Opponent's review of the PhD. thesis: Dynamics in the Extended Cass-Koopmans-Ramsey Growth Model

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The author has submitted a coherent, logical and well-arranged paper, whose main aim is to link existing mainstream models with environmental models. He has used a system dynamics approach for the analysis. System Dynamics is a methodology that helps analyse and interpret nonlinear systems exhibiting complex dynamics. For this purpose, it uses computer graphics to display the process analysed by displaying flows between nodes and to show creation and drawing of inventory. Nonlinear transformations in individual nodes, delays and feedbacks play an important role. System dynamics procedures are important for modelling more complex economic problems associated with short-term and long-term economic dynamics, i.e. economic cycle and growth. This important method has been realized by the author and he has been successfully applied in his treatise.

The introduction of the work is written in a clear and comprehensible way, so it fulfils its purpose quite well. If I understand correctly, the author considers the role of energy and its relationship with exhaustible and renewable resources to be crucial for economic theory and, above all, to growth theories. He advocates the idea that a functioning growth model should include energy as a variable. To support this idea, the results of leading world economists in this research field are cited.

The second part is short, but I find it very important. The author briefly describes the goals of his work. First, it is the choice of the basic model of economic growth and its transformation into a model of system dynamics. The resulting model will be extended by the energy sector. According to the author, the model should be kept as simple as possible. Despite this necessary simplification, it should be still able to answer the basic question of whether economic growth can be sustained with available renewable or exhaustible sources. This intention is sufficiently original, so it is definitely worth working on it in scientific work.

In the third chapter, the author has addressed the methodology he would be using in his dissertation. In the introductory section the use of system dynamics approaches for modelling economic processes have been explained. This part is elaborated on a solid level using quotes from M.J. Radzicky and S. Keen. The selection of Solow's growth model as a basis for its expansion by system dynamics is supported by the quotation from a well-known growth theorist D. Acemoglu. In this chapter the author explains the structure of system dynamics models. The text at the bottom of p.6 and is illustrated in Fig. 1 is rather confusing and some are inaccurate at times. For example, t is considered to be a constant. The statement that the system shown in Fig. 1 represents exponential growth, would require, in my opinion, a more detailed explanation or a modification of the layout. It should be additionally explained during the defence of the thesis. In the description of the Solow-Swan model, equation of capital creation is missing and it takes this shape

$$K_t = K_{t-1} + I_t.$$

Only after that the model is complete. However, its graphic representation is hardly legible in the printed version of the work. Part 3.3 has dealt with the Ramsey-Cass-Koopmans model and it should be elaborated in more detailed way, especially when it is claimed to be the model of the dissertation.

In my opinion, the title of the fourth chapter of the thesis is a bit misleading because it does not reflect the essence of this chapter, which is the presentation of selected models describing the relationship between the growth of the economy and the consumption of energy sources. While the verbal content of the chapter is quite readable, the problem is how to illustrate them. The author's choice is the graphical representation of analyzed processes. These processes are of course so complex, therefore their graphic visualisation is somewhat incomprehensible, for example Fig.10, 15. The question to be asked is whether a partial reduction of the model or its aggregation would help to make them better understandable. It is also unfortunate that the author has not provided a more detailed comparison among the models presented at the end of this chapter.

The core chapters of this thesis are Chapters 5 and 6. In these chapters, the Solow-Swan model is analyzed. Chapter 5 has provided a description of the model and chapter 6 described the individual scenarios of its dynamics. The entire interest of these two chapters is the Solow-Swan model, although the title of the thesis declares the inclusion of the Ramsey-Cass-Koopmans model, which is covered merely in two pages of Section 3.3. The description of Solow-Swan's model found in Chapter 5 is comprehensible and clear and undoubtedly demonstrates the author's perfect orientation in the problem. Unfortunately, some minor demerits of formal nature have occurred in this part. Though Figure 17 on page 36 is legible and clear, the mathematical expression of the transformation of the production block, ie the production function can be found in the figure, those of other blocks such as capital, technology and population are missing. Further, I did not find any comment for Figure 17. Another problem is the discernibility of Figure 18 where the reader must rely on a magnifier or the electronic version of the work, where it is enlargeable.

Although Solow-Swan's model itself a very simple one. However, by adding the energy sector it becomes much more complex, so dividing the model into segments and describing them in individual subsections is a sensible solution for readers to understand the problem. On the other hand, when the author tries to explain the behaviour of the individual energy sub-sectors in the added modules and their relationship with the other parts of the model, it has become difficult how to clearly describe their behaviour, which can be observed in the composition of Figures 32 and 33.

The inclusion of the individual regimes in Chapter 6 is an interesting idea that is very useful for analysing of the extended Solow-Swan model. The author includes four scenarios, of which the first one is the traditional Solow-Swan model. The other scenarios are the energy sector activity, endogenous saving rate inclusion, and the last one imposing limitations on technology growth. For this part a more detailed and precise description of those scenarios would be needed to allow for a clear interpretation.

Questions for oral defence:

1. What are the links between the capital and the energy sector in the model in Fig. 17? How are the block of production and the energy sector defined? Is household energy consumption included in Y?

2. What is the definition of investment fraction and marginal return of capital?

3. What is the nature and cause of the oscillations found in the evolution charts of Chapter 6?

Conclusion:

In the submitted dissertation has provided a sufficient overview of the intentions and the expected goals he wants to achieve. Its chosen topic is a so-to-speak very hot one, the structure and the proposed method, their implementation together with their obtained solution for the expected goals are in accordance with the requirements of the PhD. thesis. Hence, I highly recommend the thesis submitted for the doctoral defence.

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