THEORETICAL ASPECTS REGARDING THE IDENTIFICATION OF PARTIAL STRUCTURE IN SUBMODES

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Abstract

The study of the theoretical aspects regarding the identification of the partial structure of the submodels highlights the way in which it is necessary to act for the construction of models and the mathematical formalization of the corresponding equations. Practically, in the modeling of the national economy, the sub-models specific to certain sectors (branches) of the national economy are first built. Based on the study, we identify the variables that are interdependent, aiming finally to construct a model to suggest the evolution perspective. In practice, it is intended to transform a hypothetical model into an empirical model. Economic theory is the main guide in formulating economic models. It is an important distinction between considering theory as the correct representation of reality and considering theory as a guide to defining a model that includes empirical elements. At the basis of the model construction, there are five criteria that are followed and observed, ensuring the creation of models able to reveal the prospects of macroeconomic evolution through the obtained parameters.

Keywords: *parameter, submodel, cointegrated processes, function, error*

JEL Classification: C36, C50

Introduction

The author's study of the theoretical aspects of identifying the partial structure of sub-models presents a number of issues that are essential in formulating macroeconomic models. It explains extensively the stages underlying the construction of the models according to the final goal pursued. Essential aspects are addressed on: identifying structures; errors that may occur in the choice of variables; the choice of admissible data; identification of exogenous variables; identifying the parameters to be obtained; completing the model that eliminates any other opposed possibility. Reference is made to segmented errors, the development of the basic model, exact determination of the structure of the considered model. Reference is also made to the fact that a matching model is not necessarily a certain one, but it is a starting point in the analysis. The model must have a distribution function, starting from the empirical econometric analysis. The process of sequential decomposition in conditional and marginal models is the basis of the RIMINI subsystems. The study briefly presents the main important elements for modeling resulting from the analysis of many researchers in this field.

Literature review

Anghelache, Anghel, M.G. et al. (2019) studied the link between economic aggregates based on econometric models. Anghelache and Anghel (2017) analyzed the use of econometric models in macroeconomic activity. Anghelache (2008) presented the statistical indicators used in economic analyzes. Clements and Hendry (1999) addressed a number of aspects of economic forecasting. Colander (2009) studied CVAR elements. Eitrheim, Jansen and Nymoen (2002) referred to some progress from the failure of forecasting. Florens (2003) studied instrumental variables. Hendry (2003) analyzed the origin of the Econometrice LSE methodology. Hendry (2002) presented the important elements of econometrics. Lettau and Ludvigson (2005) studied aspects relating to errors in statistical and econometric models.

Research methodology, data, results and discussions

The modeling process often faces requests from incompatible model users with a closed-ended model of 3-5 equations. Often work with submodels for different sectors of the economy. Thus, it is useful to approach in terms of simplifying the multi-variable distribution of all variables observable in the model by calculating factors, conditioning and restrictions.

• We will consider distribution with several variables of the form:

$$x_t = (x_{1t}, x_{2t}, \dots, x_{nt})' \quad (1)$$

t = 1, ..., T

and $x\,\frac{1}{T} = \{x_t\}_{t=1}^{T}$

Determination of density function factors results from:

$D_x(x_t^1|x_0, \lambda_x)$ in

$$D_x(x_t^1|x_0;\, \lambda_x) = D_x(x_1|x_0;\, \lambda_x) \prod_{t=2}^{T} D_x(x_t|x_{t-1}^1, x_0;\, \lambda_x), \quad (2)$$

which became the Haavelmo distribution (Spanos 1989).

We consider x_t as the function of x_{t-1}^1, having the initial conditions x_0 and a one-dimensional time parameter vector, λ_x. Suppose it approaches the data generating process - DGP - Data Generator Process, a data generator process (Hendry 1995a), which requires error terms, $\varepsilon_t = x_t - E(x_t|x_{t-1}^1, x_0; \lambda_x)$ to be an innovative process. This approach is called the „reduction theory" because it attempts to explain the origin of the empirical models in terms of implied simplification operations in the DGP to induce the relevant empirical model.

The second step in reducing data is conditionality and simplification. We consider the division $x_t = (y'_t, z'_t)$, and the calculation of factors for the multi-variable density function in a conditional density function for yt | z_t and a function of marginal density for zt, respectively:

$$D_x(x_t|x_{t-1}^1, x_0; \lambda_x) = D_{y|z}(y_t|z_t, x_{t-1}^1, x_0; \lambda_{y|z}) \cdot D_z(z_t|x_{t-1}^1, x_0; \lambda_z) \tag{3}$$

In practice, it is further simplified by using approximations (Markov processes of Kth order) and developing models for:

$$D_x(x_t|x_{t-1}^1, x_0; \lambda_x) \approx D_x(x_t|x_{t-1}^{t-k}; \theta_x)$$

$$D_{y|z}(y_t|z_t, x_{t-1}^1, x_0; \lambda_{y|z}) \approx D_{y|z}(y_t|z_t, x_{t-1}^{t-k}, \theta_{y|z}) \tag{4}$$

for t > k.

A linear generalized dynamic class of models with a finite number of delays that is commonly used to model the n-dimensional process, x_t is VAR, k_{th} with Gaussian error, ie:

$$x_t = \mu + \sum_{i=1}^{k} \Pi_i x_{t-i} + \varepsilon_t, \tag{5}$$

where ε_t is normal, independent and repaired identically, N.i.i.d. $(0, \Lambda_\varepsilon)$.

A VAR model is a starting point for analyzing cointegrating relationships that can be identified in the x_t vector.

We will assume, for simplicity, that the x_t elements are non-static variables (which become stationary after they are differentiated). Then, if there is cointegration, VAR always has a representation of a vector equilibrium correction model, which can be written as differences and levels (ignoring the possible presence of variables determined as trends) in the following way:

$$\Delta x_t = \sum_{i=1}^{k-1} A_i \Delta x_{t-i} + \alpha(\beta' x_{t-1}) + \varepsilon_t, \tag{6}$$

where α and β are n-r matrices r (r<n), and ($\beta' x_{t-1}$) contain cointegration relationships r.

We consider cointegrated processes to define a long-lasting equilibrium trajectory, and suppose the abandonment of induced equilibrium corrections, which influence the economy in a stable way. These are useful because they allow the economic interpretation of the model properties, and their stable properties can be considered as an interpretation of long-term equilibria between economic variables resulting from economic theory. The theoretical consistency, according to which the model contains identifiable structures that can be interpreted in light of economic theory, is only a criterion for a satisfactory representation of the economy.

• If all the reduction operations involved in the transformation of a hypothetical DGP into an empirical model are taken into account, an econometric model is unlikely to coincide with DGP. An econometric model may, however, possess certain properties that will give a close representation of DGP. According to the LSE methodology, such a model should meet the following criteria:

- The model contains identifiable and interpretable structures in the light of economic theory.
- Errors must be sequential innovations of random variables, so that the model is a valid simplification of DGP;
- The model should be admissible data based on exact observations;
- Conditional variables must be exogenous for model parameters;
- Parameters must be constant over time and remain invariant to certain categories of influences (depending on the purpose for which the model is to be used);
- The model must be comprised of rival models. A M_i model includes other models (M_j, $j \neq i$), if it can explain the results obtained by other models.

Models meeting the first five criteria are considered congruent, while the compgressional model satisfies all six criteria.

Economic theory is the main guide in formulating economic models. A clear interpretation allows the communication of ideas and results between groups of researchers and structure the debate on economic issues. However, while economic theories are abstract and built on simplifying assumptions, a direct transformation of theoretical concepts into an econometric model will not automatically lead to a satisfactory pattern. Despite their structural interpretation, these models will not have specific structural properties.

It is an important distinction between considering theory as the correct representation of reality (leaving the estimation of parameters to the econometrician's latitude) and considering theory as a guide in defining a model that also includes institutional benchmarks, attempts to represent the heterogeneity of agents, express temporal characteristics for sets data, etc. Similarly, there is a significant difference between a sequential simplification procedure (while controlling innovation errors) and the practice of adopting an *a priori* axiom of a correct specification that implicitly implies white noise errors.

Innovation errors with random variable sequences result in the restriction that debris can not be predicted only from the model's own information. This property is the logical consequence of a reduction process and is a necessary requirement for the empirical model derived from DGP. If errors do not have this property, ie there are no white noise errors, data definition does not include regularity.

The requirement for the model to have admissible data implies that the model should not produce predictions that are not logically possible.

Criterion four means that the parameters are functions of $\theta_{y|z}$ which varies independently of θ_x. This property correlates with the estimation efficiency: the weak exogenity of conditional variables z_t is required to estimate the conditional model for yt without losing the information related to estimating the multi-variable model for y_t and z_t. To construct conditional forecasts based on the conditional model without loss of information, a strong exogenity is required, which is defined as the encounter between weak exogenity and *Granger noncausality*, representing the absence of feedback from y_t to z_t, ie, x^1_{t-1} in the function of marginal density for z^t, D_z $(z_t|x^1_{t-1}, x_0; \lambda_z)$, by (2), does not include the y_t decal values.

The fifth criterion in the list is formally and concisely developed on details by Hendry (1995a). It defines the structure as a set of permanent permanent benchmarks of the economic mechanism. A parameter vector defines a structure if it is invariant and directly characterizes the relationships underlying the analysis. A parameter can only be structural if it is:

- constant and invariable on the extensions of the studied period;
- unchanged from changes in the economy and thus invariably in regime changes, etc.;
- remains unchanged for expanding the set of information and thus invariably adding more variables to the analysis.

This invariability property is of special importance for a progressive research program: ideally, empirical modeling is a cumulative process in which patterns are continually replaced by new and more useful. Models considered useful are those models that possess the previously defined structural properties, especially models that are relatively invariable to economic changes, that is, they contain autonomous parameters. Models with a high degree of autonomy are structural models that remain invariable for economic policy changes and other shocks of the economic system.

However, the structural character is limited by two considerations: first, autonomy is a relative concept because an econometric model can not be invariably invoked at any possible shock; the second, it is unlikely that all the parameters of an econometric model will have invariable character. Parameters with the highest degree of autonomy represent the partial structure. For example: the elements of a vector β in a cointegration equation, which often represents the partial structure. Even if it is unlikely that the submodels contain the partial structure in the same degree, it is plausible that the highly aggregated models are less autonomous than the submodels, because they can build on a richer set of information.

Congruence of data, respectively, the ability to characterize data, remains an essential quality of econometric models. In this sense, our research strategy is to check any hypothetical general model that is chosen as the starting point of a specification search for data congruence, and to decide on the final model after a general-to-specific research. Due to recent advances in the theory and practice of building data-based models, it is known that by using Gets algorithms, a researcher has a chance to achieve a high accuracy approximation of the data generation process, and the danger of random errors is low.

A matching model is not necessarily a certain pattern. An innovation can be predicted from other information, not just from its own set of information. It follows that a sequence of congruent models can be developed, each of which can include all previous models.

A strategy that focuses on the predicted behavior, without carefully assessing the causes of the ex post forecast failure, draws the risk of different models that contain important structural elements.

The main cause of the forecast failure is represented by the deterministic evolutions (eg the equilibrium rate of the population's economies) and not the modification of some coefficients such as the propensity for consumption, a prime concern in the policy analysis. Structural discontinuities are a major concern in econometric modeling, but the only way to assess the quality of hypothetical discontinuity results from data confrontation. In addition, because it follows a comprehensive approach, a forecast failure is a potential improvement.

The full distribution function is not easy to use, so it is not an operational starting point for empirical econometric analysis. In practice, we need to divide the system into subsystems of variables and analyze them separately. Multiple variable modeling is only considered within subsystems. However, there is a risk that some possible influences on the subsystems will be ignored, leading to invalid conditioning (the assumption of poor exogenity is not satisfied) and invalid marginalization (by omitting the relevant explanatory variables in the analysis), involving inefficient estimation and inferential inference. The practical implementation of these principles is exemplified by the modeling of the RIMINI households sector (Macroeconomic model developed by Norges Bank - Norway Central Bank).

The process of sequential decomposition in conditional and marginal patterns is repeated within the RIMINI subsystems. In the subsystem of the households sector, total consumption expenditure is modeled as a function of real disposable income and real wealth of the population. Total wealth is made up of the real value of the stock of real estate plus the net financial wealth. The amount of real net financial assets is equal to the difference between the real gross financial assets and the real loans (loans) (M_t-L_t):

$$wh_t = \ln WH_t = \ln\left[\left(\frac{PH_t}{P_t}\right)H_{t-1} + M_t - L_t\right] \quad (7)$$

where:

H_t - the volume of residential real estate stock,

$(PH)_t/P_t$ - real estate price,

P_t - deflator for consumer spending.

The multi-variable distribution function for this subsystem can be defined by the relation $x_t = (ch_t, yh_t, wh_t)$. The conditional submodel for actual total consumption expenditure is of the form:

$$D_{c|y,w}(ch_t | yh_t, wh_t;\ \lambda_c) \quad (8)$$

based on the corresponding conditional density function as a valid representation of DGP. The RIMINI model contains sub-models for yh_t and for all individual components in wh_t. For example, the conditional submodel for the simultaneous determination of real estate prices, ph_t, and real borrowings of the population, lt is:

$$D_{w|y}(ph_t, l_t | RL_t, yh_t, h_{t-1};\ \lambda_w), \quad (9)$$

where:

Rl_t - interest rate on loans (loans).

Also in the RIMINI model are the submodels for the net addition to the stock of real estate capital Δh_t and the price of the real estate capital, phn_t:

$$D_{\Delta h|\cdot}(\Delta h | ph_t, phn_t, RL_t, yh_t, h_{t-1};\ \lambda_{\Delta h}) \text{ or}$$

$$D_{phn|\cdot}(phn_t | ph_t, pj_t, h_{t-1};\ \lambda_{phn}) \quad (10)$$

where:

pj_t - deflator of gross investments in buildings.

The Aggregate Consumption Model described by Brodin and Nymoen (1992) meets the criteria outlined above. Within the model, cointegration analysis determines that the linear relation:

$$ch_t = \text{constant} + 0{,}56yh_t + 0{,}27wh_t, \quad (11)$$

is the cointegrative relationship and the rank of cointegration is one. It follows that while the individual variables in the linear relationship are assumed to be non-static and integrated, the linear combination of the three variables is stationary with a constant average value showing the discrepancy between consumption and the long-term equilibrium level ($0.56yh_t + 0.27wh_t$).

Estimated income and wealth margins are an argument for the study of structural discontinuities. The simultaneous occurrence of a stable conditioning model (consumption function) and of unstable marginal models is proof of the invariance of the conditional model coefficients and hence of super exogenous conditional variables (income and wealth). The result of invariance is corroborated using an alternative method based on transition models.

The empirical consumption function has proven to be relatively stable for more than a decade, and is usually applied to a cointegrate part of the equation. Comparison with alternative models is important for consumption studies.

Financial deregulation in the mid-1980s led to a strong increase in aggregate consumption versus income in several European countries. The use of empirical consumer macroeconomic functions, functions that typically explained aggregate income, forecasting, and explanation of *ex post* data, have led to unsatisfactory results.

A conception of these forecast failures is a direct demonstration in favor of rival rational probabilities, of the permanent income hypothesis; in response to financial deregulation, consumers predicted steady revenue growth, thus creating a discontinuity in the conditioned relationship between consumption and income. Also, the occurrence of these failures was interpreted as a confirmation of the relevance of Lucas's critique.

One can compare the efficiency of two competing models: the empirical consumer function, with a long-term income, and the Euler equation derived from a probability model.

While the conditional consumption function includes the Euler equation over a sampling period from 1968 to 1984, both models fail to predict the annual increase in consumption in the coming years. We will deduce the theoretical properties of forecasts based on the two models. Considering that the Euler equation is the real model and that the consumption function is a misleading model, both sets of forecasts are immune to discontinuities (eg, the change in the equilibrium of population economies) that occur after the prognosis. In addition, the empirical consumption function prognosis failure is possible if the function is a real model. As a result, the forecast failure of the function confirms the demonstration in favor of a conditional function for the period preceding the occurrence of the event.

However, the respected consumption function, which introduced wealth as a new variable, was successful in considering the ex post fall, while maintaining the constant level of parameters in the financial consolidation years following the initial reduction in the population's savings rate. The corresponding model could have been duly taken into account for the high variability of the savings rate, while previous models were not successful in this approach.

It was explained why Lucas's criticism was weak in this case: first, the observed discontinuity of consumer-conditioned functions in 1984-85 corresponds to Lucas's criticism, meaning that interpretation is rejected by identifying a conditional model with constant parameters. Secondly, the result of invariance is similar to the Euler equation models (derived from a stochastic / random income pattern) and can not be a comprehensive model. Even though Euler's approach supports constant empirical parameters, one can not explain why a conditioning model is stable. Third, the finding that invariance is approximated empirically forms an important basis for using the dynamic consumption function in political forecasting and analysis.

Conclusion

As a result of the authors' study, the modeling methodology is very important, because only by considering the correlated variables the desired results can be obtained. The models used must be based on the submodels that are part of the general model used. The mathematical formalization of the models results in the possibility to calculate the parameters for the determination of the empirical evolution unaffected by the influence of the factors or influenced by them. Based on these theoretical aspects, we can identify the structures and submodels that can be considered in the analysis based on the general model. In practice, econometric models can be used to ensure macroeconomic analysis.

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