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Large Redevelopment Initiatives: The effect of redeveloping office stock into housing on surrounding house prices in an urban setting. A case study in the city of Amsterdam, the Netherlands.

T. Jonker

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Faculty of Spatial Sciences

University of Groningen

Supervisor: Dr. Xiaolong Liu

COLOFON

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Version	Final version
Author	Tom Jonker
Studentnumber	2759357
E-mail	t.jonker.1@student.rug.nl
Supervisor	Dr. Xiaolong Liu
Second reviewer	Dr. Mark van Duijn

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University of Groningen

Faculty of Spatial Sciences

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ABSTRACT

The Netherlands is currently struggling with the ability to offer enough supply of living spaces in its cities. One of the ways to battle this problem is through the redevelopment of the current stock of properties. This thesis wants to find what effects the redevelopment of office stock into housing has on surrounding house prices, which can be of relevance for future policy makers regarding the topic. A hedonic price model including house prices, structural characteristics of the house, neighborhood effects and time effects was in order to find the external effects of the redevelopment on three different time periods (before, during and after). The results show that before the redevelopment started the office buildings, which are often in a vacant state, are a disamenity to their surroundings, which resulted in lower house prices (-1.6%). Between the start and the end of the construction period house prices rise due to anticipation effects, in which homeowners are willing to pay a price premium based on future expectations (1.1%). At last, after the realization of the redevelopment projects house prices continue to rise due to the increased attractiveness of the neighborhood (1.6%). This thesis stresses the fact that through the redevelopment of the current stock of offices into housing positive externalities arise for the surrounding neighborhood. This means that to reduce the issue concerning a lack of supply of living spaces in Dutch cities the policy makers should first seek to offer housing through the redevelopment of the current stock, instead of expanding the city's boundaries, which results in the sacrifice of green spaces.

Keyword: House prices, offices, redevelopment, real estate, hedonics

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1. INTRODUCTION

The Netherlands is currently struggling with the ability to offer enough supply of living spaces in its cities (Gebiedsontwikkeling, 2018). Research performed by Dutch real estate consultants (Brink Management, 2018) has shown that it is currently not possible to offer enough supply of housing inside urban areas in the Netherlands to meet the current demand. This problem can be battled through the reduction of developmental regulations, which could results in the sacrifice of green spaces or through the redevelopment of the current stock of properties into housing.

The latter, the redevelopment of the current stock into housing is favored by local governments. Policy documents show that local governments want to cope with the housing shortage by offering compact high density residential buildings without expanding the city's boundaries and without the loss of greenery (Gemeente Amsterdam, 2018;Gemeente Utrecht, 2018). Since the development of new housing within the city is not always possible due to the limited supply of ground, governments are actively seeking for places in which development can take place. The redevelopment of vacant offices into housing has become an increasingly popular option to solve this issue. According to the CBS (2017) the transformation of existing buildings, such as offices, into housing comprises of already nine percent of all the houses added to the housing stock in the year 2016. Through researching the effects that the redevelopment of office stock into housing has on the surrounding house prices this research aims to find how urban citizens surrounding these redevelopment sites value the projects. This information can be of importance for future redevelopment projects or policies regarding the supply of housing.

The literature field which analyses how specific housing characteristics influence the value of the house has been studied extensively. Not only structural characteristics of the home, like the number of bedrooms and bathrooms, but also locational or neighborhood attributes can have an impact on the house price. By redeveloping office stock into housing a change is made in the neighborhood, thus it is likely that the change causes externalities on surrounding properties.

Prior to the redevelopment of offices the buildings are often in a vacant or at least partly vacant state, which has been de primary focus of existing literature about this topic. An example of this is the study of Han (2014), which shows that abandoned properties have a negative external effect on the value of nearby properties. The study of Mikelbank (2008) supports this finding, stating that vacant properties negatively affect nearby house prices. An explanation for this negative effect on prices can be found in the study of Remøy & van der Voordt (2007), who state that the vacancy of office buildings leads to social problems for the surrounding community. According to this research the vacancy of office buildings presents problems of insecurity and social uncertainty for the surrounding neighborhood as it may lead to criminality, ranging from vandalism, break-ins, illegal occupancy to fires. Apart from these

direct negative effects on the neighborhood the presence of vacant offices may also have a negative indirect effect through the bad image that it gives to the surroundings and the building itself. Following this line of reasoning it is likely that the negative effects of vacant offices are also reflected into house prices. The redevelopment of vacant offices into housing may therefore reasonably be expected to have a positive effect on the surrounding neighborhood by diminishing the negative effects mentioned above.

Beside the topic of vacancy, the effects of redevelopment are also of importance for this thesis. Earlier literature which focusses on the externalities caused by redevelopment projects in urban settings found that redevelopment often has a positive effect on surrounding house prices. The study of De Sousa et al. (2009) find that the redevelopment of brownfield has a positive influence on surrounding property values. This finding is in line with research performed by Van Duijn et al. (2016), who looked at the effect of the redevelopment of industrial heritage. In this research the effects of the redevelopment project are measured in three different timeframes: the effects before, during and after the completion of the project. During these timeframes different effects were found. Before the start of the redevelopment small negative external effects were found. At the start of the redevelopment project these negative externalities disappear. At last they conclude that after the completion of these redevelopment projects positive external effects can be found on house prices in the larger cities in the Netherlands.

Apart from the positive externalities caused by redevelopment, there is also the possibility of negative effects on surrounding house prices. By redeveloping vacant offices into housing new supply is added to the local housing market. Since the price of houses is determined by an equilibrium in demand and supply the added supply could lead to lower prices.

In the Netherlands, where the lack of supply of housing can still be seen as a problem, it is important to understand how the redevelopment of the vacant office stock into housing effects its surroundings. The aim of this research is to contribute to the literature field which concerns itself with the understanding of how house prices are determined. As was discussed above, the topics of vacancy, redevelopment and supply are studied extensively in the existing literature. However, the effects that the redevelopment projects of offices into housing have on surrounding house prices has not been studied thus far. This thesis aims to address this gap in the existing literature. To accomplish this aim, this thesis examines the effects which the redevelopment of office stock into housing has on its surrounding house prices. As became clear in the section above, homeowners seem to dislike vacant buildings in their proximity. Furthermore, most redevelopment projects seem to have a positive influence on house price. However, the precise effects that these redevelopment projects have on surrounding house prices is yet to be determined. This leads us to the following research question:

What is the effect of office redevelopment projects into housing on surrounding house prices?

In order to give an extensive answer to the main research question the following sub-questions have been formulated.

1. *What externalities can be expected when redeveloping offices into housing?*

To give an answer to the first sub-question a literature review was performed, mainly focused on the following keywords: vacancy, redevelopment, anticipation effects and housing supply.

2. *What is the effect of office redevelopment projects on surrounding house prices during the different time periods (Before, During and After construction)?*

To answer the second sub-question a hedonic price model was performed,, which is elaborated on in the methodology chapter. Data used for answering this question is obtained from the Dutch association of brokers (NVM) and the Municipality of Amsterdam (Gemeente Amsterdam).

3. *How does the size and the housing type of the office redevelopment project influence effect on surrounding house prices?*

To answer the third sub-question the office redevelopment projects analyzed in this project are divided into different groups based on the number of apartments which are created in the redevelopment project (small, medium and large) or based on the housing type which is created by redeveloping the office (student housing and apartments). After this, regressions are run for each of these groups in order to make a comparison.

This thesis consists of different sections. First, in the theoretical framework, the most important concepts and theories that are relevant for this research are described. Second, in the methodology section, the research method and the way the data has been analysed is described. Third, the data section contains information on the selection method of the data and the descriptive statistics. Fourth, the results section containing the results of the empirical analysis. At the end, in the conclusion the main findings are briefly summarized.

2. THEORETICAL FRAMEWORK

In this chapter the theoretical framework is presented which forms the basis of the empirical analysis of this thesis. The existing literature on the external effects of vacancy, anticipation, redevelopment and added supply are reviewed. At the end the hypotheses, which are based on the literature review and the sub-questions, are presented.

2.1 External effects of vacancy

According to Remøy & van der Voordt (2007) office buildings are often related to vacancy levels. The authors state that vacancy is a problem experienced on different levels. First of all, the owner of the vacant buildings is affected by the vacancy. Furthermore, they state that vacancy can present problems for the surrounding society. The presence of vacant buildings may bring about social uncertainty and insecurity in the neighbourhood. Reason for this is the increase in criminal activity, such as vandalism, break-ins, illegal occupancy and fires. Not only these direct effects have an impact on the surrounding society, but it also brings about a negative image of the neighbourhood. Through this, Remøy & van der Voordt (2007) state, a neighborhood can end up in a down-ward spiral.

Since vacant buildings are not being utilized to their full capacity the revenues generated for the owners of the buildings are often not sufficient to keep up maintenance costs. Therefore, vacant buildings are often correlated with lower levels of maintenance. Research performed by Harding et al. (2007) shows that buildings which are not well maintained have a steeper depreciation of property prices than buildings which are well maintained. In accordance to this direct effect on the building itself, the effects also spill-over to the property prices of surrounding buildings. These results are in line with the works of Van Duijn et al. (2016), whose study focused on the redevelopment of cultural heritage sites. Although the scope of the research is somewhat different, it shows that buildings with a low level of maintenance can generate negative spill-over effects on surrounding properties.

A conclusion can be drawn regarding the reviewed literature: a consensus is present which indicates that the vacancy of buildings has mostly negative spill-over effects on the surrounding properties (Han, 2014.; Harding et al., 2007; Mikelbank, 2008.; Van Duijn et al., 2016.; Remøy & van der Voordt, 2007.) which is also reflected in the corresponding house prices.

2.2 External effects of redevelopment

There are currently no studies using hedonic price modelling to research the external effects of redevelopment projects which turn offices into housing on the surrounding house prices. However, there are multiple studies which analyse the effect of redevelopment projects in urban settings (Koster & Van Ommeren. 2013.; Van Duijn et al. 2016; Schwartz et al. 2006.).

As became clear in the part above, buildings with a lower level of maintenance can generate negative spill-over effects on surrounding properties. Therefore, it is likely that these negative effects can

disappear by redeveloping the ground or the building. The study of Van Duijn et al. (2016) researched the effects of redeveloping cultural heritage sites on house prices. The negative externalities that the sites caused to the surrounding neighbourhoods disappeared during the construction, and positive externalities were found after the completion of the project.

The research of Schwartz et al. (2006) aims to find the externalities caused by subsidized housing investments. The investments which are made are used to redevelop and revitalize the neighbourhood. In the paper significant external benefits were found. In line with the research of Van Duijn et al. (2016), some of the benefits appear due to the effect of the replacement of existing disamenities. The findings of Koster & van Ommeren (2013) are also in line with these findings. The authors look at the benefits gained from public investments in poor neighbourhoods. In their research they found that the revitalisation of neighbourhoods through physical restructuring has a positive effect on the direct surroundings in which these investments are made.

Concluding from these results, the redevelopment of offices into housing could be expected to generate beneficial externalities to the surrounding neighbourhoods. Prior to the redevelopment office buildings are often left vacant and are not well maintained. Investing in the buildings, and therefore improving the physical quality is likely to improve the attractiveness of the surroundings.

2.3 Anticipation effects

As was shown in the study of Schwartz et al. (2006) anticipation effects can occur between the start and the completion of a redevelopment project. Since the redevelopment of offices into housing could generate positive spill-over effects on surrounding house prices, households might anticipate this effect before the completion of the project. In the study of Schwartz et al. (2006) a simplified model was created which reflects this effect (figure 1). After the announcement of the redevelopment project, house prices in the proximity to the project increases due to the anticipation of households. At the start of the construction period house prices rise again, since the uncertainty about whether the announced project would actually be built is resolved. After the completion of the project house prices could increase when neighbors see the finished project and new occupants begin to move in.

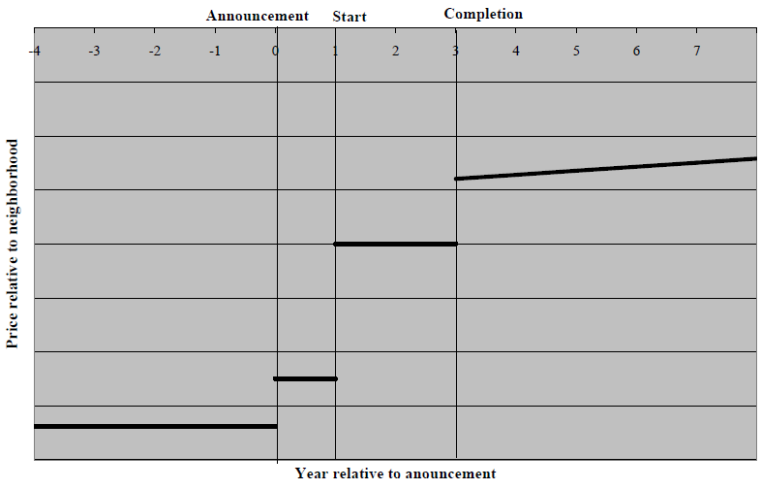

Figure 1. Model displaying the anticipation effect (Schwartz et al. (2006).

2.4 Added supply

Another effect one has to keep in mind, when studying the effects of redeveloping offices into housing, is the effect on house prices caused by the added supply to the market. DiPasquale (1999) states that the supply of housing is not only determined by production of new units, but also through the conversion of the existing stock. Since the price of an asset is determined by both supply and demand, an increase in the demand would, *ceteris paribus*, result in increased house prices (Ooi & Le 2012). This 'competition' theory predicts a negative relationship between stock adjustments and the price movement. However, measuring the effects the added supply has on house prices is not as easy as is illustrated above. According to Quigley (1979) there are real analytical difficulties for modelling supply in housing markets. DiPasquale (1999) elaborates on these difficulties, stating there are no standard housing quantities since each unit can vary considerably on many quality dimensions. In addition, the lack of information on the major actors in housing supply presents a significant obstacle to understand the housing supply.

As a reaction to the 'competition' theory discussed above, Glaeser et al. (2008) argue that the construction of new housing leads price movements rather than following them. This 'contagion' hypothesis predicts that the added supply of houses to the market will affect the house prices positively. A more recent study performed by Ooi & Le (2012) examined price adjustments of existing houses to a marginal change in the housing stock on an aggregate level. The study shows that housing supply and price adjustments are inextricably interrelated. Contrary to the 'competition' theory, this study indicates that new supply positively affects the prices of existing houses. The authors state that at the macro level the market views the launching of new construction as good news. Furthermore, the authors state that it is possible that this 'contagion' effect of new supply on existing house prices could also be attributed at the micro level, in which new supply could lead to a rise in prices of surrounding properties, because they add to the attraction of the neighbourhood.

2.5 Hypotheses

This thesis aims to find the effects of office redevelopment projects into housing on surrounding house prices. In order to compose an answer to this questions several hypotheses were constructed based on the theoretical framework and these are later on tested in the empirical analysis.

Prior to redevelopment, office locations are often in a vacant or at least a partly vacant state. A consensus is present in the existing literature, which indicates that the vacancy of buildings has mostly negative spill-over effects on the surrounding properties (Han, 2014.; Harding et al., 2007; Mikelbank, 2008.; Van Duijn et al., 2016.; Remøy & van der Voordt, 2007.) Therefore, a negative price effect on surrounding house prices prior to the redevelopment is expected (Hypothesis 1).

Hypothesis 1: *Office buildings have a negative effect on surrounding house prices prior to the redevelopment to housing (Before).*

The study of Van Duijn et al. (2016) found that during the redevelopment phase the disamenity effects of the building prior to redevelopment disappeared. In addition an anticipation effect can appear, in which homeowners are willing to pay more for the houses, anticipating the positive effects of the redevelopment (Schwartz et al. 2006). Furthermore, Ooi & Le (2012) argue that the construction of new housing leads price movements, since it adds to the attractiveness of the neighbourhood. Therefore, a positive effect on surrounding house prices during the redevelopment phase is expected (Hypothesis 2).

Hypothesis 2: *Office redevelopment projects have a positive effect on surrounding house prices during the redevelopment construction phase (During).*

Redevelopment can lead to a revitalization of the neighbourhood (Van Duijn et al., 2016; Schwartz et al., 2006; Koster & van Ommeren, 2013). This revitalization can happen through the physical restructuring of the building, but can also happen through the revitalization of the neighbourhood, both socially and physically. Another factor influencing the house price is the added supply of housing. However, as was discussed in section 2.4 it is difficult to predict what kind of effect the added supply will have on house prices. Therefore, a positive effect on surrounding house prices after the redevelopment phase is expected. (Hypothesis 3).

Hypothesis 3: *Office buildings which have been redeveloped into housing have a positive effect on surrounding house prices (After).*

In addition to the three hypothesis above, this research aims to examine how the different sizes and housing types of redevelopment projects influence the price effects on surrounding houses. Due to the fact that in a large scale project more people tend to move into the neighbourhood, and a more severe physical change is made in the neighbourhood, it is likely that a redevelopment project of large size has a more severe impact on its surroundings than a similar project of smaller size. It is therefore expected that the larger the size of the redevelopment project the larger the effect the project has on its surrounding house prices (Hypothesis 4).

Hypothesis 4: *The size of the redevelopment project (Number of apartments) is positively correlated with the effect the project has on its surrounding house prices.*

3. METHODOLOGY

In this chapter the methodology of the empirical study of this thesis is presented. At first the statistical method, the hedonic regression analyses, is described which is used to measure the effects which office redevelopment projects into housing have on surrounding house prices. Consecutively the empirical model and the alternative model that are used in this thesis are described.

3.1 Hedonic Analysis

Using features such as the structural attributes, the location and the locational determined-characteristics of the house one can find a set of determinants which explain the variance in house prices using hedonic price modelling. One of the first to use this research method was Rosen (1974). In the article it becomes clear that goods are valued based on their utility-bearing attributes. The formula $P(z) = p(z_1,\ldots,z_n)$ used by Rosen (1974) depicts this. P(z) represents the value of the good, which in turn is determined by different characteristics (z). In his theory consumers pursue the maximum amount of utility while being restrained by their income. The hedonic framework, in which goods are valued by various characteristics, are applicable to heterogeneous goods making it suitable for researching the effects certain characteristics have on house prices. In this thesis the transaction price, the location of the sold house, the structural characteristics and the neighbourhood characteristics are being examined . Putting these variables into the hedonic framework leads to the following formula:

$$P = \mathrm{f}(\mathrm{S}, \mathrm{L}, \mathrm{T}, \mathrm{E}) \qquad (1)$$

In this formula P stands for the house price, which is determined by the different factors (f) of structural characteristics (S), locational characteristics (L), the transaction year (T) and the external effect (E).

The first category *S* refers to the structural characteristics of the house, such as the floor space, number of rooms or the presence of a balcony. The variables that were used in this category are further discussed in chapter 4. The second category *L* refers to the locational determined-characteristics. This may include a variety of factors which are location-determined, such as the liveliness of the neighbourhood. The third category *T* refers to the market conditions which were present at the time the house was sold. By including this category the model controls for economic conditions such as inflation. At last category *E*, the variable which is the main focus of this research, refers to the variable which indicates the source of an externality. In this case it will include a dummy variable reflecting the distance to the nearest redevelopment site.

3.2 Defining the empirical and alternative model

The final empirical model used for this research is similar to the model used by Van Duijn et al. (2016). The dependent variable of this research is the natural logarithm of the transaction price. As was discussed in section 3.1, a set of structural characteristics, locational determined-characteristics, time variables and at last the externality dummy variables were included. The empirical model is specified as follows:

$$\ln(P_{ijt}) = b_0 + \sum_{k=1}^{k} \alpha_k S_{itk} + \gamma_t T_t + \delta_j L_j + \sum_{s=1}^{s} \beta_s R_{itrs} + \varepsilon_t \quad (2)$$

The first variable P_{ijt} is the transaction price of house *i* that is located in neighbourhood *j* at transaction year *t*. The second variable S_{itk} contains the structural characteristics *k* of house *i* sold in year *t.* The third variable T_t is a vector of dummies for each year. The fourth variable L_j is also a vector of dummies for each neighbourhood. The fifth variable R_{itrs} is a vector containing the ring variables *s* that depend on the location of each property *i* in year *t* and the treatment radius *r.* At last variable ε_t is the error term of the model. The parameters which are to be estimated are α, γ, δ and β. The variable of interest for this research is the *R* variable, capturing the external effect of redevelopment.

A target group is compared to a control group in order to measure the effect of the redevelopment projects on the surrounding house. A difference-in-difference approach has been applied to the hedonic regression to measure the difference between these groups, similarly to the research method used by Van Duijn et al. (2016). Using this approach the outcomes for the different groups can be observed in the different time periods (Before, During and After redevelopment). The time period 'before' will measure the effects that the office location had on the surrounding house prices prior to the start of the redevelopment phase. The coefficients in the period 'during' will measure the effects on house price during the transformation of the project from the start until the end of the construction period. The period 'after' will eventually measure the effects on house prices for properties which are sold after the completion of the redevelopment phase. It has to be noted that for some of the selected offices (see table 3) the development phase was finished in the year 2017. As displayed by the model of Schwartz et al. (2006) in the theoretical framework (Figure 1) prices are expected to rise over time after the redevelopment was finished. Therefore, it could be possible that house prices will continue to rise as a result of redevelopment in the future, but these effects cannot be measured in this research.

In this study the target group contains house transactions which are within 1000 meters Euclidian distance from the nearest selected redevelopment sites. It is expected that these houses receive treatment from these places, since these houses are located near the selected offices. The control group contains house transactions which took place within 1000 and 2000 meters Euclidian distance from the selected

redevelopment sites. It is expected that these houses did not receive treatment from the events that took place at the office locations, since these houses are further away from. The use of outer rings as a control mechanism is a commonly used method in recent literature (Van Duijn et al. 2016; Schwartz et al. 2006). A limitation to this research is the fact that some of the observed transactions lying in the control group and target group are overlapping with each other, as some of the office locations are located near one another (figure 2). As the construction periods of the redevelopment projects selected for this research (chapter 4) all took place in a four year time period it is possible that some of the house prices of the observed transactions are affected by different redevelopment sites. If sale was within 2000 meters of more than one redevelopment project only the distance to the nearest office was used further in the analysis. Control groups can be used to measure the effects of an event that took place, because these houses are expected to be somewhat similar to the houses which are sold in the target group. A more detailed description of the similarities between the target and the control group of this thesis is presented in chapter 4.

In order to get a better understanding of the effect the redevelopment projects has on the surrounding house prices, an alternative model has been created, measuring the effects on different distance rings to the nearest redevelopment project. In this model the target group (0 – 1000m) is cut into separate distance rings of 250 meters each, resulting in four distance rings. The choice for having 250 meters distance rings can be seen as somewhat arbitrary. In this research different distances for the rings have been considered, however due to a limited number of transactions that took place near the selected offices, the use of smaller distance rings would not be suitable for this research. The alternative model is specified as follows:

$$\ln(P_{ijt}) = b_0 + \sum_{k=1}^{k} \alpha_k S_{itk} + \gamma_t T_t + \delta_j L_j + \sum_{r=d_1-d_2}^{r_{max}} \sum_{s=1}^{s} . \beta_{rs} R_{itrs} + \varepsilon_t \quad (3)$$

As the target group is cut into separate rings, the coefficients β for each of the distance rings is estimated separately. By doing this, the problem of homogeneity within the target group is addressed. Since the target group in the baseline model is one ring variable containing all housing transactions within 1000 meters the model treats the target area as a homogenous group. However, in reality, it is likely that there are differences between areas in the target group. By separating the target group into smaller ring variables this problem is addressed. The parameters to be estimated in the alternative model are α, γ, δ and β. Similarly to the baseline model, variable *R* is of interest for this research.

4. DATA

The data used in this analysis consists of data from the Dutch Association for Realtors (NVM) and the Municipality of Amsterdam. The combined dataset contains information on housing transactions and the office redevelopment projects in the city of Amsterdam.

4.1 Data Selection

The dataset from the Dutch Association of Realtors (NVM) contains housing transaction data that took place in Amsterdam from the year 2000 until 2018. The Dutch Association of Realtors gather data of roughly 75% percent of all housing transactions that take place in the Netherlands and is therefore considered as representative for the Dutch housing market. The dataset consists of 224.969 transactions, including house prices, locational data and structural characteristics, such as floor space, number of rooms etcetera. Based on the research performed by Van Duijn et al. (2016) and Daams et al. (2016) a selection of variables is made that will be used for this analysis (table 1).

Table 1. Selected variables property data (NVM, 2019)

	Variable	Description
Transactional	House price	Nominal house price
	Year	Year in which house was sold
	Month	Month in which house was sold
Structural	House area	Living area in m2
	# of rooms	Number of rooms of the house sold
	Inside maintenance	Dummy for maintenance quality inside the house (1 = good)
	Outside maintenance	Dummy for maintenance quality outside the house (1 = good)
	Central heating	Dummy for central heating (1 = yes)
	Parking	Dummy for parking (1 = yes)
	Balcony	Dummy for balcony (1 = yes)
	Property type	Categorical variable for house and apartments types
	Building period	Categorical variable for building period
Locational	Neighborhood	Categorical variable for Neighborhood
	ZIP code	4- and 6- digit ZIP-codes

The variables used in the final dataset were carefully prepared for the statistical analysis. Variables further than 2000 meters away from the nearest office location were removed using GIS-software. Outliers, implausible values and cases with missing values were removed. Furthermore, some of the variables were log transformed. To see the full data preparation, including the histograms of the log transformations, see Appendix A. In the end 73.054 transactions were used in the empirical analysis.

A dataset which was made publicly available by the Municipality of Amsterdam was used to create a selection of offices which were redeveloped into housing (see appendix B). This dataset contains a total of 1039 redevelopment projects which took place in Amsterdam from the year 2012. The dataset contains the addresses, the long- and latitude of each redevelopment project, the floor space of the building, the current redevelopment phase, the current function, the future function of the building, the year construction started and the number of apartments which were constructed in the project. The vast majority of the redevelopment projects in the dataset are not suitable for this research. Most of the projects are either not fully constructed yet, or they were not redeveloped into housing. Therefore, a set of criteria has been created to make a selection of the dataset. Table 2 shows the selection criteria which were used to select the suitable cases for the empirical study.

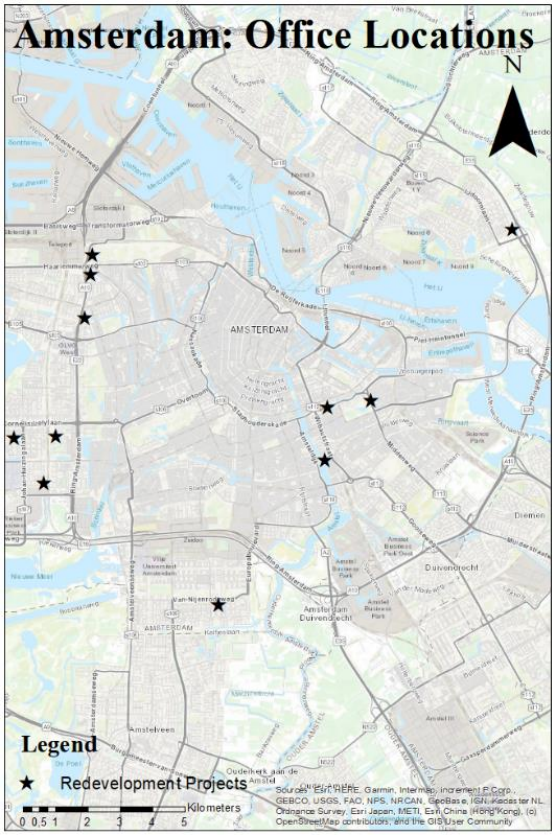

Figure 2. Amsterdam: Office Locations.

Table 2. Selection criteria

1. The function prior to redevelopment must be 'office'
2. The function after redevelopment must be 'residential'
3. The current redevelopment phase must be 'realized'
4. Number of apartments after redevelopment must be '> 20'.

11 office redevelopment projects were left after applying the above selection criteria. (Figure 2). A higher number of office locations would have been preferred for this research, however no other public data on office transformations is available. Further information about the start of the construction period, the end of the construction period and whether the created residences were either apartments or student housing was gathered for each of the selected redevelopment projects. This was either done through researching news articles and websites (see appendix C) or through direct contact with the developers of the projects. Table 3 gives an overview of the selected redevelopment projects. Further information on these projects and how the information was gathered can be found in appendix B.

Table 3. Selected redevelopment projects

Address	N of units	Start C.	End C.	Type
1. Bos en Lommerplantsoen 1	651	05-2012	04-2013	Student housing
2. Hilversumstraat 316-340	75	01-2017	07-2017	Apartments
3. Koningin Wilhelminaplein 18	129	01-2016	06-2016	Student housing
4. Linnaeusstraat 35F	89	03-2016	03-2017	Apartments
5. Mauritskade 17A	23	05-2016	12-2016	Apartments
6. Molenwerf 1-10	185	01-2013	01-2014	Apartments
7. Ottho Heldringstraat 41	65	06-2016	03-2017	Apartments
8. Sara Burgerhartstraat 25	224	05-2014	09-2015	Student housing
9. Tourniairestraat 1	140	01-2015	06-2015	Student housing
10. Van Heenvlietlaan 220	354	04-2014	10-2014	Apartments
11. Weesperzijde 99A	22	01-2015	06-2015	Apartments

Note: C. is short for construction.

4.2 Descriptive Statistics

As was explained in chapter 3.1 a target group and a control group are used in the empirical study of this thesis. In order to use a control group as a mechanism to measure the effects of an event that took place inside the target group the two groups must be somewhat similar. The mean transaction prices over the years of both the target and the control group are plotted in a two-way line graph to get more insight into this (figure 3). Inspecting this graph shows us that both lines show an upward trend in house price, following the same trajectory. Furthermore, the mean house prices of the control group are somewhat higher than the house prices of the transactions in the target group. One of the possible explanations for this lies in the fact that most of the selected office locations are located closer towards the edges of the city where house prices are generally lower. The fact that the house prices in the control group are higher than the house prices in the target group have to be taken into account when interpreting the results.

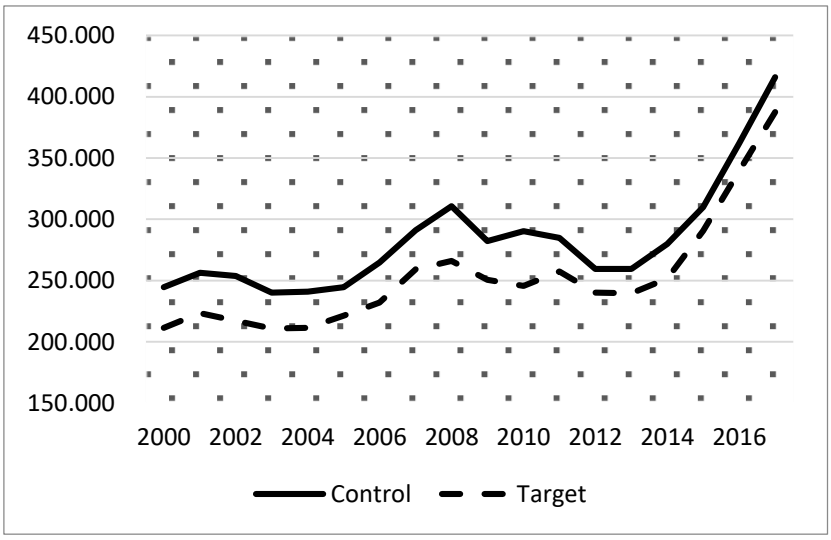

Figure 3. Mean transaction prices groups.

The full descriptive statistics of the dataset are presented in table 4. The statistics of the target and control group are illustrated separately in the table in order to get a better insight into the differences between the two groups. The statistics include the mean and the standard deviation for each variable used in the empirical analysis. Of the 73.054 observations 32.398 (44,3%) lie within the target group and 40.656 (55,7%) in the control group. All variables included show reasonable values for the total dataset. The average transaction price of the total dataset corresponds to a price of 276.723 euros. A difference of 27.447 euros in transaction price between the target and the control group is present. This difference in transaction price could be explained by the fact that the selected office locations for this research lie closer to the edges of the cities. Another explanation could be the differences in building periods, which can be observed in table 4.

Table 4. Descriptive statistics target group, control group and total

	Target group (0–1000m)		Control group (1000-2000m)		Total (0-2000m)	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Transaction price	261448.4	140302.1	288895	151146.8	276723	147069
House area	79.85104	34.47401	84.86499	35.59623	82.36513	35.17441
# of rooms	3.123989	1.142783	3.191263	1.272885	3.161429	1.217356
Inside maintenance (1 = Good)	.913328	.2813582	.9278089	.2588072	.9213869	.2691358
Outside maintenance (1 = Good)	.9773751	.1487066	.9794372	.141917	.9785227	.1449699
Central heating (1 = Yes)	.8852707	.3186999	.9015397	.2979396	.8943247	.3074236
Parking (1 = Yes)	.0750972	.2635522	.1110291	.3141721	.095094	.2933468
Balcony (1 = Yes)	.636922	.4808945	.573962	.4945054	.6018835	.489513
Building period 1500 – 1905	.1368603	.3437051	.1716598	.3770891	.1562269	.3630728
Building period 1906 – 1930	.2911908	.4543183	.3154762	.464711	.3047061	.460286
Building period 1931 – 1944	.1264893	.3324051	.091524	.2883564	.1070304	.309154
Building period 1945 – 1959	.071239	.2572276	.0430687	.2030142	.0555616	.2290748
Building period 1960 – 1970	.1437126	.3508035	.091278	.2880076	.1145317	.3184581
Building period 1971 – 1980	.0143219	.1188158	.0120031	.1089007	.0130315	.1134099
Building period 1981 – 1990	.0800049	.271305	.0628444	.2426858	.0704547	.2559136
Building period 1991 – 2000	.0847583	.278526	.1510478	.3580999	.1216497	.3268831
Building period > 2001	.0512069	.2204228	.0608274	.2390164	.0565609	.2310032
House type: Corner-house	.0089203	.0940266	.0141922	.1182843	.0118542	.1082307
House type: Detached	.0042904	.0653614	.0026564	.0514727	.0033811	.0580489
House type: Semi Detached	.0037348	.0609997	.0041814	.0645294	.0039834	.0629884
Number of observations	32398		40656		73054	

5. RESULTS

In this chapter the estimation results of the empirical study are presented. This chapter contains the most important coefficients and standard errors of the baseline model (see table 5), the alternative model (see table 6), the project size group models (table 7) and lastly two models splitting the target group into offices which were redeveloped into student housing and offices which are redeveloped into regular apartments (table 8). The dependent variable, the transaction price, was transformed into a natural logarithm, meaning that the coefficients can be interpreted as a percentage change.

In column (1) the naïve hedonic regression model is presented. This regression model only includes the variables representing the before, during and after redevelopment phase and the year fixed effects. The adjusted R-squared of this model is relatively low. From the variables before, during and after redevelopment only the variables before and after are significantly different from zero on a one percent level. Both of these variables show a negative effect on transaction prices. The negative effect of the variable after redevelopment could partly be explained due to the fact that the office redevelopment mostly took place outside the city centre (see figure 2). Therefore, Surrounding houses are sold for lower prices than the houses in the control group. Column (2) shows the same variables, but now the structural characteristics of the houses and the building periods are included in the model as well. This resulted in a better model fit as shown by an increased adjusted R-squared. In this column only the variable before redevelopment has a significant negative effect on surrounding house prices.

Column (3) reports the final model of the baseline specification. In this model the neighbourhood fixed effects are included. As can be expected, the adjusted R-squared increased to 0.9082. In this model all three variables (before, during and after) are significantly different from zero on a 1 percent level. The houses sold inside the target area (<1000m) before the redevelopment of the nearest office location are sold for 1,56% (=(exp(-.0155995)-1)*100) less than houses which are located in the control area. This result is in line with the expectation of the first hypothesis of this thesis, implying that office buildings have a negative external effect on surrounding house prices prior to their redevelopment. This negative effect can be explained by the fact that most of the selected office buildings prior to redevelopment were in a vacant or at least a partly vacant state. As Remøy & van der Voordt (2007) pointed out in their paper vacant buildings often lead to social uncertainty and insecurity in the surrounding neighbourhood. In addition the research performed by Harding et al. (2007) and Van Duijn et al. (2006) shows that buildings which are not well-maintained can cause negative spill-over effects on the surrounding neighbourhood. The houses sold inside the target area (<1000m) during the redevelopment of the nearest office location sold for 1,06% (=(exp(.0106062)-1)*100) more than houses located in the control area. This result shows that the negative effects of the office buildings prior to redevelopment disappeared. In addition, prices paid for houses inside the target area show an anticipation effect, in which home owners are willing to pay a premium based on future expectations of the area. This finding is in line

with the second hypothesis of this thesis, in which a positive effect on house prices was expected. At last, house prices which are sold inside the target area (<1000m) after the redevelopment of the nearest office location are sold for 1,83% (=(exp(.018263)-1)*100) more than houses located in the control area. This result is in line with the expectations of the third hypothesis, implying that the redevelopment of offices has a positive effect on surrounding house prices after the completion of the construction period. The positive effect for the surrounding neighbourhood can be explained by a variety of factors. First of all, investing in the building, and therefore improving the physical quality, are likely to improve the attractiveness of the surroundings. Furthermore, Glaeser et al. (2008) pointed out in their 'contagion' hypothesis that the construction of new housing in a specific neighbourhood can lead price movements and affect house prices positively. Concluding, the results of column (3) are in line with the first, second and third hypothesis of this research. However, these results must be interpreted with great care due to the limitations of this research stated in chapter three.

Table 5. Regression results of the baseline specification.

	(1)		(2)		(3)	
Sample size	< 2000 m		< 2000 m		< 2000 m	
Target area	0-1000 m		0-1000 m		0-1000 m	
Control area	1000-2000 m		1000-2000 m		1000-2000 m	
Before redevelopment	-.0932498***	(.0033967)	-.0253042***	(.0017039)	-.0155995***	(.0025084)
During redevelopment	-.0107247	(.0110242)	-.0033213	(.0054761)	.0106062***	(.0037423)
After redevelopment	-.061081***	(.0072362)	-.0036401	(.003621)	.018263***	(.0026537)
Year fixed effects	YES		YES		YES	
Structural characteristics	NO		YES		YES	
Building period dummies	NO		YES		YES	
Neighbourhood fixed effects	NO		NO		YES	
Observations	73054		73054		73054	
Adjusted R-squared	0.1345		0.7866		0.9082	

Note: Dependent variable is ln (transaction price.) Robust standard errors are reported between parentheses. The coefficients of the control variables can be obtained from the author. * p < 0.10. ** p < 0.05. ***p < 0.01.

Table 6 reports the coefficients and standard errors of the key variables of the alternative model. This model investigates the robustness of the results and measures the distance decay effect. According to Van Duijn et al. (2016) the effects are allowed to be either linear, concave or convex over distance from the office redevelopment project. Similarly to the research by Van Duijn et al. (2016), houses sold in the target area are separated into four different groups based on four ring variables of 250 meters each (0m-250m, 250m-500m, et cetera).

As can be seen in the table, all of the four Before ring variables are significantly different from zero on a one percent level. Over distance from the redevelopment project a concave effect is found. The houses sold within 250 meters from the redevelopment office site prior to transformation sold for 2,9% (=(exp(-.0290276)-1)*100) less than houses inside the control area. The negative effect is most pronounced at the ring variable 250m – 500m, with a 3,5% (=(exp(-.0350196)-1)*100) discount on house prices. After this, the negative effect of the offices prior to transformation decreases to respectively 1,57% (=(exp(-.0157019)-1)*100) and 1,2% (=(exp(-.0119312)-1)*100) over distance. Of the four During ring variables only the variable 250-500m is significantly different from zero. The variable shows a 2,4% (=(exp(.0233537)-1)*100) premium on house prices sold inside the area. All of the four After ring variables are significantly different from zero on at least a ten percent level. A concave effect over distance is found with these variables as well. The houses closest to the office locations after the completion of the redevelopment project show a 1,1% (=(exp(.016819)-1)*100) increase in house prices. The positive effect reaches its maximum in the distance 250m-500, resulting in an 4% (=(exp(.0395929)-1)*100) increase of house prices in the area. After this the positive effect of the office redevelopment on house prices decreases to respectively 1,8% (=(exp(.0176385)-1)*100) and 0,8% (=(exp(.0075624)-1)*100) the further the houses are away from the redevelopment site. The results of table 6 do not interfere with the results shown in column (3). All of the four ring variables 'before' show a negative effect on surrounding house prices prior to redevelopment, one of the ring variables 'during' shows a price premium on house prices during the redevelopment and at last all of the four ring variables 'after' show a positive effect on surrounding house prices. These results offer additional evidence supporting the first, second and third hypothesis of this research. What stands out in these results is that a concave effect is found for the ring variables 'before' and 'after'. There is a multitude of possible explanations for the trajectory of this effect. One possible explanation could lie in the fact that extra supply of living spaces is added to the local housing market. The houses nearest to the place where these living spaces are added could be affected the most by this effect. However, as was made clear in chapter 2, there are multiple different theories on how the

Table 6. Regression results of the alternative model

	(4)	
Sample size	< 2000 m	
Target area	0-1000 m	
Control area	1000-2000 m	
Before < 250 m	-.0290276***	(.0056867)
Before < 500 m	-.0350196***	(.0044375)
Before < 750 m	-.0157019***	(.0034329)
Before < 1000 m	-.0119312***	(.0026971)
During < 250 m	-.0058873	(.0103781)
During < 500 m	.0233537***	(.006953)
During < 750 m	.0109025	(.006738)
During < 1000 m	.007033	(.0063944)
After < 250 m	.0106819*	(.0064936)
After < 500 m	.0395929***	(.0045664)
After < 750 m	.0176385***	(.0043049)
After < 1000 m	.0075624**	(.0039826)
Year fixed effects	YES	
Structural characteristics	YES	
Building period dummies	YES	
Neighbourhood fixed effects	YES	
Observations	73054	
Adjusted R-squared	0.9082	

Note: Dependent variable is ln (transaction price.) Robust standard errors are reported between parentheses. The coefficients of the control variables can be obtained from the author. * p < 0.10. ** p < 0.05. ***p < 0.01.

added supply affects house prices making it difficult to draw any conclusions. Another possible explanation of the concave effect could be the fact that some of the office locations are redeveloped into student housing. Often times the inflow of students in the neighbourhood can go along with some disturbance effects, such as noise.

Table 7 reports the coefficients and standard errors of the three different models. Three different groups have been made in order to test whether the size of the redevelopment projects are correlated with the size of the measured effects. The first group consists of only redevelopment projects in which less than 50 units are built, the second group consists of redevelopment projects in which 50 to 150 units are built and the third group consists of redevelopment projects in which more than 150 units have been built. The three groups were run in separate regression models, hence the lower number of observations. Hypothesis four tests whether the size of the project is positively correlated to the effects that the redevelopment projects have on the surrounding house prices. When examining the effects before the redevelopment of the office building took place, we see a significant negative effect on all three groups on at least a five percent level. For the small sized redevelopment projects houses sold within the target area are sold for 0,9% (=(exp(-0092486)-1)*100) less than houses within the control area. For the medium sized redevelopment projects the negative effect increases to a 1,5% (=(exp(-.0145632)=1)*100) discount on house prices. This negative effect is the highest at large sized redevelopment projects, with respectively a 4,4% (=(exp(-.0438955)=1)*100) discount on houses sold within the target group. These results show an indication that the size of the office building prior to redevelopment is positively correlated with the size of the effect, which is in line with the expectations of hypothesis four. For the effects during the construction phase of the redevelopment projects only medium and large sized redevelopment projects show significant results. The houses sold in the target area of medium sized redevelopment projects sold for 0,7% (=(exp(.00721392)-1)*100) more during the construction phase. In the target area of the large sized redevelopment projects the houses sold for 1,8% (=(exp(-.0178704)-1)*100) less than houses in the control area. These results are not in line with the expectations of the hypothesis that the effects of the redevelopment projects increase with size. At last the effects after the completion of the redevelopment projects are measured in the different groups. This yields significant results for the small sized and medium sized redevelopment projects on a one percent level. After the completion of small sized redevelopment projects, houses in the target group sold for respectively 2,9% (=(exp(.0287261)-1)*100) more in the small sized target area and 3,6% (=(exp(.0358472)-1)*100) more in the medium sized target area than houses within the control area. A possible explanation for the variable ‘after redevelopment’ for large office redevelopment projects not yielding significant effects could lie in the fact that through these projects a large amount of living spaces is simultaneously added to the local housing market, inducing a supply effect depressing local house prices. Again, this supply effect is difficult to measure. Concluding, the results of table 7 show us

somewhat mixed results. Prior to redevelopment the results are perfectly in line with the hypothesis four, indicating that the size of office buildings, often in a vacant state, is positively correlated to the size of the measured effect. It seems plausible that this is true, as large vacant offices could lead to higher levels of crime such as vandalism, break-ins etcetera. The variables 'during redevelopment' and 'after redevelopment' are more difficult to interpret. The results of the variable 'during redevelopment' are not in line with hypothesis four. The results for variable 'after redevelopment' is in line with hypothesis four based on the results of the small and medium sized office buildings, however the variable does not yield significant results for the large office buildings in which more than 150 units were built. Due to the fact that there are only two significant estimators, it is difficult to draw any conclusions to the effects of the size after redevelopment.

Table 7. Regression results of the size groups.

	(5) Small <50 units		(6) Medium 50-150 units		(7) Large >150 units	
Sample size	< 2000 m		< 2000 m		< 2000 m	
Target area	0-1000 m		0-1000 m		0-1000 m	
Control area	1000-2000 m		1000-2000 m		1000-2000 m	
Before redevelopment	-.0092486**	(.0039381)	-.0145632***	(.0050621)	-.0438955***	(.0025084)
During redevelopment	.0003854	(.0076018)	.00721392***	(.0071972)	-.0178704***	(.0037423)
After redevelopment	.0287261***	(.0054528)	.0358472***	(.0067786)	.0057991	(.0026537)
Year fixed effects	YES		YES		YES	
Structural characteristics	YES		YES		YES	
Building period dummies	YES		YES		YES	
Neighbourhood fixed effects	YES		YES		YES	
Observations	24589		23310		26299	
Adjusted R-squared	0.8987		0.9070		0.8964	

Note: Dependent variable is ln (transaction price.) Robust standard errors are reported between parentheses. The coefficients of the control variables can be obtained from the author. * p < 0.10. ** p < 0.05. ***p < 0.01.

As was stated above it is possible that different effects are to be found between offices which are redeveloped into either student housing or into regular apartments. For this reason the target group is split into two groups, one containing the transactions that took place near offices which were redeveloped into student housing (model 8), one containing the transactions that took place near offices which were redeveloped into apartments (model 9). Table 8 reports the coefficients and the standard errors of these two groups. Before redevelopment, only the group student housing yields a significant result, showing that houses which are sold near these projects before redevelopment are sold for 3% (=(exp(-.029808)-1)*100) less than houses in the control area. A possible explanation for this could be that the offices which are redeveloped into student housing are on average larger than the offices which are redeveloped into regular apartments (see table 3), hence a relatively strong effect is found. As can be seen in table 7, the size of the redevelopment project seems to influence the results. During the redevelopment of the offices we observe a difference between the student housing and the apartments group. Houses which are sold near offices which are redeveloped into student housing are sold for 1,4% (=(exp(-.0140349)-1)*100) less than houses within the control area, while the houses sold near offices

which are redeveloped into regular apartments are sold for 2% (=(exp(.020455)-1)*100) more than houses sold in the control area. There are two possible explanations for the difference in these effects. Firstly, since the offices redeveloped into student housing are on average of a larger size more disturbance effects are found during the redevelopment phase. The second explanation could lie in the fact that homeowners are less encouraged to buy houses near offices which are redeveloped into student housing. At last, the variables capturing the effects after redevelopment show a surprising result. Houses sold near offices which are redeveloped into student housing are sold for 4,3% (=(exp(.0427146)-1)*100) more than houses in the control group, while houses sold near offices which are redeveloped into regular apartments are sold for 1,4% (=(exp(.0143735)-1)*100) more than houses in the control group. Again, this result could be influenced by the differences in size of the projects, hence the stronger effect for the student housing group. In addition to this, these results are possibly driven by other unobserved factors, making it difficult to draw any conclusions of the different effects between the student housing and the apartments group.

Table 8. Regression results of student/apartment groups.

	(8) Student housing		(9) Apartments	
Sample size	< 2000 m		< 2000 m	
Target area	0-1000 m		0-1000 m	
Control area	1000-2000 m		1000-2000 m	
Before redevelopment	-.029808***	(.0042835)	-.0039555	(.0031495)
During redevelopment	-.0140349**	(.0059716)	. 020455***	(.0046108)
After redevelopment	.0427146***	(.0041849)	.0143735***	(.003519)
Year fixed effects	YES		YES	
Structural characteristics	YES		YES	
Building period dummies	YES		YES	
Neighbourhood fixed effects	YES		YES	
Observations	21655		51399	
Adjusted R-squared	0.8761		0.9106	

Note: Dependent variable is ln (transaction price.) Robust standard errors are reported between parentheses. The coefficients of the control variables can be obtained from the author. * p < 0.10. ** p < 0.05. ***p < 0.01.

6. CONCLUSION

This study explored the effects of the redevelopment of offices into housing on local house prices, making a distinction between the different phases that these projects run through, including years before the start, the period between the start and the completion and the phase after the completion. Exploring this field is deemed relevant for two reasons. At first, this study expands the literature field which addresses the relationship between house prices and urban redevelopment projects. Secondly, the results can be used by policy makers which are concerned with the task of adding supply of living spaces within its city boundaries, as these results give an insight on how surrounding citizens value these projects.

In total eleven finished office redevelopment projects within the city of Amsterdam were selected for this research. In addition to this data of 73.054 transactions including structural, temporal and neighbourhood characteristics. In the baseline specification the target area is set to an area of 1000 meters Euclidian distance to the nearest redevelopment project. The control area is defined as the most outer ring consisting of transactions that took place between 1000 meters and 2000 meters Euclidian distance. A difference-in-difference hedonic price methodology was used to compare the house prices in the target group and control group during the different phases of the redevelopment project. After running the baseline model, the alternative model splits the target area into distance rings of 250 meters. At last, three separate regressions were run in order to find how the size of the redevelopment projects influences house prices. In the empirical models the omitted variable bias is reduced by adding both neighbourhood and time fixed effects.

The conclusions of this study are as follows: 1) negative external effects before the start of the redevelopment of the office building are present. Houses within the target area are on average sold for 1,6% less than houses within the control area. 2) A small positive external effect is present between the start and completion of the redevelopment of the office building. On average a 1,1% house price premium is paid on houses sold within the target area as compared to the control area. 3) Following the completion of the redevelopment of the office building positive external effects are present. On average a 1,6% house price premium is paid on houses which are sold within the target area. 4) The size of the project, measured in the number of apartments, increases the negative external effects on house prices measured before the start of the redevelopment of the office building.

The findings of this research are in line with the literature field which focusses on redevelopment projects. Similar studies, which also focussed on the relationship between house prices and externalities have shown a similar effect which indicates that the presence of negative externalities is associated with lower house prices. After the redevelopment of these places, for instance the redevelopment of cultural heritage, a positive external effect is found on the surrounding house prices (Koster & Van Ommeren. 2013.; Van Duijn et al. 2016.; Schwartz et al. 2006.).

This thesis stresses the fact that through the redevelopment of the current stock of offices into housing positive externalities arise for the surrounding neighborhood. This means that to solve the issue of the lack of supply of living spaces in Dutch cities that policy makers should first seek to offer supply through the redevelopment of the current stock, instead of expanding the city's boundaries, which comes at the cost of greenery. In addition to this, by redeveloping office buildings within the city's boundaries the urban sprawl is avoided.

All the above conclusions must be interpreted with great care. As with any study, this research has its limitations. Firstly, as was discussed in chapter 4, there are some differences present between the target- and control group, such as the mean transaction prices. Ideally these group are identical, making it possible to find consistent estimators for the effects. Secondly, since some of the office locations are relatively close to one another, it is possible that some housing transactions were affected by more than one redevelopment project. In this study the method was used to link a transaction to the nearest office location, which could be debateable as some of the transactions can be influenced by different projects. Thirdly, a few of the projects finished in the year 2017. As was found in the study of Schwartz et al. (2006) positive external effects tend to increase over time after the realization of these projects. It is therefore likely that some of the positive external effects will keep rising in the near future, however these effects are impossible to measure at this time. Fourthly, the distance from a house transaction to the selected redevelopment office was measured in Euclidian distance using GIS-software. The method could be improved by including a more refined indicator, which is especially useful when measuring the effects nearby the office location. For example, boxes could be used instead of rings in order to capture housing transactions which were directly affected by the redevelopment project. At last, there exists the possibility that the location of the target groups is driven by certain neighbourhood characteristics, meaning that the assignment to the target group is not entirely random. The study of Van Duijn et al. (2006) account for this by using a propensity score matching technique. By using this technique, a new control area is defined based on comparable neighbourhood characteristics.

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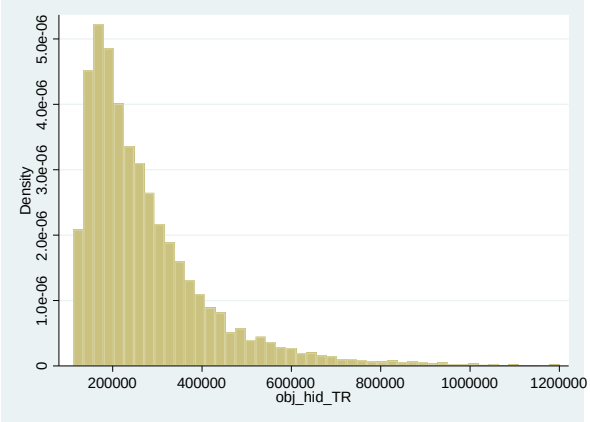
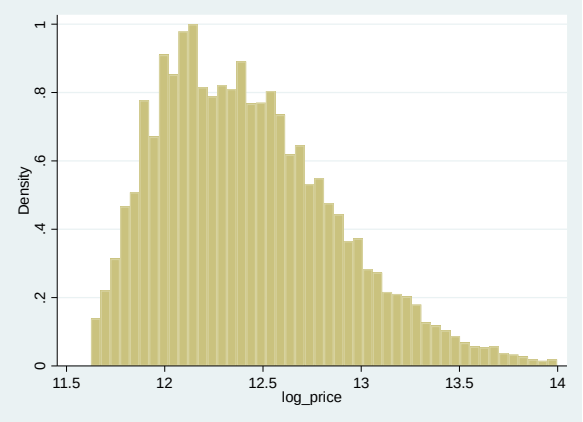
APPENDIX A: DATA PREPARATION

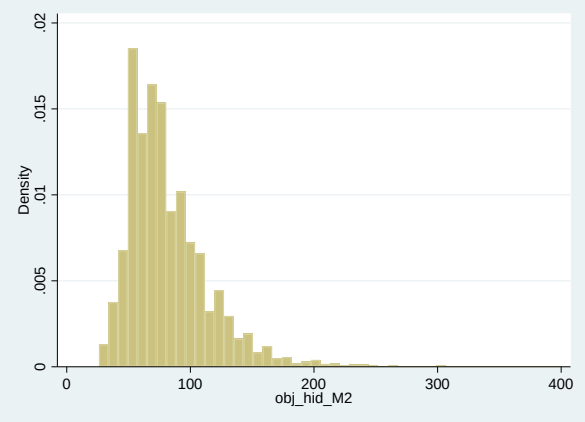
House price histogram:



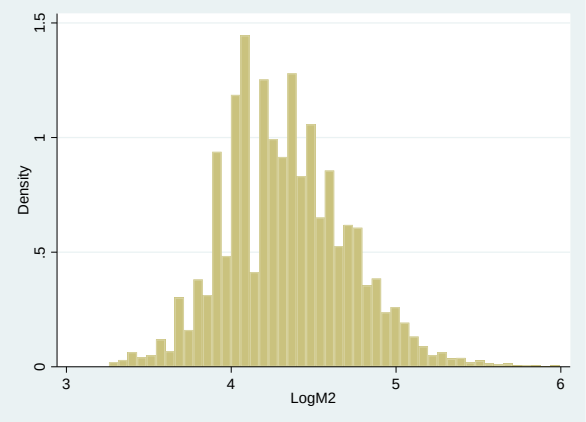
House price logarithm histogram:



M2 histogram:



M2 logarithm histogram:



Log Transformations:

Log van transactieprijs: gen LogTransactionPrice = log(obj_hid_TRANSACTIEPRIJS)

Log van m2: gen log_m2 = log(obj_hid_M2)

Excluding outliers:

Deleting missing data log_price:	drop if log_price == .
Drop cases with implausible number of rooms:	drop if Nrooms<=0
Drop if house type is not a regular house:	drop if Soorthuis==1
	drop if Soorthuis==2
	drop if Soorthuis==3
	drop if Soorthuis==4
Drop cases with implausible transaction prices:	drop if TransactionPrice<2500
	drop if TransactionPrice>2500000
Drop implausible M2:	drop if M2<1
Drop 1st and last percent LogPrice:	summarize LogTransactionPrice, detail
	keep if inrange(LogTransactionPrice, r(p1), r(p99))

Renaming (Translating)

rename obj_hid_NB Balcony

rename obj_prov_I obj_prov_ID

rename obj_hid_PO ojb_hid_ZipCode

rename obj_hid_M2 M2

rename obj_hid_HU HouseNumber

rename obj_hid__1 AdditionHouseNumber

rename obj_hid_CA Catergory

rename obj_hid_BW BuildingPeriod

rename obj_hid_PE Parcel

rename obj_hid_WO LivingArea

rename obj_hid_IN volume

rename obj_hid_IN volume

rename obj_hid_TY HousingType

rename Housetype Soorthuis

rename OpenbareRu Neighbourhood

rename obj_hid__2 HousingClass

rename obj_hid_ST obj_hid_STATUS

rename obj_hid_21 obj_hid_PERMANENT

rename obj_hid_ER obj_hid_ERFPACHT_TONEN

rename obj_hid_20 obj_hid_LIGDRUKW

rename obj_hid_19 obj_hid_LIGMOOI

rename obj_hid_18 obj_hid_LIGCENTR

rename obj_hid_IS obj_hid_ISOL

rename obj_hid_17 obj_hid_VERW

rename obj_hid_16 obj_hid_ONBU

rename obj_hid_ONBU MaintenanceOutside

rename obj_hid_ON MaintenanceInside

rename obj_hid_15 obj_hid_TUINAFW

rename obj_hid_TU obj_hid_TUINLIG

rename obj_hid_14 obj_hid_INPANDIG

rename obj_hid_PA Parking

rename obj_hid_13 BathroomsN

rename obj_hid_NW obj_hid_NWC

rename obj_hid_12 NBIJKEUK

rename obj_hid_11 KitchenN

rename obj_hid_10 NDAKTERRAS

rename obj_hid_ND NDAKKAP

rename obj_hid__9 WOONKA

rename obj_hid__8 PRAKTIJKR

rename obj_hid_VL VLIER

rename obj_hid_ZO ZOLDER

rename obj_hid_VT VTRAP

rename obj_hid__7 StoriesN

rename obj_hid_KW Quality

rename obj_hid_LI Elevator

rename obj_hid_OP OPENPORTIEK

rename obj_hid_NV NVMCIJFERS

```
rename obj_hid__6 DATUMAFMELDING
rename obj_hid__5 DATUMAANMELDING
rename obj_hid_VE VERKOOPCOND
rename obj_hid_PR PROCVERSCHIL
rename obj_hid_LA LAATSTVRKOOPPR
rename obj_hid_DA DATUMLAATSVRKOPER
rename obj_hid_OO OORSPRVRKOOPPR
rename obj_hid__4 SOORTWONING
rename obj_hid__3 SOORTAPP
rename obj_hid_KE KENMERKWONING
```

Generating housing characteristics dummies

```
gen InsideMaintenanceD = 0
replace InsideMaintenanceD = 1 if inlist(MaintenanceInside, 6, 7, 8, 9)
gen OutsideMaintenanceD = 0
replace OutsideMaintenanceD = 1 if inlist(MaintenanceOutside, 6,7,8,9)

gen Buidlingperiod1 = 0
gen Buidlingperiod2 = 0
gen Buidlingperiod3 = 0
gen Buidlingperiod4 = 0
gen Buidlingperiod5 = 0
gen Buidlingperiod6 = 0
gen Buidlingperiod7 = 0
gen Buidlingperiod8 = 0
gen Buidlingperiod9 = 0

replace Buidlingperiod1 = 1 if BuildingPeriod == 1
replace Buidlingperiod2 = 1 if BuildingPeriod == 2
replace Buidlingperiod3 = 1 if BuildingPeriod == 3
replace Buidlingperiod4 = 1 if BuildingPeriod == 4
replace Buidlingperiod5 = 1 if BuildingPeriod == 5
```

```
replace Buidlingperiod6 = 1 if BuildingPeriod == 6

replace Buidlingperiod7 = 1 if BuildingPeriod == 7

replace Buidlingperiod8 = 1 if BuildingPeriod == 8

replace Buidlingperiod9 = 1 if BuildingPeriod == 9


gen CentralHeatingD = 0

replace CentralHeatingD = 1 if obj_hid_VERW == 2

gen Apartment = 0
gen Cornerhouse = 0
gen SemiDetachedHouse = 0
gen DetachedHouse = 0

replace Apartment = 1 if inlist(NVMCIJFERS == 7,8,9,10)
replace Cornerhouse = 1 if NVMCIJFERS == 4
replace SemiDetachedHouse = 1 if NVMCIJFERS == 5
replace DetachedHouse = 1 if NVMCIJFERS == 6

gen ParkingD = 0
replace ParkingD = 1 if inlist(Parking, 2, 3, 4, 6, 8)

gen BalconyD = 0
replace BalconyD = 1 if inlist(Balcony, 1,2,3,4,5,6,7,8,9)
```

Generating key variables (before, during, after)

```
gen BeforeRedevelopment = 0
gen DuringRedevelopment = 0
gen AfterRedevelopment = 0

gen ControlGroup = 0
replace ControlGroup = 1 if Distance>1000

replace IDoffice = 1 if IDredevelopment==2
replace IDoffice = 2 if IDredevelopment==1
replace IDoffice = 3 if IDredevelopment==3
replace IDoffice = 4 if IDredevelopment==10
replace IDoffice = 5 if IDredevelopment==8
replace IDoffice = 6 if IDredevelopment==5
replace IDoffice = 7 if IDredevelopment==7
replace IDoffice = 8 if IDredevelopment==4
replace IDoffice = 9 if IDredevelopment==9
replace IDoffice = 10 if IDredevelopment==6


replace BeforeRedevelopment = 1 if year<2012 & IDoffice==1 & Distance<1000
replace BeforeRedevelopment = 1 if year==2012 & month<=5 & IDoffice==1 & Distance<1000
```

```
replace BeforeRedevelopment = 1 if IDoffice==2 & Distance<1000 & year<2017

replace BeforeRedevelopment = 1 if IDoffice==3 & Distance<1000 & year<2016

replace BeforeRedevelopment = 1 if IDoffice==4 & Distance<1000 & year<2016
replace BeforeRedevelopment = 1 if IDoffice==4 & Distance<1000 & year==2016 & month<=3

replace BeforeRedevelopment = 1 if IDoffice==5 & Distance<1000 & year<2016
replace BeforeRedevelopment = 1 if IDoffice==5 & Distance<1000 & year==2016 & month<=5

replace BeforeRedevelopment = 1 if IDoffice==6 & Distance<1000 & year<2016
replace BeforeRedevelopment = 1 if IDoffice==6 & Distance<1000 & year==2016 & month<=6

replace BeforeRedevelopment = 1 if IDoffice==7 & Distance<1000 & year<2014
replace BeforeRedevelopment = 1 if IDoffice==7 & Distance<1000 & year==2014 & month<=5

replace BeforeRedevelopment = 1 if IDoffice==8 & Distance<1000 & year<2015

replace BeforeRedevelopment = 1 if IDoffice==9 & Distance<1000 & year<2014
replace BeforeRedevelopment = 1 if IDoffice==9 & Distance<1000 & year==2014 & month<=4

replace BeforeRedevelopment = 1 if IDoffice==10 & Distance<1000 & year<2015

replace BeforeRedevelopment = 1 if IDoffice==11 & Distance<1000 & year<2013

replace DuringRedevelopment = 1 if IDoffice==1 & Distance<1000 & year==2012 & month>5
replace DuringRedevelopment = 1 if IDoffice==1 & Distance<1000 & year==2013 & month<=4

replace DuringRedevelopment = 1 if IDoffice==2 & Distance<1000 & year==2017 & month>=1 &
month<=7

replace DuringRedevelopment = 1 if IDoffice==3 & Distance<1000 & year==2016 & month>=1 &
month<=6

replace DuringRedevelopment = 1 if IDoffice==4 & Distance<1000 & year==2016 & month>3
replace DuringRedevelopment = 1 if IDoffice==4 & Distance<1000 & year==2017 & month<=3

replace DuringRedevelopment = 1 if IDoffice==5 & Distance<1000 & year==2016 & month>5

replace DuringRedevelopment = 1 if IDoffice==6 & Distance<1000 & year==2016 & month>6
replace DuringRedevelopment = 1 if IDoffice==6 & Distance<1000 & year==2017 & month<=3

replace DuringRedevelopment = 1 if IDoffice==7 & Distance<1000 & year==2014 & month>5
replace DuringRedevelopment = 1 if IDoffice==7 & Distance<1000 & year==2015 & month<=9

replace DuringRedevelopment = 1 if IDoffice==8 & Distance<1000 & year==2015 & month>=1 &
month <=6
```

```
replace DuringRedevelopment = 1 if IDoffice==9 & Distance<1000 & year==2014 & month>4 &
month <=10

replace DuringRedevelopment = 1 if IDoffice==10 & Distance<1000 & year==2015 & month>=1 &
month<=6

replace DuringRedevelopment = 1 if IDoffice==11 & Distance<1000 & year==2013

replace AfterRedevelopment = 1 if IDoffice==1 & Distance<1000 & year==2013 & month>4
replace AfterRedevelopment = 1 if IDoffice==1 & Distance<1000 & year>=2014

replace AfterRedevelopment = 1 if IDoffice==2 & Distance<1000 & year==2017 & month>7

replace AfterRedevelopment = 1 if IDoffice==3 & Distance<1000 & year==2016 & month>6
replace AfterRedevelopment = 1 if IDoffice==3 & Distance<1000 & year>=2017

replace AfterRedevelopment = 1 if IDoffice==4 & Distance<1000 & year==2017 & month>3

replace AfterRedevelopment = 1 if IDoffice==5 & Distance<1000 & year>=2017

replace AfterRedevelopment = 1 if IDoffice==6 & Distance<1000 & year==2017 & month>3

replace AfterRedevelopment = 1 if IDoffice==7 & Distance<1000 & year==2015 & month>9
replace AfterRedevelopment = 1 if IDoffice==7 & Distance<1000 & year>=2016

replace AfterRedevelopment = 1 if IDoffice==8 & Distance<1000 & year==2015 & month>6
replace AfterRedevelopment = 1 if IDoffice==8 & Distance<1000 & year>=2016

replace AfterRedevelopment = 1 if IDoffice==9 & Distance<1000 & year==2014 & month>10
replace AfterRedevelopment = 1 if IDoffice==9 & Distance<1000 & year>=2015

replace AfterRedevelopment = 1 if IDoffice==10 & Distance<1000 & year==2015 & month>6
replace AfterRedevelopment = 1 if IDoffice==10 & Distance<1000 & year>=2016

replace AfterRedevelopment = 1 if IDoffice==11 & Distance<1000 & year>2013

gen before250 = 0
gen before500 = 0
gen before 750 = 0
gen before 1000 = 0
gen during250 = 0
gen during500 = 0
gen during750 = 0
gen during1000 = 0
gen after250 = 0
gen after500 = 0
gen after750 = 0
gen after1000 = 0

replace before250 = 1 if BeforeRedevelopment==1 & Distance<250
```

replace before500 = 1 if BeforeRedevelopment==1 & Distance<500 & Distance>=250
replace before750 = 1 if BeforeRedevelopment==1 & Distance<750 & Distance>=500
replace before1000 = 1 if BeforeRedevelopment==1 & Distance<1000 & Distance>=750

replace during250 = 1 if DuringRedevelopment==1 & Distance<250
replace during500 = 1 if DuringRedevelopment==1 & Distance<500 & Distance>=250
replace during750 = 1 if DuringRedevelopment==1 & Distance<750 & Distance>=500
replace during1000 = 1 if DuringRedevelopment==1 & Distance<1000 & Distance>=750

replace after250 = 1 if AfterRedevelopment==1 & Distance <250
replace after500 = 1 if AfterRedevelopment==1 & Distance <500 & Distance>=250
replace after750 = 1 if AfterRedevelopment==1 & Distance <750 & Distance >=500
replace after1000 = 1 if AfterRedevelopment==1 & Distance<1000 & Distance>=750

model 1
reg LogTransactionPrice BeforeRedevelopment DuringRedevelopment AfterRedevelopment i.year

model 2
reg LogTransactionPrice BeforeRedevelopment DuringRedevelopment AfterRedevelopment LogM2 Nrooms InsideMaintenanceD OutsideMaintenanceD Buidlingperiod1 Buidlingperiod2 Buidlingperiod3 Buidlingperiod4 Buidlingperiod5 Buidlingperiod6 Buidlingperiod7 Buidlingperiod8 Buidlingperiod9 CentralHeatingD ParkingD BalconyD Cornerhouse SemiDetachedHouse DetachedHouse Apartment i.year

model 3
areg LogTransactionPrice BeforeRedevelopment DuringRedevelopment AfterRedevelopment LogM2 Nrooms InsideMaintenanceD OutsideMaintenanceD Buidlingperiod1 Buidlingperiod2 Buidlingperiod3 Buidlingperiod4 Buidlingperiod5 Buidlingperiod6 Buidlingperiod7 Buidlingperiod8 Buidlingperiod9 CentralHeatingD ParkingD BalconyD Cornerhouse SemiDetachedHouse DetachedHouse Apartment i.year, robust absorb(Neighbourhood)

model 4
areg LogTransactionPrice before250 before500 before750 before1000 during250 during500 during750 during1000 after250 after500 after750 after1000 LogM2 Nrooms InsideMaintenanceD OutsideMaintenanceD Buidlingperiod1 Buidlingperiod2 Buidlingperiod3 Buidlingperiod4 Buidlingperiod5 Buidlingperiod6 Buidlingperiod7 Buidlingperiod8 Buidlingperiod9 CentralHeatingD ParkingD BalconyD Cornerhouse SemiDetachedHouse DetachedHouse Apartment i.year, robust absorb(Neighbourhood)

gen LargeSize = 0

gen MediumSize = 0

gen SmallSize = 0

replace LargeSize = 1 if inlist (IDoffice, 5, 11)

replace MediumSize = 1 if inlist(IDoffice, 2, 3, 4, 7, 9)

replace SmallSize = 1 if inlist(IDoffice, 1, 6, 8, 10)

Model 5,6,7,8,9 (run in separate groups)

areg LogTransactionPrice BeforeRedevelopment DuringRedevelopment AfterRedevelopment LogM2 Nrooms InsideMaintenanceD OutsideMaintenanceD Buidlingperiod1 Buidlingperiod2 Buidlingperiod3 Buidlingperiod4 Buidlingperiod5 Buidlingperiod6 Buidlingperiod7 Buidlingperiod8 Buidlingperiod9 CentralHeatingD ParkingD BalconyD Cornerhouse SemiDetachedHouse DetachedHouse Apartment i.year, robust absorb(Neighbourhood)

APPENDIX B: DATA MUNICIPALITY OF AMSTERDAM

The data on the redevelopment projects which took place in the city of Amsterdam from the year 2012 is publicly available and can be downloaded through the link below.

Website: https://maps.amsterdam.nl/leegstand_transformatie/

APPENDIX C: ADDITIONAL INFO SELECTED REDEVELOPMENT PROJECTS

Redevelopment projects Amsterdam.

Address	N of units	Start C.	End C.	Type
1. Bos en Lommerplantsoen 1	651	05-2012	04-2013	Student housing
2. Hilversumstraat 316-340	75	01-2017	07-2017	Apartments
3. Koningin Wilhelminaplein 18	129	01-2016	06-2016	Student housing
4. Linnaeusstraat 35F	89	03-2016	03-2017	Apartments
5. Mauritskade 17A	23	05-2016	12-2016	Apartments
6. Molenwerf 1-10	185	01-2013	01-2014	Apartments
7. Ottho Heldringstraat 41	65	06-2016	03-2017	Apartments
8. Sara Burgerhartstraat 25	224	05-2014	09-2015	Student housing
9. Tourniairestraat 1	140	01-2015	06-2015	Student housing
10. Van Heenvlietlaan 220	354	04-2014	10-2014	Apartments
11. Weesperzijde 99A	22	01-2015	06-2015	Apartments

1: Bos en Lommersplantsoen 1

https://www.amsterdamwoont.nl/nieuwbouwprijs/amsterdamse-nieuwbouwprijs-2014/studio-gak-noordvleugel/

https://www.arcam.nl/gak-de-studio/

2: Hilversumstraat 316-340

https://www.transformatieteam.nl/contact/

3: Koningin Wilhelminaplein 18

https://www.at5.nl/artikelen/160156/studenten_klagen_over_

4: Linnaeusstraat 35F

https://www.bouwbedrijfleda.nl/projecten/transformatie/linnaeusstraat-amsterdam/

5: Mauritskade 17A

https://www.duravermeer.nl/nieuws/jongeren-en-statushouders-samen-in-de-maurits

6: Molenwerf 1-10

https://kow.nl/projecten/transformatie-de-westerhoek-amsterdam/

7: Ottho Heldringstraat 41

https://www.sociuswonen.nl/projecten/wonen-op-de-hoek/

8: Sara Burgerhartstraat 25

https://daf9627eib4jq.cloudfront.net/app/uploads/2017/01/attachment-iergebouw-_knevelarchitecten.pdf

9: Tourniairestraat 1

https://www.gebouwdin.amsterdam.nl/main.asp?action=display_html_pagina&name=detailpagina&booMarge=-1&item_id=1503

10: Van Heenvlietlaan 220

https://www.kondorwessels-amsterdam.nl/nl/projecten/detail/verbouw-van-heenvlietlaan-220-amsterdam

11: Weesperzijde 99A

http://www.mariheijmans.nl/in-uitvoering/