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QUANTITATIVE TECHNIQUES FOR RURAL DEVELOPMENT, WITH PARTICULAR REFERENCE TO INPUT-OUTPUT ANALYSIS

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Abstract:
The well-known instrument of input-output analysis is rediscussed. Thomson argues that it is a powerful tool to come at grips with both the essence and the impact of endogenous development patterns in rural areas.

Keywords:
GREAT BRITAIN, QUANTITATIVE ANALYSIS, RURAL DEVELOPMENT, INPUT-OUTPUT ANALYSIS, ECONOMIC ANALYSIS, AGRICULTURAL ECONOMICS.

Introduction

The great nineteenth-century physicist Lord Kelvin said, in effect, that if something cannot be measured, it cannot be understood. Whether this dictum applies as much to the social as to the natural sciences might be debated at length, but it can certainly be argued that in applied policy discussions (as opposed to academic conceptualisation) numbers speak louder than words. It is only by defining classifications and relationships in rigorous terms that public intervention can be properly articulated, operated and assessed.

This paper discusses rather briefly some general aspects of quantitative techniques for the economic analysis of development, before describing in more detail the well-known input-output method of regional economic analysis, with some results from certain Scottish applications.

Three criteria may be suggested when considering quantitative techniques for use in economic analysis. The first is the *degree of correspondence* between reality and the theoretical assumptions embodied in the mathematical relationships employed. Of course, in order to apply this criterion, reality in terms of the behaviour of individuals and socio-economic groups concerned must be `known'. There is often plenty of scope for ignorance or disagreement here, especially in areas little studied for their remoteness or difficulty. An exact fit between theory and reality cannot be expected in any case, but an understanding of the ways in which the results may mislead should be present.

In the present context, general concern might be felt in two main aspects. First, the standard market-clearing equilibrium of neoclassical economic analysis may be a poor

representation of agricultural and rural structures undergoing long-term pressures and change. In such circumstances, a persistent degree of disequilibrium in resource markets (land, labour, etc.) might be expected, although this raises serious theoretical and modelling problems. Second, previous empirical analysis may have been carried out in a different context from the one currently under study, so that relationships previously established may no longer apply. For example, a period of agricultural expansion may be ending, or a new product or economic activity may be previously unknown in the rural area concerned. Clearly, whether known behaviour is reversible, or how novel components of the rural economy will relate to traditional structures, are issues of concern.

A second criterion for quantitative analysis is the *practicality* of the technique. A highly sophisticated method for which data do not exist, or are (or will be) seriously outdated, is almost useless in practice (though it may suggest variables and behaviour of potential interest). Computational methods have progressed very much in recent years, indeed to the extent that a more relevant consideration is likely to be the professional capabilities and knowledge of the analysts themselves. Where familiarity with local and industrial conditions is also considered important, a real dilemma faces the management of relevant research and some compromises may be required.

Thirdly, the *purpose* of the quantitative approach needs to be considered. For whom is the analysis being carried out - local people, fellow economists, policy administrators, and/or national politicians, for example? Different audiences will have different priorities and levels of appreciation, and a simple technique may carry more conviction than a sophisticated one, especially if the bald numbers can be embellished with sound descriptive text. After all, in a decision-making context (which is not the only one conceivable, but has particular relevance in the present context), the informational content of the results rather than the mere accumulation of `knowledge' is what matters. Thus it is important, for example, whether the object of the exercise is to select particular areas for attention, to think up new policy instruments, or to assess the effectiveness of existing ones. It is unlikely that the same quantitative tool can be equally useful in all three of these tasks.

The `success' or failure' of rural development can be judged, at least from one point of view, in terms of the degree to which changes to, or stimulations of, specific production enterprises in the rural area(s) targeted have substantial positive backward and forward (upstream/downstream) effects in those rural areas, or, on the contrary, exhibit a high degree of `leakage' to other areas, with little local impact.

Input-Output Analysis

A standard econometric tool for intersectoral investigations is input-output (IO) analysis (Leontief 1966; O'Connor and Henry 1975). From its early days, the technique promised an operational general-equilibrium model of an economy, and since then it has so grown in importance that official IO tables are produced in several countries,

based on a Standard Industrial Classification (SIC) of sectors. These tables can be regarded as an elaboration of the national economic accounts, and, used as the basis for IO analysis, offer one route to simulation modelling of alternative economic situations, alongside (say) estimated Keynesian or Harrod-Domar econometric models.

The IO technique is well known, and will not be detailed here. Briefly, the IO table contains the financial flows of sales and purchases between different sectors of the economy (including, where appropriate, household and government consumption and import/export vectors) for a base year (usually several years in arrears, due to complexities of data collection and collation). The `upstream' linkages of final expenditure in one sector can therefore be traced back through the different sectors as raw materials, services, labour, etc. are required to produce, first the commodity concerned, and then successively the intermediate products required in its manufacture, the production of those intermediates themselves, and so on. Mathematical matrix inversion accomplishes the calculation of the total `multiplier' effect in one step, and produces multiplier coefficients, representing the average amount of economic activity associated upstream with unit expenditure, for each sector. With the (heroic) assumption of linearity in the underlying production functions, the leap can be made to using these coefficients as the predictions of the overall economic effects of an additional unit of expenditure. A common extension from the expenditure multipliers is to employment and income multipliers, so as to assess the relative significance at the economy-wide scale of various sectoral activities.

The long-term significance of regional economics in large countries led to the development of regional input-output models from the early 1950s (Isard 1951; Richardson 1972), but for several decades most of this work concerned either the application of the IO method to a single geographical region, or represented a locational elaboration of the single national model by means of multi-regional (or interregional) analysis. In the single-region case, with the need to reduce the rest of the economy (and world) to a single external vector, the general-equilibrium nature of the model is lost, while to build IO tables for several regions is a daunting task, especially if as is often the case with regional analysis, the focus of the model-builders is on a particular region.

For good statistical reasons, general regional economists have normally adopted an administrative division of the national economy, with each region centred on one or more large settlements containing higher-order service providers such as government offices, long-distance transport and advanced social services, and often with large-scale industrial plants requiring special statistical and IO treatment due to their monolithic structure. Such an approach is understandable, and possibly the only suitable method for certain policy purposes, but it clearly does not fit well the agricultural and rural approach, where there are obvious difficulties in defining rural areas, especially where economic activity is relatively intense, as in urban fringes and in leisure areas. In such work, a mixture of reliance on the SIC (some industries, such as farming and forestry, being regarded as rural by definition) and detailed survey fieldwork, must be resorted to.

A number of attempts have been made to apply IO techniques to agriculture, forestry and the rural economy generally. Midmore (1991) has edited a useful compendium of agricultural IO studies, pointing out (p.1) that "in contrast to most other activities, a large proportion of its revenue is accounted for by purchases of materials and services from other industries, and also a large proportion of its output is sold to processing industries before passing to final consumers".

In fact, about 43 per cent of the value of final agricultural production (FAP) of EC-12 agriculture is accounted for by consumption of inputs (the remainder being gross value added), but the recorded range of variation is high (CEC 1992). Amongst member states, Belgium, Germany, Portugal and the United Kingdom show input shares of FAP of over 50 per cent, while in Greece and Italy purchased inputs account for less than 30 per cent of FAP. The largest item of purchased inputs is feed (about 40 per cent of total costs at EC level), with fertilisers, energy, upkeep and repairs of farm implements, and services (such as veterinary provision) each accounting for a further 10 per cent or so. However, these shares also vary considerably from country to country, with the Netherlands showing feed as nearly 57 per cent of the total, while in Greece the figure is only half that, with fuel and implement costs each accounting for around 20 per cent.

Many of these national differences are of course accounted for by the dissimilar patterns of commodity enterprises from country to country (it is well known that, say, upland grazing animals can require fewer purchased resources than horticultural crops), and by differences in production techniques. Little pattern is discernible in the purchasing patterns over time (at least since 1985); overall, and perhaps rather surprisingly, the significance of intermediate farm `consumption' has grown in line with production, though greater growth and variation is notable in the three newer member states, perhaps as their agricultural sectors modernise towards the more intensive and heavily capitalised northern pattern.

In any case, these data serve to indicate that the upstream linkages of agriculture are liable to be complicated, partly since some animal feed is purchased from other farms, either locally or from elsewhere in the country, while the rest is imported or manufactured (mainly from farm products or by-products) as compound feeds. Again, in the livestock sector, quite complex flows of young and old animals between different farm sectors are common, with associated problems of seasonal variation and year-to-year stockholding. In standard IO work, these interfarm transactions will be `netted out' in the analysis, thus losing some of the main endogenous features of interest. Downstream, the pattern of sales of farm produce will vary, but it will often be the case that the farm commodity is taken from the farm to a centralised storage or processing unit, there to be transformed in time and space to a very wide set of uses.

Combining agricultural and regional interests, Leat and Chalmers (Midmore 1991, Chapter 6) have attempted to apply IO techniques to the north-east region of Grampian in Scotland. This is a mixed lowland/upland area, with a substantial farming and agribusiness industry in the hinterland, alongside traditional provincial settlement

activities and in recent years a prosperous oil sector based on Aberdeen. They defined 9 crop and livestock activities, 8 agriculture-related sectors (milk processing, distilling, etc.) and a further `other' sector, and used farm survey data (as collected for the EC's FADN/RICA system) to determine purchasing patterns and hence the IO coefficients. In some versions of their work, rural Grampian (i.e. the complete administrative region minus the local capital city of Aberdeen) was used as the `economy' under study. Table 1 gives some typical data and results coefficients from this work.

Leat and Chalmers's multiplier analysis indicated that reductions in agricultural output resulting from adjustment to the Common Policy would result in significant local effects, for example that for each farm job lost, approximately one off-farm job would also disappear. Estimates of the effects of milk quotas and set-aside were provided. However, local development might be sustained if raw materials for the processing industries could be obtained from elsewhere (albeit at the cost of processing employment in other regions), while a 10 per cent expansion in rural tourism in Grampian would offset a substantial proportion of threatened farm employment.

IO analysis is currently being applied to forestry in Scotland and Ireland (Psaltopoulos and Thomson 1992), and to avoid prematurity and pre-emption the results so far will not be reported here. However, the research employs the Generating Regional Input-Output Technique (GRIT) first developed in Australia (Jensen *et al.* 1979) to modify the national IO table of coefficients to (hopefully) more accurate regional ones, in order to avoid the costs of primary data collection or analysis. Forestry IO throws up some peculiar problems, some of which are also evident in the work of McGregor and McNicoll (1989). In particular, `input' and `output' are so separated in time that the usual linkages are irrelevant for most analytic purposes. Rather, timber harvesting is normally *followed* by planting; and there are a number of important non-timber aspects (water collection, leisure, game shooting) of forests which may be of interest.

Further, although government may be as deeply involved in forestry as in agriculture, public intervention in forestry often operates in a completely different way (e.g. tax regimes, fire-fighting services, public plantations) than is found for agriculture. Similarly, private forest enterprise is often larger-scale and more remote than is found in many agricultural subsectors. All these differences affect the objectives to which a completed IO table may be applied, and the way this is carried out. For example, McGregor and McNicoll (1988) analyse the impact of joint investment in afforestation and wood-processing plant, rather than simply planting, since (in Scotland at least) the viability of two large-scale investments is at stake.

Implications for Endogenous Rural Development

The material above offers a number of insights into the potential of IO analysis as a useful tool for analysing the economic effects of rural development possibilities, especially those involving the use of land. First, it offers a `macroeconomic' framework for conducting such research. Although the SIC framework used for national accounting

purposes may not be ideal for the purpose (in particular, the vital tourism component of rural development is difficult to tackle in this way), it does offer comparability with national statistics and parameter estimates from other studies, and can perhaps be adapted to be more suitable, for example by dividing some or all sectors by endogenous and exogenous control or ownership.

Second, it focuses attention not only on the primary locus of change (e.g. the construction of a small factory in a rural town, or the development of a local leisure specialty such as water sports, golf or game shooting), but also on the linkages to other local enterprises. The overall success of a rural development may be as much dependent on the `endogeneity' of upstream and downstream sectors in offering repair facilities, accommodation, and `by-services' such as tourist visits to local factories, as it is on the viability of the initial impetus.

In turn, this raises the issue of appropriate `regions' for rural development analysis. It is an unfortunate fact of life that administrative regions almost invariably contain a sizable centre of population which detracts from the `rurality' of the region as a whole. Indeed, it might be said that the standard local government regions are almost completely the wrong set of boundaries for the present purposes. Without very detailed statistical data, or primary data collection, little can perhaps be done about this, except to caution that, once conclusions about a particular standard region have been reached, further thought should be given to the local geography of the implications drawn.

Third, input-output analysis goes beyond the usual one-dimensional range of statistics required to establish eligibility priorities for regional rural assistance (CEC 1988; Copus and Leat 1992) by seeking to measure the regional economy as a whole. In this way, it may suggest multi-sectoral development of a kind directed to maximise total local impact, i.e. development which is integrated from the point of view of its net economic effect rather than its administrative character.

None of the above seeks to downgrade the importance of other aspects of endogenous rural development, for example stimulating local enterprise, encouraging the marketing of regional specialities and assisting local organisations to overcome the often difficult problems of local monopolies and traditional habits. There is also the general point that development, as a dynamic process, deserves an analytic technique that pays due attention to behaviour over time, especially technical change, than is normally incorporated. However, even if carried out at a simple level, input-output analysis may offer a practical and semi-standardised technique for carrying out some of the quantitative economic analysis involved.

Table 1. Rural Employment, Grampian Region, Scotland, 1986

	Share[1]	Change[2]	Quotient[3]
Government	17.3	1.4	1.088
Retailing	8.9	24	0.949
Construction	8.4	-17.9	1.27
Agriculture	8.3	-13.7	2.421
Social/Personal Services	7.3	16.2	1.326
Cotels, Catering, etc.	6.3	10.2	0.935
...			
Food Processing	4.1	131.2	1.288
Fishing	3.4	-0.2	2.34
Forestry	1.1	23.9	2.471

Source: Brown and Leat, *Developing Grampian and its Rural* Economy, Scottish Agricultural College, Aberdeen, 1988.

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