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RESUMEN

Los sistemas educativos públicos basados en el lugar de residencia promueven la segregación espacial (i.e. por barrios o distritos escolares) de la población en función del ingreso (e.g. Epple y Romano, 2002). Se ha argumentado en la literatura que la introducción de alternativas privadas puede reducir los niveles de segregación al desvincular calidad educativa y lugar de residencia para las familias que utilizan la educación privada (Nechyba, 1999). Por otra parte, es bien conocido que los así llamados efectos de vecindad constituyen otra fuerza segregadora en las áreas urbanas. En este artículo utilizamos un modelo de un área urbana con dos barrios (distritos escolares) para estudiar si la presencia de dichas externalidades sociológicas reduce o elimina este efecto de la educación privada. El análisis demuestra que los efectos de vecindad pueden en efecto inhibir la mezcla de grupos de diferente nivel de ingreso inducida por la educación privada. Esto ocurrirá si la mejor escuela pública se sitúa en el barrio que genera mejores efectos de vecindad. No obstante, también puede suceder que promuevan que familias de renta elevada que utilizan una escuela privada convivan con familias de renta baja que mandan a sus hijos a una escuela pública en el barrio o comunidad con los efectos de vecindad más beneficiosos.

Palabras clave: movilidad residencial, segregación por ingreso, efectos de vecindad, elección de escuela.

ABSTRACT

Residence-based public education systems promote income segregation across neighborhoods or school districts (e.g. Epple and Romano, 2002). It has been argued that allowing private schools to enter the market may reduce the levels of income segregation because private education severs the link among school quality and place of residence for those using a private school. On the other hand, the so-called neighborhood effects constitute another segregating force in urban areas. We use a two-neighborhood model of an urban economy in order to study whether such externalities inhibit the desegregating effects of private education or not. The analysis reveals that they may indeed reduce or completely eliminate private education induced income mixing. This will happen if the best public school is located where neighborhood effects are most beneficial. However, it may also be the case that neighborhood effects promote the mixing of high income households using a private school with low income ones using a public school in the neighborhood providing the most beneficial neighborhood effects.

Keywords: residential mobility, segregation, neighborhood effects, school choice.

JEL classification: D62, H42, H73, I20, R13, R31.

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1 Introduction

> ”The micro-foundations of local goods and services need further theoretical and empirical investigations. Many such goods (such as crime prevention and schooling) depend fundamentally on peer and neighborhood effects, and predictions can change fundamentally as such effects are introduced into the analysis. Similarly, locally provided goods may have private alternatives that can alter predictions when included explicitly in the analysis”.
>
> Epple and Nechyba, 2004

> ”The key theoretical feature of [neighborhood effects] models concerns how individuals with different attributes are allocated across neighborhoods... Much of the interest in neighborhood configurations, in turn, focuses on the extent to which neighborhoods are segregated by income or other attributes... Segregation by income, for example, provides a basis for understanding persistence in economic status across generations: poor households are consigned to poor neighborhoods, whose effects make it more likely their children are poor.”
>
> Durlauf, 2004

The aim of this paper is to analyze the impact of the so-called neighborhood effects on school choice and neighborhood demographic composition in urban economies. More precisely, we want to answer two main questions: First, how do neighborhood effects affect the choice among public and private education in a single location setting? Second, does private education reduce income segregation across neighborhoods when such externalities are relevant? With these objectives in mind, we build a model of a city in which (i) there exists a set of tuition-free public schools that follow residence-based admission policies, and in which (ii) competitive private schools can freely enter the market.

Neighborhood effects are sociological externalities (peer effects operating at school and community level, role models, rules of behavior, crime, etc.) whereby a household socioeconomic outcomes and, thus, utility are affected by the identity of its neighbors (see for example Durlauf, 2004). Neighborhood effects are receiving increasing attention by both empirical and theoretical researchers from different fields of economics. But, why is it relevant to consider them in an urban model with public schooling and opting-out?

Multi-community models of urban public finance (Westhoff, 1977, Fernández and Rogerson, 1998, and Epple et al., 1984 are three examples) typically reduce the community characteristics space to two dimensions: the quality (quantity) of a local public good and a price variable (housing price or gross-of-tax housing price in models with housing or income tax rate in models without housing). This assumption is analytically convenient (see Schmidheiny, 2002). Moreover, it is an adequate simplification in many cases, as the local public good can be interpreted as an index of an n-dimension vector of characteristics (see the empirical applications by Epple and Sieg, 1999 and Epple et al., 2001).

Consider a multi-community model with housing and without private alternatives to the locally provided good (education). Suppose communities differ in how much of this good they offer to their residents and in the price of housing. In this setting, it is possible to rank communities according to their level of provision (equivalently, to their price of housing). Housing markets then allocate households to locations according to their willingness to pay for the locally provided good. Suppose households vary along a single dimension (income, preferences). If the willingness to pay for living in a better location varies monotonically with the variable in which households vary, equilibrium will exhibit perfect segregation across locations.

Consider now what happens if private alternatives to the locally provided good are allowed for in this model. As it has been emphasized by Epple and Nechyba (2004), this is especially relevant for the good in which we focus our attention: education. In this case, different households value locations according to different sets of attributes. In particular, households opting for a private school do not take into account the quality of local public schools. If communities only vary along this dimension apart from the price variable, then, they will live in the lowest (housing or tax) price community. That community will also be inhabited by low income households who use the local public school. Therefore, this model predicts that private education will induce income mixing within communities. This is a basic result in Bearse et al. (2001), which is also in Martínez-Mora (2003). Advocates of voucher systems adduce this as an advantage of such policies on equity grounds (Nechyba, 1999).

It is a stylized fact, nevertheless, that in the real world households in the private sector reside in different communities with different housing prices (see, for example, the evidence in Luengo-Prado and Volij, 2003). This can only be explained using a model in which locations vary not only according to public school quality but also according to other relevant dimension(s). Reducing the location characteristics space to two dimensions is thus a natural assumption in models without opting-out. Furthermore, it is an adequate simplification for studying important aspects of sector choice or the impact of alternative education systems on the dynamics of income distribution (as in Bearse et al., 2001). But it is necessary to investigate how urban markets for education work when opting-out of public education is allowed for and locations differ in more than two characteristics.

Several characteristics could be considered for this: endogenous amenities such as commercial activity, crime and social capital; exogenous amenities such as natural and historical amenities and distance to center or housing quality. In this paper, we focus on one important type of endogenous amenities: neighborhood effects. When these externalities are at work, households location choices are affected by each community social capital. Consequently, they constitute a potential segregating force in urban settings which may inhibit the incentives households in the private sector have to mix with poor households in low housing (tax) price communities[3].

To our knowledge, no paper has investigated the impact neighborhood effects have on neighborhood and school composition when opting-out is allowed for. Nechyba's computational analyses (e.g. 1999, 2000, 2002, 2003) have shed light on *communities* and schools composition when communities are made up by several neighborhoods which differ in exogenous quality. In his 1999 paper, this author presents a very rich model in which jurisdictions are endowed with an exogenous stock of heterogeneous houses, households differ by wealth and students' ability and peer group effects affect students' achievement. This model serves as the basis for a computational general equilibrium counterpart which is used in several policy experiments. In this setting, private education is shown to promote income mixing within *communities* (not neighborhoods). The model can be interpreted as if each group of homogeneous houses make up a neighborhood. Under such interpretation neighborhoods differ in quality. However, as quality is exogenous the model can hardly be interpreted as including neighborhood effects. As the author himself recognizes (Nechyba, 2003), this makes it inadequate for studying the evolution of neighborhood configurations.

The paper is organized as follows. Section 2 introduces the model. In section 3 we present a digression on the mechanisms through which neighborhood effects may affect sector choice in a single-location context. We show that these local externalities

[3] See Bénabou (1996) for a model in which neighborhood effects are enough for generating perfect income segregation in urban areas.

may be relevant to the choice among both educational sectors, as recent empirical evidence suggests (e.g. Figlio and Stone, 2001). In section 4, we introduce multiple location alternatives into the analysis. We hold sector choice constant and establish a number of restrictions (i) the equilibrium allocation of households to communities and (ii) the equilibrium vector of housing prices must satisfy. Using all these results, section 5 analyzes the overall segregation patterns across neighborhoods and schools that may arise in equilibrium. Section 6 concludes.

2 The model

The model we present in this section is based on the one in Martínez-Mora (2003). In order to create the simplest adequate framework to study the issues of interest to this paper, we modify it in two respects. First, we assume that school quality is exogenous. Consequently, there is no need to explicitly model public school finance, the taxation system or the voting process. This simplifying assumption allows us to interpret locations as neighborhoods or communities that differ in the quality of public schooling. We also assume the existence of a hierarchy of public school qualities. This seems an adequate assumption since such hierarchy arises as a natural outcome in multi-community models with local school finance (Epple et al., 1993), or in single jurisdiction ones with neighborhood schooling (Epple and Romano, 2002). To be precise, in those models only equilibria in which public schools differ in quality are stable[4].

This simplification forces us to be cautious about the conclusions to be drawn from the analysis. In the real world, the quality of a public school is related to its demographic composition through a variety of channels (peer group effects, economic resources, students effort, parents involvement, etc.) Consequently, the lessons one

[4] For an explanation, see for example Fernández (2001).

can extract from a particular solution (equilibrium) depend on the compatibility among the demographic composition of a school and its level of exogenous quality.[5]

The second departure from the model in Martínez-Mora (2003) is the introduction of neighborhood effects. As we explained in the introduction, neighborhood effects are sociological externalities whereby the utility of a household is affected by the identity of its neighbors. When they are relevant to households' well-being and households are aware of it, their residential location decisions are affected by the demographic composition of each neighborhood.

The model has two neighborhoods that we consider the set of neighborhoods within a city. Locations can also be interpreted as communities within a metropolitan area. The neighborhoods have exogenous boundaries and each of them has a fixed housing stock. Houses are homogenous and offered along a supply schedule horizontal until the neighborhood capacity is reached and vertical at that level. These assumptions about local housing markets are not essential but considerably simplify the analysis. Residential mobility across locations is costless.

The city (metropolitan area) is populated by a continuum of households whose mass is normalized to 1. Each household is composed of one adult -the decision-maker- and one school-aged child. Households differ by their exogenous endowment of the numeraire: income. Population is characterized by a continuous density function $f(y)$ strictly positive in its domain. $D \equiv [\underline{y}, \overline{y}] \subset \Re_+$. Each household consumes one (and only one) unit of housing at price p_h. We assume that housing capacity in the economy is just enough to house the population.

[5] This assumption, however, is not stringent. As the analysis below will demonstrate, better public schools are always used by better-off households. Public school quality differentials across neighborhoods within a school district, in turn, can only be caused by differences in demographic inputs (e.g. peer effects). It is reasonable and common in the literature (e.g. Epple and Romano, 2002) to assume that better-off households provide more beneficial demographic inputs.

There exist three private commodities in the economy: educational services, housing and a composite good -the numeraire. We assume that households' utility also depends on their neighborhood level of social capital through neighborhood effects. Therefore, we hypothesize that the local externality a household is exposed to in a particular location depends on the local level of social capital. To simplify matters this is assumed to be increasing in neighborhood average income.

Assumption 1 *Neighborhood level of social capital, θ, (or at least households' perceptions about it*[6]*) is a strictly increasing and continuous function of neighborhood average income:*$\theta = \theta(\overline{y})$; $\theta'(\overline{y}) > 0$.

Preferences are therefore defined over school quality (x), the level of social capital in the neighborhood (θ) and consumption of the numeraire (b). Because all houses are homogenous and each household consumes exactly one unit of this good, we do not include it in our utility function.

Assumption 2 *Households have identical preferences captured by the utility function* $U(x, \theta, b) = u(x, \theta) + z(b)$. *Moreover,* $u(x, \theta)$ *and* $z(b)$ *are both increasing in* (x, θ) *and* b*, respectively, and twice continuously differentiable for all* $(x, \theta, b) >> 0$. *Finally,* $u(x, \theta)$ *is strictly quasi-concave, while* $z(b)$ *is strictly concave.*

For technical convenience we also assume:

Assumption 3 $\lim_{x \to 0} u(x, \theta) = -\infty$ *and* $\lim_{b \to 0} z(b) = -\infty$

Further, in order to avoid technical difficulties, we assume $\underline{y}$ is high enough so as to allow households with such income level to buy a house in the most expensive

[6] *If human capital is non-observable, the level of income can act as a signal of a household's level of human capital.*

neighborhood. This guarantees a positive level of disposable income and of numeraire consumption for all households in every location alternative.

Therefore, preferences are continuous, strictly convex and strictly monotonic. Moreover, school quality, neighborhood effects and the numeraire behave as normal goods, i.e. household demand for all of them increases with income. Finally, zero consumption of the numeraire or of school quality cannot be compensated by any amount of other commodities.

This preference schedule allows for several interpretations of θ. In the most basic one, households have preferences over private consumption, the quality of the neighborhood in which they live and the quality of the school to which they send their children. In this view, θ represents neighborhood quality, which increases with mean income. As in Brueckner et al. (1999), a neighborhood's endogenous quality may depend on the availability of restaurants or public facilities such as parks or swimming-pools. Thus, the existence of non-market interactions that make the level of local social capital relevant are not necessary to justify the analysis.

Alternatively, and this is the interpretation we adopt in this paper, one can think of θ as representing the level of social capital in a neighborhood. Under this interpretation θ serves to capture the role of social non-market interactions. Given that the socioeconomic composition of the neighborhood where a child grows affects his acquisition of human capital, households have preferences over private consumption and the level of human capital acquired by the child. The utility function allows for complementarities among school quality and the local level of social capital. Hence, $u(x, \theta)$ can be interpreted as $u(x, \theta) = s(h(x, \theta))$, where $h(x, \theta)$ is a function relating school and neighborhood social capital to the level of human capital acquired by the child and $s(h)$ captures the household preferences over the child's level of human capital. This interpretation should be kept in mind.

School quality is considered a private good, i.e. the benefits it provides are excludable and perfectly divisible. Each neighborhood has a public school. As we explained above, public school quality (E) is assumed to be exogenous to simplify matters. This allows us to ignore questions related to public school finance and the corresponding political economy problem. Furthermore, we assume there exists a hierarchy of public school qualities such that $E_1 < E_2$.

Besides the public schooling system, there exists a competitive market in which every household can acquire any level of school quality (x) at competitive price p_x. The private educational sector produces school quality from the numeraire, following a technology of production which exhibits constant returns to scale with respect to the number of students, n, and the quality level, x. The corresponding cost function is $c(x,n) = x \cdot n$. The marginal cost of providing one extra unit of school quality to one student for private producers is equal to 1. Hence, $p_x = 1$.

Note we assume households opting for a private school can always find a private school which offers exactly the level of school quality they desire. While this assumption may seem extreme, it is a useful simplification which does not alter the essence of the public-private school choice problem (see Epple and Romano, 1996a). It has an important implication: as education is a normal good and demand for school quality rises monotonically with income, each private school is attended by students belonging to households from a single income level. In other words, the private education sector perfectly segregates students across schools according to their parents income.

Public and private schools are mutually exclusive options and only public schools have a residential requirement for attendance. That is to say, households whose children attend a public school cannot supplement their consumption of education in the private sector; and households who want to use a particular public school must reside in the neighborhood where it is located.

Every adult decides: (i) where (in which neighborhood) to reside; (ii) to send her child to the local public school there or to a private school; and -if she chooses private schooling- (iii) to allocate income between consumption of school quality and numeraire. In our model with two neighborhoods, there exist four school sector-location alternatives: "public education-neighborhood 1", "public education-neighborhood 2", "private education-neighborhood 1", "private education-neighborhood 2". For notation simplicity we will denote them "*PUB1*", "*PUB2*", "*PR1*" and "*PR2*", respectively.

Adults are price-takers and they take all neighborhood variables as given. They adopt all decisions in one stage, taking into account the exogenous vector of public school qualities ($E_1 < E_2$) and households' (correct) expectations over the equilibrium vector of housing prices and neighborhood qualities $e^* = (\theta_1, p_h^1, \theta_2, p_h^2)$.

As in Martínez-Mora (2003), the notion of equilibrium we adopt here is the *free mobility equilibrium* concept. In a model without voting and taxation and with neighborhood effects the definition is:

Definition 1 Equilibrium. *An equilibrium is a partition of households across neighborhoods and schools, an allocation* (x, θ, b) *across households and a vector of neighborhood qualities and housing prices* $e^* = (\theta_1, p_h^1, \theta_2, p_h^2)$ *satisfying:*

1. Rational choices: *for each household, the pair* (x, θ, b) *associated to their choice of neighborhood and school provides the maximum utility among the alternatives available in their choice set. This implies that no household wants to move to another location or to shift school.*

2. Housing market equilibrium: *housing demand equals housing (fixed) supply in every neighborhood.*

3. The demographic composition of each neighborhood is such that $\theta_1 = \overline{y}_1$ *and*

$\theta_2 = \overline{y}_2$, *where* $\overline{y}_i$ *stands for neighborhood* i *average income.*

A central issue in this paper is the emergence of income mixing or income segregation across neighborhoods (schools). Consequently, it is necessary to precisely define what we mean by income mixing and perfect income segregation.

Definition 2 *An equilibrium:*

1. Exhibits perfect income segregation *across neighborhoods (schools) if households living in (sending their children to) each of them belong to a single income interval.*

2. Leads to income mixing *within neighborhoods (schools) if at least one neighborhood (school) is inhabited (used) by households from at least two different income intervals.*

Next, we obtain the induced preferences of a household with income y living in a neighborhood with housing price p_h, social capital θ and public school quality E. Given the preference configuration we adopt in the model, the indirect utility function of a household in the public sector depends on the quality of the public school and of the neighborhood where they live and on the price of housing there. The expression is given by:

$$v(E, \theta, y - p_h) = u(E, \theta) + z(y - p_h) \tag{1}$$

Every household has a demand function for private school quality. It depends on the level of "disposable income" (income minus the price of a house) and on the level of social capital in the neighborhood:

$$x^* = x(\theta, y - p_h) \tag{2}$$

To obtain the indirect utility function of a household who opts out of public education we plug this demand function and the household's budget constraint into the utility function:

$$w(\theta, y - p_h) = u(x(\theta, y - p_h), \theta) + z(y - p_h - x(\theta, y - p_h)) \tag{3}$$

The induced preference relation for a household who chooses between public and private schooling is:

$$V(E, \theta, y - p_h) = \max\left[v(E, \theta, y - p_h), w(\theta, y - p_h)\right] \tag{4}$$

3 A digression on sector choice within neighborhoods

This section investigates the channels through which neighborhood effects may affect households choices among public and private education within a particular location (i.e. when residential location is fixed). This analysis is the first contribution of the present paper.

Along the lines of Martínez-Mora (2003), let $\widehat{E}_i$ be the level of public education quality that makes a household living in neighborhood i indifferent among public and private education. $\widehat{E}_i$ is a continuous and differentiable function implicitly defined by $v(\widehat{E}_i, \theta_i, y - p_h^i) = w(\theta_i, y - p_h^i)$. Hence, $\widehat{E}_i$ depends on the household's level of income, the price of housing in the neighborhood and its level of social capital. We can then write: $\widehat{E}_i = \widehat{E}_i(\theta, y - p_h^i)$. Such level of public school quality determines a threshold for the choice among public and private education. For households with income y such that $\widehat{E}_i(\theta, y - p_h^i) > E_i$, the quality of the public school in the neighborhood is not enough and opt for a private alternative of higher quality. For those with a level of income y such that $\widehat{E}_i(\theta, y - p_h^i) < E_i$, in turn, the public school fulfills their demand for school quality and they prefer to use it.

Lemma 1 *1. $\widehat{E}(\theta, y - p_h)$ is monotonically increasing in $y - p_h$, $\forall y > p_h$.*

2. $\widehat{E}(\theta, y - p_h)$ is monotonically increasing (decreasing) in θ if $u_{\theta x}(x, \theta) > 0$ ($u_{\theta x}(x, \theta) < 0$), $\forall y > p_h$.

Proof. 1. Differentiate $v(\widehat{E}(\theta, y-p_h), \theta, y-p_h) = w(\theta, y-p_h)$ with respect to $(y-p_h)$ and solve to obtain:

$$\frac{\partial \widehat{E}(\theta, y-p_h)}{\partial (y-p_h)} = \frac{z'\left[y-p_h-x(\theta, y-p_h)\right] - z'(y-p_h)}{u_E(\widehat{E}(\theta, y-p_h), \theta)} > 0 \tag{5}$$

assumption 3 assures a strictly positive demand for private education when private schooling is chosen. Hence, $y-p_h-x(\theta, y-p_h) < y-p_h$, $\forall y$ and strict concavity of $z(\cdot)$ guarantees that this derivative is positive.

2. Differentiate $v(\widehat{E}(\theta, y-p_h), \theta, y-p_h) = w(\theta, y-p_h)$ with respect to θ and solve to obtain:

$$\frac{\partial \widehat{E}(\theta, y-p_h)}{\partial \theta} = \frac{u_\theta(x(\theta, y-p_h), \theta) - u_\theta(\widehat{E}(\theta, y-p_h), \theta)}{u_E(\widehat{E}(\theta, y-p_h), \theta)} > 0 \tag{6}$$

The sign of this derivative depends on the sign of the numerator, which in turn depends on the sign of the cross-derivative $u_{\theta x}(x, \theta)$. For all $y > p_h$, $x(\theta, y-p_h) > \widehat{E}(\theta, y-p_h)$. Otherwise $\widehat{E}(\cdot)$ could not make this household indifferent between the public school and their most preferred private alternative. This is obvious as private education is costly and reduces consumption of the numeraire. Consequently, if $u_{\theta x}(x, \theta) > 0$ ($u_{\theta x}(x, \theta) < 0$), this derivative will be positive (negative). ■

The first part of the lemma shows that the introduction of neighborhood effects does not alter the way in which income affects households choice among public and private schooling within a particular location with respect to the case without them (see Martínez Mora, 2003). Within a neighborhood, household income is the only source of variation in demand for school quality. Because school quality is normal, richer households demand more school quality. Given the fixed quality level of the public school, households with income above a certain threshold opt out of public education to receive higher quality private schooling. Therefore, the distribution of households across both educational sectors exhibits perfect income segregation within a particular location. This is confirmed by proposition 1:

Proposition 1 *Every neighborhood inhabited by households sending their children to a private school and by others using the local public school, exhibits perfect income sorting across educational sectors, with higher income households sending their children to private schools. These private schools are of higher quality than the local public alternative.*

Proof. Given (E_j, θ_j, p_h^j), let $\widetilde{y}$ be such that $E_j = \widehat{E}(\theta_j, \widetilde{y} - p_h^j)$. Because $\widehat{E}(\cdot)$ is increasing in y, all households with income $y > \widetilde{y}$, satisfy $E_j < \widehat{E}(\theta_j, y - p_h^j)$, and they strictly prefer a private alternative. Households with income $y < \widetilde{y}$, in turn, $E_j > \widehat{E}(\theta_j, y - p_h^j)$, and they strictly prefer the public school. That households in the private sector acquire school services of higher quality is obvious. Otherwise, they not would be willing to leave the *free* public school and to pay for a private alternative. ■

Sector choice is also influenced by the price of housing, the quality of the public school and by neighborhood effects. As in Martínez-Mora (2003), first, the better the local public school the less households opt for a private alternative; on the other hand, the higher the price of housing the lower the level of households' *disposable* income and consequently private school attendance.

There are at least two mechanisms whereby neighborhood effects may affect sector choice. First, they may alter the public school quality threshold above which a household prefers public education ($\widehat{E}$). Second, they may change public school quality itself. Therefore, the answer to the question of how social capital affects opting-out in a single-location setting hinges on how it interacts with school quality in the production of human capital.

Suppose (x, θ) are complements (i.e. $u_{x\theta}(x, \theta) > 0$). This may be, for example, because networking contacts are more likely to be useful if the young receive higher quality schooling, or because children's access to more successful role models makes parents investments in their children's education more beneficial. In this case, exposition to *better* neighborhood effects makes school quality more attractive. Consequently, increases in social capital in a particular neighborhood rise residents' demand for school quality.[7] If school quality and social capital are substitutes (i.e. $u_{x\theta}(x,\theta) > 0$), in turn, the opposite relation holds and increases in the local level of social capital reduce the demand for school quality.

From this analysis, it is possible to extract several lessons about the impact of neighborhood effects over sector choice within single location settings. If (x,θ) are complements (substitutes), a rise in θ, *ceteris paribus*, should increase (decrease) the number of households who are dissatisfied with the local public school. As a result private school attendance should increase (decrease).

As we claimed above, the quality of a public school may be related to the social capital of the neighborhood where it is located and from which it attracts students. Consequently, while the impact of neighborhood socioeconomic composition on households demand for school quality only depends on the sign of $u_{\theta x}(x,\theta)$, its effect on private school attendance also hinges on how the quality of the local public school evolves with θ.

Empirical research on these issues is still scarce. The available empirical evidence suggests that community variables indeed affect sector choice. Lankford and Wyckoff (1997), Lankford, Lee and Wyckoff (1995), Fairlie and Resch (2002) and Conlon and Kimenyi (1991) obtain evidence supporting that more white households

[7] This result provides an explanation of why higher income households demand higher quality education which does not require differences in preferences, information or students ability: apart from income effects, it may be that children from better-off households obtain greater benefits from investments in education because they grow in a better social environment.

choose private schooling where the proportion of black households is higher. Figlio and Stone (2001) find reductions in local crime rates diminish opting-out of public education. Both results can be interpreted as evidence supporting the existence of an inverse relation between social capital and private school attendance. Whether these results arise because public school quality increases with social capital or because social capital and school quality are substitutes or even for both reasons remains unanswered.

4 Residential location choices and housing prices

In this section, we relax the assumption that residential location is fixed. We take the choice between public and private education as given in order to investigate how households in each educational sector choose where to live. The objective is to determine (separately) the segregation patterns that may characterize the equilibrium distribution of both groups of households across neighborhoods. The analysis yields results on how rational residential location choices depend on and shape the equilibrium vector of housing prices and neighborhood qualities $e^* = (\theta_1, p_h^1, \theta_2, p_h^2)$.

In all the analysis below we assume $u(E_1, \theta_1) \neq u(E_2, \theta_2)$. Consider first how households in the public sector choose where to live. From a household point of view locations are characterized by the vector (E, θ, p_h), i.e., by the quality of the public school, the level of social capital in the neighborhood and the price of a house there. Taking this into account, we are able to prove:

Proposition 2 *In equilibrium, given $u(E_i, \theta_i) < u(E_j, \theta_j)$, for $i, j = 1, 2$, $i \neq j$:*

1. If $p_h^i < p_h^j$ and households using public education live in both neighborhoods, they perfectly segregate by income across neighborhoods, with richer households living in neighborhood j.

2. If $p_h^i \geq p_h^j$, all households using a public school live in neighborhood j.

Proof. 1. We first prove that indifference curves of $v(E, \theta, y - p_h)$ in the $(u(E, \theta), p_h)$ plane satisfy a slope rising in income property. Let $M(E, \theta, y - p_h)$ be the slope of indifference curves in such space. This slope is given by:

$$M(E, \theta, y - p_h) = \frac{dp_h}{du(E, \theta)}|_{v=\overline{v}} = -\frac{\partial v(\cdot)/\partial u(E, \theta)}{\partial v(\cdot)/\partial p_h} = \frac{1}{z'(y - p_h)} > 0 \qquad (7)$$

which is increasing in income:

$$\frac{\partial M(E, \theta, y - p_h)}{\partial y} = \frac{-z''(y - p_h)}{z'(y - p_h)^2} > 0 \qquad (8)$$

As a consequence, indifference curves of households with different levels of income cross at most once in $[u(E, \theta), p]$ space (see figure 1)[8]. On the other hand, given that $v(\cdot)$ is continuous in income, if both neighborhoods are inhabited by households attending the public school, there must be a level of income $\widetilde{y}^u$ that makes households indifferent between both alternatives. The single-crossing property then implies that all households with income $y > \widetilde{y}^u$ strictly prefer to live in the neighborhood with the highest housing price -neighborhood j-, and that households with income $y < \widetilde{y}^u$ strictly prefer to live in the one with the lowest housing price -neighborhood i (this is formally proved for example in Epple et al., 1993).

2. Simply note that in this case $v_i(E_i, \theta_i, y - p_h^i) < v_j(E_j, \theta_j, y - p_h^j)$, $\forall y > p_h^i, p_h^j$.

■

If housing prices were equal in both neighborhoods, every household choosing a public school would prefer to live in the neighborhood offering the combination of public school quality and social capital yielding the largest $u(E, \theta)$. Therefore, if both neighborhoods have households using their public school, housing prices must

[8]Moreover, it is straightforward to prove that these indifference curves are strictly concave:
$$\frac{d^2 p}{du(Q, \theta)^2}|_{v=\overline{v}} = \frac{z''(y - p)}{z'(y - p)^3} < 0$$

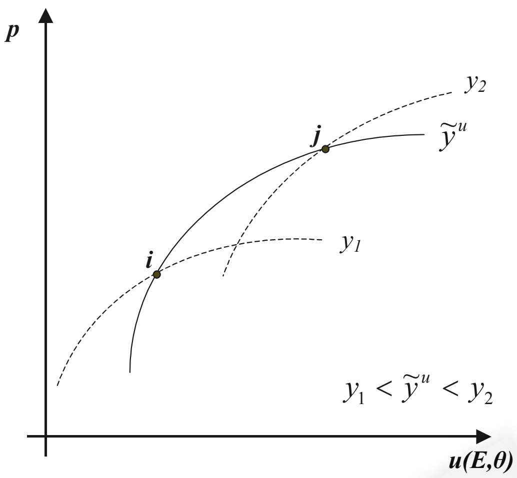

Figure 1

compensate the utility gap stemming from public school and neighborhood quality differences. In other words, neighborhood j must have a higher price of housing for the economy to be in equilibrium. On the other hand, perfect income segregation arises because richer households are willing to offer higher bids for a house in the best neighborhood (j). They do so because their marginal valuation of numeraire consumption is lower.

Proposition 2 provides a single-crossing condition guaranteing the emergence of prefect income segregation across locations when they differ along more than two dimensions[9]. This condition constitutes by itself a contribution of this paper. It depends on one assumption in the model apart from separability of utility. It is the assumption that houses are homogenous and of fixed size. If housing were malleable

[9] Epple and Sieg (1999) and Epple et al. (2001) follow a similar approach. These authors suppose communities provide a single composite good which incorporates locally provided goods, environmental amenities and other community attributes. Their single-crossing condition is then defined over this composite good and the gross-of-tax price of housing.

and households could optimally choose and adjust the size of their houses, this result would not be obtained without further assumptions. The assumptions needed are not stringent, however. For example, if utility is defined as $U(Q, \theta, h, b) = u(Q, \theta, h) + z(b)$, where h stands for housing and $z(\cdot)$ is strictly concave, it can be shown that a necessary and sufficient condition for this result is that the price elasticity of housing demand be smaller than one in absolute terms. This result also extends to models with n locational attributes. Furthermore, the available empirical evidence about the price elasticity of housing demand strongly supports the necessary and sufficient (see Whitehead, 1999, for a review).

Importantly, note that proposition 2 does not require either $E_i < E_j$ or $\theta_i < \theta_j$, although at least one of these inequalities must be satisfied. Suppose for example that $E_i > E_j$, $\theta_i > \theta_j$, with $u(E_i, \theta_i) < u(E_j, \theta_j)$. If this is so and the economy is in the case in part 1 of proposition 2, richer households in the public sector will reside in neighborhood j, where the public school is worse. They are willing to give up on some consumption of school quality in order to enjoy larger levels of social capital. Hence, our model with neighborhood effects shows that, for households using a public school, a higher level of household income does not always mean consumption of higher quality education.

We now investigate location choices of households who opt for a private school. The analysis provides results on how they allocate themselves to neighborhoods. Moreover, their rational behavior imposes further restrictions on the equilibrium vector of housing prices and neighborhood qualities.

The slope of indifference curves corresponding to households who acquire private education: $w(\theta, y - p_h)$ in (θ, p_h) space is given by:

$$S(\theta, y - p_h) = \frac{dp_h}{d\theta}|_{w=\overline{w}} = -\frac{w_\theta(\theta, y - p_h)}{w_{p_h}(\theta, y - p_h)} = \frac{u_\theta(x(\theta, y - p_h), \theta)}{z'(y - p_h - x(\theta, y - p_h))} > 0 \quad (9)$$

It is equal to the marginal benefit of social capital in terms of the numeraire. Therefore, in response to a marginal increase in θ, a household using a private school is willing to increase its bid for housing in an amount equal to the marginal benefit they obtain from social capital.

The allocation of households opting for a private school to neighborhoods will exhibit perfect income segregation if $S(\theta, y - p_h)$ varies monotonically with income. More specifically, for richer households to live in neighborhoods with higher levels of social capital (and housing prices), it must be monotonically increasing in income. That is to say, richer households must obtain a larger marginal benefit of social capital in terms of the numeraire. This slope varies with income according to:

$$\frac{\partial S(\theta, y - p_h)}{\partial y} = \frac{u_{\theta x}(x(\cdot), \theta)\frac{\partial x(\cdot)}{\partial y} z'(y - p_h - x(\cdot)) - u_\theta(x(\cdot), \theta) \cdot z''(y - p_h - x(\cdot))}{z'(y - p_h)^2} \tag{10}$$

This expression is not necessarily positive. We consequently adopt the following plausible assumption:

Assumption 4 *$S(\theta, y - p_h)$ is monotonically increasing in y.*

It is straightforward to show that a sufficient condition for assumption 4 to hold requires school quality and neighborhood social capital to be complements or unrelated goods, i.e. $u_{\theta x}(x, \theta) \geq 0$.

Proposition 3 makes use of assumption 4 to establish optimal residential choices of households who send their children to a private school.

Proposition 3 *In equilibrium, given $\theta_i < \theta_j$, for $i, j = 1, 2$, $i \neq j$, if assumption 4 is satisfied:*

1. If $p_h^i < p_h^j$ and both neighborhoods are inhabited by households using a private school, these households perfectly segregate by income across neighborhoods, with richer households living in neighborhood j.

2. If $p_h^i \geq p_h^j$, all households using a private school live in neighborhood j.

Proof. 1. By assumption 4, indifference curves corresponding to different levels of income cross each other at most once in (θ, p_h) space (see figure 2). If neighborhoods i and j are both populated by households who acquire private education, continuity of $w(\cdot)$ implies that there exists a level of income $\widetilde{y}^r$ that makes households choosing a private school indifferent between both locational alternatives. The single-crossing condition then implies that all households in the private sector with income $y > \widetilde{y}^r$ strictly prefer to live in the neighborhood with the highest housing price -neighborhood j-, and that all of them with income $y < \widetilde{y}^r$ strictly prefer to live in that with the lowest housing price -neighborhood i (again, this has been formally proved for example in Epple et al., 1993).

2. Clearly, in this case, $w_i(\theta_i, y - p_h^i) < w_j(\theta_j, y - p_h^j)$, $\forall y > p_h^i, p_h^j$. ■

Because households opting-out of public education only care about the social interactions they are exposed to in different locations, they value more those neighborhoods with higher levels of social capital. Consequently, if this group is present in both neighborhoods, housing prices must compensate the social capital gap between neighborhoods, i.e. they will be higher where the level of social capital is higher. Proposition 3 also reveals that, under assumption 4, in equilibria in which both neighborhoods have residents using a private alternative, this group of households will also be perfectly segregated by income across neighborhoods. Moreover, richer households will be living in the neighborhood with the larger pair (θ, p_h) -neighborhood j, say. This occurs because assumption 4 guarantees higher income households are willing

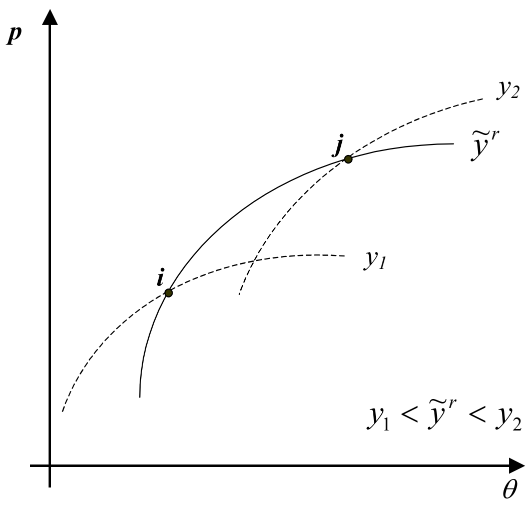

Figure 2

to offer higher bids for a house in that neighborhood. This assumption holds if (x, θ) are complements or unrelated goods, something not assured if they are substitutes.

The intuitive explanation is the following: in response to an increase in θ, households opting-out of public education are willing to increase their bids for a house in a given neighborhood in an amount equal to the marginal benefit of θ in terms of the numeraire. How this marginal benefit varies with income depends on how the marginal utility of social capital and of the numeraire change with income. Given the preference configuration in the model, richer households always have a lower marginal valuation of the numeraire. Moreover, if (x, θ) are complements or unrelated goods, marginal utility of social capital is non-decreasing in income. This is because, as x is normal, the amount of this good a household acquires increases with income, which in turn rises marginal utility of social capital if these goods are complements or does not change it if they are independent. On the other hand, marginal utility of social capital may fall with income if (x, θ) are substitutes. The reason is that as income rises, consumption of school quality also increases and the household places a lower marginal value on social capital.

5 Equilibrium neighborhood configurations

In this section, we ask whether and under which circumstances the distribution of households with different income to neighborhoods exhibits income mixing in our model. We investigate this issue by focusing on equilibria in which some households opt out of the public system and others remain using a public school. It is immediate to show that all stable equilibrium in which no household opts for the private sector exhibits perfect income sorting across neighborhoods. Moreover, in such equilibrium, high income households live in the neighborhood with the highest quality public school, which consequently has the highest level of social capital. For exposition purposes, we also restrict attention to empirically relevant equilibria in which the poorest households in the economy prefer a public school over any private alternative.

Our definition of income mixing (see section 2) requires at least one neighborhood to be populated by households from at least two separated income intervals. Lemma 2 states a necessary condition for the emergence of income mixing within neighborhoods.

Lemma 2 *For income mixing to characterize equilibrium some households with higher income than the highest income households choosing* PUB2 *(i.e. living in neighborhood 2 and using its public school) must live in neighborhood 1 and acquire private education.*

Proof. For a neighborhood to be populated by households from at least two separated income intervals, households' location choices between neighborhoods 1 and 2 must change at least twice as income grows. For neighborhood choices to change at least twice as income grows, in turn, there must be households living in 1 with higher income than a set of those living in 2. We prove that the only possibility for this to occur is that stated in the lemma. Proposition 2 establishes that if households with income y' prefer *PUB2* over *PUB1*, those with income $y > y'$ also prefer *PUB2*. By proposition 3, if households with income y'' prefer *PR2* to *PR1*, those with income $y > y''$ also prefer *PR2*. Furthermore, it is immediate to show that the same occurs with alternatives *PR2* and *PUB1*: if households with income $\widehat{y}'''$ prefer *PR2* to *PUB1* all households with income $y > y'''$ prefer *PR2* too. Therefore, there exists only one possibility for location choices to change from 2 to 1 as income rises: some households with higher income than those choosing *PUB2* must opt for *PR1*, i.e. live in neighborhood 1 and acquire private education. ∎

In our model, the neighborhood attributes households in the public sector value are the quality of the public school and the level of social capital. Households using a private school, in turn, only care about social capital. Keeping this in mind, and given $E_1 < E_2$ there exist three different configurations of neighborhood characteristics, depending on the difference among θ_1 and θ_2. First, the neighborhood endowed with the best public school may have the highest level of social capital and, thus, provide the most beneficial neighborhood effects. That is to say:

(a) $\theta_1 < \theta_2$, which implies $u(E_1, \theta_1) < u(E_2, \theta_2)$.

Clearly, in this case all households in the economy would like to live in neighborhood 2 if housing prices were equal in both neighborhoods. Obviously, space restrictions make this impossible and housing prices act as screening devices that allocate households to locations.

Alternatively, neighborhood 1 demographic composition may generate the most beneficial externalities. Two possibilities arise, as the larger level of social capital may be enough or not to compensate households in the public sector for the lower quality of neighborhood 1 public school. That is to say, either:

(b) $\theta_1 > \theta_2$, with $u(E_1, \theta_1) > u(E_2, \theta_2)$; or

(c) $\theta_1 > \theta_2$, with $u(E_1, \theta_1) < u(E_2, \theta_2)$.

Case (b) is similar to case (a) in the sense that all households have incentives for living in the same place. In this situation, if housing prices were equal across locations all households would prefer to live in neighborhood 1. Again, housing prices would serve to select which households end up living there. In case (c), in turn, households in both educational sectors have *ex-ante* opposing preferences for neighborhoods. For equal housing prices, households who send their offspring to a private school have a preference for living where the level of social capital is larger (neighborhood 1). On the other hand, households who choose a public school prefer living in 2. The higher quality of the public school there compensates them for the lower level of social capital.

For the purposes of the analysis it is convenient to classify these cases on the basis of the incentives structure they generate for households in both educational sectors. According to this criterion, it is possible to distinguish between:

(1) Situations in which all households (those using a public school and those opting for a private alternative) have incentives to live in the same neighborhood (cases a and b).

(2) Situations in which the incentives households in the private sector have are opposite to those of households using a public school (case c).

Case (c) Proposition 4 states a necessary and sufficient condition for income mixing to arise in equilibria in which the economy is in case (c). Let n^u, n^r,

n^1, n^2 denote, respectively, the mass of households using a public school, the mass of households choosing a private option, and each neighborhood's capacity. For simplicity sake, we will denote $v_i(E_i, \theta_i, y - p_h^i)$ and $w_i(\theta_i, y - p_h^i)$ as $v_i(y)$ and $w_i(y)$, respectively.

Proposition 4 *In equilibria in which $E_1 < E_2$ and $\theta_1 > \theta_2$ with $u(E_1, \theta_1) < u(E_2, \theta_2)$, income mixing will characterize equilibrium if and only if $n^r < n^1$.*

Proof. We first show that income mixing indeed characterizes equilibrium when $n^r < n^1$ if $\theta_1 > \theta_2$:

Note that if $n^r < n^1$ (and hence $n^u > n^2$), $p_h^1 \geq p_h^2$ cannot hold in equilibrium. The reason is that all households in the public sector would want to live in 2, but that neighborhood capacity is insufficient. In turn, $p_h^1 < p_h^2 \Rightarrow w_1(y) > w_2(y)$, $\forall y > p_h^2$. Hence, all households using a private school live in 1. Moreover, because $n^u > n^2$ both neighborhoods are inhabited by households in the public sector. Proposition 2, part 1, then implies that these households are perfectly segregated by income across neighborhoods, with low income ones living in 1. Finally, note that $\theta_1 > \theta_2$ requires households from the highest income interval to mix in neighborhood 1 with low income households. That is to say, requires the richest households in the economy to opt for a private school. Otherwise, again by proposition 2, they would form the set of households living in 2 and this neighborhood's mean income would be the largest, contradicting $\theta_1 > \theta_2$.

Now we prove that in any other situation equilibrium will exhibit perfect income segregation. This must hold if either $n^r > n^1$ or $n^r = n^1$:

- $n^r > n^1 \Rightarrow p_h^1 > p_h^2$. To prove it note that if p_h^1 were lower or equal to p_h^2 all households using a private school would prefer to live in 1, where land is not enough for housing all of them. In this case some households using a private school must live in 2. The lower housing price in neighborhood 2 compensates them for the lower level of social capital they enjoy there. Proposition 3, part 1, then implies that in this case, households opting for a private alternative are perfectly segregated by income across neighborhoods, with higher income ones living in 1. On the other hand, $p_h^1 > p_h^2 \Rightarrow v_2(y) > v_1(y)$, $\forall y > p_h^1$. Hence, all households in the public sector reside in 2. Finally, note that by proposition 1 if a neighborhood is inhabited by households who use the local public school and by households who choose instead a private alternative, it exhibits perfect income segregation across schools, with higher income households sending their youths to a private school. All this implies the following segregation patterns (from left to right we specify households' choices as income grows from $\underline{y}$ to $\overline{y}$): *pub2-pr2-pr1.*

- If $n^r = n^1$ and $p_h^1 \geq p_h^2$, $v_2(y) > v_1(y), \forall y > p_h^1$. Hence, all households using a public school live in 2, while those opting for a private one locate in 1. On the other hand:

$$\frac{\partial v_2(y)}{\partial y} = z'(y - p_h^2) \tag{11}$$

and

$$\frac{\partial w_1(y)}{\partial y} = z'(y - p_h^1 - x_1(\theta_1, y - p_h^1)) \tag{12}$$

By assumption 3 $x_1(\cdot) > 0 \; \forall y > p_h^1$ which, given $p_h^1 \geq p_h^2$, entails $y - p_h^2 > y - p_h^1 - x_1(\theta_1, y - p_h^1)$. Strict concavity of $z(b)$, then, implies that $w_1(y)$ grows faster than $v_2(y)$ with income. Given that each option is preferred by a set of households in the economy, continuity of direct and indirect utility functions implies the existence of an income level $\widetilde{y}$ which makes households indifferent between both alternatives. It is straightforward to show that this income level satisfies: $v_2(y) > w_1(y)$, $\forall y < \widetilde{y}$ and $w_1(y) > v_2(y)$, $\forall y > \widetilde{y}$.

- Finally, if $n^r = n^1$ and $p_h^1 < p_h^2$, $w_1(y) > w_2(y), \forall y > p_h^2$. Consequently, all households choosing a private school live in 1, while those using a public option locate in 2. Because households with the lowest level of income in the economy prefer a public option by assumption, $v_2(\underline{y}) > w_1(\underline{y})$. Again, as each option is preferred by a set of households in the economy, continuity of direct and indirect utility functions implies the existence of at least one level of income $\widetilde{y}$ which makes households indifferent between both alternatives and below which households prefer *PUB2*. This implies $w_1(y)$ crosses $v_2(y)$ from below in (y, U) space at $y = \widetilde{y}$. Given strict concavity of $z(b)$ this will only happen if $\widetilde{y} - p_h^2 > \widetilde{y} - p_h^1 - x_1(\theta_1, \widetilde{y} - p_h^1)$. And, as school quality is a normal good, this implies $y - p_h^2 > y - p_h^1 - x_1(\theta_1, y - p_h^1)$ and $w_1(y) > v_2(y)$, $\forall y > \widetilde{y}$. Therefore, all households with income above $\widetilde{y}$ choose *PR1* and the allocation of households to neighborhoods exhibits perfect income segregation.

■

In case (c) the relative mass of households choosing each educational sector is determinant. If the mass of households opting for a private school who live in neighborhood 1 is smaller than that neighborhood capacity and make $\theta_1 > \theta_2$, income mixing will characterize equilibrium.The properties equilibria of this type satisfy are similar to those of a model without neighborhood effects (see Martínez-Mora, 2003 for the kind of segregation patterns that may emerge in this equilibria). Households acquiring private education prefer living in the neighborhood with the lowest price of housing where they mix with low income households. Such an allocation of households to locations is sustained as an equilibrium because the resulting demographic composition generates more beneficial externalities in neighborhood 1. That is to say, because the mix of low and high income households in neighborhood 1 yields a higher level of mean income. The interesting and counter-intuitive conclusion one can draw from proposition 4 is that *neighborhood effects in some circumstances strengthen the incentives for income mixing private education introduces in residence-based public schooling systems*. Nevertheless, if the mass of households in the private sector exceeds (or if it is equal to) the capacity of the neighborhood endowed with the worse public school, equilibrium will be characterized by perfect income segregation. The reason is that low income households are outbid from neighborhood 1 and live in 2, where they use the local public school. In this case, the segregation patterns that arise in equilibrium are (from left to right we specify households' choices as income grows from $\underline{y}$ to $\overline{y}$): *pub2-pr2-pr1*, if $n^r > n^1$, or *pub2-pr1*, if $n^r = n^1$. Hence, *neighborhood effects can also bring back the classical perfect income segregation result from urban public finance models without private alternatives.*

Cases (a) and (b) As we explained above, the analysis of cases (a) and (b) is equivalent. For this reason, we just analyse case (a). To begin with, we state the following lemma about the equilibrium behavior of housing prices:

Lemma 3 *In equilibria in which both $E_1 < E_2$ and $\theta_1 < \theta_2$: $p_h^1 < p_h^2$.*

Proof. This result follows directly from propositions 2 and 3. ■

In case (a) parents choose among the four school sector-location alternatives (*PUB1*, *PR1*, *PUB2* and *PR2*). They face several trade-offs when making this choice. Public education is tuition-free but the private sector can offer higher quality schooling. Parents may opt for a higher quality public school instead but this is made at a cost as housing prices are usually higher the better the neighborhood public school.

Location choice is also related to neighborhood demographic composition. Housing in neighborhood 1 is cheaper but the externalities a household is exposed to are more beneficial in neighborhood 2.

Due to the richness of the model, different types of segregation patterns across neighborhoods may arise in equilibrium. Given the objectives of this paper, we will simply show that some of them lead to income mixing while others exhibit perfect income segregation. We will prove this through two examples of equilibrium, as the theoretical analysis becomes intractable soon. We consider an economy described by the model in section 2 with two neighborhoods. We assume the following separable utility function represents households preferences:

$$u(x, \theta, b) = \frac{1}{1-\sigma}\left[b^{1-\sigma} + \delta x^{1-\sigma} + \gamma \theta^{1-\sigma}\right]; \sigma, \delta, \gamma > 0 \tag{13}$$

This utility function is strictly concave for $\sigma, \delta, \gamma > 0$. Further, we suppose the income distribution function is a uniform distribution. Finally, we assume the function relating a neighborhood's mean income with its level of social capital is:

$$\theta = \eta + \phi(\overline{y}); \phi > 0 \tag{14}$$

Example 2 in table 1 demonstrates that income mixing may characterize equilibrium in such case. However, example 1 proves that this is not guaranteed, as perfect income segregation may also be the outcome of the model. The explanation is the following: there may exist high income households whose demand for school quality exceeds the level offered by the best public school and consequently decide to send their children to a private school. As for choosing where to live, these households must balance neighborhood quality (which is higher in 2) against housing prices (lower in 1). If some of them prefer the combination offered by neighborhood 1, as in example 2, income mixing will arise. If not, as it happens in example 1, equilibrium will be characterized by perfect income segregation.

Table 1. Examples of equilibrium

	Example 1 Perfect income segregation	**Example 2** Income mixing
Public school quality 1 (E_1)	2.5	2
Public school quality 2 (E_2)	2.8	2.5
Social capital 1 (θ_1)	4	5.4
Social capital 2 (θ_2)	7	6
Social capital function parameters	*ϕ=0.060* *η=2.626*	*ϕ=0.341* *η=3.684*
Mean income 1	*22.9*	*50.24*
Mean income 2	*72.9*	*67.81*
Price of housing 1 (p_h1)	3	3
Price of housing 2 (p_h2)	4.5	4.3
Community 1 size (N_1)	0.358	0.733
Community 2 size (N_2)	0.642	0.267
Segregation patterns*	pub1-pub2-pr2	pub1-pub2-pr1-pr2
Border incomes**		
b_1	40.8	44.7
b_2	77.8	64
b_3	-	97.2

Parameters: σ=2.23; δ=0.0032; γ=0.005
Uniform income distribution function: y_{min}=5; y_{max}=105

*From left to right we specify households' choices as income grows.

**b_1:highest income households choosing PUB1;
b_2:highest income households choosing PUB2;
b_3:highest income households choosing PR1.

Therefore, while private education is a necessary condition for income mixing, neighborhood effects may prevent it from generating an allocation of households to neighborhoods which does not exhibit perfect income segregation. Unfortunately, as n^u, n^r, θ_1 and θ_2 are endogenous variables, there is nothing exogenous that determines whether income mixing will characterize equilibrium or not. In fact, as in most models with neighborhood effects (Durlauf, 2004), the existence of multiple equilibria exhibiting different segregation patterns seems to be the natural outcome of this model.

6 Concluding remarks

This paper has analysed how neighborhood effects and private education interact in shaping the allocation of households to neighborhoods and schools in an urban setting with a residence-based public education system. One objective was to investigate the possibility that private education reduces income segregation across neighborhoods. As a by-product, the analysis also provided interesting results about the impact of neighborhood effects on sector choice within a given location.

With respect to the latter issue, the analysis clarified how the interactions between social capital and school quality in the process of human capital accumulation may affect sector choice. If social capital and school quality are complements in generating human capital, demand for school quality will be larger the higher the local level of social capital. If the quality of the local public school is fixed, then, this will increase private school attendance. If on the contrary, social capital and school quality are substitutes in the human capital production function, a larger level of social capital will reduce demand for school quality. This effect would, *ceteris paribus*, lead to lower private school attendance rates. Finally, if public school quality increases with social capital as it may well happen, higher levels of social capital would, *ceteris paribus*, reduce the number of households opting-out of public education. Therefore, private school attendance may rise or fall in response to an increase in the level of social capital. We commented on some empirical evidence which suggests the existence of an inverse relationship between social capital and private school attendance. Whether these results arise because public school quality increases with social capital, because social capital and school quality are substitutes or for both reasons remains nevertheless unanswered. More empirical research on the issue is therefore needed.

Regarding the other question of interest to this paper, the analysis yielded the following results. First of all, it provided a simple technical condition guaranteeing the emergence of perfect income segregation across locations when these differ along more than two dimensions (in this case social capital, public school quality and housing prices) and there are no private alternative. Second, it revealed that, in urban economies, a higher level of household income does not automatically lead to consumption of higher quality schooling. Suppose the best out of two neighborhoods in terms of their level of social capital has a public school of lower quality. If the difference in social capital is large enough so as to compensate households using a public school for the difference in school quality, higher income households will renounce to some school quality in order to live where social capital provides more beneficial contextual effects. Third, the analysis showed that private education is not sufficient for the emergence of income mixing within neighborhoods. We showed that private education cannot guarantee that perfect income segregation across neighborhoods does not arise in equilibrium. The reason is that neighborhood effects constitute a segregating force by themselves and may inhibit incentives households opting-out of public education have to live in low housing price-low income neighborhoods. This may occur if better public schools are located in neighborhoods providing more beneficial contextual effects. If this is not the case, neighborhood effects will indeed promote income mixing within neighborhoods.

To sum up, this investigation suggests that whether private education induces income integration across neighborhoods or not depends on the kind of equilibrium to which the economy tends. Further resarch about which factors determine the emergence of each type of equilibrium should provide interesting additional insights. More generally, empirical research on the impact of private education on the levels of income segregation across neighborhoods is necessary.

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