The Effects of Coastal Amenities on the Social Structure of Cities

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Most of the US population and income are clustered in counties within 80 km of the coastline or the Great Lakes (Rappaport and Sachs, 2003). These authors also show that the income of coastal counties is eight times higher than that of inland counties, and that the presence of a coast is associated with higher productivity and quality of life. This population concentration is mirrored worldwide;66% of countries have more than 60% of their population living within 100 km of the coast (Martínez et al., 2007). This can be explained by the fact that coastal cities are endowed with a large number of natural amenities that enhance the living environments of their residents.

However, the distribution of natural amenities is not uniform across the city, with nearby households benefiting more than those farther away. In US cities, Lee and Lin (2018) show that the presence of persistent natural amenities, notably oceans, anchors more advantaged households to their proximity and leads to stability in the spatial distribution of income across the city. Neighborhoods with more natural amenities were more likely to remain in high-income neighborhoods. In concrete terms, this translates into the presence of spatial segregation between different types of households, and consequently, the presence of lasting inequalities in the city. In France, in the urban region of Aix-Marseille, Schaeffer et al. (2016) showed that households' search for natural amenities (including the coast) has a significant impact on residential segregation. To our knowledge, this link between natural coastal amenities and residential segregation has only been observed empirically, and a theoretical model explaining this relationship is lacking. Furthermore, the general situation in French coastal towns, beyond the case of Marseille, has not been studied.

Few studies have examined how coastal amenities influence household location choices and their consequences on urban socio-spatial structures. Most articles on coastal cities are empirical and estimate households' WTP for coastal amenities. A few studies have investigated the effects of natural amenities on the urban socio-spatial structure of households (Lee and Lin, 2018). Similar results were found in France by Schaeffer and Tivadar (2019), who showed that households' search for natural amenities (including the coast) has a significant impact on residential segregation.

A small number of theoretical articles have focused on households' trade-offs between risks and amenities, and their impact on city development. A minority of studies dealing with our theme do not provide an analytical resolution for the theoretical model. Wu (2006) studies the effect of geographical

features on community characteristics. He used a theoretical model of urban sprawl with a resolution obtained through numerical simulations. This study shows that the heterogeneity of natural amenities leads to economic segregation between households, with wealthier households living close to amenities. An agent-based model was developed by Filatova et al. (2009), in which households have to make a trade-off between coastal amenities and flood risk. The objective was to model the land market in a coastal city influenced by amenities and disamenities, with heterogeneous agents in risk perception. Simulations with coastal amenities and homogeneous agents show that the most expensive land is found between the CBD and the coast, with the maximum on the coast. Another branch of the coastal city theory focuses on city development along the coastline. Smith (1993)'s model studies the effect of the ocean on city development and how coastal amenities influence household choices and rent prices. Wu (2001)'s model also studies city development, but in the context of urban sprawl, he locates the CBD one mile from the coast to look at the effect of major geographical features on household location choices and city sprawl. Households are identical in terms of income and preferences, and have transport costs that depend on distance from the CBD.

Our study makes theoretical and empirical contributions to this field. The aim of the modeling is to add a topographical feature in the city, the presence of the coastline, into an urban economy model and solve it following the analytical methodology proposed by Fujita (1989). The difficulty lies in adding a second distance to the sea, in addition to the distance to the urban center, and considering several types of households. A model of coastal towns already exists using both distances but does not consider household heterogeneity (Smith, 1993). Another model considers both distances and different households, but is solved numerically (Wu, 2006). The advantage of analytical resolution is that it formalizes the relationship within a general theoretical framework without assigning values to various parameters, thereby reducing the scope of the results.

The aim is to propose an empirical analysis within a framework similar to the theory based on a case study of French coastal towns. To this end, the analysis will be carried out at the level of functional urban areas, which we consider as cities that have an employment center comparable to that of the theory. Specifically, we study residential segregation and unequal access to amenities using two indices: Environmental Centralization (RCE) and Environmental Centralization (ECd).

The data comes from the "Localised disposable income system" (Filosofi) published by the National Institute of Statistics and Economic Studies (Insee) for 2017. Filosofi is based on household tax returns and considers income received in 2017, which was declared in 2018, and the housing tax on January 1, 2018. The French territory is divided into a grid of 200m x 200m squares containing different socioeconomic information on the grid cell, such as the total number of households and the number of poor households. This grid cell method bypasses the usual administrative delimitation of data, enabling studies to be conducted at the infra-communal level. In addition, we focused on the coastal municipalities. We followed the classification of the French littoral law of 1986, which defines communes in the vicinity of seas, oceans, salt ponds, and inland

bodies of water with a surface area of over 1,000 ha as littoral municipalities.

Our aim was to study the effects of coastal amenities on household location choices and socio-spatial structure. The theoretical section indicates that all four social structures are possible in a coastal city (American, European, Rich, or Poor). Our model shows that the existence of an American coastal city is permissible with a small difference in the transport cost ratio between rich and poor households to the CBD and to the coast, and vice versa for a European Structure.

The empirical section tells us that French coastal towns have American-style social structures. We find that the values of the segregation index are greater than those of environmental inequality, and that these indices are influenced by the type of nearby coastline. This variation can be explained by differences in flood risk, water temperature, beach quality, or the risk associated with swimming. We also considered the characteristics of the area in terms of the preferences of different households.

It is important to note that our study had certain limitations. Although these indices allow us to show the social structure, we cannot directly measure relative transport costs. The results of the theoretical model can be explained by our choice to model coastal amenities in terms of household budget constraints. This choice presupposes the strong assumption that households must travel to the beach to benefit from coastal amenities. The data we use suffers from imprecision, as Insee cannot release tax information for a set of one to ten households, and therefore proposes an "imputed" value for squares with fewer than eleven households. Two analyses were performed to address these limitations. First, coastal amenities were considered in the household utility function, and the model was resolved using numerical simulation. Second, recalculation of the indices using a database at the IRIS level will enable a more precise, albeit geographically less precise, analysis of household situations.

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