How population policy (one-child and multi-child policy) affect the total population in China? (Word counts: 1480)

Research Question:

This Agent Based Model is designed for how population policy (one-child and multi-child policy) affect the total population in China in the long run.

In the 1950s, rapid growth of population happened in China since the end of the war, total population immediately jumped to a high level which exacerbates poverty and economic progress (Hesketh and Zhu, 1997). Since 1976, a policy has been enacted by Chinese government, it said that one couple can only have one child, only a few families are in exception (Hesketh, Lu and Xing, 2005). This policy protected from unrestrained growth of population also released the pressure on resources all over the world. However, after few decades the ageing population has been one of the major social problems. Since 1st, January 2016, all Chinese families are allowed to have two children, which marks the end of one-child policy (Feng *et al.*, 2016).

In this model, we want to figure out whether one-child policy did help to slow down the growth of the population as well as how will universal two-child policy effect on the trend of population.

ODD Model Description

Purpose:

This social model aims to give a theoretical prediction on how the change of birth control policy, sex ratio and fertility intension age in China effect the total population and population structure in the long run. The model is designed to extend existing analysis on both one-child policy and its relaxation.

Entities, state variables, and scales:

In this model, objects represent people, which divided into two groups by their physical sex, each agent also has variables for age and marital status.

This ABM is not a spatial one, the model does not have geographic space.

In this model, one tick represents 1 year in life. This model can run permanently if there are always agents in the world or will stop once there are no agents.

Process overview and scheduling:

The agents in this model coloured with blue and red represent male and female.
In each tick, the following processes will happen:

Go ahead: agents randomly move in each step to roughly simulate the population migration in this model.

Age and die: one tick represents one year in reality, people grow up as time goes by and die when they are more than 80 years old.

Calculate fertility probability: not all the agents can give births, people have no probability to give birth to a baby when they are more than 45 or less than 20 years old. The fertility probability distribution in this model is kind of normal distributed around fertility intention age which can be set in the interface. People within the range [fertility intention -3, fertility intention +3], [-6,+6], [-9,+9] have a probability of 45%, 75%, and 95% respectively.

Get married: in this procedure, there will appear a link between married people, also define the way of people get married: people aged between 18 and 55 have a probability of 90 to get married with opposite sex who is also within 7 patches.

Give birth: this part simulates how to bear new generations in this model. There are two modes, first is called family planning, which means only one child or a twin can be in a family, the other policy is there can be two children in a family, in both model, there is the probability of 30% to have one more child beside the regulation.

Design concepts

Mergence: The main output of this model is population number, which effects by the government policy, population structure (in this model means initial population, male-female ratio) and age of fertility intention.

Adaptation: Agents in this model decide whether get married or not, new marriage family also decide whether give birth to a child (or multiple children). Both two decisions influenced by the ages, only people within suitable age range can marriage and give birth in this model. The marriage rate is pre-determined in the code. The fertility rate affected by both the intention age of giving birth (can be changed in the interface) and the probability I set in the code.

Objectives: The objective measure used by agents to decide married or not is whether there is a suitable opposite sex person around seven surrounding patches. 'Suitable' means whether this person is in the age range we set can get marriage. Another objective measure for giving births is the birth policy we choose for the model.

Sensing: In the process of 'get married', an individual can marry any person around (within 7 patches) them.

Interaction: There is a direct interaction happens when 'marriage' happens between two people, there will be a link between them. And new agents can be generated, which is indirect interaction.

Initialization:

Agents with age and sex are determined when set up. The ageing distribution of people also set at the beginning of this model, 40% are between 25 and 35, 40% between [10, 25] and [35, 30], the others are less than 10 and between 35 and 50. Also, the initial number of population and sex ratio is initialized and can be changed through sliders in the interface.

Two different limitations of children birth also in the initialization, 'one-child policy' and 'multiple birth'. In the one-child policy, when giving birth to a new generation, there is a 30% probability to have 2 children, others have 1. Multiple birth policy adds one more child with the same frame.

Input data:

There is no input data in this model.

Submodels:

Marriage:

With pre-set probability, people marriage with someone within 7 patches around them, once married, there will be a link between couples.

Give birth to the new generation:

Couple will give birth to the new generation.

Methodology:

The world of this model is 380 * 204 squares. In this report, we want to observe the total number of the population in this world as well as the 'dead time' of all population. BehaviourSpace study will be used in Netlogo for this agent based model.

In the 2010 census, there were 105 men per 100 women in China (Cai, 2013), so the sex ratio we use in all the experiments is 51% male. The median intension of fertility age used to set the fertility probability distribution is 28. Three experiments will be run in this report with BehaviorSpace.

Firstly, two experiments are running for total population, one is under the 'one-child policy' the other is 'multiple births', stop time set as 200 ticks, counting total population at that time. These two experiments aim to see the gap of the population between the two policies.

Also, during running the model, it could be observed that population under 'one-child policy' will vanish after some steps, so an experiment will help to figure out whether and when people vanish under this policy.

All of these three experiments run 80 times with an initial population from 500 to 2500, increased by 100 each time, 5 runs in each population.

Results:

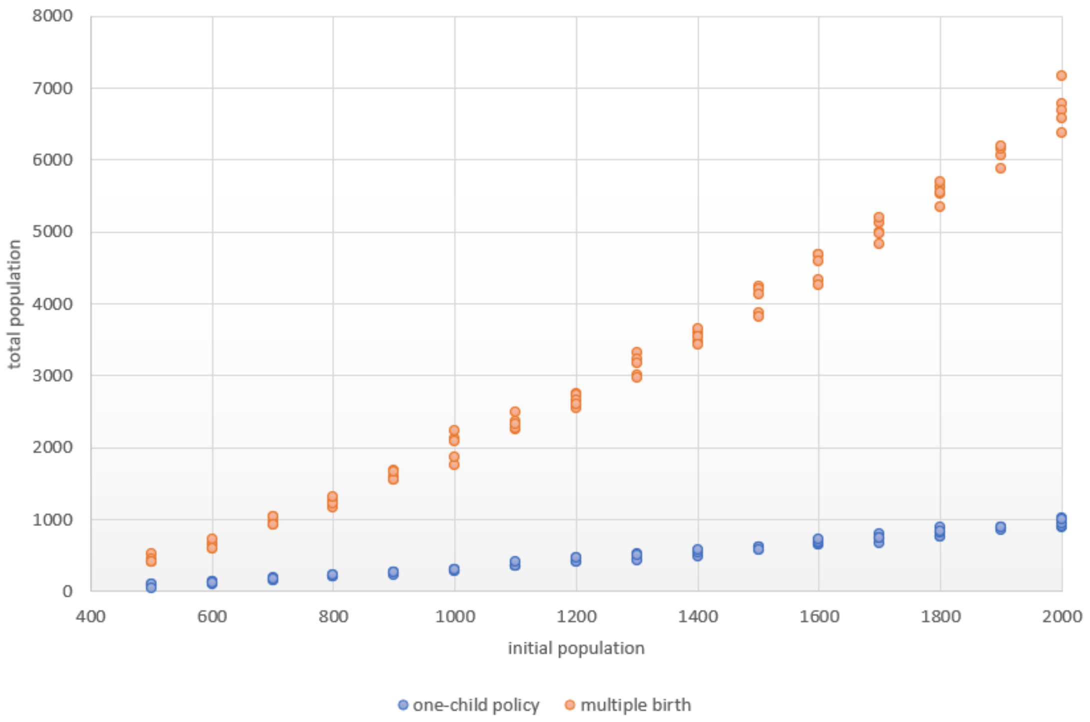

Figure 1: total number after 200 steps with different policy

The first illustration shows the result of the first two experiments which count the turtles at 200 steps with different policies. From the plot, it is obvious that one-child policy controls the population from extreme increasing. As the initial population increase, the gap between the population under the two policies increases.

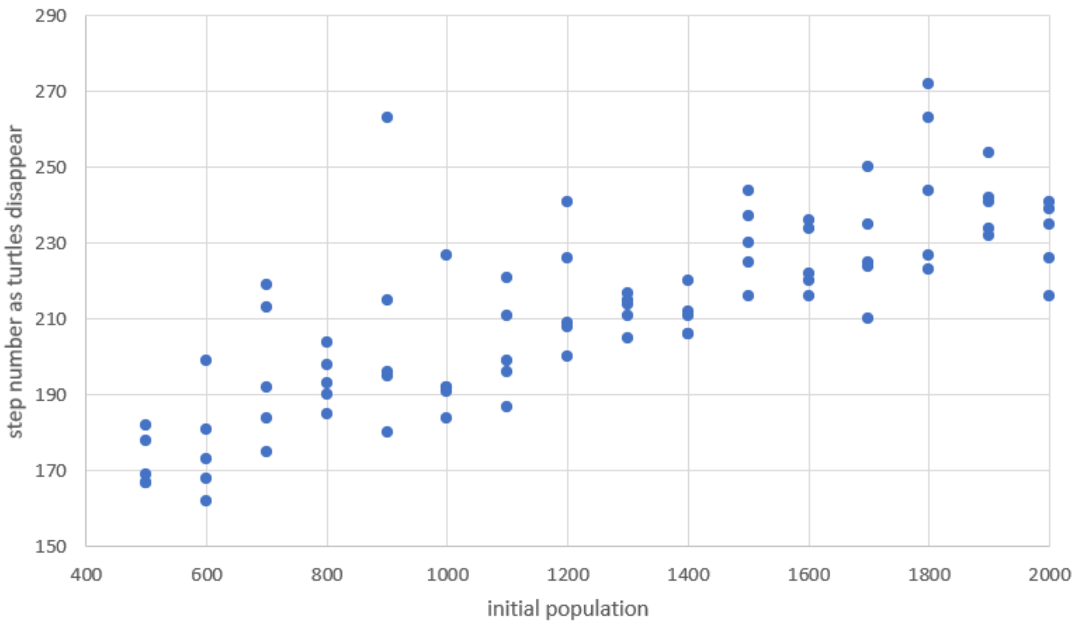

Figure 2: when turtles disappear under one-child policy

The second graph is about when will all the turtles vanish under the one-child policy. The tendency shows that if the one-child policy goes forever, there must be someday all the agents disappear. Also, in general, as the initial population increase, it will take more time to get this result.

Conclusion and Discussion:

Agent based modelling has been a useful tool nowadays for community research, especially for demography issue (Singh and Ahn, 2017). This model can be a tool to observe population with different emphasis and different social patterns, however, in this research what we focus the most is how two policies effect on the total population. This is a rudimentary model to experiment on population trend, although we have considered ageing structure, sex ratio, fertility intention age while initialization, there is still some limitation in this model. For example, the fertility rate in the real world is of notable fluctuations, and the distribution is skewed (He et al., 2019), however, what we set in this model is normal distributed around a fixed age.

In conclusion, the one-child policy in China did slow down the growth rate of the population, which can be seen from the first two experiments and figure 1. Also, from the figure 2, one-child policy is not suitable for the long run, which may lead to the rapid population decline event to zero finally. It is one of the reasons for loosing policy to multiple birth which gives less restriction to family size and will speed up the population growth.

Reference:

Cai, Y. (2013). ‘China’s New Demographic Reality: Learning from the 2010 Census’. *Population and Development Review*. Wiley, 39 (3), pp. 371–396. doi: 10.1111/j.1728-4457.2013.00608.x.

Feng, W., Gu, B. and Cai, Y. (2016). ‘The End of China’s One-Child Policy’. *Studies in Family Planning*. Wiley, 47 (1), pp. 83–86. doi: 10.1111/j.1728-4465.2016.00052.x.

He, D., Zhang, X., Zhuang, Y., Wang, Z. and Jiang, Y. (2019). ‘China fertility report, 2006–2016’. *China Population and Development Studies*. Springer Science and Business Media LLC, 2 (4), pp. 430–439. doi: 10.1007/s42379-019-00022-9.

Hesketh, T., Lu, L. and Xing, Z. W. (2005). ‘The Effect of China’s One-Child Family Policy after 25 Years’. *New England Journal of Medicine*, 353 (11), pp. 1171–1176. doi: 10.1056/nejmhpr051833.

Hesketh, T. and Zhu, W. X. (1997). ‘Health in China: The one child family policy: the good, the bad, and the ugly’. *BMJ*. BMJ, 314 (7095), p. 1685. doi: 10.1136/bmj.314.7095.1685.

Singh, K. and Ahn, C.-W. (2017). ‘A holistic agent based model for demography’. in *2017 IEEE Symposium Series on Computational Intelligence (SSCI)*. IEEE. doi: 10.1109/ssci.2017.8285415.