

# Applying Systems Thinking Methodology to Understand Dynamic of Economic Growth

## Abstract

More recently, the field of Systems Thinking has been applied widely to economic modeling and problem solving. So, this paper is originated by the idea to investigate the contributions of Systems Thinking approaches to economic growth modeling for national planning. This paper first presents a brief overview of the reasons that a national planner creates macro-models for economic growth and development and how economic models and methods in the macro-level face with some challenges specially for developing economies. The issue has grown in the key concept of Systems thinking methodology that views a system holistically rather than partial analysis as it is common in most traditional analytic methods. In order to understand how the Systems Thinking approaches can be applied in the process of growth modeling, the structure of two basic growth models namely Harrod-Domar and Solow are translated in the System Dynamics language. Then by considering a wide variety of soft variables of social and environmental sectors the growth model was improved. This process showed that Systems Thinking approach and System Dynamics modeling can contribute to growth modeling and better understanding of economic complexity and dynamic and go beyond what traditional models are able to do.

Keywords: System thinking, Soft Systems Methodology, System Dynamics, Economics, Economic Growth Model, Feedback method.

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### 1. Introduction

In order to improve the quality of life, most of the countries seek to plan economic development strategies. However, from the beginning of this century, the world is experiencing a wide variety of increasingly complex, dynamic problems. So it gives rise to the dynamic complexity in growth and national planning too, which must take into account the interactive and integrated nature of economics, society, and environment. If planning does not consider the links between them, opportunities will be missed for yielding the desired results within a long time

→ the use of systems thinking allows one to take into account perspective of developing countries & assumptions that relevant to developing countries in model development

that can be used SD & SSM. (5)

(3) → give rise to the issue initiate the need for using systems thinking methodology

(1) The reasons why create dev. macro-models

(2) Challenges face by macro-models in the case of dev countries

(4) How systems thinking can help to fulfill the limitation of macro-models

(1) → the models dev from based on the perspective of developed countries

(2) countries → lack of data → assumptions that apply to developed countries

(3) → fail to take into account the result to emergent problem

As it is conceptually illustrated in Figure 2, the rectangle represents stock of capital which is determined by the changes in inflow of investment and outflow of depreciation. Inflow and outflow indicates the change in the level of stock from  $t$  to  $t+1$ . In addition, in the middle of the loop sign of “+” shows the total effect of a loop reinforcing feedback and sign of “-“ within the total effect of the loop is balancing feedback.

Structurally, in the feedback stock-dependent relation, flow(s) itself is affected by the existing amount of stock which through a feedback loop can cause the next amount of flow. In other words flow is a function of stock as previously mentioned:  $\Delta K = K_t - K_{t-1}$ .

The left side of diagram illustrates the capital growing as long as positive inflow fraction rate and provide a process of exponential growth and the right side of diagram illustrates the capital diminishing as long as positive inflow fraction rate is identified by depreciation period and provide a process of exponential decay. It is clear that when inflow fraction is larger than outflow fraction, the system generates growth behavior exponentially and vice versa.

In general, the growth model structure determines the behavior and same structures cause similar types of behavior. Yet we will see that the simple exponential basic structure can be retrieved in all introduced growth models.

*Application of SD and macro-economic growth model in economic modelling.*

## 6. Translating the economic growth models into System Dynamics protocol

For economic modeling, System Dynamics is applied through three ways: translating an existing economic model into a System Dynamics framework; generating an economic model by following the System Dynamics paradigm principles and rules; modeling as a “hybrid” approach to mix the advantages of the first two ways (Radzicki 2011)

Here, based on the simple basic structure of the growth model, we investigate the dynamic of two existing well-known economic growth model: Harrod-Domar and Solow models. These two basic Keynesian and Neoclassic models consider limited factors of production. While, by adding a wide variety of factors including more soft variables than traditional variables of capital and labor such as social and environmental factors in the growth model we can expand it. Although, it seems complexity of the system will increase dynamically, System Dynamics modeling can analyze it.

The Harrod-Domar model is the economic growth feature in the Keynesian macroeconomic approach. The major Keynesian equations for determining a macroeconomic equilibrium is given

From a System Dynamics view, the evolution of the economic growth would arise from the interrelationships arising between feedback loops across subsystems and factors. The dynamic behavior over time of economy can be understood as a fight for dominance between positive and negative feedback loops. As a result, System Dynamics models are created by identifying and linking the relevant pieces of a system's structure and simulating the behavior generated by that structure.

Having said that, this is not trying to weaken the importance of conventional methods in economics growth studies, but it is believed that systems thinking tools and System Dynamics modeling as a simulation techniques enable us to understand effectively about the complexity of economic dynamics without the need for high level analytical mathematics and statistics. That is why in economic growth and development studies System Dynamics methods are being to be used in a wide range.

testing / proving

conventional methods helps in understanding & each the basic nature / behaviour of variables & what variables influence another variable & the sign of the influence at a particular point of time.



provide a basis for developing interrelationships between variables in the SD modeling of the office variables & sign SSM SD modeling

understanding variables relevant in the public situation  
 traditional macro economic models  
 - based on historical data.

