2 Commodity and sector classifications in linked systems of national accounts

Introduction

Professor Stone conceived 'A System of National Accounts', which was authorized by the United Nations in 1968. Traditional accounting is by means of so-called T-tables, one for each account. Professor Stone's device of matrix accounting is ingenious. Instead of a T-table, an account is a pair of a row and a column (with the same index). With T-tables it is cumbersome to locate the debit and the credit entries of a single transaction; with a matrix of accounts it is automatic. Matrix accounting employs the consistency of a system of accounts: a transaction has the same debit and credit values. T-tables need not be consistent. A seller and a buyer may report a transaction differently. In matrix accounting one must decide on a common value. This problem emerges in a well-known form: matrix accounts must be balanced. Professor Stone has not only recognized the consistency requirements of a matrix system of accounts, but also offered a scientific resolution (Stone 1984 and the references given there).

Professor Stone's contributions are relatively timeless. It is only now that his system of national accounts has been revised. The revised System of National Accounts (see United Nations 1992) will be published by the United Nations in December 1993. Even more striking is the substance of the revision. The first paragraph of Annex II ('Changes from the 1968 SNA') speaks for itself:

> The revised System of National Accounts, (revised SNA), retains the basic theoretical framework of its predecessor A System of National Accounts (1968 SNA). However, in line with the mandate of the United Nationals Statistical Commission, it contains clarifications and justifications of the concepts presented, it is harmonized with other related statistical systems and it introduces a number of features that reflect new analytical and policy concerns of countries and international organizations.

The System of National Accounts is so stable because of its flexibility. Classification problems can be accommodated by introducing separate accounts. The prime example of this flexibility is Professor Stone's resolution of classification problems called for by input–output (I–O) analysis. Professor Leontief's transactions table of the sectors of the American economy and his inversion constitute the first application of general equilibrium analysis. The power of his analysis has a price: it is rigid. The concept of a sector consolidates a commodity and an activity. In practice it is difficult to classify enterprises in this sectoral framework. The US Bureau of Economic Analysis juggles with the so-called transfer method in order to produce a transactions table. Professor Stone simply enters separate accounts for separate items, such as commodities and activities. A clean collection and organization of statistics is facilitated and manipulations are relegated to where they belong: the economic analysis.

The revised System of National Accounts (United Nations 1992, ch. II, pp. 11 and 12) proposes that commodities and activities are classified according to the Central Product Classification and the International Standard Industrial Classification of All Economic Activities, respectively. Classification problems persist. Modern establishments engage in a multitude of activities. Moreover, the specification of the latter hinges on primary output which cannot always be identified. In this chapter, I wish to point out that Professor Stone's system is so flexible that a standard classification is not required. I will investigate some traditional economic problems, the determination of productivity, competitiveness and comparative advantages, and show how they can be analysed in the framework of a System of National Accounts with different establishments classification across countries.

The measurement of sectoral productivity rates

Productivity is the ratio of output to input. For a national economy, output comprises commodities and input comprises capital and labour. We need prices to measure output and input. The appropriate numerical values will be determined in the next section. As regards notation, commodity prices are listed in a row vector, p, and the prices of capital and labour are denoted r and w, respectively. Then productivity is $py/(rM + wN)$ where y is the net output commodity vector of the economy and M and N are capital and labour inputs. If the commodity prices coincide with production costs, then productivity equals one by the equality of the national product (py) and income $(rM+wN)$. The formula becomes more interesting when it is used to account for the growth of productivity. The weights are held constant and factor productivity growth becomes the growth rate of the numerator, $p\,\mathrm{d}y/(py)$, minus the growth rate of the denominator, $(r\,\mathrm{d}M + w\,\mathrm{d}N)/(rM + wN)$. In short, total factor productivity growth equals

$$\rho = \frac{p\,\mathrm{d}y - r\,\mathrm{d}M - w\,\mathrm{d}N}{py}$$

where we invoked the national income identity.

A sectoral decomposition of total factor productivity growth using the System of National Accounts is as follows. Let the use and make tables be U and V. The commodity inputs and outputs of sector j are in column j and row j of U and V, respectively. $(V^{\mathrm{T}} - U)$ is the net output vector of sector j. Let the sectoral employment row vectors be K and L, respectively. Then $y = (V^{\mathrm{T}} - U)e$, $M = Ke$ and $N = Le$, where e is the summation vector (all entries are equal to one). Substitution yields

$$\rho = \frac{[p\,\mathrm{d}(V^{\mathrm{T}} - U) - r\,\mathrm{d}K - w\,\mathrm{d}L]e}{py}$$

$$= \sum_j \frac{p\,\mathrm{d}(V^{\mathrm{T}} - U)e_j - r\,\mathrm{d}K_j - w\,\mathrm{d}L_j}{py}.$$

The numerator is a sum of sectoral terms and each term denotes the growth of real value added per factor input. (The weights are still p, r and w.) Note that this decomposition of total factor productivity growth does not require that the number of sectors is equal to the number of commodities.

Intuitively, a great sectoral contribution to total factor productivity growth signals greater strength of the sector, a greater likelihood that a comparative advantage resides in this sector. Comparative advantages can be determined by a model of free trade between at least two economies. For a number of reasons such a model requires that there is a unique classification of commodities, common to both economies. First and foremost, total net exports are zero for each commodity and this fact can be used to balance the accounts and to specify a model of trade with sensible feasibility constraints only if net exports can be summed on a commodity by commodity basis. The United Nations Statistical Commission recommends the Central Product Classification (CPC). The aggregation level can be selected by choice of digit level (1–5).

A sector is a segment of the economy where factor and commodity inputs are transformed into outputs. The statistical unit is the establishment. Ideally a unit engages in only one productive activity at a single location. A number of complications seems to plague the System of National Accounts. First, reporting units may be large and, therefore, engage in more activities. The System of National Accounts distinguishes primary and secondary activities and recommends separation of the latter. Second, productive activities may include more than a single product. The System of National Account notes that in practice, by-products are treated in the same way as secondary products, the products of secondary activities. Third, how to group statistical units. The System of National Accounts recommends to identify a principal activity on the basis of value added and to group establishments that have the same principal activity in industries according to the International Standard Industrial Classification (United Nations 1992, ch. XI, p. 4 and ch. II, p. 11). It acknowledges that this procedure does not eliminate secondary activities, but outlines in great detail how the use and make tables can be converted into product-by-product I–O tables (ch. XV, pp. 33–45).

In many cases there is no need to relate the sectoral classification to the product classification. An example is the above-mentioned decomposition of total factor productive growth. The decomposition is by direct application on the use and make tables, without invoking the usual I–O coefficients table. Not only is there no need to reconcile sectoral classification with the CPC, but it is not even necessary to have a unique classification of sectors. International comparisons and trade studies are perfectly feasible when reporting units accommodate country-specific sectors. The need to classify statistical units by primary activity and the practice to separate secondary activities stem from the imposition of the International Standard Industrial Classification. If productive activities are not only specified by their inputs and outputs but also by location, why group them according to primary activities by ISIC? It is in the spirit of I–O analysis where commodities, activities and industries are conveniently identified by means of the concept of a sector, but there are no analytical requirements on the international comparability of industries.

The location of comparative advantages

The extension of productivity analysis to the location of comparative advantages may illustrate my point. $\mathbf{U}$ and $\mathbf{V}$ are the use and make tables of the home country. $\mathbf{K}$ and $\mathbf{L}$ are the sectoral factor employment row vectors with totals $\mathbf{M}$ and $\mathbf{N}$. Introduce a foreign country, with accounts given by U, V, K and L (and totals M and N). The commodity classification is the same, but the sectoral classification may be different. $\mathbf{U}$ and U have the same row dimensions, but the column dimensions differ. For $\mathbf{V}$ and V it is the other way round. $\mathbf{K}$ and K have different dimensions as have $\mathbf{L}$ and L. The net output vectors $\mathbf{y} = (\mathbf{V}^{\mathrm{T}} - \mathbf{U})\mathbf{e}$ and $y = (V^{\mathrm{T}} - U)e$ reside in the common commodity space ($\mathbf{e}$ and e have all entries equal to one but are of different dimensions). Net output consists of domestic final demand, $\mathbf{f}$, and net exports, $\mathbf{g}$: $\mathbf{y} = \mathbf{f} + \mathbf{g}$ and $y = f + g$. In a two-country model, $\mathbf{g} + g = 0$, since the net exports of one country are the net imports of the other. If $\mathbf{p}$ is the row vector of terms of trade, then $\mathbf{pg}$ is the trade surplus of the home country or the deficit of the foreign. To locate the comparative advantages, let us determine the re-allocation of activity prompted by competitive markets, including free trade. I make the conservative assumption that the economic agents want to stick to the observed domestic final demand proportions. If this assumption is dropped, further reallocations would take place. In other words, we will condition the comparative advantages on the observed patterns of domestic final demand. I also make the conservative assumption that no substitution takes place within sectors. (I consider them ideal statistical units in the sense of the System of National Accounts (United Nations 1992, ch. II, p. 11). It is consistent with the country-specific classification of activities. If the assumption is not fulfilled, further reallocation effects are to be expected.)

Invoking the relationship between general equilibrium and Pareto optimality, the allocation of activity under free trade can be determined by the maximization of the domestic final demand level subject to a foreign final demand level, the material balance for the commodities and the factor input constraints:

$$\max_{\mathbf{s},\mathbf{c},s} \mathbf{c} \text{ subject to}$$

$$(\mathbf{V}^{\mathrm{T}} - \mathbf{U})\mathbf{s} + (V^{\mathrm{T}} - U)s \geq \mathbf{fc} + fc$$

$$\mathbf{Ks} \leq \mathbf{M}, \quad Ks \leq M, \quad \mathbf{Ls} \leq \mathbf{N}, \quad Ls \leq N, \quad \mathbf{s} \geq 0, \quad s \geq 0.$$

The commodity accounts are pooled and the factor input accounts are separate, assuming mobility of the former and immobility of the latter. These specifications can be altered in accordance with the facts. In general, mobile inputs have pooled balances and immobile inputs have separate balances. Now let us consider the distribution of final demand. The bigger the foreign level of final demand, c, the smaller the domestic level of final demand, $\mathbf{c}$. The allocations of activity under free trade are determined by $\mathbf{s}$ and s. Net exports are the difference between net output and domestic final demand: $(\mathbf{V}^{\mathrm{T}} - \mathbf{U})\mathbf{s} - \mathbf{fc}$ for the home country and $(V^{\mathrm{T}} - U)s - fc$ for the foreign country. In the solution, the material balance will be binding and the net exports vectors are opposite. Its value is the deficit. The deficit of the home economy is a monotonic function of parameter c, the foreign consumption level. Equation with the observed deficit fixes the value of this parameter. The consequent net exports vector determines the pattern of free trade and locates the comparative advantages on a commodity basis. The underlying activity vectors, $\mathbf{s}$ and s, identify the competitive sectors. If a sectoral component exceeds unity, that sector would expand under competitive conditions.

The relationship with factor productivities is established by the shadow prices to the constraint of the maximization program. Active sectors break even and inactive sectors are unprofitable. Consequently the ratios of value added and factor costs are one and smaller than one, respectively. For the national economies, factor productivities are $\mathbf{r}$ per unit of capital and $\mathbf{w}$ per worker and their rates of change $\dot{\mathbf{r}}$ and $\dot{\mathbf{w}}$. Total factor productivity growth is obtained by weighting by the factor input stocks and the result coincides with the traditional total factor productivity growth expression, ρ, by differentiation of the main theorem of linear programming. It is the values of these shadow prices that ought to be used in the total factor productivity growth measure.

Hallmarks of economic analysis, measurement of productivity, allocation of comparative advantages, identification of competitive sectors can be based on a System of National Accounts without a standard industrial classification. International sectoral comparisons can be made in terms of productivity, but do no hinge on a common classification scheme. Consider, for example, the question if agriculture is more efficient at home than abroad. Typically, agriculture is classified as the first sector. One might compare $\mathbf{s}_1$ and s_1 in the solutions to the above-mentioned program. One might also evaluate the value added/factor costs ratios of the sectors. But strictly speaking the issue of efficient agriculture boils down to the question which sector produces those commodities and there is no reason to limit the candidate sectors to the first ones of the respective economies. It is conceivable that the products will be produced as secondary output of some other sectors. The very industrial organization or products, as determined by the make table, may in one country be different and possibly more efficient than in another.

Once it is fully recognized that activities are location specific, the identification of sectors across countries becomes redundant. A more formal approach is given by a simple rewrite of the constraints of this model. The material balance reads

$$\left(\begin{bmatrix}\mathbf{V}\\ V\end{bmatrix}^{\mathrm{T}} - (\mathbf{U}\; U)\right)\begin{pmatrix}\mathbf{s}\\ s\end{pmatrix} \leq \mathbf{fc} + fc$$

and the factor constraints are

$$\begin{pmatrix}\mathbf{K} & 0\\ 0 & K\\ \mathbf{L} & 0\\ 0 & L\end{pmatrix}\begin{pmatrix}\mathbf{s}\\ s\end{pmatrix} \leq \begin{pmatrix}\mathbf{M}\\ M\\ \mathbf{N}\\ N\end{pmatrix}.$$

The tables can be conceived as a system of world accounts in which activities remain reported separately when they take place at different locations. For example, the world-use table, $(\mathbf{U}\; U)$, has a row for each commodity and a column for each national sector. The sectors are simply stacked next to each other and there is no need to have equal numbers of them in the different countries, let alone a standard classification.

Conclusion

A standard industrial classification is of course a useful device to organize enterprise data in a system of national accounts. But, unlike the classification of commodities, there is no economic analytical requirement for uniformity across national economies. Moreover, since the industrial classification is independent of the commodity classification anyway, it may be refined to accommodate enterprise data which otherwise are difficult to classify. In other words, the national sectoral classification may reflect the industrial organization of its economic activities. The classification of commodities must be as disaggregated as possible, uniformity across national accounts.

References

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