Objectives

Our goal for this project was to create a model using quantifiable variables in order to locate grocery stores that would be able to benefit the profit of the businesses as well as the convience for the consumers. The steps we took to complete this goal were:

- Choose and create variables that would be most influential and important for the model
- Put choosen variables in mathematical model
- Code model into AMPL using actual raw data
- Use code to find best zip code to locate new store

Abstract

Optimal Location Model

$$u_{hsbt} = v_{hsbt} + \alpha_h \cdot e(b, p_{hst}) + \gamma_h(d_{hs}) + X_{hs} \cdot \beta + \xi_{hs} + \epsilon_{hst}$$

where
u_{hsbt} = total utility
v_{hsbt} = utility of bundle over time
$\alpha \cdot e(b, p_{hst})$ = utility of expenditure or price
$X_{hs} \cdot \beta + \xi_{hs}$ = observed store component and error
ϵ_{hst} = error given household h and store s
h = household
s = store
t = times
b = bundle

Background

We noticed that where Wentworth is located in Boston, there are not many decent grocery stores around. To get quality food, we would need to travel quite far, which for us, diminishes the want to go to that store. It occurred to us that maybe there is a reason that these stores are located where they are, and even for these reasons specifically. We then had the idea that if we could start over and place the grocery stores exactly where we wanted to, how would we accomplish that? This inspiration and curiosity is what made us interested in doing this project. We wanted to make a mathematical model that would be able to place specific grocery stores in locations that would be both profitable for the stores and beneficial to the customers.

Methods

$u_{hsbt} = v_{hsbt} + \alpha_h \cdot e(b, p_{hst}) + \gamma_h(d_{hs}) + X_{hs} \cdot \beta + \xi_{hs} + \epsilon_{hst}$
Let t and b be constant
Then v_{hsbt} is constant
Now considering $\alpha_h \cdot e(b, p_{hst})$:
let I_h = income of household h
$\Delta \frac{p_{hs}}{I_h} \propto \Delta u_{hs}$
$\frac{\Delta u_{hs}}{\Delta p_{hs}} \propto \frac{1}{I_h}$
$\frac{\delta u_{hs}}{\delta p_{hs}} = \frac{c}{I_h}$
$\alpha_h \cdot e = u_{hs} = \frac{c \cdot p_{hs}}{I_h}$
Consider $c = -1$ since the utility should decrease as price increases
$\alpha_h \cdot e =$
$\frac{-p_{hst}}{I_h}$

Results

Conclusion

Although our goals were altered throughout our project, we still had a successful end product. At the end of our project, we were able to:

- Find the most valuable variables, such as income and distance, that determined someone's choice to go to a specific grocery store
- Create a model, using these variables, that gives the utility of the location of a certain store
- Code the model in AMPL
- Use raw data to put into our code for real world results
- Find the utility of specific store in each location
- Determine the best location of new grocery store by zip code

Future Work

We would like to go back more to our original idea of completely starting the city from scratch and place all new stores in new locations. Also, we would like to make the locations a bit more specific. Instead of saying just which zip code the store should be placed in, we would say which corner, street, or block it would be most beneficial at. Even though our model now is a good start, we need to add more to it to make it even more reliable and accurate. We could either add in more variables that would not have as much weight as the other ones and we could also add in an error value.

References

[1] Lucrezio Figurelli, *Store Choice in Spatially Differentiated Markets* (4 January, 2013), available at `https://www2.bc.edu/lucrezio-figurelli/Site/Home_files/jmp_figurelli.pdf`.

Special Thanks

Thank you to Rachel Maitra for advising our project. She has been a great consultant and professor with giving us helpful suggestions and working through our AMPL problems with us.

Contact Information

- Email: Raisonm@wit.edu
- Email: Pecukonisj@.edu