THE DEVELOPMENT OF REGIONAL ECONOMETRIC MODELS

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Abstract

This paper aims to review some of the former specifications of regional econometric models and points out some important deficiencies (lacks) of them. By taking into consideration these missing features it is tried to develop a more reliable and complete model, which involves regionally controllable variables. The key terms are conceptual model, functional region, preference function, policy variables, environmental protection, btocfarecursive, preliminary multiplier and total (final) multiplier.

1. Overviews Some Previous Regional Models

As the importance of decentralized decision making gains power regional policies come into consideration constantly. For this purpose, previously various policy models have been formulated at both regional and state levels. Ideally, all thqse policy models must be employed to determine the optimal level of policy variables on the basis of a preference function (objective function). In the following, the general characteristics of some previous models are summarized. Some predominant previous regional and state econometric models are given in bibliography list as (1), $(6)_7$ (15) and (16). Generally speaking, none of those is directly concerned with policy variables that are controllable by the regional and/or state authorities. Because of concerning the lack of information over some variables all these models are too aggregative to be used for detailed analyses of the effects of various policy (controllable) variables. They are excessively dependent upon secondary data. Actually, it will be uncertain the causal effects of some variables without primary data are used. The proper delineation of a region is still an unresolved issue. This issue is discussed in the following literatures, (3) (4), (10), (17), (19), and (21). All of these models have at least a remote connection with some of the national models. Some of these strongly emphasize the incorporation of regional and national models. The usefulness of this integration can be argued that would provide an information linkage between regional and national policy-makers. Some of these models even developed methods of measuring the impacts of national economic fluctuations upon regional economies. Most of these models are based on single-equation approach. In formulating the model almost they all recognized that ex post observations are likely to be the only data available. Therefore, they did not utilize subjective estimates of some parameters due to a lack of data sources. Whereas, Burt (5) has discussed that, "policy models should be formulated in an adoptive framework, which involves periodic modifications as new information becomes available." Because of all these problems with the previous models as a more reliable one we propose the following specification of regional econometric models. The main characteristics of it are given in the following sections.

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2. The Main Characteristics of Proposed Regional Econometric Model;

2.1 Main Assumptions:

(i) The region considered in our model is a conceptual multi-county area, which is economically delineated from surrounding areas. In other words, the region in our model is functional economic area in that it is relatively self-contained with respect to the majority of consumer economic activities.

(ii) The region has to have a representative central authority (government) consisting of a central policy-making (decision-making) board.

(iii) The regional policy-makers have to possess equal powers as county policy-makers.

(iv) The regional policy-makers should be able to control various policy variables and their behavior rationally.'

(v) The model is formulated in such a way that it could be easily applied to a regional designation not in accordance with county boundaries.

(vi) The governmental decision-making body may not to be a true representation of the present state of affairs.

(vii) The model is enough disaggregate to be used for detailed analysis of the effects of various controllable variables.

(viii) Subjective estimates of some parameters might also be developed, when it is necessary. The subjective estimates may be revised in a Bayesian procedure.[2]

(ix) The equilibrium forces are absent from the region. That is, the model contains behavioral relationship rather than identities for determining prices and wages.

(x) The regional policy-makers base their actions on preferences or objective functions. That is, in the process of decision -making they evaluate the trade-offs(or marginal rate of substitution) between various policy objectives. The specified preference function approximates the actual aggregate social welfare function for the regional decision-making group.

(xi) The optimization process may be simplified by utilizing a decentralized policy-making process. That is, a central planning authority could determine the correct information that should be utilized by each of the single agencies within the region (8)[3].The central organization and single agencies may then exchange information in an iterative procedure to reach at some best outcome.

[1] However, in an empirical application, considerations could be given to the irrationality of some regional decision-makers. Such considerations migbt be incorporated in the control variables as well as the constraints

[2] Subjective estimates are necessarily utilized due to lack of data sources.

[3] To allowing subjective estimates the model incorporates data not available, for example information sources on pollution and other environmental protection means. In addition, since the decision-making model is in dynamic character, in specifying a dynamic model we have to consider the problem of incorporating information not currently available on future parameters changes.

(xii) The structural equations of the model are block-recursive (many of which are stepwise recursive).

2.2 The Preference or Objective Function:

The preference or objective function specified for the regional policy-making group is assumed to approximate the actual aggregate social welfare function. There are basically three alternatives to be considered for specifying and measuring the preference function. The first is Eijk and Sandee's procedure (9): this procedure is based upon obtaining the ratios or trade-offs between various variables entering the preference function. Here, a linear preference function is assumed. The second is suggested by Theil (18): this procedure presents the preference function as a quadratic form expressed as the sum of squares of deviations between actual and desired values of the function's arguments. The third suggested by Chipman (7): this approach could be based on a lexicographic ordering of preferences. This is the simplest way of communicating desires. In our proposed model each of these approaches could be employed in ascertaining the preference function of the regional pohcy making group. It may also prove useful to develop preference functions by all three procedure, and then determine and compare, via sensitivity analyses, the effects of alternative preference Junctions on the optimal levels of controllable variables. Here, we assume that the actions of the regional policy-making group can be approximated by a quadratic preference function as Theil (18) and Tinbergen (20) have done. Those variables that are assumed to enter the preference function are the uncontrolled endogenous variables and controllable policy instruments (variables). The vectors and matrices of coefficients associated with the endogenous and poUcy variables are assumed to have been obtained by some procedures.[5] Depending upon Theil's formulation (18), the quadratic preference function may be represented as:

$$W(c,y) - a'c + b'y + y_3 (c'Dc + y'Hy + c'My + y'M'c) \qquad (1)$$

where,
- a: mT vektor of parameters
- b: nT vektor of parameters
- M: idempotent matrix
- D: mT x nT matrix of parameters
- H: nT x nT matrix of parameters
- c: mT vektor of pohcy variables
- y: nT vektor of endogenous variables

Since the mode! is developed for decision-making purposes, this feature of the model allows one to delete those equations whose selected dependent variable does not enter the preference function without substantial alteration in the specified model. Furthermore, one may wish to drop certain equation in order to simplify estimating the model because they may be found to be unimportant in the context of a particular region (13). They are estimated by some estimation procedures from structural equations of the model (14).

The preference function specified as (1) is maximized against the linear constraints (2);

$$y=Rc + u \quad \textbf{(2)}$$

where, u is the stochastic (additive) term.

The set of constraints. (2) relates uncontrollable variables to controllable variables with in the regional economy.[6]

2.3 The Structural Form Of Econometric Model

As stated in the previous section the structural equations of our model are block-recursive and for many of which are stepwise recursive. This feature of the model provides some important practical advantages while it is applied in a specific region. The general notationai form of the model can be written as follows (13):

$$By + fxt = u_t \quad \textbf{(3)}$$

Where;

	is a matrix of coefficients for the predetermined variables.
B^1	is a matrix of coefficients for the endogenous variables.
yt	is a column vector of the endogenous variables for the ta, observation.
x_t	is a column vector of the predetermined variables for the t^ observation.[7]
u_t	is a vector of error term (disturbances) for the tth observation.

It is assumed that the model is linear in the unknown parameter space and the equations are linear in the variables (13), (14). In equation (3), B is block-triangular with square diagonal blocks. That is shown as follows,

$$\begin{matrix} B|,, 0 ..... & \textbf{.0} & yn \\ \textbf{B 21 B 22 0.} & \textbf{.0} & V2t \\ & & Y3t \end{matrix}$$

$$BVt- \quad \textbf{(4)}$$

$$Bci\ Bc2 .....* .....B|_{cc} \quad | \quad yet$$

The constraints are obtained from the econometric model given in the following section.

When these constraints are non-linear discontinuous stated as inequalities, general dynamic programming approach is preferable for its generality (2), (11).

The pre determined variables consist of controllable exogenous (policy) variables, lagged endogenous variables, uncontrollable exogenous variables and lagged exogenous variables (13,14)

This specification (formulation) implies that the equation system can be partitioned into c blocks (or small equation systems), each of which can be estimated independently of the other blocks in the system.

The variance-covariance matrix, £tt®

Itt® = E(Ut'u_t)is;

$$I\text{«}® = \begin{vmatrix} \text{En o ..... o} \\ 0 \quad £_{22}\ 0\ .\ ,\ .\ 0 \end{vmatrix} \qquad (5)$$

•L,

here Z_{tt}® IS block-diagonal with conforming blocks (13). It suggests that the error term from one equation in many block is known to be none-correlated in the probability limit with the error term from other equations in same block. These properties stated above for B' and Ett® allow one to treat endogenous variables from a given block of model (equations) as predetermined with respect to equations of any higher-numbered block.

Since the model is formulated mainly for decision-making purposes the dynamic representation of the system has crucial importance. Therefore, it may be represented by partitioning and rearranging of the above systems;

ii it

$$y_t = Ay_t + riCt + r2Ct\text{-}i + r3yM + r4Zt + u, \qquad (6)$$

Where;

B = I-A

$$r = (r_1, r_2, r_3, r4)$$

x_t = (ci, CM,yt-i,zt)

i.e., the predetermined variables are portioned into controllable policy variables (ct), lagged controllable policy variables (CM), lagged endogenous variables (y_M) and uncontrollable exogenous variables (zt). In a decision model (like we propose above) simulation of economical policy decisions of regional (or state) authorities is very important. The effects of undertaken economic policy decisions (such as influences of changes the values of some important policy variables upon crucial economic quantities) are evaluated by using dynamic formulation. As an example, let us take the following simple dynamic model (where uncontrollable exogenous variables, Zt, are deleted);

$$y_{t-i} = l\sim ict + Tsct-i + r_3 yt-i + ut \quad (7)$$

In this dynamic model, li represents a matrix of elements, which indicate the current (present) effects of policy variables upon endogenous variables, these are *dy% I* dcjt, on the other hand, the effects of lagged policy variables (ct-k), and lagged endogenous variables (y_t.k) upon endogenous variables are indicated by the coefficient of dyu / 5^ and Syit / c^k respectively, where t>k. which means that the effect of the j"[1] lagged policy variable upon the i* endogenous variable upon the i* endogenous variable is given by *dyt I* dya-k, those are both involved in G_s matrix and as "preliminary multipliers".

Specifically, $G_s = [_3^{5-1} (li + U\ U)$

Where;

s = t-k, and

$$-y.=r_1c,+sr_3^{oq\ S-1}(r2+r_3r.)c._5+2:r_3u_{t\cdot s}^{=0\ S} \quad ,, \quad (8)$$

Total (or final) multipliers are given as;

Zyn/Scjk or

$$ri+sr_3^{m\ fr-1}(r_2+r_3r,) = r,+c\,i - r_3 > c\,r_2+r_3^{-1}\,Ti > \quad w$$

2.4 The Estimation Procedure of The Model

In an empirical estimation of the model the blocks consisting of more than one equation may be estimated by one of the simultaneous equations methods (13). Single equation techniques may be employed to estimate the behavioural relations in the single equations block. In our case, it is suggested that the model may be estimated by a two-state procedure. That is, the stage 1 involves estimation without reference to a preference function, while the stage 2 involves the application of the estimates for prediction or/and policy-making purposes without reference to data or probability (estimation ofunknown parameters) problems (12).

Since it is recognized that e&J&sJ observations are likely to be only data available for situations in which the model is to be applied, we eliminate all desired variables (or ex ante values) presumed to enter the decision-making processes of each behavioural units from the model (14). By this way it is believed that the resulting structural form will be consistent with observable characteristics of the regional economy. This will increase the usability of the model.

2.5 The Main Relationships of Econometric Model:

The recursive feature of the proposed model may be illustrated as the following diagram in which each block has only one or more than one equations within itself.

The first block:	Sectoral Productions
The second block:	Product Prices, Wages and Demand
The third block:	Sectoral Exports and Imports
The 1th block:	Environmental Protection Aspects
Thef block:	Profits, Taxes and Income

2.5.1 Some Probable Endogenous Variables and Behavioural Relationships:

Each block in the model may involve at least one or more of the following most relevant endogenous variables which in turn determine the size of the model.

(i) Those which are determined as behavioural relationships:

- ■Q- Sectoral outputs (i= 1,2,.....,n sectors)
- -*b* Inter-sector demands
- <"■ Sectoral capital consumption
- ■$- Regional price for sectors outputs
- -*$*- Sectoral investments
- -<* Labour demands (sectors) (j=l,....,n labour types)
- ■£ Wage rates for j-type labour (sectors)
- -$■ Sectoral exports
- ■v- Sectoral use of public facilities
- ■$- Sectoral land use

■*$** Environmental pollution by sectors

■*$*- Labour migration (j=l,2, ...n labour types)

<-Labour supply (j=U2,..... n labour types)

-<- Consumer demand for sectors output

■^ Income distribution (k=0; 1,2, ... y income categories)

•*$*• Population distribution (d= 1,2, ... G areas)

■*b* Regional spending on schools

•*$*■ Regional spending on unemployment (j- 1,2, ...n labour types)

A Regional spending on health

"> Regional spending on housing

4- Regional spending for public protection

(ii) Those which are determined as identities :

■^ Sectoral capital stocks (i=l,2, ...,n sectors)

^ Total labour demand by sectors (c-j =1,2,..... ;n labour types)

<* Average wage rate by sectors (j=l,2, ...,n labour types)

■*b* Total wage expenditures by sectors A

Total wage spending in region

-*$*■ Average wage rate by labour types (j=l,2? .....,n labour types)

4- Land evaluation used by sectors

A Property taxes paid by sectors

-v- Service changes paid by sectors

■v* Total land use by sectors

■*Q** Total green belt type land in the region

^ Total pollution density over the region

*$- Total regional population

A Unemployment by labour types (j=1,2, ... ,n labour types)

■*$*■ Storage of sectors outputs

•*$*- Income taxes paid by sectors

"> Total taxes paid by sectors

-£• Sectoral profits

■*b* Gross regional product

-v^{1}- Total regional government expenditures

■v* Total regional revenue

2.5.2 Some Exogenous Variables :

Among exogenous variables the most relevant for the regions are classified as controllable policy variables and uncontrollable ones are given in the following list:

(i) Those which are controllable policy variables:

■*$*■ Sales taxes

■v* Property tax rates (I =1,2,...,p property types) *4-*

Service charges or tax rates for public facilities •*b*

Regional standards on pollution density

-♦* Average values for property types (1=1,2, ...,p property types)

-O- Regional government expenditures on schools,unemployment,health,etc, -v- Regional government expenditures on parks and recreation ■0-Regional government expenditures on maintenance of roads,etc. ■^ Land classified as green belt areas in the region ^ Regional parks and recreational areas in the region

(ii) Those which are uncontrollable variables:

*> Nationally average price of sector outputs

-Y* Average price of sector outputs in surrounding regions

•*$*■ Transportation cost rates for sector outputs

A Federal tax rate or credit on corporate investment

^ Gross national product

■$■ Interest rates

-> Average wage rates in surrounding regions (j=l,2, ...,n labour types)

-v- Nationally average wage rates (j=l ,2, ... ,n labour types)

-v- Net population increase in the region (birth rate - death rate) -^

Also , lagged endogenous and lagged exogenous variables.

2.5.3 Some Probable Blocks Among Endogenous Variables :

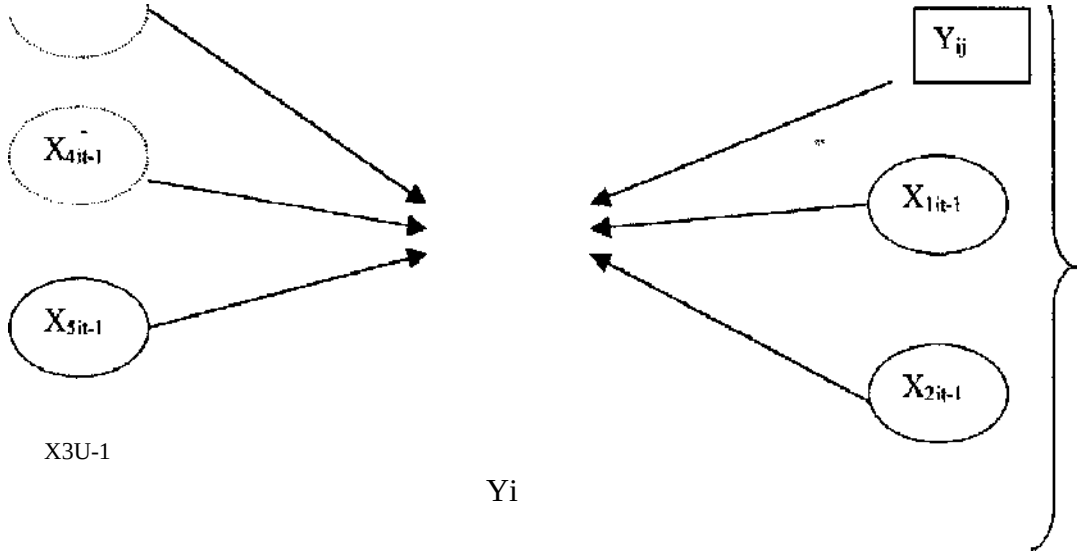
It may be possible to make the first block for the model by involving the sector outputs (i=T,2 ... ,n sectors) and inter-sector demand (i,f =1,2,.....,n sectors) that is output of sector i purchased by sector f. Sectoral capital consumption (i=l,2,,,,,,n sectors) that is depreciation and / or replacement may be indicated as the second block.The third block is likely to involve the regional price for sector outputs,sector investments,sector capital stocks,sector labour demands , total labour demands by sectors,wage rates for j-type labour by sectors,and average wage rate paid by sectors.All other endogenous variables may be taken as single equation recursive manner;that is each equation is a singular block.

The block-recursiveness of the model might be very clearly seen in the following diagram where only the relationships between two blocks (the i^{th} and the j^{th} blocks) are seen ,as an example.In this diagram, current endogenous variables in relevant blocks are illustrated as G; current endogenous variables in previous blocks are illustrated as O; predetermined variables are illustrated as G> < and uncontrollable exogenous variables are illustrated as *CD* .

2.5.4 Possible Uses of the Model:

The econometric model which -is conceptually developed in this paper has two possible uses ; (i) it may be used for deciding on future values of controllable policy variables that maximise the preference function for the regional policy- makers, (ii) it may be used for predicting future values of the endogenous variables assuming given values of the exogenous variables.

Diagram 1; Block-recursive nature of the model between i^{th} and j^{th} blocks (j > i)

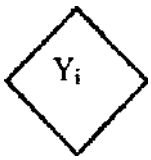


X3U-1

Yi

T
h
e i^{th}
block

Yi



Pj

2v3iM

X4j$_t$-1

Pi

VThej*
/block

XGJ

X7j,.|

T

Where,

Vj : output of sector i (i=l,2, ...,n),(endogenous variable in the i^{th} block).

Vy ; output of sector i purchased by sector j (intersectoral demand) (ij=l,2,..... , n) , (endogenous variable in the i^{1h} block).

xj $i_{t\_}j$: capital stock in sector i in the previous period (lagged endogenous variable ; predetermined for i^{lh} block), i=l,2, ... ,IL

X2h-i : profits in sector i in the previous period , (lagged endogenous variable ; predetermined for i^{th} block), i=l,2, ... ,n.

X3ii_i : nationally average price of output of sector i in the previous period,(uncontrollable lagged exogenous variable), i=l,2,....,n.

xjjM : average price of output of sector i in surrounding regions in the previous period , (uncontrollable lagged exogenous variable), i-l,2>....,n.

xsit-i : storage of sector i in the previous period ,(lagged endogenous variable, predetermined for i block), i=l,2_v...,n.

Pi : regional price per unit of output of sector i,(endogenous variable in the j^{Ih} block),i=l,2, ...,n.

Pj : regional price per unit of output of sector j,(endogenous variable in the j^{Ih} block) ,j=l,2, ...,n.

X_{GJ} : average wage rate paid in sector i,(endogenous variable in the j* block), i=I,2, ... ,a

X7iM regional consumer demand for the output of sector i, in the previous period, (lagged endogenous variable , predetermined for j^{th} block), i=l,2, ... ,a

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