issue is how can we estimate the amount of commodity i used for the production of one unit of commodity j? We consider the amount of commodity i used by the industry j (U_{ij}). The basic idea is to subtract from U_{ij} the consumptions of the commodity i used by industry j for its secondary outputs, $k \neq j$. The problem is that secondary outputs of industry j do not necessarily have the same input structure as in the industries where they are primary output. Thus, to compute the average input requirement of commodity j, we must add the secondary output to V_{ij} and the associated inputs to U_{ij}.

Consequently, the total input requirements of commodity i for making commodity j as a single product are thus:

$$U_{ij} - \sum_{\substack{k=1 \\ k\neq 1}}^{n} a_{ijk} V_{jk} + \sum_{\substack{k=1 \\ k\neq 1}}^{n} a_{ikj} V_{kj},$$

Where a_{ijk} is the amount of commodity i used by industry j for making a unit of commodity k.

Dividing by the total output of commodity j we obtain the general formula for technical coefficients for the whole economy:

$$a_{ij} = \frac{U_{ij} - \sum_{\substack{k=1 \\ k\neq 1}}^{n} a_{ijk} V_{jk} + \sum_{\substack{k=1 \\ k\neq 1}}^{n} a_{ikj} V_{kj},}{\sum V_{kj}} \qquad (1)$$

The CTA assumes that all commodities have the same inputs structure irrespective of the industry of fabrication.
This implies that $a_{ijk} = a_{ik}$, for all $j = 1, 2 \ldots n$.

Therefore, (1) become:

$$a_{ij} = \frac{U_{ij} - \sum_{\substack{k=1 \\ k\neq 1}}^{n} a_{ik} V_{jk} + \sum_{\substack{k=1 \\ k\neq 1}}^{n} a_{ij} V_{kj},}{\sum V_{kj}} \qquad (2)$$

Which in matrix terms is: A= (U-A Vt + A (diag Vt e) * Vt e exp -1
And operating with the above equation, it yields:
A= UV exp –T;

Remark: Technical coefficients can be negative when the total consumption of input i for the making of secondary output of industry j, according to each one of these commodity technologies, is larger than the total use of commodity i by the industry j; either for its primary or secondary products.

3.2 The Industry Technology Assumption

According to the Industry Technology Assumption (ITA), the same industry uses the same mix of inputs for all its outputs. In other words, each industry has it own input structure. To each industry we can attach a column of input coefficients that are typical of that industry. Even if the outputs mix of an industry changes, the proportions in which the inputs are used are not affected.

We have $a_{ijk}= a_{ij}$, for all k= 1, 2… n.

Hence (1) becomes into:

$$a_{ij} = \frac{U_{ij} - \sum_{\substack{k=1 \\ k\neq 1}}^{n} a_{ij} V_{jk} + \sum_{\substack{k=1 \\ k\neq 1}}^{n} a_{ik} V_{kj},}{\sum_{\substack{k\neq 1 \\ k\neq 1}} V_{kj}}$$

Which in matrix terms is: *A= (U-A (diag Ve) +A diagV) (diag Vme) exp -1* (4)
and operating properly we have *A= U (diag Vt e+ diag Ve- V) exp -1 = U (diag Vte +diag Ve – V)*[4]

---

[4] *A*= Technical coefficients matrix, *Vt*= Supply matrix, *U*= Use matrix, *e*= Column vector of ones

Since ^Ve = Ve- diag Ve and finally,

$$\tilde{\mathbf{V}} = \mathbf{V} - \hat{\mathbf{V}}.$$

Remark: Under the ITA no negative technical coefficient can be obtained in (4).

4. *Methodology*

4.1 *Commodity-by Commodity Versus Industry-by-Industry Tables*

A symmetric I-O table is one in which there are the same classifications in both rows and columns.

A commodity-by-commodity table shows which commodities are used in the production of which other commodities. The table is constructed from the Make and Use matrices. Conversely, industry-by-industry tables describe inter-industry relations. The intermediate part describes for each industry the use of products of the other industries (Eurostat, 2002). However, there is a slight bias in the literature in favour of the commodity-by commodity tables since, generally, they are more homogenous in their description of the transactions than industry-by industry tables[5].

In the GTAP framework, there is a preference for commodity-by-commodity tables.[6] Nevertheless, commodity-by-commodity tables require labour intensive compilation tasks, they must be based on analytical assumptions that take final results away from actual market transactions and observations, and hence they make more difficult the integration of other statistical sources and the reporting on the transformation procedure. Thus, in this exercise, we will convert the original 1998 Input-Output table for Cote d'Ivoire into a symmetric commodity-by-commodity I-O table.

4.2 *Derivation of SIOTs for Cote d'Ivoire*

The commodity technology assumption is considered theoretically superior (Kop Jansen and Ten Raa, 1990; Konijn, 1994; Rainer, 1989; Mattey and Ten Raa, 1997; Ten Raa and Rueda Cantuche, 2003), but agreement is not uniform. For instance, Mesnard (2002) stated that the commodity technology assumption has to be rejected since it breaks the linkages of commodity

---

Note: *t* will denote transposition and *exp -1* inversion of a matrix. Since the two operations commute, their composition may be denoted – *t*. Also, *diag* will denote diagonalization whether by suppression of the off-diagonal elements of a square matrix or by placement of the elements of a vector.

[5] Rueda, C., José M., Beutel, J., Neuwahl, F. (2007): A symmetric I-O table for EU 27. pp5

[6] Karen, H.; Robert Mc Dougall, and Terrie, W., (2000) Contributing I-O tables to the GTAP Data Base, pp 2.

flows internal to the industries. No information is available to determine which industry supplies a positive variation in final demand of a particular commodity.

In addition, automatic mathematical derivation in the CTA sometimes produces negative technical coefficients. Thus, in this exercise we will use the **Industry technology assumption** to derive the SIOT for Cote d'Ivoire. The ITA satisfies the Leontief material balance that the total output equals the product of Input-output coefficients and total output plus the final demand.

4.3 Application

We will use the Industry Technology assumption throughout this section.
According to the ITA each industry has its own specific way of production, irrespective of its product mix.

The application of this assumption to the Supply and Use table for Ivorian 199 Input Output table is can be explained by a transformation process.
No negatives arise in this case since the amounts transferred are never larger than the amounts available in the columns of the industries.

References

Almon, C. (2000) Product-to-product tables via product-technology with no negative flows, *Economic Systems Research*, 12, pp. 27-43.

Almon, C. (1970) "Investment in Input-Output models and the treatment of secondary products", in A. P Carter and A Brôdy, eds, *Applications of input-output analysis, Amsterdam*, Noth-Holland.

Armstrong, A. G. (1975) "Technology assumptions in the construction of United Kingdom Input-Output tables" in R. I. G Allen and W.F Gossling, eds, *Estimating and updating input-output coefficients*, London, Input-Output Publishing Co.

Braibant, M. (2002) Transformation of supply and use tables to symmetric input-output tables, Paper presented at the *XIVth International Conference on Input-Output Techniques*, Montréal, Canada.

Eurostat (2002): *The ESA-95 Input-Output Manual. Compilation and Analysis*. Luxembourg: Eurostat.

Guo, J., Lawson, A. and Planting, M. (2002) From make-use to symmetric I-O tables: an assessment of alternative technology assumptions, *Working Paper WP2002- 03*, Bureau of Economic Analysis, U.S Department of Commerce, Washington, DC.

Harthoorn, R. and van Dalen, J. (1987): "On the Adjustment of Tables with Lagrange Multipliers," in: National Accounts Occasional Papers, Nr. NA-024, Netherlands Central Bureau of Statistics. Voorburg.

Konijn, P. and Steenge, A.E. (1995) Compilation of input-output data from the National Accounts, *Economic Systems Research*, 7, pp. 31-45.

Kop Jansen, P. S.M. and ten Raa, T. (1990): "The Choice of Model in the Construction of Input-Output coefficients Matrices," *International Economic Review*, 31, pp. 213-227.

Kuroda, M. (1988): "A Method of Estimation for the Updating Transaction Matrix in the Input-Output Relationship", in: Uno, K. and Shishido, S. (Eds): *Statistical Data Bank Systems*. Amsterdam.

Rueda-Cantuche, J.M. (2007): *Stochastic Input-Output Analysis Applied to the Andalusian Economy*, Seville: Regional Statistical Office (Institute of Statistics of Andalusia)

Stone, R. (1961): *Input-Output and National Accounts*, Paris: OECD.

Ten Raa, T. and Rueda-Cantuche, J.M. (2003): "The Construction of Input-Output Coefficients Matrices in an Axiomatic Context: Some Further Considerations," *Economic Systems Research*, 15, pp. 439-455.

Ten Raa, T. and Rueda-Cantuche, J.M. (2007): "Stochastic Analysis of Input-Output Multipliers on the basis of Use and Make Matrices", *Review of Income and Wealth*, 53 (2), forthcoming.

Ten Raa, T. and Wolf, E. (2000): "Engines of Growth in the US Economy," *Structural Change and Economic Dynamics*, 11, pp. 473-489.

Ten Raa, T. and Wolf, E. (2001): "Outsourcing of Services and the Productivity Recovery in US Manufacturing in the 1980s and 1990s," *Journal of Productivity Analysis*, 16, pp. 149-165.