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Prices, capacities and service levels in a congestible Bertrand duopoly ☆

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Abstract

We study the duopolistic interaction between congestible facilities that supply perfect substitutes and make sequential decisions on capacities and prices, and compare the results to monopoly and first-best outcomes. At the Nash equilibrium prices and capacities, there is more congestion in the duopoly than in the social optimum. Given our assumptions, monopoly pricing and capacity choices result in the same congestion level as the social optimum. The higher congestion level under duopoly is due to strategic price responses to capacity investments. Moreover, higher marginal costs of capacity may increase duopoly profits. Lastly, when capacity is relatively cheap or demand relatively inelastic, stable asymmetric Nash equilibria may result, where the high-capacity facility offers low time costs at a high price, and the smaller facility offers lower service levels at a lower price. In that case, there is endogenous product differentiation by ex ante identical firms.
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1. Introduction

Facilities like seaports, airports, Internet access providers, and roads, are prone to congestion. When the volume of simultaneous users increases and capacity is constant, the time cost of using these facilities increases. More generally, the perceived quality of the service provided by a facility may decrease when it gets crowded. Facility management can respond to quality deterioration by changing prices, but also by adapting the capacity of the facility. This paper asks how capacity and price decisions are made for congestible facilities in an oligopolistic market structure, and compares the oligopoly result to the monopoly and the socially optimal outcome. More specifically, we study the duopolistic interaction between congestion-prone facilities that supply perfect substitutes in the framework of a sequential game.[1] The facilities first decide simultaneously on capacities; next, they simultaneously choose prices, given capacity decisions. Prices and capacities jointly determine consumers' time cost of accessing or using a particular facility. The level of service, defined as the inverse of time costs of using a facility, declines with crowding.

The analysis of this paper is relevant to a number of situations. Competition between airports in metropolitan areas (e.g. San Francisco Airport and Oakland Airport in the San Francisco Bay Area) is one example. The airports are congestible, so that service quality declines with the number of passengers and plane movements. If airport management maximizes profits,[2] then price decisions and capacity choices will interact with the service quality (congestion). A second example relates to competition between ports that serve the same hinterland (e.g. the ports of Long Beach and of Los Angeles in Southern California, or the ports of Antwerp and Rotterdam in Western Europe). Here too, port capacities and port charges can be chosen by the port authorities to maximize profits. Competition between Internet service providers is another example, although our maintained no entry assumption is less straightforward in this case. The quality of Internet service can be measured as a weighted average of (mainly) download speed, upload speed and mail processing speed; the capacity (computing power, disk space and network capacity) that is required to keep quality constant is approximately a linear function of the number of simultaneous users.[3]

The main insights of this paper are the following. First, we find that, at the Nash equilibrium capacities and prices, the service level in a duopolistic market structure is below the socially optimal level. This is not the case for monopoly where, given our assumptions, pricing and capacity choices result in the same service level as the social optimum. Therefore, duopoly implies more congestion than either the monopoly outcome or the first-best optimum. We show that this finding is due to strategic price responses to capacity investments under duopoly. Second, strategic interaction between prices and capacities implies that lower marginal capacity costs may actually reduce duopoly profits. The intuition is that the cost reduction in the provision of capacity

[1] The assumption of perfect substitutes is more appropriate in some applications than in others. For example, it seems quite reasonable in the case of Internet access providers, but differences in location make it less appropriate for describing competition between ports or airports (see, e.g., Gillen and Morrison [11] for a model of airport competition with differentiated demand). However, our focus on perfect substitutes simplifies the analysis and has no strong implications for the qualitative results of the paper.

[2] At present, many airports may not act as profit-maximizers, especially in the US, as they are constrained by regulation and by long run contracts with carriers (FAA/OST [9]). In a fully deregulated environment, market power deriving from airport congestion may be more likely to accrue to airports than to airlines. Moreover, the interaction between congestion, price and capacity decisions is present when airports maximize a weighted sum of revenues and output.

[3] Personal communication with Francis Depuydt, Team Manager Integrated Service Platforms, Belgacom.

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