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The Impact of Parking Policy on House Prices

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Abstract

Paid parking is the recommended policy tool to deal with cruising for street parking. In the Netherlands, residents receive parking permits when paid parking is introduced, to increase their political support. We estimate the effect of this policy on residents by examining the effect of the introduction of paid parking on house prices for Amsterdam and Utrecht during a period of 30 years. We find no effect of this policy on house prices. This finding is consistent with the idea that residents only vote in favour of a local policy when it has no negative impact on their house prices.

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1.0 Introduction

Parking policies typically aim to reduce demand for street parking in order to reduce cruising for parking. We know very little of the effect of these policies on residents (Bakis *et al*., 2017). Information on this effect is particularly relevant when residents have a strong influence on local parking policy, either as voters or informally through lobbying. For example, the political economy literature indicates that it will be difficult for local governments to introduce welfare-improving parking policies if residents are not in favour of these policies (see Marcucci *et al*., 2005 and Button, 2006 in the context of road pricing; De Borger and Proost, 2012; Russo, 2013).

In this paper we estimate the effect of the introduction of paid parking on house prices for Amsterdam and Utrecht, two major cities in the Netherlands. In both cities, paid parking and residential parking permits are introduced at the same time. These permits allow residents to park locally for an unlimited time for a fraction of the price compared to non-residents (Van Ommeren *et al*., 2011). For example, in Amsterdam the price of an annual parking permit is about €100 and maximally €400, which compares favourably to the non-residential parking tariffs of €5 per hour (or €40 per day). Parking permits are licence-plate-specific and non-tradable, and allow residents to park in the same streets where also non-residents are allowed to park.

Car ownership has strongly increased during the second half of the 20th century (Dargay and Gately, 1999; Whelan, 2007). The increase in demand for residential parking has led to excess demand for parking, which has resulted in wasteful cruising (Van Ommeren *et al*., 2012). This is particularly so in historic city centres with urban structures designed before the introduction of cars, where off-street parking is limited. Policy makers around the world have reacted with different kinds of policies in order to deal with parking scarcity (Topp, 1991; Kodransky and Hermann, 2011).

One important policy, advocated by economists, is the introduction of paid parking. In almost all European countries (the main exception is Greece), we have seen a strong rise in paid parking over the last 30 years. This strong rise is firmly supported by the theory that indicates that paid parking is the preferred tool to regulate the on-street parking market (Arnott *et al*., 1991; Arnott and Rowse, 1999; Anderson and De Palma, 2004; Arnott and Inci, 2006). In contrast to alternative parking policies that restrict parking through quantitative restrictions (such as minimum parking requirements and parking time limits; see Manville, 2013), paid parking improves welfare when reducing cruising for parking, because it generates government revenue (Arnott, 2006; Arnott and Rowse, 2009).

Paid parking is typically introduced in areas with excess parking demand, where severe cruising for parking is observed by local authorities. In the Netherlands, on-street prices in paid-parking areas are set roughly equal to commercial off-street parking prices (in contrast to cities in many other countries, including the USA). Moreover, the number of parking permits is constrained such that residential parking demand does not exceed parking supply (Van Ommeren *et al*., 2012).[1] Hence, paid parking strongly reduces parking

[1] In Amsterdam and Utrecht, parking permits are restricted to one per household in the city centre, but in some suburbs two parking permits are provided per household. Because off-street parking is scarce, households seldom have more cars than permits. For example, in Amsterdam, only 6 per cent of households with one permit have more than one car (De Groote *et al*., 2016).

demand by non-residents, resulting in minimal levels of cruising after the introduction of paid parking.

Residents benefit from the introduction of paid parking, because it reduces cruising costs, but they also have to pay higher prices for parking. A priori, it is not clear which effect dominates, so in general it is unknown whether they favour paid parking. In the Netherlands, the use of residential parking permits implies that the parking price paid by residents is much lower than for non-residents. Nevertheless, residents still face an increase in the price for parking for a number of reasons. First, they have to pay for the permit. Second, and potentially more important, friends and family who visit residents have to pay the full price for parking, leading to a potential reduction in social contacts. Third, the number of permits per household is restricted (usually one per household). When the demand for cars by the household exceeds the number of permits, then the household faces the non-residential price for parking for the marginal car, which has increased. This suggests that residents will favour the introduction of paid parking only when there is a *substantial* benefit to residents in the form of a large reduction in cruising.

The introduction of paid parking will be reflected in housing prices when it strongly affects residents. For example, Bakis *et al.* (2017) investigated the effect of paid parking on house prices in Istanbul when residents do not receive parking permits, and are therefore faced with the same price increase for parking as non-residents. They find substantial decreases in house prices (about 10 per cent) after the introduction of paid parking. In the context of Amsterdam and Utrecht, where residents vote for the introduction of paid parking and receive parking permits when paid parking is introduced, the reduction in house prices induced by paid parking must be substantially less.[2]

We estimate the effect of the introduction of paid parking and residential parking permits between 1985 and 2014 on housing prices for Amsterdam and Utrecht by using a hedonic house price analysis. In these cities, as well as other cities in the Netherlands, paid parking was still restricted to city centres until the beginning of the 1990s. Since then, municipalities have been allowed to extract revenues from parking. This gave both municipalities an incentive to increase parking tariffs and to introduce paid parking throughout the city (Van Dijken, 2002).

Importantly, in both cities, local residents play an important role in the decision whether paid parking is introduced. In Utrecht, residential parking is locally introduced after a (non-binding) referendum (Verkeersnet, 2013). In Amsterdam, it is the local council that decides on the introduction of paid parking, after which the municipal government is allowed to set the price of street parking.[3]

In the city centres of Amsterdam and Utrecht, parking prices were strongly increased in the early 1990s and mid-1990s, respectively. This led to increased demand for parking in surrounding areas, which induced residents in these areas to vote in favour of paid parking.

[2]For example, the price effect of a parking permit of €100 per year in Amsterdam amounts to a €2,000 annualised value given a 5 per cent discount rate, which is less than 1 per cent of the average house price.

[3]It is plausible that residents that own private off-street parking spaces are less likely to vote in favour of paid parking, because they do not benefit directly from reductions in cruising time. In both cities, private ownership of parking is low (about 6 per cent of households in owner-occupied housing, and less in public housing). This makes it plausible that paid parking is introduced when residents with privately owned parking are not in favour.

In our identification strategy, we exploit the strong expansion of paid parking over time in different areas.[4]

We do not find any evidence of an effect of parking policy on housing prices. We note that standard errors are quite small, so that the lack of statistically significant price effects are not related to a lack of precision. This implies that it seems that residents are, on average, indifferent to the introduction of paid parking. We will argue that this suggests that paid parking was introduced at the right moment from the residents' point of view. This interpretation is in line with a political economy argument that residents will vote for paid parking if it is beneficial to them.

The structure of this paper is as follows. Section 2 explains the econometric framework and Section 3 describes the data. Section 4 reports the results, followed by the sensitivity analysis in Section 5. Section 6 concludes.

2.0 Econometric Framework

We aim to estimate the effect of parking policy on house prices. Houses are considered to be bundles of attributes, such as floor space, maintenance, and location, including whether or not there is paid parking. Using a hedonic price function, we estimate the implied price for paid parking in a paid-parking area (Rosen, 1974; Brown and Rosen, 1982; Palmquist, 1984). In Amsterdam and Utrecht, the large majority of houses are apartments. We focus on the price effects for apartments because of their higher floor-to-area ratio, so apartments are more likely to be prone to an under-supply of parking. This also reduces variation in unobserved house and street characteristics between the city centre and other areas, which should yield more accurate results.

One statistical issue is that paid parking is more likely to occur in districts closer to the city centre, so the introduction of paid parking is not random over space. To address this issue, we exploit temporal variation in paid-parking area designation by including zip-code fixed effects, so compare price changes between treated and non-treated areas. In the Netherlands, zip-code areas encompass about half a street (on average 15 households), which is comparable to a census block in the USA. These fixed effects essentially control for all unobserved time-invariant spatial attributes, implying that we identify the effects of parking policy on house prices over time (Van Ommeren and Wentink, 2012).

Furthermore, we only include areas where paid parking was introduced after 1985, implying that we exploit differences in the timing of the implementation in paid parking.[5] The induced price change may not necessarily be instantaneous. Prices may change in anticipation of the parking policy change, or may slowly adjust to the parking policy change after implementation. In both cases, one tends to underestimate the effect of the introduction of paid parking in our set-up. To mitigate this issue, we exclude observations within one year before and after the introduction of paid parking.

[4]Waiting lists for parking permits are common in the city centres, but paid parking was introduced in these areas before 1985 and is excluded in our empirical analysis, as we focus on the introduction of paid parking after 1985.

[5]Hence, we exclude areas where paid parking was never introduced and areas where paid parking was introduced before the period investigated.

More specifically, let y_{ijt} be the logarithm of the price of apartment i in district j in year t. We control for housing attributes h_{it}, include year fixed effects θ_t, and control for the possibility that prices have developed differently within the city centre and in the suburbs by including a distance-year interaction effect $(d_i \times \tau_t)$, where d_i refers to the distance to the city centre and τ_t refers to the year. The preferred specification to be estimated is:

$$y_{ijt} = \alpha p_{jt} + \beta(p_{jt} \times o_{it}) + \gamma o_{it} + \delta c_{it} + \zeta h_{it} + \eta_i + \theta_t + (d_i \times \tau_t) + (b_i \times \tau_t) + \varepsilon_{ijt},$$

where p_{jt} is a dummy indicating whether district j has paid parking at time t, o_{it} indicates whether the apartment has a privately owned parking space, c_{it} is a vector of private parking characteristics such as having a garage, η_i are zip-code fixed effects, and ε_{ijt} is an independently and identically distributed error term. Hence, α measures the impact of a paid-parking policy, while β measures the price effects for households that own a private parking space. The latter may be important because these households most likely benefit from reductions in cruising time. γ, δ, ζ, η_i, and θ_t are other parameters to be estimated.

As apartments with private parking may have been constructed in different times and the price developments of apartments from different times may have been different, we also include a construction decade-year interaction effect $(b_i \times \tau_t)$.

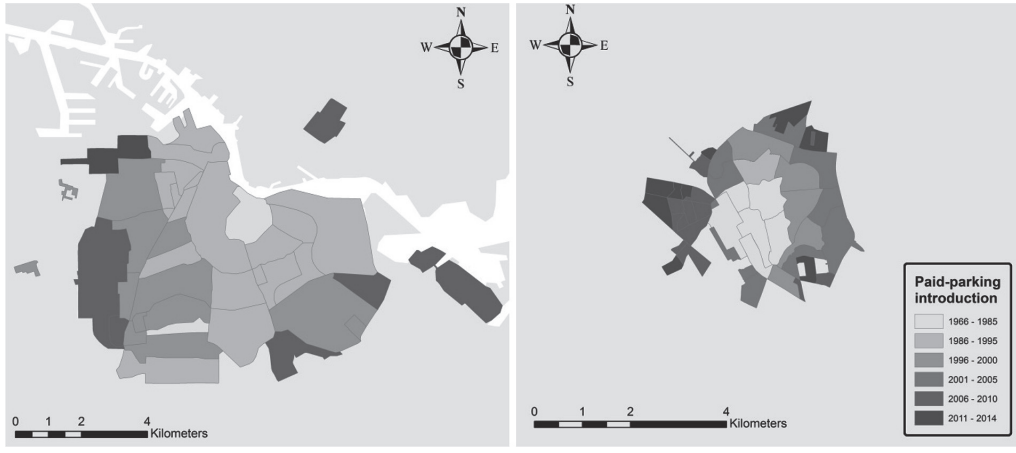
3.0 Data

We use housing transaction data from 1985 to 2014 from the Dutch Brokers Association (NVM), which includes over 2.5 million observations of owner-occupied houses all across the Netherlands and provides us with detailed information about housing transactions. The data set includes house prices and house characteristics, such as surface area, construction year, and location. We use the most detailed six-digit zip code (roughly comparable to a US census block) to identify the location of the houses. In order to reduce heterogeneity between houses over time, we only use the five-digit zip-code areas that existed before the year 2000, so newly built neighbourhoods with possibly different supply of parking facilities are excluded. This leaves us with 123,260 observations for Amsterdam and Utrecht.

We have obtained information on parking districts from both municipalities and verified for each district the year of implementation. For Amsterdam we have 40 parking districts, of which the average size is 139 hectares. For Utrecht we have 33 parking districts, which are on average 27 hectares. Figure 1 shows the paid-parking districts, including when paid parking was introduced. It can be clearly seen that paid parking was first introduced in the city centre and later in areas around the centre.

Table 1 reports the main descriptives for the full data set, but also for the subsets of paid-parking areas, free-parking areas, and transition areas, where paid parking was introduced during the study period (1985–2014). The average house price is on average €214,000. Houses are small in Amsterdam and Utrecht (82 m^2 versus the Dutch average of 117 m^2). In Table 1 we also observe that paid parking areas are usually close to the centre, as the average house price is much higher than in areas without paid parking (€253,000 versus €132,000). Areas where paid parking is implemented during the study period are comparable to the areas where paid parking has already been introduced.

Figure 1
Paid-parking Districts in Amsterdam and Utrecht



Amsterdam Utrecht

Private parking space is rare. In the data set only about 5 per cent of the houses have a garage. Outdoor parking, which is a privately owned parking space without the additional protection that a garage offers, is even less common. In the data set only about 2 per cent of the houses have privately owned outdoor parking space. It is more common in the areas without paid parking than in the paid-parking areas.

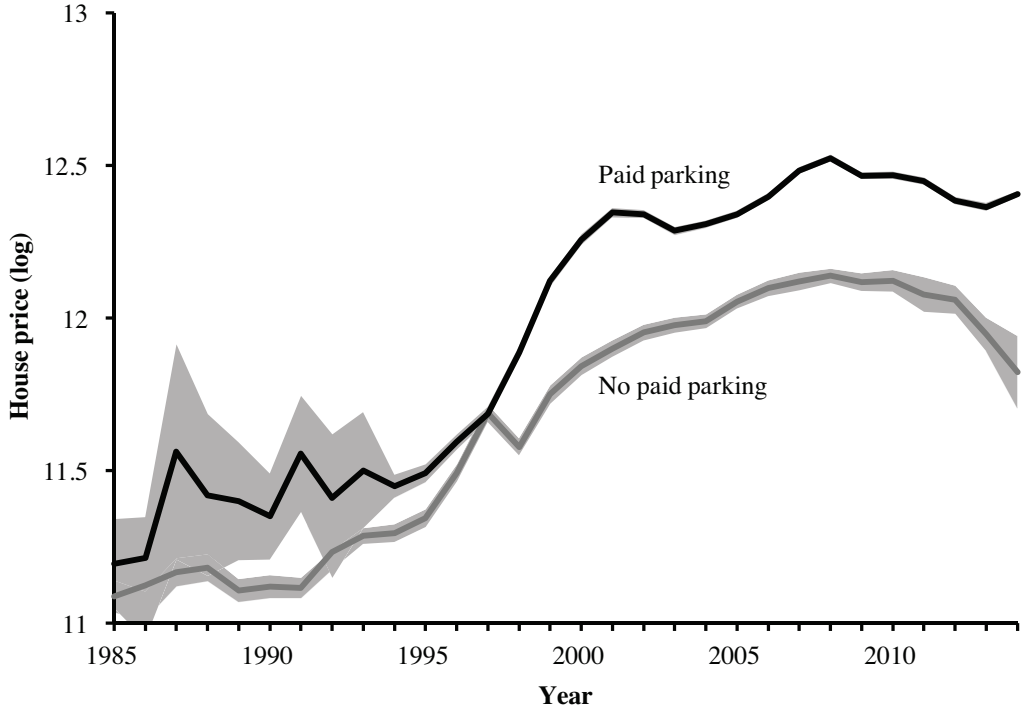
An important assumption in models that rely on temporal variation is that pre-trends are similar. We have tested this first between paid-parking areas and non-paid-parking areas (see Figure 2). The black line represents the average house price in the areas with paid parking, while the grey line represents the average house price in the areas without paid parking. The grey areas show the confidence intervals.

During the study period, house prices have consistently been higher in the paid-parking areas and seem to have similar price trends. Due to the wide confidence interval it is hard to compare the trends before the large-scale introduction of paid parking in the mid-1990s, whereas in the late 1990s, house prices have increased more rapidly in the areas with paid parking. This, however, does not necessarily mean there is a causal effect of paid

Table 1
Descriptives: Amsterdam and Utrecht

	Full data set	*Paid parking*	*No paid parking*	*Paid parking >1985*
House price (€)	213,555	253,095	131,908	232,885
Floor space (m^2)	81.7	81.9	81.3	82.0
Number of rooms	3.07	3.02	3.16	3.07
Constructed before 1945	0.589	0.723	0.313	0.731
Outdoor parking	0.021	0.016	0.032	0.017
Garage parking	0.048	0.047	0.052	0.042
Year	2005	2006	2001	2005
Number of observations	123,260	83,044	40,216	90,313

Figure 2
House Prices in Areas with Paid Parking and Areas without Paid Parking



parking on house prices. There may be other confounding factors, like different house price trends between the city centre and the fringes. We will take this into account in the statistical analysis.

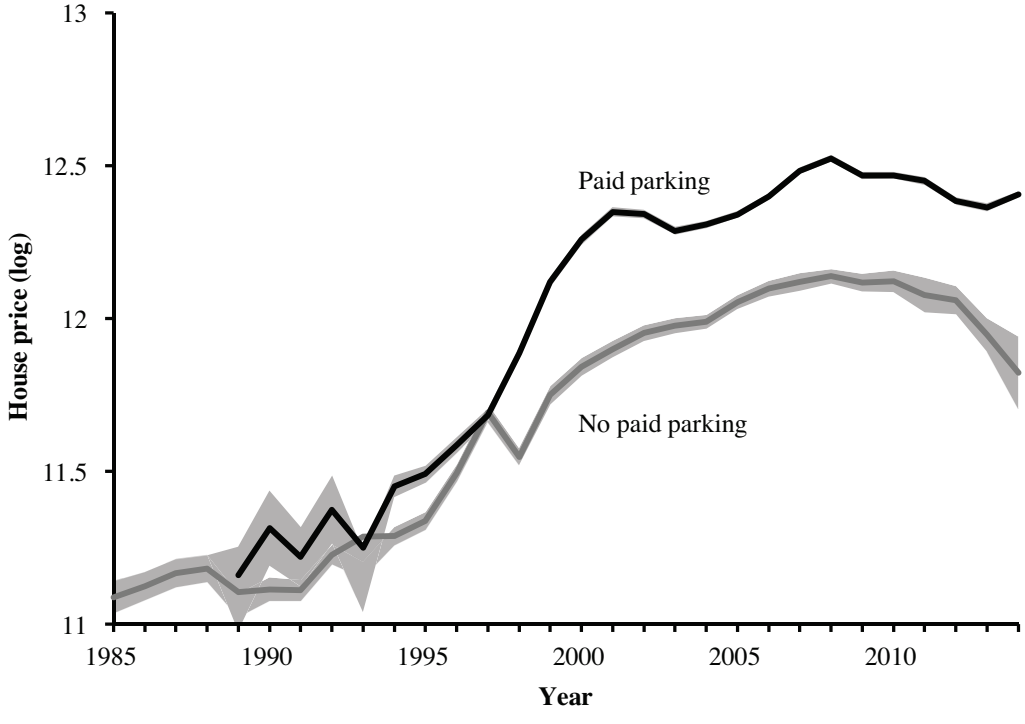
In order to obtain a more meaningful comparison between the paid-parking and non-paid-parking areas, we only analyse the areas where paid parking was introduced after 1985. This ignores the city centres and the fringes, and should therefore reduce the effect of different price trends in different areas to some extent. Figure 3 shows the average house prices within this constricted sample. The pattern is similar to that in Figure 2.

4.0 Results

As we have information on the location and timing of paid parking, we can estimate the direct effect of paid parking on house prices and on the value of privately owned parking spaces. We cluster the standard errors at the parking district level. The results are reported in Table 2.

Column (1) relies on the full data set, including apartments in the cities of Amsterdam and Utrecht. We find that the introduction of paid parking seems to have had a positive effect on house prices: prices are 4 per cent higher in paid parking areas. Properties with garage parking space are 6 per cent more expensive, while having an outdoor private

Figure 3
House Prices in Areas where Paid Parking was Introduced after 1985



parking space implies a price increase of 3 per cent. We find that private parking outdoor spaces are almost twice as expensive in paid parking areas, which probably reflects the fact that land has become more expensive in and close to city centres. In any case, this coefficient is unlikely to reflect a causal effect of parking policies.

To address the issue that paid parking areas may have had different temporal trends from free parking areas, we only include observations in parking districts in which paid parking is introduced after 1985. This reduces the number of observations by about 25 per cent and implies that we identify the effect of parking policies based on differences in the timing of implementation. Column (2) suggests that the direct effect of paid parking on house prices disappears. Also, the indirect effect via a change in the price of private parking spaces is far from being statistically significant. Private parking space is more valuable if we only focus on areas where paid parking was introduced during the study period. Private parking space increases house prices by 6 per cent (outside parking) to 9 per cent (garage parking). Interestingly, these estimations are similar or lower than those found for US cities, which indicate that private parking space is worth between 9 and 17 per cent of the price of a house (Manville, 2013; Gabbe and Pierce, 2017), with several studies finding 12 per cent (Litman, 1995; Jia and Wachs, 1999). This difference might be a result of lower levels of cruising in the Netherlands, which makes private parking less valuable, but it may also be a result of other differences between the Netherlands and the USA. For example, the value of private parking space may depend on car ownership levels.

Table 2
House Price: Amsterdam and Utrecht (Dependent Variable: Log of House Price)

	(1)	*(2)*	*(3)*	*(4)*
	Full sample	*Paid parking >1985*	*Amsterdam*	*Utrecht*
Paid parking	0.039***	−0.011	0.009	0.003
	(0.013)	(0.013)	(0.019)	(0.011)
Paid parking × private parking	0.026**	−0.016	−0.026	−0.004
	(0.011)	(0.016)	(0.018)	(0.018)
Outdoor parking	0.029***	0.064***	0.073***	0.086***
	(0.008)	(0.016)	(0.019)	(0.019)
Garage parking	0.060***	0.093***	0.103***	0.087***
	(0.009)	(0.017)	(0.021)	(0.021)
Log size	0.770***	0.774***	0.853***	0.839***
	(0.041)	(0.062)	(0.021)	(0.043)
Log size × distance to city centre^2	−0.005	−0.004	−0.024	−0.185***
	(0.027)	(0.045)	(0.023)	(0.044)
Log size × distance to city centre^2	−0.003	0.002	0.001	−0.003
	(0.003)	(0.007)	(0.004)	(0.010)
Garden	−0.033***	−0.031***	−0.029***	−0.014
	(0.006)	(0.006)	(0.006)	(0.018)
Garden maintenance	0.098***	0.102***	0.099***	0.113***
(0 = bad, 1 = good)	(0.006)	(0.004)	(0.005)	(0.006)
Central heating	0.062***	0.064***	0.068***	0.050***
	(0.006)	(0.006)	(0.007)	(0.005)
Insulation (5)	yes	yes	yes	yes
Construction year (7)	yes	yes	yes	yes
Construction year × year (7 × 30)	yes	yes	yes	yes
Distance to city centre × year (30)	yes	yes	yes	yes
Zip-code fixed effects (8,789)	yes	yes	yes	yes
Year fixed effects (30)	yes	yes	yes	yes
Number of observations	123,260	90,313	78,938	11,375
R^2	0.951	0.951	0.954	0.941

Notes: In columns (2)–(4) we only include districts in which paid parking is introduced during the study period. Standard errors are in parentheses and clustered at the parking-district level. *** $p < 0.01$, ** $p < 0.5$, * $p < 0.10$.

The coefficients of the other control variables, however, have not changed. Their signs are as expected, with positive coefficients for size and central heating. The only unexpected result is the negative coefficient for a garden. This coefficient, however, applies to a poorly maintained garden. As maintenance is valued highly, a well-maintained garden increases the value of a house.

In columns (3) and (4) in Table 2, we make a distinction between Amsterdam and Utrecht, respectively, as cities may have very different unobserved traits that may be correlated to changes in parking policies. However, it is confirmed that parking policies do not affect house prices in either Amsterdam or Utrecht. Given the 95 per cent confidence interval, the direct price effect in Amsterdam is maximally 4.6 per cent ($0.009 + 1.96 \times 0.019$), while the negative indirect effect on parking spaces is maximally

6.2 per cent ($-0.026 - 1.96 \times 0.019$). For Utrecht the maximum effects are even smaller, despite the fact that we only have a little more than 11,000 observations.

Our results imply that the house price effects of paid parking policies are unlikely to be substantial and most likely to be absent. This result strongly differs from those obtained for Istanbul, where residents did not receive residential parking permits and where residents were not able to vote about the introduction of paid parking (Bakis *et al*., 2017). The absence of such a negative (or positive) effect implies that the main benefit of paid parking to residents — that is, less cruising — is offset by additional costs (for example, permit costs, visitors that have to pay, not being able to park a second car). Such a finding is in line with political economy arguments such as that by Russo (2013), who shows that residents resist measures that are detrimental to them.

To make this argument more explicit in the context of our paper, let us now make the assumption that residential cruising costs will increase over time in the absence of change in policy. This assumption is in line with studies that show that car demand, and therefore parking demand, increases because of increases in income (Dargay and Gately, 1999; Whelan, 2007). Furthermore, let us assume that politicians favour the introduction of paid parking to reduce parking demand, but the implementation depends on the residents, who will have to vote in favour of its introduction. Arguably, when cruising costs are still low, paid parking will not be implemented, because the reductions in cruising costs will be small when paid parking is introduced. However, it will be implemented when residents are indifferent between paid and free parking, resulting in the absence of any effect of paid parking. A negative effect of paid parking would imply the absence of substantial residential cruising, indicating that paid parking was introduced too early from the residents' standpoint, whereas a positive effect would imply severe cruising for parking prior to the introduction of paid parking, indicating that paid parking was introduced too late from the residents' perspective.

5.0 Sensitivity Analysis

We shall now perform a battery of sensitivity analyses, which are reported in Table 3. In columns (1) to (3), we focus on Amsterdam, and in columns (4) to (6) we pay attention to Utrecht.

In column (1) we include not only apartments, but all other housing types (terraced, semi-detached, and detached properties). As most houses are apartments, this increases the number of observations by only about 5 per cent and leaves the results unaffected. In column (2) we try to further aim to address the issue of unobserved trends that are correlated to the introduction of paid parking by including a squared interaction term of distance to the city centre and transaction year. Again we do not find any effect. In column (3) we make a distinction between the effect of paid parking on the value of private outside and garage parking spaces. Both coefficients are statistically insignificant, but interestingly, only the garage parking coefficient is negative for both Amsterdam and Utrecht (column (6)). Hence, paid parking may have had some negative effects on the value of garage parking. However, the standard errors are again too large to make precise statements. We repeat the same set of specifications for Utrecht in columns (4)–(6), confirming the absence of a statistically significant effect of parking policy on house prices.

Table 3

House Price: Amsterdam and Utrecht: Sensitivity Analysis (Dependent Variable: Log of House Price)

	Amsterdam			*Utrecht*		
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Paid parking	0.010	0.019	0.009	−0.001	−0.001	−0.003
	(0.017)	(0.022)	(0.019)	(0.009)	(0.012)	(0.012)
Paid parking × private parking	−0.018	−0.014		−0.016	−0.004	
	(0.015)	(0.020)		(0.012)	(0.018)	
Paid parking × outdoor parking			−0.0002			0.024
			(0.011)			(0.019)
Paid parking × garage parking			−0.051			−0.027
			(0.029)			(0.033)
Outdoor parking	0.067***	0.062***	0.053***	0.055***	0.085***	0.064***
	(0.017)	(0.021)	(0.012)	(0.021)	(0.019)	(0.023)
Garage parking	0.093***	0.091***	0.126***	0.060***	0.086***	0.104***
	(0.017)	(0.022)	(0.029)	(0.013)	(0.021)	(0.024)
Insulation (5)	yes	yes	yes	yes	yes	yes
Construction year (7)	yes	yes	yes	yes	yes	yes
Construction year × year (7 × 30)	yes	yes	yes	yes	yes	yes
Distance to city centre × year (30)	yes	yes	yes	yes	yes	yes
Distance to city centre^2 × year (30)	no	yes	no	no	yes	no
Zip-code fixed effects (6,619)	yes	yes	yes	yes	yes	yes
Year fixed effects (30)	yes	yes	yes	yes	yes	yes
Number of observations	82,789	78,938	78,938	23,908	11,375	11,375
R^2	0.953	0.954	0.954	0.949	0.941	0.941

Notes: We only include districts in which paid parking is introduced during the study period. Standard errors are in parentheses and clustered at the parking-district level. *** $p < 0.01$, ** $p < 0.5$, * $p < 0.10$.

Throughout the analysis we assume that the value of parking space relative to the house has remained constant over time. We have tested if the value of private parking has changed over time in the Netherlands. Figure A1, in the Appendix, shows that the garage coefficient has remained roughly constant over time, and that there is no difference between cities with and without paid parking. For a more detailed discussion on the relative value of parking space over time, we refer to the Appendix.

6.0 Conclusion

In our analysis we have estimated changes in house prices as a result of changes in parking policy — that is, the introduction of paid parking and the introduction of residential parking permits in two large Dutch cities for a period of about 30 years. The most important result from the analysis is that there is no statistically significant effect of parking policy on house prices. We find neither a direct effect nor an effect via the willingness to pay for a private parking space. This strongly suggests that paid parking has been introduced at about the moment where residents are indifferent about the introduction of paid parking. This finding is in line with political economy arguments (Russo, 2013), which show that residents resist measures that are detrimental to them.

The influence of the introduction of paid parking on house prices of residences with private parking space is less clear, but most likely there is no effect. Some findings suggest that the economic value of privately owned parking is reduced when paid parking is introduced.

Can we say anything about the welfare effects of the introduction of paid parking? The absence of any negative effect on local residents strongly signals a *positive* welfare effect of this policy, as the introduction of paid parking for non-residents likely has improved the efficiency of this market. However, for a more elaborate welfare analysis, one should also consider the welfare effects on visitors and commercial activities such as retail. We leave this for further research.

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Appendix: Private Parking Space in the Netherlands

It may be insightful to see if the implementation of paid parking is correlated with changes in the relative value of private parking spaces. Based on reported parking revenues, we can distinguish between municipalities with and without paid parking. In 2009, about 36 per cent of the Dutch municipalities had paid parking. As paid parking is more common in the larger municipalities, 64 per cent of the observations, or about 1.5 million observations, are within a city with paid parking. We can derive whether or not the relative value of private parking space has increased (for example, due to increased car ownership) or decreased over time, and whether this development has been different between municipalities with and without paid parking. The analysis suggests that garage parking space is

Table A1
Descriptives: the Netherlands

	Full data set	*Apartments*	*Apartments with garage parking*	*Apartments with outdoor parking*
House price (€)	194,881	162,330	232,596	191.342
Floor space (m^2)	117.3	86.0	105.1	92.7
Number of rooms	4.35	3.22	3.24	3.05
Apartment	0.27	1.00	1.00	1.00
Constructed before 1945	0.26	0.28	0.05	0.05
Year	2003.2	2004.4	2004.8	2005.1
Number of observations	2,409,379	653,455	66,758	40,995

rather consistently more valuable in municipalities without paid parking, but that the difference is only about 1 per cent of the total house price.

The main analysis assumes that the relative value of a parking space has remained constant over time. The relative value of a parking space may, however, have changed over time unrelated to parking policy. Therefore, we have also estimated a model using

Table A2
Value of a Privately Owned Parking Spot (Dependent Variable: Log of House Price)

	1990–4	*1995–9*	*2000–4*	*2005–9*	*2010–14*
Outdoor parking	0.005	0.029***	0.053***	0.045***	0.048***
(paid parking)	(0.008)	(0.004)	(0.002)	(0.002)	(0.003)
Outdoor parking	0.022	0.047***	0.047***	0.028***	0.041***
(no paid parking)	(0.015)	(0.009)	(0.005)	(0.004)	(0.004)
Garage parking	0.088***	0.120***	0.097***	0.084***	0.079***
(paid parking)	(0.007)	(0.004)	(0.002)	(0.002)	(0.002)
Garage parking	0.091***	0.109***	0.114***	0.083***	0.091***
(no paid parking)	(0.011)	(0.008)	(0.005)	(0.003)	(0.004)
Floor space *(log)*	0.667***	0.577***	0.611***	0.647***	0.701***
	(0.007)	(0.004)	(0.002)	(0.002)	(0.002)
Garden	0.020	−0.009	−0.016**	−0.035***	−0.036***
	(0.026)	(0.014)	(0.006)	(0.004)	(0.005)
Garden maintenance	0.079***	0.079***	0.095***	0.092***	0.126***
	(0.004)	(0.002)	(0.001)	(0.001)	(0.001)
Central heating	0.050***	0.073***	0.062***	0.045***	0.042***
	(0.005)	(0.002)	(0.001)	(0.001)	(0.002)
Insulation (5)	yes	yes	yes	yes	yes
Construction year (7)	yes	yes	yes	yes	yes
Zip-code × year fixed effects (8,789)	yes	yes	yes	yes	yes
Number of observations	24,295	105,575	176,667	194,774	142,754
R^2	0.914	0.844	0.899	0.922	0.919

Notes: Standard errors are in parentheses and clustered at the parking-district level. The asterisks indicate the 10 per cent (*), 5 per cent (**), and 1 per cent (***) significance levels. All specifications include year and zip-code fixed effects, and year-distance to city centre interaction effects. Apartments constructed before 1945 are the reference categories.

data on the whole of the Netherlands. We distinguish between cities with and without paid parking, so we can compare the development of the relative value of parking space between cities with and without paid parking. We have estimated this model separately for every year, so we can track the coefficients related to private parking spaces over time. In short, the model looks as follows:

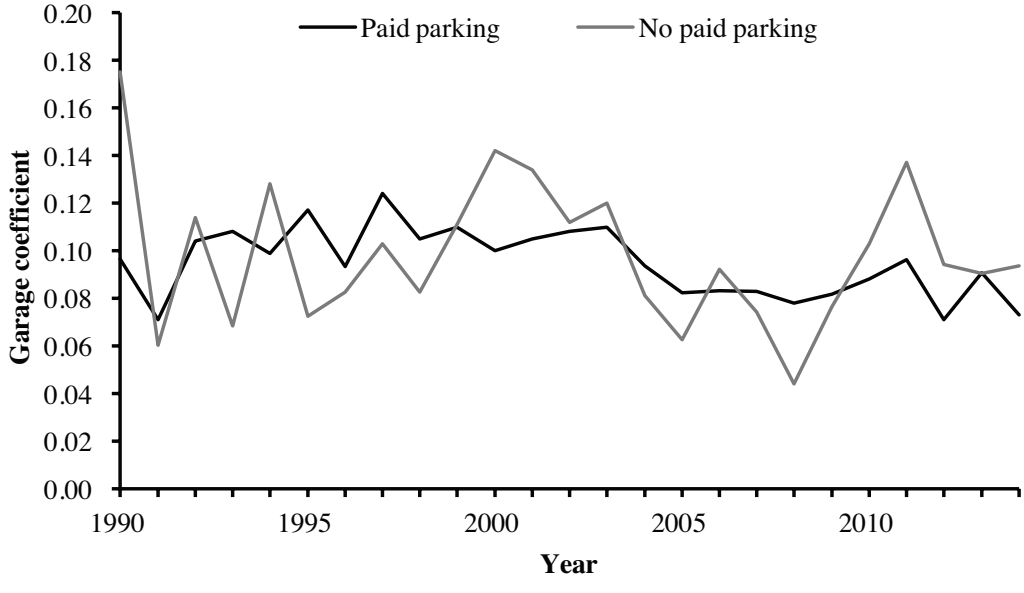
$$y_{ijt} = \beta_t c_{it} + \gamma_t h_{it} + \eta_{it} + \varepsilon_{ijt}.$$

So the coefficients are year-specific. As we estimate the coefficients per year, we do not need year dummies or year interaction effects. As we estimate the zip-code fixed effects η_{it} per year, we also control for very local differences in house-price developments.

We report the descriptive statistics for the full sample in Table A1. Average house prices have increased from €64,000 in 1985 to nearly €200,000 in 2008. In the data set, 10 per cent of the apartments possessed a private garage parking spot and another 6 per cent possessed an outdoor parking spot. Apartments with garage parking were generally larger and more expensive. Interestingly, apartments with a garage are generally more expensive than apartments without. This may indicate that garages have a non-negligible influence on house prices, but it may also be due to other characteristics, such as floor space, that are correlated with owning a garage.

We estimate the annual private-parking coefficient municipalities with and without paid parking. Table A2 shows the coefficients of the control variables at five-year intervals. The coefficients of the control variables do change a bit over time, which suggests that apartment characteristics are valued differently over different time periods. Interestingly, the coefficient of floor space has changed considerably over time. The coefficient was relatively low in the mid-1990s, but higher in the late 2000s.

Figure A1
Relative Value of Garage Parking Space



As expected, garage parking is valued higher than outdoor parking. On average, garage parking space increases the value of a house by about 10 per cent (see also Figure A1, which shows the per-year garage coefficient), while outdoor parking space increases house prices by 4 per cent. Interestingly, the relative value does not differ much between cities with and without paid parking (the per-year private parking space coefficients (not shown) are also very similar in municipalities with and without paid parking). The year-to-year changes are substantial, but the patterns are very similar. The relative value of garage parking space peaked in around 2000, and has decreased afterwards. Hence, the absence of an effect of parking policies on house prices is unlikely to be explained by time-varying preferences for private parking spaces.