External effects of vacant offices

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Abstract
This paper briefly reports the results of a hedonic price study on the presence of external effects of vacant office space on house prices. We combined the BAK-data for (vacant) offices with the NVM data for housing transactions. Using fixed effects at a small geographical scale, we were unable to find systematic evidence for presence of negative external effects.

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1 Introduction

Vacant office space is a burden for its owner because of the returns foregone. It is also conceivable that it does harm to others. Firms and households located in the vicinity may experience disadvantages, for instance if the empty building is also badly maintained. The presence and extent of such an external effect can, according to current insights in applied economics, be measured through the prices of real estate. The willingness-to-pay for nearby houses and other buildings decreases, and this decrease indicates the size of the welfare effect. To measure it, one would ideally like to compare the prices of houses that are identical except for the presence of vacant offices in the vicinity. We have investigated the existence of an external effect of empty office space in the Netherlands by carrying out a hedonic price analysis for houses in the period 2005-2015. In the next section, we document the information on vacant offices that we use. Section 3 reports the results of the hedonic price study.

2 Offices data

Office vacancy data (source: Bak) contain vacancy information for 15,958 office properties in the Netherlands between the years 2000-2016 (see table 1). Mean office size in the sample is 3,185 m2, but median size is 1,750 m2, which implies that office size average is influenced by high values of large office complexes.[1] The average vacancy rate of offices throughout the examined period is approximately 9.7%, and the average vacancy period is approximately 6 months. Approximately 4.5% of the properties in our sample were completely vacant. These figures were not constant over time. The share of properties which were not fully occupied (namely, had a certain amount of vacant space) has increased from approximately 14% in 2006 to over 25% in 2016 (see table 2). This trend is also visible when we consider only properties which have vacancy for at least 2 years as 'vacant' ("structural vacancy"). The share of total properties which were vacant for at least 2, 3 or 4 years has doubled in the past 10 years.

Among structurally vacant properties, average vacancy rate[2] is approximately 47-50%, a rate which has remained constant in the past years (see Table 3). The increase in total vacancy rate can therefore be attribute to the increase in number of vacant properties along the years.

The share of fully vacant properties among vacant properties also remained relatively unchanged. In general, there seem to be less completely empty offices when the vacancy period is longer. This is likely due to sale of the property, conversion to other uses or property demolition.

Table 1 - Office vacancy data descriptives

Statistic	N	Mean	Median	St. Dev.	Min	Max
Floor space	251,290	3,185	1,750	5,010.67	360	105,000
Vacancy	251,290	367	0	1,439.76	0	62,090
Vacancy rate	251,290	0.097	0	0.259	0	1
Vacancy period	251,290	0.536	0	1.673	0	17
Fully vacant	251,290	0.044	0	0.205	0	1

[1] The largest complex in our data is the Turfmarkt in The Hague, which consists of 105,000 m2. These are central-government buildings.

[2] Vacancy rate is calculated is the vacant area divided by the total office area.

Table 2 - Office vacancy rates per year and structural vacancy period

	N	1+ years		2+ years		3+ years		4+ years	
year	count	count	share	count	share	count	share	count	share
2000	13,039	774	5.94%						
2001	13,573	687	5.06%	225	1.66%				
2002	14,036	1045	7.45%	307	2.19%	99	0.71%		
2003	14,325	1569	10.95%	691	4.82%	215	1.50%	67	0.47%
2004	14,510	1,699	11.71%	1,075	7.41%	496	3.42%	170	1.17%
2005	14,613	1,689	11.56%	1,218	8.34%	817	5.59%	391	2.68%
2006	14,745	2,087	14.15%	1,284	8.71%	959	6.50%	661	4.48%
2007	14,885	2,041	13.71%	1,533	10.30%	997	6.70%	775	5.21%
2008	15,017	2,018	13.44%	1,510	10.06%	1,182	7.87%	796	5.30%
2009	15,175	1,971	12.99%	1,386	9.13%	1,087	7.16%	859	5.66%
2010	15,283	2,772	18.14%	1,622	10.61%	1,187	7.77%	941	6.16%
2011	15,357	3,008	19.59%	2,112	13.75%	1,259	8.20%	942	6.13%
2012	15,407	3,250	21.09%	2,374	15.41%	1,749	11.35%	1,077	6.99%
2013	15,404	3,573	23.20%	2,695	17.50%	2,009	13.04%	1,509	9.80%
2014	15,378	3,726	24.23%	2,969	19.31%	2,307	15.00%	1,750	11.38%
2015	15,312	3,858	25.20%	3,045	19.89%	2,488	16.25%	1,981	12.94%
2016	15,231	3,852	25.29%	3,178	20.87%	2,553	16.76%	2,121	13.93%

Table 3- Vacancy rates among vacant offices, per year and structural vacacny period

	Total		1+ years		2+ years		3+ years		4+ years	
year	Vacancy rate	Fully vacant rate	Vacancy rate	Fully vacant rate	Vacancy rate	Fully vacant rate	Vacancy rate	Fully vacant rate	Vacancy rate	Fully vacant rate
2000	4.42%	1.99%	49.93%	33.46%						
2001	3.95%	1.81%	51.28%	35.81%	41.47%	28.00%				
2002	5.84%	2.45%	49.81%	32.92%	45.05%	27.36%	33.86%	19.19%		
2003	9.05%	3.56%	51.27%	32.50%	47.96%	27.79%	42.06%	20.93%	34.31%	14.93%
2004	9.81%	3.37%	50.28%	28.78%	50.06%	27.81%	46.13%	24.19%	38.98%	17.06%
2005	9.76%	3.13%	49.73%	27.12%	48.75%	25.12%	48.73%	24.60%	43.63%	20.97%
2006	10.84%	3.55%	47.98%	25.11%	47.75%	22.43%	47.21%	21.27%	46.21%	20.12%
2007	10.71%	3.07%	47.53%	22.39%	45.59%	20.29%	44.91%	18.76%	44.18%	17.42%
2008	10.29%	3.12%	47.44%	23.24%	44.77%	19.80%	41.99%	17.17%	41.42%	16.08%
2009	9.83%	3.39%	48.43%	26.08%	47.04%	21.86%	44.18%	18.58%	41.41%	15.72%
2010	12.55%	4.88%	47.61%	26.88%	47.59%	21.95%	46.14%	18.11%	43.14%	15.73%
2011	13.52%	5.61%	48.92%	28.66%	47.46%	23.96%	47.00%	19.46%	45.14%	16.35%
2012	14.32%	5.94%	48.62%	28.15%	47.83%	24.26%	46.29%	20.30%	45.73%	16.34%
2013	15.72%	6.70%	50.17%	28.88%	48.89%	25.34%	47.96%	22.00%	46.65%	18.95%
2014	16.72%	6.50%	50.42%	26.84%	49.30%	24.35%	47.98%	20.72%	47.18%	18.40%
2015	17.53%	7.00%	51.08%	27.79%	50.44%	24.20%	48.80%	21.58%	47.73%	18.63%
2016	17.36%	7.53%	51.20%	29.78%	50.06%	26.46%	49.15%	22.76%	47.23%	20.56%

3 The hedonic price study

3.1 The general setup

To investigate the presence of external effects of vacant offices, we estimated hedonic price functions on NVM housing transaction data. Apart from a number of commonly incorporated characteristics of the house we included two indicators related to the office market: one is always the amount of office space in the vicinity, the other reflects various aspects of vacant office space. In the base version of our equations, fixed effects for 4-digit postal code areas (PC4) have been included. This means that we control for all characteristics of such areas that remain constant over time. The important implication is that the coefficients we estimate for the office market indicators are determined only by variation over time in these variables, not by what remains constant. Since we control for the general development of house prices (through including 'year dummies'), we measure if changes in the office market indicators associate with deviations of local house price development from the trend.

The total amount of office space in the vicinity is included to take into account the possibility that the presence of offices, regardless of their emptiness, has an impact on the price of housing. There could, for instance, be the effect traffic caused by those employed in the offices and perhaps their use of parking space. This is not the effect we are after, and we therefore control for it.

3.2 Indicators for vacant office space

Two indicators of vacant office space were developed: (1) vacant floor space and (2) number of fully vacant buildings, both which are derived directly from the Bak database. For each of these indicators, we tested three different types of measures:

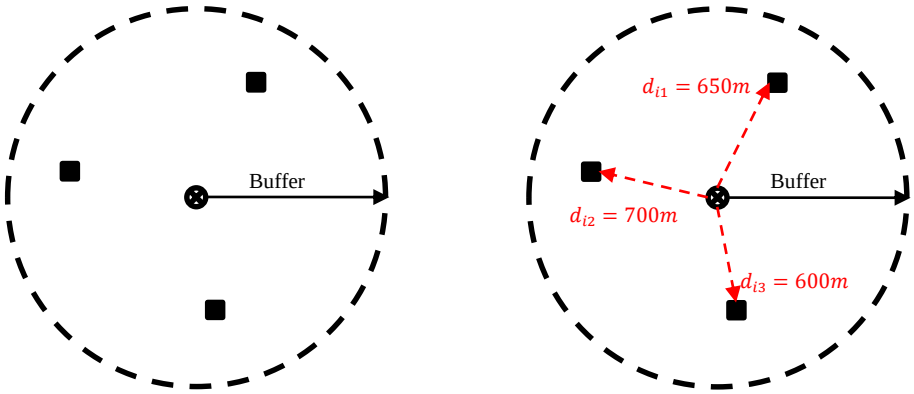
- *Area measures* – which are defined by the sum of the vacant office space indicators within the same official (administrative) area as the residential property transaction, specifically the "buurt" and "wijk".
- *Distance measures* – which were defined as the sum of the vacant office space indicators within a given distance, or radius, of the residential property transaction. While different distances were tested, our baseline results relate to a distance of 1 kilometer.
- *Distance-decay measures* – which were defined as the distance measures described above, except that the contribution of vacant office space indicators for each commercial property were linearly-weighted based on the distance to each individual residential property transaction.

The distance-decay weight w_{ij} assigned to commercial property j for residential property transaction i is defined as

$$w_{ij} = 1 - \frac{d_{ij}}{d_{buffer}}$$

where d_{ij} denotes the Euclidean distance from i to j, and d_{buffer} =1 kilometre denotes the maximum distance, beyond which commercial properties were assigned a weight of zero. The weight w_{ij} therefore takes on a range from 0 to 1, which has the effect of reducing the contribution of commercial properties that are located further away from the residential property.

The distinction between the distance and distance-decay measures are illustrated in the following two figures. The left-hand figure illustrates a residential property where the 1 kilometer buffer has been drawn, within which are three commercial properties. If these commercial properties are recorded as having vacant floor space, or are completely vacant, then they will contribute to the vacant office space indicators for the distance measures for this residential property.



Alternatively, the right-hand figure illustrates the same residential property, except in this case the distances to the three commercial properties are also illustrated. The distance-decay measures use these distances to calculate the weights $w_{i1} = 0.35$; $w_{i2} = 0.30$; and $w_{i3} = 0.40$. For the distance-decay measures, these weights are first applied to the vacant floor space and/or vacant building indicators before they are added together.

In what follows we report results that have been obtained using the distance decay measures, which we regard as the most convincing indicator for research on possible external effects of vacant office space. Intuition suggests that such effects – if they exist – are especially important when the empty offices are close. The discontinuity in the effect of vacant offices that is supposed to be present in the area and distance measures is intuitively less appealing, except perhaps when there is a very clear distinction between a geographical area and its surroundings. The distance decay measure is therefore our preferred one. However, we have experimented also with the other measures (for various definitions of the geographical areas – *buurt*, *wijk*, pc4 area - and threshold values for the distance). The results were in no cases systematically better or more in accordance with our *a priori* expectations.

3.3 Estimation results

In all specifications, the (natural) logarithm of the house price is the dependent variable. Table 4 presents estimation results for the simplest specification; ordinary least squares (OLS) regression with the indicators of the office market included linearly. We use the total amount of vacant space as the indicator for vacancies.

In the first three columns, we use total floor area to control for the amount of office space in the area and the total amount of office space that has been vacant for at least 2, 3 or 4 years as the indicator for vacancies. In all cases we find very small coefficients. They have the anticipated negative sign and are significant in the first two columns. Alternatively, in column (3) the indicator for vacant office space has a positive sign, but it is no longer significant.

In the last three columns, we distinguish between existing office space (available before 2000) and new office space. We find – surprisingly – that the amount of new office space appears with a

negative sign, while vacant office space in existing buildings has a positive sign. These two variables become statistically significant if we focus on office space that has been vacant for at least 3 (column 5) or 4 years (column 6).

Table 4 - OLS results with vacant space (log-lin)

	(1) 2y+ vacancy	(2) 3y+ vacancy	(3) 4y+ vacancy	(4) 2y+ vacancy	(5) 3y+ vacancy	(6) 4y+ vacancy
tot_floor space	0.000	0.000	0.000			
	(0.000)**	(0.000)**	(0.000)**			
tot_supply	-0.000	-0.000	0.000			
	(0.000)**	(0.000)**	(0.000)			
tot_ floor space _existing				0.000	0.000	0.000
				(0.000)**	(0.000)**	(0.000)**
tot_ floor space _new				-0.000	-0.000	-0.000
				(0.000)	(0.000)*	(0.000)**
tot_ supply _ existing				0.000	0.000	0.000
				(0.000)	(0.000)**	(0.000)**
tot_ supply _ new				-0.000	-0.000	-0.000
				(0.000)**	(0.000)**	(0.000)**
R2	0.70	0.70	0.70	0.70	0.70	0.70
N	1,261,124	1,261,124	1,261,124	1,261,124	1,261,124	1,261,124

Table 5 reports results of similar specifications with the number of (completely) vacant buildings as the indicator for vacant office space. We find statistically significant coefficients but not with the expected sign for this indicator in the first three columns. In the last three columns, we distinguish again between existing and new space/buildings. The unexpected positive sign only occurs for existing vacant buildings, while for new vacant buildings we find the expected negative sign. The existing amount of new office space also has a negative sign.
Tables 6 and 7 repeat the analysis for specification in which the indicators for the office market are expressed in logarithms. The results in the first three columns of Table 6 are similar to those in the first three columns of Table 4. In column 4 of Table 6 we find the expected negative signs

Table 5 - OLS results with entirely vacant buildings (log-lin)

	(1) 2y+ vacancy	(2) 3y+ vacancy	(3) 4y+ vacancy	(4) 2y+ vacancy	(5) 3y+ vacancy	(6) 4y+ vacancy
tot_ floor space	0.000	0.000	0.000			
	(0.000)**	(0.000)**	(0.000)**			
tot_vacant	0.007	0.007	0.005			
	(0.001)**	(0.001)**	(0.001)**			
tot_ floor space _ existing				0.000	0.000	0.000
				(0.000)**	(0.000)**	(0.000)**
tot_ floor space _ new				-0.000	-0.000	-0.000
				(0.000)**	(0.000)**	(0.000)**
tot_vacant_ existing				0.007	0.008	0.006
				(0.001)**	(0.001)**	(0.002)**
tot_vacant_ new				-0.011	-0.014	-0.008
				(0.004)**	(0.005)**	(0.006)
R2	0.70	0.70	0.70	0.70	0.70	0.70
N	1,261,124	1,261,124	1,261,124	1,261,124	1,261,124	1,261,124

Table 6 - OLS results (log-log)

	(1) 2y+ vacancy	(2) 3y+ vacancy	(3) 4y+ vacancy	(4) 2y+ vacancy	(5) 3y+ vacancy	(6) 4y+ vacancy
tot_floor space (log)	0.001	0.001	0.001			
	(0.000)**	(0.000)**	(0.000)**			
tot_ supply (log)	-0.001	-0.001	-0.000			
	(0.000)**	(0.000)**	(0.000)			
tot_ floor space _ existing (log)				0.001	0.001	0.001
				(0.000)**	(0.000)**	(0.000)**
tot_ floor space _ new (log)				0.000	-0.000	-0.001
				(0.000)	(0.000)	(0.000)**
tot_ supply _ existing (log)				-0.001	-0.000	0.000
				(0.000)**	(0.000)	(0.000)
tot_ supply _ new (log)				-0.001	-0.001	0.000
				(0.000)**	(0.000)**	(0.000)
R2	0.69	0.69	0.69	0.69	0.69	0.69
N	1,261,124	1,261,124	1,261,124	1,261,124	1,261,124	1,261,124

for both indicators of vacant office space (supply). In column 5 one of them becomes insignificant. In column 5 both are insignificant and have a positive sign. The total amount of new office space now has a negative and significant coefficient.
The results presented in Table 7 are qualitatively similar to those in Table 5, except for the last column where we find an insignificant coefficient for new offices that have been vacant for at least 4 years.

A possible concern with the results presented thus far is that the development of (vacant) office space and house prices can be correlated for other reasons than the external effects associated with offices. For instance, one can imagine that increasing house prices and a smaller amount of vacant office space both reflect that the neighbourhood has become more attractive because a

Table 7 - OLS results (log-log)

	(1) 2y+ vacancy	(2) 3y+ vacancy	(3) 4y+ vacancy	(4) 2y+ vacancy	(5) 3y+ vacancy	(6) 4y+ vacancy
tot_ floor space (log)	0.000	0.000	0.000			
	(0.000)**	(0.000)**	(0.000)**			
tot_vacant (log)	0.003	0.012	0.013			
	(0.001)**	(0.002)**	(0.002)**			
tot_ floor space _ existing (log)				0.001	0.001	0.001
				(0.000)**	(0.000)**	(0.000)**
tot_ floor space _ new (log)				-0.001	-0.000	-0.001
				(0.000)**	(0.000)**	(0.000)**
tot_vacant_ existing (log)				0.016	0.017	0.000
				(0.002)**	(0.002)**	(0.000)
tot_vacant_ new (log)				-0.022	-0.028	0.000
				(0.005)**	(0.006)**	(0.000)
R2	0.69	0.69	0.69	0.69	0.69	0.69
N	1,261,124	1,261,124	1,261,124	1,261,124	1,261,124	1,261,124

new road has opened in the vicinity. One possibility to remove such neighbourhood-specific effects out of the analysis is to use 'instruments' for the office space variables that reflect the state of the office market at a higher geographical scale, but not the neighbourhood-specific component. See, for instance, Evans, Oates, & Schwab (1992) for a similar approach in a different context. We have constructed such instruments based on the development of the total amount of office space and that of office-related jobs in the COROP-region in which the house is located. That is, we constructed an index for the total amount of available office space that follows the development of the total amount of office space in the COROP region and used this as an instrument for the actual amount of office space. We transformed the number of office-related jobs to the required amount of office space using the amount of office space used per employee (see Buitelaar et al., 2017) and subtracted that from the indicator of the total amount of available office space to get an instrument for vacant office space. This instrument was used for both types of indicators for office space and for all durations of vacancies. If we distinguish between existing and new office space, only the latter was instrumented.

The results for the double-logarithmic specification are presented in Tables 8 and 9. If we look at column 4 of Table 8 we find negative coefficients for vacant office space which confirms our expectations. However, the effects become only marginally significant if we look at office space that has been vacant for at least 3 years and insignificant if we look at office space that has been vacant for at least 4 years. Moreover, if we use completely vacant offices as our indicator, the results are not confirmed.

Table 8 - IV results (log-log)

	(1) 2y+ vacancy	(2) 3y+ vacancy	(3) 4y+ vacancy	(4) 2y+ vacancy	(5) 3y+ vacancy	(6) 4y+ vacancy
tot_ floor space (log)	-0.520	-0.117	-0.085			
	(0.225)*	(0.066)	(0.066)			
tot_ supply (log)	0.484	0.087	0.042			
	(0.451)	(0.026)**	(0.011)**			
tot_ floor space _ existing (log)				0.346	0.525	1.136
				(0.086)**	(0.165)**	(0.747)
tot_ floor space _ new (log)				-0.032	-0.051	-0.131
				(0.012)**	(0.022)*	(0.092)
tot_ supply _ existing (log)				-0.131	-0.236	-0.401
				(0.047)**	(0.098)*	(0.227)
tot_supply_ new (log)				-0.027	-0.035	-0.077
				(0.011)*	(0.018)	(0.058)
N	1,261,124	1,261,124	1,261,124	1,261,124	1,261,124	1,261,124

Table 9 - IV results (log-log)

	(1) 2y+ vacancy	(2) 3y+ vacancy	(3) 4y+ vacancy	(4) 2y+ vacancy	(5) 3y+ vacancy	(6) 4y+ vacancy
tot_ floor space (log)	-0.168	-0.083	-0.097			
	(0.072)*	(0.072)	(0.071)			
tot_vacant (log)	0.223	0.600	0.536			
	(0.069)**	(0.145)**	(0.133)**			
tot_ floor space _ existing (log)				0.193	0.241	-0.131
				(0.100)	(0.098)*	(0.092)
tot_ floor space _ new (log)				-0.039	-0.041	1.136
				(0.015)*	(0.015)**	(0.747)
tot_vacant_ existing (log)				8.494	4.822	-0.401
				(1.719)**	(0.979)**	(0.227)
tot_vacant_ new (log)				-0.276	-0.286	-0.077
				(0.104)**	(0.093)**	(0.058)
N	1,261,124	1,261,124	1,261,124	1,261,124	1,261,124	1,261,124

All results reported thus far have been obtained using neighborhood fixed effects at the pc4 level. To investigate the robustness of our results we have also used CBS-defined *buurten* and *wijken* (neighbourhoods) as our basic geographical units. The results obtained then are similar: we never find solid evidence for negative external effects of vacant offices.
One limitation of this study is that we assumed a national trend in house prices, whereas it is possible that local trends differ from the national average. A limited number of analyses at the local scale show similar outcomes: differing results without a systematic pattern.

5 Conclusion

In this research, we have considered the possible existence of negative external effects of vacant office space by studying the development of house prices. Fixed effects at a small geographical scale were used and we controlled for the development of the total stock of office space. We used the floor area that was vacant for at least 2, 3 or 4 years and the number of office buildings that were vacant for at least 2, 3 or 4 years as indicators for vacant office space. To rule out the possibility that local factors affecting the office market and house prices disturbed the results, we instrumented the indicators for the office market, using aggregate developments at the COROP level as the basis of our instruments. Results differed, but the general conclusion is that we were unable to find systematic evidence for the presence of significant negative external effects of vacant office space.

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