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Wouter Vermeulen and Jan Rouwendal

CPB Netherlands Bureau for Economic Policy Analysis
Van Stolkweg 14
P.O. Box 80510
2508 GM The Hague, the Netherlands

Telephone +31 70 338 33 80
Telefax +31 70 338 33 50
Internet www.cpb.nl

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Abstract in English

Residential development at the urban fringe raises the cost of trips to open space. We derive a simple expression for the tax that internalizes this effect of sprawl in a monocentric city and apply it using survey data on recreational activity.

Keywords: urban sprawl, open space, growth controls, outdoor recreation
JEL classification: Q26, R13, R52

Abstract in Dutch

Mensen recreëren gemiddeld genomen bijna wekelijks in open ruimte buiten de bebouwde kom. De ontwikkeling van uitleglocaties maakt dit soort open ruimte voor stedelingen minder bereikbaar. In hoeverre rechtvaardigt dit externe effect een restrictief ruimtelijke-ordeningsbeleid? We bepalen de optimale heffing op het ontwikkelen van open ruimte in een stedelijk model en passen het resultaat aan de hand van informatie over vrijetijdsbesteding toe op Amsterdam. De geschatte schaduwprijs van daadwerkelijke restricties op nieuwbouw blijkt vele malen groter.

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A Taste for Trips out of Town:
Urban Sprawl and Access to Open Space

by

Wouter Vermeulen

CPB Netherlands Bureau for Economic Policy Analysis

VU University

Spatial Economics Research Centre (SERC)

Jan Rouwendal

VU University

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A Taste for Trips out of Town:
Urban Sprawl and Access to Open Space

Abstract

Residential development at the urban fringe raises the cost of trips to open space. We derive a simple expression for the tax that internalizes this effect of sprawl in a monocentric city and apply it using survey data on recreational activity.

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1 Introduction

Urban sprawl is inefficient if landowners ignore the social value of open space in their decision to develop it. The absence of a market for open space amenities impedes reliable estimation of their value, so policies that control urban growth may be ill-informed (Brueckner, 2000). Our approach to this valuation problem relies on the well-established notion that travel costs of recreational activity serve as an implicit price (Hotelling, 1947; Phaneuf and Smith, 2006). We extend the conventional monocentric city model with a demand for 'trips out of town': recreation in large contiguous undeveloped areas like forests, wetlands or the countryside, for which open space within the urban boundary is an imperfect substitute. Urban expansion reduces accessibility of such 'true open space' for prior inhabitants. We derive a simple expression for the tax on conversion of agricultural land to urban use that internalizes this effect and apply it to the city of Amsterdam.

The travel cost approach has rarely been applied to the valuation of open space in or near urban areas (McConnell and Walls, 2005). In particular, most applied welfare analyses of open space provision in a general equilibrium framework have been based on capitalization of benefits into local property values. This entails a focus on comparably localized effects.[1] Notably, open space amenities in Cheshire and Sheppard (2002) are confined to a surrounding squared kilometre. Walsh (2007) also considers the benefit of proximity to public open space, yet the average distance is only about one kilometre in his empirical application. In large cities, visits to true open space will generally require a much longer trip.

2 Theory

We consider a circular city with radius *b*, surrounded by agricultural land. The amount of land available for residential purposes at distance $r \leq b$ from the centre is $L\ r$. True open space is agricultural land at some critical distance $d \geq 0$ from the urban fringe, large enough for instance to make the city skyline disappear from the horizon.[2]

Residents derive utility *u* from the consumption of a composite consumption good *z*, from land *s* and from trips to true open space *n*:

[1] Although Anderson and West (2006) find that property values rise with proximity to special parks, which on average have a size of thousand acres and a distance of two kilometres in their sample.

[2] This condition effectively ensures that true open space is not provided within the urban fringe. See Lee and Fujita (1999) for a more general model of optimal greenbelt provision.

$$u = u\ \ z, s, n\ \ . \tag{1}$$

True open space is nonexcludable, so residents only incur travel costs. The price of a trip equals $t_n\ \ b - r + d\ \ $, where $b - r + d$ is the distance to the nearest place where true open space can be enjoyed and t_n denotes the per unit travel costs for recreational trips. All prices are expressed in units of the composite good.

Jobs are located in the city centre and each resident provides one unit of labour with a constant marginal product of *w*. This requires an exogenous number of commuting trips *m* and the commuting costs per unit of distance t_m is allowed to differ from t_n, possibly because of a difference in the valuation of travel time. For the city to maintain its monocentric structure, we must have that $t_m m > t_n n\ \ r\ \ $, so that locations at closer distance to the centre are more attractive. This inequality is likely met in practice as for most people $m \gg n\ \ r\ \ $.

In order to derive the efficient allocation of resources, we define social surplus as the total income generated in the city minus all costs incurred in order to assure a utility level *u* for its inhabitants. The minimum amount of the composite good that has to be consumed in order to reach utility level *u* when $n\ \ r\ \ $ trips to open space are made and $s\ \ r\ \ $ units of land are consumed is denoted $Z\ \ n\ \ r\ \ , s\ \ r\ \ ; u\ \ $. Surplus may then be written as:

$$S = \int_{r=0}^{b} \left(\frac{w - t_m m r - t_n n\ \ r\ \ \ b + d - r\ \ - Z\ \ n\ \ r\ \ , s\ \ r\ \ ; u}{s\ \ r\ \ } - p^A \right) L\ \ r\ \ \ dr\ , \tag{2}$$

where p^A is the agricultural land rent. The problem of a benevolent planner is to find $n\ \ r\ \ $, $s\ \ r\ \ $ and a boundary *b* that optimize this expression. This yields the following first order conditions:

$$-\frac{\partial Z\ \ n\ \ r\ \ , s\ \ r\ \ ; u}{\partial n} = t_n\ \ b + d - r\ \ , \tag{3}$$

$$-\frac{\partial Z\ \ n\ \ r\ \ , s\ \ r\ \ ; u}{\partial s} = \frac{w - t_m m r - t_n n\ \ r\ \ \ b + d - r\ \ - Z\ \ n\ \ r\ \ , s\ \ r\ \ ; u}{s\ \ r\ \ }\ , \tag{4}$$

and, making use of Leibniz's rule,

$$\frac{w - t_m m b - t_n n\ \ r\ \ \ d - Z\ \ n\ \ b\ \ , s\ \ b\ \ ; u}{s\ \ b\ \ } = p^A + \frac{1}{L\ \ b\ \ } \int_{r=0}^{b} \frac{t_n n\ \ r\ \ L\ \ r\ \ }{s\ \ r\ \ } dr\ . \tag{5}$$

Hotelling's approach to the valuation of public parks is embodied in condition (3), which states that at the margin, the willingness to pay for trips to true open space should equal the

travel cost. Condition (4) states that the marginal willingness to pay for residential land should equal the maximum a person can afford to pay if she earns her marginal product and pays the expenses for travel and consumption of the composite good from it. Hence, condition (5) implies that at the urban fringe, the willingness to pay for residential land should exceed the agricultural land rent by a certain levy τ that may be rewritten as:

$$\tau = \frac{t_n \hat{n} N}{L \; b}. \tag{6}$$

In this expression, $\hat{n}$ denotes the average frequency of trips to true open space and N is the total number of residents in the city. The numerator equals the total additional travel cost to true open space that is imposed by expanding the urban fringe by one unit of distance and the denominator scales this amount to the additional residential land that becomes available.

Consider an open city in which migration ensures an exogenous utility level u. The social optimum in this city may be decentralized by trading labour, residential land and the composite good on competitive markets, while levying a tax on the conversion of agricultural to residential land that equals τ. Developers will then find it profitable to build the city outwards until condition (5) is met. Furthermore, in a spatial equilibrium, residents will choose the trip frequency and lot size that maximize their bid for residential land, thus ensuring that conditions (3) and (4) hold. Cities that neglect to implement the development tax are too large and not sufficiently dense, since residential land is worth less if trips out of town are more costly.[3]

3 Application

We define trips out of town in a Dutch leisure activity survey either as 'outdoor recreation' that takes place outside the municipality of residence, or as activities conducted in types of open space that are usually not found within city boundaries – see Table 1 for an overview and some basic descriptives. Trips with a length of over 50 kilometres have been discarded as these are unlikely to be affected by city size.[4] Table 2 illustrates that in line with our model, the monetary travel costs are higher and the frequency of trips is lower in more urbanized places. Table 3 puts numbers into expression (6) for the city of Amsterdam, while assuming that $L \; r \; = \omega r$, where ω denotes the share of land in residential use. The implied optimal

[3] This may induce crowding out of internal open space, as noted in Walsh (2007).
[4] About 10% of all trips exceed this threshold in either definition.

development tax of about 10 Euros per square metre is modest compared to estimates of the actual shadow tax on residential land use at the fringe of this city. For instance, Vermeulen (2010) reports a gap of 254 Euros per square metre between the value of residential land and its opportunity and development cost.[5]

4 Conclusion

We have derived a simple tax rule for internalization of the loss of open space benefits that urban expansion induces. This rule is crude in that it assumes specific urban form and ignores the non-use value of open space and unique locational attributes like outstanding beauty, environmental quality or historical value. Yet, as the informational burden is minimal, it may serve a useful benchmark. Our application suggests that open space preservation warrants controls on urban growth that are rather moderate in degree.

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[5] The implied regulatory tax rate of almost 30% ranks Amsterdam amongst the more restrictive cities in the US, as measured by Glaeser et al. (2005) – only San Francisco and San Jose impose regulatory tax rates that are significantly higher.

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TABLES

Table 1: Defining trips out of town

	Outdoor recreation outside municipality of residence	Trips to surroundings classified as true open space
Surroundings (%)		
Forest	20.0	31.8
Sea / water / wetlands	13.0	21.3
Countryside	14.4	27.0
Park outside built-up area	6.2	10.8
Dunes / sands / heath	6.5	9.1
Other	40.0	-
Location (%)		
Own municipality	-	37.0
Elsewhere	100.0	63.0
Descriptives		
Weekly frequency	0.69	0.70
Total duration (hours)	2.9	2.7
Distance to location (km)	11.3	8.9
Monetary travel cost (€)	1.13	0.74

Note: Based on Continu VrijeTijdsOnderzoek (CVTO) 2006-2007. The sample consists of 16,392 respondents who report their leisure activities for one week. Total duration of the activity includes travel time. Distance to location of the activity refers to the point of departure in the case of 'mobile activities' like hiking and cycling. Monetary travel costs incurred for the recreational activity have been imputed in the CVTO on the basis of distance and modal choice.

Table 2: Urbanization and trips out of town

Degree of urbanization	Outdoor recreation outside municipality of residence		Trips to surroundings classified as true open space	
	cost (€)	*frequency*	*cost (€)*	*frequency*
High	1.19	0.68	0.84	0.59
Medium	1.11	0.66	0.77	0.68
Low	1.06	0.72	0.60	0.88

Note: The definition of the degree of urbanization from Statistics Netherlands is based on local address counts: high is more than 1500 addresses and low is less than 1000 addresses per square kilometre.

Table 3: Optimal development tax

Variable	Value	
Annual frequency of trips	35	28
Travel cost (€/km)	0.2	
Total population	1 million	
Total area of city (ha)	45 thousand	
Share in residential use	0.18	
Length of residential boundary (km)	13.5	
Discount rate	0.05	
Optimal development tax	10.3	8.3

Note: Trip frequencies for both alternative definitions have been estimated for residents of the urban agglomeration of Amsterdam. An average monetary travel cost of 0.08 €/km is based on CVTO 2006-2007. The total travel costs are based on a speed of 80 km/h and a value of time of 10 €/h. The total population, area and share of land in residential use for Amsterdam are obtained from Statistics Netherlands.

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