UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

WORKING PAPERS IN ECONOMICS

No 686

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January 2017

ISSN 1403-2473 (print)
ISSN 1403-2465 (online)

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The effect of land lease on house prices*

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January, 2017

Abstract

In Amsterdam, houses located on private land and houses with various land-lease contracts coexist. In this paper, we investigate the impact of future land-lease payments on the house price. We look at the impact on house prices of: (i) the number of years that the land lease has been paid in advance and (ii) the amount that must be paid up front. Houses on privately owned land are on average 10% more expensive. Houses with a land-lease contract that has been paid in advance are 0.41% more expensive for each year that no land lease has to be paid. We find a large and negative impact of the land-lease rent that needs to be paid on the house price.

Keywords: House prices, Land lease

JEL-codes: R30, R38

*We would like to thank Carla Flemmincks for valuable help with the land-lease data and the NVM for sharing their housing data with us.

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1 Introduction

This paper estimates the effect of land lease on house prices using a unique dataset from Amsterdam based on land-lease contracts and information on residential real-estate transactions for the period 1985-2011. Land lease is common in European cities like Amsterdam, Frankfurt, Helsinki, London, Stockholm and Vienna.[1] Also in New York and Hong Kong, some houses are located on land that is owned by the city.

Knowing to what extent house prices depend on various land-lease contracts is important for cities that either consider to introduce a system of land rent or to abandon it. For example, Amsterdam has introduced a new system of infinite land lease which one can buy for newly built houses from 2016 onwards. Existing contracts will receive an offer in the near future to switch to the new system and for this one needs to properly price those contracts.

Land lease is one way to tax land. One of the lessons of the public finance literature is that one should tax the most inelastic factors. Since land does not move or disappear, it has been proposed to tax land since Adam Smith and George (1879) and more recently by Arnott and Stiglitz (1979). Knowing whether people care about payoffs that occur far away in the future, as occurs with land lease, is also important for policies that come with costs today and benefits in the distant future (i.e. policies to reduce global warming).[2]

In this paper we perform two empirical exercises. First, we look at the impact of

[1] See http://www.amsterdam.nl/publish/pages/418782/use_of_public_ground_lease_in_european_cities.pdf

[2] See for example Weitzman (1998), Nordhaus (2007), Stern (2008), Pindyck (2013) and Giglio, Maggiori and Stroebel (2015).

the number of years that the land-lease rent is paid in advance at the moment of a sale. Houses can be paid up to 75 years in advance in Amsterdam and these payments are not refundable but are transmitted in case the house changes hands. Using OLS, we find that houses on private land are on average 10.29 percent more expensive than houses with a land-lease contract that has not been paid in advance. This difference is about twice as high as the numbers found in Tyvimaa, Gibler and Zahirovic-Herbert (2015) for Helsinki. In addition, we find that a house with land lease is 0.15 percent more expensive for every year that the land-lease rent is paid in advance, which implies that a house for which the land-lease rent is paid 65 years in advance is almost as valuable as a house that is located on privately owned land. These results are remarkably close to the results that we obtain when we allow for random house specific effects, suggesting that unobserved house characteristics are not extremely important. However, we find that our results change considerably when allowing for correlation between these house specific effects and the right-hand side variables (*i.e.* allowing for fixed effects). In particular, we find for that case that paying one year in advance results in an increase of the house price by 0.41 percent. If we evaluate this at the average house price (240,010 Euro), this implies 984 Euro per year which is even more than the average land-lease rent of 711 Euro per year.

Our second exercise looks at the actual land-lease rent of houses for which the land-lease rent is not paid in advance. In Amsterdam, the land-lease rent depends on the estimated value of the house in the absence of land lease. Hence, one cannot simply estimate the effect of land-lease rent on the house prices by ordinary least squares, because houses for which a lot of land lease must be paid would also, in the absence of land lease, be more

expensive. Therefore, we need an instrument. It turns out that the year of contract can be used as a suitable instrument because of changes in the terms of the contract. The terms of the land lease are specified in a contract called the "general conditions" (GC). The earlier the starting date of the GC, the more favorable the conditions were. For example, the land-lease rent is fixed at a low price before 1966 and it is higher after 2000. Hence, older contracts result in lower land-lease rent payments, while it does not directly affect the house price after correcting for the year in which the house was built. We find that land lease has no or even a small positive effect on house prices when using ordinary least squares, but when using the instrument, we find that a 10% increase of the land-lease rent decreases the selling price by 0.29%. Based on the average house prices of 201,759 Euro for the relevant sub-sample and an average land-lease rent of these houses of 420 Euro per year, this implies that a one Euro increase in yearly land lease leads to an average decrease of 13.45 Euro of the expected selling price of the house.

Our paper is closely related to papers that try to estimate the impact of future financial obligations and the selling price of the house. For example, Giglio, Maggiori and Stroebel (2015) look at the impact of leasehold versus freehold in London and Singapore. They find a negative and significant impact of leasehold, especially when the remaining lease length is relative short (in their case 80 to 100 years). Fesselmeyer, Liu and Salvo (2016) look at newly built apartments in Singapore. Hjalmarsson and Hjalmarsson (2009) look at the impact of future rents for co-ops in Sweden. They conclude that houses with higher rents are overpriced when taking account of the discounted value of the future rents. Janssen (2003) uses Swedish data of income property and compares houses on private land with

houses that pay land lease. He finds an average increase in selling prices of 16.87 Euro for one Euro increase in the land-lease rent, which is close to our findings. Our data allow us to also look at the value for each year that no land lease has to be paid. Moreover, our data are extremely rich in terms of observable house characteristics and we have a lot of within neighborhood variation in terms of houses on private land and houses with various land-lease contracts.

The paper is organized as follows. Section 2 discusses the land-lease system in Amsterdam. Section 3 describes our data sources. Sections 4 and 5 discuss our main results for the two empirical exercises performed in this paper. Finally, Section 6 concludes.

2 Land lease

Land lease is defined as the right to hold and to use the land of the city of Amsterdam. For this right, the leaseholder must pay the city an annual fee. This is called the land-lease rent. Land lease is different from tenancy because it can be traded without the intervention of the owner. The city of Amsterdam uses land-lease contracts since 1896. Before that period all land was sold, while after that period the city of Amsterdam always remains the owner of the land. Some houses were property of the city before 1896 and were sold afterwards and the city also frequently buys land belonging to pre-1896 houses. Therefore, there are also land-lease contracts in the older neighborhoods. Houses built after 1896 always have a land-lease contract unless these houses were built on land that was already sold before 1896. This implies a non-perfect concentration of houses on own land in the

older (and usually more popular) neighborhoods of the city. We take this into account in our empirical analysis by focusing on the neighborhoods that were built around the year 1896 and therefore have a mixture of different house types.

The duration of a land-lease contract is typically 50 years, which we call the period of lease. At the beginning of the lease period the terms are specified in a contract called the "general conditions" (GC). At present, new contracts are based on the *General conditions for perpetual land leases in Amsterdam 2000* (GC2000). However, land-lease contracts with an earlier starting date belong to different GC's. At the date of termination the newest conditions are valid. An important difference between the recent GC's and older ones concerns the land-lease rent which was mainly a fixed amount before 1966 and is sometimes fixed after 1966 and always variable under GC2000.[3] Another difference between the period before 1966 and the period afterwards is that in the contracts from the earlier periods the land-lease period was 75 years, while it is only 50 years for the more recent contracts.

At the end of the period of lease, the municipality offers a new contract.[4] As Veen (2004) documents, this is based on the consultation of independent experts who are typically real-estate agents. Their procedure is as follows: (1) estimate the total value of the property and multiply this by the *land ratio*, which is a parameter that depends on the neighborhood of the house, and (2) multiply the result with 0.6 in order to take into account that land with property has less value than land without property.[5] A final aspect

[3]In the period between 1966 and 2000 different systems were effective from variable to fixed over the period of lease.

[4]In very special cases, the municipality is able to terminate further land lease after the end of the period of lease. In that case the municipality pays the value of the houses. However, these cases happen very rarely and hence we can safely assume in our empirical analysis that leaseholders expect their right to lease the land to last indefinitely.

[5]In practice, the land ratio differs between 0.20 and 0.25, see Veen (2004) for more details.

of the price determination of the experts is that they try to follow the long-term market trends by determining the total value of the property (in step (1)) instead of the short-term fluctuations of the market. After determining the land price, the (yearly) land-lease rent is simply calculated as a percentage of the land price.[6]

3 Data

We use three different data sets for this paper. First, we use data on land-lease contracts that were effective between 2007 and 2011. We distinguish between houses for which land-lease rent is paid in advance (158,380 houses) and houses for which the land-lease rent must be paid immediately (56,242 houses). For these houses we have the identifier of the house from the Dutch register, the beginning and the end date of the contract and the beginning and the end date for which the land-lease rent has been paid in advance. Finally, we have information on the *general conditions* of the land-lease contract, we have the special conditions of the payment period and the exact amount that has to be paid annually during the years of observation.

Second, we use data from the Dutch association of real-estate agents which contains more than 70 percent of the houses that were sold in Amsterdam within our observation window (1st of January 1985 till the 31st of June 2011). We have information on 117,176 sales. The following characteristics are available for each house: the address, zip code, the selling price, size (both in square and cubic feet) and many other features, see Appendix D. Finally, we have an indicator that specifies whether the house is under a land-lease

[6]The exact percentage depends on the specific contract and on the district within the city.

contract or not.

Third, we use a data set from the municipality of Amsterdam that contains all houses registered in Amsterdam in 2010. This data set contains the identifier from the Dutch register as well as the address and zip code. We use this data set to match the other two data sets since it contains both the address, zip-code and the registration code which is used for the land-lease contracts of our first data set.

We merge the second and third data set to obtain the identifiers from the registers of all the houses in the second data set. We use street address (with house number and addendum) and zip code. We could match 99,093 out of the 117,176 house sales that appeared in the data from the real-estate association. Some houses could not be matched because the house identifier used by the real-estate agent was not always equal to the house identifier used by the municipality. Especially, the addendum was sometimes different from the addendum used by the municipality. We have been quite conservative to fix this in order to minimize the number of wrong matches. Another reason for not being able to match all houses is that some houses sold between 1985 and 2009 no longer exist in 2010 and the newly built houses during 2010 did not yet have an official address. We also delete the houses that are not a single unit for the Dutch land register. The problem with these houses is that they do not have a private contract for land lease with the municipality, but instead have a collective contract together with the other houses. Hence, we cannot identify the exact amount of land-lease rent that must be paid by the owner of such a house. This resulted in a deletion of 28,464 houses.

Finally, we merge the resulting data set with the first data set of all the land-lease

contracts. Houses located on own land are identified as houses without a corresponding land-lease contract. There are however a few cases where the real-estate agent indicates that the house is not located on private land despite the fact that there is no land-lease contract. If this occurs, we delete the observation from our data set (about 2 percent). In addition, we merge houses based on the contract that was in place at the moment of the sale. Since we only have information on contracts that were effective over the period 2007 to 2010, some house sales are lost since we do not have any information about the land-lease contract of the house at the moment the house was sold. In total this leaves us with 60,998 house sales and we keep 53,397 of these after deletion of the houses that do not have all information necessary for estimation (such as size).

Descriptive statistics based on our final dataset are given in Table 1. We distinguish between private land and land lease. Houses with land lease are further subdivided into *paid in advance* and *variable* and *fixed* land lease. Table 1 shows that a minority of houses are on private land and that the prices of these houses are higher than the prices in any other category. At first sight, it is surprising that houses with a variable land-lease rent are more expensive than those paid in advance. The most likely reason for this is the fact that those houses are typically sold after 2000. The different categories are quite similar in terms of size. However, there are differences between the neighborhoods. For example, private land is overrepresented in the (more expensive) areas in the city center and the western and southern parts close to that city center. Fixed land rent is underrepresented in those neighborhoods.

We have divided Amsterdam into 90 different neighborhoods which correspond to the

Table 1: Descriptive statistics of the data set.

	Own land	Paid in advance	Not paid in advance	
			Fixed	Variable
Including neighborhoods with few observations				
Number of observations	31973	14305	5764	1355
Price	254427	249374	176092	280275
Size in square feet	930	1088	955	1036
Land-lease rent	0	0	174	651
Number of neighborhoods	90	90	90	90
Neighborhoods				
City center	30.6	6.2	0.6	3.4
West	26.5	9.1	9.2	16.4
East	10.4	23.2	1.5	9.7
North	1.6	12.7	12.5	12.7
New-West	0.9	30.3	25.7	2.1
South-East	0.2	11.2	9.8	15.4
South	30.0	7.3	40.8	40.4
Excluding neighborhoods with few observations				
Number of observations	17119	3302	788	482
Price	257948	240010	123169	268875
Size in square feet	953	931	813	952
Land-lease rent	0	0	79.4	711
Number of neighborhoods	27	27	27	27
Neighborhoods				
City center	32.3	23.1	4.3	6.6
West	14.8	16.7	66.1	42.7
East	11.9	24.6	11.0	26.6
North	0.8	19.9	0.6	3.1
New-West	0.9	4.0	14.6	1.5
South-East	0.0	0.0	0.0	0.0
South	39.3	11.7	3.3	19.5

definitions of Statistics Amsterdam. Our empirical implementation is based on comparisons within neighborhoods. Therefore, if some neighborhoods only contain houses on own land or only houses with land lease, then we cannot separately identify a neighborhood and a land-lease effect. Therefore, we deleted all neighborhoods that do not have at least 10 observations from either houses on own land, land-lease rent paid in advance or land-lease rent not paid in advance. This results in a deletion of 53 neighborhoods. Descriptive statistics of the final data set can be found in the lower panel of Table 1.

4 The impact of payments made in advance

We estimate the following equation in our empirical analysis,

$$\log p_i = x_i\beta + \gamma \mathrm{YPA}_i + \delta \mathrm{Own}_i + u_i \tag{1}$$

where p_i is the selling price of house i, x_i is a set of characteristics of the house (including neighborhood dummies), YPA_i is the years of land lease paid in advance and Own_i is a dummy that indicates that there is no land-lease contract. We exclude houses for which no land lease is paid in advance because these houses can be either on a variable or a fixed land-lease payment system (see discussion in the previous section). For some of the houses that are under a fixed land-lease payment system, the land-lease may be very low (old contracts) and this is very similar to a situation in which the land lease is pre-paid.

The first panel of Table 2 lists the results. Apart from the regressors listed in that table, we correct for a second-order polynomial of the year of sale, type of the house, a categorical

variable for the type of location of the house, whether the house is a monument or has either a garage, balcony, attic, garden and/or roof terrace, type of heating, period of construction, type of isolation, number of bathrooms, whether the house is newly built, and whether the house is (partly) let and/or is used as residential income property. Details about most variables can be found in Appendix A. Moreover, we use neighborhood dummies and neighborhood dummies interacted with size in squared feet, construction period, and year in which the sale took place. We find, as expected, that a house on own land is more expensive. The coefficient of 0.1029 means that the houses with a land-lease contract that has not been paid in advance have a 10.29 percent lower price. In addition, we find that the number of years that no land-lease rent has to be paid (because the previous owner paid this in advance) has a significant and positive effect on the house price: one year that is paid in advance results in an increase of 0.15 percent of the expected selling price. This implies that houses for which the lease has been paid $\log 10.29 / \log 0.0015 \approx$ 65 years in advance sell for about the same price as a house on own land. In addition, using the average house price of 240,010 Euro for these houses (see Table 1), we can derive that paying one year in advance results in a 360 Euro increase in the sales price. This is remarkably less than the 711 Euro per year that must be paid for houses with a variable land rent.

Table 2: Results of the impact of the number of years that the land lease is paid in advance on house prices.

	OLS	Random effects	Within difference	First difference
Number of years paid in advance	0.0015	0.0015	0.0041	0.0041
	(0.0006)	(0.0006)	(0.0019)	(0.0019)
Privately owned land	0.1029	0.1029		
	(0.0262)	(0.0262)		
Other variables				
Squared feet	0.2009	0.1950		
	(0.0034)	(0.0035)		
Squared feet^2 ($\times$ 100)	-0.6846	0.6705		
	(0.0215)	(0.0215)		
Squared feet^3 ($\times$ 1000)	0.1057	0.1030		
	(0.0051)	(0.0051)		
Squared feet^4 ($\times$ 10000)	-0.0059	-0.0057		
	(0.0004)	(0.0004)		
Cubic feet	1.547	1.547		
	(0.226)	(0.226)		
Number of rooms	0.0122	0.0122		
	(0.0012)	(0.0012)		
Maintenance outside				
2	-0.1157	-0.1157		
	(0.2005)	(0.2005)		
3	0.1783	0.1783	0.3647	0.3885
	(0.0658)	(0.0658)	(0.1054)	(0.1033)
4	0.3911	0.3911	0.6504	0.6852
	(0.0814)	(0.0814)	(0.1365)	(0.1279)
5	0.2351	0.2351	0.4420	0.4688
	(0.0644)	(0.0644)	(0.1637)	(0.1015)
6	0.3105	0.2915	0.4769	0.5312
	(0.0652)	(0.0652)	(0.1037)	(0.1030)
7	0.2915	0.2915	0.4769	0.4995
	(0.0644)	(0.0644)	(0.1037)	(0.1015)
8	0.3100	0.3100	0.5097	0.5319
	(0.0652)	(0.0652)	(0.1050)	(0.1028)
9	0.3652	0.3052	0.4750	0.4998
	(0.0645)	(0.0645)	(0.1039)	(0.1017)

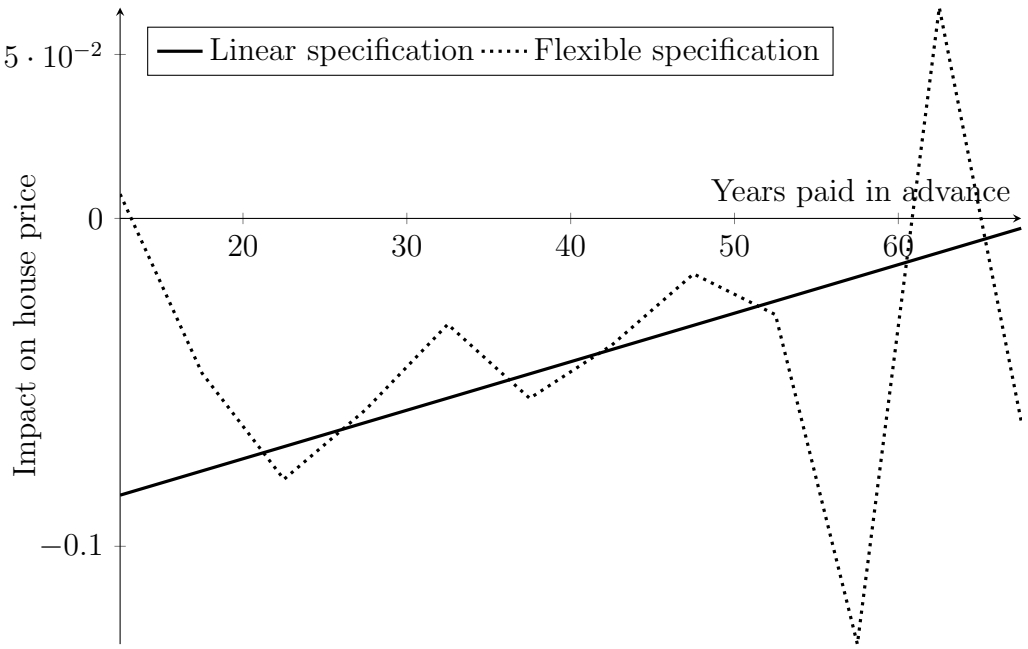
Table 2: Results of the impact of the number of years that the land lease is paid in advance (*continued*).

	OLS	Random effects	Within difference	First difference
Maintenance inside				
2	0.0992	0.0992		
	(0.0762)	(0.0762)		
3	-0.0102	-0.0102	-0.0218	-0.0694
	(0.0270)	(0.0276)	(0.0463)	(0.0463)
4	0.0623	0.0623	0.1037	0.0648
	(0.0353)	(0.0353)	(0.0669)	(0.0674)
5	0.0377	0.0378	0.0464	0.0638
	(0.0259)	(0.0260)	(0.0446)	(0.0447)
6	0.0968	0.0968	0.1273	0.0947
	(0.0274)	(0.0274)	(0.0472)	(0.0471)
7	0.1481	0.1481	0.1766	0.1347
	(0.0259)	(0.0259)	(0.0445)	(0.0445)
8	0.2135	0.2135	0.2409	0.2053
	(0.0273)	(0.0273)	(0.0468)	(0.0468)
9	0.2149	0.2149	0.2482	0.2041
	(0.0262)	(0.0262)	(0.0448)	(0.0448)

We also estimated (1) using a flexible specification for the years the land lease is paid in advance. The results of this flexible specification are illustrated in Figure 1. For comparison we also draw the line that we obtained from the estimate of γ using the results of the first column of Table 2. Based on the figure, we conclude that the linear specification approximates the more flexible specification well. The only exception is the large variation that comes from the houses for which the contract must be renewed in less than 25 years. This can be explained by the fact that we have very few observations for those houses.

We can control for unobserved house characteristics by restricting attention to repeated

Figure 1: Relationship between house price and the number of years that no land lease has to be paid



sales. This implies the following modification with respect to (1)

$$\log p_{ik} = x_{ik}\beta + \gamma \mathrm{YPA}_{ik} + \delta \mathrm{Own}_i + u_i + \varepsilon_{ik}, \tag{2}$$

where p_{ik} is now the selling price of house i when sold for the k-th time. The house-specific effect u_i includes any unobserved characteristic affecting the average selling price. The residual ε_{ik} contains buyer and seller characteristics and is supposed to be independent from the observed and unobserved characteristics, including the number of years that the land-lease rent is paid in advance. Apart from year, all characteristics can be expected not to change over time and hence cancel out when using a fixed-effects regression. This implies that we are no longer able to estimate the impact of having a land-lease contract.

The second column of Table 2 lists the results of a random-effects model and the results

of the within- and first-difference estimators are listed in columns 3 and 4. The estimates of pooled OLS and the random-effects estimator are remarkably close to each other. The fixed-effects estimators give a larger effect of the number of years paid in advance on the house price. Hausman tests of a correlation between the fixed effects and the regressors give values equal to 126.8 using the within estimator and 107.4 using the first-difference estimator. Under the null-hypothesis of no correlation, this test statistic follows a χ^2-distribution with 39 degrees of freedom and this implies that both estimators reject this null hypothesis. As listed in Table 2, an important reason for the correlation is that the coefficients of maintenance are quite different when we use the fixed-effects methods. This indicates that there is a high level of correlation between unobserved heterogeneity and the maintenance of the house. Comparing the results between columns 3 and 4 with columns 1 and 2 shows that the impact of one additional year of advanced payment on the house price more than doubles to 0.41 percent per year. Hence, one additional year of pre-payment results – on average – in an increase of 984 Euro per year and this is even more than the average payments that must be made for variable land-lease contracts. An explanation for this high number is that these contracts expire in the future and therefore the expected payments for land lease can be considerably higher than what is paid during our observation window for variable land lease.

Using the error term of the first-difference estimator gives Δu_{it} and regressing this on its lag gives a coefficient of -0.513. Its t-value for the null-hypothesis that it does not differ from -0.5 equals 0.806 and hence is not rejected. As described in Wooldridge (2002), this test can also be interpreted as a test against no serial correlation of the error term in (2).

This implies that the within-estimator is in this case more efficient than the first-difference estimator.

5 The impact of land-lease rent

Next, we turn to houses where the buyer must immediately start to pay for land lease. For these houses, we use the following specification

$$\log p_i = x_i\beta + \theta \mathrm{LL}_i + u_i, \tag{3}$$

where LL_i is the log yearly land-lease payments for house i. Specifically, we would like to know whether θ is negative and significantly different from zero. However, the estimation of (3) is complicated by the method land-lease contracts are renewed: houses with attractive unobserved characteristics will come with a higher land-lease rent. Hence, the unobserved characteristics that are captured in u_i are likely to be positively correlated with LL_i and this will result in an upward bias of θ. This implies that we should either use repeated sales or use an instrument to solve the endogeneity problem. Using repeated sales is not an attractive exercise here since there are only 1270 house sales and the majority of these houses (representing 788 house sales) do not have any variation of the land-lease payments over time, while the variation in the land lease of the other houses is a deterministic function of time. Luckily, due to the exogenous variation in the general conditions, there are very good instruments available based on the year in which the last contract started. We explain the main features of these instruments below.

Apart from the value of the house in case it was built on privately owned land, there is

also variation in the land lease based on whether it is variable or fixed. This variation is to a large extend based on the moment at which the contract was renewed. Hence, conditional on construction period, this variable is not likely to be correlated with the price of the house. Because the difference between variable and fixed land-lease increases with the time since the contract started, we also use as an additional instrument the indicator of a fixed land-lease rent interacted with the time since the contract started. Both instruments have the caveat that they also indicate the time till the contract expires and this may have a direct and negative impact on the house price. Therefore, we include the time till the contract ends as a control variable.

Table 3 lists the results of the estimation of equation (3), while Table 4 lists the results of the first-stage estimates of a regression of log land-lease rent on a set of characteristics including our instruments. The first column of Table 3 uses only basic regressors as squared feet (up to a forth degree polynomial), cubic feet, neighborhood, year, year squared, garden, maintenance (inside and outside) and the number of rooms. Even though this is already a rich set of controls, Table 3 clearly indicates the endogeneity bias resulting in a positive but insignificant coefficient for the land-lease rent. The second column corrects for the same set of regressors as in the previous section and this results in a negative but marginally significant value of the coefficient of the land-lease rent. The third column of Table 3 lists the results using only the indicator of a fixed land-lease rent as an instrument. We find that the absolute value of the impact of the land-lease rent more than doubles in size and is now significantly different from zero. The F-test for relevance of the instrument is equal to 328 and therefore the null hypothesis of an irrelevant instrument

is rejected. A Hausman test with the null-hypothesis that land lease is exogenous has a value of 50721 and therefore the null-hypothesis is highly rejected. The final column of Table 3 list the results using both the indicator for fixed land-lease rent as well as the same indicator interacted with the number of years since the contract started. The coefficient for the impact of the land-lease rent further increases in absolute value, indicating that a 10 percent increase of the land-lease rent decreases the selling price of the house by 0.29 percent. The relevance of instruments test gives a value of 462 and hence we find again that the instruments are highly relevant. Finally, the Hausman test statistic to test against an exogenous regressor is now equal to 59938. This implies that also using this set of instruments indicates that land-lease rent is highly endogenous.

Looking at the other regressors in Table 3, we find that the selling price of the house increases with size. Inside maintenance has a positive and significant impact, but outside maintenance does not seem to have any impact.

Table 4 lists the results of the first-stage regression of land lease. We find that both fixed land lease and fixed land lease multiplied by the number of years since start of the contract are negative and highly significant. In addition, we find that the impact of size is highly significant. Maintenance inside has a positive impact when we do not use the interaction term of the period since contract start. Again, maintenance outside does not have any impact.

Table 3: Results of the impact of land lease on the price of the house

	OLS		IV	
	I	II	III	IV
Log land lease	0.0042	-0.0098	-0.0211	-0.0280
	(0.0052)	(0.0057)	(0.0097)	(0.0088)
Squared feet	0.1521	0.3295	0.3477	0.3589
	(0.0177)	(0.1044)	(0.1053)	(0.1054)
Squared feet^2	-0.6490	-1.4141	-1.4879	-1.5332
	(0.1382)	(0.4299)	(0.4337)	(0.4341)
Maintenance inside				
3	0.1754	0.1001	0.1067	0.1108
	(0.1798)	(0.1543)	(0.1546)	(0.1551)
4	0.0905	0.1133	0.1214	0.1263
	(0.2032)	(0.1757)	(0.1760)	(1766)
5	0.1297	0.0888	0.0926	0.0950
	(0.1755)	(0.1501)	(0.1504)	(0.1509)
6	0.2658	0.1973	0.2006	0.2027
	(0.1784)	(0.1526)	(0.1529)	(0.1537)
7	0.2426	0.1954	0.1981	0.1998
	(0.1752)	(0.1498)	(0.1501)	(0.1505)
8	0.3447	0.2593	0.2658	0.2698
	(0.1796)	(0.1540)	(0.1543)	(0.1547)
9	0.3321	0.2733	0.2775	0.2801
	(0.1755)	(0.1502)	(0.1505)	(0.1510)
Maintenance outside				
3	-0.2286	-0.1557	-0.1746	-0.1861
	(0.2046)	(0.1763)	(0.1771)	(0.1775)
5	-0.0450	0.0334	0.0223	0.0155
	(0.1767)	(0.1529)	(0.1533)	(0.1538)
6	-0.0064	0.0432	0.0342	0.0286
	(0.1837)	(0.1598)	(0.1602)	(0.1607)
7	-0.0346	0.0231	0.0119	0.0051
	(0.1751)	(0.1510)	(0.1515)	(0.1518)
8	-0.0125	0.0782	0.0664	0.0593
	(0.1802)	(0.1565)	(0.1569)	(0.1573)
9	-0.0560	0.0035	-0.0077	-0.0146
	(0.1753)	(0.1516)	(0.1521)	(0.1525)

Table 4: Estimation results of the first step

	I	II
Fixed land-lease rent	-1.984	-0.982
	(0.0840)	(0.113)
Fixed land-lease rent ×		-0.0254
years since start of contract		(0.0021)
Squared feet	0.8248	0.7290
	(0.4450)	(0.4219)
Squared feet^2	-3.312	-2.760
	(1.854)	(1.738)
Maintenance inside		
3	0.0962	-0.0150
	(0.1553)	(0.6268)
4	0.1121	-0.2381
	(0.1765)	(0.7127)
5	0.0838	-0.1557
	(0.1509)	(0.6093)
6	0.1929	-0.0090
	(0.1533)	(0.6188)
7	0.1889	-0.1937
	(0.1506)	(0.6080)
8	0.2570	-0.1938
	(0.1548)	(0.6251)
9	0.2686	-0.2311
	(0.1511)	(0.6097)
Maintenance outside		
3	-0.1703	-0.4388
	(0.1773)	(0.7139)
5	0.0254	0.2103
	(0.1534)	(0.6198)
6	0.0353	0.3076
	(0.1603)	(0.6477)
7	0.0142	0.2730
	(0.1516)	(0.6124)
8	0.0680	0.3365
	(0.1571)	(0.6344)
9	-0.0053	0.2580
	(0.1522)	(0.6148)

6 Final remarks

Land lease is a way for the government to appropriate the rents from land. The way this is done is likely to affect house prices. Estimating the precise effect is not trivial because in practice in Amsterdam, future land lease depends not only on the expected value of the land but also on the value of the house. Therefore, we have used the contract type as an instrument. We find that houses with land lease are significantly cheaper than similar houses on private land. The house price is also an increasing function of the number of years that the land lease rent has been paid in advance. Houses on private land are on average 10% more expensive, while each year that no land lease has to be paid (because the previous owner already paid this in advance), increases the value of the house by 0.41%.

Our results are in line with Giglio et al. (2016), who also find an important impact on the sales price of a leasehold versus the price of a freehold, even in the case that the leasehold terminates after more than a hundred years from the transaction date. Apparently, home buyers seem to take cash flows into account even in the case that these flows occur at a moment that is in the distant future. In Gautier and Van Vuuren (2016), we show that in order to use the variation in land-lease contracts to estimate short- and long-run discount rates, one needs to make a number of additional assumptions on credit constraints and the possibilities to smooth consumption over time.

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Appendix

A Description of the variables in the main regressions

Period of Construction
(0) Unknown or before 1500 (base), (1) 1500-1905, (2) 1906-1930, (3) 1931-1944, (4) 1945-1959, (5) 1960-1970, (6) 1971-1980, (7) 1981-1990, (8) 1991-2000, (9) after 2001.

Maintenance inside
(0) Bad (base), (1) in between poor and bad, (2) poor, (3) poor to average, (4) average, (5) average to good or not stated, (6) good, (7) good to excellent, (8) excellent.

Maintenance outside
See maintenance inside for the description of

this variable

Year
Every year from 1985 (base) to 2011.

Neighborhood
Dummy for all remaining 27 neighborhoods of Amsterdam

Location/View
(0) Not stated (base), (1) Next to large park, (2) Along a canal/river/lake, (3) next to small park, (4) Free view.

Heating system
(0) No heating system (base), (2) Traditional heating system, (3) Modern central heating system, (4) idem with air-conditioning or solar system.

Type of house
(0) Simple, (1) single family dwelling, (2) Canal house, (3) mansion, (4) homestead, (5) bungalow, (6) villa, (7) country house or cottage, (8) first floor apartment (in small building) (9) apartment in small building which is not first floor, (10) duplex apartment, (11) apartment in every sized building, (12) apartment in large building, (13) apartment for elderly, (14) apartment in small building, floor not stated.

Isolation
Dummy variable for the number of isolation techniques used in the house.