Urban Density, Residential Location and Transport Emissions of Air Pollutants

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Abstract

A major consequence of urban sprawl is the increase of average travel distances by urban households (Anas et al. (1998); Agency (2006)). As transport is one of the main contributors of local polluting emissions as well as a major emitter of greenhouse gases (GHGs) (Agency (2013)), urban sprawl is a real matter of concern for many policy-makers. Over recent years, a remarkable consensus among international institutions as well as local or national governments has emerged towards the development of *compact cities*. This 'compact city' requirement is one key component of what had been called *smart growth* (see Downs (2001) ; Downs (2005)). One possible way for obtaining a more compact city is to promote by various means increases in urban residential densities. From a theoretical point of view, it has been shown by Gaigné et al. (2012) that policies aiming at increasing population densities could have detrimental effects by leading to higher pollution levels when considering the possible relocation of activities and households.

In this paper, we investigate this question by implementing an economic experiment where households compete for residential location, being possibly constrained by regulations over maximum housing demand. To this aim, a theoretical model is built that assumes a monocentric city (Alonso (1964); Fujita (1989)) where homogeneous households make some trade-off between commuting costs and land-rent costs. As usual, housing demand is endogenously determined by households' preferences as well a location places and, consequently, commuting costs for reaching the CBD. One key element in this model is to consider a negative externality that depends on the total distance travelled by all households within the city. Our policy tool consists in having a maximum housing demand when total housing space per unit of land is constrained. As a consequence, any increase in the regulatory constraint will cause the population density to rise. The main impacts of increasing regulation is to decrease commuting distances, as well as city frontier and land rents. Of course, the decrease of commuting distances leads to lower polluting costs.

The experimental design consists of having a situation game where 15 participants compete for housing in a simultaneous generalized second-price auction market where 9 slots of space are available. For each slot, the total housing space is fixed at the same level. Participants could gain more payoff by achieving higher levels of space consumption, but should pay private and social costs regarding their commuting distance and should also pay land rents as the outcome of auction competition. Different experimental

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treatments are considered. The first one is a benchmark treatment, where no housing-size regulation exists — i.e., called the *Business-As-Usual (BAU)* treatment —. The other treatments consist either in a *strong* or in a *weak* housing-size regulation. The former corresponds to a situation where maximum housing size regulation is lower than the minimum housing demand that would be chosen by households for the central areas. The latter consists in an intermediate situation, maximum housing-size regulation being more than the minimal one, but higher than the maximum demand that would be chosen at the city frontier.

The theoretical predictions show that the effect of housing-size regulation is mixed. If the regulation is strong, commuting costs will decrease compared to a BAU situation, as well as the size of the city. But if regulation is weak, then commuting costs could increase compared to BAU situation. This is due to a population-size effect. As the number of households that succeed to locate within the city is higher under the Weak Regulation scenario, the total commuting distance is increasing. Nevertheless, any regulation of housing-size should increase households' welfare, as the possible detrimental effects of higher transportation costs are more than offset by decrease in land-rents due to regulation. In order to test these theoretical predictions, we chose to implement a within-subject design where 195 participants were confronted successively to two treatments, either to a sequence *"Strong + BAU"*, to a sequence *"Strong + Weak"*, or finally to a sequence *"BAU + Strong"*. Each treatment was repeated during 7 rounds, after achieving a first set of 3 trials at the beginning of the experiment. The main experimental results are the following. The first one is that total commuting costs decrease when regulatory constraint is the strongest, but increase when the regulation is too weak, thus confirming theoretical predictions. The second one is that land rents are lower as the regulatory constraint becomes stronger. The last one is that, surprisingly, the net payoffs for participants are lower under the Weak Regulation treatment compared to both other treatments, consisting in BAU or Strong Regulation.

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