STRUCTURAL PERMANENCE

Its Role in the Analysis of Structural Dualisms and Dependences and for Prediction and Decision Purposes

Camilo Dagum

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Econometric Research Program
Princeton University
207 Dickinson Hall
Princeton, New Jersey

ABSTRACT

The present work is an analysis of the concept of structural permanence and its practical utility. Within it are introduced the concepts of partial and total structural permanence of a sector (equation), groups of sectors or subsystem (subsets of equations) with respect to the rest of the structure or a part of it. We have demonstrated that this concept can serve to contribute to an explanation of the degree of dependence and interdependence between sectors of economic activity and national economies (i.e. international economy). In a like fashion we have introduced the concept of structural permanence as a method of analysis of structural dualisms, a phenomenon that is typical of underdeveloped countries and of critical importance to them.

We proceeded to illustrate a distinction between direct and indirect effects of a structural change upon the rest of the economic structure and its significance in the determination of the degree of structural permanence. At the same time this concept was employed for purposes of identification, illustrating this aspect with a model of instantaneous equilibrium of supply and demand as shown in the classic criticism of E. J. Working (Ref. 19).

The above mentioned concepts were applied in detail to the Wold's market model and to particular structures of that model.

Our analysis of structural permanence with the purpose of prediction, has been performed in the cases of predictable and non-predictable changes. We have distinguished between recursive (causal chain) and interdependent structures, demonstrating the superiority of the former. In particular, when a structure

is recursive, it has eo ipso predictors both in the primary (structural) and reduced forms. Given the condition of localized structural change, we are able to predict a subset of endogenous variables only in the case of a recursive structure. Interdependent structures can be employed for this end in the particular case whereby the performance of a suitable partition enables us to transform a class of subsets of equations into a recursive structure. This analysis deals always with stochastic structures. An important consequence of this analysis is that it becomes possible to make partial eo ipso predictions without the imposition of the ceteris-paribus clause.

Other than the application of the concept of structural permanence for explanation and prediction purposes, it can also be used as a tool in decision-making. We keep clear the distinction between cases where we want to change and cases where we want to preserve a structure. In this context we analyze the relationship between actual and objective structures, and in so doing, formulate a corresponding philosophy for action.

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Princeton University

1. Introduction

Economic theory is an empirical science. It exhibits with increasing clarity and force, a systematic coordination, in the process of scientific construction, of theory and empirical observation.

The empirical base of economic theory permits an estimation of an economic structure. This is, in general, the result of an estimation of parameters corresponding to a mathematical specification of the stochastic process which generates statistical information.

Any structure, in agreement with the definition given in [Ref. 4], is an idealistic and synthetic formulation of a theory that explains a determinate reality; i.e., it represents a significant concordance with that reality. Upon the satisfaction of this requirement - which is coincident with the basic principles of logical empiricism [Ref. 15] - it becomes possible to apply a theory by means of the practical utilization of its corresponding structure.

In effect these applications may be:

1) Used for prediction

2) Used for decision-making.

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In order to achieve these ends, a structure must first undergo an analysis of the structural permanence of its equations. The objectives of decision-making and prediction are more approximated if they are based upon the knowledge provided by this analysis.

Under the name "autonomy" the concept of structural permanence was introduced by Ragnar Frisch [Ref. 6]. T. Haavelmo [Ref. 9] contributed to its systematization. Subsequently, in the 1954 meeting of the Econometric Society, held in Uppsala, the economists R. Bentzel and B. Hansen proposed the name of permanence, a proposal which was accepted by all, including Frisch.

2. The Concept of Structural Permanence (SP)

An equation has the property of structural permanence if it maintains its validity, i.e., continues to explain in a statistical satisfactory way its own sector of economic activity, even when confronted with structural changes, that can invalidate other equation of the structure.

These changes can originate in any of the following causes.

a) Changes in the behavior of economic subjects: changes in consumer preferences which generate new demand equations; changes in the propensities to save or consume with their concomitant effects upon functions of consumption and investment, etc.

b) Technological changes: a consequence of the incorporation of a new technology (indigenous or imported). This will, to cite a few instances, bring about a new production function, a reallocation of resources and change in the import function.

c) Institutional or legal changes: e.g., a reform in the tax structure, in social security, financial structure (change of the rate of interest, Federal Reserve requirement, etc.), laborlegislation. These changes will alter the composition of government spending, investment (public and private), consumption, et. al. These phenomena will give rise to new structural equation in the various sectors of activity.

3. Mathematical Formulation. Partial and Total Structural Permanence

In order to illuminate this concept of structural permanence we will deal with the following linear model.

$$(1) \quad B\, y_t + \Gamma z_t = u_t$$

where:

$B = (\beta_{gj})$ is a non-singular (regular) matrix of the order $G \times G$;

$\Gamma = (\gamma_{gk})$ is a matrix of the order $G \times K$;

$y_t = (y_{gt})$ is the vector of the endogenous variable (of the order G);

$z_t = (z_{kt})$ is the vector of the predetermined variables (of order K);

$u_t = (u_{gt})$ is the stochastic vector (of order G).

If the stochastic model (1) is interdependent we assume that it is identifiable. We assume also that model (1) is specified as eo ipso predictors [Wold[1], Refs. 13 and 14]. That is if it is recursive (causal chain), then, its primary (structural) and reduced form are eo ipso predictors. But, if it is interdependent, only the reduced form is an eo ipso predictor.

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[1] H. Wold [Ref. 13] effected a change in terminology from unbiased to eo ipso predictors on the consideration that the underlying notion of conditional expectation usually enters as an assumption, not as an implication.

The stochastic vector u_t, satisfies the following four requirements. Among them the first is an assumption pertaining to, and the fourth an implication derived from, eo ipso predictors.

i) The mathematical expectation of the vector u_t is the null vector, that is to say:

(2) $$E(u_t) = 0 \Rightarrow E(u_{gt}) = 0 \; ; \quad g = 1,\dots,G \; ; \quad t = 1,\dots,T \; .$$

ii) The components of the vector u_t are mutually independent or, in other words, the matrix of variance-covariance $\Lambda = (\sigma_{gj})$ is a diagonal matrix, i.e.:

(3) $$E(u_{gt}\, u_{jt}) \begin{cases} = 0 & \text{if } g \neq j; \quad g,j=1,\dots,G \; . \\ = \sigma_g^2 = \sigma_{gg} = \text{var}\,(u_{gt}) & \text{if } g=j; \; t=1,\dots,T \; . \end{cases}$$

iii) The components of the vector u_t are not auto-correlated; i.e.:

(4) $$E(u_{gt}\, u_{g,t+\tau}) = 0 \quad \text{if } \tau \neq 0 \; ; \quad g=1,\dots,G \; .$$

iv) The components of the stochastic vector are not correlated with the vector of pre-determined variables; i.e.;

(5) $$E(u_{gt}\, z_{kt}) = 0 \; ; \quad g=1,\dots,G \; ; \quad k=1,\dots,K; \quad t=1,\dots,T \; .$$

Once the parameters that pertain to the model have been estimated, we have the following stochastic structure [Ref. 4]:

(6) $$\hat{B}\, y_t + \hat{\Gamma}\, z_t = \hat{u}_t$$

This is a structure belonging to the set of all possible structures contained in the stochastic model (1).

The vector $\hat{u}_t$, that constitutes the residual, is the empirical interpretation of the stochastic vector u_t . In fact, bearing in mind the concept of the eo ipso predictor, it follows:

(7) $$\hat{B}\,\hat{y}_t + \hat{\Gamma}\,z_t = 0$$

Subtracting (7) from (6):

(8) $$\hat{B}(y_t - \hat{y}_t) = \hat{u}_t$$

then:

(9) $$y_t - \hat{y}_t = \hat{B}^{-1}\,\hat{u}_t \quad .$$

The residual $\hat{B}^{-1}\,\hat{u}_t$ is a statistical estimation and empirical interpretation of the difference between the observed vector y_t and the estimated vector $\hat{y}_t$. It can be derived directly from the correspondent reduced form of the structure (6). In effect:

(10) $$y_t = -\hat{B}^{-1}\,\hat{\Gamma}\,z_t + \hat{B}^{-1}\,\hat{u}_t$$

(11) $$\hat{y}_t = E(y_t\,|z_t) = -\hat{B}^{-1}\,\hat{\Gamma}\,z_t$$

whose difference reproduces (9).

The concept of structural permanence will be applied to the stochastic structure (6). With that purpose, we will introduce the notion of partial and total structural permanence of an equation or subset of equations.

Using J as a symbol for the set of G integers (which is in a one-to-one correspondence with the set of equations of structure (6)), we have:

(12) $$J = \{1,2,\ldots,G\}$$

(13) $$J_T \subset J; \quad J_T^C = J \setminus J_T = J \cap J_T^C \neq \emptyset$$

$\emptyset$ symbolizes the empty set and J_T^C the complement of J_T in J.

(14) $$J_P \subset J; \quad J_E \subset J; \quad J_P \cap J_E = \emptyset$$

$$J_P \cup J_E \neq J \Rightarrow J \setminus (J_P \cup J_E) \neq \emptyset$$

where J_T, J_P and J_E are subsets contained in J and which fulfill conditions (13) and (14).

Then:

(15) $$SP\,[J_P\,(J_E)] = SP\,(J_P \mid \text{structural changes in } J_E).$$

Given the structural changes in the subset (subsystem) J_E, (15) symbolizes the degree of partial structural permanence of the subset (subsystem) J_P.

(16) $$SP\,[J_T\,(J_T^C)] = SP\,(J_T \mid \text{structural changes in } J_T^C).$$

Given the structural change in any or all of the remaining equations (J_T^C), (16) symbolizes the degree of <u>total structural permanence</u> of the subset (subsystem) comprised of the J_T equations of structure (6).

If $J_P = \{g\}$, then (15) symbolizes the degree of partial structural permanence of the equation g^{th} with respect to the subsystem formed by the set J_E, where $g \notin J_E$, in agreement with (14). The subset J_E can be such that $J_E = \{j \mid j \neq g\}$; which is to say it has only one element, in this case, the j^{th} equation. Likewise in (16), if $J_T = \{g\}$, the degree of total structural permanence is that of the g^{th} equation.

4. Quantitative Measurement and Explanation: Dualism, Dependence and Interdependence

If one interprets (15) and (16) in terms of probability, which is to say that they assume values in the interval [0,1], one can reach some interesting conclusions about the way in which a specific economic system operates; moreover the same technique can be employed for decision-making and prediction. Indeed, if (15) takes on values that approach zero, one can advance the conclusion that the structure of the subsystem which is explained by the set of equations associated with J_P are strongly dependent upon the structure of the subsystem explained by the set of equations that is associated with J_E. That is to say, that the J_P substructure is vulnerable to changes in the J_E substructure. More categorically, this substructure (J_P) is a function of the J_E substructure. In contrast, if (15) takes on values that approach one, one can conclude that the J_P substructure is almost completely independent of the J_E substructure.

From the foregoing argument one can derive a conclusion that is eminently practical; vix., the application of the degree of partial and total structural permanence as a measurement of structural dependence and interdependence, independence being a particular and limiting case of dependence.

One particular case of independence, in a national economy, is structural dualism (dual economy), a phenonmenon typical of underdeveloped economies.[2]

Wide application can be made of the determination of structural dependence and interdependence, both in the intersectorial analysis of a national economy as well as in the analysis of international economic relations.

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[2] In an underdeveloped economy, structural dualism is significant of the co-existence of a highly developed and efficient economic activity (modern economy) with another that is inefficient and backward (a primitive economy); with the further proviso that between them there is very little economic interchange. Such would be the case in a country with a localized modern mining industry that produces for export and, alongside of that, a primitive agricultural sector characterized by latifundia and their complementary minifundia.

The Leontievian models made manifest the degree of intersectorial dependence in the functioning of an economic system (within a given structure). At the same time, these models opened the door for the introduction of structural change as an objective of economic policy. The concept of structural permanence contributes to the quantitative formulation of such a policy by means of the estimation of the degree of permanence of a sector or subset of sectors, given the assumption of structural changes in one or more other sectors of the structure under consideration.

In the realm of international economics, the knowledge of the degree of permanence illuminates the vulnerability and dependence of some national economies. An explanation along these lines has implications for the formulation of predictions and for decision making; this assertion is applicable to national economies as well as international institutions, such as the World Bank, one of whose tasks is to contribute to the stable development of national economies.

An example that illustrates this point might be the following:

a) Country I is the world's principal producer and exporter of a mineral, e.g. tin. The economy of this nation is under-developed and its GNP depends upon this economic activity.

b) Country II is highly developed and industrialized; it is the principal importer of Country I's tin and the international price of this mineral is determined in country II's national market.

Leaving unspecified, for the moment, the mathematical law of correspondence between its variables, the economic structure of the afore-mentioned countries can be symbolized by means of the following partitioned matrix [Ref. 5]:

$$S = \begin{pmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{pmatrix} \qquad (17)$$

A_{11} symbolizes the domestic structure corresponding to Country I (A_{22} for Country II). A_{12} symbolizes the structure corresponding to the flow (export) of goods, services, capital, labor etc. from Country I to Country II and A_{21} same process in reverse order (Country II to Country I).

Bearing in mind assumptions a) and b), we can deduce that the economy of Country I is highly dependent (vulnerable) with respect to structural changes in Country II, which changes could imply changes in the quantity of tin as well as its price. Moreover, if Country II decides to cut back drastically on imports from Country I, reducing to near zero the economic activity of structure A_{12}, this action will affect the kernel [Ref. 10] of activity in A_{11}. The result will be unemployment and a drop in the GNP of Country I, which would, in turn, generate structural changes. We can conclude, then, upon the basis of the expected change in A_{11}, that the internal economy of Country I has a very low level of structural permanence in respect to the structural changes in country II that affect the price of tin and/or the amount imported.[3]

The structural changes in A_{12} can be direct (a result of Country II's import policy) or indirect (generated by structural changes in A_{22}).

For the particular case that interests us, it follows:

(18) $$SP\ [\ A_{11}\ (A_{12})\ ]\ \rightarrow\ 0\ .$$

The direction of structural change in A_{12} will condition the direction of change in A_{11} and A_{21}. A steady growth in international demand may result in better prices and increased production in Country I. A big drop in international

[3]Some of the possible causes might be, i) the discovery and exploitation of new tin mines in Country I, ii) a technological change that increases the demand for tin, or which presents an efficient substitute for it (thereby lowering demand).

demand would produce the opposite effect. By virtue of assumptions a) and b), structural changes that have a significant effect on the international tin market, will not only affect the level of activity within its pre-existing structure, but also condition the changes within that structure.

The degree of structural permanence is a useful methodological device for the localization, delimitation, and objective explanation of dualism, structural dependence and interdependence. And, for this reason, further illuminates the levels of integration or disintegration between sectors of economic activity within a national economy or between two or more countries within the world-economy. A high degree of asymmetric structural dependence will localize a kernel with respect to changes in the dominant sector or economy.[4]

5. Analysis of the Wold Market Model

For purposes of illustration the concepts developed in the previous sections will be applied to a particular structure. Given a good X, in a specific market, the set of behavior units in relation to good X can be disaggregated into three sectors: consumers (C), producers (P), and intermediaries (I). Operating under the assumption of linearity and using those economic variables that are most relevant, we arrive at the following market-model of Wold.

$$(19.1)\quad D_t = \alpha_1 - \beta_1 P_t + u_{1t}, \quad \alpha_1, \beta_1 > 0$$

$$(19.2)\quad S_t = \alpha_2 + \beta_2 P_{t-1} + u_{2t}, \quad \beta_2 > 0$$

$$(19.3)\quad P_t = P_{t-1} + \lambda (D_{t-1} - S_t) + u_{3t}, \quad \lambda > 0 .$$

[4] The concept of kernel or core in that context were introduced by O. Morgenstern [Ref. 10]. There he analyses the role of a kernel, of a given state of technology, and the asymmetric relationships among sector of an economy, among other important questions.

The more compact matrix expression of this model is

(20) $$B y_t + \Gamma_1 z_t = u_t \ .$$

Being:

(21.1) $$B = \begin{pmatrix} 1 & 0 & 0 \\ \lambda & 1 & 0 \\ 0 & \beta_1 & 1 \end{pmatrix} ; \quad y_t = \begin{pmatrix} S_t \\ P_t \\ D_t \end{pmatrix} ; \quad u_t = \begin{pmatrix} u_{2t} \\ u_{3t} \\ u_{1t} \end{pmatrix}$$

(21.2) $$\Gamma_1 = (\alpha, \Gamma) ; \quad \alpha = \begin{pmatrix} -\alpha_2 \\ 0 \\ -\alpha_1 \end{pmatrix} ; \quad \Gamma = \begin{pmatrix} 0 & -\beta_2 & 0 \\ 0 & -1 & \lambda \\ 0 & 0 & 0 \end{pmatrix}$$

(21.3) $$z_t = \begin{pmatrix} 1 \\ y_{t-1} \end{pmatrix} = \begin{pmatrix} 1 \\ S_{t-1} \\ P_{t-1} \\ D_{t-1} \end{pmatrix} .$$

Bearing in mind the notations introduced in (21), (20) can be expressed in the following form:

(22) $$B\, y_t + \alpha + \Gamma\, y_{t-1} = u_t \ .$$

By virtue of (19) there exists the following particular or deterministic equilibrium solution for (22):

(23) $$y^* = \begin{pmatrix} S^* \\ P^* \\ D^* \end{pmatrix} = \frac{1}{\beta_1 + \beta_2} \begin{pmatrix} \alpha_1 \beta_2 + \alpha_2 \beta_1 \\ \alpha_1 - \alpha_2 \\ \alpha_1 \beta_2 + \alpha_2 \beta_1 \end{pmatrix} \Longrightarrow S^* = D^* = q^* .$$

In fact, at the point of equilibrium, we have for (22)

$$By^* + \alpha + \Gamma y^* = 0 \Longrightarrow y^* = (B+\Gamma)^{-1} (-\alpha)$$

which is the result obtained in (23).

Once we estimated the parameters that correspond to the model (20), on the basis of a sample realization of size T, the following stochastic structure is the resultant:

(24.1.2.3) $$\hat{B} y_t + \hat{\alpha} + \hat{\Gamma} y_{t-1} = \hat{u}_t$$

whose corresponding reduced form is

(25) $$\begin{aligned} y_t &= -\hat{B}^{-1} \hat{\alpha} - \hat{B}^{-1} \hat{\Gamma} y_{t-1} + \hat{B}^{-1} \hat{u}_t \\ &= -\hat{B}^{-1} \hat{\alpha} -\hat{B}^{-1} \hat{\Gamma} y_{t-1} + \hat{v}_t \ ; \quad \hat{v}_t = \hat{B}^{-1} \hat{u}_t \end{aligned}$$

Given the initial condition $y_{t_0} \neq y^*$ we can deduce the following solution (with respect to period t_0), which gives the time path of vector y_t :

(26) $$y_t = y^* + (-\hat{B}^{-1} \hat{\Gamma})^{t-t_0} (y_{t_0} - y^*) + \sum_{h=0}^{t-t_0-1} (-\hat{B}^{-1} \hat{\Gamma})^h \hat{v}_{t-h} \ .$$

A special feature of the matrix $(-\hat{B}^{-1} \hat{\Gamma})^{t-t_0}$, which can be immediately verified, is the following:

(27) $$(-\hat{B}^{-1} \hat{\Gamma})^{t-t_0} = \hat{\delta}^{t-t_0-2} (-\hat{B}^{-1} \hat{\Gamma})^2 \ ; \quad t-t_0 \geq 2 \ ; \quad \hat{\delta} = 1 - \hat{\lambda} (\hat{\beta}_1 + \hat{\beta}_2) \ .$$

As a consequence (of (27)) one can deduce that the necessary condition for the dynamically stable behavior of the structure is:

(28) $$|\hat{\delta}| = |1-\hat{\lambda}(\hat{\beta}_1 + \hat{\beta}_2)| < 1 \Longrightarrow 0 < \hat{\lambda} < \frac{2}{\hat{\beta}_1+\hat{\beta}_2} \ .$$

Therefore, inequality (28) is fulfilled for any point $(\beta_1 + \beta_2, \lambda \in \Omega_1$; i.e., the interior of a subspace in the Euclidean plane (Fig. 1, shaded area) limited by the positive halfaxes and the rectangular hyperbola

$$\lambda(\beta_1 + \beta_2) = 2 .$$

If $\hat{\delta}$ satisfies the condition of inequality (28), then:

(29) $$(-\hat{B}^{-1}\hat{\Gamma})^{t-t_0} = \hat{\delta}^{t-t_0-2} (-\hat{B}^{-1} \hat{\Gamma})^2 \longrightarrow 0$$

in consequence, the second term in the right hand side of (26) approaches zero as T increases.

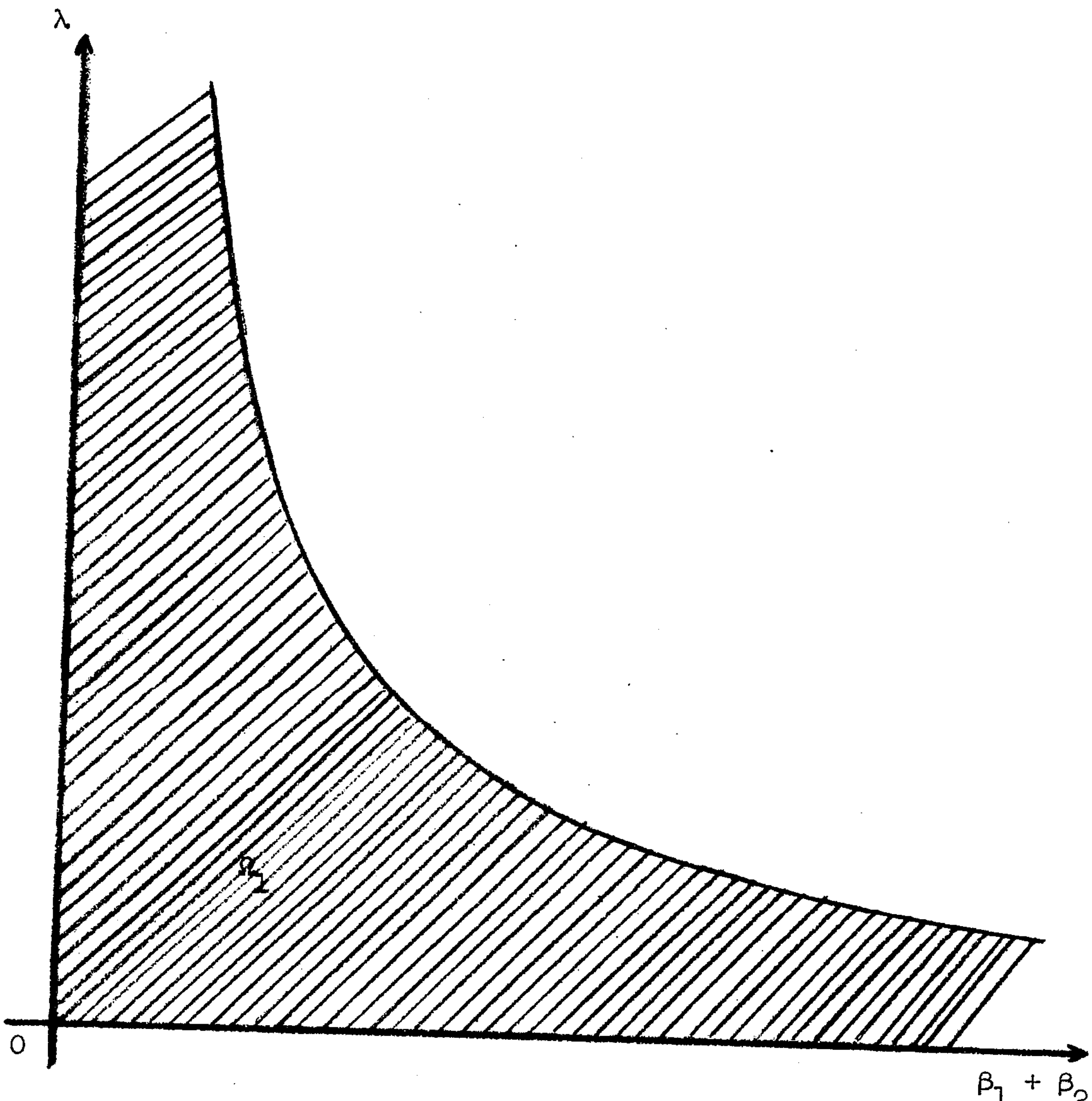

Fig. 1: Parameter Subspace Ω_1

$\Omega_1 = \{(\beta_1 + \beta_2,\lambda)|\beta_1 + \beta_2 > 0, \lambda > 0, \lambda(\beta_1 + \beta_2) < 2\}$

In consequence, the time path of the vector y_t is now explained by two terms:

i) one of which is deterministic and constant, y^* ;

ii) the other being the last term of (26), which is stochastic.

By virtue of the concept of eo ipso predictors, and keeping in mind the substitution (25) for the stochastic vector u_t and the stability condition (28), the stochastic term in (26) has mathematical expectation equal to zero and a bounded variance-covariance matrix.

Accepting the representativeness of the stochastic structure (24) as explanatory of the behavior of the economic subjects (as consumers, producers, and intermediaries of good X , in a specific market), one can expect a high degree of partial and total structural permanence of each one of the equations and subsets of equations of (24). Using the letters C, P and I as symbols for the specification of the equations that describe the behavior of consumers, producers, and intermediaries, respectively, in the enumeration of the members belonging to the index set J in (12), we have

(30) $$J = \{C, P, I\} \quad .$$

Then,

(31) $$SP[C\ (P)]$$

symbolizes the degree of partial structural permanence of consumers in respect to structural changes in the behavior of the producers.

(32) $$SP[C\ (P,I)]$$

symbolizes the degree of total structural permanence in the behavior of the consumers in respect to changes that might occur in the rest of the structure (24), and

(33) $$SP[P(C)]$$

symbolizes the degree of partial structural permanence in the behavior of the producers in respect to structural changes in the behavior of the consumers.

The remaining six combinations between the members of (30) are obvious. It should be observed that (31) and (33) are conceptually distinct.

The extreme cases are worthy of our consideration. With respect to (31) they are:

(34) $$SP[C(P)] = 1$$

(35) $$SP[C(P)] = 0$$

(34) indicates to us that the behavior of consumers is <u>independent</u> with respect to behavioral, technological, institutional, and legal changes that might affect the behavior of producers. (35) tells us that the behavior of consumers is <u>dependent</u> upon changes in the behavior of the producers. This is the general situation of the equation under the reduced form, with the exception of recursive structures, and more restrictively, partitionable structures. Indeed, an equation that belongs to the reduced form of the structure, generally contains parameters that belong to all the equations of the structure in its primary form. Then its structural permanence will approach zero if said equation is a function of all the parameters of the structure to which it belongs. In that case, it will change in respect to structural changes that significantly alter any of the other equations that derive from the same structure.

This concept may then be applied to the reduced form (25), in which case the equations may be expressed in the following explicit forms:

(36.1) $S_t = \hat{\alpha}_2 + \hat{\beta}_2 P_{t-1} + \hat{u}_{2t}$

(36.2) $P_t = -\hat{\lambda}\hat{\alpha}_2 + (1-\hat{\lambda}\hat{\beta}_2) P_{t-1} + \hat{\lambda} D_{t-1} - \hat{\lambda}\hat{u}_{2t} + \hat{u}_{3t}$

(36.3) $D_t = \hat{\alpha}_1 + \hat{\lambda}\hat{\alpha}_2\hat{\beta}_1 - \hat{\beta}_1(1-\hat{\lambda}\hat{\beta}_2) P_{t-1} - \hat{\beta}_1\hat{\lambda} D_{t-1} + \hat{\lambda}\hat{\beta}_1\hat{u}_{2t} - \hat{\beta}_1\hat{u}_{3t} + \hat{u}_{1t}$.

The equation (36.1) has not changed its degree of permanence; it is identical to its corresponding equation in structure (24). The structural permanence of (36.2) depends on the structural permanence of (24.1), or, to say the same thing, (36.1). Any change in the behavior of the producers that will imply a different specification for (19.2) or a different estimation for its parameters α_2 and - or β_2 and - or σ_{22} will invalidate the practical utilization of (36.2). On the other hand, it will maintain its validity with respect to structural changes in (24.3), that is, with respect to the behavior of consumers. (36.3) has neither partial nor total structural permanence. Since it is a function of all the parameters of (24),(36.3) will be invalidated by any change in (24.1), (24.2), or both.

We can observe, symbolically, that SP[P(I)] takes on the same value in (24) and (36), but: SP[I(P)] assumes a high value in (24) and is practically zero in (36). The interpretation of the other cases clearly follows.

The special features of the degrees of partial and total structural permanence of the equations of (36) in its reduced form, are due to the recursiveness of the stochastic structure (24) from which it ((36)) was derived. In its reduced form, the degree of partial or total structural permanence of the equations and subsets of equations of an interdependent structure, is practically null.

6. A Numerical Example

Given a sample realization of size T , we may estimate the parameter vector.

(37) $$\hat{w} = (\hat{\alpha}_1, \hat{\alpha}_2, \hat{\beta}_1, \hat{\beta}_2, \hat{\lambda}, \hat{\sigma}_{11}, \hat{\sigma}_{22}, \hat{\sigma}_{33}) \in \Omega$$

which belongs to parameter space Ω [Ref. 4], and which is determinate of the stochastic structure symbolized in (24). This structure is a member of the family of structures (model) specified in (19).

If one supposes that in (37):

(38) $$\hat{w} = (8;\ 1.50;\ 0.80;\ 1.60;\ 0.50;\ 0.20;\ 0.07;\ 0.09) \in \Omega$$

when the time path of the vector y_t given in (26) is stable, by virtue of (27), because $\hat{\delta} = -0.20$. In effect:

(39) $$y_t = y^* + (-0.20)^{t-t_0-2} (-\hat{B}^{-1}\hat{\Gamma})^2 (y_{t_0} - y^*) + \sum_{h=0}^{t-t_0-1} (-\hat{B}^{-1}\hat{\Gamma})^h \hat{v}_{t-h}$$

$$= y^* + (-0.20)^{t-t_0-2} (-\hat{B}^{-1}\hat{\Gamma})^2 (y_{t_0} - y^*) + \hat{v}_t - \hat{B}^{-1}\hat{\Gamma}\, \hat{v}_{t-1} + (-\hat{B}^{-1}\hat{\Gamma})^2 \sum_{h=2}^{t-t_0-1} (-0.20)^{h-2} \hat{v}_{t-h}$$

whose determinist component converges at y^* . Its numerical value, in agreement with (23) and (38) is:

(40) $$y^* = \begin{pmatrix} S^* \\ P^* \\ D^* \end{pmatrix} = \frac{1}{2.40} \begin{pmatrix} 24.80 \\ 6.50 \\ 24.80 \end{pmatrix} .$$

A change in producer behavior, due to a greater sensitivity in respect to variations in prices, as, for example, a greater price elasticity of production, might not affect the behavior of consumers and intermediaries. In this case, the remaining equations of structure (24), viz. (24.2) and (24.3), continue explaining their respective sectors of activity. On the other hand, (36.2) and (36.3), since they do not possess structural permanence with respect to (24.1), will be affected by changes in (24.1). With greater reason, the three equations in (39) will manifest a different time-path. If, as a consequence of the change in the price elasticity of production we estimate

$$\hat{\beta}_2 = 3.40$$

then, the time-path of vector y_t in (39), because $\hat{\delta} = -1.10$, will become divergent or explosive. Thus, in passing from $\hat{\delta} = -0.20$ to $\hat{\delta} = 1.10$, the vector y_t has undergone an exceptionally important change of time-path as a result of the change in the estimation of β_2 as illustrated above.

Our analysis up to this enables us to advance the conclusion that the degree of structural permanence of these equations can also contribute to an explanation of the generative causes of inflation. In order to do this, our analysis should concentrate on macro-economic structures, whose variables should be suitably disaggregated.

7. Direct and Indirect Effects

The concept of structural permanence and its measurement should be expressed with explicit reference to the direct and indirect effects of structural change.

By direct effects we mean the degree of structural permanence of an equation or subset of equations within a short interval as the result of behavioral, technological, or institutional changes that can invalidate another equation (or other equations) of the same structure.

But a structural change of this type might just as well generate changes in a class of economic subjects that is not explained by the structure under consideration. These changes might then, in turn, invalidate one or more equations of the original structure. This type of causal process of change is characterized by what we call indirect changes.

This distinction between direct and indirect change are not applicable to macroeconomic structures, the variables of which are suitably disaggregated into acceptably homogenous classes of behavioral units and which (i.e. these structures) explain the functioning of an economic system as a whole.

But if we are dealing with the isolated explanation of a subsystem, sector or sub-sector of economic activity, it is necessary that we bear in mind the possible indirect effects in the degree of structural permanence. Such might be the case of structure (24) which explains the configuration of prices, production, and consumption of a good, X , in a specific market. In effect, a change in structure (24.1), determined by a change in the behavior of producers, owing to the incorporation of a new technological advance, a tax cut or increase, etc., could well generate a redistribution in the composition of total consumer expenditures. Such a redistribution will produce a change in the demand equation (24.3).

The degree of price and income elasticity of demand of certain goods, in particular that self same X , and its complementary goods and substitutes, will determine a modification of the composition of expenditure, and in consequence, in the elasticity of demand in respect to price and income. These changes in equations that are not included in structure (24), which explains a subsystem of activity, are those that reflect back upon (24) in order to generate a change in the demand equation. For this reason, the degree of structural permanence of (24.3) is less than one first suspects, if one considers structure (24) as an autonomous explanatory unit.

The causal chain previously explained is a general characteristic of the functioning of an economic system. This characteristic, owing to the causal intervention of equations that belong to the system but not the subsystem, conditions the real structural permanence of the equations of a subsystem. These external equations serve as intermediary (or indirect) causes in the process of change.

The degree of structural permanence and the magnitude of indirect effects are not only conditioned by the characteristic of the structure itself (in as much as it explains a system or subsystem, etc.). Rather, it is conditioned, in general, by whether the structure pertains to a basic or derived model. As Haevelmo explained it [Ref. 9]. "It is obvious that the autonomy (permanence) of a relation is a highly relative concept, in the sense that any system of hypothetical relations between real phenomena might itself be deducible from another, still more basic system, i.e., a system with still higher degree of autonomy with respect to structural changes. The construction of systems of autonomous relations is, therefore, a matter of intuition and factual knowledge."

In sum, the degree of structural permanence is neither a mathematical property nor the result of the analysis of a given structure. It does not try to "see through" the equations. It is, in contrast, the result of the fecundity of a system of hypothesis (the generality of its postulates) which is derived from the real behavior of economic subjects and their degree of dependence. Thus, the foundation and justification of this concept is firmly rooted in the domain of economic theory.

8. Structural Permanence and Identification

The degree of structural permanence constitutes information that can contribute towards the identification of an equation that is underidentified with respect to the information proceeding from the *a priori* restrictions placed upon the parameters of the model of which it belongs. Such is the case of the now classic model of supply and demand (under the assumption of moving equilibrium). That is

$$
(41) \qquad
\begin{aligned}
D_t &= \alpha_1 - \beta_1 P_t + u_{1t} \qquad \alpha_1, \beta_1 > 0 \\
S_t &= \alpha_2 + \beta_2 P_t + u_{2t} \qquad \beta_2 > 0 \\
D_t &= S_t = q_t
\end{aligned}
$$

If the behavior of the "suppliers", during a period T - corresponding to a sample observation - has been submitted to successive structural changes, and the behavior of the "demanders" has a high degree of structural permanence, let us say γ % (but we lack information about the actual behavior of the "demanders" in period T), then we may conclude, with a probability of γ % , that the equation estimated *is* the demand equation (41.1).

This is an interpretation, in terms of degrees of structural permanence, of the particular case illustrated in (41), which is the classical problem posed by E. J. Working in 1927 [Ref. 19].

The concept of structural permanence is implicit in the analysis of Working. The alternatives that he presents correspond, in reality, to the different degrees of permanence of one equation in respect to changes in another. This analysis throws light upon Working's *correlated shifts* of the functions of supply and demand. In this case, the fitted function is neither a function of supply nor of demand.

predictions. If the probability is greater than or equal to 1/2, then our prediction is by region (an interval, ellipse, or ellipsoide, depending on whether we are dealing with one, two or more dimensions).

The types of prediction under consideration are scientific predictions. They belong to that category of predictions which are verifiable under the conditions and methodology imposed by our formulation. More restrictively, all such predictions must recognize a theoretical basis and follow a scientific methodology. In order to do this it is necessary that we begin with explicit evaluations of the structural conditions of the phenomenon under consideration and progress to clear statements of the structure corresponding to the period comprehended by our prediction.

The ceteris paribus clause is highly restrictive, perhaps too much so, as a criterion of scientific prediction in social science. It corresponds to the extreme case of certainty; i.e., a proability of one (theoretical certainty) or $p \geq 1-\epsilon$, $\epsilon > 0$ (practical certainty) for the measurement of the maintenance of the estimated structure during the period covered by the prediction. It becomes necessary, then, to formulate an explicit statement of the maintenance or change of the structure under consideration (within the period of prediction). In this last case, we likewise need a statement of the degree of partial and total structural permanence as a probabilistic measurement of the expected effect of changes in other equations upon the subset under consideration. In this manner we are able to give an explicit historical (temporal) conditioning to our predictions.

These requirements become even more necessary when we undertake economic investigations in the context of frequent structural changes. This realization explains the affirmation of Haavelmo [Ref. 9] wherein he maintains: "Every research worker in the field of economics has, probably, had the following experience: When we try to apply relations established by economic theory to actually observed series for the variables involved, we frequently find that the theoretical relations are unnecessarily complicated; we can do well with fewer variables than assumed a priori. But we also know that, when we try to make predictions by such simplified relations for a new set of data, the relations often break down, i.e., there appears to be a break in the structure of the data. For the new set of data we might also find a simple relation, but a different one."

10. Structural Maintenance and Prediction

Predictions conceived under conditions of structural maintenance are ceteris paribus predictions. In effect, given a dynamic model, and symbolizing by $y_1^*, \dots y_T^*$, a sample realization during T periods, we can use this information in the prediction of $y_{T+1}, \dots, y_{T+n}$. Let $E_1 = (y_1, \dots, y_T)$, be a variable vector in a sample space of T dimension; $E_2 = (y_{T+1}, \dots, y_{T+n})$, a variable vector in a sample space of n dimensions; $E = (y_1, \dots, y_T, y_{T+1}, \dots, y_{T+n})$, a variable vector in a sample space $T + n$ dimensions; $\hat{E}_2 = (\hat{y}_{T+1}, \dots, \hat{y}_{T+n})$, a point within an n-dimensional sample space. The probability of events E, E_1, E_2, is, respectively:

(42) $$p(E) = p(y_1, \dots, y_{T+n})$$

(43) $$p_1(E_1) = p_1(y_1, \dots, y_T)$$

(44) $$p_2(E_2|E_1) = p_2(y_{T+1}, \dots, y_{T+n}|y_1, \dots, y_T)$$

then

(45) $$p(E) = p_1(E_1)\ p_2(E_2|E_1) \quad .$$

The assumption of maintenance in the period [T+1, T+n] of the structure estimated in the period [1,T], that is to say the introduction of the *ceteris paribus* clause, and the added assumption that the sample realization $E^* = (y_1^*, \ldots, y_T^*)$ possess sufficient degrees of freedom to enable us to estimate the parameter vector $\omega \in \Omega$, imply that the specification of $p_1(E_1)$ is sufficient for the complete specification of $p(E)$ and $p_2(E_2|E_1)$. Moreover, the sample realization and the specification of the probability distribution law permits an estimation of the parameter vector $\omega = (\omega_1, \ldots, \omega_N)$. That is to say, $\hat{\omega} = \hat{\omega}(y_1^*, \ldots, y_T^*)$. Then:

$$(46) \qquad p_1(E_1;\omega) = p_1(y_1, \ldots, y_T;\ \omega_1, \ldots, \omega_N) \quad .$$

By virtue of the *ceteris paribus* clause, the probability functions in (42) and (44) are also functions of the vector ω. In consequence

$$(47) \qquad \hat{E}_2 = \hat{E}_2(y_1^*, \ldots, y_T^*;\ \hat{\omega}_1, \ldots, \hat{\omega}_N) = (\hat{E}_2|E_1^*, \hat{\omega})$$

defines a point prediction. Given a significance level and a law of distribution of prediction, one can estimate a confidence region.

Eo ipso predictions, made under the assumption of the maintenance of the structure, are, in essence, projections of the time-path of jointly determined variables, whose numerical values are a function of those values corresponding to the vector of predetermined variables. This particular case may be illustrated by means of structure (24), which belongs to model (19), and its reduced form (25), the equations of which are written in full in (36). For the period T, given the numerical value of the components of the vector

$$(48) \qquad y_t' = (S_t, P_t, D_t)$$

one can estimate the expected value of vector (48) for all $t > T$. Employing (25) or (36) we have:

$$(49) \qquad \hat{y}_{T+1} = E(y_{T+1} | y_T) = -\hat{B}^{-1}\hat{\alpha} - \hat{B}^{-1}\hat{\Gamma}\, y_T \quad .$$

Prediction (49) furnishes the necessary information for the prediction of (48) in the period $T + 2$, etc., always under the assumption of the maintenance of structure (24).

The process of prediction, as previously explained, requires the successive prediction of all the periods posterior to the last one observed, in this case, period T. The utilization of (26), which is the solution of the system of difference equations of (25), permits the direct prediction of vector y_t for all $t > T$, without the necessity of performing the same process for the intermediate periods. For any natural (integer and positive) h, it follows:

$$(50) \qquad \hat{y}_{T+h} = E(y_{T+h} | y_{t_0}) = y^* + (-\hat{B}^{-1}\hat{\Gamma})^{T+h-t_0} (y_{t_0} - y^*)$$

where y^* is given in (23).

If the parameter vector (38) is an estimation of the structural parameters of (19), then (50) may be obtained from (39). The value of y^* is given in (40).

Structure (24) is a recursive structure that corresponds to model (19), introduced and systematized by Herman Wold [Ref. 12 and 18]. The recursive process and, likewise, the prediction process (by period) is graphically illustrated in Fig. 2, making use of the arrow scheme introduced by Jan Tinburgen [Ref. 12].

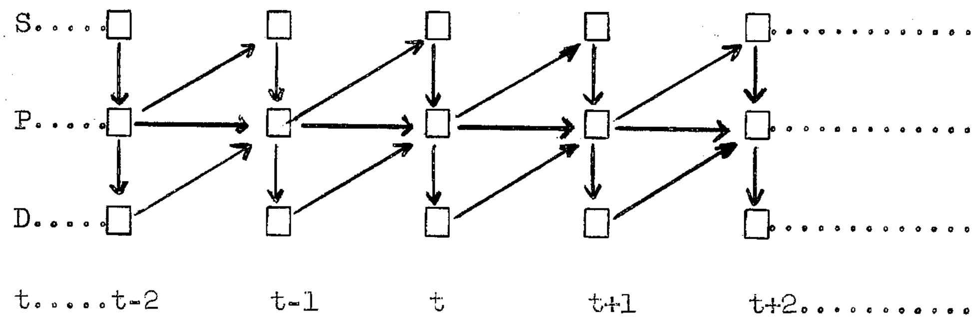

Fig. 2: Arrow Scheme Corresponding to Wold's Model.

11. Structural Change and Prediction

Scientific predictions under conditions of structural change are only admissable when we are first able to formulate consistent hypotheses concerning the direction, the quantitative magnitude and the time period of structural changes. In order to estimate the quantitative magnitude of an expected change, it is necessary that we first estimate the new structural parameters and that we perform a statistical analysis of the significance of the change, with respect to those previously estimated parameters.

The direction of the change implies a statement concerning the expected impact of a change in one sector (or sectors) of activity upon the remaining sectors of the structure. In this analysis, the concept and measurement of partial and total structural permanence enters fully into play, as does the distinction between recursive and interdependent structures. And in the latter case the distinction is made between partitionable and non-partitionable structures.

12. Hypotheses of Predictable Structural Change

Hypothesizing that structural changes, within a given time, and of a certain magnitude, can be predicted, it is necessary that we take into consideration the nature of the expected change, and that we further consider whether the other sectors of the structure possess a high degree of permanence in respect to the expected change.

If the equations that explain the behavior of the economic subjects in the remaining sectors do not have structural permanence, then the prediction process will have to be cognizant of changes in these sectors which are resultant of the initial structural change under consideration.

From the foregoing argument it can be seen that the vector $\omega \in \Omega$ is now a function of time. So that:

(51) $$\omega(t) = [\omega_1(t),\ldots,\omega_N(t)] \in \Omega \quad .$$

For the particular case of model (19) we have the following parameter vector:

(52) $$\omega(t) = [\alpha_1(t),\ \alpha_2(t),\ \beta_1(t),\ \beta_2(t),\ \lambda(t),\ \sigma_{11}(t),\ \sigma_{22}(t)\ \sigma_{33}(t)] \in \Omega \ .$$

The process of prediction is performed period by period, beginning with the $(T + 1)^{th}$ period. If we assume:

i) Structure (24) explains the behavior of the consumers, producers and intermediaries of good X up to the period $t_1 > T$;

ii) Beginning with period t_1 , the process of structural change explained by (52) becomes operative. It is assumed that this process has passed, without a loss in generality, from structure (24) to other, significantly different, structure that are also members of model (19) [Ref. 4];

iii) In (52), the parameters are specified and estimated as a function of time. Consequently, we have:

(53) $$\hat{\omega}(t) \in \Omega$$

iv) The ultimate period, for which there is statistical information concerning the variables belonging to structure (24), is T .

Within the period of predictable change, and for all $t > t_1$, the estimation of the jointly determined variables (48) follows directly from these four assumptions. So that, by substituting vector (53) for the parameter vector $\hat{\omega}$ in (24), we have the new structure

(54) $$\alpha(t) + \hat{B}(t)\, y_t + \hat{\Gamma}(t)\, y_{t-1} = \hat{u}_t \quad .$$

For every t there is a specific structure in (54), upon the basis of which we may estimate vector (48) as a function of observed values, or failing the possession of empirical data for this period, as a function of the values estimated for the $t-1$ period. That is:

(55) $$\hat{y}_t = E(y_t | y_{t-1}) = -\hat{B}^{-1}(t)\,\hat{\alpha}(t) - \hat{B}^{-1}(t)\,\hat{\Gamma}(t)\, y_{t-1} \quad .$$

13. Hypothesis of Unpredictable Structural Changes

Under conditions of structural changes of unpredictable magnitude, the process of prediction becomes impossible, if we consider the intervention of the equations affected by the change. The remaining equations of the structure are utilized to the extent that they possess a high degree of structural permanence. If they do, then we may look at this phenomenon from two distinct vantage points:

a) recursive structures

b) interdependent structures.

13.a: Recursive Structures

For the case of recursive structures we can say: if the anticipated change modifies only the last G-r equations, then the first r equations will maintain their validity for prediction purposes. Following Wold's method of analysis [Ref. 13], a recursive model takes the following form:

$$(56) \qquad y_{gt} = L_g(y_{1t},\dots,y_{g-1,t};z_t) + u_{gt} \;; \quad g=1,\dots,G$$

$$= L_g(y_{1t},\dots,y_{g-1,t};\, y_{t-1},y_{t-2},\dots,;x_t,x_{t-1},\dots) + u_{gt}$$

where L_g is a linear operator; z_t is the vector of predetermined variables partitioned in order to express: 1) $y_{t-1},y_{t-2},\dots$, the vector of lagged endogenous variables; 2) x_t, $x_{t-1},\dots$, the vector of exogenous variables with and without lags. Each one of these equations is an eo ipso predictor, as are all of their respective equations in reduced form. This is a property specific to recursive models, a property that interdependent stochastic structures do not possess, as was shown by Wold [Ref. 13] in theorems 4 and 9.

Given that a structure belonging to (56) has been estimated, and given that it is reasonable to anticipate structural changes in the ultimate G-r equations of the recursive structure during the period of prediction, then, working under the assumption of the partial and total structural permanence of the first r equations, it is possible to predict the values of the first r endogenous variables; i.e., it is possible to predict the values of $y_{1t},\dots,y_{rt}$. This is possible by virtue of the fact that, in its primary form, the recursive structure is an eo ipso predictor. Because of this property, the structural parameters of those equations affected by the change in question do not enter into the prediction. Thus:

$$\begin{aligned}\hat{y}_{gt} &= E(y_{gt}|y_{1t},\ldots,y_{g-1,t};\ y_{t-1},y_{t-2},\ldots;\ x_t,x_{t-1},\ldots) \\ &= \hat{L}_g(y_{1t},\ldots,y_{g-1,t};\ y_{t-1},y_{t-2},\ldots;\ x_t,x_{t-1},\ldots)\end{aligned} \tag{57}$$

where the symbol $\hat{L}_g$ indicates that the parameters corresponding to linear operator L_g have been estimated. For $g > r$, prediction is no longer possible, since in (57) we are presented with some equations that will, by hypothesis, change.

13.b: Interdependent Structures

In the case of interdependent structures, predictions are made on the basis of the structure in its reduced form. Because parameters of the equations of the structure (in reduced form) are affected by structural change, i.e., do not have structural permanence, it is not possible to make predictions under conditions of structural change.

In specific cases however, it is possible to make predictions of a subset of endogenous variables. These cases come under the category of partitionable structures. Given that in an interdependent structure (model) the matrix $\hat{B}$ (B) is not triangular, then we assume that

i) The matrix B, suitably partitioned, is transformed into a triangular matrix;

ii) Upon being partitioned in the manner of matrix B[5], the variance-covariance matrix Ω of the stochastic variable vector should be transformed into a diagonal matrix.

---

[5]Because it is symmetric, matrix Ω can never be triangular, whether or not it is partitioned.

Hence we may apply the conclusion obtained from recursive structures[6] towards interdependent structures.

Example:

An example should serve to illustrate the preceding argument. For this purpose we will consider the model of Girshick and Haavelmo [Ref. 8]. Employing our notation and suitable re-ordering the equations, we have:

$$
\begin{aligned}
& y_{1t} + \gamma_{12} z_{2t} + \gamma_{14} z_{4t} = u_{1t} \\
& \beta_{21} y_{1t} + y_{2t} + \beta_{23} y_{3t} + \gamma_{23} z_{3t} + \gamma_{24} z_{4t} = u_{2t} \\
& \beta_{32} y_{2t} + y_{3t} + \beta_{34} y_{4t} + \gamma_{33} z_{3t} = u_{3t} \\
& y_{4t} + \beta_{45} y_{5t} + \gamma_{41} z_{1t} + \gamma_{43} z_{3t} = u_{4t} \\
& \beta_{52} y_{2t} + y_{5t} + \gamma_{53} z_{3t} = u_{5t}
\end{aligned}
\tag{58}
$$

The stochastic vector u_t satisfies the conditions specified in (2), (4) and (5); i.e., its mathematical expectation is equal to zero; its components are not auto-correlated; and it is independent of the vector of pre-determined variables.

[6] The analysis of partitionable structures is performed exclusively on the basis of jointly determined and stochastic variables. In his analysis of the causal ordering of equations, Herbert A. Simon [Ref. 11], introduced the concept of subsets of self-contained equations of the order 0,1,...,k $(k > 0)$, belonging to deterin-istic structures (models). He also considered the vectors of jointly determined and predetermined variables. - Since he was working with determinist structures (or models) he did not deal with stochastic vectors. - This study of Simon compelled him to introduce more equations into the structure (or model) in order to explain the behavior of predetermined variables. Concerning these variables, for period t : i) the lagged variables (endogenous and exogenous), have already been observed (or predicted in the case where the prediction covers a longer period than the lag) and, ii) the exogenous variables (non-lagged) must be estimated or predicted with ancillary information, devices and assumptions.

For (3), let us now suppose (less restrictively):

(59) $$E(u_{1t}\, y_{jt}) = 0 \;; \quad j \neq 1, \quad t=1,\ldots,T \,.$$

(60) $$E(u_{it}\, u_{jt}) = \sigma_{ij} \;; \quad i,j = 2,3,4; \quad t = 1,\ldots,T \,.$$

Using matrix notation for (58), we have:

(61) $$B\, y_t + \Gamma\, z_t = u_t$$

(62) $$B = \begin{pmatrix} 1 & 0 \\ B_{21} & B_{22} \end{pmatrix} = \left(\begin{array}{c|cccc} 1 & 0 & 0 & 0 & 0 \\ \hline \beta_{21} & 1 & \beta_{23} & 0 & 0 \\ 0 & \beta_{32} & 1 & \beta_{34} & 0 \\ 0 & 0 & 0 & 1 & \beta_{45} \\ 0 & \beta_{52} & 0 & 0 & 1 \end{array}\right)$$

(63) $$\Lambda = \begin{pmatrix} \sigma_{11} & 0 \\ \Lambda_{21} & \Lambda_{22} \end{pmatrix} = \left(\begin{array}{c|cccc} \sigma_{11} & 0 & 0 & 0 & 0 \\ \hline 0 & \sigma_{22} & \sigma_{23} & \sigma_{24} & \sigma_{25} \\ 0 & \sigma_{23} & \sigma_{33} & \sigma_{34} & \sigma_{35} \\ 0 & \sigma_{24} & \sigma_{34} & \sigma_{44} & \sigma_{45} \\ 0 & \sigma_{25} & \sigma_{35} & \sigma_{45} & \sigma_{55} \end{array}\right)$$

If, in model (58): a) we partition the matrix B according to the form indicated in (62), and b) once partitioned in the manner of (62), the variance-covariance matrix of model, though not necessarily diagonal, does <u>become</u> diagonal insofar as we treat the partitions as elements of the matrix; then we have

(64)
$$\begin{pmatrix} 1 & 0 \\ B_{21} & B_{22} \end{pmatrix} \begin{pmatrix} y_{1t} \\ \eta_t \end{pmatrix} + \begin{pmatrix} \Gamma_{11} & \Gamma_{12} \\ \Gamma_{21} & \Gamma_{22} \end{pmatrix} \begin{pmatrix} z_{1t} \\ \zeta_t \end{pmatrix} = \begin{pmatrix} u_{1t} \\ \nu_t \end{pmatrix}$$

where

(65)
$$\eta_t = \begin{pmatrix} y_{2t} \\ y_{3t} \\ y_{4t} \\ y_{5t} \end{pmatrix} ; \quad \zeta_t = \begin{pmatrix} z_{2t} \\ z_{3t} \\ z_{4t} \end{pmatrix} ; \quad t = \begin{pmatrix} u_{2t} \\ u_{3t} \\ u_{4t} \\ u_{5t} \end{pmatrix}$$

and the matrix Γ has been suitably partitioned in order to facilitate a consistent presentation of (64).

Bearing in mind (62) and (63), model (64) is recursive. Assuming that its parameters have been estimated, it follows, then, that if the equation

(66)
$$y_{1t} + \hat{\Gamma}_{11} z_{1t} + \hat{\Gamma}_{12} \zeta_t = u_{1t}$$

maintains a high degree of permanence in respect to structural changes that might modify the remaining equations, then it (the equation) will retain its validity as a prediction device.

14. Structural Permanence and Decision Making

The degree of permanence of structural equations is of great importance in the formulation of an economic policy. Once the structure has been estimated, one of the first problems to emerge is a value judgement, founded upon basic socio-philosophic considerations. This judgement leads to one of the following alternatives:

i) Maintenance of the structure

ii) Structural change.

The consequence will be the formulation of an objective structure that defines a conception of the future. In order to arrive at an objective structure, we must construct a decision model. If the objective (or desired) structure coincides with the actual existent structure, then the decision model should propose the maintenance and consolidation of that structure. If the structure has a high degree of permanence, then the decision model will generally take the form of a simple model of stable growth (a model which holds true for national and regional economies as well as businesses). If the structure contains sectors or subsystems with a low degree of permanence, then the decision model should, from the point of view of stability and efficiency, consider the suitability of a consolidation or structural re-inforcement that will be conducive to a higher degree of partial and total structural permanence.

If the objective structure differs from the existent structure, then the degree of structural permanence of the equations will be of crucial importance in the construction of a model designed to realize a desired change. The amount of force exerted upon the various controllable variables in order to bring about a change in a sector or subsystem will be greater to the extent that the permanence of a sector or subsystem is greater. And this increase of force will not be a merely quantitative one but also an increase in the span of time in which the variables will be acted upon (with all that this implies in the way of greater economic, political and social costs and risks). However, if the degree of permanence is somewhat lower, then the model should take notice of the direction of change defined by the objective structure and at the same time, of the direction toward which the structure tends to change. If the direction of proposed change is coincident with the direction towards which the actual structure tends, then our decision model should only be concerned with the necessity of restrained action upon very few controlable variables. In this case we may affirm that proposed structural changes can be achieved at a relatively low cost.

If the direction of proposed change is not coincident with the actual tendency of the structure, then perhaps the model should act more intensively upon a greater number of controlable variables. In this case the costs of change are greater. It becomes imperative, then, that we undertake a painstaking consideration of economic, political, and social costs of change, in which is included an estimation of resistance to change (and its consequences). Action upon controllable variables during the application of a decision model, implies some type of economic restriction upon some of the economic subjects. Such change is always resisted by those sectors of opinion whose economic interests, political power, and social position are affected by change.

These considerations are fundamental to the achievement of an acceptable measure of success in the execution of an economic policy. Thus, for example, in the industrialization of a developing country we were to encounter the obstacle of a traditional (primitive) agriculture, with a low level of productivity and characterized by a strong concentration of land ownership (latifundia), then a model with industrial goals would have to make allowances for changes in the agriculture structure of the economy. If the political power structure is responsive to and representative of the interests of the landed proprietors, then the agricultural sector will present a high degree of permanence, which in turn, will retard the development of a policy of industrialization. An example of this order is illustrative of the generative causes of structural dualism. In this case, the dualism is intersectorial and the policy of industrialization can only be successful insofar as it does not affect the status quo of the agricultural sector.

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