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Residential Segregation: A Literature Review

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Abstract

This essay presents a literature review about residential segregation. Given the vast extension of it, the focus has been on those works that we have considered either more influential or with the potential to define the new trends of this kind of research. We have classified the literature into the following subjects: definitions, measures, causes and consequences. Our main conclusions are that the measurement and description of segregation must be based upon techniques that incorporate spatial factors; it is crucial to use individuals interactions and social dynamics models in order to understand the segregation causes and consequences; it is necessary to consider general equilibrium models, with endogenous location decisions and the interaction of relevant markets to shed light on the segregation consequences upon the society as a whole and to evaluate any policy designed to deal with it.

JELCodes: R, R14, R31, R34 y R38.

Key words: Residential Segregation, Urban Economics.

1 Introduction

The first academic work dealing with residential segregation (**RS** hereafter) is Park (1926). Since then, an important quantity of research on this topic has been done. One of the aims of the present essay is to classify this literature. To see whether it is dedicated to cast a light on **RS** definition, its measures and both its causes and its consequences. In all these subjects, both empirical and theoretical research, has been conducted. With regards to the amount of investigation done on each one of them, by far the emphasis has been placed on **RS** measures, meanwhile the literature's focus on causes and consequences has been more limited. Amongst the possible explanations about this fact it is feasible to think of the lack of formal

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models or econometric techniques and data bases (Bayer et al., 2004a). Nonetheless, during recent years, some important developments on economic and econometric theory applied to social interactions and social dynamics have occurred, and have been useful to incorporate new individuals' behaviour concepts into formal models which have facilitated the empirical and theoretical analysis of **RS** (Durlauf and Young, 2001; Meen and Meen, 2003). Because of these reasons, a new and interesting research avenue has been opened , based on the concepts previously mentioned , which has allowed to restart the study of this phenomenon putting a particular emphasis on both its causes and its consequences.

Due to the extensive amount of research, the focus of this essay has been limited to two subjects. First, to establish a taxonomy of this literature, classifying it in a simple and easy way in order to allow any economist to be able to understand its basis and the main facts related to it. Second, to draw the reader's attention to the most important new advances of this kind of investigation, and what the future tendencies may be.

According to these aims this essay is organised as follows. The first section is dedicated to **RS** definitions. Then, it develops the topic of **RS** measures which explains the main characteristics of all the different indices that have been proposed by the literature to identify the level of segregation of a given urban area. In the next section an analysis of what has been done concerning the causes of **RS** is presented. Then, the analysis is focused on the consequences of **RS**. Finally, conclusions are presented.

2 RS Definition

The most general **RS** definition that it is possible to find talks about the level of dispersion of a particular group in a given geographical area. Park (1926) presents the very first definition. He says that **RS** is the link that exists between both the social distance and the physical distance. White (1983) defines **RS** as the existing distance amongst those areas inhabited by different social groups. Jargowsky (1996) defines **RS** as the concentration level of social groups in given areas of the city. Sabatini et al. (2001) says that **RS** is the extent of spatial proximity, or territorial agglomeration, of households belonging to the same social groups, where a social group can be understood in terms of race, age, religion or income. Rodríguez (2001) indicates that **RS** corresponds to the level of concentration of different social groups in specific city areas. As one

can see, there is no consensus on an unique definition of **RS**. However, the work that arrives closest to a universal definition is Massey and Denton (1988). In this article **RS** is presented as the result of different social phenomena interactions. This idea relies upon the concept that urban spatial social structures is inherently multidimensional (Timms, 1971). Specifically, the **RS** definition is based on five dimensions: evenness, exposure, clustering, centralisation and concentration. The main characteristic of this work is the clarity and richness with which **RS** has been addressed. Accordingly, it is possible to say that in one way or another all the **RS** definitions that have been found in literature are included in these five dimensions. These elements have made this work one of the most influential in **RS** literature and not just with respect to how to define this phenomenon but also with respect to how **RS** can be measured, as it will be seen later on. The five Massey and Denton (1988) dimensions definitions are the following:

- *Evenness*: it refers to the distribution differences between two groups over geographical units, as census tracts, inside a city. A minority group will be segregated if it is unevenly distributed over the geographic units. The evenness will be maximised, and hence the **RS** minimised, when every geographic unit has the same proportion of the minority group that the city as a whole has . For instance, if in the city as a whole the minority group proportion is 20% in order to have a full evenness, every geographic unit must have also a minority group proportion of 20%.

- *Exposure*: corresponds to the degree of potential contact, or the interaction possibility, between a minority group and the remaining population within a geographic area or city. Although exposure looks similar to evenness, they are conceptually different, because the latter takes into account the relative size of the groups that are compared.

- *Concentration*: is the amount of relative physical space occupied by a minority group in either a given geographical area or city. Those groups that occupy a small part of the total area will be segregated.

- *Centralisation*: has to do with the degree of proximity of the place where a minority group lives to the city centre.

- *Clustering*: is the degree of agglomeration of those areas inhabited by a minority group.

It measures the extent at which a minority group lives, unbalanced, in contiguous areas. Although it seems to be similar to Centralisation, they are not. The difference rely on the fact that Concentration exists, for instance, when a minority group lives just in two census tracts within a city without considering whether these two census tracts are contiguous or not, as Clustering exists when not only the minority group lives in two census tracts but when these two census tracts are contiguous.

In order to have a clearer picture of the differences that exist between all the dimensions explained above, figures 1, 2 and 3 illustrate high and low segregation situations for each one of them. Every one of these figures shows the distribution of households within a hypothetical city. The black squares represent the minority group and the white squares represent the majority group. Dimensions are arranged in column, so in figure 1 column "**a**" represents evenness and column "**b**" represents exposure. The upside hypothetical city in every column shows high levels of segregation meanwhile the downside city shows low levels of segregation, so, following with figure 1 example, the upside city in column "**a**" shows high levels of segregation related to evenness and the downside one in column "**a**" illustrates a case of low segregation related to the same dimension. The column "**b**" of figure 1 shows high (upside city) and low (downside city) degree of segregation related to exposure measured as isolation. Figure 2 illustrates concentration in column "**a**" and centralisation in column "**b**". Finally, figure 3 presents the clustering dimension. This figure is very useful to clarify the difference between concentration and clustering. As can be appreciated in figure 2 column "**a**" concentration arises when minority group occupies a small proportion of land within the city, it does not matter if this small areas are contiguous or they are not, meanwhile, as can be appreciated in figure 3 upside city, clustering arises when the minority group live in neighbourhoods that are contiguous.

As it can be seen, this approach widely covers the main possible aspects of **RS** and it has not been possible to find in literature a more complete definition than this one. As a matter of fact, Massey et al. (1996) revisited this multidimensional approach and reconfirmed its validity.

The importance of these results does not rely just upon the possibility of having a better understanding of the **RS** concept, but has allowed for empirical analysis. Within the latter, economists' work has been focused, mainly, on the study of evenness and exposure. A possible explanation for this fact can be, as it is discussed later on, that it is easier to get indices to

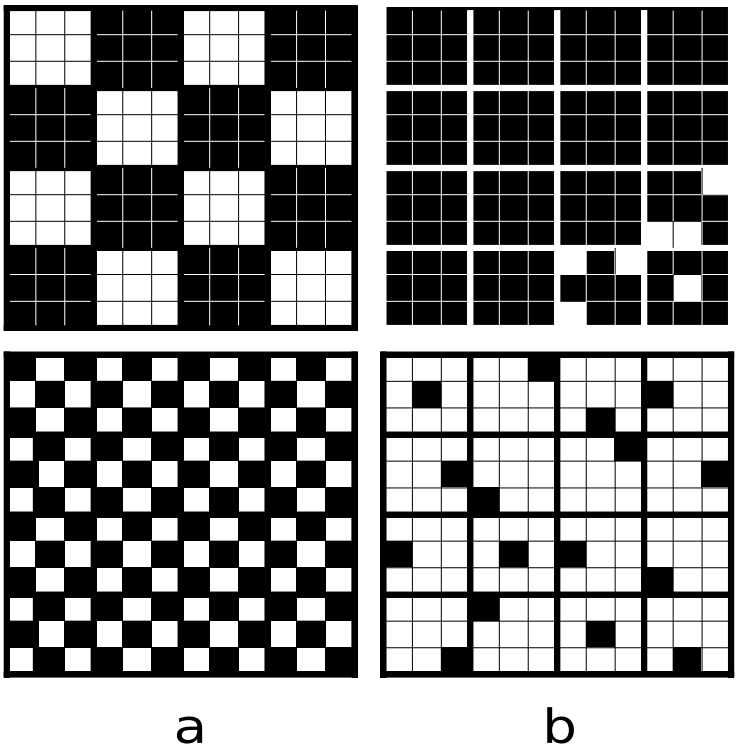

Figure 1: High and Low segregation with evenness and exposure

measure and to study these **RS** dimensions than to get indices for the reminding dimensions. However, as Echenique and Fryer (2007) pointed out, there is a feature that makes these two dimensions interesting to work with: only these two dimensions can take into account the effects of **RS** on social interactions.

3 RS measures

As Reardon and Firebaugh (2002) indicates, the first systematic and critic endeavour for doing a deep analysis on indices and measures of **RS** is the work presented by Duncan and Duncan (1955). One of their main conclusions is that there is few information of **RS** indices that is not contained in the index of dissimilarity. Later on Taeuber and Taeuber (1965) reaches the same conclusion. One of the main consequences of this was the popularisation of its use. Despite this conclusion, during a long period of time there was no such a thing as a consensus about one particular way of measuring **RS** and several different authors based their investigation on

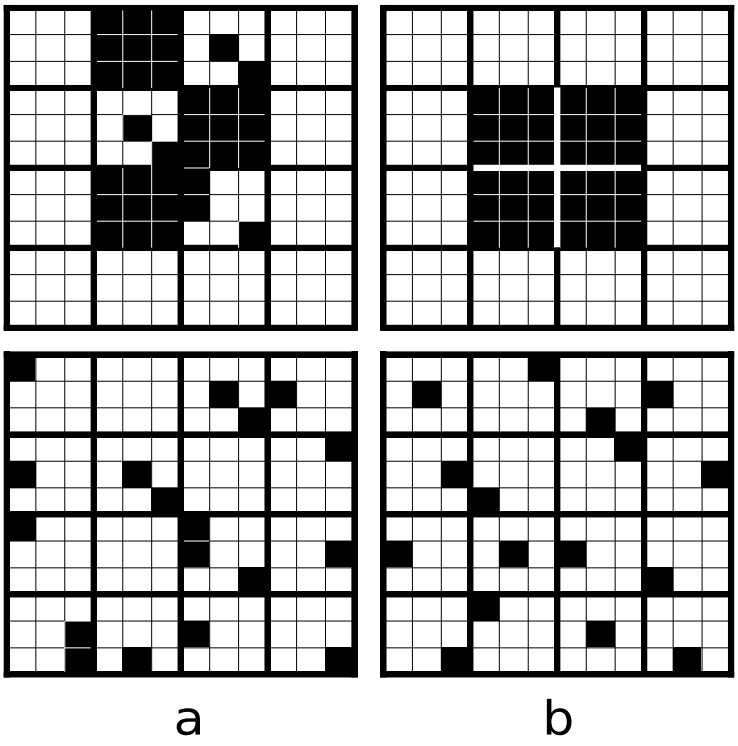

Figure 2: High and Low segregation with concentration and centralisation

different **RS** definitions and different **RS** measures. For instance, Bell (1954), Farley (1984), Farley (1977), Lieberson and Carter (1982a) and Lieberson and Carter (1982b) did their research based on the index of exposure. Coleman et al. (1982) and Zoloth (1976) conducted research using the variance ratio applied to **RS** and applied to educational segregation. Thus, during the 70s and 80s, it was possible to watch an avid discussion with respect to virtues and defects of **RS** indices. Some interesting examples of this debate are Cohen et al. (1976); Coleman et al. (1982); Cortese et al. (1976); Falk et al. (1978); James and Taeuber (1985); Kestenbaum (1980); Lieberson and Carter (1982b); Morgan (1983); Taeuber and Taeuber (1976); Winship (1977, 1978).

A crucial advance to this discussion was James and Taeuber (1985). This work develops a set of four criteria whose aim is to evaluate the performance of the different indices of **RS**. The four criteria, which indicate how RS indices must react to changes in the groups' distribution between geographical sub areas, are:

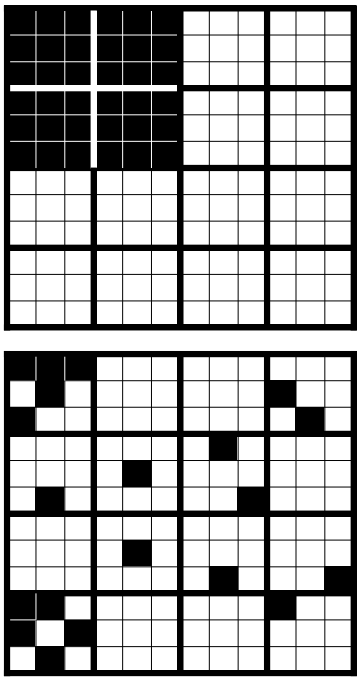

Figure 3: High and Low segregation with clustering

1. Organisational equivalence: if one geographical sub area is divided into k units, every one of these new units with the same groups proportion of the original area, **RS** does not change. The same happens if k geographical sub areas with the same group proportion are merged into one single area.

2. Size invariance: if the number of individuals in each group within each geographical sub area is multiplied by a constant factor **RS** remains the same.

3. The principle of Transfers: if an individual belonging to one group is moved from one geographical sub area to another, where the proportion of persons of this group is greater in the sub area of origin than the sub area where the individual arrives to, then **RS** is reduced.

4. Composition invariance: if the number of individuals of one group in each geographical sub area increases by a constant factor and the number and distribution of individuals of all other groups is unchanged, **RS** is unchanged.

This criteria also demonstrates that indices that are highly correlated in empirical studies may nonetheless behave very different under certain circumstances, such as when the population shares of groups change.

Massey and Denton (1988), using factor analysis classify **RS** indices according to the five dimensions that they proposed. Besides, applying empirical and conceptual criteria they determine which index is the best for each one of these five dimensions.

This analysis was carried out for 20 indices, which is a bigger figure than the five indices analysed by James and Taeuber (1985). Massey and Denton (1988) came to the conclusion that the most suitable measures for each dimension are respectively: the index of dissimilarity, the index of exposure, relative concentration, absolute centralisation and spatial proximity. The remaining indices that were studied are: Gini, entropy and Atkinson indices for evenness; ration of correlation for exposure; delta and absolute concentration for concentration; city centre proportion and relative centralisation for centralisation; and absolute clustering, relative clustering, interaction and isolation with distance adjustment for clustering.

However, this is not the only approach that is possible to find in **RS** literature. The development of geographical information technologies and the spatial statistics have made it possible to incorporate in an explicit way spatial variables into the analysis.

Including spatial elements responds to a necessity for studying this phenomenon following a strategy that allows to embrace all of its possible edges. For example, each individual environment definition has been left out of the analysis which has been focused upon non-spatial aspects because of this kind of non-spatial approach considers just the equivalent social environment or some sort of spatial organisation unit such as census tracts concentrating its efforts only on the degree to which these spatial organisation units could differ amongst individuals (Reardon and O'Sullivan, 2004).

Consequently, a group of indices based on these spatial concepts has been proposed to measure **RS**. Examples of these measures are the spatial dissimilarity index, the I of Moran and the local indicator of spatial autocorrelation $LISA$. As Massey and Denton (1988) did previously, Reardon and O'Sullivan (2004) evaluate the spatial indices and as a result they indicate that those indices with better properties are the index of spatial exposure and the index of spatial information.

There is another reason to use spatial indices: **RS** in general has the peculiarity of being

sensitive to changes in the geographical scale used, so the higher the level of geographical disaggregation the higher the level of **RS** that will be reported. For example, let us consider the case of a chess board where every square is occupied by individuals belonging to two different groups (one group occupying the white squares and the another one occupying the black squares), the dissimilarity index will reach its higher value, 1, if the sub geographical unit used to calculate this index is the square. However, if instead of considering every square as a single sub geographical unit the board is divided into two half and every one of these two halves is considered to be a sub geographical unit to calculate the index of dissimilarity, the latter will reach a value of 0, albeit the individual distribution across the boar has not changed at all.

This is one of the problems generated by what has been called in literature as "The Modifiable Areal Unit Problem" (MAUP), and it is known as the scale effect. Heywood (1998) defines MAUP as the problem that arises due to the imposition of artificial units of spatial reporting on a continuous geographical phenomenon resulting in the generation of artificial spatial patterns.

Given the fact that this problem arises when spatial aspects such as distance, the level of contact between geographical units, and the extent of local individuals interactions, are not taken into account, then it seems that a possible solution for this problem is to include these sort of variables into the measures used. However, Wong (2004) shows that this approach is not enough to resolve the MAUP: the spatial indices are sensitive to scale as well. For instance, Krupka (2007) show that the common knowledge about the fact that greter cities are more segregated tha smaller ones is based on a spurious correlation amongts segregation and city size. The reason behind this fact is that measures based upon census tracts data will tend to report higher values for bigger cities because this kind of cities have more neighbourhoods that are big enough to contain one or more than one census tract meanwhile smaller ones need to pair neighbourhoods in order to fill-up a censcus tract. This bias will be reduced at smaller levels of spatial aggregation.

Consequently, it is important to be careful when comparing the level of **RS** between the different cities or between **RS** measured in different moments for the same city. Moreover, it is advisable to carry out a multi-scale analysis. Reardon and O'Sullivan (2004) developed a methodology to compute a **RS** profile which describes the level of **RS** at a given scale and the extent that the **RS** structure changes when the scale changes also. Although this represents an interesting strategy in order to deal with this problem, it has not yet been widely used in

literature, so it is not possible to compare its performance against other kinds of **RS** measures.

Echenique and Fryer (2007), propose another approach to deal with these sort of problems based on social interactions and social networks theory: the spectral segregation index (SSI). The SSI is based upon two premises: first, a measure of segregation should disaggregate to the level of individuals, and second, an individual is more segregated the more segregated are the agents to whom he interacts with. As the authors point out, the SSI has four important features that give it important advantages over others indices of **RS**. First, it is invariant to arbitrary partitions of a city. Second, it allows to investigate how segregated multiple minority groups are within and between cities. Third, it allows for analysis of the full distribution of segregation, allowing researches to move beyond aggregate statistics, which can be misleading. Fourth, there are inherent multiplicative effects captured by SSI which other indices omit given the fact that it is built based on a social network framework. The main disadvantages of this index are the following: first, it depends on the quality of the information that can be obtained on social interactions. For instance, in the case of **RS**, the typical information available is restricted to the place where the individuals live within a city and not in the way they interact with one another. Second, it is sensitive to the fraction of individuals in a network who have the characteristic under study. Third, implementing the SSI can imply a momentous computational effort.

The next subsection presents conceptual and technical descriptions of the indices mentioned above classifying them as non-spatial and spatial measures.

3.1 Non-spatial measures

The index of dissimilarity, D, developed by Jahn et al. (1947) and Duncan and Duncan (1955), measures the percentage of the group that must change its location from one neighbourhood to another in order to reach the percentage of this group within the neighbourhood so that this percentage is the same percentage in the city as a whole. For instance, if the group of interest within the city has a participation of 20%, in order to have no **RS**, in every neighbourhood the group participation must be 20%. The index value varies between 0 and 1, representing the minimum and maximum level of **RS** respectively.

3.1.1 The Duncan index

This index can be obtained from the Lorenz curve. It represents the maximum vertical distance between the Lorenz curve and the diagonal line that represents full evenness. When the group under study is small compared to the number of geographical sub areas (like the census tract) the Duncan index is highly affected by the deviation from evenness and it is not sensitive to redistributions between geographical sub areas where the proportion of the group under study is below to the same group proportion of the city as a whole. According to this index, just by moving people belonging to the group under study from the geographical sub areas where they are over-represented to geographical sub areas where they are under-represented can affect the level of **RS** (Massey and Denton, 1988).

The functional form of the Duncan index is:

$$D = \sum_{i=1}^{n} \left[\frac{t_i}{p_i} - \frac{P}{2TP(1-P)} \right] \tag{1}$$

where t_i and p_i are the total population and minority population of areal unit i, and T and P are the population size and minority proportion of the whole city.

3.1.2 Exposure indices

The both basic exposure indices are the index of interaction (xP^*y) and the index of isolation (xP^*x). These indices represent, respectively, the probability that an individual belonging to the group under study has of sharing a residential area with the remaining population.

The index of interaction measures specifically the level of exposure that one group has to the remaining population. On the other hand, the index of isolation measures the level of exposure that individuals belonging to the group under study have to themselves.

When there are only two different groups, the result of the addition of these two indices is 1.

Both low levels of interaction and high level of isolation indicate high levels of **RS**.

Albeit, the Duncan index and the both indices of exposure are correlated empirically, they differ conceptually because of the latter depends on the relative size of the two groups that are being compared, while the former does not. For example, the Duncan index can indicate a low level of **RS** for a certain group of the population, but the level of exposure can be low, which means a high level of **RS**, if this group has a high total population participation.

The functional form of these indices, interaction and exposure, are the following:

$$xP^*y = \sum_{i=1}^{n} \left[\frac{x_i}{X} \frac{y_i}{t_i} \right] \tag{2}$$

$$xP^*x = \sum_{i=1}^{n} \left[\frac{x_i}{X} \frac{x_i}{t_i} \right] \tag{3}$$

where X is the total population of the minority group, Y is the total population of the majority group, x_i, y_i and t_i are the minority, majority and total population within the geographical sub area i.

3.1.3 The Theil index

An important critique that can be done to Massey and Denton (1988) and James and Taeuber (1985), and consequently to all the indices presented above, is that they do not consider **RS** measures involving more than two groups within society. Reardon and Firebaugh (2002) deal with this issue and propose to work with multi-group indices. They derive and evaluate 6 multi-group indices. The criteria used for this evaluation is, basically, the same used by James and Taeuber (1985), but, they split the principle of the transfers criterion into two criteria, namely, transfers and exchanges. The reason this is done is because the two group indices respond in a different way to transfers (one way transfers from one sub area i to a sub area j) and exchanges (two ways transfers from one sub area i to a sub area j) when there are more than two groups. Besides, they define two decomposability properties that are desirable for **RS** indices: the additive organisational decomposability and the additive group decomposability. The exact description of these new criteria is as follow:

- Exchanges: if an individual of a group m in an organisational unit i is exchanged with an individual of group n from organisational unit j, where the proportion of persons of group m is greater in unit i than in j and the proportion of persons of group n is greater in unit j than in i, **RS** is reduced.

- Additive organisational decomposability: if J organisational units are clustered into K clusters, then a segregation measure should be dividable into a sum of independent factors within —and between—clusters components.

- Additive group decomposability: if M groups are clustered in N supergroups, then a

segregation measure should be dividable into a sum of independent factors within —and between—supergroups components.

Following this procedure, they concluded that the best index is the Theil index of information. The Theil index can be interpreted as a measure of the average difference that exists between different groups' proportions, within a geographical sub area, to the same groups' proportions within the city as a whole.

This index value varies between 0 (when all the geographical sub areas have the same population composition that the city has) and 1 (when every geographical area is inhabited by one single group).

The functional form of the Theil index is:

$$H = \frac{1}{E} \sum_{m=1}^{M} \pi_m \sum_{j=1}^{J} \frac{t_j}{T} r_{jm} \ln r_{jm} \tag{4}$$

where i and j index the geographical sub areas and m indexes the groups. t_j is the number of individuals in the geographical sub area j. T is the total number of individuals. π_m is the proportion of group m. E is the Theil index of entropy, where $E = \sum_{m=1}^{M} \pi_m \ln\left(\frac{1}{\pi_m}\right)$. r_{jm} reflects the extent to which the group m is disproportionated against as represented within the geographical sub area j.

3.2 Spatial Measures

3.2.1 The index of relative concentration

The index of relative concentration (RCO) measures the percentage of space occupied by a group in society compared to the space occupied by other group in society . This index value lies between -1 and 1. A level of 0 means that both groups are equally concentrated across the urban space. If the index reaches a value of -1 implies that the group under study concentration is exceeded by the other group concentration, meanwhile a score of 1 means the opposite.

The technical description of the index of relative concentration is as follow:

$$RCO = \frac{\frac{\sum_{i=1}^{n} \frac{x_i a_i}{X}}{\sum_{i=1}^{n} \frac{y_i a_i}{Y}} - 1}{\frac{\sum_{i=1}^{n_1} \frac{t_i a_i}{T_1}}{\sum_{i=n_2}^{n} \frac{t_i a_i}{T_2}} - 1} \tag{5}$$

where the geographical sub areas are sorted by size, from smallest to biggest. a_i is the land area of the geographical sub unit i, and n_1 and n_2 corresponds to the rank of the area where the sum of all t_i from area 1 (smallest in size) up to area n_1 is equal to X, and to the rank of area where the sum of all t_i from area n (largest in size) down to area n_2 is equal to X, respectively. X is the sum of all x_i (the total minority population), x_i is the minority population of the geographical sub area i, and t_i is the total population of area i. y_i is the majority population of area i.

T_1 is the sum of all t_i in area 1 up to area n_1 and T_2 is the sum of all t_i in area n_2 up to area n.

3.2.2 The index of absolute centralisation

The index of absolute centralisation (ACE) examines the group under distribution study around the centre. The index values lies between -1 and 1. Positive values indicate a group under study has a tendency to live close to the city centre, meanwhile negative values imply the opposite. A score of 0 means that the group under study has an uniform distribution across the urban area.

The functional form of the index of absolute centralisation is:

$$ACE = \left(\sum_{i=1}^{n} X_{i-1}A_i\right) - \left(\sum_{i=1}^{n} X_i A_{i-1}\right) \tag{6}$$

where the n geographical sub areas are sorted according to their distance to the city centre, from the closest to the furthest one. X_i is the cumulative proportion in geographical sub area i and A_i is the cumulative proportion of area of sub unit i.

3.2.3 The index of spatial proximity

The index of spatial proximity (SP) is the the average of intra-group proximity for the group under study and the rest of population, weighted by the proportions that each group represents of the total population. If the index of spatial proximity equals 1 then there is no differential clustering between the group under study and the rest of the population. When this index is greater than 1.0 then members of each group live nearer to one another than to members of the other group, and if it is less than 1 then the group under study and the rest of the population live nearer to members of the other group than to members of their own group.

The functional form of the index is:

$$SP = \frac{(XP_{xx} + YP_{yy})}{TP_{tt}} \tag{7}$$

where $P_{xx} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} x_i x_j c_{ij}}{X^2}$, is the average distance between the members of group X. P_{yy} and P_{tt} are the distances between the members of Y and between the total population respectively, and they can be calculated as P_{xx}. Besides, $c_{ij} = e^{-d_{ij}}$ and d_{ij} is the distance between the individual i and the individual j.

3.2.4 The index of spatial dissimilarity

The index of spatial dissimilarity ($D(s)$), developed by Wong (1993), modifies the traditional index of dissimilarity adding information about the relationship between the area and the perimeter of the geographical sub unit. Following this procedure it can be incorporated the fact that the geographical sub unit shape affects the interaction probability of individuals belonging to different geographical sub units. Its value lies between 0 and 1. The closer to 1 the index value the higher the **RS**.

The technical description of the index is the following:

$$D(s) = D - \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}|z_i - z_j| \frac{\frac{1}{2}\left[\frac{p_i}{a_i} + \frac{p_j}{a_j}\right]}{\max\left(\frac{p_i}{a_i}\right)} \tag{8}$$

where D is the index of dissimilarity, $w_{ij} = \frac{d_{ij}}{\sum_{i=1}^{n} d_{ij}}$, z_i is the group under study proportion within the geographical sub unit i, d_{ij} is the length of the common border of geographical sub units i and j, p_i is the perimeter of the geographical sub unit i, a_i is the unit area and $\max\left(\frac{p}{a}\right)$ is the maximum ratio among perimeter and area.

3.2.5 The I of Moran

The I of Moran (I), developed by Moran (1948), is a measure of spatial autocorrelation, a concept similar to autocorrelation in time series, but in this case the spatial lags are the ones that have information. As a matter of fact the I of Moran functional form corresponds to the correlation test Durbin-Watson weighted by the values in the contact matrix, which can be either the distance among points or 0 and 1, depending on whether the points are contiguous or not. The null hypothesis is that there is not spatial autocorrelation. The index value lies

between -1 and 1. A value of -1 implies negative autocorrelation. A value of 1 means positive autocorrelation and a value of 0 implies a random spatial structure.

The functional form of the I of Moran is:

$$I = \left(\frac{N}{S_0}\right) \frac{\sum_{i=1}^{n}\sum_{j=1}^{m} c_{ij}(x_i - \mu)(x_j - \mu)}{\sum_{i=1}^{n}(x_i - \mu)^2} \tag{9}$$

where μ is the average value of the variable x, c_{ij} are the components of the contact matrix, N is the number of geographical sub units, and S_0 is a normalisation factor equivalent to the sum of the elements of the contact matrix.

3.2.6 The Local Indicator of Spatial Association

The I of Moran is an index that summarises information for a complete urban area. Given the need of identifying local concentrations of a variable under study, called hot spots in literature, Anselin (1995) introduced the Local Indicator of Spatial Association (LISA), I_i, which takes different values for each observation. Besides, it allows to visualise local instabilities, such as deviations from the global structure of spatial association.

$$I_i = \frac{x_i - \mu}{\frac{\sum_{i=1}^{n}(x_i-\mu)^2}{n}} \sum_{j=1}^{n} c_{ij}(x_j - \mu) \tag{10}$$

where μ is the average value of the variable x, and c_{ij} are the components of the contact matrix.

3.2.7 The spectral segregation index (SSI)

Due to Echenique and Fryer (2007) the spectral segregation index (SSI) measures the connectedness of individuals of the same group. The theoretical framework on which this index is based is the social network theory. According to the SSI an individual will be more segregated if the agents to whom he interacts with are segregated also, so the higher the segregation of the agents he interacts with, the higher the individual segregation. Hence, the index depends upon the network of social interactions among individuals in a given group. Albeit this index can be applied to a myriad of situations, for most of them are not necessarily related to the spatial phenomena, it has been included as a spatial measure because in the case of **RS**, the interaction among individuals can be modelled as the geographical distance between them. As it was previously mentioned, and as the same authors point out, this index has interesting characteristics.

First, it is invariant to arbitrary partitions of a city, second, it allows for the investigation of how segregated the multiple minority groups are; and finally, it allows for the analysis of the full distribution of segregation, allowing researches to go beyond aggregate statistics, which can be misleading. To calculate the index can be a difficult task because it is highly data demanding.

The procedure to obtain the SSI, which is a bit longer than those described above, is as follows. First, let us consider a group of individuals V and a level of interaction, $r_{vv'} \geq 0$, between two individuals, v and v' belonging to this group. If there is no interaction $r_{vv'} = 0$ otherwise $r_{vv'} > 0$. A matrix R is a matrix containing all this interaction information. Let us now consider a sub group, or race, h. If all the information related to individuals that do not belong to h is dropped from R, the matrix B is obtained, which reflects the extent of interaction between individuals belonging to a same group. Another important feature of this index is that it can be disaggregated to the level of individuals. Therefore, there will be two kind of segregation indices: an aggregated index, $S^h(B)$, and another one for each one of the individual, $s_v^h(B)$. Let us consider a group N_v of all the individuals of group h connected to individual v, and then let us consider the groups of all the individuals of group h connected to the members of N_v and so on. The resulting set of individuals, with direct or indirect interactions with v, is called the connected component of B that v belongs to; denote this set of individuals by C_v. The SSI of each connected component will be the largest eigenvalue of the corresponding irreducible sub-matrix of B. The spectral segregation index, finally, is calculated by taking the average SSI of each connected component weighted by the size of those connected components. The individual SSI is obtained by using the eigenvector corresponding to the largest eigenvalue.

4 Causes of SR

Here, it is proposed to classify **RS** into two groups: endogenous **RS** and exogenous **RS**. The former is a consequence of the interaction of individuals preferences, restrictions and characteristics, meanwhile the latter is the result of an external force, that it is not related to individuals preferences, that sorts people across an urban area. The endogenous **RS** sources can be classified into two different kinds: income and willingness-to-live-amongst-peers. The former is the most common and easy to see **RS**. The latter is the force that drives **RS** based upon race, religion, language, or nationality. If the willingness-to-live-amongst-peers is very strong it can be called

prejudice. The exogenous **RS** drivers have been classified into two kinds: as the outcome of a policy and real estate markets dynamic. Albeit they are different, these forces are correlated and interact between one another, which has as a consequence a reinforcing process. Therefore, dynamic aspects of **RS**, as migration, are crucial to understand this phenomenon. Besides, these interactions make it difficult to isolate, empirically, the drivers behind **RS**, an issue that is very sensitive to policy application. For instance, Bayer et al. (2004b) is the first attempt at trying to examine the degree of importance of households characteristics as **RS** drivers. They conclude that depending on their racial background the drivers of the **RS** that they must face are different.

4.1 Endogenous RS

As it was mentioned above, endogenous **RS** arises due to the interaction between the economic agents' preferences, budget restrictions and characteristics, such as age or household size. These aspects also consider agents' decisions for the supply of housing services. The forces driving this kind of **RS** have been sorted into two groups: income and willingness-to-live-amongst-peers. A description of these two kind of forces is now presented.

4.1.1 Income as a driver of RS

The "Bid-Rent" model provides a simple and clear explanation, from the theoretical point of view, of the phenomenon of **RS** based upon income. The decision location across the city will be based on the idea that agents must commute from home to their work place which is located in a central business district (**CBD**) where all economic activities are concentrated. Consequently, the transport cost becomes an important element at the moment of taking a location decision. In the canonical example, the households of higher income will choose a location far away from the **CBD** because they can pay the higher transport cost that this location decision implies, meanwhile the household of lower income will choose a location closer to the **CBD** to avoid high transport costs. This urban structure depends on the assumption that land is a superior good. This model was developed by Wingo (1961), Alonso (1964), Mills (1967), Muth (1969) and Evans (1973), and since its first appearance several extensions have been developed. Fujita (1989); McCann (2001) and Zhang (2002) present detailed explanation of this model and its extensions.

The bid, that is the land rent, is all the income left after other goods have been purchased and the transport cost has been paid. Hence, there will be an inverse relationship between the distance to the **CBD** and the land rent per unit of land, which is represented by the negative sloped bid-rent curve as it can be appreciated in Figure 4. Under the assumption that the higher the income the higher the preference for land, the low income households will have a steeper bid-rent curve than the bid-rent curve of higher income households, which means that low income households will offer a higher bid in areas located close to the **CBD** than the offer that household of higher income will do. If it is assumed that there exist only three kinds of households with low, middle and high income, the city will present a spatial framework with an area located close to the **CBD** inhabited just by low income household, an area located in middle of the city inhabited just by middle income households and an area located at the edge of the city inhabited just by high income households.

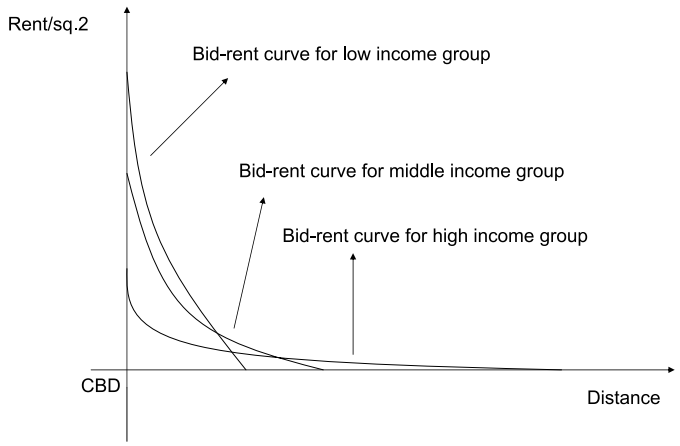

Figure 4: Bid rent model

This urban structure can change if there are others elements apart from work, such as entertainments activities, that generate trips to the **CBD**, or if the individuals' preferences change (Brueckner et al., 1999). For example, it could be possible to split up the high-income group into two different groups: young high-income and old high-income. The first one could have preference for accessibility meanwhile the latter could have preference for land in order

to accommodate families with more members. As a consequence, the young high-income group will choose a location in the closest area to the CBD. This type of residential pattern broadly represents the urban land allocation in cities with large international financial activities, such as New York, Tokyo, London and Paris. The urban land allocations will be fully reversed if the income elasticity of demand for accessibility is greater than the income of demand for space. If that is the case then high-income earners will live in the city centre, with middle-income earners in the immediately adjacent areas, and low-income earners will be located on the outskirt of the city (McCann, 2001). However, despite the exact urban structure, the underlying concept is the same: if two households are competing for land, it will be adjudged to the household that offers the highest bid, which generates segregated neighbourhoods according to the households income.

An alternative approach to explain **RS** based upon income is the one given by Tiebout (1956) and his voting-with-your-feet theory. In this model municipalities within an urban area or region offer different public amenities at different tax rates. Individuals, according to their preferences for public amenities, will choose a location such that, subject to their budget constrains, their utility is maximised. This model is based on the following assumptions: consumers are free to choose where they live and that there are no transport cost, there is complete information, there are many municipalities to chose from, public amenities do not spill over of benefits/costs from one municipality to the next, an optimal city size exists, municipalities try to achieve optimal size, municipalities are rational and try to keep the public bad consumers away. In the end, affluent households will occupy the municipalities with better public amenities crowding out low income households because they are able to pay a higher land rent as a way to guarantee the access to these better public amenities. A good example of this kind of segregation is the one that arises due to school selection by households. As they compete for living in the municipality with the best school provision, the land price will get higher in those municipalities with better schools and consequently the households with higher income will live closer to the those schools, a process that sorts out households across the city according to their income. Benabou (1993) develops a game theory model which explains how a process of these characteristics can generate segregation when local schools are funded by local taxes.

4.1.2 The willingness-to-live-amongst-peers as a driver of RS

The bid-rent model has also been used to explain **RS** driven by willingness-to-live-amongst-peers, through an extension of it called the border model. In the border models there exists an area where one group of society looses utility if it lives close to it. For instance, in group 1 the population would loose utility if it lives close to a neighbourhood inhabited by people that belong to a group 2, i.e. group 2 generates negative externalities on group 1. As a consequence, the group 1 population would be willing to pay a higher price in order to get away from this border, which will change the bid-rent curve slope. The reason explaining the change of the bid-rent curve slope is that the further the location from the border the higher the land rent will be. After a certain point the effect of the border will be negligible and, therefore, the bid-rent curve slope will be negative again. If the negative effect of living close to the border is high enough, it will be a derelict piece of land between the two groups, as can be appreciated in Figure 5.

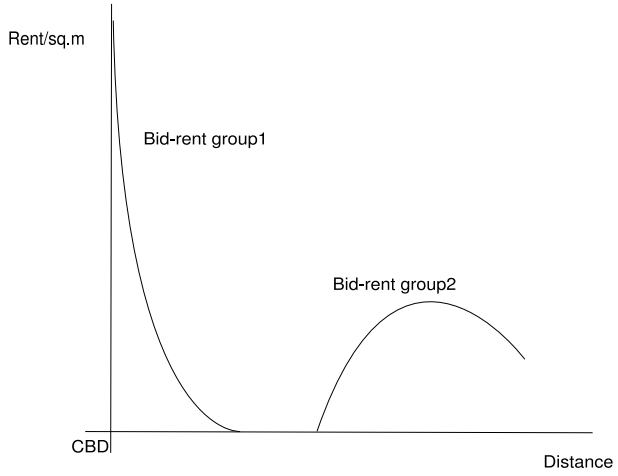

Figure 5: Border model

The Border models were developed by Bailey (1959) and Rose-Ackerman (1975), (1977), whom adopted the approach of Stull (1974), which was originally used to explain externalities amongst producers and households. The Border models work under the assumption that there is a urban pattern with full **RS**. This is considered to be as an important weakness of this approach because **RS** must be derived endogenously from the model. Alternative approaches to the classical border model, considering **RS** as an endogenous result of the model (but that

respond to the same logic of the bid-rent model), are the local externalities models and the global externalities models.

Local externalities models were developed by Yinger (1976) and Schnare (1976). The reason to call these models in this way is due to the fact that they consider that households are concerned about the racial composition of their own neighbourhood. Albeit **RS** arises endogenously in this model, it is also restrictive because they assume that households do not care about the race of households that live just a bit further away from their neighbourhood's border.

Global externalities models attributed to Yellin (1974), Papageorgiou (1978a), (1978b), Kanemoto (1980) and Ando (1981), assume that households are concerned about the race of all the city's inhabitants. Specifically, the negative externalities that one group of people suffer are the weighted sum of all the other group population that live in the city. The weights considered in these models comes from a decreasing function of the distance that exists between both group populations.

All the models mentioned above give an explanation of the process that generates **RS** when there is a sector of the population that only wants to live amongst its peers —except the border model which assumes exogenously the existence of **RS** —, and its consequences to the urban structure. The people that belong to this group will suffer a negative externality if they must live with people belonging to a different type of population, like, for instance, a different race. Besides, all these models belong to bid-rent kind of models. In the first type, border model, **RS** is exogenous, meanwhile in local and global externalities models it is endogenous. Despite this difference the main conclusion of all of them is the same: **RS** is Pareto-efficient.

As it was mentioned previously, the border model assumes exogenously the existence of **RS**, and local and global externalities models consider only the interaction between the group but not at an individuals' level. Besides, all these models produce full **RS** under any circumstances, which is an unrealistic result since it is empirically possible to observe a certain degree of intermingle between groups.

An alternative approach is the one that offers Schelling (1971). Schelling's model is an important forerunner of social interaction literature, and agent-based simulation applied to social sciences. In this model individuals' behaviour depends on local interaction with their neighbours. In particular individuals who have preferences about the kind of neighbours they want to live with, and depending upon those preferences they choose a location across the city.

Placing pennies and nickels —as a way to represent two different groups living in the same city—, on a chessboard, Schelling starts his analysis considering a full integrated city (Figure 6.a), then a random perturbation is introduced —two inhabitants of the city are interchanged, or one inhabitant leaves the city —, as a consequence of this perturbation the individuals that live in a neighbourhood, or neighbourhoods, that have suffered it, will be in an uncomfortable situation, and consequently, they will want to move to another neighbourhood, which starts a process that ends up with high levels, or even full level of **RS** in the city (Figure 6.b). This process depends on a rule that is previously determined and that specifies individuals' preferences. Schelling analyses the system behaviour under two kind of rules. The first one considers that individuals only want to live amongst peers, hence if there is only one different individual in the neighbourhood, individuals belonging to the majority in this neighbourhood will be hurt. Consequently, it does not seem to be surprising the fact that the city will end up in a high level of **RS**. However, what is indeed surprising is that this result is the same even when individuals have a small preference for living amongst peers. The main conclusion of this model is, then, that **RS** is the unique stable equilibrium even when individuals have small preferences for living amongst peers.

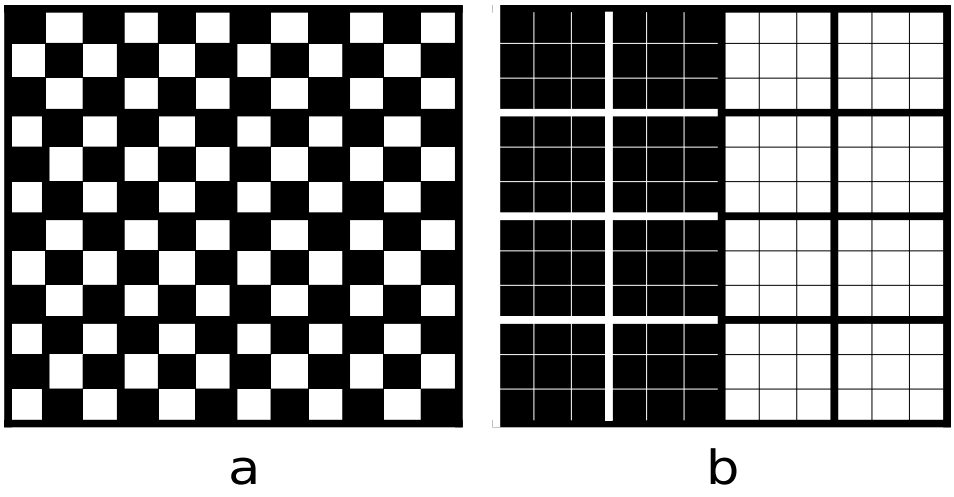

Figure 6: Schelling model

The lack of mathematical formalisation of this model is one of the reasons that explains why it has not been applied in a more general way to the study of **SR** (Krugman, 1996; Young,

1998; Zhang, 2004). Despite the latter, this model has been fundamental for understanding the social dynamic processes underlying **SR**. Social dynamics studies individuals' interaction at local levels and how these local interactions can produce macro social structures. In order for these macro structures to arise, it is essential to observe the system's dynamic evolution because the macro behaviour is the consequence of dynamic and cumulative processes, which are strongly determined by thresholds.

4.2 Exogenous RS

Within exogenous **RS** a taxonomy of two groups of drivers has been proposed: those related to policies which either intentionally or unintentionally produce segregation, and real estate markets' dynamics. The latter is understood as exogenous to the individuals —who are consumers of housing services—point of view.

4.2.1 Public policy as a driver of RS

Either intentionally or unintentionally public policy can generate **RS**. The former kind of public policy is known as *de jure* segregation, which occurs when the law explicitly requires some kind of residential exclusion. Examples of *de jure* **RS** are the former European Jewish ghettos, the Nazi Germany racial laws or the South African and former Rhodesia (now Zimbawe) apartheid. Christopher (1990) investigates the impact of apartheid on the levels of **RS** in South Africa, his main conclusion is that **RS** in South Africa raised markedly during the 20th century reaching remarkably high levels as a result of the legislative programmes implemented in order to exclude black people. Albeit most of these kinds of policies have been prohibited in western societies, as it has been the case in the United States since the mid 60s or the apartheid since the early 90s, their consequences, as Saff (1995) points out, still have effect on the urban patterns. Falah (1996) investigates the features of **RS** in Israeli mixed cities. His conclusions are that as an outcome of state politics these cities have experienced a continuous trend of high indices of segregation and that the scope of of both social and economic interactions between the two communities sharing the same urban space remains underdeveloped.

Public policies that unintentionally have as a result **RS** are those policies which aim is not to produce any kind of exclusion or **RS**, but either through their use or as a side effect of their use, **RS** can arise. Weiher (1989) using examples taken from jurisprudence argues

that the federal court policy in the United States has reinforced devices which support inter-jurisdictional **RS**. The idea behind this argument is that policy developments have shifted **RS** from the neighbourhood to the jurisdictional level through two ways: first, reinforcing and encouraging the use of exclusionary powers on the part of predominantly white and well-off municipalities, and second, changing the nature of the information available to people making location decisions. The central hypothesis is that this change in segregation mechanisms should generate a change in geographic patterns of **RS**. Using Census data from Los Angeles and the Cook Counties, the conclusion is that this shift has taken place, and that is in these counties that **RS** occurs by race, educational attainment and occupation and have come to organise the areas by cities rather than neighbourhoods over the period of 1960-1980.

Other examples of public policies that can generate **RS** are: zoning and public housing. As Berry (2001) indicates zoning regulations most commonly used as exclusionary devices include bans on multifamily housing and a variety of minimum building standards such as lot size and width, building size, density, etc. Albeit restrictions like these do not explicitly exclude specific people or groups of people, they effectively establish minimum limits on the cost of housing, which can generate **RS**. Besides, given the correlation amongst race and income, **RS** based on income would generate racial segregation.

According to Sugrue (1962) the Federal government in the United State since the end of the Second World War and until 1960 implemented two strategies to deal with the lack of housing: to build housing for the working class and to finance mortgages through the Federal Housing Administration. As Jackson (1985) points out, almost all these loans went to white households in white neighbourhoods. The latter combined with white demand to exclude black people, avoided the construction of public housing in white neighbourhoods. Thus, Jacobs (1962) indicates that the bleak architecture of public housing also isolates their residents and blocks out social interactions.

The Chilean public housing policy is also an interesting case of how a public policy can produce, as a side effect, **RS**. The reason is that Santiago, the capital of Chile, is one of the most segregated cities in Latin America, despite the fact that Chile is the country with the highest income per person of Latin America. The chapter 3 of the present dissertation develops an empirical study of the **RS** drivers in Santiago. One of the main results is that the public housing policy is the most important driver of segregation. The mechanism behind this fact

works as follow: as a way to reduce the shortage of affordable housing, the Chilean government bought cheap land in the outskirts of the cities to build the public housing projects. Households must apply for a subsidy to buy these affordable dwellings. However, once the households have won this subsidy they cannot buy a house in any place, but they are forced to buy it in a particular neighbourhood of these public housing projects. As a result the government, albeit has been successful in reducing the lack of affordable housing, has created ghettos of low income households in the outskirts of the city.

Given the consequences of **RS**, governments must be very careful in order to design and to implement policies that can be generate segregation, particularly when this segregation is based on income which is one that has the worst effects on individuals' well-being, as is going to be discussed later on.

4.2.2 Real Estate Markets Dynamics as a driver of RS

According to Meen et al. (2005), one of the most important elements to understand the processes behind **RS** is to look at the local Real Estate Markets Dynamics and how they can change the neighbourhoods' structure. The underlying mechanism is the filtering process. Hoyt (1939) is the first research that talks about this phenomenon. The idea behind this concept, as Hoyt points out, is that the wealthier households will tend to move towards new real estate developments, mainly in suburb of the cities, then, as an outcome, old neighbourhoods will be occupied by progressively lower-income residents.

Yates and Wood (2005) indicate that there are three kinds of filtering processes that literature has identified: by income, price and quality. The processes that are relevant to this section are those related to price and quality.

The filtering by price arises when the dwellings' physical characteristics remain the same but either demand or supply movements generate higher or lower ground prices. As a consequence of these movements either relatives or real prices would change, depending on whether these variations are local or generalised. Bond and Coulson (1989), Brueckner (1977) and Little (1976) provide examples of how the filtering process can describe changes of neighbourhoods' composition as a result of dwellings' relative prices changes.

The filtering by quality has to do with the phenomenon in which the housing services provided by one particular dwelling decrease due to physical deterioration, or they increase because the

dwelling has experimented physical improvements.

These processes are influenced by the owners' maintenance decisions, and these maintenance decisions are, in turn, determined by the extent of the filtering by the price process (Yates and Wood, 2005).

Through these two kinds of filtering processes is possible that some neighbourhoods tend to polarise, changing from a mixed composition to one with inhabitants belonging just to one socio-economic group, and therefore **RS** will arise (Galster, 2001; Grigsby et al., 1987; Vandell, 1995).

Consequently, if either the dwellings' quality is improved or the ground price increases, the supply of low price housing services is going to be dropped from the market and they will be replaced by higher price housing services. This process is called gentrification, and the opposite, i.e. when high price housing services are replaced by low price ones, is called deprivation, which implies a deterioration of the neighbourhood.

An interesting feature of these two processes, gentrification and deprivation, is that they are cumulative. For instance, once a gentrification process has started it will put pressure on the price of housing services, which, in turn, will give incentive to improve the dwelling's quality, which will put pressure on the housing services price again and so on. Another important element, related to the latter, is the existence of non-linearities and thresholds. Therefore, before any of these two process start, gentrification or deprivation, they must reach a given threshold, such as a certain price level, like it is depicted in figure 7. Hence, only when gentrification rate passes this threshold, the local area, or neighbourhood, will take off or it will go into decline. This could generate situations such that dwellings' prices in a given area can take off meanwhile in a contiguous neighbourhood they present just little changes. This kind of relationships have been investigated by Galster (2002), Meen and Meen (2003) and Meen et al. (2005).

Yates and Wood (2005) test this behaviour for Sydney Housing Market. Their main conclusion is that low rent housing is characterised by a growing polarisation, and that the cumulative dynamics reinforce this polarisation. In this manner, a locality with low proportion of low rent dwellings has a higher probability of having future reductions of this kind of houses. Meen et al. (2005) perform a similar analysis for England and their conclusions are not different from those of Yates and Wood (2005).

Finally, it is important to say that albeit deprivation and segregation seem to be a similar

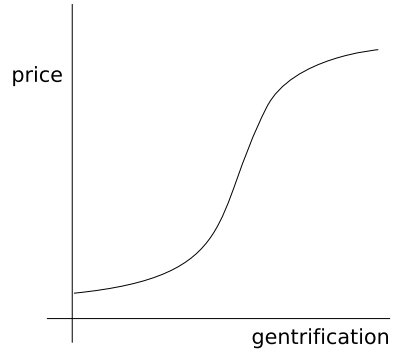

Figure 7: Relationship between dwellings prices and gentrification

concept they are not. As Meen et al. (2005) indicate that in an extreme case all the geographical units within a city can have a high level of deprivation, in such a case there will be no segregation because **RS** has to do with the dispersion of deprivation across the city.

5 Consequences of RS

The discussion about **RS** consequences is still open. During years the literature has been focused upon negative consequences of **RS** on households' well-being. However, most recently two important results have been found. Firstly, it has been shown that **RS** can have, at least in the short term, positive consequences. Secondly, and mainly after the Moving to Opportunity experiment in the USA, a group of new investigations have indicated that **RS** has almost negligible effects upon households well-being. Thus, **RS** consequences literature has been classified into three groups: positive, negative and no consequences.

5.1 Positive consequences of RS

RS has, in the short run, positive effects mainly when is based upon nationality or language. For example, if in a city there is a Chinese community, a new comer that speaks only Chinese will have an easier chance of getting a job due to the existence of this community. A similar situation can arise with Hispanic communities, independently of the particular nationality of the new comers. Namely, **RS** can have positive effects through social capital formation and networking. Following the approach of individual-based models of social capital formation, —by Glaeser et al. (2002), Alesina and LaFerrara (2000), Portes (1998) and Portes and Landolt (2000)—Molina et

al. (2002) identify three transmission mechanisms that link **RS** and individual-level of outcomes. The first one is positive inter generational effects accruing from parental social capital in the form of expanded social networks and access to an array of inter generational weak ties. Second, income and labour effects accruing from individual membership in local groups, associations and networks. Third, political effects through a more effective neighbourhood voice. Segregated neighbourhoods can start collective action easier than nonsegregated neighbourhoods by mobilising ethnic or cultural ties. A further discussion on the **RS** positive effects, particularly on migrants, can be found in Bosswick et al. (2007).

Another potential source of welfare related to **RS** is the labour market matching. Bayer et al. (2005) find evidence supporting the hypothesis that social interactions within neighbourhoods amongst individuals of similar characteristics are a significant factor behind the labour market behaviour and and they are used by people as a device to find jobs. Hence, **RS** generate specialized neighbourhoods and such kind of neighbourhoods seem to be a fertile source of job matching through the use of neighbours, friends and acquaintances (Cheshire, 2007).

Cheshire (2007) indicates also that segregated neighbourhoods can provide consumption benefits because households of similar incomes, tastes or age tend to consume similar goods and services, and they require similar amenities.

Luttmer (2005) tests the hypothesis that individuals welfare depends not just upon their own income, but also on their neighbours income, that is to say individuals care about their relative income. Using a sample of 10,000 individuals, he finds that loosing $2,000 of income makes people feel as worse as their neighbour gaining $2,000. Furthermore, he does not find a significant effect about the neighbourhood overall inequality, so what lower the income welfare is having an income lower than the the neighbourhood average. Consequently, households can derive more utility if they live amongst households of similar or even lower income than theirs own income.

5.2 Negative consequences of RS

Literature has identified that **RS** has effects on joblessness, academic performance, premature parenthood, health, births out of wedlock, drug abuse, criminality and poverty (Dawkins et al., 2005; Charles et al., 2004; Clapp and Ross, 2004; LaVeist, 2003; Dosh, 2003; Burton, 2003; Yinger, 2001; Massey, 2001; Madden, 2001; Wilson and Hammer, 2001; Logan and Messner,

1987; Burnell, 1988; King and Mieszkowski, 1973). Amongst this investigation the following present some interesting results: Bayer et al. (2004a); Benabou (1996); Borjas (1995); Cutler and Glaeser (1997) and Nechyba (1999). The latter presents a recapitulation of what social science has done to study the neighbourhoods and peer effects on individuals. According to this work a wealth of evidence exists indicating that **RS** perpetuates income inequality.

Cutler and Glaeser (1997) raises the question whether racial **RS** would have positive effects based on the idea that positive spillovers can exist as an outcome of the interaction between low income and high income individuals that belong to the same race, and due to segregation, share the same neighbourhood. After examining academic performance, joblessness and premature parenthood for the Afro-American population in the United States (cities with more than 100,000 inhabitants and more than 10,000 Afro-American inhabitants) the conclusion is that the members of households with these characteristics living in highly segregated localities exhibit worse outcomes than those that do not.

Borjas (1995) develops a theoretical model to enquire about the consequences of **RS** and then he uses it to perform an empirical analysis of this phenomenon. The result of this empirical analysis is that there is an ethnic spillover: ethnic groups with low income tend to live clustered in low income neighbourhoods, and the neighbourhood's effect influences negatively the intergenerational mobility.

Bayer et al. (2004a) is the first attempt for testing the hypothesis that **RS** reduces the minorities public goods' consumption. Using a detailed data base from the San Francisco Bay area, they found enough evidence to support this hypothesis.

Benabou (1996) builds a theoretical general equilibrium model in order to analyse the **RS** consequences on both efficiency and equity. According to this investigation, little differences in education technologies, endowments, preferences, income or access to the capital market can drive higher levels of **RS**, and **RS**, in turn, make education and income inequalities pervasive between generations, albeit this is not necessarily true for the level of wealth, i.e. a population can get richer but the income distribution remains the same.[1]

[1]This would be the case of Chile, a country that in last decade has become the richest country in Latin America (14,000 USD per person PPP) but its income distribution has not changed (a Ginni index of 0,56) and that exhibits also high levels of **RS**.

Anas (2002) develops a general equilibrium model in order to understand the **RS** effects on individuals well-being and on labour, land and goods markets behaviour. The analysis considers an urban space with a city centre and suburbs, and the economic activities can be performed in both city ends. The results depend on the degree of prejudices that the white population has against the Afro American population. As white prejudice increases the percentage of city centre residents who are black, the percentage of suburban residents who are white increases and the price of land rent falls in the city centre. As the city land becomes cheaper relative to suburban land, suburban labour becomes cheaper relative to city labour, and city product becomes cheaper relative to suburban product. These relative price changes cause labour supply to the city centre to increase and the suburbs to decrease. City centre output increases while suburban output decreases, but total output falls. An interesting finding of the Anas' model is that white prejudice increases the utility level of blacks because city centre land rents fall relative to city centre and suburban wages.

As it can be appreciated, there is not dissent about the characteristics of the negative consequences of **RS**. However, some interesting questions have not been addressed yet. For instance, an interesting issue to research empirically is the extent that **RS** can affect the society as a whole and not just how it can have effects on the segregated population.

5.3 No consequences

As Goering et al. (2003) point out, a major difficulty to research on **RS** consequences is the fact that researchers are restricted to cross-sectional, non-experimental data, which makes almost impossible to separate the effect of personal factors affecting choice of neighbourhood from impacts of neighbourhood. Hence, there exists a direction of causation problem that has not been yet settled (Cheshire, 2007). The Moving to Opportunity experiment in USA, due to the way it was designed, has been an unprecedented chance to deal with this problem. After more than 10 years since the programme began, a significant amount of investigations that have been done to analyse the MTO results have reached to the conclusion that segregation has almost no consequences upon households well-being. A discussion about these findings is provided in this section. However, in order to have a better picture, first, a description of the MTO programme is presented.

5.3.1 The Moving to Opportunity Experiment

The Moving to Opportunity programme (MTO hereafter) aim has been twofold: to relieve the problems that segregated households must deal with, and to provide scientific evidence about the benefits that policies oriented to achieve mixed communities can generate. In order to achieve this aim, the programme focuses on enabling low-income households with children to move from high-poverty inner city neighbourhoods to middle-class neighbourhoods.

The programme was undertaken by the U.S. Department of Housing and Urban Development (HUD hereafter), which implemented a controlled experimental design to try to overcome the problem of separating the impact of personal factors affecting choice of neighbourhood from the effects of neighbourhood and the direction of causation. Neighbourhoods were defined as census tracts. To be eligible households must live in a public or assisted housing in a neighbourhood with 40 percent or more of residents below the poverty line in 1989, to have at least one child under 18, not to be behind in rental payments, all households members had to be named on their current lease and no household member should have a criminal background.

Eligible participants were randomly assigned, as a way to ensure that will not be systematic differences, to one of the following three groups:

- The experimental group, which received vouchers usable only in tracts with less than 10 percent poverty, along with counselling assistance in order to find a unit.
- A comparison group, which received regular vouchers with no special restrictions or counselling.
- An in-place control group, which would continue to receive project-based assistance.

The MTO programme was first implemented in Baltimore, Boston, Chicago, Los Angeles and New York. The random assignment started up in late 1994 in Boston and concluded in late 1998 in Los Angeles.

5.3.2 Empirical findings on MTO programme and other studies upon neighbourhood effects

The first findings, summarised in Goering and Feins (2003), were promising: after two years, indications of children behaviour, health and educational performance improvements, compared

to the control group, would be observed. These improvements were more marked in the boys case. Nevertheless, incomes and other labour market indicators showed no a better outcome relative to the other groups. Durlauf (2004), comparing 25 studies published between 1982 and 2003, concludes there is a significant neighbourhood effect, although he is aware about the identification problems.

Longer term follow-up studies overtake that results. Kling and Liebman (2004), using data for the five cities, examine indicators of educational performance, mental and physical health, and behaviour. For none of these indicators they found any significant overall differences between the treatment and comparison groups compared to the control group. Kling et al. (2005) separate young males and females. They found that for both boys and girls during the first two years after moving, property arrest fell, but this reduction was not statistically significant. For boys this figure changes and after the second year it rises significantly compared to the control group. Overall, males in treatment and comparison group show worse results regarding behaviour and porperty crime than those of the control group, but for both sexes combined there was no significant reduction because the differences for boys and girls balanced out (Cheshire, 2007).

Long-term cohort studies offer an alternative approach to isolate the effect of neighbourhood upon households opportunities. Oreopoulos (2003) and Bolster et al. (2007) are, according to Cheshire (2007), two of the most convincing of these cohort studies. Oreopoulos (2003), using a Canadian sample which tracts individuals over 30 years, concludes that neighbourhood characteristics in which an individual was born has no statistically significant impact upon either long-term labour market outcomes or prosperity. Bolster et al. (2007) using a panel data for Britain follow individuals for ten years. They find no evidence supporting the hypothesis that the original place of residence has effect upon labour market success.

5.3.3 Critiques to the MTO programme

The MTO programme has received also some critiques. For instance, Stal and Zuberi (2010) have indicated that one of the main MTO programme problems is that it does not include community involvement, besides it could be improved if it had considered programmes and policies to get a better social, physical and economic integration of high poverty neighbourhoods into the city.

The most important critique to the MTO programme has been made by Clampet-Lundquist and Massey (2008). These authors, based on their conceptual analysis and empirical investi-

gation, claim that the MTO programme design and implementation suffer of several problems that work against the detection of neighbourhood effects. First, due to the fact that in America non-poor black neighbourhoods are not equivalent to non-poor white neighbourhoods in terms of resources, and because the most of MTO households participant move into a segregated neighbourhood instead of doing it into a integrated one, these households were exposed to a limited range of resources and opportunities.

Second, because households randomly allocated housing voucher were not required to use them, selectivity pollutes the study design: amongst those families assigned to be experimental subjects, selection into the category of whom complied with the experimental treatment and moved to a low-poverty neighbourhood was non-random. Furthermore, as African-Americans are reluctant to enter white neighbourhoods for fear of ostracism and harassment, the decision of choosing residence in an integrated versus a segregated non-poor neighbourhood was also non-random.

Third, since to remain in the neighbourhood was not compulsory, there was an important quantity of families that moved out of low-poverty neighbourhoods back to poor settings, therefore, experimental subjects accumulated little time living in low-poverty neighbourhoods.

The main conclusion of Clampet-Lundquist and Massey (2008) is that the MTO programme cannot refute the existence of neighbourhood effects, but the authors cannot find evidence in favour of them either. Besides, the authors point out that if the MTO programme data are used to investigate upon neighbourhood effects, researchers must be aware of if the voucher offer was accepted and used, if households considered in the programme go to a segregated or integrated neighbourhood and how long households remain living in a low-poverty neighbourhood.

6 Final remarks

Since the literature on **RS** is vast, the focus of the present essay is on those aspects that have been considered either the most influential or those that have the potential to determine future trends of **RS** research. The literature has been classified according to the following four subjects: **RS** definition, measures, causes and consequences.

With regards to definition without a doubt Massey and Denton (1988) is the most complete and widely accepted. This definition considers **RS** as a multidimensional phenomenon based on

the following dimensions: evenness, exposure, concentration, centralisation and clustering. This multidimensional definition has been useful to determine the most suitable indices to measure **RS**. Every dimension can be measured using different indices; however, according to Massey and Denton (1988) the best dimensions for them are the following: dissimilarity index, exposure index, index of relative concentration, index of absolute centralisation and index of spatial proximity, respectively. Despite their utility, these indices suffer of two problems. First, they were not designed to consider the case where more than two groups must be compared. Reardon and Firebaugh (2002) deal with this problem and posit the Theil index as the best to measure **RS** under these circumstances. Second, they are highly sensitive to the geographical scale used, i.e. the level of **RS** will depend on the degree of geographical disaggregation. The latter makes necessary to use spatial measures, multi-scale measures or measures based on social interactions and networks.

The causes can be either endogenous or exogenous. Amongst the endogenous causes the income, through the land and dwelling prices, and the desire for living amongst peers have been identified as the main drivers of **RS**. With regards to exogenous causes **de jure RS**, like the former South African apartheid, and some public policies side effects, like the case of some public housing policies, are the main drivers.

Regarding consequences, there is not such a thing as a consensus. The earlier investigations have claimed that consequences can be either positive or negative. They are positive in the short term when are, mainly, linked to the migrants' formation of social capital and networking. Amongst negative consequences the most relevant are the effects on joblessness, health, academic performance, criminality, births out of wedlock, premature parenthood, perpetuation of poverty and bad income distribution. However, new findings, mainly due to the Moving to Opportunity programme data because it was carefully designed as an experiment, have shown that **RS** has almost negligible effects on households well-being. The intuition behind this argument relies upon the fact that the negative consequences observed in segregated population are linked to those factors that make households to choose a neighbourhood instead of any kind of neighbourhood effect. Still some critiques have been formulated to this approach. The main ones say that the programme has failed in assigning the treatment group in a random way, and that an important amount of families returned to poor areas, which implies that they were exposed to a better living conditions just for a short time. Consequently, MTO data cannot refute the existence of

neighbourhood effects. Hence, if **RS** has any sort of effects upon households well-being is still an open question and it is still a subject of debate.

The former discussion is the result, amongst other things, of the identification problems that exist when one wants to measure the neighbourhood effect. The latter implies that the causation between segregation and income inequality has not been determined.

In general, the **RS** consequences have been studied with respect to their effects on the segregated population. However, in the case that **RS** has effectively impact on individuals, its impacts could expand to the rest of the population. For example, the existence of low skilled labour, as a consequence of the bad academic performance of the segregated population, would affect negatively the economic growth rate. Besides, given these effects that **RS** has on the economy as a whole, conducting research on this issue would give a positive foundation to control segregation instead of giving a normative one.

If this negative effect on economic performance is combined with the negative externalities that one group of the population would generate on another one, or with the desire for living amongst peers, it is possible to conclude that there is a trade-off and, consequently, that there must be an optimum level of segregation, different from 0 but also different from full segregation. Characterising this optimal **RS** is something that has not be done yet, and it is a task with important policy implications.

This is a discussion that is still open. As a matter of fact, there is plenty of research to be done, especially due to the development of new econometric techniques that allow to deal with the problems of specification and identification, like the omission of relevant variables, errors of measure, selection bias and simultaneity, that arise when empirical research on this phenomenon is performed.

It is also important to take into account the individuals' interactions as key element in order to understand aggregated population's behaviour, as **RS**. There is evidence about the fact that households' characteristics, besides race and income, can generate interactions patterns that could have as an outcome **RS**. Thus, to use models of social dynamics to fully understand the forces behind **RS** becomes an important issue. It is also important to consider models where the characteristics of the neighbourhoods and the characteristics of the individuals living in these neighbourhoods are endogenous, as a way to analyse the consequences of **RS** and to evaluate public policies.

These theoretical concepts, related to social dynamics, can be also applied to the empirical analysis of causes and consequences of **RS**, due to the development of categorical dependent variable models that incorporate the individuals' interaction as explanatory variables. Durlauf and Young (2001) give a detailed description of these models, Blume and Durlauf (2001) explain how to introduce individuals' interactions into these discrete choice models. Meen and Meen (2003) show how to apply these models to the study of housing markets and **RS** and provide three reasons to base this procedure: first, because housing markets are particularly sensitive to the presence of externalities; second, because housing markets are characterised by the existence of non-linearities and multiple equilibria; and finally, because these models allow for the analysis of policies oriented to affect individuals interactions instead of just private incentives.

An striking issue related to **RS** research is a sort of a divorce between the theoretical definitions and the empirical analysis. As a matter of fact, most of the empirical studies have been done based on Duncan and Exposure indices. The latter has been done without a strong theoretical foundation. The most plausible explanation is the fact that these indices are of easy calculation and that there are several historical series for different cities, which facilitate the result comparison. Notwithstanding, this fact has methodological implications as well, because the research that has been conducted enquires only of two of the **RS** dimensions, namely evenness and exposure. Thus, to identify causes and consequences of every **RS** dimensions is an outstanding task.

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