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Dissecting income segregation: Impacts of concentrated affluence on segregation of poverty

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ABSTRACT
This article investigates how income inequality shapes residential segregation by income. Using agent-based modeling, it develops a residential preferences model that is capable of generating results mimicking empirical income segregation patterns. Simulation analysis shows how varying income inequality produces differential residential mobility outcomes that alter income segregation profiles. The model is used to capture the distinct impacts of households' moves into richer or poorer neighborhoods, and how these impacts are further differentiated with respect to the moving household's income. The article demonstrates how aggregating such diverse outcomes of micro-level interactions at a meso-level can help us to better understand the changes in macro-level income segregation patterns. Analyzing residential mobility patterns carefully, the article suggests that i) segregation of affluence and of poverty can trigger each other via initiating cascades of residential mobility and housing prices, and ii) increasing income inequality can disrupt housing market and lead to shortages in affordable housing, which can yield high residential instability and eviction rates among the poorest stratum.

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1. Introduction

Residential segregation by income, or income segregation, is noted to be influential for various individual and social outcomes, ranging from individuals' health conditions (Mayer & Sarin, 2005; Ross, Nobrega, Dunn, & Ross, 2001) to neighborhood crime rates (Kang, 2016; Sampson, Raudenbush, & Earls, 1997). Quality of public goods and services such as public schools (Mayer, 2002), access to higher social capital (Small, 2004), exposure to different sets of norms and social processes (Sampson, Morenoff, & Earls, 1999; Sampson et al., 1997), and influence on the dynamics of the housing prices and rents—most visible in gentrification dynamics (Zukin, 1987), are among the ways in which how income levels of the households in a neighborhood affect each other's life chances. The impact of income segregation on individual and social outcomes is more acute and direct when public goods and social services provided in a neighborhood, such as education or parks and recreational facilities, are primarily funded by the taxes of its residents (Durlauf, 1995). Accordingly, through such neighborhood effects, income segregation is one of the most important drivers of persistence of income inequality (Durlauf, 1996, 2004), and of concentration of poverty (Quillian, 2012; Wilson, 1987).

Given that the income levels of our neighbors have some influence on our lives, the inconvenient fact that income inequality has been on the rise invites us to be more concerned with the problem of income segregation. Indeed, the persistent rise in income inequality in the past four decades has been documented alongside with a rise in income segregation in several studies

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(Jargowsky, 1996; Massey, 1996; Mayer, 2001; Reardon & Bischoff, 2011; Watson, 2009). Reardon and Bischoff's (2011) study is an exemplary recent contribution in this vein of research. Focusing on income segregation as a distinct object of research, they study how contemporary trends in income inequality affect the level and character of income segregation as well as its racial and geographic-scale dimensions. Introducing a sophisticated income segregation measure, they analyze not only the overall level of income segregation—the classical way of studying residential segregation of any kind—but also portray a complete spectrum of income segregation experienced at all income percentiles, which they call income segregation profile. Using this profile, they can address the segregation of different strata in a city simultaneously, such as the poorest and richest groups, and precisely describe the different kinds of segregation experienced in a society. For instance, they argue that the segregation of affluence, "the extent to which the highest-income households are isolated from the rest of the population," has increased more than the segregation of poverty "the extent to which the lowest-income households are isolated from the rest of the population" in the past 40 years in the US (Reardon & Bischoff, 2011, p. 1097). They claim that this specific change in the income segregation profile of the US metropoles, in addition to its overall increase, is due to a particular kind of rise in income inequality, namely the disproportionate increase in the incomes at the top percentiles.

Although the presence of statistical evidence that the rise in income inequality is coupled with increasing income segregation is "suggesting a causal link" (Watson, 2009, p. 837), there is still room for finer grained, mechanism-based explanations of how income inequality actually gets translated into a deleterious spatial sorting, income segregation. While income inequality is a necessary condition of income segregation, it is possible to have low levels of income segregation in the presence of high income inequality. For instance, Reardon and Bischoff (2011, pp. 1103–6) argue with a hypothetical example that an increase in income inequality that is reflected by a rise in 90/50 income ratio while keeping 50/10 income ratio same could in fact reduce segregation of poverty because such a change in income distribution would mean compression among income levels of low-income households. Similarly, Watson (2009) argues that the inequality among the rich households is responsible for segregation of the rich whereas the inequality among the poor households are responsible for segregation of the poor. While these arguments are plausible in themselves, complex feedbacks between segregation of affluence and of poverty can complicate these claims. For instance, there is already a call for sociologists to focus on segregation of affluence to better understand the issue of concentration of poverty (Reardon & Bischoff, 2011, pp. 1140–41), and the issue of stratification in general (Massey, 1996, p. 409). Hence, the question how income inequality shapes income segregation does not have a straightforward answer. What we need is a more holistic account that considers all parts of income segregation simultaneously, allowing potential feedbacks between the processes of segregation of affluence and of poverty, as well as residential mobility patterns of middle classes.

In this article, I tackle the question of how changes in income inequality shape income segregation patterns using agent-based modeling (ABM) to build a residential preference model[1] of income segregation. In the remaining of the article, I continue with a discussion of how ABM can help us to advance our understanding of the link between income inequality and income segregation. Then, I describe the simulation model and give the results of simulations. The results show that the model is

[1]The model presented here purposefully leaves out some other significant drivers of income segregation such as racial segregation, prejudice, and discrimination; housing and urban policies such as zoning laws and rent control; home ownership, wealth distribution and inequality; spatial particularities of the cities, and the like. It does so purposefully to gain analytical leverage because including these would make this model notoriously complicated to analyze the main research questions namely how income inequality affects residential preferences, housing market, and the interaction between the two, and eventually gets spatially sorted and lead to income segregation. While it might be promising further research to complicate the findings of this article by introducing these other factors into the simulation model, this study is just a humble beginning of sorting out the mechanisms that translate income inequality into spatially uneven distributions of income, which is already an analytically complex problem to deal with even in the absence of these aspects. I discuss the role of these omitted factors and some related experiments that I did with this model in the discussion section.

capable of generating stylized facts about income segregation, such as the positive relationship between income inequality and income segregation, as well as of imitating shapes of empirical income segregation profiles. After that, I begin to dissect the problem of income segregation to build insight and I report how I experimented with the simulation model to capture the distinct impacts of households' moves into richer or poorer neighborhoods. These experiments illustrate that these distinct impacts of moving into poorer or richer neighborhoods are further differentiated with respect to the income level of moving household. Armed with these insights, I demonstrate how aggregating such diverse outcomes of micro-level interactions at a meso-level can help us to better understand the changes in macro-level income segregation patterns. More precisely, I show how varying income inequality levels influence the residential mobility of the poorest and richest as well as middle-income strata, and explain the changes in income segregation patterns accordingly. I also argue that these experiments of residential mobility patterns imply that segregation of affluence and poverty can trigger each other via initiating cascades of residential mobility and housing prices. After that, I look at the high income inequality case, and I suggest that high income inequality can be responsible for high residential instability and eviction rates among the poorest stratum via disrupting housing market and leading to shortages in affordable housing. Finally, I conclude by discussing the key findings and contributions, and the aspects of income segregation that I purposefully omitted in the model.

2. Modeling income segregation

I tackle the question of how income inequality shapes income segregation using agent-based modeling (ABM), which is a useful tool in this inquiry for several reasons. First and foremost, income segregation problem is analytically very complex; the interaction between households' dynamic residential mobility preferences and abilities, and a dynamic housing market is simply unpredictable. Moreover, unlike racial segregation, which is usually studied with a focus on the relation between two categorical variables such as black and white or white and non-white, income is a continuous variable, making income segregation a more diverse problem to conceptualize as well as analytically more difficult to deal with than racial segregation, which has already been studied with ABM for a long time due to its complexity.

Such high level of complexity begs for simulation modeling for a causal inquiry as it provides researchers with an experimental platform, boosting their capacity to untangle the analytical complexity of the problems they deal with. Furthermore, simulations enable us to conduct controlled experiments, most of which are impossible in real life, and hence, offer opportunities to generate more mechanism-based explanations by means of tracing the chain of events to their origins. Moreover, ABM is particularly useful in addressing problems with spatial dimensions because not only it can incorporate spatial particularities but also visualization can help to build more intuition and insight about income segregation and its patterns.

The analytical sociology school of thought in particular treats ABM as an opportunity to shed light on the processes yielding macro outcomes via micro-level interactions (Breen, 2009; Hedström, 2005; Hedström & Bearman, 2009; Hedström & Swedberg, 1998; Hedström & Ylikoski, 2010; Manzo, 2010; Squazzoni, 2010). Schelling's (1971) seminal work on residential segregation has been the trend-setting example for this research program. It has also been the guiding framework for many residential segregation studies, both inspiring many researchers and limiting their vision as well, and it has been started to be challenged and advanced (see Bruch and Mare's (2006, 2009a, 2009b, 2012) studies and Rijt, Siegel, and Macy (2009)). This article also builds on the same line of research and contributes to this body of studies by focusing exclusively on income segregation.

Finally, ABM is particularly fruitful in studying income segregation because it enables us to have complete information about each household's total income. Available empirical data, which only consist of information about whether a households' income lies in a certain threshold or not, allow us to calculate income segregation only for these thresholds and to approximate income segregation profiles by fitting a polynomial (Reardon & Bischoff, 2011). In contrast, having such fine-grained information with ABM, it is possible to calculate the level of segregation at each income percentile and to generate complete income segregation profiles. Although it is argued that the available number of thresholds usually provide sufficient data to *predict* income segregation profiles (Reardon, 2011; Reardon & Bischoff, 2011; Reardon & Firebaugh, 2006), evidence is still needed to evaluate these findings more rigorously, particularly for extreme values in a segregation profile, which represents segregation of the poorest and the richest percentiles.[2]

Here I briefly review two notable studies that use ABM to study residential segregation, which modeled some key processes of income segregation. These works helped me to tailor my agent-based model to study the problem of income segregation better. First, Fossett (2006a) identifies some real-world scenarios and uses his ambitious model, *SimSeg*, for explorative purposes.[3] He seeks to find out to what extent racial segregation can emerge and sustain itself even in the absence discrimination in housing market. What is relevant in his model for us here is that he incorporates affordability checks for housing, a necessary condition to observe income segregation. Nevertheless, these checks consider socioeconomic status rather than economic purchasing power. Moreover, Fossett does not decouple the desirability of a neighborhood and a house from its affordability, which is a serious limitation to study income segregation properly. Additionally, the affordability of houses is held constant throughout the model, which is another serious limitation since the dynamic aspect of prices is the heart of a housing market.

Second, Benard and Willer's (2007) study segregation of wealth and of status with a simple ABM, which served as a foundation to the model presented in this article. Similar to this study's motivations, they exclude race from their analysis "as race has already been extensively examined in a number of models" (Benard & Willer, 2007, p. 151). Moreover, unlike Fossett does in his *SimSeg* model, they decouple the desirability of neighborhoods (which is a function of the status of its residents) from the affordability of housing, or simply put, prices. Furthermore, they experiment on different levels of endogeneity in housing prices. With endogeneity in housing prices, they capture the fact that the income levels of residents in a neighborhood affect the housing prices in that neighborhood, which is a key mechanism creating or sustaining wealth segregation as well as linking it directly with wealth inequality.[4]

In their analysis, Benard and Willer (2007) show that as the correlation between wealth and status increases, wealth segregation increases as well. Price endogeneity also turns out to be positively related to further segregation. A puzzling issue with their study is that the wealth distribution in their analysis follows normal distribution, and in a footnote, they state that they also tried exponential distribution but the results turned out to be identical (Benard & Willer, 2007, p. 154). This is a curious finding as, after all, exponential distribution points to a very uneven wealth distribution and we expect to see more wealth segregation, but this is not the case. This might stem from the over-simplicity of their model. Alternatively, it might really be the case that wealth distribution does not inform or condition wealth segregation. Nevertheless, this contradicts with Reardon and Bischoff's empirical findings (2011). These suggest that further research is compulsory to shed more light on the relation between income inequality and income segregation.

Moreover, Benard and Willer's (2007) report wealth segregation using the measures used for racial segregation, namely a revised version of Massey and Denton's (1988) index of dissimilarity, developed by Winship (1977), and a revised index of isolation. However, this covers only a small aspect of the segregation where you identify people as either poor or rich, based on their location with respect to median income. Income, unlike gender or race variables, is a continuous variable by definition, rendering the segregation problem even more complex, begging for more elaborate measures. Their findings might even change

[2]Although while calculating the overall segregation level they weight segregation of the poorest and the richest least, it is still important to focusing on these parts to provide a complete panorama of the segregation experienced in a city.

[3]For a sophisticated and thorough review of the literature on residential segregation as well as the related modeling studies, see the special issue of *Journal of Mathematical Sociology* on Fossett's work (2006a, 2006b; Skvoretz, 2006) and Bruch and Mare's works (2006, 2012).

[4]Although they frame their study around the concept of wealth and I choose income instead, our studies are still comparable, because in both, wealth and income serves the same purposes of affordability and of informing SES levels of residents. Moreover, I also abstain from using similar concepts of class segregation or economic segregation as I think they need more conceptual elaboration than income segregation.

when a more calibrated measure for income segregation is used such as Reardon's (2011) rank order information theory index.

2.1 *Measuring income segregation*

Measuring residential segregation is addressed in a number of studies and there is a well-established literature on indices of segregation (Massey & Denton, 1988; Reardon, 2011; Reardon & O'Sullivan, 2004; Winship, 1977). Among all segregation measures, Reardon & Firebaugh's (2006) *rank-order information theory index* proved to be the most useful for the purposes of this study. While majority of segregation indices focus on the overall level of segregation rather than its distribution among different segments of population, crafted specifically for income segregation, this measure enables us to draw segregation levels for each income segment of population. This is possible by focusing on the *H(p)* curve which illustrates the income segregation profile of a city, which is computed during calculations of H^R, the overall level of income segregation in that city (Reardon & Bischoff, 2011, pp. 1110–11):

$$E(p) = p \times \log_2 \frac{1}{p} + (1-p) \times \log_2 \frac{1}{1-p} \tag{1}$$

$$H(p) = 1 - \sum_j \frac{t_j \times E_j(p)}{T \times E(p)} \tag{2}$$

where p is income-percentile ranks, T is total population, t_j is the population in neighborhood *j*, *E(p)* is the entropy of the population split into two as below and above p, and $E_j(p)$ is the entropy within the neighborhood *j*. Then, the interpretation of a point on the *H(p)* curve is as follows: the level of segregation between households with income percentile below p and above p. The overall income segregation measure H^R is calculated as follows:

$$H^R = 2\ln 2 \int_0^1 E(p)H(p)\mathrm{d}p \tag{3}$$

H^R ranges from a minimum value of zero when there is no income segregation to a maximum value of 1 when there is complete income segregation. [5] *E(p)* is used as a weight where extremes have lower values than the middle portion: it is maximized for $p = 50$ and minimized for $p = 0$ and $p = 100$. This weighting tells us that segregation between the population with incomes higher and lower than median income level is most informative. Another important aspect of this measure is that it is independent of changes in income levels as it only uses rank-order of household incomes, not incomes themselves. Hence, the confounding impacts of monetary changes on income are kept away from the segregation measure (Jargowsky, 1996).

I exemplify the use of this measure on an empirical case. Figure 1 shows the evolution of income segregation profile of the 100 largest metropolitan areas in the US from 1970 to 2000 (Reardon & Bischoff, 2011, p. 1120). In these, *H(10), H(50)* and *H(90)* are marked as reference points, where for example, *H(10)* value gives us how segregated the poorest 10% of population is from the rest of the society or the richest 90% of population. Reardon and Bischoff interpret *H(10)* and *H(90)* as segregation of poverty and affluence, respectively. Note that by segregation of poverty and of affluence, they do not mean the segregation of the poor from only the rich or vice versa. Instead they address the segregation of the poor or the rich from all the rest of the society.

Another interesting point about income segregation profiles in Figure 1 is that the overall shape of *H(p)* curves are stylized U-shaped curves. An ideal U-shape curve suggests that the harshest income segregations are held at the lower and higher extremes of income pyramid. Empirical

[5] Minimum income segregation occurs when income distribution in each neighborhood mirrors that of the city as a whole. Maximum income segregation occurs when there is no income variation within any of the neighborhoods (i.e. every household in a neighborhood has the same income) while each neighborhood's income differs from one another.

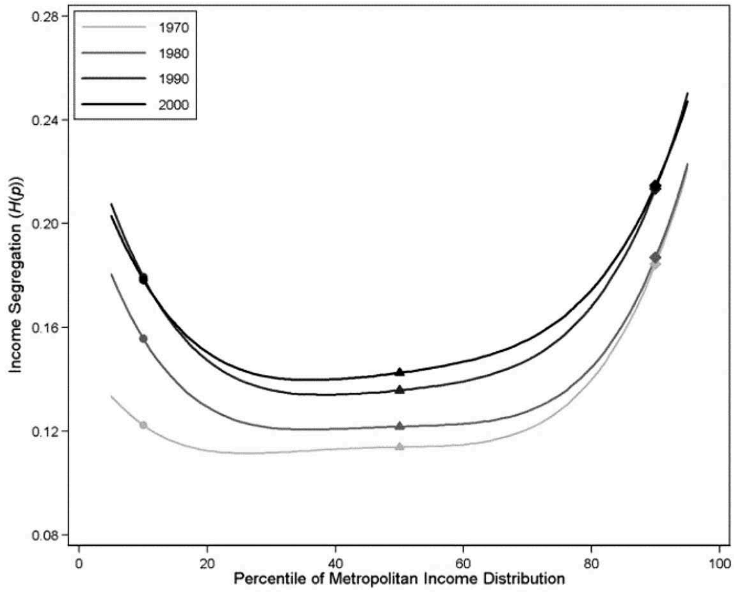

Figure 1. Empirical examples of income segregation profiles.

examples usually take U-shapes, though with different forms (Reardon, 2011; Reardon & Bischoff, 2011; Reardon & Firebaugh, 2006). Even though this is intuitive and commonsensical, theoretically and practically, an *H(p)* curve can take any shape and I will explain why it is so, as well as what different shapes imply later in the article.

3. Model description

3.1 *Households*

The most important element of the model[6] is households. Each household has a constant income, which determines its purchasing power—in this case, its housing budget, and a socio-economic status (SES), which determines its housing preferences and aspirations, as well as its desirability by other households as neighbors. Distinguishing SES from income is important because without decoupling the two, observing gentrification—relatively richer and higher-SES people moving into cheaper and lower status neighborhoods—dynamics becomes impossible to see in the model.[7]

Households' incomes[8] follow lognormal distribution, which is chosen to approximate empirical income distributions. Following Benard and Willer (2007), SES is modeled as a function of the household's income.[9] For household i, income and SES are determined as follows:

$$Income_i = a, \tag{4}$$

$$SES_i = \beta \times Income_i + (1 - \beta) \times b, \tag{5}$$

[6]I coded and executed my model in Net Logo (Wilensky, 1999).

[7]Similarly, without decoupling SES and income, it is not possible to have *nouveau riche*, who has high income but low SES, which can create unpredictable dynamics in housing market as gentrification does.

[8]In the model, the budget and the income of a household equal to each other for the sake of simplicity.

[9]Benard and Willer (2007) found that higher values of the correlation between income and SES lead to higher levels of segregation. I experimented with different levels of correlation as well and found the same impact. In the simulations, the coefficient β is taken as 0.7, yielding 0.9 correlation between income and SES on average.

where a and b[10] are random variates following lognormal distribution, and β coefficient determines the level of correlation between income and SES.

3.2 *Houses and neighborhoods*

The other significant part of the model constitutes the houses and neighborhoods. Our artificial city is a 60×60 checkerboard with 3,600 houses. Each neighborhood covers a 5×5 space, yielding 144[11] neighborhoods. Similar to the above discussion of decoupling SES and income, affordability, and desirability of a house are differentiated as well: each house has a dynamic rent and status. The status level of a house is the perceived desirability of it where that perception is a function of the SES levels of residents living in its close vicinity and within the same neighborhood.

3.3 *Residential mobility*

To approximate households' housing search and moving patterns, I adopt a discrete choice model of preferences and decision making (Bruch & Mare, 2012, p. 111). In the simulation, households follow a hierarchical multi-step approach to residential mobility: first, households check whether they need to change their current houses or not. They do not consider moving to a new house as long as the rent is lower than their budget and the status level of their house is higher than their SES.[12] If they are satisfied with the rent but not with the status level of their current house, then they engage with a status-seeking move; they look for a house with higher status. If they are satisfied with the status level of their current house but not with the rent, then they engage with an economical move; they search for a house with cheaper rent. If they are dissatisfied with both, then they give priority to what bothers them most and this is captured by having their search preference as probabilistic such that (Bruch & Mare, 2006, 2012):

$$\Pr(\text{searching for lower rent house}) = \frac{\frac{\text{Budget}-\text{Rent}}{\text{Budget}}}{\frac{\text{Budget}-\text{Rent}}{\text{Budget}} + \frac{\text{Status}-\text{SES}}{\text{SES}}} \tag{6}$$

$$\Pr(\text{searching for higher status house}) = \frac{\frac{\text{Status}-\text{SES}}{\text{SES}}}{\frac{\text{Budget}-\text{Rent}}{\text{Budget}} + \frac{\text{Status}-\text{SES}}{\text{SES}}} \tag{7}$$

After a household has decided what kind of a house they want to move into, first, they attempt to choose a neighborhood based on the neighborhoods' average rents and status levels. Note that the households' scopes of searching and access to information are limited. More precisely, the household picks (arbitrarily) only a single neighborhood from their list of candidates satisfying the household's criteria for their new house: if the aim is to find a cheaper status house, then the neighborhoods with average rent less than the present tolerable rent are put to the candidate list; and if the aim is to find a higher status house, then the neighborhoods with average status more than the present tolerable status are put to the candidate list. Put differently, the household choose a potentially better neighborhood, but not necessarily the best one.

[10]To gain analytical leverage, other determinants of SES are not specified in the model such as race or ethnicity, jobs, and family. They are purposefully ignored by the modeler and can be thought as if they are combined under the rubric of desirability in a single random variate *b* following similar distributions to income distribution.

[11]The number of neighborhoods is determined such that the distortion in the extreme ends of income segregation profile is minimized. The reason of doing is to ensure that 1% of population can fill a neighborhood (so that any *H(p)* value can practically hit its maximum value of 1).

[12]The households in my model, as in reality, have some tolerance of residing in a house in which they would not prefer. More specifically, if the rent is less than (100+*tolerance*) % of their budget and the status level is higher than (100- *tolerance*) % of their SES, then the household is satisfied and stays put. However, if either of these two conditions is not satisfied, then the household wants to move to a better (with respect to their budget and SES) house. In the experiments that I report here, the tolerance level is determined as 33%. Sensitivity analyses showed the findings are resilient, but they are clearer when it is around 33%. For the sake of clarity, I dropped the tolerance expression from the text and simply referred to the budgets and SES levels as if they are absolute.

Afterwards, the household looks for empty houses in the chosen neighborhood. Among them, an appropriate choice is made if there is any available: an appropriate candidate is a cheaper and empty house if the aim is to move into a cheaper house, and it is a higher status and empty house—which the household can afford—if the aim is to move to a higher status place. If the household finds an appropriate candidate, the household moves there. If not, the household stays put for another round. Note that the household can fail to find an appropriate house even if one or more is available because their scope of searching and access to information are limited.

Motivated by Bruch and Mare's challenge to Schelling's choice functions and debates around it (Bruch & Mare, 2006, 2009a; Rijt et al., 2009), I experimented with different choice functions, that is, agents' having different kinds of rationality. I ended up with incorporating bounded rationality, which is much more plausible than the erroneous *homo economicus* assumption.[13] First, if the households are satisfied, they continue to stay where they are. They are not programmed for always seeking something better or the best possible option. Second, they are imperfect; they cannot search for the best house, but for a better one, which may or may not be the best option for the household. They have limited information; they do not know the rents and status levels of all houses or they do not know if a neighborhood is full or not, and they can only focus on a single neighborhood at a time. Moreover, they do not have the perfect and infinite computing capacity and time to find and choose the best option.

3.4 *Housing market dynamics*

There are 3,060 households, yielding 15% vacancy rate, which both facilitates turnover and is used as a proxy for supply and demand dynamics (Zhang, 2004, p. 149). After all households have checked their conditions and acted accordingly one by one, the rents and status levels of all houses are updated. A composite weighting equation is used to update the rents and status levels. The average rent of the neighborhood, the average income of the residents of the neighborhood, as well as the average rent of the Moore neighborhood, and the average income of the Moore neighbors are weighted[14] to determine an implied rent. To approximate the lagged nature of changes in prices, the rents are updated by the anchor and adjust heuristic, where the anchor is the implied rent:

$$\begin{gathered}\text{Implied Rent}_{\text{t}} = \text{Weight of Income} \times 0.5 \\ \times(\text{avg.budget of all neighbors} + \text{avg.budget of Moore neighbors}) \\ +(1 - \text{Weight of Income})\times 0.5 \\ \times(\text{avg.rent in the neighborhood} + \text{avg.rent in the Moore neighborhood})\end{gathered} \tag{8}$$

$$\text{Rent}_t = \frac{\text{Implied Rent}_t - \text{Rent}_{t-1}}{\text{Rent Adjustment Time}} + \text{Rent}_{t-1} \tag{9}$$

To approximate the supply and demand effects of housing market, the rents of vacancies are updated by the following equation:[15]

$$\text{Rent}_t = \frac{\text{Implied Rent}_t - \text{Rent}_{t-1}}{\text{Rent Adjustment Time}} + \text{Rent}_{t-1} - (\text{Empty House Multiplier} \times \text{Rent}_{t-1}) \tag{10}$$

[13]Note that this is in contrast with the existing models of segregation, where agents usually seek and are able to find the best available alternative (Benard & Willer, 2007, p. 156; Fossett, 2006a, p. 232). More importantly, to the best author's knowledge, the researchers of income segregation using agent-based models have not tried to model the agents with bounded rationality. In fact, I experimented and saw that how unrealistic assumptions of perfect rationality, which can be calibrated to bounded rationality with little effort, lead to the erroneous results such that the impact of income inequality on income segregation becomes negligible.

[14]The weight of income in determining the rents is calibrated to be 0.2 in the benchmark model. It is assumed that the weight of Moore neighborhood and *the* neighborhood are equal and 0.5. If there is no one in the Moore neighborhood of a household, then the weight becomes 0.33 instead of 0.25.

[15]The empty house multiplier is approximated by the amount of excess housing supply. It is equal to vacancy rate.

These equations ensure that the rent of a house increases when richer people move closer to it and/or move into the same neighborhood, and when poorer people move away from it and/or move out to a different neighborhood. On the other hand, the rent of a house decreases when it remains empty, and when poorer people move closer to it and/or move into the same neighborhood, and when richer people move away from it and/or move out to a different neighborhood.

To update the status levels of houses, again, anchor and adjust heuristic is used. The anchor is the weighted average of SES of all residents in the neighborhood and the Moore neighbors:[16]

$$\text{ImpliedStatus}_t = (\text{avg.SES of all neighbors} + \text{avg.SES of Moore neighbors}) \times 0.5 \tag{11}$$

$$\text{Status}_t = \frac{\text{Implied Status}_t - \text{Status}_{t-1}}{\text{Status Adjustment Time}} + \text{Status}_{t-1} \tag{12}$$

These equations ensure that, much like the rents, status level of a house increases when high SES people move closer to it and/or move into the same neighborhood, and when low SES people move away from it and/or move to a different neighborhood. Similarly, status level of a house decreases when low SES people move closer to it and/or move into the same neighborhood, and when high SES people move away from it and/or move to a different neighborhood.

4. Simulation analyses

In the initialization of the simulation, a perfect correspondence between the rents and budgets, and status levels and SES levels of the households is assumed: the rent of each house is equal to its residents' budget, and the status level of it is equal to the residents' SES. Put differently, all households start satisfied with their current houses. The rents and status levels of vacant houses are determined as if they have residents. The initial distribution of households in the city is random. Hence, the initial level of income segregation is negligible.

After initialization, the simulation model starts running. Holding households' budgets and SES constant through the end of each run, each iteration consists of i) asking households whether they want to move, ii) moving those who want to and can move, and after all moves are realized one by one, iii) updating the rents and perceived status levels of all houses.

Each simulation model runs for 500 iterations, long enough that it reaches a dynamic equilibrium. All simulations reach a dynamic equilibrium as Mayer (2001, p. 10) hypothesized: "[I]f economic inequality were fairly constant over a long period, a stable level of economic segregation would evolve based on the distribution of income and individual preferences."

4.1 *Results*

In Figure 2, the relationship between income inequality and income segregation can be seen. Here, each point represents the result of a simulation run. There are 50 observations around each Gini index value in the range of 0.25–0.55—which covers majority of real-world income inequality cases—with increments of 0.05. As expected, a positive relationship between the two is observed: a rise in income inequality is accompanied by an increase in income segregation as well. Figure 2 also illustrates that the variation of overall income segregation level for a certain level of income inequality is narrow. This implies that, *ceteris paribus*, overall level of income segregation is conditioned by the level of income inequality, as Mayer (2001) hypothesized.

To illustrate the spatial outcomes better, Figure 3 shows a typical initial condition where there is almost no income segregation. Here, each agent represents a household and each patch stands for a single house with the capacity to house a single household. The red agents represent the poorest 25%, the blue

[16]Moore neighborhood covers the 8 immediate neighbors of the ego agent. If there are no one living in the Moore neighborhood, then only the average SES of all neighbors is used.

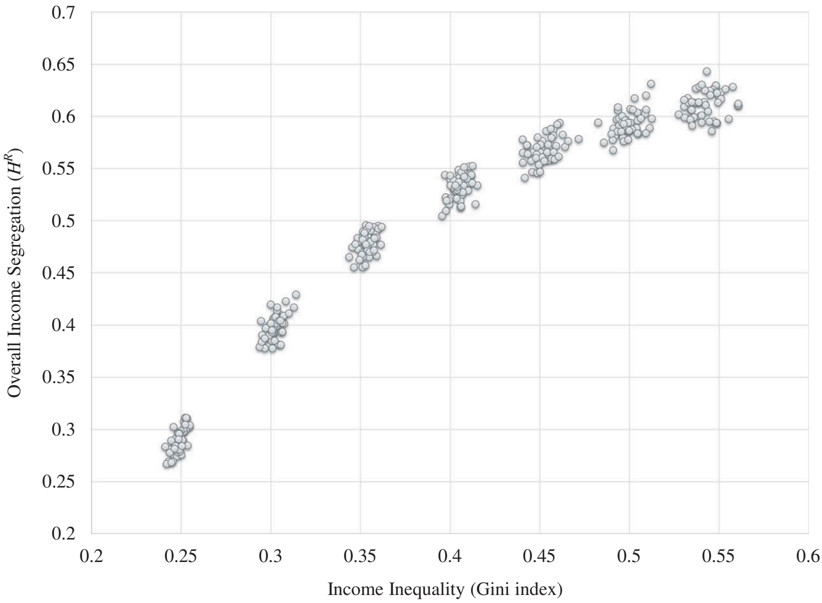

Figure 2. The impact of income inequality on the overall income segregation.

agents represent the richest 25% of the population. The rest, arguably the middle class, are the green agents. The shading of each house signifies its rent: as it gets darker/lighter, the rent becomes cheaper/more expensive and the darkest/lightest colored house has the cheapest/most expensive rent. Note that the coloring as well as dividing population into quarters is a heuristic to illustrate the segregation more clearly. Figure 4, on the other hand, shows the resulting spatial outcomes for two extreme conditions for very low (where Gini coefficient is around 0.25) and very high (around 0.55) levels of income inequalities. Income segregation is notably higher in the second figure; we see higher number of homogenous neighborhoods, blue, red, or green-only neighborhoods, compared to low income inequality case. Moreover, these homogenous neighborhoods cluster together more closely, creating larger blocks of not only blue/affluent and red/poor but also solely green/middle-class enclaves.

For a more comprehensive analysis that goes beyond overall level of income segregation, I calculated the resulting *H(p)* curves, put differently income segregation profiles, for different income inequality levels, which are visible in Figure 5. The results show that as it is observed in empirical cases (Reardon, 2011; Reardon & Bischoff, 2011; Reardon & Firebaugh, 2006), most of the *H(p)* curves are mostly U-shaped, validating the model's capability of generating real-life income segregation profiles.[17] Figure 5 illustrates the impact of income inequality on both overall level of income segregation and more importantly, its characteristics: the levels of segregation of poverty and of affluence can be assessed from *H(p)* curves simultaneously by examining the left and right tails of the curve, respectively.[18] We see that rising income inequality has differential impacts on segregation of poverty and of affluence such that higher

[17]For empirical examples, see (Reardon, 2011; Reardon & Bischoff, 2011; Reardon & Firebaugh, 2006). Nevertheless, as it is discussed before, *H(p)* curves can take shapes other than the ideal U-shape. For instance, when Gini coefficient is around 0.55, the left tail of the *H(p)* curve violates a perfect U-shape. I will explain this later.

[18]Reardon and Bischoff (2011) interprets *H(10)* and *H(90)* as reference points for segregation of poverty and affluence, respectively. Such a point-wise approach may be easier to interpret the results or since their data contains samples of income thresholds, such point-wise approach is more valid than using the polynomial estimates. Nevertheless, this can be misleading. For example, it is possible to have a case where the segregation of the poorest 10% increases, the segregation of the poorest 5% can decrease. As I have the whole population's data by virtue of simulation, I focus on the larger portions of the left and right tails of the curve as interpretations of segregation of poverty and of affluence, for example focusing on the poorest percentiles between 1–20% or 25% and on the richest percentiles between 75% or 80–99%.

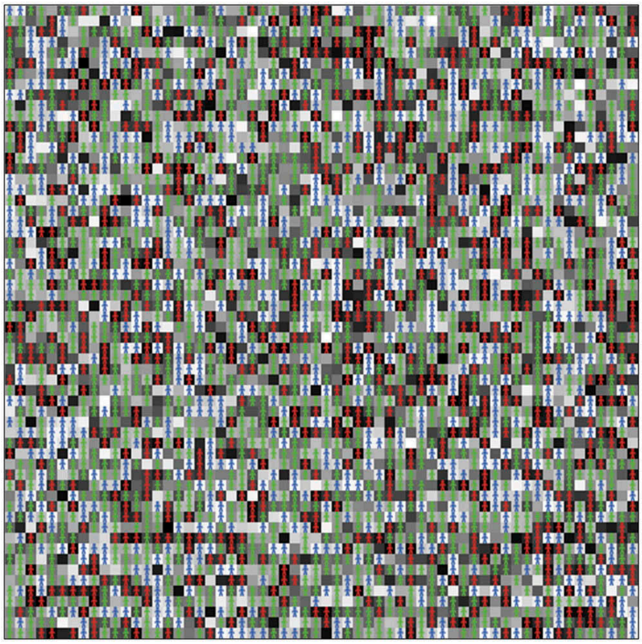

Figure 3. A typical initial condition of the model where there is negligible level of income segregation.

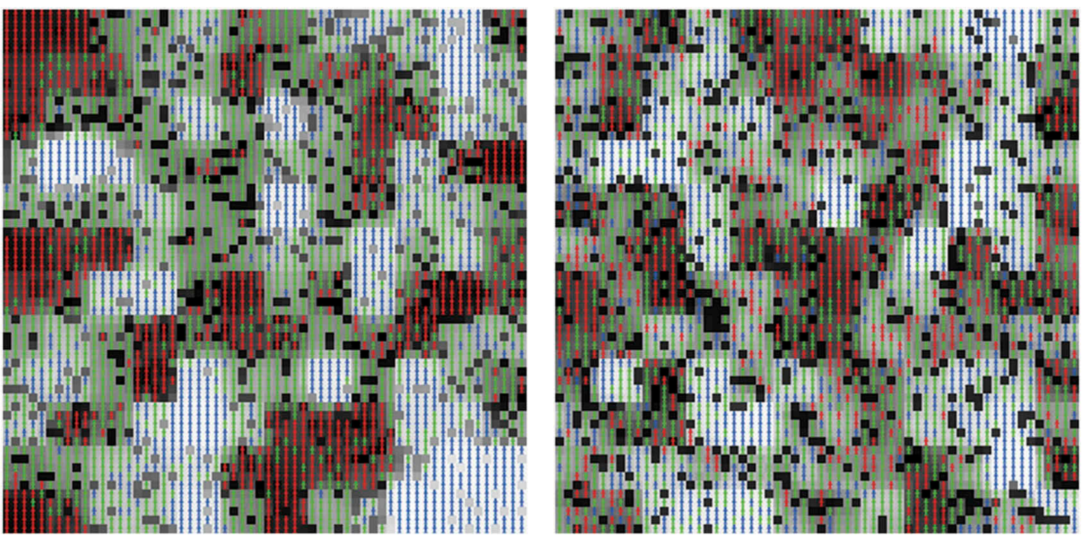

Figure 4. The spatial outcome of two simulations starting with the same initial conditions except that Gini coefficient is 0.25 on the left and 0.55 on the right.

levels of income inequality boost segregation of poverty less than segregation of affluence. Moreover, as income inequality increases, we see integration among the poorest percentiles instead of segregation. To shed light on these, and even going beyond—to understand why an *H(p)* curve takes certain shapes after changes in income inequality, I utilized the simulation model as an experimental platform to support my cognitive capacity by selectively decreasing the complexity of income segregation even further to advance our understanding of it. Put

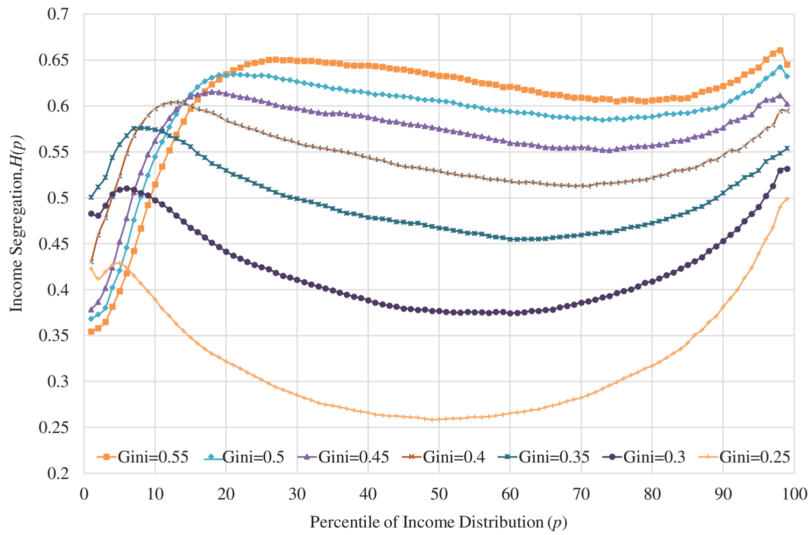

Figure 5. Income segregation profiles for different levels of income inequality.

differently, echoing the analytical sociology school of thought's metaphor of dissection (Hedström, 2005), I tried to, methodically, cut up the problem of income segregation to figure out the interplay of its internal parts, by utilizing agent-based modeling to its full extent.

4.2 *Dissecting income segregation*

Figures 6 and 7 illustrate such efforts where I run the model under some extreme and unrealistic conditions such that some portions of population are made to act as I specified while paralyzing the remaining households and suspending the housing market and residential mobility interactions. Put differently, I isolate a layer of reality that is under investigation and analyze how this part of reality affects income segregation profiles. More precisely, while keeping everyone else immobile, I made the poorest 25% of population to pursue economical moves, meaning that they tried to move into cheaper houses. Respectively, in the other experiment, again, while keeping everyone else immobile, I made the richest 25% to pursue status-seeking moves, that is, they tried to move into higher status houses.[19] In these two experiments, I seek to understand the impact of status-seeking moves of the richest households and economical moves of the poorest ones on the overall profile of income segregation.

Figure 6 shows that status-seeking moves of the richest people increase the segregation of affluence significantly. Curiously, it also raise the left part of the curve, meaning that the segregation of poverty also increases, though it increases less than the segregation of affluence. Since the remaining households are immobile, this observation dictates the following: the moves of affluent households to more affluent neighborhoods increase not only segregation of affluence but also segregation of poverty by leaving the poor neighborhoods much more homogeneous in terms of income. In other words, a move has an impact on its target as well as its destination. I think it is this interconnectedness of the effects of a move that makes residential segregation problems in general, and income segregation in particular as analytically complex phenomena. This interconnectedness becomes more complicated when we also add the interactions of residential mobility and housing market, and how segregation of affluence and of poverty, further affect each other via housing market. I will investigate this further later in the paper.

[19]Here, aggregating the richest and poorest at 25% is a just heuristic. The reason of such aggregation at a meso-level is highlight and magnifies the typical impact of a rich or poor household's residential mobility.

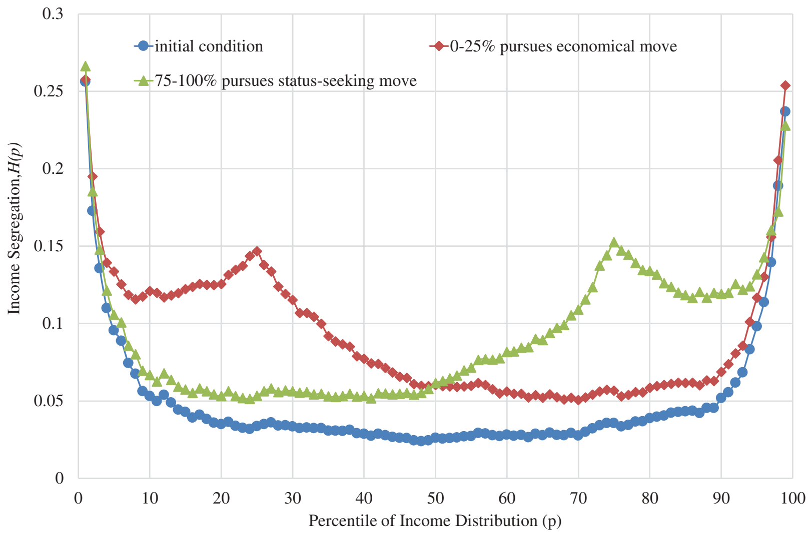

Figure 6. Cases with the 1st quarter pursuing economical and the 4th quarter pursuing status-seeking moves, while keeping everyone else immobile.

Relying on the observation and the argument above, I further argue that formation and expansion of affluent neighborhoods such as increasing number of gated communities can have a reinforcing impact on formation and expansion of ghettos in a city, and vice versa. Thus, segregation of poverty or affluence should not be studied in isolation since income segregation, as shown above, requires a more holistic approach due to the reciprocal relations of its elements.

The other interesting observation is the little U-shape observed at the right tail in Figure 6. Since only the richest 25% were trying move, it is not surprising that $H(p)$ values where $p > 0.75$ are higher than $H(p)$ values where $p \leq 0.75$. However, in this 4th quarter, as p increases, in a seemingly puzzling way, $H(p)$ decreases. The reason for this decrease is that although the richest 25% of population segregated from the rest, they get mixed well among themselves. For instance, $H(80)$ is less than $H(75)$ because the richest 20% of the households shares the same neighborhoods more with the rest than the richest 25% of the households' sharing the same space with the rest due to the fact that the households with $75 < p < 80$ live among the richest 20%. The similar analysis is valid for the case where poorest 25% pursues economical moves.

Moreover, the impact of each kind of move, such as economical or status-seeking moves, on the income segregation profile depends on who is doing which move. For instance, the impact of a rich household's status-seeking move is different from of an upper middle-class or lower middle-class household's status-seeking efforts, to the extent that the sources of the move as well as the possible targets, and the ability to move differ. Figure 7 illustrates that status-seeking moves of the upper-middle quarter of the population increase segregation of poverty and actually, decrease the segregation of affluence by being mixed with the richest households. Vice versa is also valid for economical moves of the lower-middle quarter. [20]

With this exercise, we build more intuition about the complex nature of the income segregation problem and the above analyses boil down to the following arguments: each household's move constitutes a part of the changes in income segregation level and characteristics. Two kinds of household moves are considered here: economical moves and status-seeking moves. Each of these moves has

[20]Similarly, when we make the 2nd quarter to commit to status-seeking and 3rd quarter to economical moves, we see that while segregation experienced in the middle income percentile decreases, segregation of poverty and segregation of affluence slightly increases, respectively.

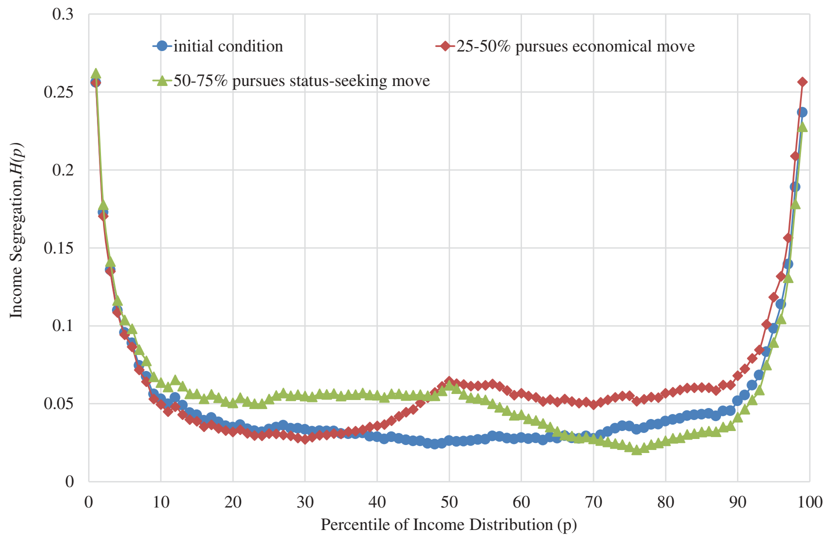

Figure 7. Cases with 2nd quarter pursuing economical and 3rd quarter pursuing status-seeking moves, while keeping everyone else immobile.

distinct impacts, which are further differentiated by the actor of the move. Put differently, an actor's position in income pyramid determines her move's impact on income segregation profile. The macro level outcome, income segregation, is this complex combination of all these differentiated effects each of which is observable in real life. Armed with these insights, I now focus on the analysis of households' residential mobility patterns to shed more light on how income equality shapes income segregation profiles.

4.3 *How does income inequality shape income segregation?*

Table 1 shows average total attempts to move as well as moves themselves, realized by agents during a simulation. It shows that they increase with inequality. In the light of the insights raised above, it is easier to understand why income inequality bolsters income segregation. More precisely, as inequality rises, overall, people become more dissatisfied with their houses and neighborhoods, pursue residential mobility more, and hence, there is greater deviation from the model's initial condition of negligible income segregation.

To explain why the shape of *H(p)* curve or the shape of income segregation profile changes with income inequality, I again put the insights we gained with the above experiments into use. Table 2 shows the distribution of net household moves among quarters of population, ranked with respect to their incomes. Here, the values in each cell correspond to the number of economical moves

Table 1. Macro-level distribution of households' moving attempts and moves.

	Total Attempts to Move		Total Moves	
GINI	Economical	Status-Seeking	Economical	Status-Seeking
0.55	57,648	8502	28,481	3652
0.50	46,518	7237	25,182	2793
0.45	35,954	6401	21,153	2130
0.40	25,407	5635	16,353	1663
0.35	16,308	4991	11,575	1291
0.30	10,171	4155	8007	972
0.25	5658	3134	4929	653

Table 2. The distribution of net residential mobility among quarters of population.

Net Impact of Economical and Status-Seeking Moves by each quarter				
GINI	Q1	Q2	Q3	Q4
0.55	23,772	3047	−624	−1366
0.50	21,801	2304	−499	−1217
0.45	18,861	1637	−385	−1091
0.40	14,928	1038	−301	−974
0.35	10,810	544	−224	−847
0.30	7669	232	−146	−720
0.25	4812	82	−68	−551

subtracted by the number of status-seeking moves performed by each quarter. Comparing the pattern of moves among quarters of population, the presence of U-shaped *H(p)* curves is no surprise: majority of the economical moves are performed by the poorer quarters and their net impact is to raise segregation of poverty whereas majority of the status-seeking moves are realized by the richer quarters and their net impact is to raise segregation of affluence.

Another pattern of change in income segregation profiles in Figure 5 is that segregation of poverty increases slower than that of affluence as income inequality rises, and we even see decreases in the segregation of the poorest percentiles. This is parallel to Reardon and Bischoff's (2011) empirical finding that rising income inequality can compress the income levels on the lower end, and hence, can even lead to a decrease in segregation of poverty, while it leads to higher levels of income segregation mainly by increasing segregation of affluence. The main reason of this is that as income inequality increases, the income distribution becomes more right skewed, leading richer household's impact on housing prices to rise as well.[21] Imagine the arrival of significantly richer households to a poor neighborhood. Their arrival makes the distance between average and median prices even larger. As the housing market interacts with this, rising prices push middle and lower income households away from the rich more powerfully thus boosting segregation of affluence.

But what about local maxima that we observe at left tails of income segregation profiles that violate the ideal U-shape? What do they imply and how do we explain such characteristics of income segregation? In Figure 5, we see that a *perfect* U-shape is never attained; the left-most ends always distorts the ideal U-shaped[22] look of income segregation profiles by introducing local maxima or hills. The decrease of segregation of the poorest is even more puzzling because we see a higher rate of residential mobility among the poor, seeking and moving to cheaper houses: Table 2 shows that rising income inequality leads an exponential increase in the number of economical moves realized by the poorest quarter. This suggests that rising income inequality hurts the poorest strata most, urging them to desperately engage in residential mobility, much more frequently than the rest of the society. This is indeed well-documented by studies on eviction (Desmond, 2012). Nevertheless, contrary to the effect of rising number of status-seeking moves of the affluent on the segregation of affluence, increasing number of economical moves realized by the poor does not mean that each economic move brings further segregation of poverty. This suggests that there are both redundant and integrative residential mobility within such economical moves as well. Nevertheless, we need a closer look at how and why this takes place.

[21] I have experimented with using median income and SES instead of mean in calculating the housing prices and qualities, and the results show that segregation of poverty becomes larger than segregation of affluence. Similar results are observed for larger values of *the weight of income* parameter used in the price calculation function. The results of these experiments are available from the author by request. I thank one of the reviewers for stimulating this insight.

[22] It is important to stress that an ideal U-shape is not the only possible form of income segregation profile. Yet, it is the most intuitive one; commonsense suggests that the poorest and richest households should be the most segregated. Moreover, while it is known from empirical studies that segregation profiles approximate U-shape (Reardon, 2011; Reardon & Bischoff, 2011), recall that their sampled empirical data do not let them to draw *complete H(p)* curves. The model here enables us to have the information of each household in our population and hence to draw *H(p)* curves completely, including the extreme ends of income distribution.

Before doing so, I would like to stress the meaning of a hill in an *H(p)* curve. As I showed with the experimentations above, having a hill implies a relatively more integrated group within themselves—though segregated from the rest. Accordingly, a hill on the left-hand side can be interpreted as a proxy of the portion of the population living in ghettos, which is distinctively segregated from the rest while integrated inside. Put differently, within this stratum of population, we cannot find further segregation. In fact, this observation and interpretation suggests that we should update our definition of poverty with rising inequality; as income inequality increases, we see larger segments of the society with low-income, living closer to each other both spatially and income-wise. Doing so and, for instance, treating income percentile below 20% instead of 10% as the poverty line (*cf.* Reardon & Bischoff, 2011), we can even argue that we see segregation of poverty rising faster than segregation of affluence.

4.4 *The case of segregation of the poorest under very high income inequality*

To illustrate the local integration better, let us focus on the segregation of the poor under very high income inequality, the curve with Gini = 0.55 in Figure 5. Here, the resulting income segregation profile has a hill around p = 25. This tells us that the segregation of the poorest 25% from the richest 75% of the population is higher than, say, the segregation of the poorest 10% from the richest 90%. In other words, the poorest 25% are mixed well among themselves although they are significantly separated from the rest of the population. Figure 8 illustrates this visually; in the figure on the left, the red agents represent poorest 25% and the larger sized red agents represent poorest 10%. We see that the spread of the poorest 10% of the population overlaps with the spread of the poorest 25% to a large extent, explaining why the left extreme of *H(p)* has that particular hill shape.[23] We see the contrary in the figure on the right, where the richest 10% is represented by larger sized blue agents and the richest 25% is represented by the blue agents.

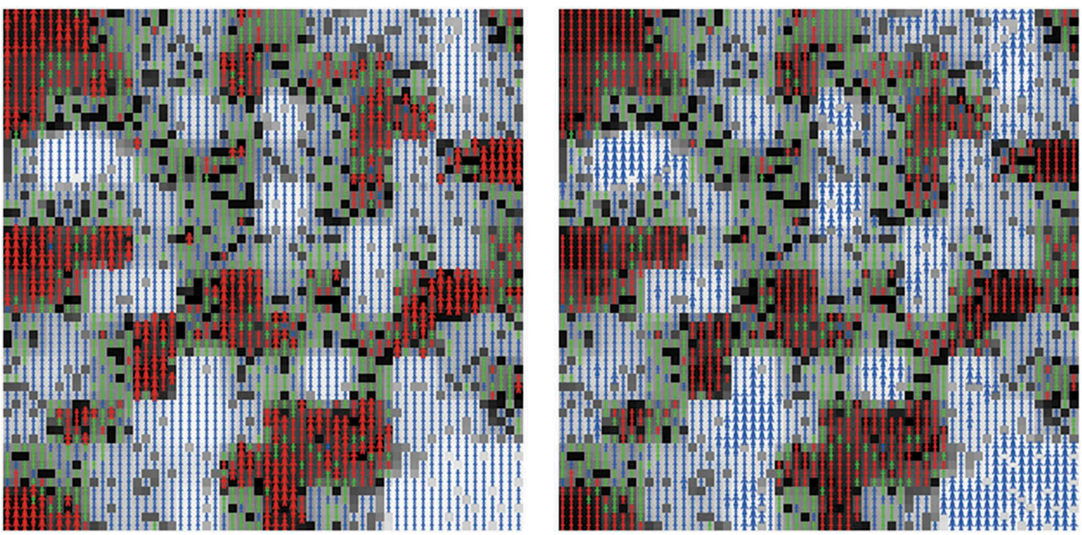

Figure 8. The spatial outcome of a simulation where Gini coefficient is 0.55.

[23]Recalling the calculation of *H(p)*, the more fully the selected people (for the corresponding p-value) fills a neighborhood, the higher *H(p)* values we have since it is the ratio of the selected people in a neighborhood that matters. Hence, if the poorest 10% spread to the same neighborhoods with the poorest 25%, then *H(10)* will inevitably be lower than *H(25)*. If, on the other hand, the poorest 10% is not as spread as the poorest 25%, but concentrated on a limited subset of neighborhoods that the poorest 25% is spread over, then we would have *H(10)* higher than *H(25), as we see with the illustration of richest 10% vs. 25%.*

Table 3. Share of the poorest 5% that pay rents higher than their budgets.

GINI	% of overpaying among the poorest 5%
0.55	97.62%
0.50	90.01%
0.45	71.91%
0.40	43.15%
0.35	21.06%
0.30	10.61%
0.25	4.89%

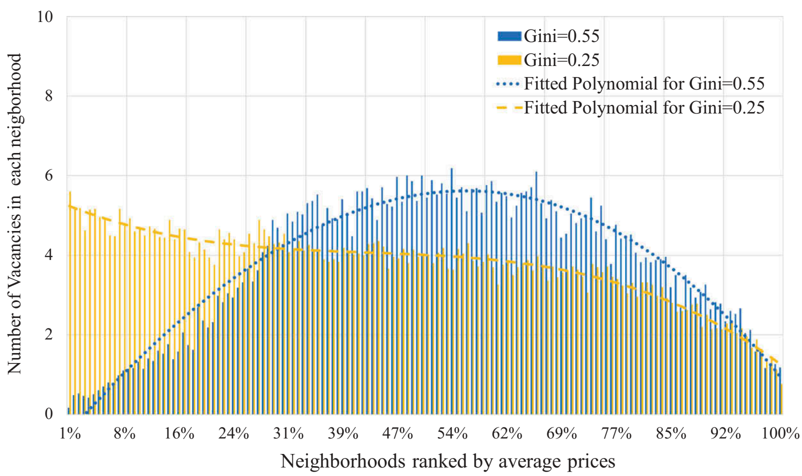

Figure 9. The distribution of vacancies among the neighborhoods ranked by average rents in very high and very low income inequality cases.

Having such local integration does not suggest any social problems as long as they do not conceal a significant injustice: affordable housing shortage.[24] The housing market's inability to match poor households with affordable houses properly can yield lock-ins, disabling them to find better alternatives. While this mismatch decreases segregation locally, it can force some households to pay rents that are significantly higher than they can afford. Studies on eviction show that some poor people have to devote up to 80–90% of their income to paying rents (Desmond, 2012, p. 107). The model captures a similar dynamic. In Table 3, for example, we see the ratio of the poorest 5% who pay rents that are beyond their budget because they fail to find a better alternative, a cheaper one.[25] As income inequality increases, this overpaying ratio of households among the poorest 5% rises exponentially.

[24]There are two other possible reasons of observing local integrations. First, it can be due to the size of census tracts or neighborhoods calculated in *H(p)*. Imagine a large neighborhood such that it can accommodate 5% of the population and suppose that poorest 4% of the population lives in the same neighborhood. Recalling the calculation of *H(p)*, inevitably, *H(4)* will be lower than *H(5)*. This suggest that the size of census tracts matter in calculating income segregation with rank order information index, and in fact, this justifies further Reardon and Bischoff's effort to delineate geographical scale of income segregation (2011; Reardon & O'Sullivan, 2004). Yet, the hills in the model's segregation profile output do not stem from this explanation since it is eliminated by having neighborhood sizes around 1% of population (see footnote 11). Second, hills on income segregation profiles can stem from some voluntary mismatches between neighborhoods and houses, and households. As the discussion of the smaller U-shapes in Figure 6 suggests, sometimes further stratification and segregation might be deemed unnecessary with respect to households' expectations. For example, the richest 1% households may not mind whether they reside in the utmost richest neighborhood in the city; they simply may be content as long as they are among the richest, say, 5%.

[25]I did not account for eviction and homelessness in my model and hence, the households who pay rents beyond their budgets can stay put though they are constantly searching for a cheaper option.

Here, the characteristics of the vacant units can be the key to the explanation of how high income inequality can hurt the poorest most. Figure 9 compares the distribution of number of vacant units among the neighborhoods, ranked with respect to average prices in them, in very high and very low income inequality cases. More precisely, it counts the number of vacant units in each neighborhood, and then ranks them with respect to the average rents in the neighborhoods. We see that when inequality is low, the vacancies are distributed more or less evenly, with poorest neighborhoods having highest number of vacancies. In contrast, when inequality is high, we see a shortage of affordable housing in cheaper neighborhoods in the expense of an increase in vacancies in more expensive neighborhoods. This suggest that a part of the local integration might stem from this low-cost housing shortage, leading to lock-ins, where some poor households are forced to live in houses with rents beyond they can afford as they cannot find cheaper vacancies. Note that as inequality drops, the percent of overpaying poor households decreases and thus the hill moves leftwards and finally disappears. This example of overpaying households in the case of high income inequality suggests that higher levels of income inequality can disrupt the functioning of housing market and result in low-cost housing shortages which might trigger eviction epidemic.

5. Discussion and conclusion

In this study, an agent-based model of residential preferences is built to investigate how income inequality gets translated into income segregation. The model is capable of generating income segregation profiles that are similar to real-world examples and of demonstrating the positive relationship between income inequality and income segregation, both statistically and visually. The simulation results show that, overall, as income inequality increases, people become more unsatisfied with their houses and neighborhoods, and want to change them more frequently. This leads to higher rates of residential mobility among all with increasing rates of economical and status-seeking moves, particularly among the poorest and the richest strata, respectively. This rising mobility's impact on the shape of income segregation depends on the distribution of economical and status-seeking moves among households, and how they interact with the housing market.

The distinctive feature of residential segregation that renders it as an analytically complex phenomenon is that a household move has a double impact; first, on its target neighborhood, and second, which is usually easier to overlook, on its original neighborhood. What is more, these distinct impacts on income segregation profiles are further differentiated by the moving household's position in income ranking. By highlighting that the moves of affluent households to more affluent neighborhoods increase not only segregation of affluence but also segregation of poverty, I argue that formation or expansion of affluent neighborhoods or gated communities has a positive impact on formation or expansion of ghettos or slums in a city, and vice versa. There seems to be two drivers of this positive feedback between the processes of segregation of poverty and of affluence. First, when a rich household leaves a poorer neighborhood, be it a poor or middle-class neighborhood, the poorer neighborhood becomes more homogenous in terms of income: While the rich households' move to an affluent neighborhood increases segregation of affluence, if the source neighborhood is a poor one, this move increases segregation of poverty directly as well. When the source neighborhood is a middle-class neighborhood, it might trigger some cascades that would lead the rich household's old, middle-class neighbors to be engaged with more aspirational residential mobility, which eventually would increase segregation of poverty as well. These dynamics are well captured with the tipping model of racial segregation such that how a few moves might trigger a white flight (Schelling, 1971), and with Wilson's (1987) account of how the flight of black middle-class renders black majority neighborhoods poorer.

Second, there is an emergent aspect of the housing market dynamics that could mainly emanate from segregation of affluence, particularly more visible in high income inequality cases. Continuing the example above, when a rich household leaves a poorer neighborhood and moves to an affluent one, the concentration of rich people in affluent neighborhoods can render these enclaves as repellent cores in the city; by means of skyrocketing rents and housing prices in close neighborhoods, concentration of affluence can push the poor and even the middle-class further away due to the affordability constraint. As a result of this repelling force, increasing number of houses around more expensive neighborhoods remain vacant due to higher prices, and the ratio of more expensive housing in vacant units increases in the expense of cheaper ones. In other words, high income inequality influences the ratio of available low-cost housing in vacant units such that more expensive vacant units crowd out cheaper ones. This loss of affordable vacant units leaves the poor with fewer neighborhoods and houses to choose from, encouraging the poor to concentrate to fewer neighborhoods and eventually, causing an increase in segregation of poverty.

Considering these two cascades of residential mobility and housing prices that explicate the interconnection between the processes of segregation of affluence and of poverty, I argue that studying the two should not be done isolation from one another to be able to account for important feedbacks between them. Such internal dynamics to the problem of income segregation can be significant such that by means of the positive feedback between segregation of affluence and of poverty, income segregation can perpetuate itself, even in the presence of external interventions to alleviate it, such as deconcentrating assisted housing (Owens, 2015).

The potential repelling force of the segregation of affluence, that can trigger significant cascades, also suggests the need to study not only concentration of poverty, but also concentration of affluence in depth. Although concentration of affluence does not present problems for the affluent *per se*, as this study suggests, it might nourish concentration of poverty, something we know to be deleterious. Put differently, we know a lot about how spatial concentration and isolation of poverty is harmful, but we still know little about how its counterpart, spatial concentration of wealth reinforces concentration of poverty.

Simulation analysis of high income inequality cases also implies that if we leave housing market on its own without any regulations of housing and urban policies, increases in income inequality can disrupt the market and lead to affordable housing shortages, which would trigger residential instability and evictions. Indeed, I experimented with rent-control policies that limit the rate of increase in rents to test whether they can offset such negative impacts of high income inequality on income segregation. Congruent with some empirical analyses of rent-control (Enström, Söderberg, & Wilhelmsson, 2014), I found that rent-control implementation decreases segregation of poverty and the ratio of households who are paying rents beyond their budgets.[26] Similarly, I experimented with varying vacancy rates and found that higher vacancy rates have similar effects as rent control. Nevertheless, parallel to my discussion of the role of characteristics of the vacant units—such as whether it has sufficient affordable houses or not—on income segregation, a rise in housing supply can lead to further segregation as well, particularly if it mainly consists of luxury and extravagant houses (Dwyer, 2007), or if the new affordable houses are spatially concentrated (Owens, 2015). Further research is necessary to learn more about how these or similar policies as well as changes in house market would influence income segregation.

Note that with this study, I definitely do not mean to suggest that residential preferences are the primary causes of income segregation. Rather, I acknowledge that there is more to what is represented in the model. First, there are issues of ethnic conflicts—racial segregation is the generic example, particularly for the case of the United States—that I omit in this article purposefully to better focus on income segregation. Of course, racial segregation and ethnic conflicts breed further income segregation (Bruch, 2014, p. 1127; Massey & Denton, 1993), more acutely so when some racial or ethnic groups are significantly more disadvantaged than the others. Additionally, institutional facilitations of racial or ethnic segregation such as housing market discriminations should also be thought as significant drivers of income segregation. Nevertheless, as we learnt from racial segregation studies that even in the absence of housing discrimination, residential preferences could be sufficient to generate high levels of racial segregation (Fossett, 2006a), income segregation could get to high levels

[26]I do not discuss the experiments and the results here in detail for space considerations. They are available from the author by request.

even in the presence of low levels of racial or ethnic segregation (Pinarcioglu & Isik, 2009, p. 473), justifying to treat income segregation as a problem in and of itself for the purposes of this article.

Second, urban and housing policies developed and enforced by the states and municipalities such as "urban renewal" projects, public housing projects, zoning laws, rent control policies or lack thereof, or implementations of immigration and internal migration policies, influence income segregation not only directly but also at larger scales. Acknowledging these omitted aspects of income segregation problem and their significance, I humbly argue that other important, maybe of secondary importance, and complex facets of income segregation, such as residential preferences and mobility abilities, can be analytically decoupled from the above significant influences to be studied in isolation to advance our understanding of income segregation problem. I hope that, highlighting the fruitfulness of focusing on fine-grained residential mobility data, this research reinforces the recent contributions to the residential segregation literature such as (Bruch, 2014), and stimulates residential segregation researchers to collect and work on residential mobility data for empirical analysis to better understand the causal mechanisms of residential segregation.

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