Review of: "Time evolution and convergence of simple migration models"

Daniel Arreola[1]

1 Universidad Nacional Autónoma de México

Potential competing interests: No potential competing interests to declare.

The main idea of this article is interesting and could contribute to the analysis of steady States on migration, I recommend the author to consider the observations made in the attached file and work on the comments for a new manuscript.

Decision: Major Revisions

Referee's report on:

"Time evolution and convergence of simple migration models"

Manuscript number: 46M58H

https://doi.org/10.32388/46M58H

In this project, The author considers two of the most fundamental mobility models in migration, the Gravity and the Radiation models, and investigate their long-term trends. His analysis consists of determining the models' steady states and investigating their temporal dynamics for different applications and scenarios. He finds that a simple Gravity model results in two different long-term solutions, depending on its parametrization, which are independent of spatial population divisions and initial population distributions. The Radiation model on the other hand shows a strong dependency on spatial properties, due to its usage of intervening opportunities. He finds that the dynamics differ significantly when it is applied to gridded population division or to population distribution divided into heterogeneous administrative units, like national counties or municipalities.

Here are my questions/comments/suggestions:

1.- Throughout the paper, there are a bunch of typos and reference mistakes, for instance; There is a mention of Fig.2 in the text while describing the fig.1, also, right before Equation 5 "for the Radiation mode to be in a steady state:" but it looks like you refer instead to "for the Radiation **model** to be in a steady state:". There is no Figure 7.

I recommend reading the work and looking for this kind of mistake that makes it harder to follow the main ideas.

2. Figure 1. is very informative on trends among the population, but is not clearly explained in the text what every colour means, I understand that the heat scale on the right-hand tries to describe its meaning but should be clear in the text, and further interpretation will improve the reading flow. Similar comment for Figure 3.

3. Along with the development of the paper the term distance is used, but never defined which makes it difficult to follow since most of the ideas are based on distance but not clear if when you are talking of distance you mean geographical distance. Or a norm or how you use the term, additionally is not clear if the distance is used in the same manner for both models.

4. In conclusion of the gravity model author mentions that “d_ij do not influence the final steady state of the system but only the convergence time”:

-should be clear how the convergence time is computed and if possible describe the trajectory of the model to see how d_ij does not influence it.

-Exploring the relaxation of the assumptions on convergence behaviour would make this analysis clearer.

5. It lacks a discussion on why i and j can be considered steady states individually, and why only the case with beta=alpha is steady at the origin. Appears that if i and j are steady states individually only an external shock would cause a movement, therefore the system in all three cases regarding the parameters is a steady state. If not should be discussed why.

6. Equation 4 has a weird notation and should be corrected or explained.

7. When discussing boundaries for “s_ij-circle” seems like the author ignores literature working on the same issue, for instance, **https://rdcu.be/deevd** if this work is irrelevant to the author’s approach it should be described why regarding the importance of this publication on the matter.

8. When declaring “it resembles global migration” seems like there is literature supporting this idea. However, it is not discussed why and if there is a general consensus that it is the case.

9. The paragraph explaining Figure 6 is not clear in the phrasing “the distribution first shows two maximus” and then?

10. Declaring that outer points have a “naturally” smaller number seems incorrect, what in the first place is natural? It results from your assumption on Gaussian distribution and the choice of one or other distribution is not natural.

11. Even if you wrote for an expert audience, saying “as one can easily confirm” you can just describe it intuitively, prove it mathematically or quote some other paper where this easy confirmation is already developed.

12. The simulation of both models is not described, then it is not clear the implications on “homogenous population”, m_i= m_j It seems like a contradiction given that you declare a Gaussian distribution but this condition appears to be a uniform distribution, this may be clarified when you add to the document how you carried out the simulations.

13. When you assume that intervening conditions on Equations 16 and 17 are about the same for “larger distances” is not clear yet what you are considering a distance and larger in relation to what?

14. After Equation 17 you mention i-cities are bigger for the first time, and it's not clear if that analysis starts there or is

been throught the whole document, additionally if the case starts from there should be clear that you are making a definition there.

15. Last equation is not numbered nor clear, which makes its interpretation ununderstandable.

16. There is no Figure 7 to compare and after Figure 8 the paragraph is unclear as to where are the patterns to author mentions.

17. The way the computation is carried out should be added whether as an appendix or as part of the text with details to make it clear where the author's conclusions are coming from.

18. Once both simulations are computed, using spatial and periodic boundaries, why not using then both to see their interactions towards the steady state?

19. In general seems like the idea of analysing long-run trends seems fruitful, however, a lot of contexts is lacking in the way you are doing it, also a deeper state of art review would make it clear where your work is positioned among the research of this topic and clarify the relevance of it. As I understand the long-run trend analysis of these models is a new contribution, well this should be clear from the beginning. For other instances where long-run trends are analysed within the mobility of populations see: https://rdcu.be/c2xsm