# Home-ownership, Community Interactions, and Segregation*

Karla Hoff
The World Bank
*khoff@worldbank.org*

Arijit Sen
Indian Statistical Institute
*arijit@isid.ac.in*

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**Abstract**

We present a "social interactions" model of home-ownership patterns that can explain the emergence of blighted communities. Residents have an incentive for home improvement and civic participation only if they own sufficient home equity. Capital market imperfections may bar poorer households from becoming home-owners. Complementarities among actions taken by home-owners lead to tenure-segregated communities. Our results can explain the emergence of polarized cities – the rich in home-owning communities with high levels of home improvement effort and civic engagement, the poor in rental communities with low levels of both. Multiple equilibria are possible, and small interventions can have large effects.

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## 1. Introduction

### *A. Motivation and Overview*

Blighted neighborhoods with high crime are a central policy concern in the United States. Growing up in such neighborhoods has a deep, negative impact on health, personal development and school outcomes, which helps transmit low socioeconomic status from one generation to the next.[1] Many of the debates over government interventions to reduce neighborhood blight and social disorganization reflect a divide between those who take an *atomistic* view of the problem and those who believe that *social interaction effects* should inform policy.[2] Such a debate takes place over housing policy. The centerpiece of US urban development policy is to expand home-ownership among low-income households (US Department of Housing and Urban Development [HUD], 1991). Representative statements explaining this policy are that a "critical mass" of low- and middle-income home-owners can "turn around the dynamic" of a distressed neighborhood: "If there is a silver bullet in urban redevelopment, it is home-ownership."[3]

However, the view of the public economics literature is atomistic. It dismisses, on efficiency grounds, policies to spur low-income home-ownership (Aaron and von Furstenberg,1971), Rosen, 1985, and Smith *et al.*1988). A typical statement is by Rosen (1985, p. 378): "it is the poverty associated with poor housing, rather than the housing *per se*, that causes these costly social problems (high crime rates, delinquency, etc.)." This prescription is based on models that admit no externalities

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[1] See Garbarino *et al.* (1997), Bowen and Bowen (1999), the survey in Leventhal and Brooks-Gunn (2000), and Katz, Kling, and Liebman (2000).

[2] In the debates over crime and punishment, the atomistic view emphasizes the role of "bricks and sticks" (prisons and police), while the social interactions view emphasizes the role of community norms (e.g., Akerlof and Yellen,1994 and Glaeser, Sacerdote, and Scheinkman, 1996). In the debate over education vouchers, the atomistic view focuses on the effect from increased school competition, while the social interactions view looks at the way that students of various ability and income levels are sorted across schools (e.g., Epple and Romano, 1999).

[3] *New York Times*, April 16, 1998; and *Washington Post*, April 12, 1997.

across households, eliminating the possibility that home-ownership subsidies to low-income households might correct for market failure.

This paper presents a model in which we study the consequences of local externalities from home-ownership. Our basic story goes as follows: Every household desires to own its home because it realizes that then it will obtain a greater return on any effort it makes to improve its home and community (since it can "capitalize" the gains from these investments). However, because of capital market imperfections, a household can afford to buy its home only if its income is above a threshold. So the richer households buy their homes and expend more effort in improving their homes and communities than do the poorer households, who rent. It is in these effort choices that there exist community-wide "interaction effects." The quality of a home and its future market value are higher when it is in a community where neighbors expend high effort (a *spillover effect*); and for an individual household, the marginal returns to effort are higher when neighbors expend high effort (a *complementarity effect*).

The interplay of these effects has important consequences for community formation. For one, community tenure distribution affects the income threshold for home-buying, and thus matters in each household's decision to own a home in a community. As a result, there can be multiple Pareto-ranked equilibria within a community that differ in ownership rates and community quality (a *coordination problem*). More importantly, there can be inefficient sorting of households by tenure across the many communities of a city, with rich living with rich in home-owning communities with high levels of home maintenance and civic engagement, and poor residing with poor in rental communities with low levels of both (a *segregation problem*). *The end result is that households that are identical in all respects except income, self-organize into "good" and "bad" communities*. The contracting problems faced by the poorer households induce in them a set of behaviors that make

them less desirable as neighbors. This, in turn, induces a pattern of community formation where "bad behavior" is concentrated.

By establishing these kinds of market failure in home-ownership decisions, our model provides a framework for analyzing the role that policy can play. In a set of examples, we show that a policy to subsidize home-ownership can coordinate individual choices in a way that leads to mutual gains. We analyze the policy implications of "threshold effects" (where the behavior of a large set of residents may have to be changed to change the character of a community as a whole) and "multiplier effects" (where the change in the behavior of a group of residents can, by itself, change the behavior of another group). Further, we show that a subsidy that increases the number of home-owners can change the relative rental rates across communities in a way that hurts the poor, and can cause relocation that increases income segregation. This highlights the care that has to be taken in designing and evaluating housing subsidy policies.

This paper brings together two strands of the literature – theoretical work on wealth effects on incentives, and the literature on community formation. Our model is one where heterogeneity in income endowments causes different agents to choose different "incentive contracts" and thus to behave differently. In this, our paper relates to Banerjee and Newman (1993), Legros and Newman (1996), Aghion and Bolton (1997), Bowles and Gintis (1998), and Mookherjee and Ray (2000). Our model also has the feature that non-market interactions are determined by space and the spatial organization of economic activities is determined by non-market interactions. In this respect, ours is a "social interactions model" *à la* de Bartolome (1991), Bénabou (1993, 1996), Durlauf (1996), and Fernandez and Rogerson (1996) (see the surveys by Durlauf (1999) and Blume and Durlauf (2000)). The structure of our model is similar to that of Bénabou (1996), who provides a general framework for analyzing community stratification, but with one important difference. In our model, the

interaction effects exist in *what agents choose to do* (own and expend effort *vs.* rent and not expend effort) rather than *what they are* (rich or poor). This feature generates the possibility of multiple equilibria in our model. We are also able to show the connections between the forces that lead to segregation with respect to the endogenous heterogeneity (in that different agents take different actions) and those that lead to segregation with respect to the exogenous heterogeneity (in that agents' income endowments differ).

*B. The Building Blocks of the Model*

As described above, our model is based on three "building blocks": (*i*) home-ownership changes behavior, (*ii*) credit markets are imperfect, and (*iii*) there exist interaction effects in the behavior of community residents. We claim that these three features of our model are eminently plausible, and that there exists sufficient empirical evidence regarding them.

Table 1 summarizes some of the findings of a large literature that establishes that controlling for observables, home-owners take better care of their property than absentee landlords, and are better "neighborhood citizens" than renters. In a 10-year longitudinal study, Spivack (1991) finds that home-ownership is a critical factor in determining the maintenance of residential structures. Based on his cross-section survey, Cox (1982, p. 112) concludes that "it is the combination of home-ownership and the experience of neighborhood problems...that results in substantially greater rates of activism": among residents who perceive a neighborhood problem, home-owners are 39 percent more likely to be involved in individual and collective political action. There are, however, serious self-selection issues in inferring causality from these studies. Home-ownership may increase housing maintenance and local civic participation, or individuals who are innately better citizens may be more likely to become home-owners. Recent studies try to get around this problem in various ways.

In a quasi-experimental, longitudinal study reported in Rohe and Stegman (1994), the opportunity to purchase new housing units was made available to low-income households through a one-time subsidy, and a comparison group was constructed of renters with similar demographic characteristics (households headed by single African-American women, living in private units and receiving rent subsidies). The study finds that the event of buying a home increases by 20 percent the number of neighborhood and block associations to which a household belongs. The evidence is consistent with the view that a family who owns its own home not only has an investment in a housing unit, but also has an incentive for civic participation.

The massive Citizenship Participation Study of Verba et al. (1995) addresses the self-selection problem in a different way. It establishes that home-ownership increases the probability of voting in local elections, but not in national elections, and that the effects of home-ownership do not disappear when length of local residence is controlled.

DiPasquale and Glaeser (1999) use IV techniques to estimate the effect of home-ownership on behavior. They find that home-owners are better informed about, as well as more involved in, civic life, and that this relationship remains when the effects of length of local residence are controlled. The OLS estimates are that homeowners are 16 percent more likely to vote in local elections and 13 percent more likely to know the identity of the school board head, and these estimates increase by a factor of two or three under IV estimation.

Down-payment and debt service provisions prevent many a majority of renters from becoming home-owners whereas, in a perfect capital market, household income would affect only the quantity of housing services consumed, not the decision to rent *vs.* own (Arnott (1987)). A representative finding is that 70 percent of families that rented in the U.S. were unable to purchase a $20,000 home in 1995 (Savage (1999); see also Caplin *et al.* (1999, ch. 2)).

To complete the discussion of the building blocks of our model, we report evidence of interaction effects in the behavior of residents. We distinguish three, quite independent channels.

(i) *Complementarities in home maintenance effort*: There are severe, well-known identification problems in inferring externalities from geographic association (Manski, 1993), but one indirect approach is to examine the relationship between homeowners' behavior and their expectations about qualitative neighborhood changes. In empirical results using data from special surveys conducted in Wooster, Ohio and Minneapolis, Minnesota, Galster (1987) finds that compared to the most optimistic home-owners, the most pessimistic ones spend 61 percent less annually on their homes, and evidence a 14 percent higher incidence of exterior defects, when individual characteristics are controlled for. "If home-owners perceive the quality of their area as improving, they will *flow with the trend* and intensify their own reinvestment behaviors"(p. 229). In a panel study based on the American Housing Survey, Ioannides (2000) finds that individuals' decisions about home maintenance are highly positively affected by the predicted maintenance behavior of their neighbors.[4]

(ii) *Complementarities in social control efforts by residents*: Reporting criminal activity to the police, or confronting persons who are exploiting or disturbing public space, entails risks that are decreasing in the number of others who are willing to take such risks. Absent activism by others, even small efforts by a citizen to protect property or bring criminals to justice can be extremely costly to the citizen. For example, in empirical work on one low-income urban neighborhood, Merry ( 1981 p. 142) estimated that 40 percent of the robberies and burglaries of black families were retaliatory acts against families who were perceived to have "big mouths"

[4] The flip side of this is that the lack of care by a small set of residents also quickly magnifies to general apathy. As one Tucson resident observed, "When an area has graffiti, people feel comfortable dumping debris, so [the area] just

(i.e., they reported crimes to the police).[5]

(iii) *Complementarities among citizens' efforts to monitor, and obtain services from, government:* When a greater number of households stay informed and monitor government actions, government is more responsive to the electorate,[6] which in turn increases incentives for individuals to stay informed, seek services from government (e.g., garbage collection, fire stations, police, and housing code enforcement), and respond to threatened cuts in such services.

In his study using the American Housing Survey, Ioannides (2000) finds that predicted neighborhood average values are a stronger influence on a housing unit's value than its own lagged value, and that even when a full set of control variables is present, the sum of the estimated coefficient of the lagged dependent variable and of the neighborhood average exceeds one. We take this as evidence that the "market" recognizes the presence of neighborhood interaction effects.

### *C. Evidence on Tenure Segregation*

We have not found any empirical study that addresses our central result, *viz.,* whatever the reason a household becomes an owner or a renter, conditional on having made that choice, renters

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declines and declines." (*The Arizona Daily Star*, Nov. 14, 1999, p. 1B)

[5] Formal models are in Akerlof and Yellen (1994) and Cooter (2000).

[6] In empirical work in India on public food distribution and disaster relief expenditure, Besley and Burgess (2000) find that governments are more responsive where newspaper circulation is higher and where governments face greater electoral accountability. Anderson's (1991) interview with a community leader in his study of a US urban neighborhood graphically illustrates the role that a determined residents' organization can play in strengthening incentives for government performance:

> "We have to get them [drug dealers] off the corner. You must force the police to do their job. See, the police who know that taxpayers are there [on the corner watching] have to behave differently. See, they were under the impression that didn't nobody black care. I've heard them [the police] say that.... But now we got the senators, the governor.. We've shook them up....Because we got over a thousand people [city-wide in the residents' group against drugs]. See, this is what we do. We have about 45 people. We have policemen....[Outside a crack house, we] block the corners, block the streets. Citizens and neighbors... Then, after we raid it, we board it up. Soon as the police take them away, we start nailing it up..." (pp. 107-108).

live with renters, and owners with owners. We use the 1990 US Census data on the ten largest metropolitan areas (MSAs), covering 37% of the population, to examine the pattern of tenure segregation.[7] We proxy for "communities" with census tracts, which are areas of between 2,500 and 8,000 people separated by boundaries such as rivers, highways, or major streets.

There are many dimensions of spatial segregation, and we report the most commonly used index – the *dissimilarity index*, analyzed in Massey and Denton (1988). The index, applied to housing tenure, answers the following question: Within an MSA, what proportion of the renter (or owner) population would need to change tracts (from those where they are over-represented) so that each tract's population would have the same proportion of renters and owners as that of the MSA as a whole? The index ranges from zero (when all tracts have the same ratio of renters to owners) to one (when no renters and owners share a common tract). Because there are forces that lead to segregation by race and income,[8] we calculate the index separately for households with different characteristics. The index for households with characteristic $c$ is:

$$\textit{Dissimilarity index} = \frac{\sum_i \left| \frac{r_{ic}}{R_c} - \frac{h_{ic}}{H_c} \right|}{2},$$

where, counting only families with attribute $c$, $r_{ic}$ is the number of renter households in the tract, $h_{ic}$ is the number of owner households in the tract, $R_c$ is the total number of renter households in the MSA, and $H_c$ is the total number of owner households in the MSA.

Table 2 shows that the dissimilarity index is moderate to high for every income class and race.

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[7] This, to our knowledge, constitutes the first empirical finding on this issue. The data also support our basic prediction that low-income households are disproportionately renters, and high-income households are disproportionately home-owners. For households with children, the fraction of households who are home-owners rises from 31.0 percent to 64.9 percent as annual income rises from the $15-25K bracket to the $35-50K bracket.

[8] See, for example, Tiebout (1956), Schelling (1971), Epple and Romer (1991), Bénabou (1993, 1996), Durlauf (1996), Fernandez and Rogerson (1996), and Cutler, Glaeser, and Vigdor (1999).

At incomes below $25,000 and above $50,000, more than 65% of black households with children would have to move for each tract to have the same owner/renter composition as that of the MSA. The corresponding number for non-black families with children is over 50%.[9] Whatever is driving this pattern of tenure segregation, the pattern cannot be explained by race or income or the presence of children, because it occurs *within* groups in the same race, household type, and income class. Our analysis provides one possible explanation for this pattern.

We proceed as follows. After setting up the model in Section 2, we solve in the next three sections (Sections 3, 4, and 5) for the tenure choice of individual households, the single-community equilibria, and the equilibria in a multi-community city. Section 6 contains our concluding remarks. Proofs of the results on segregation (Propositions 4 and 5) are presented in an Appendix.

## 2. The Model

### *A. People and Timing of Events*

We consider a metropolitan area consisting of $N$ communities, each having single-family homes of measure $1/N$. The housing units are "owned" by a large number of real estate companies. Successive generations of households flow in and out of the metropolitan area over time. Time is divided into discrete periods. A generation of households move into the metropolitan area at the beginning of every period, and move out at the end of the period. We think of a generation of households as composed of families who enter the area when the family is formed, remain during the working lives of the adults, and move away when the adults retire. For simplicity, we assume that

[9] The extent of segregation between owners and renters across census tracts is comparable to the level of racial segregation. Cutler, Glaeser, and Vigdor (1999) find that the dissimilarity index for blacks and whites in all US cities in 1990 is .56, and when weighted by black population, it is .66. We find that the pattern of tenure segregation is similar across the 10 largest MSAs, but Table 2 reports only the weighted average (with weights based on MSA population).

the number of households in every generation is the same as the number of all housing units across the $N$ communities, a continuum of measure one.

In this ongoing life of the metropolitan area, our study focuses on the behavior of a *particular* generation of households. The households differ in only one respect—their current (endowed) income $y$, which is distributed across households according to $F(.)$ on an interval $\boldsymbol{Y} \equiv [Y, Y^{+}]$. A household's future income (the same for all households) is denoted by $w$.[10]

In the period under study, our analysis starts after the households have entered the metropolitan area and have received their incomes $y$. Each household then selects a housing unit in a particular community and negotiates a *housing tenure contract* with the real estate company that owns the unit. This contract is a pair $\{\alpha, \beta\}$: for an up-front payment of $\beta$, the household acquires the right of residence for the period, and the right to $\alpha$ fraction of the "market value" of the home at the end of the period. After taking up residence, a household decides on its level of effort to improve its home and its neighborhood, which we term *home improvement effort*. This effort cannot be observed by an outsider and so cannot be specified in a tenure contract. At the end of the period, the household moves away, taking $\alpha$ fraction of the assessed market value of the home.[11]

A defining feature of home-ownership is the ability of an owner to capitalize the value of her home (by executing the right to sell). Here different values of $\alpha$ represent different degrees to which a household holds such capitalization rights. We will refer to $\alpha$ as the amount of *home equity* owned by a household, and will associate "home-ownership" with the holding of a tenure contract with a

[10] We assume that $w$ is the same for all households only for expositional simplicity. We could allow for $w$ to be related to $y$, all that our results require is that an increase in $y$ entails an increase in lifetime income $y + \delta w(y)$.

[11] In modeling only "linear contracts," we make a compromise between the theoretically most complicated incentive contracts and the simple [0,1] contracts typically observed. Allowing for the optimal nonlinear contract would leave our qualitative results unchanged as long as the moral hazard problem, described below, was not fully resolved. The more radical simplification of fixing contracts at 0 or 100 percent home-ownership would not permit an analysis of the limited home equity programs that are the subject of active experimentation in programs to expand low-income

sufficiently high value of $\alpha$ (see Section 3).[12] A tenure contract with $\alpha = 0$ is a standard rental contract, and we will use $\rho$ to denote the rental rate (the up-front payment in a rental contract).

*B. Housing Quality and Prices*

In order to focus on the forces that lead to heterogeneity in housing quality (state of repair, security, and amenities), we assume that at the beginning of the period of our study, all housing units across the $N$ communities have the same quality $Q_0$. The household chooses its level of home improvement effort, which adds to this stock of quality. There are many dimensions to such effort (as noted in the Introduction), but for brevity we assume that there are two possible actions, $a \in \{e, n\}$, where $e$ is high effort and $n$ is negligible effort. The increment to a housing unit's quality is $q = q(a, x)$, where $x$ denotes the fraction of community residents that expend high effort. We will refer to $x$ as the level of *community effort*; this is what distinguishes one community from another.

ASSUMPTION 1 (*Community Interaction*): For all $a$ and $x$, (*i*) $q_x(a, x) > 0$, and (*ii*) $q_x(e, x) > q_x(n, x)$.

Part (i) of Assumption 1 states that a home's quality is increasing in the level of community effort – the *spillover effect*; and part (ii) states that a household's payoff to high effort relative to low effort is increasing in the level of community effort – the *complementarity effect.*

During its residence in its home, a household enjoys the quality level $Q_0 + q(a, x)$. At the end of the period, the home is of quality $Q_1 = Q_1(Q_0 + q(a, x))$, where $Q_1' > 0$. Our assumption is

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home-ownership (see, e.g., Davis 1993). See also footnotes 34 and 43.

[12] We thus employ a specific notion of home-ownership, similar to the limited equity housing contracts analyzed in Simon (1991, Section IIIB). A household with a contract $\alpha = 1$ fully capitalizes the future value of the home, but at the end of the period the physical possession of the home reverts to the real estate company, which makes the decisions regarding the housing tenure contracts for subsequent residents. Our assumption that there are infinitely-lived real estate companies simplifies our analysis (in that we do not have to keep track of what a household does with a housing unit at the end of its life) without being crucial to it; an analogous assumption of homes being owned by "absentee landlords" is

that at least a part of the current improvement in housing quality *persists* in the future.

The evolution of housing prices depends on the evolution of housing quality. To keep things simple, we take two objects as primitives. First, we take as primitive the end-of-period expected "market value" $\hat{P}(Q_1)$ of a home of quality $Q_1$ (with $\hat{P}' > 0$).[13] In what follows, we use the notation $P(a,x)$ for $\hat{P}(Q_1)$. We assume that individual and community effort levels affect the future market value of a home in the same way as they affect its current quality: $P(e,x) > P(n,x)$, and $P_x(e,x) > P_x(n,x) > 0$.[14] Second, we take as primitive the current-period rental rate $\rho$ for a housing unit in any *one* community in the metropolitan area. In this, our approach is similar to that in de Bartolome (1990) and Bénabou (1996), where the "equilibrium" rental rates in all other communities are expressed in terms of an exogenously specified rental rate in a particular community. Since all homes have the same initial quality, and since all homes within a community are similarly affected by local interactions, we take the rental rate to be the same for all homes in a given community.[15]

*C. Preferences*

Households value smoothing consumption over time. To capture this in a simple way, we assume a minimum subsistence level for the consumption good, below which a household's utility is unboundedly low. For simplicity, the subsistence level is normalized at zero. A household selects

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made in Bénabou (1996).

[13] The market value of a home will of course depend on expectations regarding future community quality, and other macroeconomic variables. We subsume this dependence in our definition of $\hat{P}(.)$. What matters for our analysis is how the actions of the current household affect $\hat{P}(.)$.

[14] Given Assumption 1, these inequalities hold as long as the $\hat{P}(.)$ and $Q_1(.)$ functions are not too concave.

[15] This will indeed be true "in equilibrium." We assume that when a household selects its home, its "default" contract is a rental contract where the rent is the one prevailing in the community; it can then renegotiate and buy equity in its home (see Section 3). In our definition of a multi-community equilibrium (in Section 5), we require that a household must not want to relocate to another housing unit either in the same community or in another community. While this condition determines the relative rental rates across communities (and this is highlighted in

its equity share ($\alpha$), effort level ($a$), and borrowing ($b$) to maximize its lifetime utility:

$$u = \begin{cases} [y - \beta + b] + [Q_0 + q(a,x) - a] + \delta[w - R(b)b + \alpha P(a,x)] & \text{if } y - \beta + b \geq 0, \\ -\infty & \text{otherwise} \end{cases} \quad (1)$$

where $\delta$ is the discount factor, $R(b)$ is the "gross rate of interest," and (for notational simplicity) the utility cost of effort $a$ is $a$. First-period utility is increasing in numeraire consumption [$y$ - $\beta$ + $b$] and housing quality net of effort costs [$Q_0 + q(a,x) - a$], and second-period utility is increasing in future expected income [$w$ - $R(b)b$ + $\delta P(a,x)$].[16]

ASSUMPTION 2 (*Credit Market Imperfection*): When a household borrows, the gross interest rate is a constant ($1+r_B$) which exceeds the marginal rate of time preference ($1/\delta$), which in turn exceeds the gross interest rate when a household saves.

The magnitude of the "borrowing wedge" is thus $C \equiv \delta(1+r_B) - 1 > 0$. This wedge discourages borrowing when $\beta \leq y$; but when $\beta > y$, a household has to borrow ($\beta$ - $y$) for subsistence.

We formalize the idea that home-ownership changes behavior by assuming that a household has an incentive to expend high home improvement effort if and only if its home equity stake is sufficiently high. Denoting the current surplus from expending high effort (relative to low effort) by $s_0(x) \equiv [q(e,x) - e] - [q(n,x) - n]$, and the expected future surplus by $s_1(x) \equiv P(e,x) - P(n,x)$, we make:

ASSUMPTION 3 (*Incentive Problem*): For all $x \in [0, 1]$, $s_0(x) < 0$ and $S(x) \equiv s_0(x) + \delta s_1(x) > 0$.

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Section 5), it also implies that the rental rates for all housing units within a community must be the same.

[16] In specifying (1), we assume that if a household finds it optimal to borrow, it is able to repay its debt out of its future income. Introducing default possibilities in our model will in no way affect our subsequent result that a

Assumption 3 and the inability to contract on a household's effort choice lead to a moral hazard problem. In the next section, we study its implications for household tenure decisions.

## 3. Individual Tenure Choice

In choosing its housing tenure contract, an individual household (which is atomistic in its community) takes as given the community effort level $x$. If it chooses an equity share $\alpha$, its payoff from expending high effort is $s_0(x) + \alpha\delta s_1(x)$, which, from Assumption 3, is increasing in $\alpha$ and strictly positive above a critical value, $\alpha^*(x) \in (0, 1)$, where

$$\alpha^*(x) = \frac{-s_0(x)}{\delta s_1(x)}. \qquad (2)$$

The complementarity effect implies that $\alpha^*(.)$ is falling in $x$.[17] Our model thus emphasizes, in a stark way, two forces that influence individual effort towards home improvement: for a given community effort level, individual effort is increasing in its share of home equity; and for a given amount of home equity, individual effort is increasing in the level of community effort.

We assume that at the beginning of the period, when a household selects a home, its "default" contract is a rental contract $\{0, \rho\}$, where $\rho$ is the prevalent rental rate in the community. The household can then renegotiate and offer a positive-equity contract $\{\alpha>0, \beta>\rho\}$ to the real estate company that owns the unit. The price $\beta$ of purchasing equity share $\alpha$ is determined by a take-it-or-leave-it offer by the household, with the *status quo* point of no renegotiation.[18] Note that in the

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household will become a home-owner if and only if its income is above a threshold level (see Proposition 1).

[17] From (2), $d\alpha^*/dx = -\alpha^*(x)\{[s_0'(x)/-s_0(x)] + [s_1'(x)/s_1(x)]\}$, which is strictly negative since the surplus functions $s_0(.)$ and $s_1(.)$ are strictly increasing in $x$ by Assumption 1(*ii*).

[18] This contract renegotiation process gives the household the entire surplus that is generated from renegotiation. Any other process will yield qualitatively similar results as long as the household obtains some of the surplus.

*status quo* $\{0, \rho\}$, a household will expend negligible effort and will have a lifetime utility of

$$u^n(y, x, \rho) = [y - \rho] + [Q_0 + q(n, x) - n] + \delta w, \quad (3)$$

[19]

and the present value of the home will be $[\rho + \delta P(n, x)]$. So, if a household chooses to renegotiate and purchase some equity, it will offer the real estate company a price so as to make it indifferent between selling and not selling. This price of equity, $\beta(\alpha, x, \rho)$, is implicitly defined by:

$$\beta(\alpha, x, \rho) + \delta[1-\alpha]P(a(\alpha, x), x) = \rho + \delta P(n, x). \quad (4)$$

The LHS of (4) is the present value payoff to the real estate company under the contract $\{\alpha, \beta(.)\}$. In calculating it, the company recognizes that the household will expend that level of effort, $a(\alpha, x)$, that is "sequentially optimal" for it: $a(\alpha, x) = e$ for $\alpha \geq \alpha^*(x)$ and $a(\alpha, x) = n$ otherwise.[20]

Figure 1 depicts the set of contracts $\{\alpha, \beta(.)\}$ available to a household in a community with community effort $x$ and rental rate $\rho$. At $\alpha^*(x)$, the price of equity drops discretely by the amount of the total surplus from high effort $S(x) \equiv s_0(x) + \delta s_1(x)$, and the marginal price of equity increases. Let $\beta^*(x, \rho) \equiv \beta(\alpha = \alpha^*(x), x, \rho)$ denote the price of the critical equity share $\alpha^*(x)$:

$$\beta^*(x, \rho) = \rho + \alpha^*(x)\delta P(n, x) - S(x). \quad (5)$$

[21]

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[19] We assume throughout that the community rental rates are "small" in relation to individual incomes, so that no household has to borrow simply to pay the rent.

[20] We assume that the real estate companies are risk neutral, and that they cannot lend to households at a rate more favorable than the market rate $r_B$.

[21] If it is known that a household will expend negligible effort, the real estate company should charge $[\rho + \alpha^*(x)\delta P(n, x)]$ for $\alpha^*(x)$. However, once a household buys $\alpha^*(x)$, both parties recognize that it will put in high effort, and this leads to the discount $S(x)$. Note that $S(x) \equiv s_0(x) + \alpha^*\delta s_1(x) + [1-\alpha^*]\delta s_1(x)$. $s_0(x)$ is the current cost of high effort, and $\alpha^*\delta s_1(x)$ is the minimal "incentive payment" required to elicit this effort, with $s_0(x) + \alpha^*\delta s_1(x) = 0$. The remaining surplus $[1-\alpha^*]\delta s_1(x)$ goes to the household as it has all the bargaining power in renegotiation.

We will refer to $\beta^*$ as the *price of home-ownership* since, if a household invests this amount in home equity, it can capitalize "enough" of the end-of-period value of the home to have an incentive to expend high effort in home improvement. From here on, we will call a household that invests at least $\beta^*$ in home equity a "home-owner," and one that does not a "renter."

Lifetime utility under a home-ownership contract $\{\alpha^*(x), \beta^*(x, \rho)\}$ is

$$u^e(y, x, \rho) = u^n(y, x, \rho) + S(x) - \max\{C[\beta^*(x, \rho) - y], 0\}. \quad (6)$$

Thus, every household with income below the price of home-ownership $\beta^*$ faces a trade-off: a share of home equity sufficient to provide incentives for high effort enables it to obtain the surplus $S(x)$, but imposes a cost $C[\beta^* - y]$.[22] Equating the two defines a *threshold income level* $y^*$, where

$$y^*(x, \rho) = \beta^*(x, \rho) - \frac{S(x)}{C}. \quad (7)$$

PROPOSITION 1: If $y < y^*(x, \rho)$, a household rents and expends negligible effort, while if $y > y^*(x, \rho)$, it becomes a home-owner and expends high effort.

Proposition 1 summarizes our story so far: Given income heterogeneity among households, the presence of a moral hazard problem and credit market imperfections cause richer households to choose ownership contracts, and the poorer to choose rental contracts. Since the former have better incentive properties, home-owners also generate better outcomes than the renters in terms of home (and community) improvement.[23] Given this mapping, we go on to study the impact of the

[22] There are a variety of factors that raise the price of home equity for the poor relative to that for the rich, which are omitted from the model for brevity. One obvious factor is the possibility of default which is likely to be greater for the poor and thus generate higher transactions costs, which are then reflected in higher interest rates charged.

[23] We have established the relation between a household's income endowment and its tenure and effort choices

community interaction effects on the nature of tenure distribution and community quality.

## 4. A Single Community and Coordination Problems

We begin by considering the case where the metropolitan area consists of a single community (i.e., $N = 1$) with a continuum of homes of measure one.[24] Our purpose in considering this simple case is to highlight the intuitive idea that when the fraction of home-owners in the community matters in each household's decision to be a home-owner, a community can be characterized by a *coordination failure*: by an all-around change in individual decisions, mutual gains could be obtained, but the market does not suffice to coordinate these changes.

### *A. Community Equilibria*

A single community equilibrium is completely described by the fraction of households who choose to be home-owners or, equivalently (given Proposition 1), by the level of community effort. Given a rental rate $\rho$, a level of community effort $x$ maps to a unique threshold income level $y^*(x, \rho)$ and thus to a fraction of households who would want to be home-owners.[25] So, given $\rho$, $x^*$ is an equilibrium if and only if $\lim_{y \to y^*(x^*, \rho)} F(y) \leq 1 - x^* \leq F(y^*(x^*, \rho))$.

How does the threshold income level $y^*$ change as $x$ changes? From (5) and (7),

$$y_x^*(x, \rho) = \delta P(n, x) \frac{d\alpha^*}{dx} - \frac{[1 + C]}{C} S'(x) + \alpha^*(x) \delta P_x(n, x) \tag{8}$$

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under a host of simplifying assumptions regarding the nature of the available contracts, utility function, and the form of credit market imperfections. We emphasize that such a relation can be established under much more general conditions where heterogeneous households face contracting problems under moral hazard.

[24] Alternatively, the reader can think of this analysis as applying to a particular community in an $N$-community city, where the community residents are pre-determined and not allowed to relocate to any other community.

[25] In this single community case, we take $\rho$ to be exogenously given. See the discussion in Section 2B.

The first two terms in the RHS of (8) are negative by the complementarity effect, and the last term is positive by the spillover effect. With an increase in community effort, complementarity among residents' efforts causes a fall in the critical equity share $\alpha^*$ and an increase in the total expected surplus $S(x)$. Both effects increase the investment attractiveness of purchasing a home and thereby lower $y^*$. A countervailing effect is the spillover effect $P_x(n, x)$. When community effort increases, the expected future price at which a real estate company can sell a housing unit goes up, which makes the purchase of a home more costly, thus raising $y^*$.

We now argue that if $y_x^*(x, \rho) \geq 0$ for all $x$, then the community equilibrium is unique. Suppose that there are two equilibria $x_A^*$ and $x_B^*$, with $x_A^* > x_B^*$. If $y_x^* \geq 0$ for all $x$, then $y^*(x_A^*, \rho) \geq y^*(x_B^*, \rho)$. This implies that any household which rents at $x_B^*$ must rent at $x_A^*$ (as the threshold is lower in the former case), i.e., $x_A^* \leq x_B^*$, and we have a contradiction, which proves the result. This argument also indicates that there can be multiple equilibria if $y_x^* < 0$ for *some* $x$. When both the curves $y = y^*(x, \rho)$ and $x = 1 - F(y)$ are downward sloping, they can have multiple intersections. This is shown in Figure 2, which considers a continuous $F$ function. There are three equilibria in Figure 2: $x_B$ and $x_C$ are stable equilibria, while $x_A$ is a "tipping point"—an unstable equilibrium where a slight perturbation can change the character of the whole community.[26]

PROPOSITION 2: If the threshold income level $y^*(x, \rho)$ is non-decreasing in $x$ for all $x$, then there is a unique "single community equilibrium" $x^*$. If not, there can be multiple equilibria.[27]

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[26] An unstable equilibrium is one where the $y^*(.)$ curve cuts the $x = 1\text{-}F(y)$ curve from above. To see this, consider a perturbation in expectations below $x_A$, such as $x_1$ in Figure 2. At the threshold income level evaluated at $x_1$ (point 1 in the figure), the fraction of the population who want to be home-owners is less than $x_1$ (point 2). But given expectations that the fraction of home-owners corresponds to that at point 2, the threshold income $y^*$ is at point 3, and the fraction of the population with income above that value of $y^*$ corresponds to point 4. This process of adjusting expectations will not come to rest till the community is at the low-level equilibrium $x_B$.

[27] Equilibrium existence can be proved by standard fixed-point arguments. Note that when $y_x^*(x, \rho) < 0$, there can be

From (8), note that for a given magnitude of the spillover effect $P_x(n, x)$, there exists an $\varepsilon > 0$ such that if the complementarity effect $s_t'(x) > \varepsilon$ for all $t$ and $x$, then $y^*(x,\rho)$ will be strictly decreasing in $x$ for all $x$.[28] We refer to this as:

*The Decreasing Threshold Condition* (*DT*): For all $x \in [0, 1]$, $y_x^*(x^*, \rho) < 0$.

*DT* is equivalent to the statement that for a fixed $\rho$, a home-owner values an increase in community effort more than a renter does, i.e., $\partial u^e/\partial x > \partial u^n/\partial x$. If *DT* holds, the maximized intertemporal payoff to each household — $u^*(y, x, \rho) \equiv \max\{u^n(y, x, \rho), u^e(y, x, \rho)\}$ — is strictly increasing in $x$. Thus,

**Proposition 3**: If *DT* holds and there are multiple equilibria, then an equilibrium with a higher fraction of home-owners Pareto dominates one with a lower fraction.

Under *DT*, the households face a coordination problem. If a large fraction of residents become home-owners, the community effort is high and so the appreciation of future home prices is high, and this encourages a larger fraction of residents to buy home equity in equilibrium. But if the set of home-owners is small, this discourages residents from buying home equity, and so this can also be an equilibrium, where all residents are worse off as compared to the former outcome.

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multiple equilibria in a single community, *all with the same rental rate*. When there are many communities, there can be multiple equilibria where the relative rental rates across communities differ; see Section 5.

[28] The complementarity effect may be stronger in practice than our model suggests. First, the borrowing rate is fixed in our model. But it is standard practice for appraisers, in assessing the collateral of a home loan, to take into account the proportion of owner-occupied homes in the neighborhood (Reynolds (1983, p.133)). Banks perceive that a smaller proportion of owner-occupied homes in a neighborhood increases the risk of default on mortgages, and this causes them to charge higher interest rates. A lower value of $x$ then lowers the return to home-ownership for an additional reason – the borrowing rate rises. Second, in our model, community effort affects only the return from an individual household's effort in home improvement, and not the cost of making that effort, e.g., of providing security, removing litter, and contacting local officials. If, defining $c(a,x)$ to be the disutility of effort $a$ given $x$, we assume that $c_x(e,x) < c_x(n,x)$, this will increase the magnitude of the complementarity effect $s_0'(x)$.

*B. An Example*

We now use an example to address two questions: When *DT* holds, how does a change in income inequality change the set of equilibria? And what is the role for home-ownership subsidies? Letting $Y \equiv y^*(0.5, \rho)$, we consider the following income distribution: 50% of households have income $Y$ (the middle class), 20% of households have high income $Y + z$ (the rich), and the remaining 30% have low income $Y - (2/3)z$ (the poor). An increase in $z$ increases income inequality while leaving aggregate income unchanged at $Y$. We suppose that $y^*(x, \rho)$ is decreasing in $x$, and that there exist two numbers $z^0$ and $z^1$, with $z^0 < z^1$, such that (*i*) $Y + z^0 = y^*(0.2, \rho)$ and $Y - (2/3)z^0 = y^*(0.7^*, \rho)$, and (*ii*) $Y + z^1 = y^*(0, \rho)$ and $Y - (2/3)z^1 = y^*(1, \rho)$.[29]

In this example, when inequality is low ( $z < z^0$), all households becoming home-owners is an equilibrium ($x^* = 1$), as is all households staying renters ($x^* = 0$). As inequality increases, the *range* of the equilibrium values of $x^*$ shrinks, as shown in Figure 3. For high inequality ($z > z^1$), the worst equilibrium for every household is one where only the rich become home-owners ($x^* = 0.2$), and the best is one where only the poor do not ($x^* = 0.7$). For intermediate levels of inequality ($z \in (z^0, z^1)$), all the outcomes described above are equilibria.[30] The intuition is the following: In our example, a small increase in the expected market value of a home can make investing in a home attractive to households at or near the mean income. Thus when household incomes deviate little from the mean, both $x = 1$ and $x = 0$ are equilibrium outcomes. But at a high level of inequality, the richest

[29] It is only for simplicity that we assume that the *same* $z^0$ equates the high income to $y^*(0.2, \rho)$ and the low income to $y^*(0.7, \rho)$, and similarly for $z^1$. It can be easily checked that the basic properties of the equilibria remain unchanged even if we do not make these simplifying assumptions.

[30] The equilibria described above are all stable. In addition to these, there are unstable equilibria in which households in the same income class make different tenure choices. For all $z$, $x^* = 0.5$ is an equilibrium, where all rich and 60% of the middle class own homes. For any $z \in (z^0, z^1)$, there is an equilibrium where a fraction of the rich are home-owners – $x^* \in (0, 0.2)$, and an equilibrium where a fraction of the poor are renters – $x^* \in (0.7, 1)$.

households choose to own and the poorest choose to rent, regardless of their neighbors' decisions.[31]

In this setting, a low-income home-ownership subsidy is one way to move a community from a "bad" to a "good" equilibrium. Consider the case of high income inequality ($z > z^1$), and a housing subsidy scheme where all households in a given income class receive the same amount of subsidy for buying home equity. Starting from the bad equilibrium ($x^* = 0.2$), such a scheme has to give each middle class household a subsidy of $[y^*(0.2^*, \rho) - y^*(0.5, \rho)]$ to induce it to become a home-owner. The total subsidy bill is $0.5[y^*(0.2, \rho) - y^*(0.5, \rho)]$, and if this is less than $0.2[(Y+z) - y^*(0, \rho)]$, the outcome can be achieved by taxing the rich while keeping their tenure choice unaffected. Note that this subsidy bill is likely to be large, and that any incremental subsidy will fail to move the community from the bad to the good equilibrium. This is consistent with the recognition by policy-makers like HUD Secretary Cuomo of the existence of a "threshold effect."[32]

In many situations, a housing subsidy scheme is just one of several instruments that can be used. Any other intervention that changes expectations of sufficiently many households can also solve the coordination problem.[33] There can, however, be situations where a home-ownership subsidy is the *only* policy that will make residents better off. This occurs when outcomes with different income distributions are Pareto-rankable. In our example, if households care "enough" about neighborhood quality (i.e., if $\partial u^*/\partial x >> \partial u^*/\partial y$), it can be that for some $z'' > z^1 > z'$, we have

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[31] Glaeser, Sacerdote, and Scheinkman (1996) coin the term "fixed agents" for those who can influence their neighbors but who cannot themselves be influenced. In our example, high inequality creates "fixed agents".

[32] In our model, a threshold effect arises because actions are discrete. This effect would also arise in a model where the action space was continuous, but housing tenure contracts provided for a discrete choice of equity share e.g., 0 or 1, as in most real-world contracts. If we indeed consider only 0-1 tenure contracts in our example, it is easy to see that its effect will simply be to push up $y^*$ for every $x$ and $\rho$. This will tend to reduce the fraction of home-owners in the "best" equilibrium, while leaving the possibility of multiple equilibria unaffected.

[33] Consider two recent examples. First, two non-profit organizations started a program in a Baltimore neighborhood that guarantees the value of a house no matter how much market prices may drop (*New York Times*, June 13, 1999, pp. l, 34). Second, in an effort to erase associations with its past, authorities planned to rename the place names (as well as to undertake renovations) in a Newcastle, UK neighborhood that had suffered from high

$u^*(Y+z', x^*=1, \rho) > u^*(Y+z'', x^*=0.7, \rho)$; that is, the best equilibrium under medium inequality Pareto-dominates all equilibria under high inequality (see Figure 3). Then even the rich will prefer income redistribution as long as this increases the number of home-owners and thus community quality. A housing subsidy scheme can achieve the necessary income redistribution *and* ensure that the more equal community chooses the best equilibrium by tying the subsidy to home-buying.

Finally, consider the design of an optimal housing subsidy where, starting from high inequality ($z > z^1$), the aim is to achieve $x = 1$. One policy might be a home-ownership subsidy to the poor so that each has income just above $y^*(0.2, \rho)$; then they will become home-owners, and given that, the middle class will follow suit. The total subsidy will be $0.3[y^*(0.2, \rho) - (Y-2z/3)]$. If this exceeds the maximum amount that can be collected in taxes from the high-income households, such a scheme cannot be implemented. However, the following alternative scheme may be cheaper and thus implementable: provide a subsidy to the middle class households so that each has income just above $y^*(0.2, \rho)$, and subsidize the poor so that each has income just above $y^*(0.7, \rho)$. This scheme, with a total subsidy bill of $0.5[y^*(0.2, \rho) - y^*(0.5, \rho)] + 0.3[y^*(0.7, \rho) - (Y-2z/3)]$, will "pull up" the middle class into home-ownership, and given that, induce the poor to own their homes.

Recognize that all the above policies have a "multiplier effect": they directly affect the behavior of a group of residents, which produces externalities, which causes the behavior of another group to change. The existence of this multiplier effect has important implications for subsidy design: it may be better to give a moderate subsidy to both middle- and low-income households than a large one to the latter, *even if* the social objective function counts only the welfare of the latter.

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crime and abandonment (*The Economist*, June 26, 1999, p. 64).

## 5. Multiple Communities and Segregation

In this section, we return to our general model where a city is made up of $N > 1$ communities. Here, we endogenize the community formation process. We show that when complementarities between individual and community effort are strong, communities will be *segregated by tenure*: every community except at most one will have only home-owners or only renters. This, in turn, may lead to *segregation by income.*

### *A. Equilibrium Segregation*

For any community $i$ ($i = 1,..., N$), let $x_i$ be the fraction of home-owners, $\rho_i$ be the rental rate, and $\boldsymbol{Y}_i$ be the set of incomes $y$ such that household $y$ resides in community $i$. Given the rental rate for one of the communities, say $\rho$ for community 1, an $N$-community equilibrium is a vector $\{\rho_i^*, x_i^*, \boldsymbol{Y}_i^*\}_{i=1}^N$, with $\rho_1^* = \rho$, that satisfies the following three conditions. (1) All households are equally divided across the communities: $\{\boldsymbol{Y}_1^*, ..., \boldsymbol{Y}_N^*\}$ are partitions of $\boldsymbol{Y}$ such that the measure of households with income $y \in \boldsymbol{Y}_i$ is $1/N$. (2) There is within-community equilibrium: given $\rho_i^*, x_i^*$ is an equilibrium in community $i$. (3) The rental rates $\{\rho_1^*, ..., \rho_N^*\}$ are such that no household prefers to relocate: for all $y \in \boldsymbol{Y}_i^*$, $u^*(y, x_i^*, \rho_i^*) \geq u^*(y, x_j^*, \rho_j^*)$ for $j \neq i$, where $u^*(.) = \max\{u^n(.), u^e(.)\}$.

Note that when the initial quality of all homes is the same, there exist *symmetric equilibria* where the community effort level is the same across the $N$ communities. Such equilibria are "replications" of a single-community equilibrium (i.e., where $N = 1$, and the single community has a continuum of homes of measure one).[34] However, such equilibria are not "robust" in the following sense: If $Q_{0,i} \neq Q_{0,j}$ for any two communities $i$ and $j$, then generically (i.e., for arbitrary income distributions), there does not exist a symmetric equilibrium where there are some home-owners and

[34] Formally, when $Q_{0,i} = Q_0$ for all $i$, there exists an equilibrium with $x_i^* = x^*$ and $\rho_i^* = \rho$ for all $i$ in an $N$-community city if and only if $x^*$ is a single-community equilibrium given $Q_0$ and $\rho$.

some renters across the $N$ communities.[35] Given this, in what follows we focus exclusively on *asymmetric equilibria* where there are at least two communities $i$ and $j$ such that $x_i^* \neq x_j^*$.

When will an asymmetric equilibrium be characterized by tenure segregation? To answer this question, we need to look at the slope of an indifference curve in the $(x, \rho)$ space for the three types of households: renters, home-owners that borrow (mortgagees), and home-owners that do not. Differentiating $u^*(.)$, we have:

*Renters:*
$$\left.\frac{d\rho}{dx}\right|_{\substack{y<y^* \\ u^*cons\tan t}} = q_x(n,x) \tag{9a}$$

*Mortgagees:*
$$\left.\frac{d\rho}{dx}\right|_{\substack{y^*<y<\beta \\ u^*cons\tan t}} = \frac{q_x(n,x) - Cy_x^*(x,\rho)}{1+C} \tag{9b}$$

*Non-borrowing home-owners:*
$$\left.\frac{d\rho}{dx}\right|_{\substack{\beta^*<y \\ u^*cons\tan t}} = q_x(n,x) + S'(x) \tag{9c}$$

Note that all home-owners, because they expend high effort and obtain the surplus $S(x)$, "take out" more from the community than renters. However, households who borrow have a higher marginal cost of funds than renters. So, while (9c) > (9a), to have (9b) > (9a) we require:

*The Single Crossing in Tenure Condition* (*SCT*): $-y_x^*(x, \rho) > q_x(n, x)$ for all $x \in [0, 1]$.

When *SCT* is satisfied, the indifference curves of renters and home-owners satisfy "single crossing" in the $(x, \rho)$ space: at any $(x, \rho)$ pair, home-owners are willing to pay more than renters for an incremental increase in community effort. *SCT* is stronger than *DT*; the latter only requires that for a

[35] The proofs of the two results stated in this paragraph are available from the authors on request. While the intuition behind the first result is easy to grasp, the intuition behind the "non-robustness" result is as follows. When $Q_{0,i} = Q_{0,j}$ for all $i$, $j$, every "interior" symmetric equilibrium has the feature that all home-owners are indifferent as to which community they live in. This allows one to take the set of all households who want to be home-owners and divide them equally across the communities. However, when $Q_{0,i} \neq Q_{0,j}$, the indifference property is lost, and generically, it is not possible to find equal-sized sets of home-owners for each of the communities.

fixed $\rho$, home-owners' marginal utility of $x$ exceeds that of renters.

PROPOSITION 4: If *SCT* holds, then every asymmetric equilibrium in an $N$-community city exhibits *tenure segregation*: home-owners and renters co-reside in at most one community.[36]

Tenure-segregated equilibria may be very inefficient in the sense that average community quality may be much lower in tenure-segregated cities than in integrated ones. The quality of a community with a fraction $x$ of home-owners is naturally defined as $Q(x) = xv(e, x) + (1-x)v(n, x)$, where $v(a, x) \equiv q(a, x) + \delta P(a, x)$. Note that $Q''(x) = 2\{v_x(e, x) - v_x(n, x)\} + \{xv_{xx}(e, x) - (1-x)v_{xx}(n, x)\}$. The first bracketed term is positive by the complementarity effect (this is what leads to tenure segregation), but the sign of the second bracketed term depends on the *curvature* of the $q(.)$ and the $P(.)$ functions. If these are sufficiently concave in $x$ so that $Q(.)$ is strictly concave in $x$, an efficient $N$-community outcome must have $x_1 = x_2 = ... = x_N$. Thus, a symmetric outcome (which is never a robust equilibrium) can be efficient in terms of aggregate surplus, yet home-owners' efforts to relocate to communities where their *private* return to effort is the greatest can lead to tenure segregation.[37]

Next, we address the issue of segregation across income classes. We ask: at any $(x, \rho)$ pair, when is it the case that when household $y'$ is richer than household $y''$, the former will be willing to pay more in rent for an increase in community effort? For this, we need the following chain of inequalities to hold: (9c) > (9b) > (9a). This is equivalent to the following condition:

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[36] If *SCT* does not hold, there can exist asymmetric equilibria which are not tenure segregated; an example is available from the authors. While we do not have a general result regarding the existence of asymmetric equilibria when *SCT* holds, we can construct examples where such equilibria exist; see our example below. A sufficient condition for existence in the 2-community case is this: a household with median income has to borrow a critical amount if it wants to own a home in a community of owners (the proof is available from the authors).

[37] This argument is similar to the one presented in Bénabou (1993, 1996).

*The Single Crossing in Income Condition* (*SCI*): $\frac{1+C}{C} S'(x) + q_x(n, x) > -y_x^*(x, \rho) > q_x(n, x) \; \forall \; x.$

*SCI* contains two inequalities, and they bound the complementarity effect. The second inequality is simply *SCT,* which requires that the complementarity effect be large enough that mortgagees are willing to bid more than renters for a housing unit in a community with a higher proportion of home-owners. On the other hand, the first inequality requires that the complementarity effect not be too large. Mortgagees benefit in two ways from an increase in community effort: it increases the return to high effort ($S$) *and* it reduces the cost of home-ownership ($C[\beta^*-y]$). If the latter effect is too large, mortgagees will be willing to pay more for an increase in community effort than the home-owners who do not borrow. *SCI* rules out that possibility.[38]

PROPOSITION 5: Suppose *SCI* holds, and suppose $\{x_1^*, ..., x_N^*\}$ is the tenure distribution in an asymmetric equilibrium (which is necessarily tenure-segregated). If two communities $i$ and $j$ have $x_i^* = 1$ and $x_j^* = 0$, then all residents in community $i$ are (weakly) richer than those in community $j$. Looking across all $N$ communities, there exists at least one equilibrium with the same tenure distribution that is segregated by income in the following sense: for any two communities $k$ and $l$, if $x_k^* > x_l^*$, then all residents in community $k$ are (weakly) richer than those in community $l$.[39, 40]

Proposition 5 provides conditions under which households segregate themselves by income

[38] Here is one contribution of our paper that we want to emphasize: when the interaction effects exist with respect to endogenous actions, the conditions for segregation of agents who choose different actions can be distinct from the conditions for segregation of agents who differ in their exogenously specified "types".

[39] Note that since we have specified a linear utility function, the slope of the indifference curve in the $(x, \rho)$ space is the same for all households in each of the three categories: renters, mortgagees, and non-borrowing owners. That is why it is possible, even under *SCI*, to have an equilibrium with $1 > x_i^* > x_j^* = 0$, where the renters in community $j$ are richer than the renters in community $i$ (and similarly for the other two household categories). However, if that *is* the case, then the two households are indifferent between renting in either community, and so they can be "switched." Thus, there will be at least one equilibrium that exhibits income segregation.

[40] If *SCI* does not hold (but *SCT* holds) there can be $N$-community equilibria which are segregated by tenure but not by income. An example showing this is available from the authors.

*exclusively due to the relationship between income and housing tenure choice.* Of course, the forces towards income segregation will be stronger when there are publicly provided goods like community school systems that are locally financed (see, for example, Epple and Romano (1991), Fernandez and Rogerson (1996), Bénabou (1996), and Durlauf (1996)).

Our analysis has shown that interaction effects among home improvement efforts chosen by heterogeneous households can have two important implications for community formation. There can be segregation on the basis of the chosen actions (i.e., housing tenure and effort) and on the basis of the underlying differences (i.e., income). And there can be multiple equilibria and coordination failure. We now present a simple example to highlight these possibilities.

*B. A Two-Community Example*

Consider a city with two communities. Suppose that *SCI* holds and that no home-owner is so rich that she can self-finance. We assume the same income distribution as in our earlier example, with high income inequality ($z > z^1$), and the same threshold income function $y^*(.)$. We fix the rental rate in community 1 to be $\rho$. We establish conditions under which the following outcomes, which are all segregated by tenure, are equilibrium outcomes:[41]

*Outcome A*: The rich own homes in community 1, and all others rent: $x_1^* = 0.4$ and $x_2^* = 0$.

*Outcome B*: The rich and 60% of the middle class own homes in community 1, and all others rent: $x_1^* = 1$ and $x_2^* = 0$.

*Outcome C*: The poor rent in community 2, and all others are home-owners: $x_1^* = 1$ and $x_2^* = 0.4$.

[41] Such examples can also be constructed when tenure contracts are restricted to being 0-1contracts.

For $z > z^1$, $A$ is always an equilibrium outcome (since $Y < y^*(0.4, \rho) < Y+z$). It is supported by: $\rho_1 - \rho_2 = q(n, 0.4) - q(n, 0)$. For these rental rates, $y^*(0.4, \rho_1) < y^*(0, \rho_2)$ by *SCI* (see the implication of *SCI* in the Appendix), and so the rich strictly prefer to own in community 1. The middle class and the poor households, who rent, are indifferent between the two communities.

For $B$ to be an equilibrium outcome, the rental rates have to be such that a middle class household is indifferent between being a mortgagee in community 1 and renting in community 2: $\rho_1 - \rho_2 = [q(n, 1) - q(n, 0)] + C[Y - y^*(1, \rho_1)]$. When $[Y - y^*(1, \rho_1)]$ is not too big, we can have $y^*(0, \rho_2) > y^*(1, \rho_1)$ by *SCI* and continuity, and then $B$ will be an equilibrium outcome.

For $C$ to be an equilibrium outcome, the rental rates have to be such that a home-owning household is indifferent between the two communities: $\rho_1 - \rho_2 = [q(n, 1) - q(n, 0.4)] + C[y^*(0.4, \rho_2) - y^*(1, \rho_1)]$. Note that when $[Y - y^*(1, \rho_1)]$ is not too small, there will exist a $\rho_2$ that satisfies the above equality and satisfies $y^*(1, \rho_1) < y^*(0.4, \rho_2)$, so that middle-class households are owners and the poor are renters in community 2. Then $C$ will be an equilibrium outcome where all rich and middle class households are indifferent between owning in either community.

Under specific parameter configurations (with intermediate values of $[Y - y^*(1, \rho)]$), all the three outcomes $A$, $B$, and $C$ will be equilibrium outcomes. Note that in all three outcomes, a middle class household is a "boundary agent" who is indifferent between living in either community. However, the outcomes differ in that the boundary agent's indifference is with respect to *different* tenure choices: in $A$ (resp., $C$), it is indifferent between renting (resp., owning) in either community, while in $B$, it is indifferent between owning in 1 and renting in 2. Straightforward comparison of the households' equilibrium payoffs in the three outcomes establishes that all households are strictly worse off in $A$ (which has the smallest number of home-owners) as compared to $B$ and $C$.

There are two sources of "coordination failure" in the $N$-community case. The first arises

because of the direct effect on community quality of residents' behavior. The second arises because of the indirect effect on relative rents of a change in the indifference condition of the boundary agent. This also means that if the total number of home-owners (across the $N$ communities) in one equilibrium is greater than in another, it is not necessarily the case that all households are better off in the first equilibrium — there is no natural analog of Proposition 3 in a multi-community setting. In our example, even though the total number of home-owners is larger in $C$ than in $B$, the poor are worse off in $C$**.** For them, the benefits of living in a community with some home-owners as opposed to none are more than offset by the higher rents to be paid.

This last point bears on the design of housing subsidy policies. Suppose that the two communities are stuck at $B$, and that the policy-maker devises a scheme to provide a subsidy to the middle class, by taxing the rich, to induce home-ownership in community 2. Such a scheme can switch the equilibrium from $B$ to $C$, where all middle class residents do become home-owners. But competition for housing units among the middle class will then raise rents in community 2 to such an extent that the middle class is no better off and the poor, who continue to rent, are worse off. In general, any housing subsidy policy in a multi-community city has the potential to alter the relative rental rates across communities and also to induce relocation that increases income segregation.[42] These changes have to be taken into account in assessing the overall benefits of the policy.

[42] In our example, suppose that the two communities are stuck at $A$, and suppose that all the middle-income households rent in community 2. A subsidy to the middle class (by taxing the rich) may switch the outcome to $B$, where 60% of the middle class relocate to community 1 and become home-owners there. This subsidy-induced relocation leads to income segregation. There is no social cost to this in our example, but one can easily consider richer models where income segregation has a social cost, and in such a case the benefits of the housing subsidy scheme will be reduced to the extent that the scheme causes relocation that leads to greater income segregation.

## 6. Conclusion

A key feature of a healthy community is that individuals have incentives to maintain their housing units, alert the police to suspicious behavior, and monitor government actions. This paper presents a model in which a set of market failures can produce areas of concentrated disadvantage where residents lack incentives to take actions that would lead to healthy communities.

In the model, all individuals desire to be home-owners, but capital market imperfections may bar poorer households from home-ownership. All individuals desire, as well, to live near homeowners. But homeowners outbid renters for land in communities with a high proportion of homeowners, which leads to tenure segregation. The model is in the tradition of Schelling (1978), where there is some population statistic (e.g., the fraction of whites in the neighborhood) to which each person relates in two ways: the person has a preference about the statistic, and the person contributes something to that statistic. Schelling shows that correlation between the two leads to residential separation. But we extend the analysis by allowing that what people care about in their neighbors includes their behaviors, and that they are endogenous. Social interactions play a role in creating "good" or "bad" citizens and in clumping each group together. Our analysis is important because it helps to explain the extreme segregation of rich *v.* poor and renters *v.* owners that we see in the US.[43] None of the social interactions in our model plays any part in current theoretical models of housing tenure, which are atomistic.

[43] We recognize that mobility differences across households can generate similar results: Some households perceive that they will stay in a neighborhood for a long time. That is why they buy their homes, expend effort to improve their homes and communities, and desire to live among "stable" neighbors. While there is some truth to this, Verba et al. (1995) and DiPasquale and Glaeser (1999) find that the mobility variable explains only a part of the difference between the behavior of owners and renters. Green and White (1997) and Sampson *et al.* (1997) find that home-ownership has effects on outcomes for children and on neighborhood quality that cannot be accounted for by mobility. We have intentionally taken mobility to be exogenous and identical for all households in our model, while recognizing that the above argument can certainly complement our own and thus strengthen our results.

This work has many policy implications. It accords well with the recent emphasis in the US government on expanding home ownership opportunities to low-income households.[44] It also accords well with recent thinking on ways to eliminate dangerous neighborhoods. The Moving to Opportunity (MTO) demonstration, which has been operating in five US cities since 1994, involves moving families from the least desirable housing projects to safer (often suburban) neighborhoods (Katz, Kling, and Liebman, 2000). Such policies can only raise total welfare if the segregation of renters and homeowners is inefficient.

The analysis also suggests why one traditional response by economists to the problems of blighted neighborhoods –namely, to increase government expenditures on local public goods—is, at best, incomplete. The failure of government responsiveness should be viewed as *endogenous*. The thrust of the recent explosion of work on "social capital" associated with Putnam (1993) is that without citizen involvement and civic community, local government cannot be effective. Calling for better government performance may be "pushing on a string."

Our model may be broadly interpreted as a parable of capitalism, but one which highlights the non-market-mediated interactions among entrepreneurs and, thus, the idea that there are *complementarities in patterns of ownership*. The model may therefore have applications beyond that of residential communities. For example, if the "enterprise" is interpreted as agricultural land, then one may apply this kind of analysis to shed light on the failure of agricultural privatization in Russia.[45] If the "enterprise" is interpreted as a firm, then one may apply the analysis to the

[44] The very large subsidy for home-ownership in the US tax system is does not benefit poorer households; wage-earners in the lowest one-third of household incomes are not, in general, subject to the US income tax.

[45] In 1991, Russia legalized individual farming and dismantled the federal subsidies for cooperative farmers. Many transition advisers expected that they would exit the inefficient collectivist system in droves. Yet six years later, the share of agricultural land used by cooperatives had fallen little and the services that they would require to succeed (marketing, storage, processing, etc.) were not in prospect, either (Amelina, 2000).

formation of industrial belts, within which each entrepreneur's efforts produces externalities in the form of knowledge spillovers, demand externalities, etc. Our framework may thus explain pockets of underdevelopment within a more developed region by appealing to endogenous differences in the contracts agents enter into, the spillovers they produce, and the neighborhoods they create.

There is scope for further work to develop the dynamics of the model, and to draw from that analysis testable implications that could discriminate between this theory of tenure segregation and alternative theories based on Tiebout sorting. The process of spatial arbitrage that we treat here as instantaneous plays out over time. It would be useful to analyze the time path of rents, housing prices, home-ownership rates, and government services in response to a home-ownership program. An often-cited success case of interest is the turn-around of Charlotte Gardens —from one of the worst ghettos of the South Bronx in the early 1980s, to a high-quality home-owning community in the 1990's.[46] The model points to a possible way to break out of a "vicious circle" where neighborhoods do not function well because individuals lack incentives to take efficient actions in the community, and governments do not perform well because the electorate does not provide incentives for government responsiveness.

[46] The Charlotte Gardens home-ownership program in the period 1983-1986 has been a national success story. Upon completion of the first ten houses, Mayor Ed Koch remarked that the new owners would "defend these houses with their lives" (Vergara 1998, p.73). When it looked as if the funds for the project would dry up, the authorities ordered the remaining foundations to be poured – 79 at once – "to remove any doubt." New York City sold the 89 houses for $50,000-$60,000 to moderate-income households who committed not to sell their homes for ten years. By 1997, property values for these houses had risen to $185,000 and property values had risen all over the South Bronx ("Confirmed by the Market: In the South Bronx, Housing Prices Reflect Comeback from Blight," *New York Times*, Nov. 2, 1997, pp. 37, 40.)

## Appendix

Here we present the proofs of Propositions 4 and 5. We use the following notation: given an *N*-community equilibrium, let $y_i^* \equiv y^*(x_i^*, \rho_i^*)$, $\beta_i^* \equiv \beta^*(x_i^*, \rho_i^*)$, $q_i^* \equiv q(n, x_i^*)$, and $S_i^* \equiv S(x_i^*)$. Further, let $u_i^*(y)$ denote household $y$'s maximized utility when it resides in community $i$. Note that $u_i^*(y) = u^n(y, x_i, \rho_i)$ for $y \leq y^*(x_i, \rho_i)$, and $u_i^*(y) = u^n(y, x_i, \rho_i) + min\{C(y - y^*(x_i, \rho_i)), S(x_i)\}$ for $y > y^*(x_i, \rho_i)$. Also note the following implications of the conditions *SCT* and *SCI*. *SCT* implies that if for two communities $i$ and $j$, it is the case that $\rho_i^* - \rho_j^* \leq q_i^* - q_j^*$, then $y_i^* < y_j^*$. *SCI* implies the above condition and that if for two communities $i$ and $j$, it is the case that $\rho_i^* - \rho_j^* \geq (q_i^* - q_j^*) + (S_i^* - S_j^*)$, then $\beta_i^* > \beta_j^*$.

*Proof of Proposition 4:*

Suppose that in an asymmetric equilibrium there is more than one community where owners and renters co-reside. Then there must be at least two communities, $i$ and $j$, such that $1 > x_i^* > x_j^* > 0$. Since there are renters in both communities, $\rho_i^* - \rho_j^* = q_i^* - q_j^*$. Then $y_i^* < y_j^*$ by *SCT*. This implies that for all $y \in (y_i^*, y_j^*]$, $u_i^*(y) > q_i^* - \rho_i^* = q_j^* - \rho_j^* = u_j^*(y)$, and that for all $y > y_j^*$, $u_i^*(y) = q_i^* - \rho_i^* + min\{C(y - y_i^*), S_i^*\} > q_j^* - \rho_j^* + min\{C(y - y_j^*), S_j^*\} = u_j^*(y)$. So, all households with income $y > y_i^*$ strictly prefer to live in community $i$ (and be home-owners). Then there cannot be any home-owners in community $j$, contradicting our original supposition.

*Proof of Proposition 5:*

We suppose that SCI holds, and consider any two communities $i$ and $j$, with $x_i^* > x_j^*$, in any particular tenure-segregated asymmetric equilibrium. First, we consider the case where $1 > x_i^* > x_j^* =$

0. In this case, using the same arguments as in Proposition 4, we can establish that $\rho_i^* - \rho_j^* = q_i^* - q_j^*$, $y_i^* < y_j^*$, and that all households with income $y > y_i^*$ strictly prefer to live in community $i$. So if $y' > y''$, and household $y'$ lives in community $j$ while household $y''$ lives in community $i$, it must be that the two households are renting and so are indifferent between the two communities. Then this pair of households can be relocated ($y'$ moved to $i$ and $y''$ to $j$) without disturbing any other properties of the equilibrium.

Next, consider the case where $x_i^* = 1$ and $x_j^* = 0$. Suppose that $y' > y''$, and that household $y'$ lives in community $j$ and household $y''$ lives in community $i$. Then it must be that household $y'$ prefers to rent in community $j$ than own in community $i$, and that household $y''$ prefers to own in community $i$ than rent in community $j$. This requires: $min\{C(y'' - y_i^*), S_i^*\} \geq \rho_i^* - q_i^* - \rho_j^* + q_j^* \geq min\{C(y' - y_i^*), S_i^*\}$. This inequality can be satisfied if and only if $y'' \geq \beta_i^*$, and in that case, $\rho_i^* - \rho_j^* = q_i^* - q_j^* + S_i^*$. But then, $\beta_i^* > \beta_j^*$ by *SCI*, and this implies that $y' > y'' \geq \beta_i^* > \beta_j^*$. This implies that household $y'$ strictly prefers to own in community $j$ which contradicts our original supposition.

Finally, in the case where $1 = x_i^* > x_j^* > 0$, it can be proved using similar arguments as above that for any $y' > y''$, either it cannot be that household $y'$ lives in community $j$ and household $y''$ lives in community $i$, or households $y'$ and $y''$ are indifferent to living in either community and can be relocated without disturbing any other properties of the equilibrium.

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# Table 1. Predicting behavior by homeownership status

| Source | Behavior | Estimated effect on behavior | | Control variables |
|---|---|---|---|---|
| | | OLS | IV | |
| ***Maintenance*: Absentee landlords compared to homeowners** | | | | |
| Stratified sample of 102 residential structures in Rhode Island over a 10-year period<br><br>Spivack (1991) | Probability a residential structure without a housing code violation remained in that state in the preceding year | -.15<br>(6.3) | | Characteristics of the structure, neighborhood and tenants; tax and zoning policies; local construction activity |
| | Probability a residential structure with a housing code violation corrected the housing code violation in the preceding year | -.09<br>(1.5) | | |
| ***Local civic participation*: Homeowners compared to renters** | | | | |
| Survey of 500 residents of Columbus, OH<br><br>Cox (1982) | Probability of neighborhood activism<br>‣ when a resident perceives a neighborhood problem<br>‣ when he does not | .39<br>(sig. at .0001)<br>.27<br>(sig. at .0001) | | Children in household[47] |
| Longitudinal study of 226 low-income homebuyers and renters in Baltimore<br><br>Rohe & Stegman (1994) | Number of community organizations that a resident belongs to | .20<br>(significant at .01 level) | | Age, race, gender, marital status, income, education, children, dwelling type, satisfaction with neighborhood |
| | Index of the frequency of attending meetings of community organizations | .10<br>(insignificant at .05 level)[48] | | |
| Citizenship Participation Sample, a cross-section of 15,000 adults in the US<br><br>Verba et al. (1995) | Probability of local participation: votes in most or all local elections, works in a campaign for a candidate for local office, protests on a local issue, contacts a local official | .09 (significant at .01 level) | | Years in the community, school-aged children, education, parents' education, race, etc. |
| US General Social Survey<br><br>DiPasquale and Glaeser (1999) | Probability of neighborhood activism | .10<br>(.03) | .19<br>(.12) | Age, race, gender, marital status, income, education, children, city size |
| | Probability votes in local elections | .16<br>(.03) | .29<br>(.13) | |
| | Number of non-professional organizations in which he participates | .22<br>(.06) | .59<br>(.23) | |
| | Probability knows identity of the school board head | .13<br>(.03) | .46<br>(.15) | |
| | Probability gardens | .18<br>(.04) | .34<br>(.18) | |

Standard errors are in parentheses.

[47] The parameters are little changed when an additional control variable, for high- and low-socioeconomic status, is used, but in that case it is impossible to compute tests of significance holding SES constant because there are no high SES households in the sample who are renters.

[48] This regression coefficient is significant when only block and neighborhood organizations, and not church organizations and PTAs, are counted.

## Table 2. Index of homeowner-renter segregation (dissimilarity index) for family households in the 10 largest US MSAs, 1990

| Annual income | Nonblacks with children | Nonblacks, no children | Blacks with children | Blacks, no children |
|---|---|---|---|---|
| < 25K | 0.624 | 0.450 | 0.676 | 0.619 |
| 25K – 50K | 0.423 | 0.351 | 0.576 | 0.618 |
| 50K – 75K | 0.424 | 0.354 | 0.600 | 0.669 |
| 75K – 100K | 0.570 | 0.414 | 0.799 | 0.824 |
| > 100K | 0.610 | 0.438 | 0.878 | 0.871 |

Source: 1990 US Census

**Fig. 1. The set of available contracts**

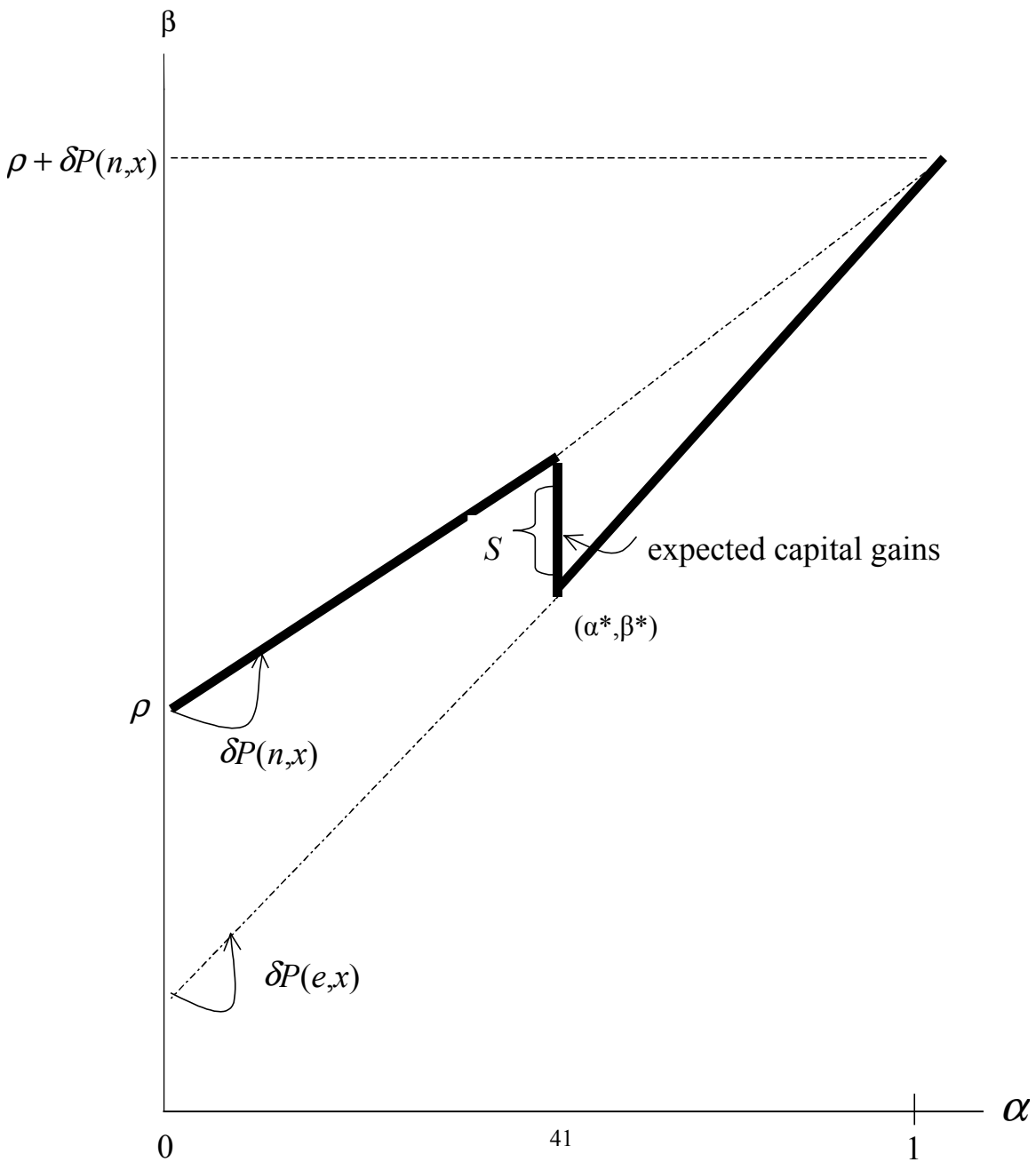
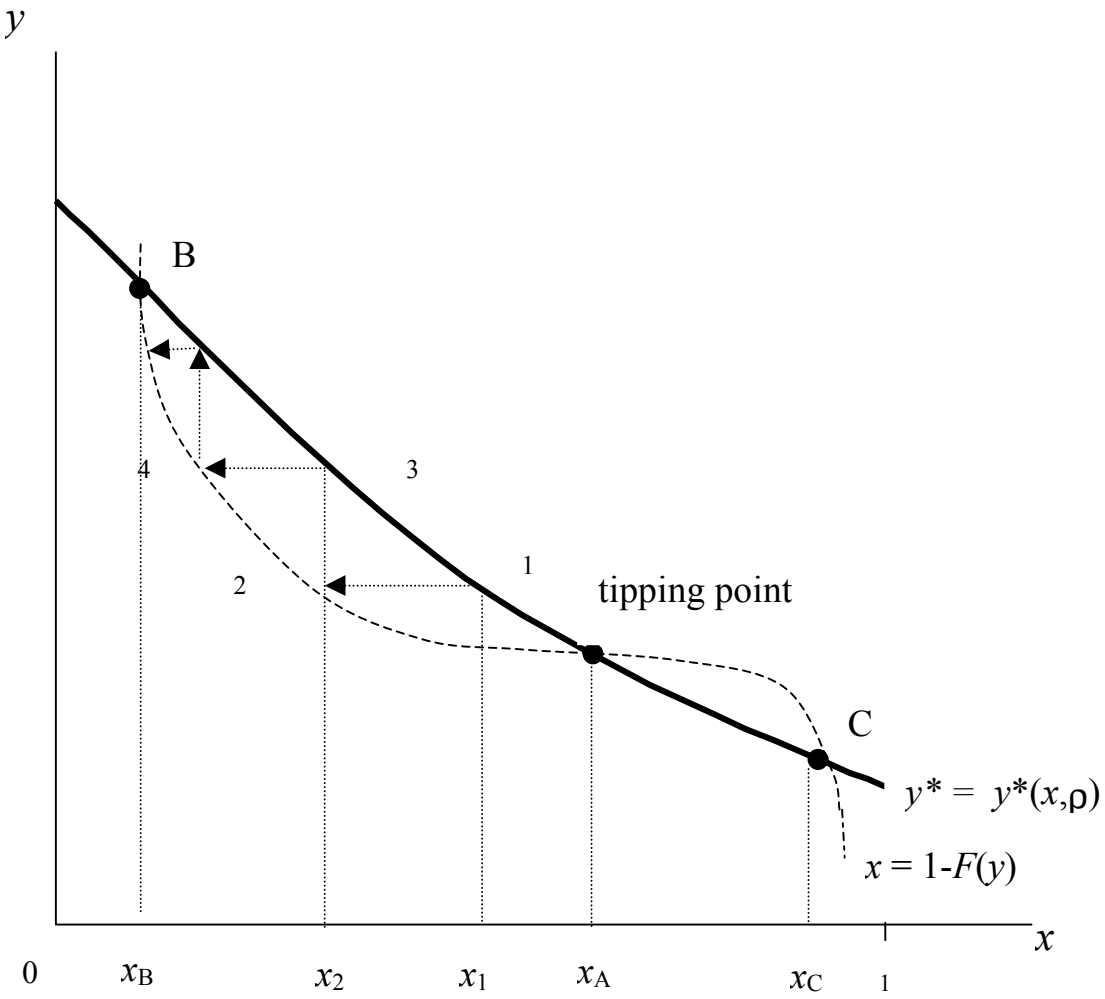
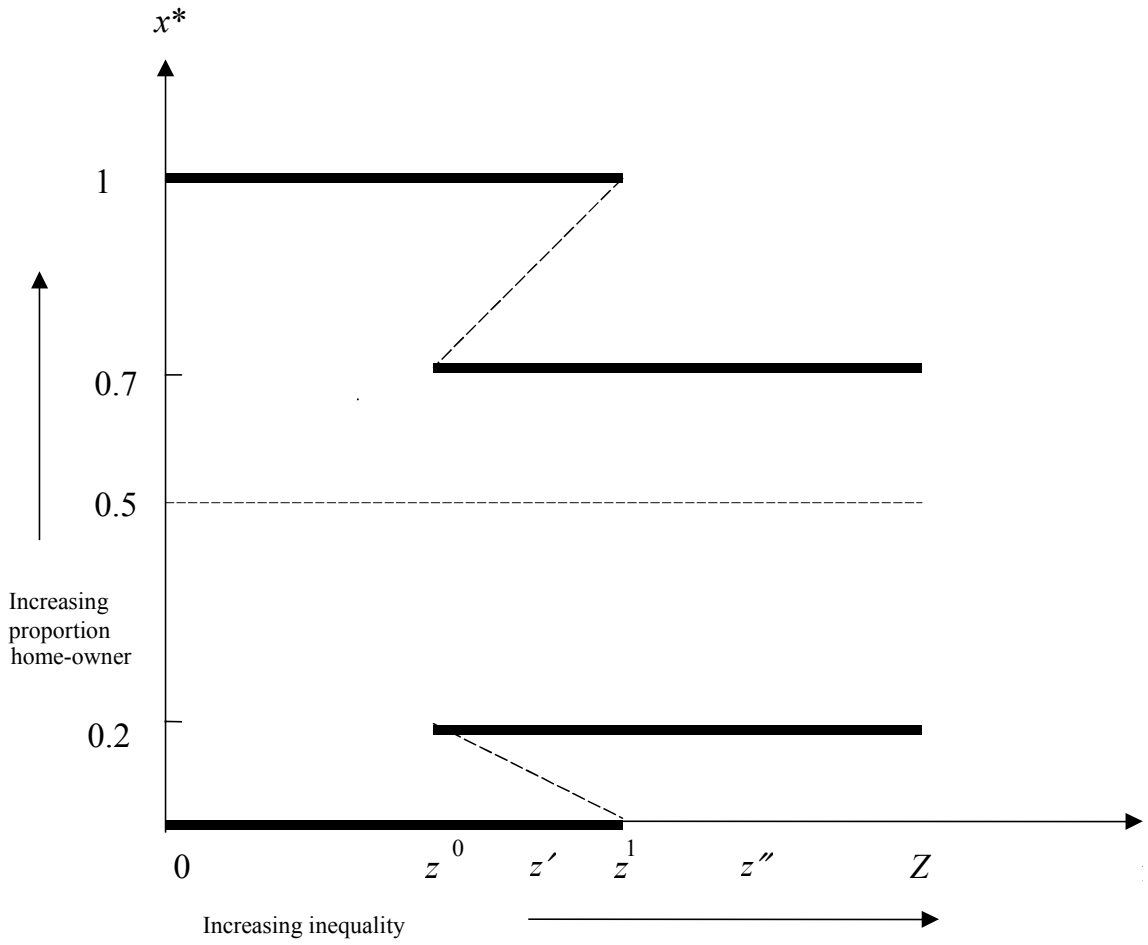


**Fig. 2. Multiple equilibria in a one-community city**



## Fig. 3. Equilibrium proportions of home-owners in a one-community city




For any $z$, the points on the bold lines vertically above $z$ denote the stable equilibria, and the points on the dashed lines denote the unstable equilibria.

**Proofs and examples not to be published**

This note presents proofs and examples of certain claims made in Section 5 of the paper. In this note, we restrict ourselves to the case of two communities; the results can be generalized to the case of $N > 2$ communities.

*1. Symmetric N-community equilibria are replications of a single-community equilibrium.*

Suppose $x^*$ is a single-community equilibrium given $Q_0$ and $\rho$. In this equilibrium, let $H^*$ be the set of home-owner incomes, and let $R^*$ be the set of renter incomes. Let $H_1^*$ and $H_2^*$ (resp., $R_1^*$ and $R_2^*$) be any equal-sized partition of $H^*$ (resp., $R^*$). Then, setting $x_1^* = x_2^* = x^*$, $\rho_2^* = \rho_1^* = \rho$, $Y_1^* = H_1^* \cup R_1^*$, and $Y_2^* = H_2^* \cup R_2^*$, it is easy to show that $\{\rho_1^*, \rho_2^*, (x_1^*, Y_1^*), (x_2^*, Y_2^*)\}$ is a two-community equilibrium when $Q_{0,1} = Q_{0,2} = Q_0$.

Alternatively, given the common initial quality $Q_0$, consider any two-community equilibrium with $x_1^* = x_2^*$. In such an equilibrium, it must be that $\rho_1^* = \rho_2^*$ (otherwise all residents would strictly prefer to live in the community with the lower rental rate). Then a single-community equilibrium can be constructed with $\rho = \rho_1^*$ and $x^* = x_1^*$, by reversing the steps of the construction described above.

*2. Symmetric N-community "interior equilibria" (i.e., with $x_i^* = x^* \in (0, 1)$ $\forall$ i) are not robust.*

Suppose $Q_{0,1} > Q_{0,2}$. Here we will explicitly consider the dependence of $P(.)$ on $Q_0$. Recall that $P(a, x; Q_0) \equiv \hat{P}(Q_1(Q_0 + q(a, x)))$. This implies that $\partial P/\partial Q_0 > 0$. We will assume that $\partial^2 P/\partial Q_0^2$ is non-zero on its domain, but that its absolute value is small. For the surplus expressions, this implies that while $s_0$ is independent of $Q_0$, $\partial s_1/\partial Q_0$ is non-zero on its domain with a small absolute value. This, in turn, implies that $\partial y^*/\partial Q_0 > 0$. [When the absolute value of $\partial^2 P/\partial Q_0^2$ is small, the positive effect of an increase in $Q_0$ on P dominates any negative effect in determining the sign of $\partial y^*/\partial Q_0$.]

Suppose that there exists a two-community equilibrium with $x_1^* = x_2^* = x^* \in (0,1)$. Then there

are renters in both communities, and so $\rho_1^* - \rho_2^* = Q_{0,1} - Q_{0,2} > 0$. Then, $y_1^* > y_2^*$. Further, the total net surplus in the two communities, $S_1 = S(x^*, Q_{0,1})$ and $S_2 = S(x^*, Q_{0,2})$, will be distinct since $\partial^2 P/\partial Q_0^2$ is non-zero. Then the following results can be established: All households with income $y < y_2^*$ strictly prefer to be renters and are indifferent between the two communities. For all households with income $y > y_2^*$, one of two cases arise. If $S_1^* < S_2^*$, then all such households strictly prefer to be home-owners in community 2. If $S_1^* > S_2^*$, there exists a $y' \in (y_1^*, \beta_1^*)$ such that all households with $y \in (y_2^*, y')$ strictly prefer to be home-owners in community 2, while all households with $y > y'$ strictly prefer to be home-owners in community 1. In the former case, it is obvious that $x_1^* = x_2^* = x^* \in (0, 1)$ cannot be an equilibrium. In the latter case, $x_1^* = x_2^* = x^*$ can be an equilibrium if and only if there are two sets of households of equal measure such that one set prefers to be home-owners in community 1 while the other set prefers to be home-owners in community 2. But this cannot happen generically, that is, for arbitrary income distribution functions.

*3. When SCT fails, there can exist asymmetric equilibria that are not tenure segregated.*

We consider an example with the following income distribution structure: there are positive measures of high-, middle-, and low-income households. Let $y_H$ denote the high-income level, $y_M$ the middle-income level, and $y_L$ the low-income level; and let $\mu_j$ ($> 0$) denote the measure of households with income level j, for j = H, M, L. We posit that $0.5 > \mu_H > \mu_M$. Our proposed equilibrium has the following outcome: All high-income households are home-owners in community 1, all middle-income households are home-owners in community 2, and all low-income households are renters across the two communities. This is a non-segregated outcome with $1 > x_1 = 2\mu_H > x_2 = 2\mu_M > 0$.

As there are renters in both communities in this outcome, the equilibrium rental rates have to satisfy $\rho_1 - \rho_2 = q(n, x_1) - q(n, x_2)$. Contrary to *SCT*, we posit that $y^*_1 > y^*_2$, but assume that $[y^*_1 - y^*_2]$ is small so that we have the following chain of inequalities: $\beta^*_1 > \beta_2 > y^*_1 > y_2^*$. Next, we posit that

the three income levels satisfy the following conditions: $y_L < y_2^*$ so that a low-income household will rent in either community; $y_1^* < y_M < \beta^*(x_2, \rho_2)$ so that a middle-income household will be a mortgagee in either community; and $y_H = \beta^*_1 - \varepsilon > \beta^*_2$ for some $\varepsilon > 0$ so that a high-income household will be an owner in either community while being a mortgagee in the former. Note that under these parameter specifications, for a small enough value of $\varepsilon$, the following are true: Each low-income household strictly prefers to rent and is indifferent between the two communities; each middle-income household strictly prefers to live in community 2; and each high-income household strictly prefers to live in community 1. So the proposed outcome is an equilibrium.

*4. When SCI fails, equilibria can be tenure-segregated but not income-segregated.*

We consider the same income distribution as before, and posit that $\mu_H = \mu_L = 0.25$. Consider the following outcome: All middle-income households are home-owners in community 1, and in community 2, the high-income households are home-owners while the low-income households are renters. This outcome is tenure-segregated, with $1 = x_1 > x_2 = 0.5$, but not income-segregated.

Given the fixed community 1 rental rate $\rho_1$, define $\rho'$ such that $\rho_1 - \rho' = [q(n, 1) - q(n, 0.5)] + [S(1) - S(0.5)]$. We posit that the complementarity effect is so strong that $y^*(0.5, \rho') = \beta^*(1, \rho_1)$, thus violating SCI. Then we have the following chain of inequalities: $\beta^*(0.5, \rho') > \beta^*(1, \rho_1) = y^*(0.5, \rho') > y^*(1, \rho_1)$. We posit that $y_H > \beta^*(0.5, \rho')$ so that a high-income household will be an owner in either community and will never have to borrow; $y_L < y^*(1, \rho_1)$ so that a low-income household will be a renter in either community; and $y_M \in (y^*(1, \rho_1), \beta^*(1, \rho_1))$ such that $C[y_M - y^*(1, \rho_1)] > S(1) - S(0.5)$ (which will be the case for $y_M$ close to $\beta^*(1, \rho_1)$) so that a middle-income household will be a mortgagee if put in community 1 and a renter if put in community 2.. Then it is easy to establish that for a community 2 rental rate $\rho_2 = \rho' - \varepsilon$, with $\varepsilon$ (positive) sufficiently close to zero, our proposed outcome is an equilibrium where middle-income households strictly prefer to live in community 1,

while high- and low-income households strictly prefer to live in community 2. Because of strict preferences, the households cannot be "switched" in any way to generate income segregation.

*5. A sufficient condition for the existence of asymmetric equilibria in the two-community model.*

Consider any equal-sized partition of Y, $\{Y^H, Y^L\}$, such that $y' \geq y''$ for all $y' \in Y^H$ and $y'' \in Y^L$. Define $y^m$ as the infimum of the set $Y^H$ (if incomes are continuously distributed on Y, $y^m$ is the median income). We then have the following result: Assume that SCT holds. Then, given $\rho_1$, there exists an $\varepsilon > 0$ such that whenever $[y^m - y^*(1, \rho_1)] < \varepsilon$, a tenure segregated two-community equilibrium exists and has the following features: $x_1^* > x_2^*$, and $Y_1^* = Y^H$ and $Y_2^* = Y^L$.

The result is proved by constructing an equilibrium with the desired features. Here we present the essence of that construction. Put all households in the set $Y^H$ in community 1 and consider the equilibrium in that community, given $\rho_1$. That single community (with measures of households and homes equaling half) must have an equilibrium x*, and we construct the two-community equilibrium on the basis of the magnitude of x*. [We assume that $x^* \neq 0$, for if it is then the following is an equilibrium in the two-community world: $\{(\rho_1^* = \rho_2^* = \rho_1, x_1^* = x_2^* = 0, Y_1^* = Y^H, Y_2^* = Y^L\}$.]

If $x^* \in (0, 1)$, the following asymmetric outcome is an equilibrium: $\{(\rho_1^* = \rho_1, x_1^* = x^*, Y_1^* = Y^H), (\rho_2^* = \rho_1 - [q(n, x^*) - q(n, 0)], x_2^* = 0, Y_2^* = Y^L)\}$. This is an equilibrium outcome since $y^*(x_1^*, \rho_1^*) < y^*(x_2^*, \rho_2^*)$ by SCT. The case where $x^* = 1$ has to be handled more carefully. Note that $x^* = 1$ requires that $y^m \geq y^*(1, \rho_1)$. However, if $y^m$ is sufficiently close to $y^*(1, \rho_1)$ (which is what the condition in the statement of the result requires), then the poorest household in community 1 will be a mortgagee. Define $\rho'$ such that $q(n, 1) - \rho_1 + C[y^m - y^*(1, \rho_1)] = q(n, 0) - \rho'$. When $y^m$ is sufficiently close to $y^*(1, \rho_1)$, then SCT and continuity imply that $y^*(0, \rho') > y^*(1, \rho_1)$. In that case, the following outcome is an equilibrium: $\{(\rho_1^* = \rho_1, x_1^* = 1, Y_1^* = Y^H), (\rho_2^* = \rho', x_2^* = 0, Y_2^* = Y^L)\}$.