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Downtown parking in auto city[☆]

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ABSTRACT

Arnott and Inci [Arnott, R. and Inci, E., 2006. An integrated model of downtown parking and traffic congestion. Journal of Urban Economics 60, 418–442] developed an integrated model of curbside parking and traffic congestion in a downtown area. Curbside parking is exogenously priced below its social opportunity cost, and the stock of cars cruising for parking, which contributes to traffic congestion, adjusts to clear the market for curbside parking spaces. Denser downtown areas have garage as well as curbside parking. Because of economies of scale in garage construction, garages are discretely spaced. The friction of space confers market power on parking garages. Spatial competition between parking garages, as modeled in Arnott [Arnott, R., 2006. Spatial competition between downtown parking garages and downtown parking policy. Transport Policy 13, 458–469], determines the equilibrium garage parking fee and spacing between parking garages. Also, the stock of cars cruising for parking adjusts to equalize the full prices of curbside and garage parking. This paper combines the ingredients of these two models, hence presenting an integrated model of curbside parking, garage parking, and traffic congestion, and examines curbside parking policy in this context through a numerical example with parameters representative of a medium-sized US city. The central result is that raising the curbside parking fee appears to be a very attractive policy since it generates efficiency gains that may be several times as large as the increased revenue raised.

1. Introduction

Anyone who has parked in the downtown area of a major city during the business day will attest to its high cost. Parking in a convenient parking garage is expensive, while finding cheaper curbside parking normally entails cruising for parking and walking some distance. To our knowledge, there are no reliable estimates of the proportion of the average full price of a trip with a downtown destination that is associated with parking. Informal estimates of one half seem too high. It seems warranted to say, however, that economists have paid less attention to downtown parking than its importance merits. There is a large literature in economics on urban auto congestion but only a few recent papers on the economics of downtown parking (which will be reviewed below).

Arnott and Inci (2006) constructed an integrated model of curbside parking and traffic congestion in an isotropic downtown area with identical drivers and price-sensitive demand. The curbside meter rate is set below its social opportunity cost. This results in excess demand for curbside parking spaces. Parking is saturated, and cars cruise for parking waiting for a parking spot to open up. The expected time spent cruising for parking adjusts to clear the market, which is achieved via adjustment in the density of cars cruising for parking. The cars cruising for parking contribute to traffic congestion as well. Under reasonable assumptions, Arnott and Inci demonstrated the existence and uniqueness of steady-state equilibrium with saturated parking, and also examined curbside parking policy in the context of the model.

Denser downtown areas have garage as well as curbside parking. Because of economies of scale in garage construction, garages are discretely spaced. The friction of space then confers market power on parking garages. Arnott (2006) developed a model of spatial competition between parking garages, which generates an equilibrium parking fee that is above marginal cost. With underpriced curbside parking and overpriced garage parking, the stock of cars cruising for parking adjusts to equalize their full prices. This paper combines the ingredients of these two models (except, to simplify, it assumes inelastic demand for downtown parking), hence presenting an integrated model of curbside parking, garage parking, and traffic

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congestion, and examines curbside parking policy in this context through a numerical example with parameters representative of a medium-sized, auto-oriented city such as Winnipeg, Perth, San Diego, Sacramento, or Phoenix.

The addition of garage parking alters the economics of downtown parking in three interesting ways. First, the equilibrium condition determining the stock of cars cruising for parking changes. With only curbside parking, the stock of cars cruising for parking adjusts to clear the market for trips. In contrast, with both curbside and garage parking the stock of cars cruising for parking adjusts to equalize the full prices of curbside and garage parking. Second, even though the overpricing of garage parking does not create inefficiency directly, since overall parking demand is assumed to be inelastic, it does so indirectly in two ways, first, as noted already, by increasing the price spread between curbside and garage parking and hence the stock of cars cruising for parking, and second by causing parking garages to be inefficiently small and too closely spaced. Third, the presence of garage parking magnifies the distortion associated with the underpricing of curbside parking, or, put alternatively, increases the social benefit of increasing the curbside parking fee. With only curbside parking, the equilibrium full price of a downtown trip is determined by the intersection of the trip demand curve and the curbside parking capacity constraint. Raising the curbside meter rate does not alter this full price of *trips*, but simply converts travel time (which includes in-transit and cruising-for-parking time) costs dollar for dollar into meter revenue, so that every extra dollar of revenue raised increases social surplus by one dollar. But with garage parking, there is a magnification effect. Raising the curbside meter rate does not alter the full price of *parking*. Raising the curbside meter rate converts cruising-for-parking time costs dollar for dollar into meter revenue. But there is the added benefit that the reduction in the stock of cars cruising for parking reduces traffic congestion, which benefits everyone. In our favored numerical example, this magnification effect results in a $3.20 increase in social surplus for every dollar increase in meter revenue.

As noted above, the literature on the economics of parking is small. We start by reviewing the broader literature, and then turn to the small number of papers that distinguish between curbside and/or garage parking or analyze cruising for parking.

Early work on the economics of parking argued that parking, like any other commodity, should be priced at its social opportunity cost (Vickrey, 1954; Roth, 1965). Vickrey (1954) also developed a scheme for demand-responsive pricing of curbside parking. Over the next three decades, parking was largely ignored by economists, in modal choice studies being treated simply as a component of the fixed cost of a trip. Modern interest in the economics of parking started in the early 1990s. Shoup (2005) has led the way in generating interest in the economics of parking. In the 1990s, he championed cashing out employer-provided parking, and has considered many aspects of the economics of parking since then. Arnott et al. (1992) and Anderson and de Palma (2004) extended the Vickrey bottleneck model (1969) to analyze the temporospatial equilibrium of curbside parking when all drivers have a common destination and desired arrival time, such as for a special event or the morning commute. Arnott and Rowse (1999) examined the steady-state equilibria of cars cruising for parking on a circle when parking is unsaturated.

Arnott et al. (2005, Ch. 2, The basic model) presented a model that examines the interaction between cruising for parking and traffic congestion with only curbside parking. A more thorough treatment of that model was provided in Arnott and Inci (2006). Several papers in the literature have recognized that the stock of cars cruising for parking adjusts to equalize the full prices of curbside and garage parking (Calthrop, 2001; Shoup, 2005,[1] 2006; Arnott et al., 2005; Calthrop and Proost, 2006). Calthrop (2001) and Arnott (2006) considered the potential importance of garage market power, Calthrop by assuming a monopoly supplier, Arnott by modeling spatial competition between parking garages. The Los Angeles model of Arnott, Rave, and Schöb includes curbside parking, garage parking, endogenous cruising for parking, and garage market power, but provides an unpersuasive treatment of garage market power. Arnott (2006) contained all four elements as well, but focused on the treatment of garage market power rather than providing a complete analysis of the model. This paper provides a complete analysis with the more satisfactory treatment of garage market power, and also provides calibrated numerical analysis of a variety of parking policies.

In terms of policy insights, our principal finding – which was noted above – is that, under conditions of even moderate traffic congestion, the social benefits from raising curbside parking rates may be several times the additional meter revenue generated, a double dividend result. Another important finding is that, with realistic parameter values, less space should typically be allocated to curbside parking the larger is the wedge between curbside and garage parking rates.

Section 2 sets the stage by presenting a simplified model in which garage parking is provided at constant unit cost. Section 3 presents and analyzes the central model that takes into account the technology of garage construction and spatial competition between parking garages. Section 4 presents calibrated numerical examples for the central model. Section 5 notes some directions for future research. And Section 6 provides some concluding comments.

2. A simple model

Understanding the central model of the paper will be facilitated by starting with a simplified variant. A broad-brush description is followed by a precise statement.

2.1. Informal model description

The model describes the equilibrium of traffic flow and parking in the downtown area of a major city.[2] To simplify, it is assumed that the downtown area is spatially homogeneous (isotropic) and in steady state, and also that drivers are homogeneous. Drivers enter the downtown area at an exogenous uniform rate per unit area-time, and have destinations that are uniformly distributed over it. Each driver travels a fixed distance over the downtown streets to his destination. Once he reaches his destination, he decides whether to park curbside or in a parking garage.[3] Both curbside and garage parking are provided continuously over space. If he parks curbside, he may have to cruise for parking, circling the block until a space opens up. After he has parked, he visits his destination for a fixed period of time, and then exits the system. Garage parking is assumed to be provided competitively by the private sector at constant cost, with the city parking department deciding on the curbside meter rate and the proportion of curbside to allocate to parking. The curbside parking fee (the meter rate) is less than the garage fee. Consequently, all drivers would like to park curbside but the demand inflow is sufficiently high that this is impossible. Curbside parking is saturated (the occupancy rate is

[1] Shoup, Table 11-5, displays the results of 16 studies of cruising for parking in 11 cities over an eighty- year period. The mean share of traffic cruising was 30% and the average search time was 8.1 min. While the study locations were not chosen randomly, the results do indicate the potential importance of cruising for parking.

[2] The model differs from that in Arnott and Inci (2006) in two respects. Arnott and Inci consider the situation where all parking is curbside and the demand for trips is sensitive to the full price of a trip. Here, in contrast, the demand for trips is completely inelastic, and there is both curbside and garage parking. The model specification is independent of the form of the street network, but for concreteness one may imagine that there is a Manhattan network of one-way streets.

[3] The paper does not consider parking lots. Parking lots are difficult to treat because most are transitional land uses between the demolition of one building on a site and the construction of the next.