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Duopoly locations and optimal zoning in a small open city

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Abstract

This paper analyzes a duopoly location model with an asymmetric zoning that prohibits firms from locating to a specific interval in a small open linear city. It is shown that the maximum differentiation principle presented in d'Aspremont et al. [Econometrica 47 (1979) 1145] is still valid under area zoning regulation. Moreover, a zoning regulation can be seen as a policy instrument to limit firms' excess profits, and a proper regulation may even reduce the distortion in total transportation costs, therefore enhancing social welfare. Specifically, the optimal zoning is about 29.5 percent of the city with no amenity effect. Finally, all the land rents raised by zoning are eventually confiscated by the absentee landowner.

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1. Introduction

The duopoly model with a spatial framework was first developed by Hotelling [7] and then revised by d'Aspremont et al. [2]. The model was developed further by Economides [4], Lambertini [9], and Irmen and Thisse [8]. The basic concept of these models is that consumers are uniformly distributed in a linear market with each person buying one unit of (homogeneous) product in a given time interval. This product is produced by two identical

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firms that simultaneously choose locations in the first stage and set prices simultaneously in the second stage.

Hotelling [7] shows that firms will agglomerate at the market center (minimum differentiation principle), while d'Aspremont et al. [2] prove that the Hotelling equilibrium does not even exist. They provide a stable (simultaneous) location equilibrium whereby firms locate at the two ends of a linear market (maximum differentiation principle) by using a quadratic transportation form. This paper introduces a zoning constraint into the d'Aspremont et al. [2] model to find the duopoly equilibrium.

Since zoning is also a spatial issue in urban development, borrowing the duopoly framework to analyze zoning is realistic and, to the authors' knowledge, also a new attempt in the literature. Generally speaking, the purpose of urban zoning is to restrict some kinds of economic activities in specific areas so as to prevent some disturbance or to provide a high quality environment. Therefore, zoning is a very popular urban policy in modern cities, as shown by Mills [11], Henderson [6], Miceli [10], and Wheaton [14].

As a regulation tool, traditional wisdom says that there is a trade-off consideration on zoning: it offers quiet and clean communities (amenities), even though people may experience an inconvenience for ordinary shopping purposes. The alternative view, that zoning regulation may act as an industrial policy, is rarely noted. The purpose of this paper is to analyze how a zoning regulation affects the location decisions of duopoly firms and to offer optimal zoning from the aspects of industrial policy and public welfare.

For the model designed in this paper, three things need to be noted. First, as pointed out by d'Aspremont et al. [2], duopoly firms in equilibrium will locate at two ends (or outside, Lambertini [9]) of the Hotelling-type market with quadratic transportation costs. Therefore, a zoning constraint at the middle part of the market has no effect on firms' location choices. Thus, this paper's zoning regulation is based on one-sided (asymmetric) zoning, which indeed affects the location choices of firms. Second, an asymmetric zoning regulation may result in asymmetric location choices in a pattern of firms, and prices as well as profits may also be different. Therefore, the city authority may use the zoning policy to intervene in the location decisions of firms and achieve some social goals. Third, in order to focus on zoning and industrial location, the urban structure for the sake of simplicity is assumed to be a uniform linear city (without a central business district (CBD)).

The major contribution of this paper is to analyze the duopoly location choices on a Hotelling market¹ under a zoning regulation and to provide an optimal zoning policy both from an industrial aspect and an amenity aspect (most in the literature only discuss the latter). The rest of the paper is organized as follows. Section 2 introduces the model, with the welfare analysis appearing in Section 3. Section 4 discusses the land rent pattern under a zoning regulation. The last section provides some concluding remarks.

¹ Fujita and Thisse [5] develop a general equilibrium of duopoly locations in a Hotelling model, but their model does not have the price subgame (product price is fixed), while the current model herein includes both the location and price subgames. Moreover, residents in their model can freely consume the composite good, while residents in the current model can only consume one and only one unit of the composite good.

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