An Urban Location Model Incorporating Agglomeration Economies and Preferences for Open Space

Chen Feng Ng

Abstract

This paper is based on my dissertation research, which aims to analyze urban sprawl with a model incorporating agglomeration economies and preferences for open space. In the simplified model presented here, the city is linear with fixed lot sizes. Firms choose their office locations while households choose both residential and workplace locations. Both firms and households have heterogeneous tastes. Simulation results show equilibrium location patterns, rents and wages under different conditions. However, convergence is very difficult when agglomeration economies or traffic congestion are included in the model.

Advisor: Kenneth A. Small

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1 Introduction

My dissertation aims to analyze the issue of urban sprawl and the impacts of different anti-sprawl policies. Urban sprawl is generally associated with low-density, scattered development that causes urban boundaries to expand spatially. Sprawl has been blamed for a whole host of problems, such as traffic congestion and air pollution as a result of long commutes, loss of open space, expensive infrastructure, low aesthetic value, income segregation, reduced social interaction, and even obesity.

Numerous policies have been proposed to combat sprawl or specific problems associated with it. These policies include urban growth boundaries (UGBs), open space preservation, congestion pricing, development taxes, impact fees, infill development, and regional land-use planning.

This paper presents a simplified version of my main model. The following components from my main model are retained in this paper: both households and firms, who are non-identical, choose their locations; households have preferences for open space; there are agglomeration economies for firms; multi-directional travel is allowed; and traffic congestion may occur.

In this paper, the city is linear with fixed lot sizes. Hence, this model is unable to directly address the issue of urban sprawl, which is largely concerned with urban densities and spatial growth of cities. However, this model still allows me to explore some of the same concerns that would arise in a richer, two-dimensional model with endogenous lot size. In particular, we can see how heterogeneity and preferences for open space affect location patterns, rents and wages.

Moreover, finding the equilibrium is undoubtedly difficult since household location choices depend on the location of other households (due to traffic congestion) and similarly for firms (due to agglomeration economies). As seen in section 4, even with the simplified model convergence is difficult except in cases where agglomeration economies are set to be very weak.

This paper first discusses why open space and agglomeration economies are the focus of this model. The next section provides the mathematical setup of the model while section 4 presents the simulation results. Section 5 concludes.

2 The Importance of Open Space and Agglomeration Economies

Numerous papers have looked at urban sprawl and the impacts of various anti-sprawl policies. These papers differ widely in terms of their modeling assumptions. For instance, Brueckner (2005) compares UGBs and congestion tolls using a model where jobs are all located at a single point in the city center. Meanwhile, Anas and Rhee (2006) study this issue with a model incorporating dispersed employment, discretionary trips, individual heterogeneity and a greenbelt at the city periphery.

Bento et al (2006) use a model with a greenbelt but with no traffic congestion to evaluate anti-sprawl policies aimed at preserving open space. One of the few models which have open space both within and without the city is formulated by Walsh (2004) using a zonal approach calibrated with data from North Carolina.

Since the effects of various anti-sprawl policies may depend critically on modeling assumptions, careful attention should be paid to these assumptions. I try to provide a more realistic and complete picture of how firms and households choose their locations with my model, especially in terms of open space preference and agglomeration economies.

2.1 Open Space

It is reasonable to think that households place some amenity value on open space both within and without the city. Open space is used as a generic term to indicate land (or water) that is not used for residential, commercial or industrial development. It can be either natural (forests, mountains, marshes, etc) or man-made (neighborhood parks, golf courses, etc).

However, it is difficult to empirically assess the value of open space, not least because it is associated with a use value as well as an existence value. Some studies have used contingent valuation methods based on stated preference surveys, e.g., McGonagle and Swallow (2005), Earnhart (2006) and Breffle et al (1998). However, there are numerous problems associated with contingent valuation studies, including valuations that appear to be implausible or inconsistent with rational choice assumptions.

Other studies have used hedonic regressions to look at the capitalization of environmental amenities in house prices. For instance, Anderson and West (2006), Doss and Taff (1996) and Shultz and King (2001) find that proximity to certain types of open space positively influenced housing values.

It is difficult to pin down the value of open space, especially since most studies have looked at specific parcels of open space or housing markets. The safest conclusion is that willingness-to-pay for open space varies widely depending on the type of open space in question and household characteristics. The alternative uses of a particular tract of open space as a result of possible development probably also affect how individuals value its preservation. It is evident, though, that households do place some value on their proximity to and the size of many types of open space.

2.2 Agglomeration Economies

Agglomeration economies have yet to be incorporated in a model analyzing sprawl policies, even though it is generally recognized that agglomeration economies are one of the main reasons for the existence of cities.

It is probable that agglomeration economies are not viewed as a problem that is closely associated with sprawl. However, since agglomeration economies have a tendency to draw firms to locate closer together and thus create more compact cities, it is important to take agglomeration economies into account to get more accurate comparisons of various anti-sprawl policies' welfare effects.

Agglomeration economies for urban firms can be classified either as localization economies (firms from the same industry benefit from locating close to each other) or urbanization economies (firms benefit from the scale and diversity of firms in other industries). These proximity effects arise because of various factors: access to a large – possibly specialized – labor pool or common inputs, knowledge spillovers, large demand markets, and common infrastructure (see Fujita and Thisse [2002] for an overview).

Numerous studies have provided empirical evidence for agglomeration economies in general, e.g., Ellison and Glaeser (1997) and Rosenthal and Strange (2003). One of the most important findings of the latter paper is that agglomeration economies attenuate rapidly with distance, at least initially. Meanwhile, Glaeser et al (1992) find evidence of urbanization economies but not localization economies, while Henderson (2003) finds that localization economies had stronger productivity effects in high-tech industries than urbanization economies.

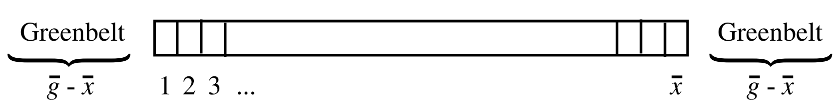
Although there may be disagreement as to whether localization or urbanization economies are prevalent in different industries, it is clear that firms do tend to cluster together. In many cases, geographic features and natural resources are the main reasons for agglomeration, but there is also strong evidence that many a firm's productivity depends on its proximity to other firms. Therefore, it is important that an urban model in which firms choose their locations take agglomeration economies into account.

Another reason for including agglomeration economies is that agglomeration also causes congestion, which mitigates the benefits of clustering together. Since traffic congestion is one of main problems associated with sprawl, the inclusion of agglomeration economies gives a more complete picture of how firms and households trade off various factors in their location decisions.

3 Mathematical Setup of the Model

The city is linear, with a greenbelt at either end of the city. Households and firms can locate anywhere within the city, with lot sizes fixed at 1 unit each. x is used to denote locations within the city, with $\bar{x}$ denoting the last lot on the right side of the city. The amount of open space at each end of the city is $\bar{g} - \bar{x}$ where $\bar{g}$ is chosen exogenously (see figure 1).

Figure 1: Layout of the City



The city is closed, with rents accruing to absentee landlords. The supply of land is depicted only to the extent that it is assumed that land goes to the household or firm willing to pay the highest rent, i.e., the highest bidder for land.

Households consume a numeraire good and open space at the urban periphery. The household chooses its residential and workplace locations to maximize utility.

Each household has one worker and workers can travel in either direction to their workplace. Firms, which each have one worker, produce the numeraire good. There are agglomeration economies for firms where a firm's profit depends on the presence of nearby firms.

Individual heterogeneity is introduced by assuming households and firms have some idiosyncratic taste for locations. Since the number of households, N, is equal to the number of firms, the size of the city is fixed at $\bar{x} = 2N$.

3.1 Households

Each household has two locations associated with it: x_h for its residence and x_f for its workplace (see the Appendix for a summary of the notation used in the paper). Throughout this paper, individual household (or firm) subscripts will be suppressed but should be clear from the context.

The household's utility function depends on its consumption of the numeraire good, c, open space, $s(x_h)$, and idiosyncratic taste for its residential and workplace locations, u_h. It is assumed, as is usual in the literature, that the household's utility function is log-linear:

$$U(c, s, u_h) = \mu_1 \ln c + \mu_2 \ln s(x_h) + u_h(x_h, x_f) \tag{1}$$

where $0 \leq \mu_1, \mu_2 \leq 1$ and $\mu_1 + \mu_2 = 1$.

The consumption of open space, $s(x_h)$, depends on the household's proximity to the greenbelts at either edge of the city:

$$\begin{aligned} s(x_h) &= 1 + \alpha_1 \int_{\bar{x}}^{\bar{g}} \exp\left[-\alpha_2(\tilde{x} - x_h)\right] d\tilde{x} + \alpha_1 \int_{\bar{x}-\bar{g}-1}^{1} \exp\left[-\alpha_2(x_h - \tilde{x})\right] d\tilde{x} \\ &= 1 + \alpha_1 \left[\frac{1}{\alpha_2} e^{\alpha_2 x_h}(e^{-\alpha_2 \bar{x}} - e^{-\alpha_2 \bar{g}}) + \frac{1}{\alpha_2} e^{-\alpha_2 x_h}(e^{-\alpha_2} - e^{-\alpha_2(\bar{x}-\bar{g}-1)})\right] \end{aligned} \tag{2}$$

where the functional form is chosen so that the value of open space declines with distance, and when there is no open space outside the city, μ_2 has no effect on utility.

$\alpha_1 \geq 0$ is the factor for the strength of open space values, while $\alpha_2 > 0$ determines the household's weight on proximity to the greenbelt.

Heterogeneity among households is modeled along the lines of Anas (1990). u_h is defined as an idiosyncratic constant measuring a household's preference for residing at a location x_h and working at x_f. This is conceptually similar to assuming a household has idiosyncratic taste for a particular distance from the city center in a standard monocentric model with all employment located in the central business district (CBD).

It is assumed that u_h are distributed i.i.d. (across residential and workplace combinations) and Gumbel with mean zero and variance $\sigma_h^2 = \frac{\pi^2}{6\lambda_h^2}$. λ_h is the taste heterogeneity parameter. Utility can then be modeled such that choice probabilities are multinomial logit where as $\lambda_h \to \infty$, taste idiosyncracies vanish (i.e., households are homogeneous) and if $\lambda_h \to 0$, random tastes dominate all other locational determinants (thus workers choose randomly).

Since travel is multi-directional, the distance, d, from the household's residence to workplace is $|x_h - x_f|$. Initially, it is assumed that there is no traffic congestion, so travel cost per unit x is $\bar{t}$. With this, the budget constraint is:

$$w(x_f) - \bar{t}d = c + p(x_h) \tag{3}$$

where $w(x_f)$ represents the wage paid by the firm based at x_f and $p(x_h)$ is the rent at the household's residential location.

If there is traffic congestion, travel cost at location x is modeled along the lines of Brueckner (2005):

$$t(x) = \eta + \gamma_1 \left[\frac{n(x)}{\rho}\right]^{\gamma_2} \tag{4}$$

where $n(x)$ is the number of workers traveling in the same direction at that location and ρ is the fraction of land used for roads. For now, roads are planned and funded exogenously but it is possible to later incorporate a head tax on households to fund roads. Should congestion tolls (a possible anti-sprawl policy) be imposed in the city, that would also enter the household's budget constraint.

With this, the household chooses (x_h, x_f, c) to maximize its utility function, $U(c, s, u_h)$, subject to the budget constraint in equation (3). Solving for c in the budget constraint and replacing it in the utility function, we get (with simplified notation):

$$U = \mu_1 \ln(w - \bar{t}d - p) + \mu_2 \ln[s(x_h)] + u_h \tag{5}$$

Let $V = U - u_h$ be defined as the non-stochastic part of the utility function. If H is the number of possible joint location choices of (x_h, x_f), the household's probability of choosing a particular residence-workplace combination i is:

$$P_i = \frac{\exp(\lambda_h V_i)}{\sum_{j=1}^{H} \exp(\lambda_h V_j)}$$

3.2 Firms

Firms maximize profit by producing the numeraire good and hiring one worker. Since the city is closed, the number of firms is equal to the city population. It can be thought that firms take the price of the good as given, possibly because there is a world price for that good. Firms' output can be sold to households within the city or exported to other cities, and the city can import the good as well to meet local demand, all with zero transport and transaction costs.

The firm's choice variable is its location x_f, which affects its rent (p) and the wage (w) it has to pay the worker. Let $f = \bar{f}$ be the production function; it is a constant since there is no other input aside from the one worker.

Like that of Fujita and Ogawa (1982), the model assumes that a firm's profit depends positively on its proximity to other firms with distance weighted by a negative exponential function. Since all firms produce the same good, this implies localization economies occur here.

Let $F(x_f)$ denote the function for agglomeration economies, which is modeled as below:

$$F(x_f) = 1 + \beta_1 \left(\sum_{i=1}^{x_f-1} [e^{-\beta_2(x_f-i)}\delta(i)] + \sum_{i=x_f+1}^{\bar{x}} [e^{-\beta_2(i-x_f)}\delta(i)] \right)$$

where $\delta(x)$ represents the density of firms at that location. With fixed lot sizes, the density is the probability that a firm chooses that location. $\beta_1 \geq 0$ determines the strength of the agglomeration economies and $\beta_2 > 0$ is the weight on distance.

Similar to households, firms have idiosyncratic tastes for their office locations, u_f. u_f is distributed i.i.d. and Gumbel with mean zero and variance $\sigma_f^2 = \frac{\pi^2}{6\lambda_f^2}$. With this, the firm chooses x_f to maximize the profit function:

$$\Pi = fF(x_f) - p(x_f) - w(x_f) + u_f(x_f)$$

If "systematic" profit at location i is defined as $\hat{\Pi} = \Pi - u_f$, then the firm's probability of choosing a particular office location i from M possible locations is:

$$P_i = \frac{\exp(\lambda_f \hat{\Pi}_i)}{\sum_{j=1}^{M} \exp(\lambda_f \hat{\Pi}_j)}$$

3.3 Equilibrium

The land market equilibrium, which is based on the rent profile generated by the demand for land parcels, requires that all households and firms be accommodated within the city. Since the simulation tries to solve the model according to the household's and firm's logit probabilities, the land market equilibrium condition is that each lot in the city has an expected demand of 1 from all firms and households combined. That is, for each location, the sum of all firms' probability of locating in that lot plus the sum of all households' marginal probability of choosing that lot as a residence is equal to 1. Rents adjust until this condition is met.

The employment equilibrium requires that each household is associated with a workplace and is based on the wage profile of the city. Thus, the employment equilibrium condition is that for each location, the sum of households' marginal probability of choosing that location as their workplace is equal to the sum of firms' probability of choosing the same location. Wages adjust until this condition is met.

Firms' location choices are interdependent due to the existence of agglomeration economies. Meanwhile, with traffic congestion, each household's residence-workplace location choice also depends on the choices of other households. Due to these interdependencies coupled with the incorporation of individual heterogeneity, a simulation program is needed to solve the model.

It is generally expected that firms would tend to cluster together due to agglomeration economies. However, this may not guarantee just a single center of employment since idiosyncratic tastes and/or travel costs may generate an urban spatial structure of subcenters. Households in general would like to locate closer to the greenbelts due to their preferences for open space. On the other hand, average travel cost without congestion at each residential location to all possible job locations is lower at the city center due to multi-directional travel. As such, for the same rent, this would give households a tendency to locate closer to the city center.

4 Simulation Results

The simulation steps are laid out in Appendix 2. The simulation was run for 50 households and 50 firms, leading to a city size of 100 lots. Rents at all locations were initially set at 10 while wages were set at 30, and allowed to adjust throughout the simulation depending on the land and employment probabilities. Transport cost per unit distance without congestion, $\bar{t}$, was set at 0.05 so that if households traveled about half the distance of the city to their workplace, they would spend almost 10% of their income on travel given initial wages.

The size of each greenbelt at either end of the city was set to be 20 (i.e., $\bar{g} = 120$).

The household's relative weights on the numeraire good and open space (μ_1 and μ_2) were fixed at 0.8 and 0.2 respectively. The open space parameters, α_1 and α_2, were set at 2 and 0.25 respectively so that the value of open space was very close to 0 once a household was about a quarter way inside the city.

The firm's basic output, $\bar{f}$, was set to 60 so that under the initial setup of wages and rents "systematic" profit (without agglomeration economies) at each location was 20. The agglomeration economies parameters, β_1 and β_2, were fixed at 0.25 and 0.3 respectively. With this, if all firms are initially clustered around the city center, the maximum "systematic" profit would be almost 10% higher than in the case without agglomeration economies. In addition, agglomeration economies attenuates rapidly with distance (as found by Rosenthal and Strange [2003]).

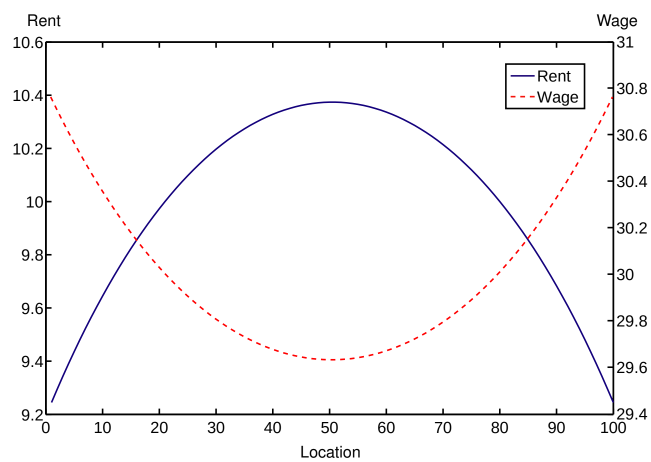
The parameters λ_h and λ_f are used respectively to determine households' and firms' heterogeneity. In most of the cases presented here, they are both set to 4 so that households and firms are neither homogeneous nor extremely heterogeneous as done in Anas and Rhee (2006).

The simulation results under various modeling assumptions are presented below, with initial locations based on a traditional monocentric model: firms cluster in the city center and households occupy the outskirts (the simulation converges to the same solution under different initial positions). Unfortunately, it turns out that when agglomeration economies are incorporated, the probabilities do not converge to meet the equilibrium conditions unless the agglomeration economies are set to be very weak.

4.1 No agglomeration and no open space preferences

In the benchmark case without agglomeration economies and no open space preferences ($\mu_2 = 0$), households and firms are spread evenly throughout the city. That is, the sum of households' marginal probabilities for residential locations is very close to 0.5 at every location and similarly for firms' probabilities for office locations. The rent profile has the classical inverted U-shape because households want to locate in the center, where average travel cost to all possible job locations is lower. Meanwhile, the wage profile also makes sense - wages are higher at the outskirts since firms have to compensate workers for the longer commutes.

Figure 2: No agglomeration and no open space preferences

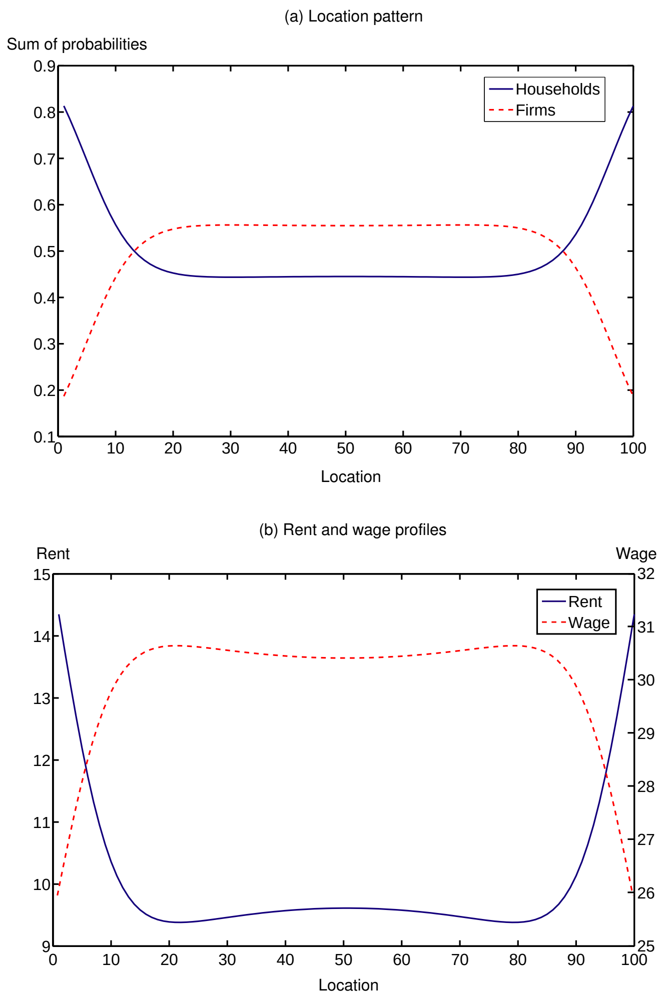


This resulting location pattern is very different from the traditional monocentric urban models where it is assumed all firms locate in the city center. One reason this location pattern emerged is that lot sizes are not included in this model. It is generally recognized that households have a preference for larger residential lots, and achieve that further away from the city center because of lower rents there. It should be noted that adding preferences for open space and agglomeration economies, as seen below, result in more traditional location patterns where firms locate closer to the city center.

4.2 Open space preferences

Once open space preferences are included in the model, it is clear from Figure 3 that households prefer to locate near the greenbelts. This pushes firms to locate closer to the city center, although land use is fairly mixed at those locations.

Figure 3: No agglomeration and with open space preferences



The rent and wage profiles look very different from the earlier case. Due to the high demand for land by households at the outskirts of the city, rents are higher there as well. Rents fall rapidly toward the center, then rise slightly again in the middle. This is because households have a slight tendency to locate in the center due to lower average travel costs. The increase in households' marginal probabilities for residential locations near the city center is very small and therefore not noticeable in Figure 3a. The wage profile is an inversion of the rent profile; wages are low at the city outskirts because the demand for jobs close to residential locations at the outskirts is very high and there are very few firms there. Wages gradually rise toward the city center in order to attract households from peripheral locations.

Making households and firms more homogeneous by increasing both λ_h and λ_f from 4 to 20 results in a location pattern very similar to the above, with a sharper tendency for households to locate near the greenbelts (see Figure 4). In fact, locations at the very edge of the city are almost completely occupied by households.

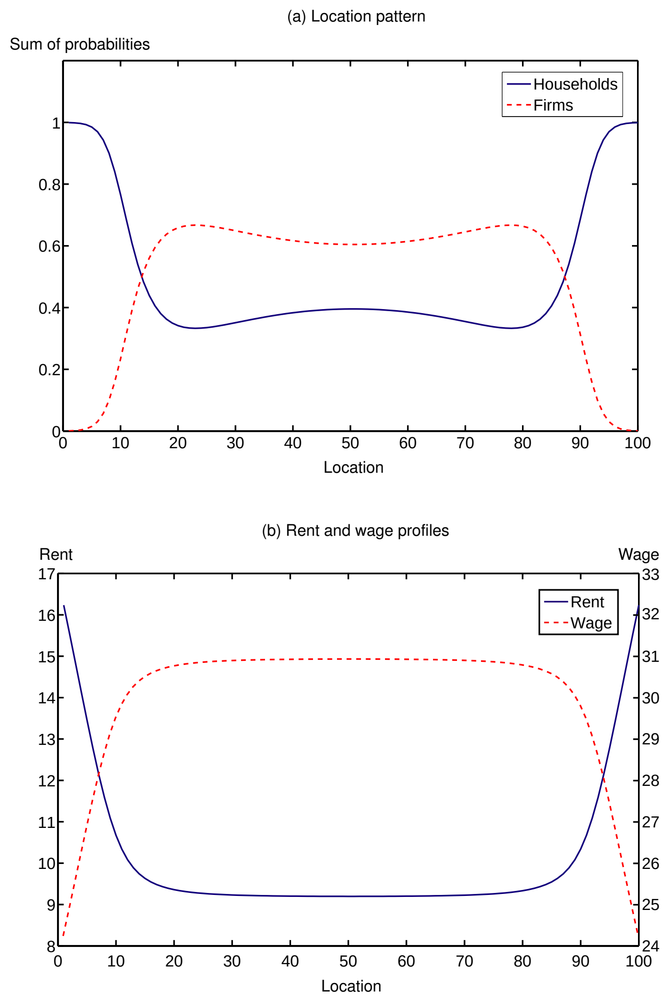
With more homogeneous households, the rent and wage profiles look fairly similar to that in the previous case except that there is no slight bulge in the middle (see Figure 4a). The maximum rent is greater and the minimum wage paid is lower here than in the previous case since preferences for open space at the city periphery dominate idiosyncratic tastes for all locations, which are now very small.

On the other hand, making households and firms more heterogeneous by setting λ_h and λ_f at 0.01 softens the tendency to locate near the greenbelts due to more pronounced idiosyncratic tastes over different locations in the city. The idiosyncratic tastes for lots all over the city mitigate the strong preferences for locations at the outskirts. Thus, the rent and wage profiles are flatter but otherwise look similar to the two previous cases.

4.3 Agglomeration economies

With agglomeration economies possibly increasing firms' output by almost 10% in the base case, the simulation would not converge and it turned out that firms desired only one location (although this location would not be an equilibrium and would change

Figure 4: No agglomeration economies, more homogeneous firms and households

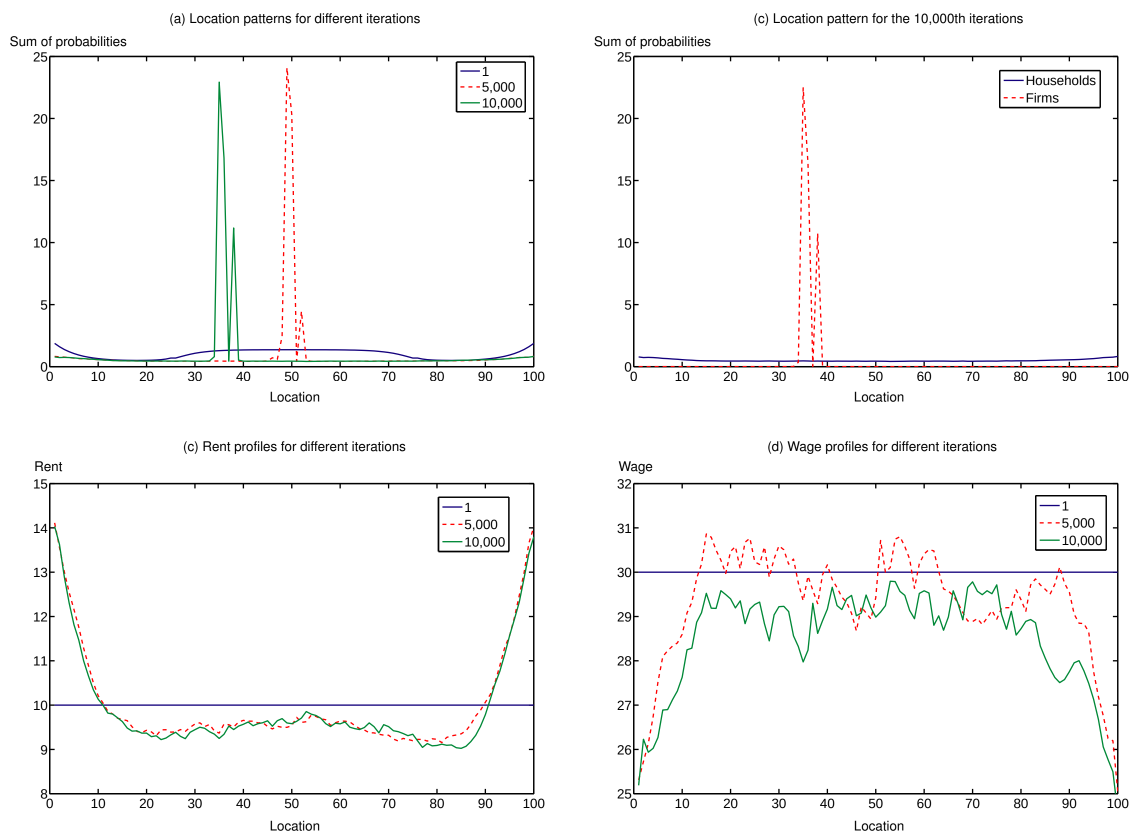


throughout iterations). Decreasing the strength of agglomeration economies through the parameter β_1 led to more reasonable results. With very weak agglomeration economies, (e.g., setting β_1 below 0.08 compared to the base case of $\beta_1 = 0.25$), the simulation would converge and the resulting location patterns and rent/wage profiles looked almost identical to the previous case with no agglomeration economies.

Figure 5 shows the results from a simulation run of 10,000 iterations for $\beta_1 = 0.08$. With this, under the initial set-up agglomeration economies would increase firms' profits by up to 2.5%. Figure 5a shows the evolution of land probabilities over iterations; it can be seen that the simulation is not moving toward convergence. From Figure 5b it is clear that firms are the root of the problem: although households' marginal probabilities for residential locations are relatively stable in the 10,000th iteration, firms' probabilities for location are not.

By the 10,000th iteration, rent and wage profiles have the same general shape as in the case without agglomeration economies (see Figures 5c and d), but they are not smooth due to the oscillation in firms' location probabilities.

Figure 5: Location patterns, rents and wages with agglomeration economies



To reduce the oscillation in probabilities, a persistence effect was introduced whereby firm probability calculations and rent adjustments were based on results from the previous 50 iterations rather than than just one iteration. I also tried making households and firms more heterogeneous but although these lessened the oscillations somewhat, the simulation still failed to converge unless agglomeration economies were set to be very weak.

Not surprisingly, the same problems arise when traffic congestion (with or without agglomeration economies) is included in the model, since then household choices are interdependent.

5 Conclusion

This simplified model was useful in presenting different location patterns, rent and wage profiles under various modeling assumptions and parameter values. Moreover, it showed that finding an equilibrium (i.e., reaching convergence in the simulation) is extremely difficult with a reasonable level of agglomeration economies or traffic congestion. More work is needed to refine the simulation, or alternatively a different approach (e.g., a multi-agent simulation) could be attempted.

Appendix 1

Variable	Description
x	Location in the city
c	Household consumption of the numeraire good
u_h	Household's idiosyncratic taste for residential and workplace location combination
u_f	Firm's idiosyncratic taste for office location
$\delta_f(x)$	Indicator equal to 1 if there is a firm at a particular location, 0 otherwise
$p(x)$	Rent per unit of land
$w(x)$	Wage paid by firm to household
$t(x)$	Cost of travel at each location if there is congestion
$n(x)$	Number of workers who travel at that location in a particular direction
ρ	Fraction of land for roads
$U(\cdot)$	Household utility function
$s(\cdot)$	Household preference function for open space
$\Pi(\cdot)$	Firm profit function
$F(\cdot)$	Firm agglomeration economies function

Parameter	Description
$\bar{x}$	Number of lots in the city, equal to two times the number of households
$\bar{g}$	Geographic boundary of city
$\bar{t}$	Cost of travel per unit distance if there is no congestion
η	Fixed component of travel cost if there is congestion
γ_1, γ_2	Congestion parameters for travel cost
λ_h	Household taste heterogeneity parameter
λ_f	Firm taste heterogeneity parameter
α_1	Multiplicative factor for strength of open space values
α_2	Distance parameter for open space preference
β_1	Multiplicative factor for strength of agglomeration economies
β_2	Distance parameter for agglomeration economies
$\bar{f}$	Firm's basic output without agglomeration economies

Appendix 2

The simulation steps are as follows:

1. Start with an initial setup of firm and household locations, rents and wages.

2. Calculate firms' profits and probabilities (which are identical across firms) for all locations. In the case of agglomeration economies, firms' profits are calculated based on the initial setup in the first iteration, and subsequently on firms' probabilities in the previous iteration.

3. Calculate households' utilities and probabilities for all possible residential-workplace combinations.

4. Check to see if the land and employment equilibrium conditions in section 3.3 are satisfied (maximum deviation allowed: 0.000001).

   - If yes, stop iterating.
   - If no, adjust rents and wages accordingly. For instance, if the sum of all firms' probability of locating at a particular lot plus all households' marginal probability of residing at that lot is greater than 1, the rent at that location will be increased by some updating factor based on that difference.

5. Repeat steps 2-4 with the new setup of firm and household locations, rents and wages.

References

Anas, Alex, 1990. "Taste Heterogeneity and Urban Spatial Structure: The Logit Model and Monocentric Theory Reconsidered," *Journal of Urban Economics*, Vol. 28, pp. 318-335.

Anas, Alex and Hyok-Joo Rhee, 2006. "Curbing Excess Sprawl with Congestion Tolls and Urban Boundaries," *Regional Science and Urban Economics* (forthcoming).

Anderson, Soren T. and Sarah E. West, 2006. "Open Space, Residential Property Values and Spatial Context," *Regional Science and Urban Economics* (forthcoming).

Bento, Antonio M., Sofia F. Franco, and Daniel Kaffine, 2006. "The Efficiency and Distributional Impacts of Alternatives Anti-sprawl Policies," *Journal of Urban Economics*, Vol. 59, pp. 121-141.

Breffle, William S., Edward R. Morey and Tymon S. Lodder, 1998. "Using Contingent Valuation to Estimate a Neighbourhood's Willingness to Pay to Preserve Undeveloped Urban Land," *Urban Studies*, Vol. 35, No. 4, pp. 715-727.

Brueckner, Jan K., 2005. "Urban Growth Boundaries: An Effective Second-Best Remedy for Unpriced Traffic Congestion?", working paper.

Doss, Cheryl R. and Steven J. Taff, 1996. "The Influence of Wetland Type and Wetland Proximity on Residential Property Values," *Journal of Agricultural and Resource Economics*, Vol. 21, No. 1, pp. 120-129.

Earnhart, Dietrich, 2006. "Using Contingent-Pricing Analysis to Value Open Space and Its Duration at Residential Locations," *Land Economics*, Vol. 82, No. 1, pp. 17-35.

Ellison, Glenn and Edward L. Glaeser, 1997. "Geographic Concentration in U.S. Manufacturing Industries: A Dartboard Approach," *Journal of Political Economy*, Vol. 105, No. 5, pp. 889-927.

Fujita, Masahisa, and Hideaki Ogawa, 1982. "Multiple Equilibria and Structural Transition of Non-Monocentric Urban Configurations," *Regional Science and Urban Economics*, Vol. 12, pp. 161-196.

Fujita, Masahisa and Jacques-François Thisse, 2002. *Economics of Agglomeration*, Cambridge University Press.

Glaeser, Edward L., Hedi D. Kallal, José A. Scheinkman and Andrei Shleifer, 1992.

"Growth in Cities," *Journal of Political Economy*, Vol. 100, no. 6, pp. 1126-1152.

Henderson, J. Vernon, 2003. "Marshall's Scale Economies," *Journal of Urban Economics*, Vol. 53, pp. 1-28.

McGonagle, Michael P. and Stephen K. Swallow, 2005. "Open Space and Public Access: A Contingent Choice Application to Coastal Preservation," *Land Economics*, Vol. 81, No. 4, pp. 477-495.

Rosenthal, Stuart S. and William C. Strange, 2003. "Geography, Industrial Organization and Agglomeration," *Review of Economics and Statistics*, Vol. 85, No. 2, pp. 377-393.

Shultz, Steven D. and David A. King, 2001. "The Use of Census Data for Hedonic Price Estimates of Open-Space Amenities and Land Use," *Journal of Real Estate Finance and Economics*, Vol. 22, No. 2/3, pp. 239-252.

Walsh, Randall P., 2004. "Endogenous Open Space Amenities in a Locational Equilibrium," University of Colorado at Boulder, Working Paper No. 04-03.