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An abstract model of gentrification as a spatially contagious succession process

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ABSTRACT

The paper describes a simple, abstract model to simulate gentrification from both supply and demand side perspectives. Three theories—rent gap theory, filtering theory and household life cycle theory—are employed to construct a combined cellular automaton and agent-based model. This abstract model has good potential for simulating urban development. It exhibits a distinctive relationship between the spatial dynamics of gentrification patterns and different rent gap thresholds and rent gap impacts: at low rent gap thresholds and limited rent gap impact, renovation events occur at all locations leading to a mixed rent map distribution. As the rent gap threshold and rent gap impact increase, gentrification becomes more spatially concentrated, leading to spatially segregated rent patterns. Also, gentrification starts in run-down areas neighboring wealthier regions in agreement with empirically observed gentrification.

1. Introduction

A term coined by Glass (1964), gentrification is "a process of socio-spatial change where the rehabilitation of residential property in a working-class neighborhood by relatively affluent incomers leads to the displacement of former residents unable to afford the increased costs of housing that accompany regeneration" (Pacione, 2005, p. 288). Generally, there are two types of gentrification theories (Hamnett, 1991; Pacione, 2005): production-side (supply-side) explanations and consumption-side (demand-side) explanations. The former emphasizes the role of the state and developers in encouraging gentrification and of financial institutions providing funding. In the latter, neighborhood change is driven by the choices of individual households both to invest in their housing and also to relocate in response to changes in neighborhoods. Lees, Slater, and Wyly (2008) argue that demand-side scholars from a more humanist and sociocultural perspective tend to emphasize the process at the scale of individuals (Butler & Robson, 2003; Ley, 1996). They attribute gentrification to individual decisions and to relatively small groups of people with shared residential preferences. On the other hand, supply-side scholars who favor politico-economic explanations of gentrification account for gentrification as the outcome of economic processes, such as capital investment (Hackworth, 2002; Smith, 1996).

In this paper we describe a simple and abstract dynamic spatial model to simulate gentrification, embracing both supply-side (Rent Gap Theory and Filtering Theory) and demand-side (Household Lifecycle Theory) theories. The remainder of the paper is organized as follows: Section 2 briefly reviews the supply and demand side explanations of gentrification in more detail; Section 3 provides details of the model; Section 4 discusses results and Section 5 draws some conclusions and considers avenues for further work.

2. Three gentrification theories

2.1. Rent gap theory

"Rent Gap is the disparity between the potential ground rent level and the actual ground rent capitalized under the present land use…" (Smith, 1996, p. 65) Capitalized ground rent is the actual quantity of ground rent. For rental housing, the landlord's capitalized ground rent comes from rent paid by the tenants. Under owner occupancy, capitalized ground rent appears as part of the sale price when the building is sold. Potential ground rent is the ground rent that could be achieved under the land's optimal usage (Smith, 1979). As long as an urban region experiences population growth or economic growth which increases demand for land, the potential ground rent of any particular location is generally increasing. The essence of the rent gap theory is

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that falling real capitalized ground rents occur due to neighborhood and housing physical decline and also due to technological and style obsolescence. The latter effect may have been particularly powerful in inner urban areas during the rapid suburbanization in many cities in the second half of the twentieth century. Further, processes such as 'blockbusting', in which real estate agent encourage owners to sell their homes by exploiting fears of racial change within their neighborhood (Mehlhorn, 1998), may exacerbate the situation (Smith, 1996). If housing depreciation of an individual site outpaces its neighborhood's in periods of urban decay, its rent gap gradually increases. When the gap reaches some threshold level, an opportunity for profitable reinvestment exists, and if such investment occurs it may then trigger wider neighborhood gentrification.

However, rent gap theory has been disputed in several respects: (a) it is unnecessary to propose a new economic concept — the rent gap (Bourassa, 1993); (b) capitalized ground rent should be not only influenced by individual land parcel properties, but also shaped by neighborhood conditions (Hammel, 1999b); (c) it overemphasizes economic determinism and underestimates the significance of individuals (Lees et al., 2008); and (d) the rent gap is extremely hard to measure based on current data (Badcock, 1989; Clark, 1988; Hammel, 1999a; Sýkora, 1993), and also because it derives from the difference between two inferred quantities (capitalized and potential ground rents). This article is not the place to resolve these debates. Instead, acknowledging the debates, a framework including both demand and supply side factors is employed in our model, offsetting the shortcomings of rent gap theory, and also recognizing multiple aspects to the gentrification process.

2.2. Filtering theory

Filtering is defined as "a change in the real value (price in constant dollars) of an existing dwelling unit" (Lowry, 1960, p. 363). The strict definition is based on an endogenous market process where the quality of a dwelling declines with age. Other scholars (Arnott, Davidson, & Pines, 1983; Galster, 1996; Hoyt, 1939; Jones, 1978; Kristof, 1972; Kutty, 1995; Myers, 1975) argue that household behavior is an indispensable part of the theory alongside the deterioration of dwellings. Therefore, filtering can be considered as "the dynamic of dwelling price and quality changes and households' associated moves" (Galster, 1996, p. 1800) and refers both to life-cycle processes of housing units (changes in their price or quality) and to the behavior and responses of households (socioeconomic position of households, such as their income levels). Gray and Boddy (1979) add that household mobility and house turnover should be included in the filtering process. In this process, while dwellings 'filter down' the social scale due to both physical and capital deterioration, households may relocate from current housing that does not suit their income level, to better housing.

Filtering theory implies that the distribution of household characteristics plays an important role in explaining the dynamics of the housing market. Researchers (Arnott et al., 1983; Jones, 1978) have examined the influence of household status and preferences. Jones (1978) argues that filtering and the accompanying trading up by households provide only a partial explanation of the housing process and that the preferences and constraints of households, such as income, should also be taken into account. Rather than analyze the process from a snapshot in a household's life experience, the author suggests that the time span for housing process should be expanded to the family life cycle. However, although the household life cycle factor appears in filtering theory, working from a top-down perspective cannot address the problem of individual factors (for instance, household income, life cycle of household). Thus, Kristof (1972) suggests that no conclusion about effectiveness of filtration is warranted until the relevant exogenous factors are thoroughly scrutinized. This argument further suggests the importance of both supply and demand side explanations to an adequate account of gentrification.

2.3. Household lifecycle theory

Delving into the aggregate effects of population aging on the housing market can inform the study of individual household life cycles in gentrification. Although consideration of the impacts of demographic change on house prices has increased in recent years, there is a debate revolving around two questions: whether, and to what extent, does population aging affect the dynamics of the housing market? The longstanding controversy starts with Mankiw and Weil (1989) who forecast the impending real estate price increase in the US housing market because of the aging of those born in the baby boom. This forecast triggered a heated debate over the methodology and conclusions of their research. Levin, Montagnoli, and Wright (2009) provide a useful review of the subsequent literature.

Opponents (Alperovich, 1995; Engelhardt & Poterba, 1991; Green & Hendershott, 1996; Hamilton, 1991; Holland, 1991; Pitkin & Myers, 1994; Swan, 1995; Woodward, 1991) argue that the omission or underestimation of the influence of factors other than aging is problematic. However, proponents believe that household life cycle factors (e.g. child bearing, children leaving home) exert a vital influence on housing market dynamics, second only to economic factors (e. g. household income) (Gober, 1992; Levin et al., 2009; Nijkamp, Van Wissen, & Rima, 1993; Pitkin, 1990). Investigating the relationship between housing price and aging baby boomers in the U.S., Myers and Ryu (2008) suggest that the progression of baby boomers into adulthood fueled urban sprawl and gentrification as well as escalating house prices. In any case, it seems clear that the demand side is an important component of any theory of housing market dynamics and hence of gentrification, and it is valuable to consider the relationship between household life cycles and gentrification.

2.4. Relationship of the three theories

Setting aside the question of whether filtering processes actually provide decent housing for low-income households, Smith (1979, p. 545) admits that as a universal phenomenon in housing markets, filtering almost always precedes gentrification. Taken together the rent gap and filtering theory can account for one facet of gentrification: housing deterioration and rehabilitation. On the demand side, household life cycle can help account for the relocation of households,

Table 1
Housing rent categories.[a]

Housing type	Rental value range
Run-down	$r \le \mu_r - \sigma_r/2$
Affordable	$\mu_r - \sigma_r/2 < r < \mu_r + \sigma_r/2$
Expensive	$r \ge \mu_r + \sigma_r/2$

[a] μ_r and σ_r are the mean and standard deviation of all housing unit rental values respectively.

Table 2
Household entry probability P' matrix.[a]

	Rent Level		
Household type	*Run-down*	*Affordable*	*Expensive*
Young	$P_{RY'} = N(1/3 + p_R/6, 0.01)$	33.3%	$P_{EY'} = N(1/3 - p_E/6, 0.01)$
Middle-aged	$P_{RM'} = N(1/3 - p_R/6, 0.01)$	33.3%	$P_{EM'} = N(1/3 + p_E/6, 0.01)$
Old	$P_{RO} = 1 - P_{RY}' - P_{RM}'$	33.4%	$P_{EO}' = 1 - P_{EY}' - P_{EM}'$

[a] The household entry probability is only for vacant housing, so the sum of each column is equal to 1. p_R represents the proportion of vacant run-down housing, p_E for that of the expensive ($0 \le p_R, p_E \le 1$). $N(\mu,\sigma)$ is a normal distribution with a mean μ and a standard deviation of σ.