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Imperfect competition and congestion in the City

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Abstract

This paper presents a model to study the interplay of imperfect competition and congestion. Residents live in the city center while they shop and work in subcenters (shopping centers, airports, etc.). Each subcenter offers one differentiated product and one differentiated workplace. Shopping and commuting from the city center to the subcenter requires the use of transport infrastructure that can be congested. We derive the Nash equilibrium in prices and in wages and analyze the welfare impacts of congestion charging and infrastructure policies. We generalize the literature on imperfect competition with (spatially) differentiated products in the presence of (un) priced congestion.
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1. Introduction

This paper presents a model to study imperfect competition with congestion. A city with fixed population is served by a number of subcenters that offer variants of the same product. The location of the subcenters and of the population is fixed and the access to each of the subcenters can be congested by shoppers, workers and trucks. These subcenters can stand for different types of products: they can represent specialized shops selling one product (cars or bikes) or they can represent shopping centers selling a fixed bundle. In the case of metropolitan areas they can also

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represent larger facilities like airports. Each subcenter produces only one variant of the product. The subcenters compete in prices for customers coming from the city but also compete in wages for their employees as each subcenter is a differentiated workplace. Both types of competition are linked since selling more product requires a larger work force. In the short term, the number of subcenters is fixed and we consider a Nash equilibrium in prices and wages. In the long run, free entry and exit can change the number of subcenters. We study the properties of the short and long run equilibrium and examine the effects of congestion pricing, road capacity expansion and other policies that affect directly the number of subcenters.

Our model can be compared to four strands of the literature: the imperfect competition literature, the literature on congestion pricing with imperfect competition, the urban economics literature and the literature on the endogenous location of shopping centers. Our model uses the logit model to represent differentiated goods. Compared to the traditional models of imperfect competition (surveyed in [8]), our model offers two additional features. First, it examines imperfect competition in a general equilibrium (yet simple) framework as the labor market and the delivery of intermediate goods are explicitly modeled. Second, our model introduces congestion. Both elements will be shown to have an important effect on the equilibrium outcome. Introducing a general equilibrium framework and a differentiated job market offers more complexity as firms compete on two markets rather than one. The equilibrium mark-up and the equilibrium number of firms are shown to be increasing in the product and job heterogeneity parameters. Congestion adds another component to the equilibrium mark-up because congestion acts as a disincentive to cut prices. The welfare economics of the number of firms also changes as we now have two market imperfections that interact. Congestion (and market power) can be relieved by having congestion pricing, by having more subcenters but also by having larger road infrastructure. The three strategies are to some extent substitutes.

The interplay between congestion and imperfect competition has already been covered in the case of homogeneous goods for a monopoly by [7], and for a duopoly by [6]. They show that congestion can lead to higher mark ups if the level of congestion is indeed a function of the total sales of the monopolist. We generalize this literature in three ways. First, we use a general equilibrium framework with shopping, commuting and delivery traffic where the three types of traffic are influenced by the strategy of the firms. Second, we study the case of differentiated rather than homogeneous goods and finally we allow for any number of competitors on the market.

The urban economics literature takes a more global approach to the problem of congestion and imperfect competition by including endogenous location of production and residence and having therefore an endogenous urban form (see [11]). In our paper, locations of subcenters and residences of population are fixed although the number of subcenters is endogenized. Since we consider only symmetric equilibria, all subcenters are at the same distance from the center and we can therefore make the natural assumption that the price of land is identical for all subcenters and can therefore be omitted from the analysis. This would not be true if firms were competing for space within each subcenter, a case that is disregarded in this paper.[1] Given the many differences in the type of forces at work (relocation and agglomeration or present in the urban economy models but not in our model), our results are not directly comparable to the results obtained with endogenous location models.

Fujita and Thisse [5, p. 221] survey shopping center models. These models study the endogenous location of shops and employment centers as well as consumers in a linear or homogeneous

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[1] We discuss the case of several firms per subcenter briefly in the conclusions.