

ARX Parametric Model of a Regional Economy and Its Managerial Implications -A Case Study of Northern-East in China

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ABSTRACT

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Northern-east ARX parametric model was developed in connection with the large delay characteristics of northern-east economy. This paper presents the framework, the model and managerial implications for the underlying northern-east economic system. The case scenarios were also applied to Liaoning Province in northern-east. The managerial implications were proposed to help economic entities as well as local authorities to understand the using of the model. Thus, it is an effective tool for decision-making in northern-east.

KEYWORDS: *ARX parametric model ; Nonlinear system ; managerial implications ; Extended Instrumental Variable Method*

1. Introduction

In regional economic research, models are always key points when one needs to explain its mechanism. To this end, their managerial implications and flexibility of solution methods represent key features in establishing their usefulness. However, the research on them is still lagged behind the management theory study. From 2003 to 2010, there are 10000 pieces of papers about the theory innovation of the regional economic administration, besides the 16 pieces of papers from the journal indexed by EI. Thus, there are few mature regional economic models, including CAS model^[1], changing CAS model^[1],

and state variable control model^[2] etc.. Too many variables were placed in these models so that they are more complex and the control strategies on basis of them are also complicated. For the aforementioned reasons, some experts believe that the quantities administration of the regional economic system can not work. Fortunately, ARX models were employed in regional economic administration in 2007^{[3][4]}. It is a progress in the quantities administration of the regional economic system because the model has sufficient information and the structure of the model is simple. However, there are few models for specific region and seldom researches which

discuss the managerial implications in detail.

The purpose of this paper is to propose the model and managerial implications for the underlying northern-east economic system.

2. System Analysis of the Northern-East Economy

A definition of a region was ever given by the Hoover in 1984, "for the purpose of narrative, analysis, management or policy-making, a region can be regarded as an objective entity. It can be distinguished according to the homogeneity of the internal economic activity or functional identity".

He also pointed out that, "regarded a region as a kind of agglomerations, data and events to grasp and handle can be reduced, which helps to describe the region".

According to the statement of Hoover and related work in the regional economy, a framework is design to analyze the operation mechanism of northern-east in China(see fig.1). The details of the framework are demonstrated in fig.2. Fig.2 shows that local authorities observe the economic by the relevant data and then make the economic measurements in a new round.

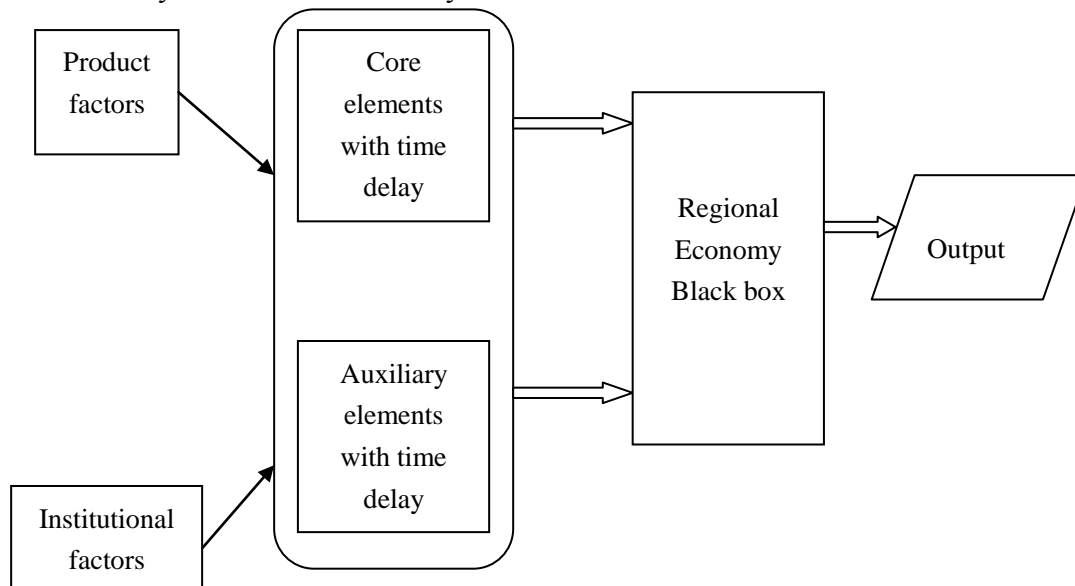


Fig.1 Framework of the northern-east economy mechanism

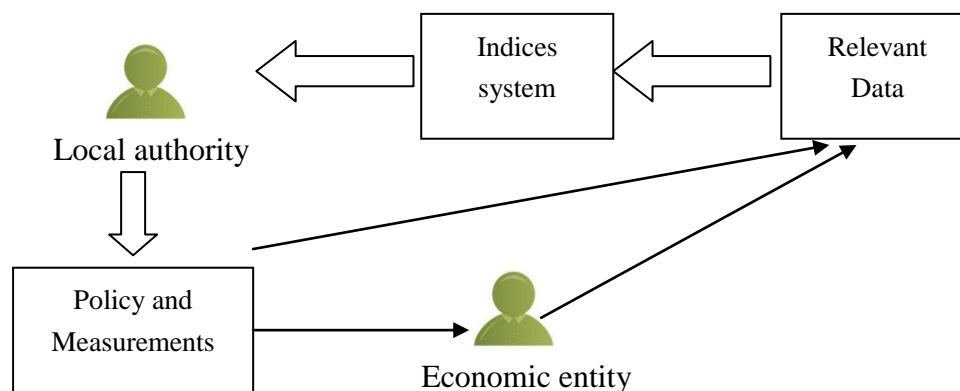


Fig.2 Framework of the northern-east economy mechanism in detail

The northern-east economy has three characteristics: aging industrial structure, exhausted resources, and rigid system. They were reflected by the northern -east statistical data in China. The associated situation is the slow reaction of the northern-east economy to the macro-economic policy. In order to quantity the time delay of the northern-east economy, it is necessary to refine and generalize the inputs and outputs of the northern-east economy. The northern-east economy can be regarded as a nonlinear time delay system which changing of the comprehensive competitiveness is caused by the core-elements and auxiliary-elements competitiveness. In the first stage, the statistical indices of the system were transformed into measurement ones. In the next stage, AHP method and fuzzy monitor control techniques were employed to obtain the core-elements competitiveness, auxiliary-elements competitiveness and comprehensive competitiveness^[5].

3. Northern-East ARX Parametric Model

Parametric models are a family of mathematical models, in forms such as difference equations, differential equations, and state-space equations. We believe that a kind of auto regressive model is the best one to describe the northern-east economy due to its nonlinear and large time delay characteristics. Among the auto regressive models, the ARX parametric model is more accurate one to describe the exogenous variables, such as macro policies, regional policies.

Thus, ARX parametric model is employed in this paper. Besides, the following reason also makes us employ an ARX parametric model: First, the state-space equation model can describe the characteristics of northern-east economy, but it

needs a lot of data more than are readily available to our research. Secondly, regional competitiveness is a discrete variable. For example, if there is a change in regional administration policy, a new regional competitiveness will appear. As we know that differential equations can only describe the relationship among continuous variables. So this kind of model cannot be used. Thirdly, since multiple AR models can hardly use the data to estimate the parameters of the regional economic competitiveness elements at the same time point, and that it cannot preserve the data. This kind of model is also excluded. The simulation data of the tested ARX model has not only the same correlation as model construction data, but also has the same distribution characteristics. The northern-east MIMO ARX model is as follows:

$$A(q^{-1})y(k) = B_1(q^{-1})u_k + B_2(q^{-1})v_k + e_k \quad (1)$$

Where q^{-1} is the unit lag operator, $A(q^{-1})$, $B_1(q^{-1})$, $B_2(q^{-1})$ are the parameters of the MIMO ARX model (1), i.e. lagged operator or translation operator polynomial. e_k is a random error term.

The parameter process optimization process of the ARX model includes estimation of the parameters and order selection of the model. The detail of estimation process has been discussed in Literature [18].

4. Case Scenario

4.1 Model Estimation

The purpose of the northern-east economy control is to predict and dynamically control the competitiveness index of the northern-east economy, so as to enhance the northern-east

economic competitiveness. The nonlinear characteristics dynamics of the process depend on the output of the northern-east economy. The observable nonlinear characteristics are sourced from the fluctuation of the competitiveness. There were considerable time delay involved in the competitiveness indices (for instance, a macro-policy or regional policy released in seven years ago brings about policy effect in this year.). We took LiaoNing province as an example; the structure of model (1) was employed. On the basis of 6 years statistical data (2000-2005), the system identification method in MATLAB toolbox was extended and applied to the system identification of the model (1) in section 3.

Model (1) is a mature regional economic model in literature [3], where the noises are colored one.

In order to realize identification on-line and reduce the memory occupation, recursive estimation method was employed. There are different kinds of recursive methods, such as many transformation of estimation method off-line, Kalman Filter method, stochastic approximation method, model reference adaptive parameters recursive estimation method. The extended instrumental variable method and recursive estimation are employed. The formula is as follows:

$$\hat{\theta}(k) = \hat{\theta}(k-1) + K(k)[z(k) - h'(k)\hat{\theta}(k+1)] \quad (2)$$

After programming and calculating, the following model was obtained:

$$(1 - 0.8389 q^{-1})y(k) = 0.1745 u_{k-7} - 0.2887 v_{k-7} + e_k \quad (3)$$

The model fitness is 89.25. The loss function is 0.000776957. The FPE (Final Predictive Error) is 0.00129493.

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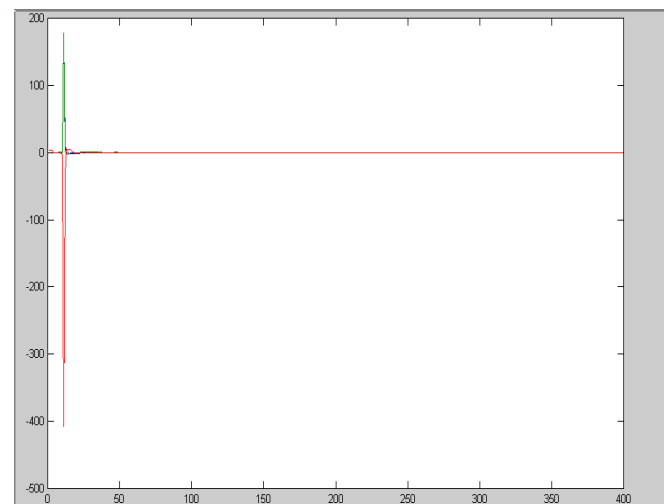


Fig. 3 The transition process of the parameters to be estimated

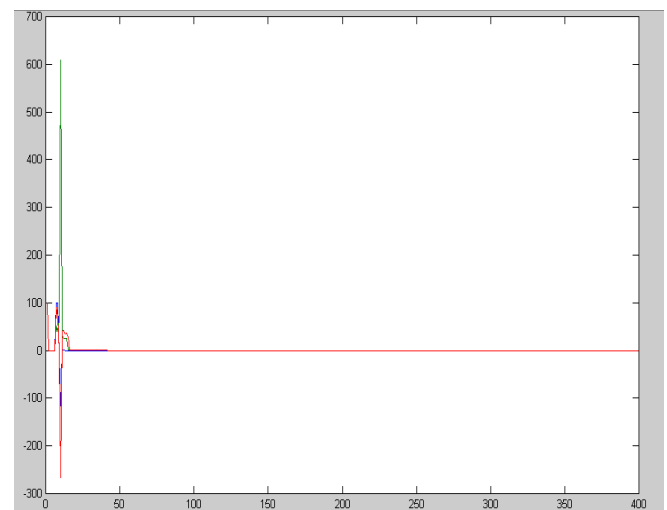


Fig. 4 The transition process of the variance to be estimated

Fig. 3 and fig. 4 show the transition process of the parameters and variance to be estimated. In sum, various methods are tried. The extended instrumental variable method is valid in northern-east economy identification.

4.2 Managerial Implications

For local authorities and economic entities, time delay of policy making should be taken into consideration. The convergence of their attitude towards the tolerance of the time delay of policy

effect can be beneficial in terms of the regional economic development. As demonstrated by the case scenario in section 4.1, the positive effect brought by the policy from 2000 to 2005 is not evident. Foremost, the model developed in this paper plays an important role in macro-economic administration.

An important benefit of the model for local authorities is to implement the measurements by the observations of the relevant data which represents the features of the output, since the model is on the basis of the relevant data.

To be viable, model simplification can pave a way for the intelligence administration in regional economic development.

5. Conclusions

The managerial implications and flexibility of solution methods represent key features in establishing the usefulness of a model. The model in this paper not only has a high convergence rate but also abroad application prospect for the situation which other methods cannot work. It has advantages for the nonlinear systems such as a regional economic system etc. It also has important value in practice, when it was applied to the system with large time delay. Therefore, it has great strategic significance in solving the extensive management problem which occurred in the northern-east economy, as well as in improving the management efficiency.

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