

Research on World Economic System Evolution Theory and Application under Symmetry Perspective

Hu Jiaqi

Zhejiang University, Hangzhou, Zhejiang, China

Keywords: economic system, symmetry, evolution, sense response.

Abstract. Economic system is a complicated system with continuous evolution. Exploring the evolution of world economy has great significance. The paper applies symmetry theory to research the characteristics of world economy structure, evolution essence, process and mechanism of world economy structure, and proposes some practical and new viewpoints. In specific research, the paper introduces modern symmetry theory and complicated network theory analysis method into world economic system analysis, for expounding the essence, process and mechanism of the evolution of world economic structure.

Introduction and Literature Review

Economic system is a complicated system with continuous evolution. It includes many subsystems, and has many variables with complicated relationship. The system is multi-level, strong coupling, nonlinear, open, uncertain and dynamic, which shows the complicated evolution of economic system. As a complicated dynamical system, economic system relates to the survival and development of the human. For world economic system center—formation and evolution process of symmetrical structure in peripherally local area, the paper combines SAR system theory, and establishes a mathematical model which can accurately describe the dynamic evolution process of world economic system. And based on the model, the paper deeply analyzes the evolution reason, condition and development process of micro-economic system, and the formation and evolution process of symmetrical structure of world economy network local area.

Introduction of Economic System Evolution Model

In the 18th century, the classical economists researched economic growth. But they didn't propose the mathematical model about economic growth theory. In the 2040s, Harrod and E.Domar proposed the similar long-term economic growth model—Harrod—E.Domar model which was considered to be the mark of modern economic growth theory. The model makes the short and static analysis of Keynes long term and dynamic, and introduces economic growth theory in to the modern time, which realizes the leap of macro economic growth theory from qualitative analysis to quantitative analysis.

In the mainstream economic models researching economic growth, Harrod—E.Domar model is the most famous, and the form is the simplest. The model hypothesizes that producing a product needs to production factors, capital K and labor L . The technical coefficients of production are fixed, which means that producing an unit product needs to consume α unit cost and β unit cost, and the capital and labor can't replace mutually. Therefore, Y_t means the total output at time t , $Y_t = F(K_t, L_t) = \min[K_t/\alpha, L_t/\beta]$, which means that the total output Y_t at time t depends on the number of a production factor.

Harrod—E.Domar model is based on three different growth rates, guaranteed growth rate(G_w), actual growth rate(G) and natural growth rate(G_n). If the growth rates are equal, $G_w = G = G_n$, it realizes the unique optimal growth of economy. The economic growth with the same growth rates is an accidental coincidence, and is considered as a growth on the edge by many economists. The reason for balance on the edge is that the model supposes fixed technical

coefficients, or indirectly supposes that capital k and labor L can't replace mutually in the growth process, which is a defect of Harrod— E.Domar model.

Single Economic System Evolution SAR Model in World Economic System

The paper considers the evolution and development of economic system in a country. The development level of economic system is represented by Y . Firstly, the economic system is supposed as follows.

(1) The spatial economic structure at any time is the result of the function evolution of the previous stage, which has the economic vestige. In addition, history has the right to speak. The reason why the economic development history and accumulation process in different countries is different is the influence of the history. And path dependence really exists. So it is necessary to consider the initial state to research the evolution of economic system in a country.

(2) Under the condition without the influence of external environmental factors, economic system has the features of self-circulation and self-increment under the action of technical progress, capital and labor factor.

(3) With the increase of capital, the communication and traffic technique develops rapidly, trade barrier reduces and the expansion of market is overwhelming. In the early stage of economic globalization, the country nearly doesn't participate in economic world market. When the factor of market scale expansion has little influence on the economic development in the country, the influence is 0. When the integration of world economy is deep, the national economic policy needs to make adjustment to regulate and control the development of economic system. The influence of new policy is little in the beginning.

(4) When market scale increases, the influence increases after taking various economic measures, which achieves the critical value of perceptual reflect. And the factors are captured into the model by the system. When the influence achieves the peak, it may reduce, and it tends to be 0 at last.

Above all, the simplified model of economic system in a country is

$$\frac{dy(t)}{dt} = a_0 + a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4 + a_5x_5 + \mu \quad y(0) = y_0 \quad (1)$$

$$\frac{dx_1(t)}{dt} = b_{11}x_1 + b_{12}y + b_{13}x_4 + b_{14}x_5 \quad z_1(0) = z_{10} \quad (2)$$

$$\frac{dx_2(t)}{dt} = b_{21}x_2 + b_{22}y + b_{23}x_4 + b_{24}x_5 \quad z_2(0) = z_{20} \quad (3)$$

$$\frac{dx_3(t)}{dt} = b_{31}x_3 + b_{32}y + b_{33}x_4 + b_{34}x_5 \quad z_3(0) = z_{30} \quad (4)$$

$$\frac{dx_4(t)}{dt} = \begin{cases} 0 & 0 < x_4 < x_4^* \\ b_{41}x_4 + b_{42}y & | x_4 > x_4^* \end{cases} \quad (5)$$

$$\frac{dx_5(t)}{dt} = \begin{cases} 0 & 0 < x_5 < x_5^* \\ b_{51}x_5 + b_{52}y & | x_5 > x_5^* \end{cases} \quad (6)$$

In the above formula, $a_i (i = 0, 5)$ is a constant, and it means the development speed of economic system. $a_j (j = 0, 3) > 0$ means that three variables, capital, technique and labor, have positive correlation with economic development. a_4, a_5 is positive or negative, and means the positive or negative influence of market scale and economic system policy regulation on the economic country in the country. $b_{ij} (i = 1, 5, j = 1, 5)$ means the development speed of level, capital, labor, market scale and economic system policy variables. We supposes that the relationship between economic system evolution development and influencing factors is simple linear form with the equation (1). And the equations from (2) to (6) represent that the development level of economic system and each influencing factors influence each other. Then, the paper analyzes the movement evolution process of economic system. It is supposed that the world economic globalization degree is not high in the

beginning. And domestic market is the emphasis of the national economic development, and the influence of international market scale is not large, which meets $|x_4| < x_4^*$. Economic system policy has not need to be regulated, which meets $|x_5| < x_5^*$. So there is no reaction, which shows the environmental variables. And the system has solution, $y(t) = (a_0 + a_1x_1 + a_2x_2 + a_3x_3)t + y(0)$. In the beginning, $x_1(0) = x_2(0) = x_3(0) > 0$ and $a_0 > 0$, so economic system has self-increment state. The increase of economic magnitude or qualified evolution requires the economic market to expand, and the market scale expands. Unit at time t_1^* , $x_4(t_1^*) = x_4^*$, the influence of market scale can't be ignored. And x_4 is captured by the system, and equation (5) is activated.

After equation (5) is activated, the market scale variable enters the evolution and development of economic system, which forms new five-order model. After reconstructing the structure, the ontology system has two possible development directions. One direction is that under the action of market scale factor, the economic system development has short-term rapid increase. The other direction is that the market scale expansion effect shocks the economic system of the country while brings little profit. The increasing liberalization of the market and the appearance of lots of new competitors makes the economic competition in the world fierce, which not only causes the national economic competition reduce, but also makes the development of economic system slow. No matter the evolution or reverse of economic system requires the guarantee of economic system policy. For economic evolution, the existing economic system can't endure the expansion of economy, which needs to adjust the existing economic system policy. For reverse, when it is difficult to make profits under old system, the country tends to implement new economic policy matching with new techniques. The adjustment and implementation of economic policy needs to consider the cost. Until at time t_2^* , the profit made by policy regulation is greater than the cost, $x_5(t_2^*) \geq x_5^*$. And x_5 is captured by the system, and the equation (6) is activated.

In order to implement the stable evolution and development of economic system, the economic policy equation (6) is activated, and the system equation forms new six-order system. The economic system can achieve balanced stage at some point. And market scale variables and economy policy tool realizes the expected purpose, and drifts away the system and become the environmental variables of the ontology system. The dynamic behavior mode of the system relates to the matching way of the parameters in the system. In Figure 1, a parameter combination is selected, and the system shows the dynamic evolution development state. If the interaction parameters are selected appropriately, it can make effective control on the evolution of economic system on different levels. Not only the perceptual reflect condition of x_4, x_5 can have different expressions, but also there is various connection between reaction conditions, which forms colorful hierarchy of economic system. The hierarchy makes the structure of economic system diversified, which reflects strong life vitality of economic system.

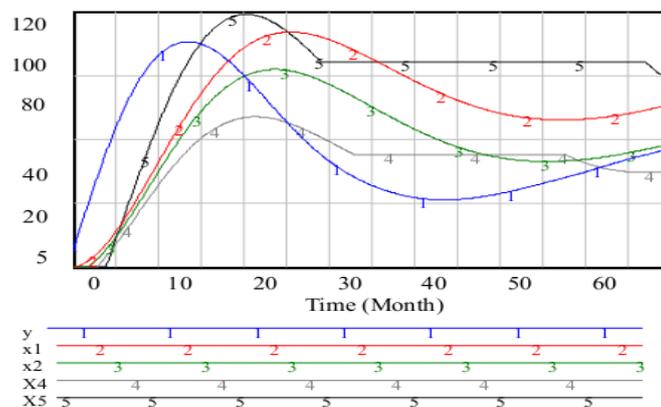


Figure 1 Dynamic evolution development simulation of the system under a parameter combination

Conclusions

From the dynamic perspective, a national economic structure participating in international division of labor can't be invariable. With the development of economy and the improve of per capita income, the function of the factors changes, and the requirement structure of the world changes. Therefore, in the process of external economic environment changing, it is not difficult to get some important conclusions by exploring the evolution development of an open economic system. Firstly, we must regulate the industrial structure from the change of supply and demand, for preventing from the profit loss made by the invariability of industrial structure. Secondly, we have no need to be afraid if the position of China in the present international division of labor can provide enough power for the development of China in the future. In fact, if the economic structure can make profit by participating in international division of labor, it can make the wealth increase in the country, which can change the structure of the country. With the change of the structure of national factor, the position of the country in international division of labor can be changed finally. The change of comparative advantage of factors and international competition makes the regulation of economic structure and change of international division of labor, which consists of economic growth history of most developed countries. Therefore, our country should incorporate into the world process of world globalization actively to become a country with sustainable economic growth.

The process of world economic structure evolution is symmetric and constantly emerging. No matter the overall economic structure or internal national economic relationship is symmetry breaking. Technical innovation is the most active factor in economic system, and it is the most important impetus for symmetry breaking of economic structure. The development of traffic and communication technique made by technical innovation breaks away from the constraint of spatial distance. Therefore, production structure must be recombined in global range to optimize resource allocation, promote symmetry breaking of economic structure and promote the evolution of economic system.

References

- [1] World Bank. Global Economic Prospects and the Developing Countries, Washington D.C., 2003.
- [2] Wolfgang Keller. The Geography and Channels of Diffusion at the World' s Technology Frontiers. NBER Working Paper, 2001, 8150.
- [3] Martin Carnoy and Castells, Manuel, et al. The New Global Economy in the Information Age. Pennsylvania: The Pennsylvania State University Press, 1993,
- [4] Robert Brenner. The world economy at the turn of the millennium toward boom or crisis?. Review of International Political Economy, 2001, 8:1, spring, 6-44.
- [5] Daron Acernoglu and Philippe Aghion, et al. Distance to Frontier, Selection and Economic Growth. forthcoming, 2003.
- [6] JEH. Theoretical Problems of Economic Growth. 1947.
- [7] Peter Howitt. Adjusting to Technological Change. The Canadian Journal of Economics, 1994, Vol.27, Iss.4, November, 763-775.
- [8] Carlota Perez. Structural Change & the Assimilation of New Technologies in the Economic System. 1983, Futures 15, Spring, 357-75.
- [9] Jacob J. Van Duijn. The long wave in economic life. London & Boston: Allen & Unwin, 1983, 154.