Determination of Land Rents: A simple approach

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Abstract

This note develops a simple methodology to derive land rents from housing prices by exploiting information on variation of lot sizes. The methodology is used for the Netherlands using unique information on more than one million transactions over the period 1985–2007. The spatial variation in derived land rents is illustrated as well as the association with, among others, population density and distance to the city centre.

Key words: land rents, hedonic pricing
JEL codes: Q15, R31, R51

[1] This note is partly an outgrowth of a research project at CPB Netherlands Bureau for Economic Policy Analysis that resulted in the publication *Stad en Land* (in Dutch) and serves as background information for the analyses in Chapters 2 and 5 of that study. This research would not have been possible without the generous provision of data by the Dutch Association of brokers (NVM). Useful comments from and discussions with Jasper Dekkers, Harry Garretsen, Gerard Marlet, Piet Rietveld, Coen Teulings, Wouter Vermeulen and Vriso de Vor are gratefully acknowledged. The usual disclaimer applies.

1. Introduction

'Corn is not high where rents are high, but rents are high where corn is high.' This simple but fundamental insight from David Ricardo is still at the heart of most urban economic models. The simple monocentric city models explain variation in land rents from the difference in the returns to labor between the city centre and the periphery and from the distance to the city centre. The larger the return and the smaller the distance to the location where this return can be reaped, the larger the land rent that consumers are willing to pay. This insight can easily be generalized to situations where, for example, the city centre provides unique amenities or relatively high wages due to agglomeration externalities (cf. Roback, 1982).

Information on variation in land rents can hence be an important tool to value amenities, accessibility, public goods, etc. A huge empirical literature using hedonic pricing techniques uses this insight for the purpose of valuation of individual aspects of the location, such as accessibility of jobs, facilities and open space, noise levels, etc. Despite the importance of land rents for policy purposes, surprisingly little systematic information on variation in land rents is available.[2] In so far as local governments have information on actual transactions, this information is oftentimes not publicly available. This note develops and applies a simple methodology that can be helpful in deriving variation in land rents across space at refined levels of spatial aggregation allowing for analyses of within- and between variation of land rents in cities. The obtained information on land prices can subsequently be used for valuation exercises, assessing impacts of regulation, etc. We refer to Glaeser et al. (2005), Davis and Heathcote (2007) and Davis and Palumbo (2008) for roughly comparable exercises to derive hedonic land prices in US metropolitan areas.

Our methodology critically hinges on the availability of information on lot sizes. By adding lot sizes to an otherwise standard hedonic pricing model that explains variation in housing prices from variation in their characteristics, we can derive the willingness to pay at the margin for an additional square meter of land. This information is available in the Netherlands for a long period (viz. 1985–2007). This provides us with a unique source of information, both in terms of time span as well as coverage since the brokers united in the NVM cover about 70–80% of all housing transactions in the Netherlands. We use this unique source of

[2] For an interesting exception, see Dekle and Eaton (1999) who used information on the price of land in Japan at the level of prefectures to find evidence for agglomeration externalities.

information to apply the methodology for deriving land rents. The results are shown to generate a very sensible picture of land rents and their variation across space. We can also use the information to derive relationships between, for example, land rents on the one hand and population densities or distances from the city centre on the other hand. The information also enables us to show temporal dynamics.

This note proceeds as follows. Section 2 develops the methodology and describes the data. Section 3 presents and discusses the results, and Section 4 concludes and presents directions for further research.

2. Methodology and data

Methodology

We follow a more or less standard hedonic pricing methodology by estimating the following regression model:

$$lnP_{ijt} = \alpha + \sum_{j=1}^{J} \beta_j lnL_{ijt} + \sum_{k=1}^{K} \gamma_k X_{ijt}^{k} + \sum_{t=1985}^{T} \delta_t D_{ijt} + \varepsilon_{ijt} \quad (1)$$

where P_{ijt} is the price of transaction i in area j at time t, L_{ijt} stands for the lot size, and the X's are house characteristics that we control for. The key parameters of interest are the β_j's. These capture the share of land in the total transaction price. Important for the proper identification of land rents is that we allow the β_j to vary over relatively small spatial units. In our application, we take zip codes at the four-digit level as our smallest spatial unit (some 4000 units across the country). Ideally, one would like to have variation at even lower spatial levels, but we have too few observations for that. Since:

$$\beta_j = \mathrm{d}lnP_{ijt} / \mathrm{d}lnL_{ijt} = L_{ijt} / P_{ijt} \cdot \mathrm{d}P_{ijt} / \mathrm{d}L_{ijt} \quad (2)$$

and since $\mathrm{d}P_{ijt} / \mathrm{d}L_{ijt}$ is the marginal effect of an additional square meter (m^2) of land on the transaction price, that is $\mathrm{d}P_{ijt} / \mathrm{d}L_{ijt}$ is the price of land, β_j is the share of land in the transaction. Using this information, the price of land per m^2 can be easily derived as $\beta_j \cdot P_{ijt} / L_{ijt}$. Real transaction prices are derived by correcting for overall price increases as captured by the time dummies (viz. we do not correct for increases of, for example, consumer prices, but we do correct for overall increases of house prices in determining real prices of land in a particular year).

Data

Our data are derived from the Dutch Organization of Brokers (NVM) that collect information on transactions of houses in the Netherlands. The NVM is by far the largest organization and covers 70–80% of the Dutch market of housing transactions. They are present in the entire country, although somewhat underrepresented in the more peripheral regions. Table 1 provides an overview of variables and their exact definitions, including basic descriptive statistics.[3]

Table 1. List of variables and descriptive statistics (*N*=1,091,247)

Variable	Description	Mean	St.dev.
P	Transaction Prize (x 1,000 euro)	211.96	147.43
L	Parcel size (in m^2)	441.15	1739.35
S	Surface of living area (m^2)	136.46	42.57
D_terraced	Dummy equal to 1 if terraced	0.44	0.50
D_corner	Dummy equal to 1 if corner	0.18	0.39
D_semidetached	Dummy equal to 1 if semi-detached	0.21	0.41
D_garage	Dummy equal to 1 if there is garage	0.34	0.47
D_carport	Dummy equal to 1 if there is carport	0.05	0.21
D_parkout	Dummy equal to 1 if there is outside parking	0.04	0.20
D_carpgar	Dummy equal to 1 if there is garage and carport	0.02	0.15
D_2garages	Dummy equal to 1 if there is double garage	0.04	0.19
D_heat	Dummy equal to 1 if there is central heating	0.95	0.21
D_b06	Dummy equal to 1 if built before 1906	0.04	0.20
D_0630	Dummy equal to 1 if built between 1906 and 1930	0.10	0.30
D_3144	Dummy equal to 1 if built between 1931 and 1944	0.07	0.27
D_4559	Dummy equal to 1 if built between 1945 and 1959	0.06	0.23
D_6070	Dummy equal to 1 if built between 1960 and 1970	0.13	0.33
D_7180	Dummy equal to 1 if built between 1971 and 1980	0.25	0.43
D_8190	Dummy equal to 1 if built between 1981 and 1990	0.19	0.39

[3] Further detailed descriptive statistics are available upon request.

3. Results

This section presents the main results from our analysis. Equation (1) was estimated for each province separately. This allows for flexibility in estimated coefficients for the housing characteristics.[4] Note that the key parameters of interest are the estimated coefficients for parcel size, which are allowed to vary by 4 digit ZIP code (further referred to as PC-4 areas). Table 1 presents the results from the estimated hedonic price equation for all provinces.

Figure 1 presents information on the land rents that are derived from these regression results. The figure reveals a clear pattern of high land rents in the urban areas in the Randstad area in the Western part of the country (especially in the North wing). Land rents decline rapidly moving to peripheral areas in the North-East and also South-West of the country (to values less than 25 euro per square meter of land). Also inside the metropolitan areas, we see a clear pattern of high land rents in the city centres (reaching an extreme value of approximately 3500 euro in the centre of Amsterdam) that decline rapidly when moving to the city's outskirts.

At the municipality level, land rents vary between 15 euro in Reiderland (North-East Groningen) and 952 euro in the capital city Amsterdam (see Table 2). The variation clearly declines as we increase the aggregation level, but even at the NUTS-2 level (provinces), there is almost a factor 6 between the province with the highest (North Holland) and the lowest (Drenthe) land rent per m^2.

Table 2. Variation of land rents at different aggregation levels (2007 prices)

	PC-4 area	Municipality	GSA	NUTS-3 (Corop)	Province
Min	2.25	15.2	94.6	41.9	68.1
Max	3525	951.7	711.2	598.7	384.1
Ratio	1570	62.5	7.5	14.2	5.6

Note: land rents at aggregation levels higher than the PC4-level are weighted averages of the information at the PC4-level, using built area in the respective PC4-areas as weights.

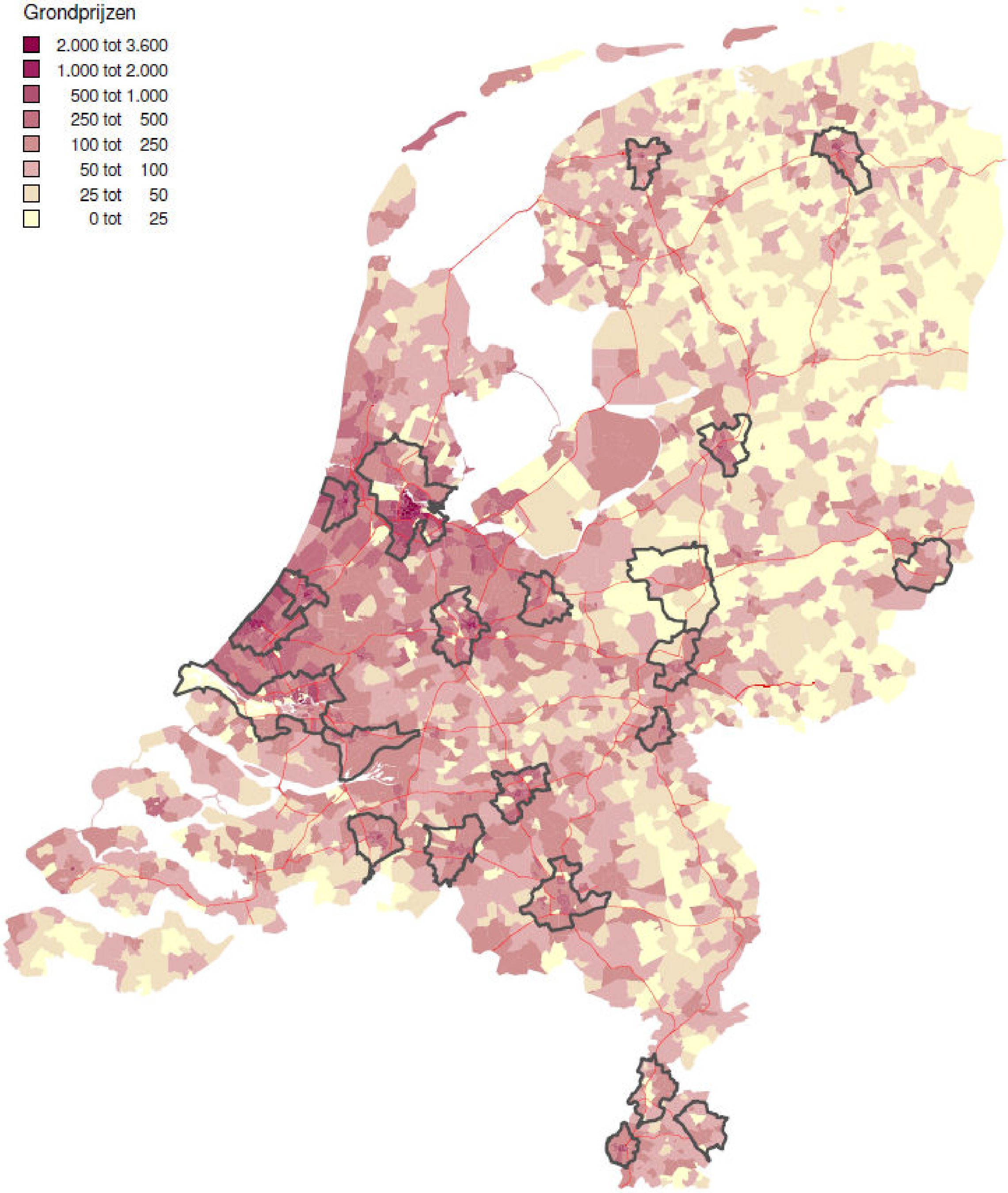
[4] Regressions were also run for the entire sample (imposing the coefficients to be equal across space). Details are available upon request.

Table 1. Regression results per province.

	Limburg	Zeeland	Noord Holland	Noord Brabant	Friesland	Drenthe	Overijssel	Flevoland	Groningen	Zuid Holland	Utrecht	Gelderland
# of observations	29358	16232	169193	175914	45267	48435	86008	36400	39140	181531	106915	156854
Living area	0.44	0.55	0.59	0.52	0.46	0.48	0.52	0.38	0.50	0.58	0.56	0.51
Garage	0.06	0.10	0.08	0.06	0.09	0.09	0.09	0.11	0.09	0.09	0.07	0.07
Terrace	-0.22	-0.20	-0.18	-0.23	-0.22	-0.27	-0.21	-0.29	-0.20	-0.18	-0.22	-0.23
Corner house	-0.22	-0.20	-0.18	-0.22	-0.22	-0.26	-0.22	-0.30	-0.20	-0.19	-0.22	-0.22
Semi-detached	-0.16	-0.11	-0.10	-0.13	-0.15	-0.17	-0.15	-0.19	-0.12	-0.08	-0.09	-0.12
Carport	0.05	0.05	0.04	0.04	0.09	0.07	0.06	0.05	0.07	0.04	0.04	0.04
No central heating	-0.15	-0.20	-0.14	-0.14	-0.15	-0.14	-0.14	-0.10	-0.18	-0.14	-0.13	-0.12
Own parking lot	0.02	0.03	0.02	0.01	0.05	-0.01	0.03	0.04	0.03	0.02	0.02	0.00
Carport and garage	0.08	0.13	0.09	0.08	0.12	0.11	0.11	0.12	0.12	0.11	0.08	0.09
Double garage	0.09	0.14	0.07	0.08	0.11	0.12	0.08	0.12	0.11	0.10	0.07	0.08
Built before 1906	-0.15	-0.16	-0.11	-0.13	-0.16	-0.13	-0.16	0.03	-0.23	-0.12	-0.02	-0.11
Built between 1906 and 1930	-0.24	-0.22	-0.14	-0.19	-0.20	-0.18	-0.22	0.09	-0.25	-0.16	-0.09	-0.16
Built between 1931 and 1944	-0.19	-0.22	-0.09	-0.15	-0.18	-0.16	-0.17	-0.01	-0.20	-0.13	-0.05	-0.11
Built between 1945 and 1959	-0.22	-0.23	-0.16	-0.18	-0.20	-0.17	-0.18	-0.14	-0.25	-0.17	-0.12	-0.15
Built between 1960 and 1970	-0.19	-0.21	-0.17	-0.18	-0.19	-0.17	-0.17	-0.20	-0.23	-0.17	-0.16	-0.15
Built between 1971 and 1980	-0.13	-0.15	-0.13	-0.13	-0.16	-0.13	-0.13	-0.13	-0.15	-0.12	-0.11	-0.11
Built between 1981 and 1990	-0.10	-0.08	-0.08	-0.08	-0.10	-0.08	-0.08	-0.10	-0.10	-0.08	-0.07	-0.06
Minimum lot size elasticty	0.083	0.120	0.104	0.126	0.083	0.091	0.119	0.096	0.105	0.127	0.146	0.094
Maximum lot size elasticity	0.319	0.294	0.435	0.318	0.319	0.229	0.289	0.306	0.329	0.361	0.318	0.242
Minimum implied land rent per m^2	2.33	2.31	4.56	6.33	2.33	2.75	2.25	20.42	4.23	9.73	13.90	2.42
Maximum implies land rent per m^2	634.21	556.80	3525.10	858.99	634.21	282.96	641.83	507.11	908.00	3006.18	1699.39	588.63

Note: in all regressions, 4 digit ZIP code specific lot size elasticities have been estimated, of which only the maximum and minimum value per province are shown. Also month dummies for the month in which the transaction took place and year dummies for the year in which the transaction took place have been included. Results are not reported, but are available upon request. All transactions of houses with a garden over the period 1985–2007 have been included.

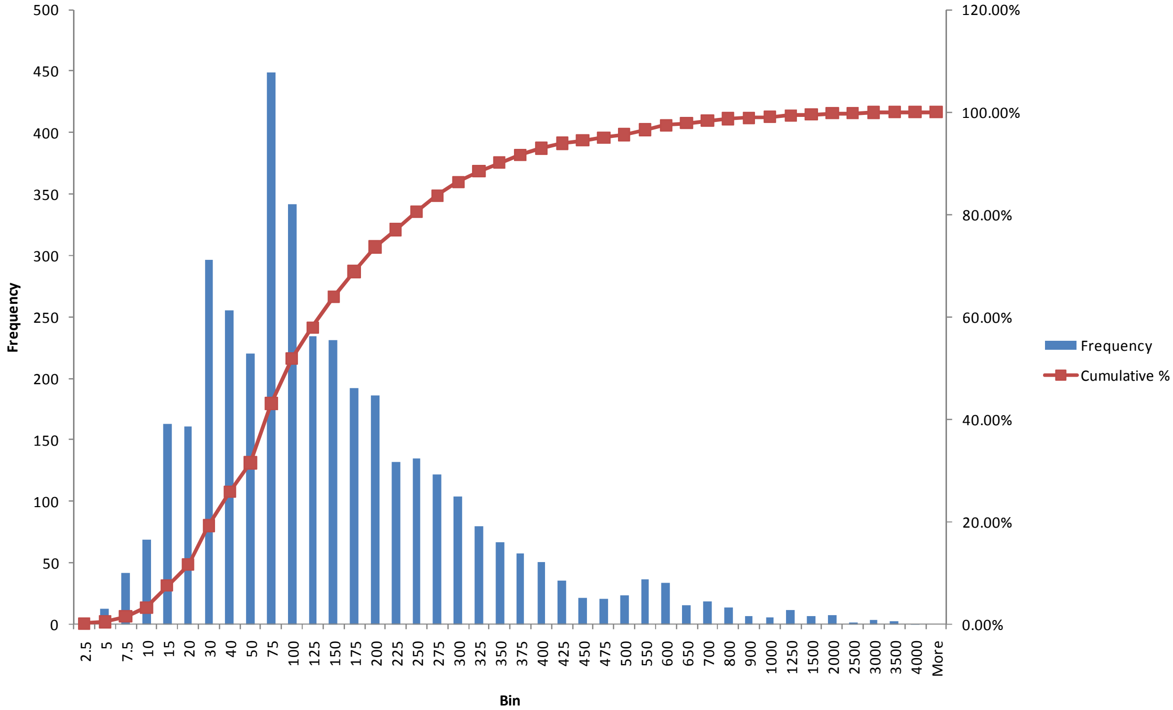
Figure 1. Spatial variation in land rents at 4 digit ZIP code level (constant prices 2007).



Note: the black lines are the boundaries of the Dutch 'metropolitan areas' (Grootstedelijke Agglomeraties in Dutch). We use the commonly applied definition developed by CBS Statistics Netherlands.

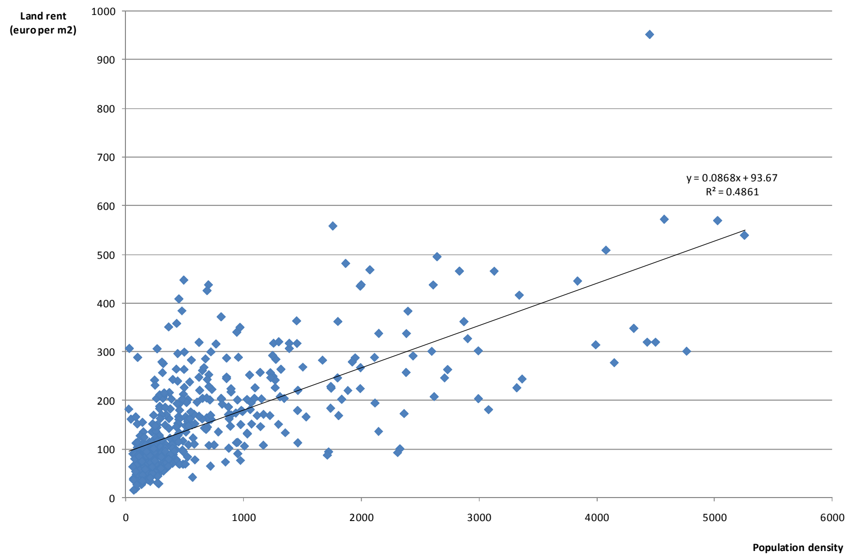
Figure 2 presents an a-spatial picture of the variation in land rents by means of a histogram. In the majority of PC4-areas, the land rent is in the range of approximately 75–100 euro per square meter. Less than 20% of the areas have land rents exceeding 300 euro per square meter.

Figure 2. Histogram of land rents per square meter in the Netherlands (2007 prices).



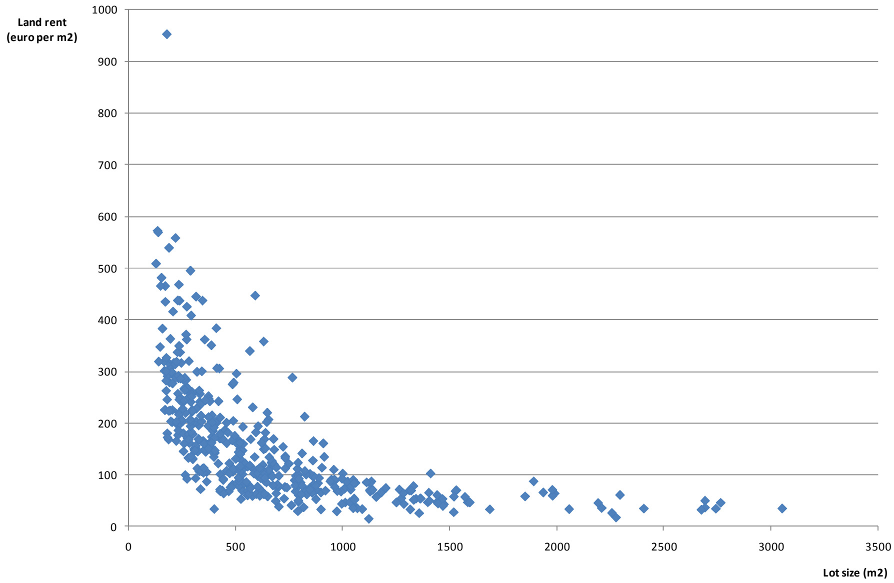
Figures 3–5 look further into the relationship between land rents and population density, land rents and lot size, and land rents as a function from the distance to the city centre. Figure 3 confirms the correlation between population density and land rents.

Figure 3. Land rents (per m^2) and population density at municipality level



Where land rents are high, economic agents will substitute away from the relatively expensive good, viz. land. According to standard urban economics theory, this results in relatively small lot sizes in places where rents are high. This efficient economic process is illustrated in Figure 2 which shows that lot sizes in the peripheral areas where rents are less then 50 euro on average exceed 1500 m^2, whereas lot sizes in urbanized municipalities where land rents exceed 500 euro per m^2 are all smaller than 250 m^2 on average.

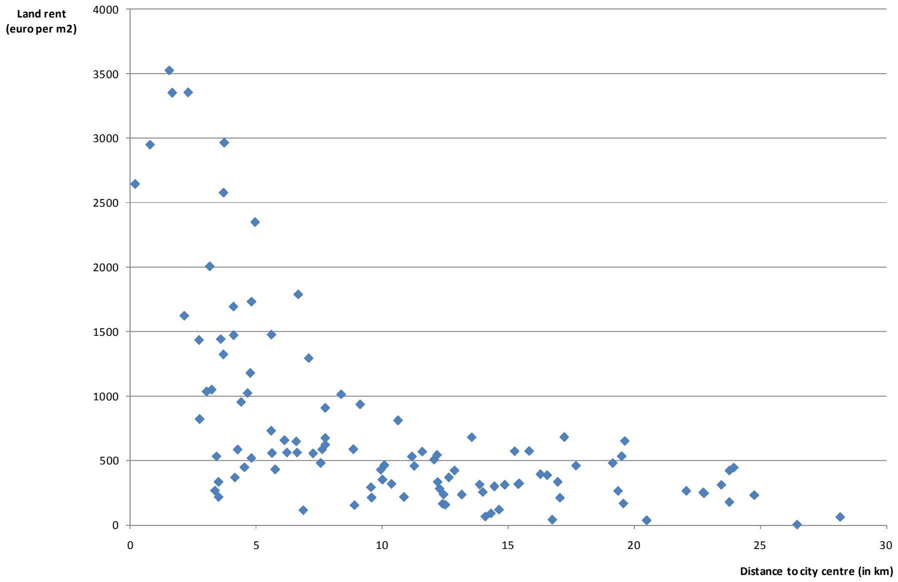
Figure 4. Land rents and lot size at municipality level



A final traditional urban economics picture is the bid rent curve describing a pattern of increasing land rents as one moves closer to the city centre. This is neatly illustrated in Figure

5 for the case of Amsterdam. Within 5 km from the city centre, land rents exceed 2500 euro. Moving out from the centre, areas further than 10 km from the centre all have land rents less than 1000 euro, whereas areas at more than 20 km from the centre are values less than 500 euro.

Figure 5. Land rents as a function from distance to the city centre of Amsterdam



4. Conclusion

This note presented a simple methodology to derive land rents from information that is typically used for hedonic pricing studies. Crucial information that we used for identification is variation in lot sizes. Land rents in the Netherlands were shown to vary substantially. Information on these land rents will prove useful for valuation exercises but also for spatial planning.

Further extensions of this approach can contribute by explaining variation in land rents from characteristics of the neighborhood. As such, they can be helpful to identify agglomeration externalities, the returns to accessibility, etc. Also variation of land rents over time are interesting to study further in view of ongoing discussions on, for example, the perceived death of distance. In order to assess the quality of our derived land rents, a confrontation of with actually observed transactions of land will prove useful to further validate our methodology. And finally, information on commercial property should ideally be included in the analysis (see for example Drennan and Kelly, 2010, for an attempt to identify agglomeration economics using office rents).

References

Davis, M.A. and J. Heathcote (2007): ‘The Price and Quantity of Residential Land in the United States’, *Journal of Monetary Economics*, 54, pp. 2595–2620.

Davis, M.A. and M.G. Palumbo (2008): ‘The Price of Residential Land in Large US Cities’, *Journal of Urban Economics*, 63, pp. 352–384.

Dekle, R. and J. Eaton (1999): ‘Agglomeration and Land Rents: Evidence from the Prefectures’, *Journal of Urban Economics*, 46 (3), pp. 200–214.

Drennan, M.P. and H. F. Kelly (2010): ‘Measuring Urban Agglomeration Economies with Office Rents’, *Journal of Economic Geography*, pp. 1 – 27.

Glaeser, E.L., J. Gyourko and R. Saks (2005): ‘Why is Manhattan so Expensive? Regulation and the Rise in Housing Prices’, *Journal of Law and Economics*, 48, pp. 331–369.

Groot, H.L.F. de, G. Marlet, C.N. Teulings and W. Vermeulen (2010): *Stad en Land*, The Hague: CPB Netherlands Bureau for Economic Policy Analysis.

Glaeser, E.L. (2011): *Triumph of the City*, London: Macmillan.

Ricardo, D. (1817): *On the Principles of Political Economy and Taxation*, London: John Murray.

Roback, J. (1982): ‘Wages, Rents, and the Quality of Life’, *Journal of Political Economy*, 90 (6), pp. 1257–1278.