THE EMPIRICAL IDENTIFICATION OF KEY SECTORS IN AN ECONOMY: A REGIONAL PERSPECTIVE

GEOFFREY J. D. HEWINGS

I. INTRODUCTION

MANY OF the methods employed in regional economic analysis were first developed for use in national and international analysis. Another major source of regional methodological inspiration may be traced to the literature on the economics of developing countries since these economies, like their regional counterparts, are characterized by a marked degree of openness. In the context of the national economic development literature, the notion of key or critical sectors has become an accepted component of development strategy. The transportation of this idea to regional economic development was seen to be consistent with the theoretical exposition of regional development strategies associated with growth center hypotheses. In recent years, a number of attempts have been made to identify key sectors at the regional level: this paper will attempt to review and evaluate these contributions in the light of their utility in the planning and analysis process.

The paper will begin with a review of the key sector identification problem and report on problems of application at the regional and developing country scale. Following this review, some alternative procedures will be presented, drawing on work undertaken at the regional level. Finally, some implications of the procedures used to date will be reviewed with reference to further sharing of insights from the two scales of analysis (regional and national). Furthermore, as increasing attention appears to be directed toward regional problems *within* developing economies, the experience of the developed world may prove of value in an examination of the issues and the context in which they are to be evaluated.

II. THE IDENTIFICATION PROBLEM: KEY SECTOR INDICES

No matter what method or set of methods that is used in the identification of key sectors, the central issue involves the explicit determination of sectors which are assumed to exercise, through backward and forward linkages, a "greater than average" impact upon an economy. Since the term "key sector" implies selection from a set of sectors, the most appropriate accounting device available with the requisite amount of detail would appear to be the input-output model. The se-

This paper was written while the author was a visiting scholar in the Department of Economics, University of Queensland, Australia.

lection of this model has, at one and the same time, created many obvious advantages for ease of identification and, unfortunately, it has also tended to foster a myopic perspective which may be characterized as one of technological orientation to the exclusion of other perspectives.

The initial conceptual developments may be traced to the work of Rasmussen [54] and Hirschman [34]. Rasmussen suggested the use of two indices, the *power of dispersion* and the *sensitivity of dispersion*: these indices have now become generally accepted techniques of key sector identification (see [37]). If we define b_{ij} as a typical element of the Leontief inverse matrix, B; $B_{.j}$ and $B_{i.}$ as typical column and row sums of the matrix and $\bar{B}$ as an average, unweighted value of an element in the inverse matrix, then the indices may be developed as follows:

Power of dispersion: $U_j = [B_{.j}/n]/\bar{B}$,

Sensitivity of dispersion: $U_i = [B_{i.}/n]/\bar{B}$,

where n is the number of sectors in the economy. Hence U_j or $U_i > 1$ implies that the average value in the column j or row i of the inverse matrix is greater than the average value in the matrix as a whole. A unit change in final demand in a sector where $U_j > 1$ will thus generate an above average increase in activity in the economy while a change in final demand in all sectors will generate an above average increase in sector i's output if $U_i > 1$.

III. MODIFICATION AND CRITICISMS OF THE INDICES

A. *Unequal Variation Problem*

A number of authors have claimed that the averaging procedure developed by Rasmussen ignores the possibility of unequal variation within sectors. Hazari [25], for one, proposed the use of the coefficient of variation as an alternative: in analogous fashion to Rasmussen's indices, these are defined as:

$$V_j = \sigma_j / \bar{b}_j,$$

$$V_i = \sigma_i / \bar{b}_i,$$

where σ_j and σ_i are the standard deviations of the column entries in j and the row entries in i. The denominators, $\bar{b}_j$ and $\bar{b}_i$ are the column and row means.

However, Beyers [9] has claimed that Rasmussen's power of dispersion index should not be calculated using the row sums of the Leontief inverse matrix since, in effect, one is measuring forward linkages on the strength of backward linkage coefficients. Using some ideas advanced by Augustinovics [2], Beyers proposed that a new inverse be calculated, $[I-S]^{-1}$ where S represents the sales matrix, a typical element of which, S_{ij}, would indicate the sales made by industry i to industry j per unit of sales of industry i. Hence, U_i and V_i would be calculated from this inverse matrix in analogous fashion to the earlier procedures.

B. *Relationship to Policy Objectives*

Even utilizing the improvement suggested by Beyers [9], there remains a fundamental problem with the strictly technological identification process discussed thus far, namely, that it is totally divorced from any goals articulated for either the regional or national economy. Hazari [25] clearly recognized this and suggested that key sector identification should be explicitly related to what he referred to as a policymakers' preference function. At the national level, Hazari claimed that this function could be mapped into the final demand sectors such that the following indices could be developed:

$$\lambda_j = b_{.j} \cdot W_j,$$
$$\lambda_i = b_{i.} \cdot W_i,$$

where $W_i = Y_i / \Sigma_i Y_i$ and Y is the final demand in sector i. The summation down the columns of the Leontief inverse provides a familiar measure, the sectoral gross output multiplier. Summation across the row of the inverse provides a measure of the direct and indirect output required from sector i to meet a unit change in all other sectors. Since these summations take no account of the magnitude of deliveries to final demand, a simple weighting scheme was applied in which the indices were weighted by the proportion of final demand generated by sector i or j.

However, as a number of authors have pointed out, the weighting scheme chosen may be regarded as arbitrary (see [13] [21] [28] [39] [40] [41]). The arbitrariness derives from two issues: (1) the weights chosen are usually elements of the final demand vector and, hence, represent a choice reflecting distribution at one point in time rather than some normative distribution desired in a target year and (2) since most regions and countries typically prepare multiobjective plans, a much more sophisticated weighting scheme would be required than one based on the relative contribution of each sector to total final demand. In essence, one is suggesting that there is not a simple mapping from the final demand vector to the policymakers' preference function. In the first place, final demand is not an homogeneous category whose impact on the economy can be measured as a simple function of the relative magnitude of sectoral sales to final demand. Secondly, since the components of regional final demand contain categories like household expenditure, state and local government expenditures, interregional and foreign exports and investment, it is highly unlikely that the links between an individual industry and the components of final demand will be identical across these components.

Using the weighting scheme suggested by Hazari [25], key sectors were identified for the Washington State (U.S.) economy for 1963 for total final demand and its components. According to the scheme adopted, twenty-two sectors (of the fifty-two) were identified as key sectors when the disaggregated components of final demand were used as weights. However, only two sectors appeared key in four of the seven categories of final demand. The results of this analysis cast serious doubt on the efficacy of the weighting schemes proposed by Hazari [25] and later by Laumas [40].

Diamond's work [21] in this regard is illuminating. Using Turkey as a case study, he has demonstrated considerable empirical and conceptual difficulties with

TABLE I
SUMMARY OF KEY SECTORS IN THE TURKISH ECONOMY

Industry	Maximize Employment	Maximize Income	Minimize Foreign Exchange
Agriculture	yes	no	no
Animal husbandry, fishing	yes	yes	no
Beverages	no	no	yes
Chemicals	yes	no	no
Electricity	no	yes	no
Railroad	yes	no	no
Other transportations	no	yes	no
Communications	no	no	yes
Public services	no	no	yes

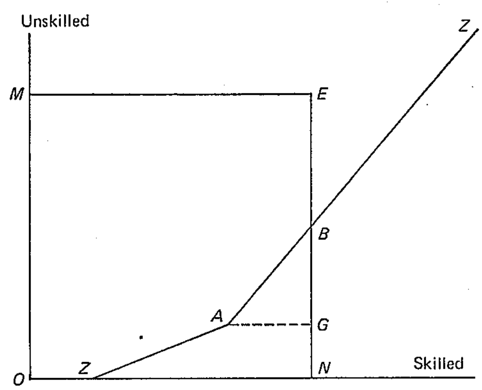
Source: [21].
Note: The table presents industries within the top third ranking by both forward and backward linkage effects.

the key sector concept. In particular, he observed the distinct possibility of conflict between development objectives related to employment, income, or imports (foreign exchange). Table I shows the key sectors which were identified using these three criteria: the table reveals the inconsistency of identification when the measures are related directly to specific policy targets rather than being confined to technological interrelationships. Compounding this problem was the omnipresent development issue of a lack of consistency between long- and short-run objectives.

In the application of these ideas to a regional economy, one could point to the following dilemma. Assume a region whose economy has a comparative advantage in the production of goods from a small set of industries (key industries). Should the message to be conveyed to the appropriate planning agency seeking to enhance regional growth prospects contain the inference that these industries represent areas of high potential profitability for new ventures locating in the region? Here the potential for all manner of difficulties arises: for example, the level of demand (supply) may be such that the addition of a new firm might create serious disequilibria in the market structure. A new firm might tighten the demand for skilled labor and thus create pressure for increases in wage rates: these increases could then "spill over" into other parts of the regional labor market. In this regard, Berman's model [4] provides useful insights into this process.

Assume that the regional labor force can be divided into two broad groups, skilled and unskilled and further assume that the supply of both groups is fixed in the short run. With reference to Figure 1, the supply of skilled may be represented by ON and the supply of unskilled by OM. The curve ZZ represents the regional employment expansion path. Assume a new firm, producing the same type of products as one of the existing key sectors, enters the region. As a result, the employment level changes from point A on the ZZ curve to point B. At this juncture, the supply of skilled workers is exhausted: this factor may result in

Fig. 1. Regional Disequilibrium in a Two-Sector Skill Classification Model



Source: Berman [4].

competitive bidding among regional firms for this skilled labor thus creating increases in wages. In the short run, the net impact on the region may be one in which local unemployment levels remain at or near their levels prior to the entry of the new firm (since very few unskilled workers have been hired). Of course, the indirect and induced income effects may create additional job opportunities for some of the unskilled workers. In the longer run, additional skilled workers may migrate into the region or there may be some incentive on the part of the regional government or the local firms to raise the skill levels of existing unskilled workers. The main point to be made here is that the benefits from an expansion within a key sector may not always be positive. In fact, as Miernyk [46] has shown, the impacts of new firms on local unemployment levels is often difficult to estimate since the availability of new job opportunities may cause substantial structural changes in the composition of the labor force—the impacts of the "discouraged worker" and "additional worker" hypotheses. Furthermore, the major impact may be on the *occupational* structure rather than the labor force in aggregate. (See, for example, Folk et al. [24] for the results of such an analysis related to the demands of energy related activities on the demands for scientific and technical personnel.) In Hirschman's terms, the process described above may be regarded as unbalanced and generating opportunities for investment—but in this case in human capital rather than directly or indirectly productive activity. In this context, the conjoining of the interindustry model with a skill or occupations matrix would assist the analysis (see the Sri Lankan social accounting system [53]).

While there is no *direct* evidence supporting such a process, it is clear that it could happen. From another, similar perspective, additional firms in the same industry moving into the region might foster a trend toward regional dependency on too narrow a range of activities and thus place the region in a position of being seriously impacted through a downturn in the business cycle. New firms locating in Canada under the auspices of the Department of Regional Economic Expansion (DREE) incentives tended to further specialization tendencies already existing within regions [16]. This is not to suggest that specialization is, de facto, undesirable; however, as the work of Thirlwall [59] and Hewings [29] has demonstrated, the less prosperous regions of Britain and Canada appear to be more sensitive to national business cycle activities than their more prosperous counterparts. Part of the reason for this may be ascribed to the higher degree of specialization in cyclically sensitive industries in less prosperous regions.

Another parallel issue, in this context, is the one centered on the argument over the benefits of capital-intensive development versus employment creation. Diamond [22] raised this issue at the national level in examining key sector identification; again, it would appear to be an equally important issue at the regional level. In fact, Woodward [63] has been very critical of DREE's policy since it has been, on the one hand, an advocate of maximum job creation in the less prosperous regions of Canada yet has been a very heavy subsidizer (through development grants) of capital-intensive activity. This issue leads, once again, to an examination of the time-frame for evaluation of key sectors. While a capital-intensive industry may not yield a large number of jobs in the short run, one would need to evaluate the contribution over the longer run. If one assumes that the new industry embodies what may be regarded as "best practice" technology, the probability of it being viable in future years may be much greater—hence, the accumulated man-years of employment and its associated stability must be viewed in the long run. The failure record with new firms may be described by a negative binomial distribution with the probability of survival after the first three or so years being very good. Far too often, less prosperous regions have experienced substantial short-run employment increases from the location of new activities only to see these activities go out of business a year or two later.

C. *The Aggregation Problem*

In the discussion of the Yotopoulos and Nugent paper [64], which attempted to test the Hirschman linkage hypothesis, a number of authors commented about the effect of aggregation on the identification of key sectors in an open economy [13] [40] [55] [65]. Bharadwaj [11] and Jones [36] have both pointed out that the use of the inverse matrix does not avoid some of the problems of aggregation bias which would occur with the use of the Chenery and Watanabe classification scheme (see [28]). While the issue of aggregation may be regarded as moot, in that data availability is often too restrictive to provide for rigorous testing, it is clear that the identification procedures are rather sensitive to aggregation levels. An earlier test [28] revealed a certain type of inconsistency with reference to aggregation and the appearance of key sectors. In a small number of experiments in which simple aggregation of sectors was carried out, several sectors "disappeared" as key sectors during the aggregation process only to reappear again at lower levels of aggregation. The problem was avoided in the use of Leontief's aggregation scheme (see [28]).

The issue of aggregation becomes most critical when a sectorally discriminatory investment strategy is followed. In this case, the problems of bias and unexpected results follow from the aggregation in input-output matrices experiencing non-proportional (to base year) increases in final demand (see [42] [50]).

D. *Interregional and Feedback Issues*

One issue in key sector identification which appears uniquely in regional analysis (although there is no reason why it should not be considered at the national level) is the problem of interregional feedback effects. The early work of Miller [47] [48] and some later empirical investigations by Beyers [6] [7] [10] have shown that interregional feedback effects can be very important components of the growth-inducing mechanisms of certain industries in a regional economy. One may find that sectors classified as key at the national level may not be important at the regional level. Part of this phenomenon may be explained by the fact that, at the national level, the process of key sector identification operates on the components of the technical coefficients matrix (a_{ij}'s) while, at the regional level, the indices are usually derived from the matrix of regional requirements coefficients (r_{ij}'s). Since the latter are almost always less than or equal to their national total technological counterparts, the degree of structural interdependence is likely to vary from one region to another. Hence, in Washington State, Beyers [9] noted that the aerospace industry had the lowest power of dispersion, yet it ranked fifth highest in the nation as a whole. The reverse was true for the services and construction sectors which were ranked much more highly at the regional than at the national level.

IV. KEY SECTOR IDENTIFICATION AND DEVELOPMENT ISSUES

The problems raised earlier related more to the technical aspects of key sector identification. In this section, more attention will be focused on the associated development issues. McGilvray [42] has proved several trenchant criticisms of the key sector identification process in its role in the development of an open economy. One of the issues relates to the earlier discussion about what the most widely used indices do, in fact, identify. McGilvray commented that a number of authors have associated high values of the index (say, Rasmussen's) with a corresponding high value of income or employment creation within a regional economy. In essence, the confusion results from associating the output multiplier effects directly with the income or employment generating effects. It is well known that many sectors with low intraregional interindustry multipliers may contribute substantially to regional income and employment. For example, Meller and Marfan [44] found in Chile that for over twenty-five of the forty manufacturing sectors, the direct employment impacts were in excess of 50 per cent of the total (direct and indirect) impact.

A more serious fault with the concept associates linkages and investment strategy in a far too simplified manner. Induced investments within a region depend on the level of demand for the inputs (in the case of backward linkage effects) or the level of supply (in the case of forward linkage effects). The key sector identification process does not take the *level* of activity into consideration. A further point, raised by McGilvray [42], concerns the fact that the weighting schemes that have been proposed (for example, the ones by Hazari [25] discussed earlier) deal with linkages in an ex post manner whereas investment decisions will be taken on the basis of anticipated opportunities.

Hirschman's use of the key sector concept in the development of a strategy for developing countries has created additional confusion about the role of linkages. A number of authors have attempted to examine Hirschman's unbalanced growth hypothesis in which investment is deliberately biased sectorally to create a succession of disequilibria and, hopefully, foster additional investment opportunities. The hypotheses arising from this strategy have been tested by Yotopoulos and Nugent [64] and, more recently, by Bulmer-Thomas [15]. It was felt that a country whose sectoral growth rates were positively correlated with indices of sectoral linkages would confirm the Hirschman strategy. Several authors have responded to this analysis [13] [36] [40] [55] and have criticized it as an inadequate test since the key sector hypothesis does not imply that the sectors with the highest indices will be the ones liable to exhibit the fastest growth rates. However, both Bulmer-Thomas [15] at the national level and Hewings, Merrifield, and Schneider [32] at the regional level yielded little strong causal relationship between key sectors and growth.

In fact, given the nature of key sectors (and the emphasis on their spread effects), it may well be that the faster growth rates may be found in those sectors not identified as key sectors yet linked to them (Blumenfeld [12] argued similarly in discussing the economic base model). These may be the sectors with the greatest potential for achieving import substitution. Attempts to test this hypothesis are complicated by our inability to net out the influence of product cycles, business cycles, and distinctions between long-run and short-run growth responses when our data are often available only for two or three points in time.

Diamond [23] has noted that the development issue tends to get lost in the debate on Hirschman-type strategies for economic development. In an earlier section, reference was made to the distinction between regional and total technical requirements in a regional input-output model (or, similarly, at the national level between domestic and total input coefficients). Diamond noted, in the case study he conducted for Turkey, that different rankings of sectors would occur even within the same matrix. He ranked sectors with reference to matrix B (the Leontief inverse), to matrix B' $(=[B-I])$, and with reference to B'' $(=[B-B^*]$ where B^* is a diagonal matrix with entries b_{ii}). In the first case, one would be measuring the direct and indirect effects, the indirect effects in the second case, and the total effects, net of the initial and feedback effects on the industry initiating the development, in the third case. Diamond suggested the use of the latter two matrices since, as Boucher [13] has suggested, the issue is really one of identifying the spread effects from an industry. Laumas [40] has proposed that one may be able to point to some characteristic structure associated the stage of economic development. With reference to Diamond's notation, the least developed economy would exhibit strong intraindustry vis-à-vis interindustry dependence, whereas a more developed economy would begin to reflect increasing interindustry interdependence. In other words, the spareness of the matrix A or R would be reflected in small values in B' and B''. Applying the key sector indices to either A or R would, as we suggested earlier, lead to different key sectors being identified. While, at the regional level, it may be claimed that the use of the R matrix is more appropriate, since it measures intraregional effects, the potential for new industrial development may be in those industries funding only a small percentage of the total input requirements into other industries (see [36] [55]).

Following in the spirit of Bulmer-Jones [15], one might wish to evaluate sectors with the maximum "distance" between the A and R matrix as providing potential for future imput substitution. However, the existence of the potential is not purely a function of this distance but would also require consideration of the *level of potential demand.* The level of potential demand may, in turn, depend on the degree to which the product produced by the industry is available locally, as well as the availability of the necessary inputs. A certain degree of indeterminacy appears in this matter.[1]

In summary, McGilvray [42] noted that in the linkage-based development process, not enough consideration was given to patterns of interregional/international trade, interregional and international competitiveness, natural resource availability and endowments of skills and technology, all of which would appear to exercise a dominant role in the development of regional and developing country economies. In the remainder of this paper, some ideas will be proposed (and tested where tests have been conducted) which suggest that the concept of key sector identification would have greater utility if viewed within the context of simulation experimentation within the economy under consideration.

V. ALTERNATIVE PROCEDURES FOR KEY SECTORS IDENTIFICATION

In an earlier section, it was noted that the methods employed in key sector identification had, for the most part, viewed the regional economy through the assumptions and restrictions of the input-output framework. In this section, some modifications, extensions, and new analytical approaches to the input-output model will be discussed.

A. *The Problem of Capacity and Structural Complexity*

One of the more demanding assumptions embodied in the input-output framework is the absence of capacity limitations upon expansion in response to new demands placed upon industries. A more realistic approach would be one in which some industries operate below full capacity while others require time to

[1] Round's recent work [57] has explored the compensating mechanisms in interregional input-output systems under conditions where certain accounting constraints are maintained. It is not clear, however, what effects extension to M region (from two discussed in his paper) or the relaxation of accounting constraints would have on the estimation procedures. In the context of this discussion, the specification of the compensating mechanism would appear to be critical.

TABLE II
STRUCTURAL COMPLEXITY OVER TIME: WASHINGTON STATE, 1963, 1967, AND 1972

	Average Number of Transactions per Industry	Total Number of Transactions	Percentage Change in	
			Final Demand	Transactions
1963	3.175	2,710		
1963–67			+54.1	−5.6
1967	3.060	2,557		
1967–72			+36.2	+26.4
1972	3.270	3,234		

Source: [32].

adjust and, hence, may not be able to meet demands placed on them in time period t until $t+1$. Robinson and Markandya [56] approached this problem by utilizing the power series expansion of the Leontief inverse matrix and assumed that each power of the matrix represented a "production round." Thus, in the following expression:

$$X(t+n)=[I+A(1)+A(1)A(2)+A(1)A(2)A(3)+\ldots]\ Y(t+n).$$

The terms in parentheses refer to time periods (say, six months or one year). If it is assumed that some industries will not be able to meet all the new demands placed upon them, then the values of the entries in the $A(t)$ matrices may be adjusted accordingly. Thus, it would be possible to simulate the rounds of spending with a varying coefficient matrix—with imports occurring in some industries to meet short-run bottlenecks and, perhaps, eventual import substitution taking place if the level of new demand appears to indicate a longer-run increase for these outputs.

To accomplish this type of simulation, some good approximations for regional capacity by industry would be required: the concept of a key sector would take on a slightly different meaning. It might refer to a sector producing a critical component not available within the region in sufficient quantity to meet the new levels of demand, rather than to the sector which generates the greatest direct, indirect, and induced impact. Finally, it should be noted that a temporal decomposition of final demand would be required since deliveries to final demand would not be made in one time period. The empirical evidence on regional supply-demand relationships over time is virtually nonexistent: the evidence for Washington State, gleaned from three static input-output models provides only a few insights into the problem [5] [7]. The models were produced for years in which the business cycle was at different stages of the cycle, thus making it difficult to assign changes in regional coefficients to relative price changes, technological change or short-run responses to changes in the levels of demand.[2]

Table II provides some broad hints at what may have happened in terms of regional adjustment over time. Using the Robinson and Markandya approach,

[2] On these issues, see Beyers [8] for a discussion of the temporal phasing of proposed petroleum developments and Conway [17] [18] for an analysis of the time-phasing of expansion in the aerospace industry on various components of the regional economy.

each time an industry produced during a production round, a value of 1 was indicated in all the cells in which $a(t)_{ij}$ was non-zero. The summation of these matrices indicates the total number of transactions in the economy to meet a specified bill of final demand. Note that, while the change between 1963 and 1972 was toward an increase in structural complexity (the average number of transactions per industry increased as did the number of transactions), the change was not monotonic. In fact, the rapid expansion between 1963 and 1967 resulted in less interindustry transactions within the region and a concomitant rise in imports. The sectoral analysis (Table III) reveals that, in total, twenty sectors changed their rounds of spending during at least one of the periods and for six of them the change was symmetric.

B. *The Role of Households*

In the literature on key sector analysis, very little attention has been given to the role of households and their impact on economic activity through what Beyers [7] refers to as the *laterally induced system,* while other authors refer to simply as the induced impact. Essentially, it involves tracing the path of that part of value added which becomes local income and which is then spent on regional production—thus injecting further stimuli into the regional economic production process. For a large number of industries in a region, these linkages may be far more important than interindustry linkages. Two alternative ways of dealing with this problem are approached here: the Miyazawa [49] and the social accounting frameworks proposed by Pyatt and Roe [53]. Dealing with the former, let us assume

$X =$ the output vector $(n\times 1)$,
$B =$ the Leontief inverse matrix (households exogenous) $(n\times n)$,
$C =$ household expenditures on regional goods $(n\times r)$,
$V =$ household income from value added $(r\times n)$,
$r =$ number of household types (e.g., high, middle, low income),
$K = [I-L]^{-1}$,
$L = VBC$,
$f =$ the vector of final demand (excluding households),
$Y =$ regional income, and
$g =$ exogenous income.

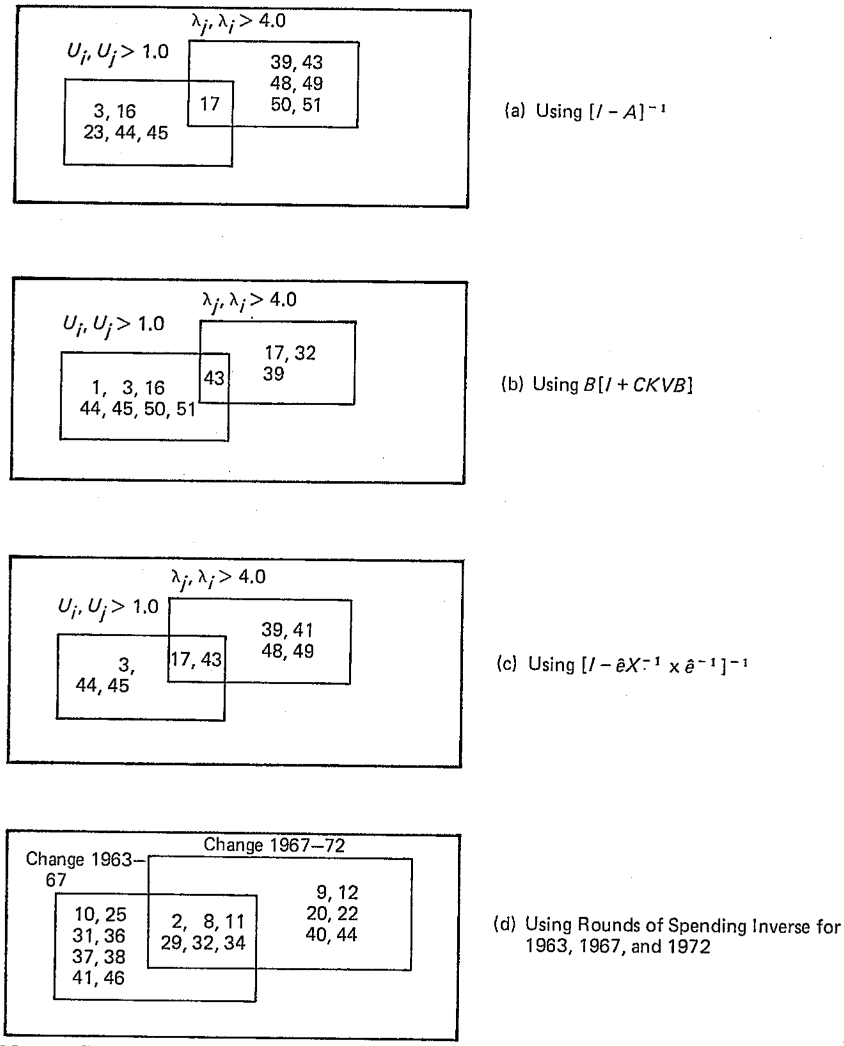
Then, the regional accounting framework can be presented as:

$$\begin{bmatrix} X \\ \hline Y \end{bmatrix} = \left[\begin{array}{c|c} B[I+CKVB] & BCK \\ \hline KVB & K \end{array}\right] \begin{bmatrix} f \\ \hline g \end{bmatrix}.$$

Thus, the elements of the upper left hand part of the partitioned matrix may be shown to be equivalent to the Leontief inverse matrix with household endogenous. This matrix can then be subjected to key sector analysis in the usual fashion; in this case, however, the income effects will be likely to change the relative importance of some of the sectors.

If the policymakers' preference function places explicit consideration on household employment, then the following form of the input-output model could be

Fig. 2. Key Sectors in the Washington Economy, 1972



Note: See Appendix A for sector listing.

used. Note that, in this case, household income-consumption activities are assumed to be exogenous although there are no conceptual difficulties involved in including these impacts within the model. If we assume

e = the employment vector,
x = the matrix of gross flows,
X = the vector of total output,
f = the final demand vector, and
$\hat{}$ = indicates a diagonalized matrix:

$$e = [I - \hat{e}X^{-1}x\hat{e}^{-1}]^{-1}\hat{e}X^{-1}f.$$

The inverse of this matrix can be evaluated for key sector identification in the usual way. Figure 2 shows a comparison of key sectors identified using some of

TABLE III

STRUCTURAL COMPLEXITY OVER TIME: SECTORAL ANALYSIS OF TABLE II

Direction of Change 1963–67 : 1967–72	Number of Sectors $n=49$
0 : 0	29
+ : −	0
− : +	6
− : −	0
+ : +	0
0 : +	4
− : 0	4
+ : 0	4
0 : −	2

Source: [32].

the standard techniques applied to models identifying output, output plus income, employment, and structural complexity measures. The data were those for the Washington State 1972 model for the first three measures and for the 1963, 1967, and 1972 models for the final set of measures. As one would have suspected, the identification process tends to favor the nonmanufacturing sectors (sectors 43 to 52) when consideration is not made of the relative importance of final demand. The degree of homogeneity among these methods is certainly not striking; in part, this reflects the earlier comments of Diamond [21].

Pyatt and Roe [53] approach the role of households within the context of a complete set of social accounts. One advantage of this approach is that it enables a more accurate tracing of impacts through the specification of a set of multiplier matrices which detail the interactions between factors of production, institutions, and production activities. The utility of this framework was admirably demonstrated by Bell and Hazell [3] recently in an application to the Muda region of Malaysia. They were able to show clearly the different downstream benefits of a major irrigation project on urban and rural households. In the Sri Lanka model [53], the marked difference in the linkage between various household sectors and the activity system as well as the dependence of household sectors on non-wage-and-salary income lead to different impacts on the economy associated with various types of exogenous change in demand.

C. *Key Sectors in a Semi-Input-Output Framework*

Karunaratne [37] has shown how sectoral development prospects in Papua New Guinea could be evaluated through the joint use of the Rasmussen-Hirschman criteria in the semi-input-output model. The method was developed by Tinbergen (see [45]) and, subsequently, has been extensively modified [19] [26] [60]; the basic concepts are reviewed in Kuyvenhoven [38] but essentially center around the disaggregation of the economy into tradeable (international) sectors and non-tradeable (national) sectors. The latter are assumed, because of high transport costs or other factors such as economic protection issues, to move only within the national economy.[3] The model is used to develop some cost-benefit criteria for evaluation of potential projects.

Following Karunaratne [37], define the economic system in the following fashion, with the subscripts T and N referring to tradeable and non-tradeable sectors:

$$\left[\begin{array}{c|c} A_{TT} & A_{TN} \\ \hline A_{NT} & A_{NN} \end{array}\right] \left[\begin{array}{c} X_T \\ \hline X_N \end{array}\right] + \left[\begin{array}{c} F_T \\ \hline F_N \end{array}\right] = \left[\begin{array}{c} X_T \\ \hline X_N \end{array}\right],$$

$$\begin{bmatrix} K_T & K_N \\ V_T & V_N \end{bmatrix},$$

where

A (and appropriate subscripts) = input coefficients,
X = total output,
F = final demand,
K = capital coefficients, and
V = value added coefficients.

By assuming (for purposes of project evaluation) $F_N=0$ and the solution becomes for non-tradeables:

$$X_N=[I-A_{NN}]^{-1}A_{NT}X_T,$$

or any given sector j, the cost-benefit criterion is:

$$T_j=\frac{k_j+K'_N[I-A_{NN}]^{-1}A_{nj}}{v_j+V'_N[I-A_{NN}]^{-1}A_{nj}},$$

where

k_j = the direct capital coefficient of the jth sector,
v_j = the value-added coefficient of tradeable sector j,
V'_N = the non-tradeable value-added coefficient vector,
K'_N = row vector of non-tradeable sector capital coefficients,
A_{nj} = column vector of inputs for the tradeable sector j from the non-tradeable sectors.

Karunaratne then demonstrates the use of this system in conjunction with the familiar key sector methods discussed earlier.

In applications at the regional level, a number of problems arise: in particular, the distinction between tradeable and non-tradeable becomes less distinct (although Herman, Mennes, and Waardenburg [26] have suggested a hierarchical approach) and the possibility for significant interaction between the tradeable sectors could also occur. Furthermore, in developing economies, more and more activity is being oriented toward the nonmanufacturing sectors with the result that service activities are now being exported from some regions. There is one issue which needs to be addressed within the context of the integration of cost-benefit and input-output analysis and that relates to the placement of households endogenously or exogenously. The evidence provided by Maki [43], Pyatt and Roe [53], and Hewings [30] suggests that households may provide one of the largest

[3] Those readers familiar with economic base analysis will recognize a strong relationship between this bifurcation of economic activity and the categorization of sectors as export or local in the development of a regional aggregate multiplier (see [29]).

links between the various elements of the social accounting subsystems. Notwithstanding these problems, the possibilities of linking cost-benefit (or other project appraisal methods) with the notion of key sector identification appear most attractive.

D. *Key Sectors or Key Coefficients: A Parametric Uncertainty Approach*

Increasing concern for energy supply, substitution and conversion at both the regional and national levels has created a demand for methods of analysis which could handle the possibilities of endogenous coefficient change. Such a model is described in [51] in which a regional input-output model is linked with a linear programming energy supply-demand allocation model. The input-output part of the model operates with a partitioned coefficient matrix in which endogenous change is made possible in the energy-related submatrices while preserving standard rectangular production functions in other submatrices. In essence, the model represents a compromise between the excessive restrictions of classical input-output analysis and the difficulties of implementing the degree of endogeneity embodied in the Hudson-Jorgenson model [35].

In the development of the model, it became clear that the notion of key sector could be related to energy concerns either through the identification of individual coefficients whose change would likely result in a significant change in energy demand or through the identification of a complete sector with similar characteristics. In this section, the focus will be on individual coefficients: the algorithm used is described in [14] and only the salient features are shown here.

The objective is to find the small set of coefficients whose change will likely effect the system to a much greater degree than others; in this regard, some judgment is involved in the definition of "critical coefficients." For example, one may wish to examine the effect of a 20 per cent change in an a_{ij} and identify that set of a_{ij}'s for which this change might cause a 10 or 20 per cent change in one or more elements, b_{ij}, of the associated inverse. In notation:

$$\hat{b}_{mn}=b_{mn}+\frac{b_{mi}+b_{jn}\delta a_{ij}}{1-b_{ji}\delta a_{ij}},$$

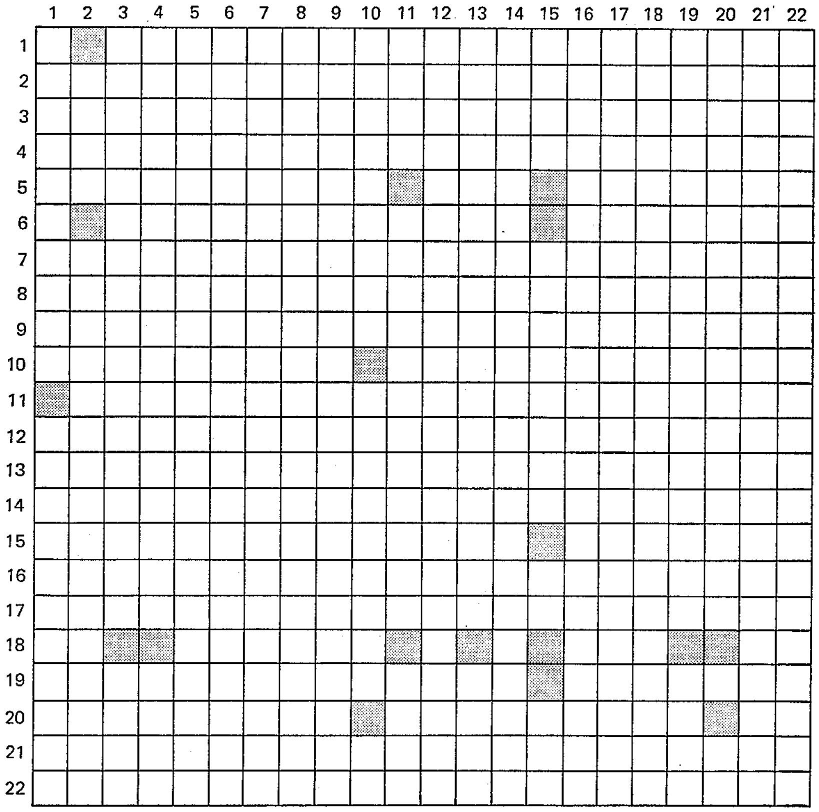
subject to $1-b_{ji}\delta a_{ij}\neq 0$ and where $\hat{b}_{mn}$ is an element of the $[I-A]^{-1}$ matrix with a_{ij} perturbed by δa_{ij}. Hence, a_{ij} is critical if:

$$b_{mi}b_{jn}\geq\frac{\beta}{100}\left[\frac{1-b_{ji}\delta a_{ij}}{a_{ij}}\right]b_{mn},$$

where $\delta a_{ij}=[\alpha/100]\,a_{ij}$ and where α and β represent the percentage perturbations of the original and inverse matrices respectively.

In the application to sectors at the regional and national level in Greece [31], the algorithm was modified to show the effects of a 20 per cent change in the a_{ij}'s on gross output. A sector was deemed "critical" if this change in the coefficient results in a 10 per cent or more change in total output in a sector. Figures 3 and 4 show the results of the application of this idea of critical coefficients to the input-output table for Evros, a small region in N.E. Greece, and the Greek economy as a whole. Note the larger number of critical coefficients at the

Fig. 3. Inverse Important Coefficients: Evros Survey Model



Source: [31].
Note: For sector classification, see Appendix B.

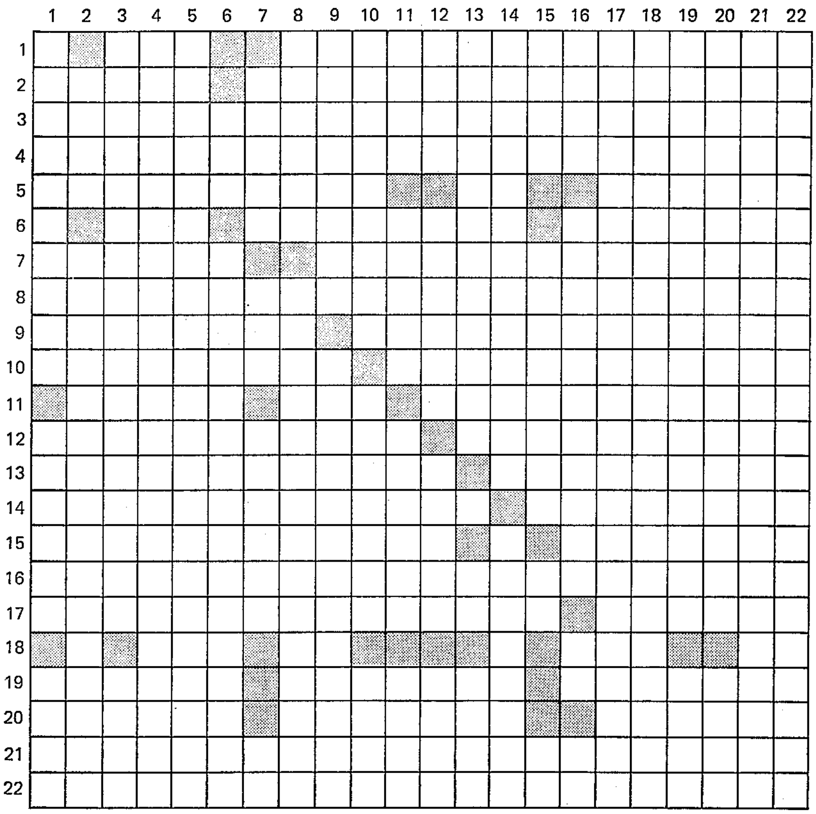
national level.[4] When households were made endogenous at the regional level through the addition of a 23rd row (wage and salary coefficients) and column (consumption expenditures), the number of critical coefficients doubled—and all the new entries were in the 23rd row or column.

Bulmer-Thomas [15] suggested that the distance between the domestic and total technical requirements matrix may be regarded as a measure of the potential for import substitution.[5] We tested the identification of key sectors when the Evros regional coefficients were moved toward the national coefficients, i.e., $r_{ij} \rightarrow a_{ij}$ and evaluated how many of these changes would significantly alter the output levels in the regional economy. The results are shown in Figure 5. Note the density of entries—in comparison to Figure 3. However, these are only potential changes: the policymaker would have to conduct an analysis of the degree to which any import substitution possibilities could be realized. Recall, also, that only

[4] The tendency for these to occupy the diagonal elements unfortunately reflects aggregation necessary to make the regional and national tables comparable.

[5] Bulmer-Thomas used the inverse matrices rather than the direct coefficients.

Fig. 4. Inverse Important Coefficients: Greek National Model



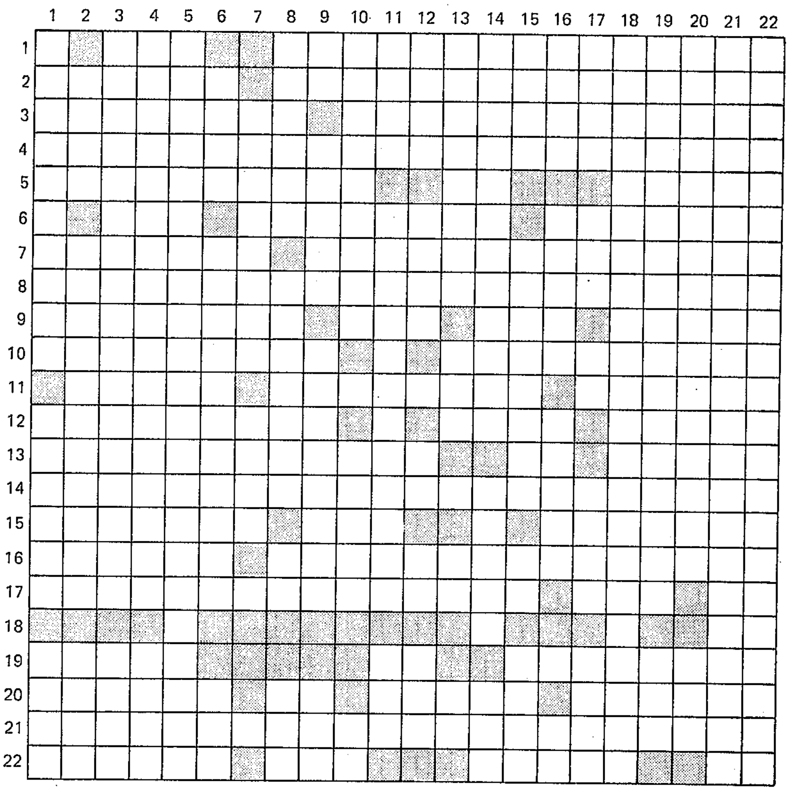
Source: [31].
Note: For sector classification, see Appendix B.

one coefficient was changed at a time. If more than one changed (or a whole row or column moved toward the national coefficient levels), the changes might be even more dramatic.

E. *Key Sectors, Alternative Linkage Systems and the Role of Cycles*

In a regional economy, and one suspects increasingly at the developing economy scale, an alternative form of linkage mechanism may be far more important. Pred's work [52] on the nature and role of major job-providing organizations has suggested that the interregional transmission of decision-making may transcend that portion originating in the local economy. For example, the decision to expand plant capacity in response to increases in demand may not be taken without reference to the expansion possibilities in other firms within the same multi-firm organization. Since these other firms may be located in a number of regions, the response mechanism may involve a complex pattern of decision-making not readily conceptualized within traditional interindustry modelling terms. As the hegemony of the federal government as a consumer of goods and services increases, it, too, exercises a more profound influence over the economic health of

Fig. 5. Inverse Important Coefficients: Movement of Evros to Greek National Technology



Source: [31].
Note: For sector classification, see Appendix B.

regional economies. Thus, the traditional view of regional economies as ones influenced by external market demand forces is being replaced by a far more sophisticated view of the process of regional change involving many factors hithertofor ignored or deemed of little significance (see [33]).

While data are not available to quantify the actual magnitude of the influence of the new decision-making processes, and their impact on spatial development, it can be surmised that the direct and indirect impacts of policy decisions of large multinational enterprises are likely to have far-reaching impacts on regional prosperity. An earlier U.S. Department of Commerce study [62] on the impact of U.S. federal expenditures on regional economies pointed in this direction. It appeared that the nature of interregional linkages is such that some regions, by virtue of their production structure emphasizing intermediate goods, may derive considerable benefits from federal government purchasing decisions *in other regions*. These indirect interregional linkages are difficult to trace but they probably account for significant levels of employment creation and income generation in many regional economies [10].

Finally, it should be stated that the usefulness of the key sector notion hinges very closely on the degree to which it can be linked to the various mechanisms creating change in the broadest sense. In this regard, the increasing recognition of the role of cycles in regional economic activity provides some potential for recasting the key sector idea into a more dynamic, responsive framework. Abramovitz's suggestion [1] that Kuznets's cycles, which are of intermediate length between the long-run Kondratieff cycles and the shorter-run business cycles, may provide the necessary behavioral framework for an understanding of the process of structural change in a fifteen to twenty-five year period. The idea of linking key sectors to growth processes provides for the capability for the examination of many dimensions and interactions of growth mechanisms at any spatial scale.

Abramovitz [1] also noted that a distinction has often been made between long-run cycles and their associated changes in capacity—growth of labor, capital, and the productivity with which resources are employed—and the shorter-run cycles which are associated with fluctuations in the intensity with which resources are employed. In the context of the Kuznets's cycles, this distinction may not be a very meaningful one since, typically, most economies exhibit characteristics of both the longer- and shorter-run features.

Tiebout [61] suggested that similar mixtures of events are associated with the difficulty of determining the differing impacts of extensive versus intensive growth. The former, extensive growth, would be associated with in-migration and capacity expansion while the latter, intensive growth, would be associated with increases in the utilization of resources. In fact, Kuznets's cycles contain migration processes as a major element in the explanation of fluctuations of national economies; at the regional level, one would anticipate a similar important role and associate it with the process of capital deepening and capital expansion that are so important in providing the region with the capacity to change and grow.

Once these ideas are accepted, the restrictiveness of the key sector ideas within the existing framework becomes readily apparent. The complex interactions between capital expansion, productivity growth, in-migration, and various accelerator-multiplier effects in an open economy create suspicion about the utility of an attempt to reduce such complexity to a set of indices.

VI. CONCLUSIONS

There are, of course, many other important issues: the recent exchange in the *Quarterly Journal of Economics* symposium (see [13] [36] [40] [55] [64] [65]) and the debate between Laumas [41], Diamond [23], and Schultz and Schumacher [58] point to many other problems within this general theme.

As is the case with most ideas generated in one context and translated into another, the meaning and intent are often lost in translation. Regional economic development theory, free of "balance of trade" concerns at the national level, has focused an interindustry linkage transmission: the growth center theories and industrial complex analysis research of Czamanski [20] have provided critical needs for future research into the mechanisms by which regions grow.

As more and more developing economies devote attention to problems of regional development, there will be a demonstrable need to integrate the procedures of key sector identification project selection monitoring and evaluation in ways suggested in the previous section of this paper. Key sectors defined outside the context of multiple development goals and explicit consideration of the linkage mechanisms across different spatial levels are unlikely to provide much practical utility to policy decision-making.

REFERENCES

1. ABRAMOVITZ, M. "The Nature and Significance of Kuznets Cycles," *Economic Development and Cultural Change,* Vol. 9, No. 3 (April 1961).
2. AUGUSTINOVICS, M. "Methods of International and Intertemporal Comparison of Structure," in *Contributions to Input-Output Analysis,* ed. A. P. Carter and A. Bródy (Amsterdam: North-Holland, 1972).
3. BELL, C. L. G., and HAZELL, P. B. R. "Measuring the Indirect Effects of an Agricultural Investment Project on Its Surrounding Region," *American Journal of Agricultural Economics,* Vol. 62, No. 1 (February 1980).
4. BERMAN, B. R. "Alternative Measures of Structural Unemployment," in *Employment Policy and the Labor Market,* ed. A. M. Ross (Berkeley: University of California Press, 1965).
5. BEYERS, W. B. "On the Stability of Regional Interindustry Models: The Washington Data for 1963 and 1967," *Journal of Regional* Science, Vol. 12 (December 1972).
6. ————. "Growth Centers and Interindustry Linkages," *Proceedings, Association of American Geographers,* Vol. 5 (1973).
7. ————. "On Geographical Properties of Growth Center Linkage Systems," *Economic Geography,* Vol. 50, No. 3 (July 1974).
8. ————. "Estimating Impacts of Alternative Petroleum Developments with the Washington Interindustry Model," mimeographed (Seattle: University of Washington, 1974).
9. ————. "Empirical Identification of Key Sectors: Some Further Evidence," *Environment and Planning,* Vol. 8 (1976).
10. ————. "Migration and the Development of Multiregional Economic Systems," *Economic Geography,* Vol. 56, No. 4 (October 1980).
11. BHARADWAJ, K. R. "A Note on Structural Interdependence and the Concept of 'Key' Sector," *Kyklos,* Vol. 19, No. 2 (1966).
12. BLUMENFELD, H. "The Economic Base of the Metropolis," *Journal, American Institute of Planners,* Vol. 21 (1955).
13. BOUCHER, M. "Some Further Results on the Linkage Hypothesis," *Quarterly Journal of Economics,* Vol. 90, No. 2 (May 1976).
14. BULLARD, III, C. W., and SEBALD, A. V. "Effects of Parametric Uncertainty and Technological Change on Input-Output Models," *Review of Economics and Statistics,* Vol. 59, No. 1 (February 1977).
15. BULMER-THOMAS, V. "Trade, Structure and Linkages in Costa Rica," *Journal of Development Economics,* Vol. 5, No. 1 (March 1978).
16. Canada, Department of Regional Economic Expansion. "Assessment of the Regional Development Incentive Program" (1973).
17. CONWAY, R. S. "The Stability of Regional Input-Output Multipliers," *Environment and Planning,* Vo. 9 (1977).
18. ————. "The Simulation Properties of a Regional Interindustry Econometric Model," *Papers, Regional Science Association,* Vol. 41 (1980).
19. CORNELISSE, P. A., and VERSLUIS, J. "The Semi-Input-Output Method under Upper Bounds," in *Towards Balanced International Growth,* ed. H. C. Bos (Amsterdam: North-Holland, 1969).

20. CZAMANSKI, S. "Linkages between Industries in Urban-Regional Complexes," in *Studies in Economic Planning over Space and Time,* ed. G. G. Judge and T. Takayama (Amsterdam: North-Holland, 1976).
21. DIAMOND, J. "The Analysis of Structural Constraints in Developing Economies: A Case Study," *Oxford Bulletin of Economics and Statistics,* Vol. 36 (1974).
22. ————. "Interindustry Indicators of Employment Potential," *Applied Economics,* Vol. 7 (1975).
23. ————. "Key Sectors in Some Underdeveloped Countries: A Comment," *Kyklos,* Vol. 29, No. 4 (1976).
24. FOLK, H., et al. *Scientific and Technical Personnel in Energy-Related Activities: Current Situation and Future Requirements* (Urbana: University of Illinois, 1978).
25. HAZARI, B. R. "Empirical Identification of Key Sectors in the Indian Economy," *Review of Economics and Statistics,* Vol. 52, No. 3 (August 1970).
26. HERMAN, B.; MENNES, L. B. M.; and WAARDENBURG, J. G. "Some Exercises with a Simple Model for World Development Planning," in *Towards Balanced International Growth,* ed. H. C. Bos (Amsterdam: North-Holland, 1969).
27. HEWINGS, G. J. D. "Aggregation for Regional Impact Analysis," *Growth and Change,* Vol. 5 (1972).
28. ————. "The Effect of Aggregation on the Empirical Identification of Key Sectors in a Regional Economy: A Partial Evaluation of Alternative Techniques," *Environment and Planning,* Vol. 6 (1974).
29. ————. *Regional Industrial Analysis and Development* (London: Methuen; New York: St. Martins, 1977).
30. ————. "Trade, Structure and Linkage in Developing and Regional Economies," mimeographed (Urbana: University of Illinois, 1981).
31. HEWINGS, G. J. D., and ROMANOS, M. C. "Simulating Less Developed Regional Economies under Conditions of Limited Information," *Geographical Analysis,* Vol. 13 (1981).
32. HEWINGS, G. J. D.; MERRIFIELD, J.; and SCHNEIDER, J. D. "Regional Tests of the Linkage Hypothesis," mimeographed (Urbana: University of Illinois, 1981).
33. HEWINGS, G. J. D., and O'HUALLACHAIN, G. "The Role of Industrial Factors in the Development of Regional Systems," in *Spatial Analysis, Industry and Industrial Environment,* ed. F. E. I. Hamilton and G. J. R. Linge (London: Wiley, 1981).
34. HIRSCHMAN, A. O. *The Strategy of Economic Development* (New Haven: Yale University Press, 1958).
35. HUDSON, E. A., and JORGENSON, D. W. "US Energy Policy and Economic Growth, 1975–2000," *Bell Journal of Economics,* Vol. 5 (1976).
36. JONES, L. P. "The Measurement of Hirschmanian Linkages," *Quarterly Journal of Economics,* Vol. 90, No. 2 (May 1976).
37. KARUNARATNE, N. D. "Quantification of Sectoral Development Prospects in Papua New Guinea Using Tinbergen and Rasmussen Criteria," *Developing Economies,* Vol. 14, No. 3 (September 1976).
38. KUYVENHOVEN, A. *Planning with the Semi-Input-Output Method* (Leiden: Nijhoff, 1978).
39. LAUMAS, P. S. "Key Sectors in Some Underdeveloped Countries," *Kyklos,* Vol. 28, No. 1 (1975).
40. ————. "The Weighting Problem in Testing the Linkage Hypothesis," *Quarterly Journal of Economics,* Vol. 90, No. 2 (May 1976).
41. ————. "Key Sectors in Some Underdeveloped Countries: A Reply," *Kyklos,* Vol. 29, No. 4 (1976).
42. MCGILVRAY, J. W. "Linkages, Key Sectors and Development Strategy," in *Structure, System and Economic Policy,* ed. W. W. Leontief (Cambridge: Chambridge University Press, 1977).
43. MAKI, W. "Regional Input-Output and Social Accounting Systems for Agricultural and Rural Development Planning in Thailand," paper presented at the First World Regional Science Conference, Cambridge, Massachusetts, 1980.

44. MELLER, P., and MARFAN, M. "Small and Large Industry: Employment Generation, Linkages, and Key Sectors," *Economic Development and Cultural Change,* Vol. 29, No. 2 (January 1981).
45. MENNES, L. B. M.; TINBERGEN, J.; and WAARDENBURG, J. G. *The Element of Space in Development Planning* (Amsterdam: North-Holland, 1969).
46. MIERNYK, W. H. "Local Labor Market Effects of New Plant Locations," in *Essays in Regional Economics,* ed. J. F. Kain and J. R. Meyer (Cambridge: MIT Press, 1971).
47. MILLER, R. E. "Interregional Feedback Effects in Input-Output Models: Some Preliminary Results," *Papers, Regional Science Association,* Vol. 17 (1966).
48. ————. "Interregional Feedbacks in Input-Output Models: Some Experimental Results," *Western Economic Journal,* Vol. 7 (1969).
49. MIYAZAWA, K. *Input-Output Analysis and the Structure of Income Distribution,* Lecture Notes 116 (Berlin: Springer-Verlag, 1976).
50. MORIMOTO, Y. "On Aggregation Problems in Input-Output Analysis," *Review of Economic Studies,* Vol. 37, No. 1 (January 1970).
51. PAGE, W. P.; GILMORE, G.; and HEWINGS, G. J. D. *An Energy and Fuel Demand Model for the Ohio River Basin Energy Study Region* (Urbana: University of Illinois, 1981).
52. PRED, A. *Major Job Providing Organizations and Systems of Cities,* Resources Paper 27 (Washington, D.C.: Association of American Geographers, 1974).
53. PYATT, F. G., and ROE, A. R. *Social Accounting for Development Planning* (Cambridge: Cambridge University Press, 1977).
54. RASMUSSEN, P. *Studies in Intersectoral Relations* (Amsterdam: North-Holland, 1952).
55. RIEDEL, J. "A Balanced-Growth Version of the Linkage Hypothesis: A Comment," *Quarterly Journal of Economics,* Vol. 90, No. 2 (May 1976).
56. ROBINSON, S., and MARKANDYA, A. "Complexity and Adjustment in Input-Output Systems," *Oxford Bulletin of Economics and Statistics,* Vol. 35, No. 2 (May 1973).
57. ROUND, J. I. "Compensating Feedback Effects in Interregional Input-Output Models," *Journal of Regional Science,* Vol. 19 (1979).
58. SCHULTZ, S., and SCHUMACHER, D. "Key Sectors in Some Underdeveloped Countries: A Comment," *Kyklos,* Vol. 29 (1976).
59. THIRLWALL, A. P. "Regional Unemployment as a Cyclical Phenomenon," *Scottish Journal of Political Economy,* Vol. 13, No. 2 (June 1966).
60. TINBERGEN, J. "Some Refinements of the Semi-Input-Output Method," *Pakistan Development Review,* Vol. 6, No. 2 (Summer 1966).
61. TIEBOUT, C. M. *The Community Economic Base Study* (Washington, D.C.: Committee for Economic Development, 1962).
62. U.S., Department of Commerce. *Regional Effects of Government Procurement and Related Policies* (Washington, D.C., 1967).
63. WOODWARD, R. S. "The Capital Bias of DREE Incentives," *Canadian Journal of Economics,* Vol. 7, No. 2 (May 1974).
64. YOTOPOULOS, P. A., and NUGENT, J. B. "A Balanced-Growth Version of the Linkage Hypothesis: A Test," *Quarterly Journal of Economics,* Vol. 87, No. 2 (May 1973).
65. ————. "In Defense of a Test of the Linkage Hypothesis," *Quarterly Journal of Economics,* Vol. 90, No. 2 (May 1976).

APPENDIX A

SECTOR CLASSIFICATION FOR THE WASHINGTON ECONOMY, 1972

1 Field crops
2 Vegetables
3 Livestock
4 Other agriculture

5 Fisheries
6 Meat products
7 Dairy products
8 Canning and preserving
9 Grain mills
10 Beverages
11 Other foods
12 Textiles
13 Apparel
14 Mining
15 Forestry
16 Logging
17 Sawmills
18 Plywood
19 Other wood
20 Furniture and fixtures
21 Pulpmills
22 Paper mills
23 Paperboard mills
24 Printing
25 Industrial chemicals
26 Other chemicals
27 Petroleum refining
28 Glass and stone
29 Cement and clay
30 Iron and steel
31 Nonferrous metals
32 Aluminum
33 Heavy metals
34 Light metals
35 Nonelectrical motive
36 Machine tools
37 Nonelectrical industrial
38 Electrical machinery
39 Aerospace
40 Motor vehicles
41 Shipbuilding
42 Other manufacturing
43 Transport
44 Utilities
45 Communications
46 Construction
47 Trade
48 Finance
49 Insurance
50 Real estate
51 Business services
52 Personal services

APPENDIX B

SECTOR CLASSIFICATION FOR THE EVROS AND GREEK ECONOMIES, 1980

1 Crops
2 Livestock
3 Forestry
4 Fishing
5 Mining
6 Food
7 Textiles
8 Clothing
9 Wood
10 Paper and printing
11 Chemicals
12 Stone, clay & glass
13 Metal manufacture
14 Transportation equipment
15 Other manufacturing
16 Utilities
17 Construction
18 Transportation & communications
19 Trade
20 Banking & insurance
21 Housing
22 Services