Analysis of determinants that influence rural-urban migration

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Abstract: Infrastructure Modelling is the backbone of any development project. Commonly analyzed key performance indicators towards the success of a new project are parameters such as population growth, economic growth, etc. of the region. There are various factors that affect these parameters, hence the success, of a city development project. In our system, we will try to model these factors and simulate their effects on the rate of growth of population in a city.

1. Description of the system

In this project, we simulate the migration of the human population from rural or semi-urban areas to a city which is our object of study. All the regions of this system under investigation are considered to be graded on various socio-economic factors that drive migration. Based on these properties, the population of every region changes with each simulation. This model thus analyses the rate of population growth by changing the values of these determinants with each simulation.

In the real world, a city council could use this model for budget resolution and informed authorization of public improvements. Population growth generates new jobs, new income, increased tax revenue, and higher property values. [10] A city council could thus benefit from this simulator and invest in the right part of the infrastructure in the city.

Another application of this simulation is to determine the feasibility of investments in large-scale urban development. The builders and developers of any new city project invest based on the prediction of the timeline of the occupancy of their project, and that determines the success and failure of that project. Our study of the rate of growth of population or rate of migration based on different factors could prove beneficial to them in order to make various infrastructure modeling decisions.

2. Conceptual model

2.1 Structure

Each identical lattice will signify a single person. We assume that this person represents a section of the population. Each region will be assigned scores based on socio-economic factors that drive migration.

2.2 Initialization

The initial condition of each lattice in a 50 by 50 grid of a Cellular Automata model will have some probability of being in a particular state. The center of this grid would be a 20 by 20 region which we would describe as a city, and the remaining cells would be considered to be rural areas.
This initial condition will be given to every person based on factors provided by the city/rural area. This initial condition state will take the values 0, 1. 0 represents that the person will migrate towards the city, while 1 represents no inclination to migrate.

2.3 Properties of the system

Majority rule Moore's neighborhood will be our central simulation engine. At a particular time period, the quality of infrastructure of the city will be the factor that will influence the decision of a person. The effect of a factor will be determined by a logarithmic regression model giving results between 0 & 1. That value between 0 & 1 will be

translated to states 0, 1. Once initial values are given to each lattice based on a regression analysis framework, we will run Moore's neighborhood majority rule.

2.4 Transitions

The system will go through transitions at every time step in the following ways:

- In that our rules will be, if there are 5 or more adjacent lattice which have state 0 means no population then the central state will turn to 0
- If there are 4 to 6 lattices having state 1, the central state will become 1.
- If there are 5 or more than 5 lattices having state 2, the central lattice will feel overpopulated and it will become 0.

2.5 Validation & Datasets

The simulation outputs will be validated using historical data like census reports obtained through the United States Census Bureau[11], HealthStats[12] & the Migration Data Portal[13]. Initial properties will be assigned based on cities for which the data already exists. The validation against known results will determine the feasibility to use this model for a new object of study.

3. Platform(s) of development

We are using Python 3 in a Jupyter Notebook environment to build and test our simulator. We've chosen Python due to its large number of libraries and packages which can easily support our project ideas. We have also used the forest fire simulator shared in class as a starting point for our simulator which is also another reason why we decided to stick to Python.

4. Literature review

4.1 Factors

- *Healthcare*

  The primary indicator for determining whether or not people are able to "be" or "do" desirable things in life is the Human Development Index (HDI), by the United Nations Development Program (UNDP), which combines the performances of countries based on health, education, and economics. Migration due to lack of fundamental human rights such as health care is prominent as location matters when it comes to health.[13] To measure this, we look at the cost of care and life expectancy rates for different regions. A more holistic approach to quantify this could be an amalgamation of several other factors as well. A region can prioritize its citizen's health care by promoting wellness, keeping medical services affordable & accessible, or just maintaining cleanliness, even. The most pressing issue in the current scenario is the COVID-19 pandemic, implying that how well a city handles such a situation can also be a factor to rate it based on healthcare services as it largely impacts the physical and mental wellness of its residents.

- *Infrastructure & transportation :-*

  For years, it has been evident that the increase in connectivity has always witnessed a rise in the growth of the region. The paper [1] has found a quantitative effect of infrastructure development on growth as well as income inequality. And in doing so, they have provided a comprehensive evaluation of that impact. The data set which they used covers 100 countries. It is with respect to the quantity indicator of each infrastructure network and making a linear regression framework model of each infrastructure impact. To evaluate the impact, they used GMM econometric methods to minimize their fluctuations in the data set. They found positive and significant correlations of three types of infrastructure assets – telecommunications, transport and power. It signifies the contribution of each sector from the 3 shortlisted infrastructure networks. The data such as telephone density change, power consumption data were taken for the study. Lastly, they identified that conceptually, along with growth in infrastructure, the underprivileged

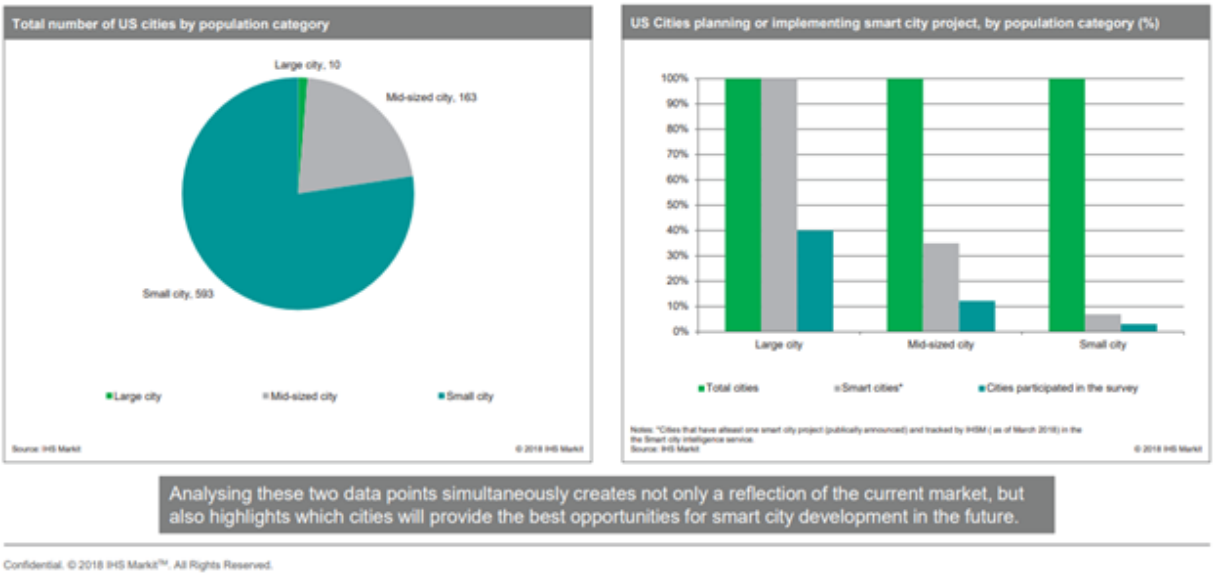
individuals and underdeveloped areas obtain better connectivity. This indeed opens up opportunities for jobs or economic growth and reduces economic inequality.

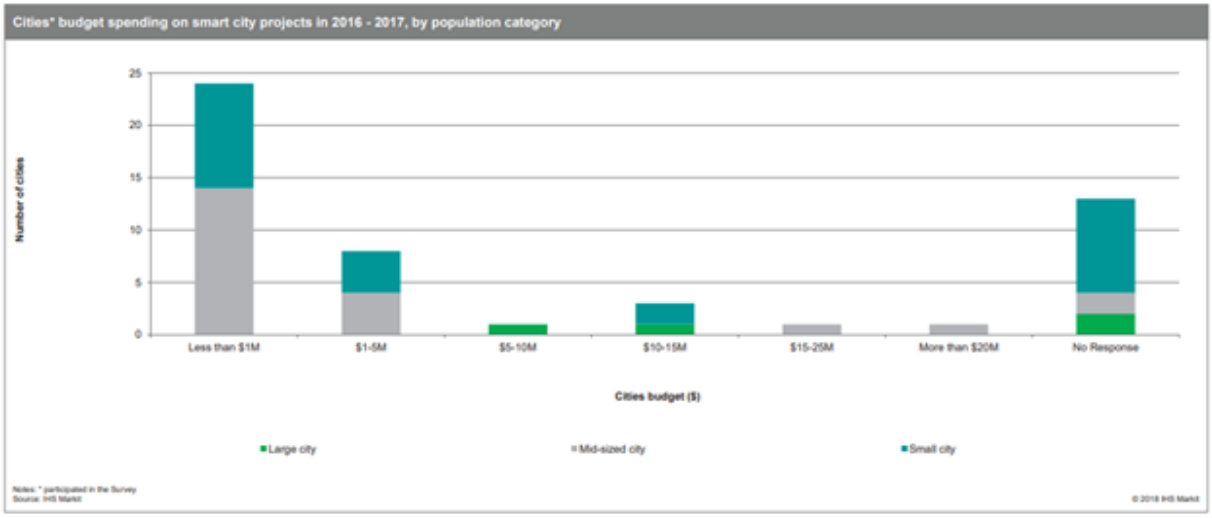
- *Taxation*

  It is widely believed that an increase in taxes will eventually lead to an exodus of people from a city. This belief has been strengthened in the last few years due to the large outflow of people from the state of California to other parts of the US with lower taxes, such as Texas or Virginia. However, research [9] conducted by the Political Economy Research Institute at the University of Massachusetts has shown that people are likely to remain in regions of high taxation because they value the public services financed by taxes. Additionally, the cost of moving is often fairly high with not much to gain from it. The main reasons for moving are employment, family related matters and education. This suggests that migration can be heavily influenced by improvements in infrastructure, even if it is funded by higher taxes.

- *Smart City*

  Smart city development projects are a subset of infrastructure projects but since the sector is not flourishing and it is growing, the need to study its impact becomes of higher-order priority. This will help to make decisions on future investment in the right kind of projects. Here the indicator we have identified to study the impact on the economy due to a smart city is by growth in spending on smart city projects. The above literature forms our basis of references, which shows the distribution of smart city development projects trends concerning the population of the city. In their survey, they have found that all large cities at least have 1 smart city project and a higher population range in mid-cities shows great potential to invest in smart city projects. This shows that regions with higher populations favour having smart city projects. Since it is proved in the paper [2] that budget remains the major barrier towards implementing smart city projects, we consider the indicator of smart city growth to be an increase in the amount of spending on smart city projects by a city. This study also shows the trend that mid-size cities are willing to invest more in smart city projects (Fig 1)





- ## Education

  If simplified to a certain extent, we can say that people migrate for security concerns, livelihood opportunities, and economic incentives. They base this decision on a comparison of expected lifetime earnings in the current region and in the alternative region. Education and skill acquisition are closely related to this ultimate goal. However, the literature survey [6] points to the fact that education is a primary factor only in certain groups of the population. For the rest, it is a secondary driver or a socio-economic factor that is considered as a family investment in children's education. These groups can be identified by dividing the population on the basis of age and gender.

  Age: Migration is mainly often observed among the working-age population and education is not a predominant force in that case. Better schooling is a major issue for mainly two broad groups: youth aged 15-25 and people with children. For students, education is their chance to improve their economic situation and for young parents, this is an implicit factor towards building a better life.

  Gender: A detail that could potentially add weight to education as a driver for migration is more freedom to seek better and more opportunities for skill acquisition. Here education acts as a push factor instead of a pull factor.

- ## Immigration leading to job creation/economic improvement

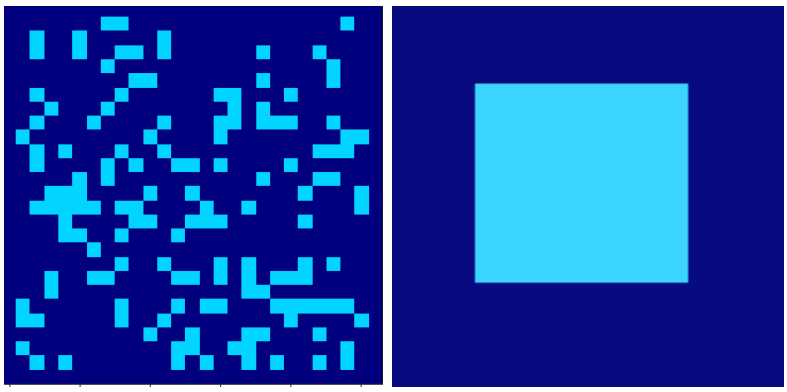
  The National Foundation for American Policy in 2016 released a study titled "Immigrants and billion dollar startups" in which it was shown that more than half (55%) of America's billion-dollar startups had at least one immigrant as part of their team of founders. While the topic of immigration is quite contentious politically, from an economic standpoint the research is quite clear - immigration leads to more jobs and economic growth. It is a misconception that immigrants are taking up jobs that would have otherwise gone to Americans. In fact, the jobs taken up by immigrants (whether it is high or low skilled) make it possible for more jobs to be created which are taken up by Americans - for example in the service sector where Americans enjoy the advantage of soft skills over immigrants.

5. Progress update

So far, we have built a basic simulator using a Cellular Automata model. We have included one property - GDP per capita. In further development stages, we intend on integrating each additional factor on a step-by-step basis. The code for this simulator is shown below:

All code will be updated on our Github repository - https://github.gatech.edu/dpailla3/ModSimProject

Sample outputs of the population randomly spread across the grid on the left, and population all centered in a city on the right



6. Major changes

Based on our literature review, we realized that migration of population, increase in a city's revenue, and growth in the number of jobs are all correlated concepts. This has guided our decision in focusing on the economic impact or the return of investment on infrastructure development. Our project is now focused on trying to build a simulator that adequately simulates real-life migration based on infrastructure improvements, and then figuring out what potential combinations of infrastructure would further increase the economic output of a city.

Initially, our project idea was focused on the development of a smart city neighboring a major city. This remains a good application of our simulator, however, this would be difficult to validate due to the scarcity of good data. Hence, we have shifted our focus to rural-urban migration.

Despite these changes to our project idea, our focus continues to remain on infrastructure. Public funds are always limited, so it is crucial to determine what areas of infrastructure a city should prioritize and invest in to improve the livelihoods of its citizens.

Anticipated minor changes in the future - While our main project idea has been decided, the various factors that we build into the simulator may change depending on the feasibility of modeling these parameters and our ability to find census data to validate its effect on our population model.

7. Division of labor

Our base simulator is built, however, each additional feature needs to be represented differently in our model and then be validated based on compiled census data. We have divided the features equally amongst the 3 of us -
Riya - Healthcare, Transportation
Rajiv - Education, Telecommunication
Dheeraj - Taxation

Dheeraj will combine all the various feature representations into the final model.
Once the simulator is fully built, Riya and Rajiv will analyse the effects of infrastructure investment to optimise the return of investment on such projects.

References

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[12]https://datatopics.worldbank.org/health/

[13]https://wallethub.com/edu/healthiest-cities/31072

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