City growth and Zipf's Law

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CPB and Zipf's Law

- The largest cities in a country show a Zipfian distribution
  - Can we influence this type of city growth?
  - Can w
  - What

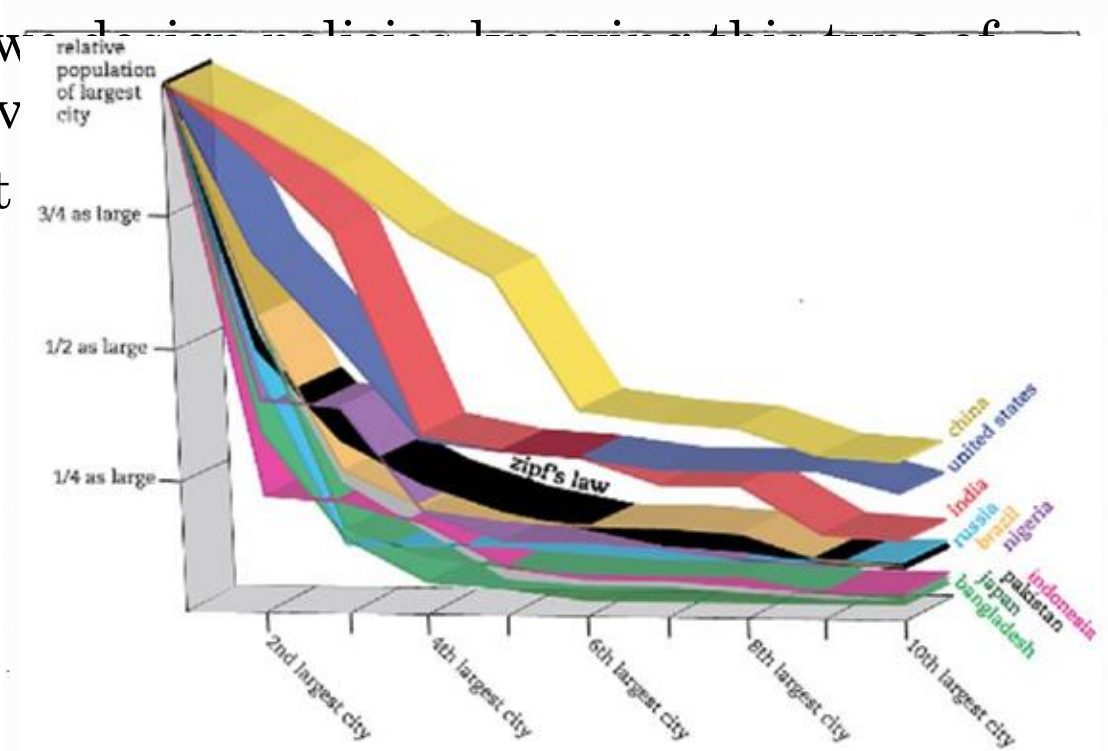


FIGURE I
Log Size versus Log Rank of the 135 largest U. S. Metropolitan Areas in 1991
Source: Statistical Abstract of the United States [1993].

Research question & Approach

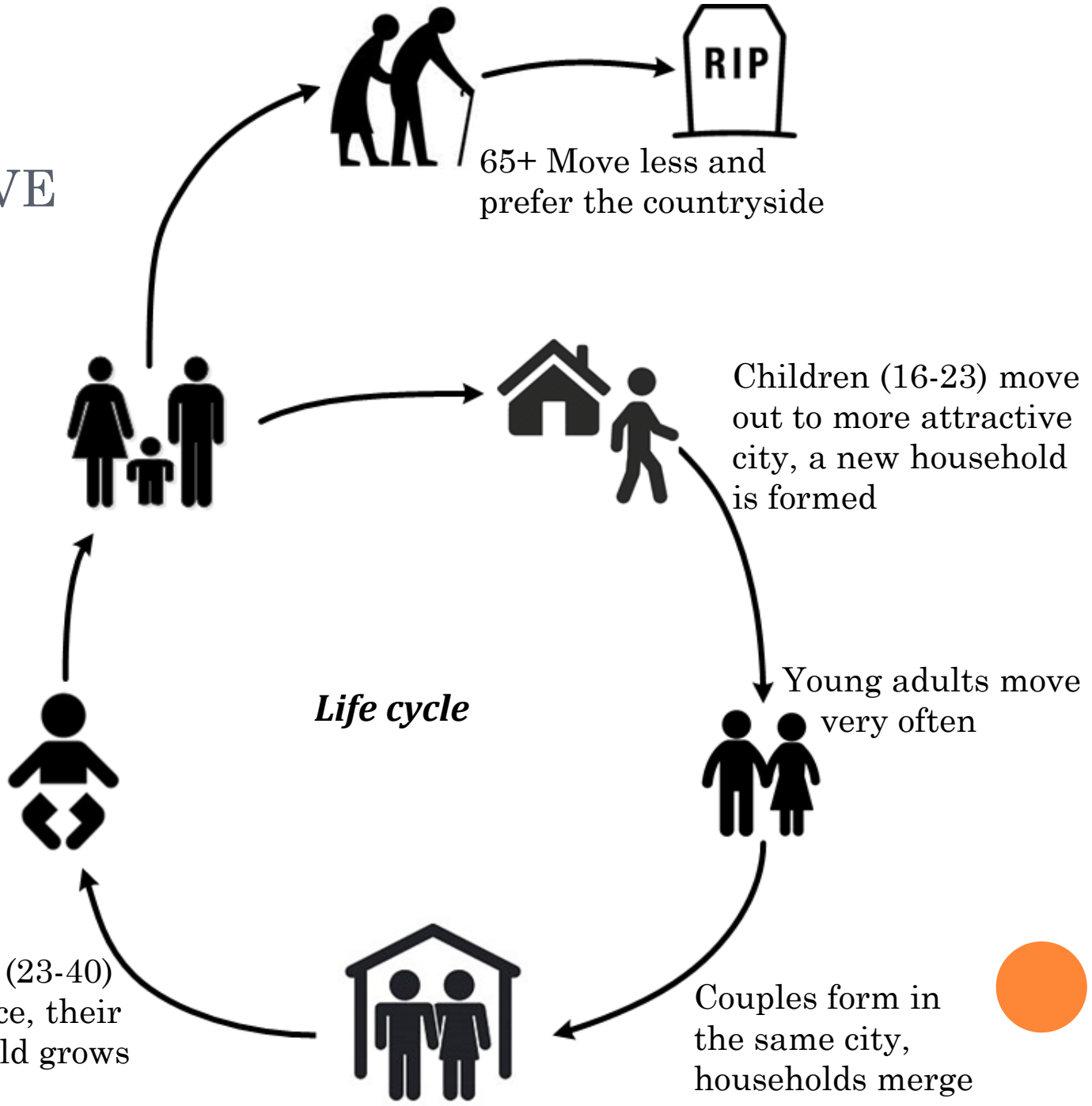
- Focus: Decisions made on household level

Research question:

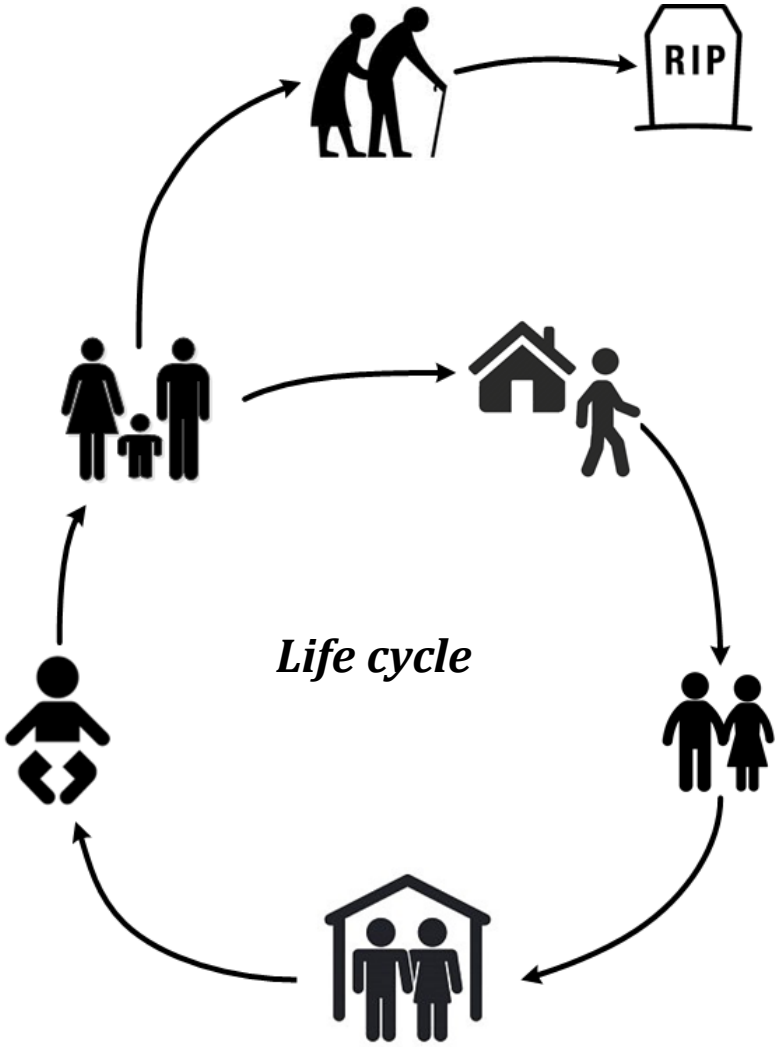
How do decisions made at household level influence moving behaviour between cities to cause the emergence of the Zipf's law?

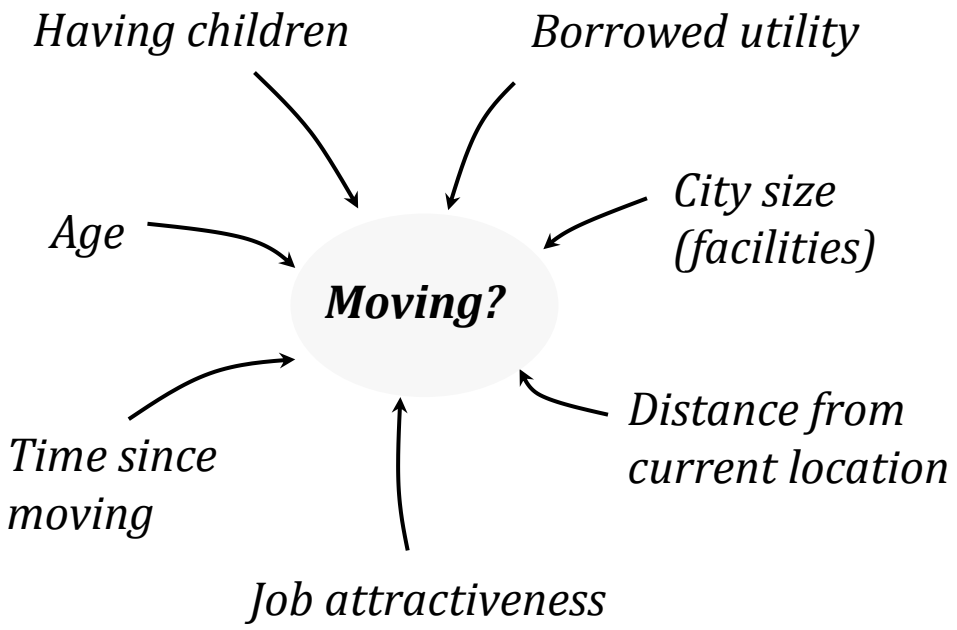
- Approach:
  - Literature research: for what reasons do people move?
    - Stage of Life
    - Job opportunities

Narrative


RIP
65+ Move less and prefer the countryside
Children (16-23) move out to more attractive city, a new household is formed
Young adults move very often
Couples form in the same city, households merge
Couples (23-40) reproduce, their household grows
Life cycle

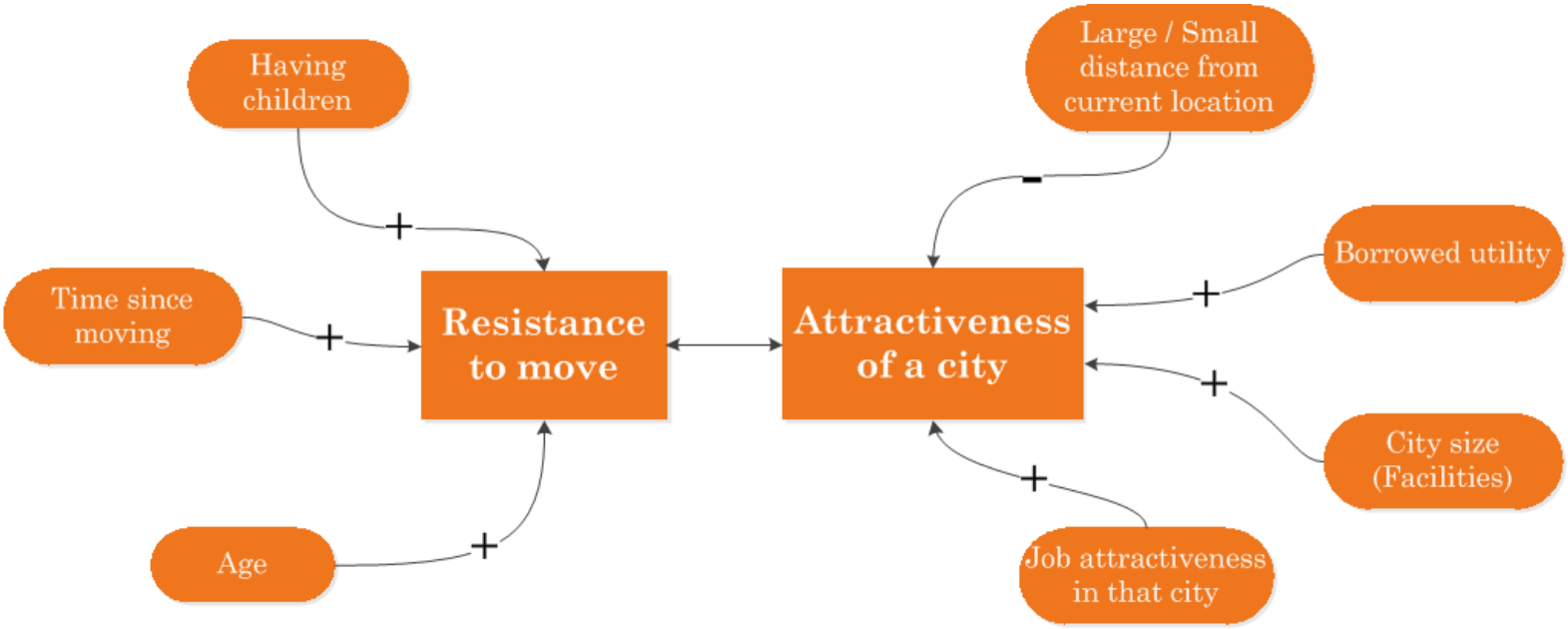
Narrative


RIP
Life cycle

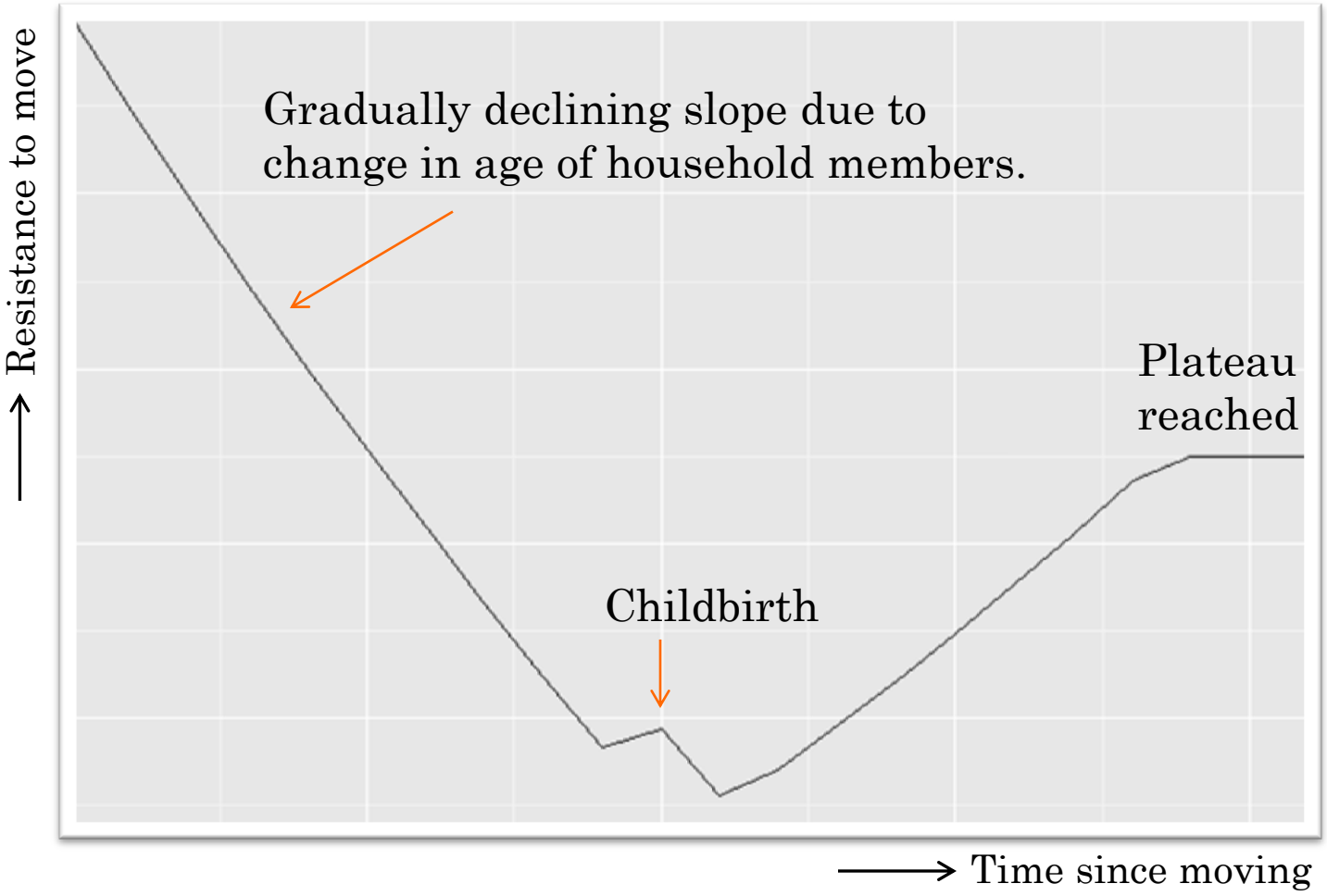

Having children
Borrowed utility
Age
City size (facilities)
Moving?
Distance from current location
Time since moving
Job attractiveness

Model Logic

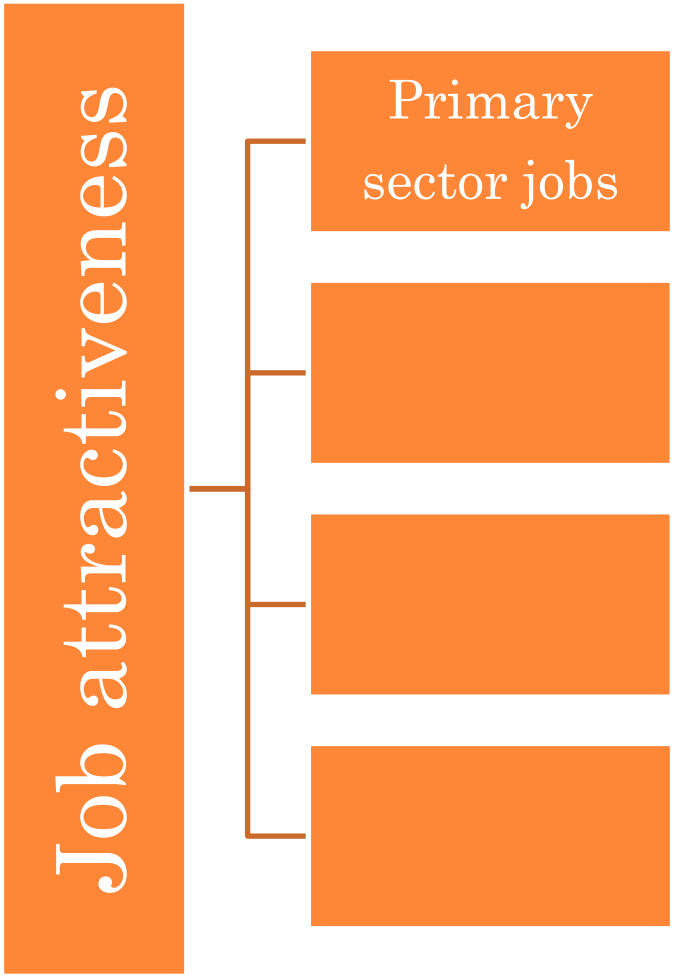
- Rule: A household moves to a random city for which its 'Attractiveness' > 'Resistance to move'

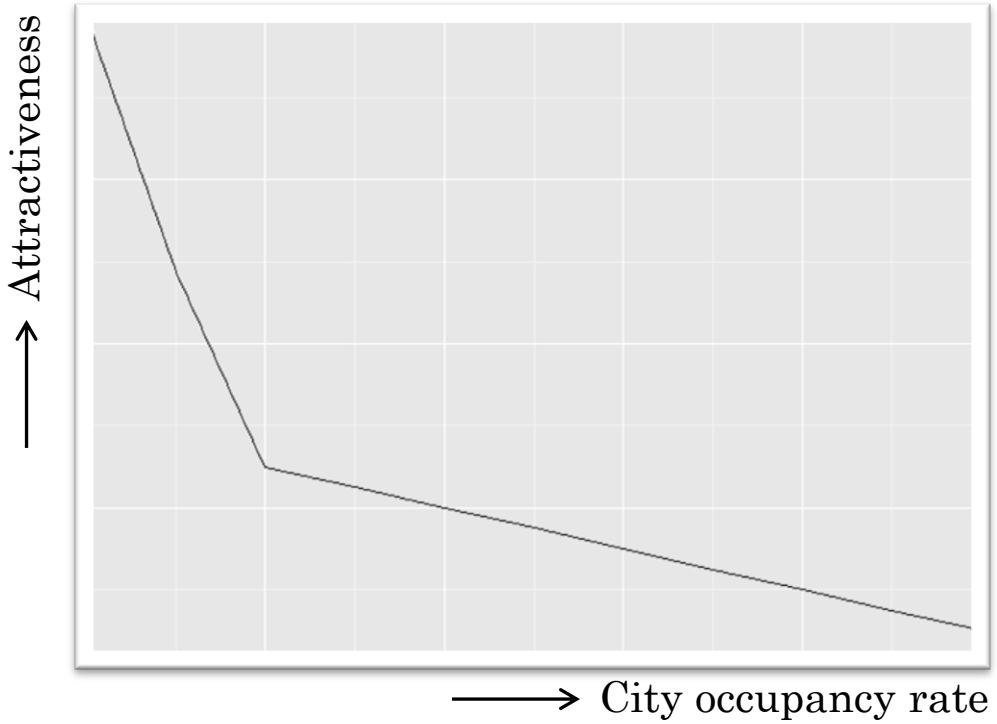


Model Logic: Resistance to Move

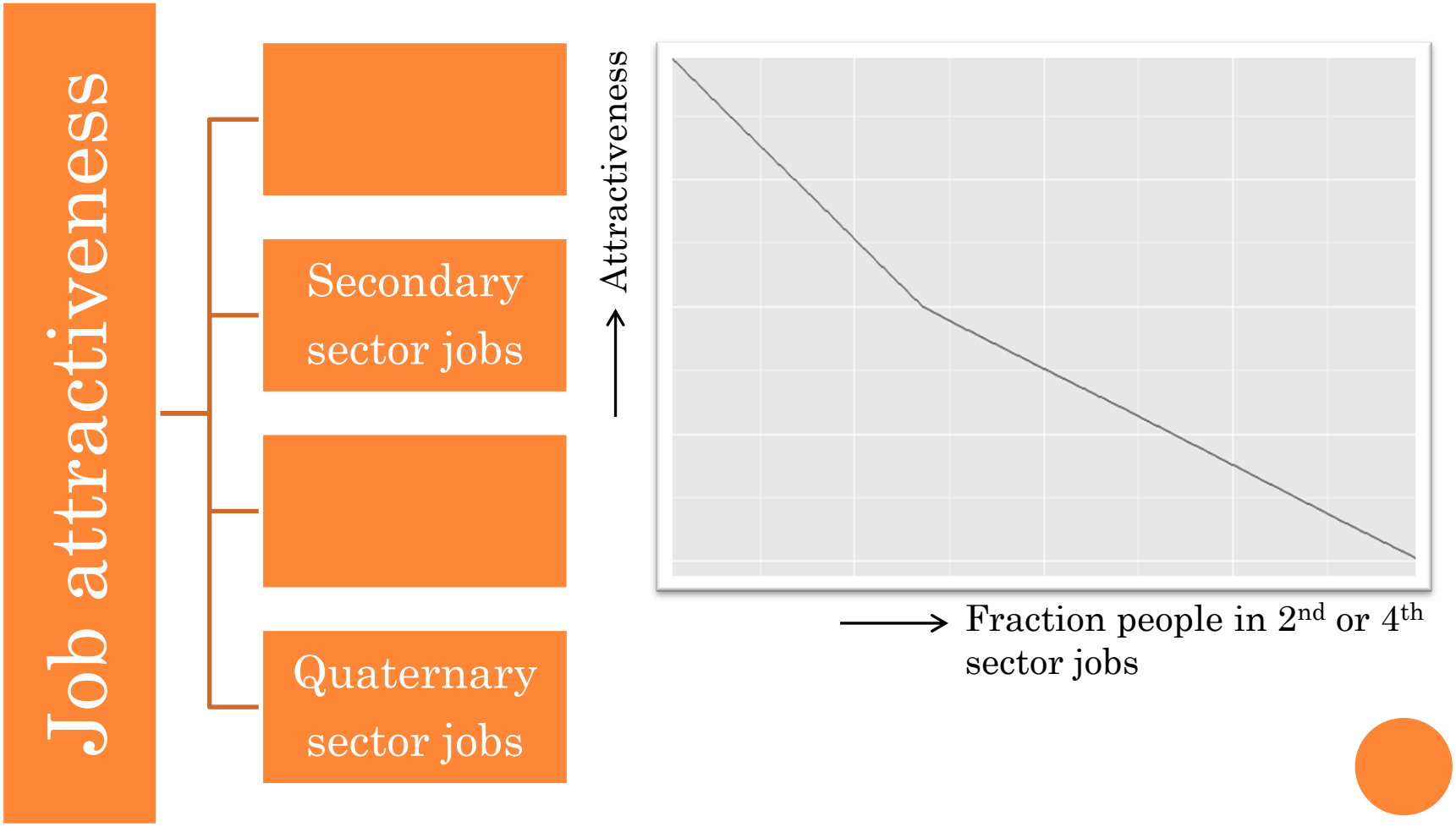


Model Logic: Job Attractiveness

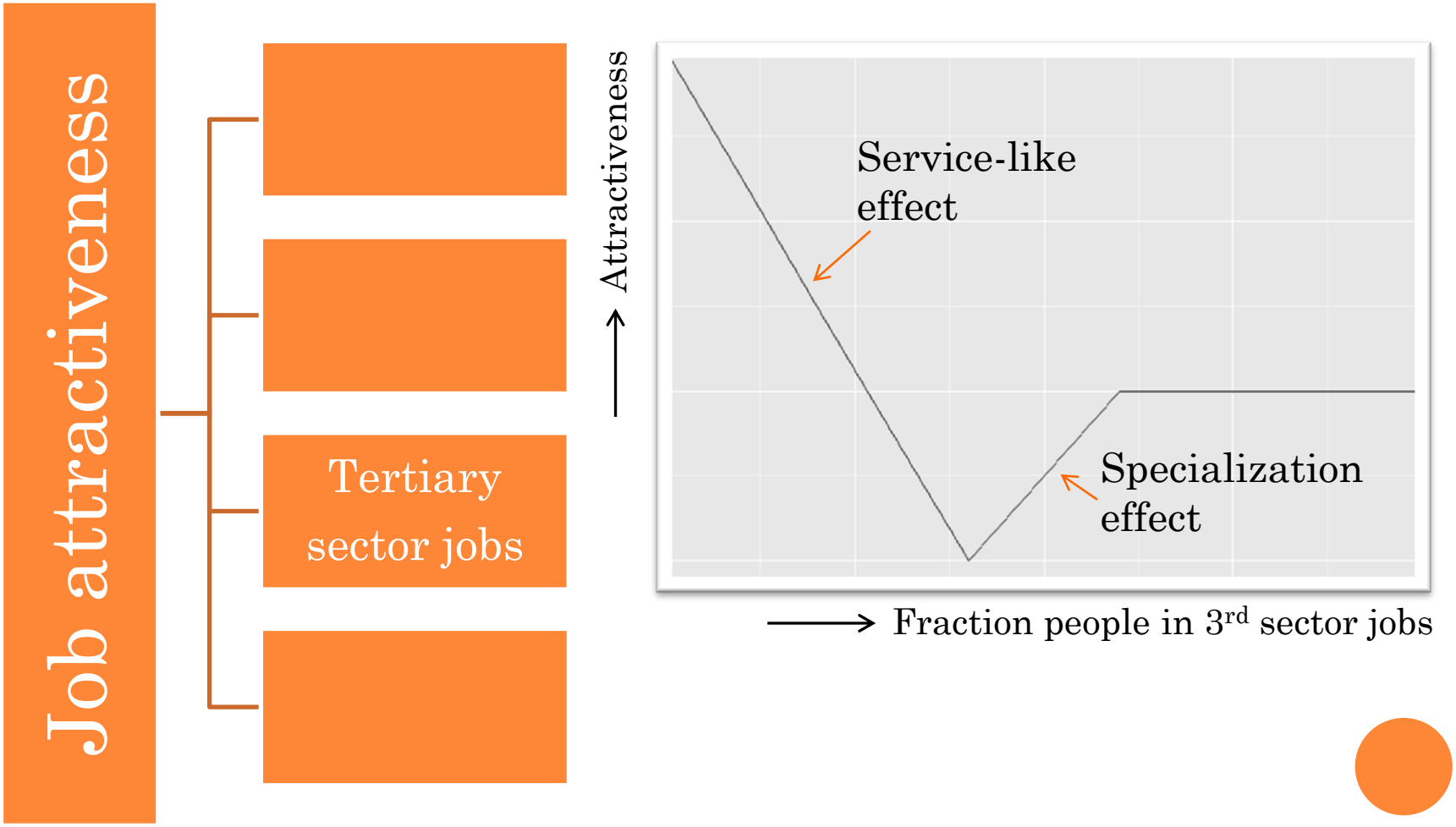




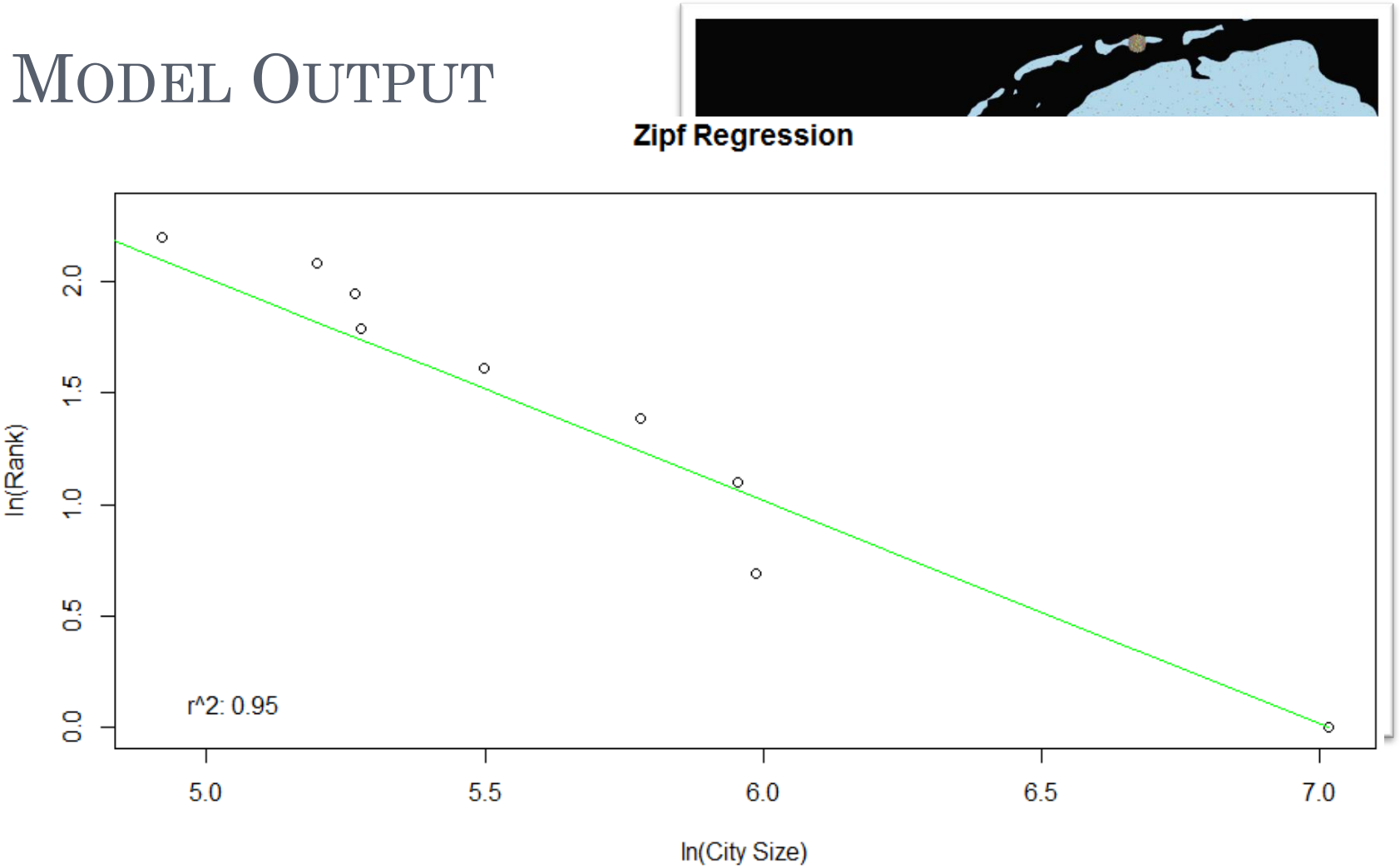
Model Logic: Job Attractiveness



Model Logic: Job Attractiveness



Model Output



- Number of households in and out of cities
- Number of households for the 10 different cities

Verification & Validation

- Verification
  - 6 Tests on a single-agent, minimal interaction and multi-agent level
  - The model is implemented as intended
- Literature validation
  - Parameters and relations are based on literature
- Face validation through expert consultation
  - Assumptions
  - Relations
  - Concepts

Experimental Design

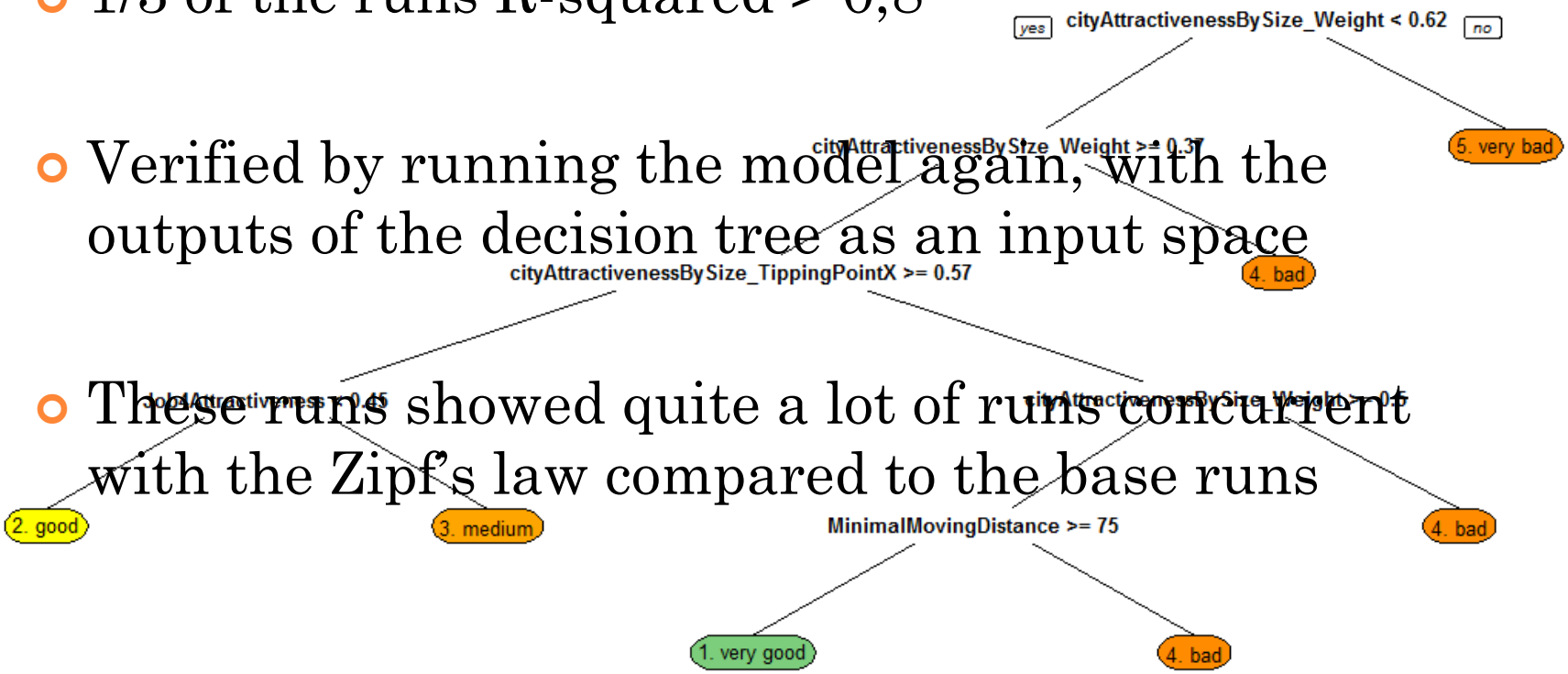
- Which variables have the most influence on creating the desired model output?

- Multi-variate analysis
- Latin hypercube
- Because of long run time, limited number of runs (300)

- Compare R-squared to a pure Zipfian distribution
- R-squared > 0,80 found in literature

Model Experimentation

- 1/3 of the runs R-squared > 0,8
- Verified by running the model again, with the outputs of the decision tree as an input space
- These runs showed quite a lot of runs concurrent with the Zipf's law compared to the base runs



Conclusions

- Our model is able to produce cities according to a Zipfian distribution
- However, very specific parameter values are needed to obtain a Zipfian distribution
- The Zipf's law has been around for centuries

- Two variables seem to have the most effect:
  - The city size effect
  - Distance between cities

- Do we now understand why a Zipf's law emerges?

Future Research

- Why doesn't the Zipf's law fit as well in the Netherlands as it does abroad and how does this affect decision making?

- What happens when European borders disappear entirely?
  - Will Paris or London become the most important city?
  - What will happen to our cities?

Netlogo in Practice

- Netlogo is all about turtles, and it moves about as fast as one
- Too much time spent on making model run at reasonable speeds
  - Table implementation 100x slower than regular list
  - Subtracting sets undoable
- No support for unit testing or assertions
- Memory leaks in RNetlogo
- Overall unsuitable due to speed limitations

Model files & Referenes

- If you're interested in the model files and documentation, please visit:

https://github.com/MBrouns/Zipfs-Law-and-city-development

- References

- Newitz, A. 2013. *A mysterious law that predicts the size of the world's biggest cities*. Retrieved from: http://io9.com/the-mysterious-law-that-governs-the-size-of-your-city-1479244159 at the 6th of January, 2015.
- Infrastructurist. 2011. *A Capital On The Move*. Retrieved from http://keith-travelsinindonesia.blogspot.nl/2011/06/capital-on-move.html at the 20th of January, 2015.