Does the development of industrial sites influence the price of residential properties?

Evidence for the Netherlands

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ABSTRACT

Since 2008, industrial property prices have risen, and construction has increased. Combined with the high and still increasing density in the Netherlands, this leads to industrial properties to be located closer to residential areas than would be preferred. Therefore, I estimate the effects of the new development of these industrial sites on prices of existing houses in the vicinity. To do this, I use a hedonic pricing model, combined with a difference-in-difference approach, and I control for property characteristics, location characteristics, transaction characteristics and characteristics of the industrial sites. I find that, in contrary to expectations due to existing studies on industrial sites in the Netherlands, the development of these new industrial sites has a significant positive effect on nearby house prices. This would suggest that the planning policies of the Dutch municipalities ensure that no negative externalities arise and that new industrial sites which increase economic activity may increase house prices.

Keywords: Industrial sites, Hedonic price models, House prices, Difference-in-difference, Netherlands

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1. INTRODUCTION

1.1 Motivation

Industrial real estate prices in The Netherlands are booming. Prime rents have risen, while the prime yields compressed to 4%, from 8% in 2012 (Cushman & Wakefield, 2021). Since 2018 industrial property has seen historically high levels of take up of 2.3 (2018) and 2.2 (2019) million square metres, and the construction of new industrial property has since been on the rise (CBRE, 2020). This upswing in demand, combined with the fact that The Netherlands also has one of the highest population densities in the world (Worldbank, 2019), may lead to new industrial real estate to be located in the proximity of residential areas. This is what, among others, happened to families in the Dutch Dordrecht, where a new industrial site was developed right in their backyard (AD, 2020).

These industrial sites are very important in the economic development of the Netherlands. The employment on industrial sites accounts for a great share of the employment of the Netherlands, up to approximately one-third of the country's share in 2006 (Weterings et al., 2008). Companies settle on these industrial sites because it benefits them, as companies who settle on industrial sites grow faster (Louw and Bontekoning, 2007), and because zoning policies are very strict in the Netherlands and there are not many alternatives. The development and allocation of industrial sites takes time and once developed it often is a near permanent allocation of the land (Beckers and Schuur, 2015). Therefore, policy makers need to have a clear image of the forecast in demand and the externalities caused by such planning and development decisions.

The development of these industrial sites may pose disamenities for residential areas nearby due to external effects like air and noise pollution. This is because of the industrial nature of the companies that will locate on these industrial sites and the associated negative external effects such as pollution that come with the industrial character. On the other hand, positive effects may arise as well, for example through an improvement in infrastructure to account for the traffic that will come with the industrial site, or a surge in economic activity and demand for (non)skilled workers.

Overall, over 300 industrial sites have been developed in The Netherlands since 2008 (IBIS, 2021). Due to zoning regulations in The Netherlands not all these industrial sites will end up near residential areas. The Dutch zoning policy has determined environmental zones to indicate expected external effects and the required buffer between these industrial sites and residential areas, ranging from 1 to 6. I will elaborate on the zoning policies in section 3. I only use industrial sites with a minimum environmental zone of 4 to analyse external effects. The Dutch zoning policies should ensure no negative external effects should occur when an industrial site is developed near residential areas, however, it has shown that house prices are affected by existing industrial sites (De Vor and De Groot, 2011). This raises the question what implications the development of new industrial sites has for neighbouring residential areas. To analyse these effects, I will study house transactions in the proximity of newly developed industrial sites in the Netherlands. In the end, I use industrial sites developed between 2010 and 2014, consisting of environmental zone 4 and 5 and house transactions in the same period on the municipal level of the industrial sites.

1.2 Literature review

The effects of amenities on house prices have been researched widely (Kohlhase, 1991; Hite et al., 2001; Kiel and Zabel, 2001; Kaufman and Cloutier, 2006; Farber, 1998; Visser and Van Dam, 2008; De Vor and De Groot, 2011). Farber (1998) summarizes the effects of undesirable facilities on property values. The undesirable facilities range from health risks to public images of the neighbourhood. Farber (1998) finds that facilities that pose a health risk or amenity risk on surrounding communities result in a declining value of houses in the area. The value will decline when the distance to these facilities decreases.

Neighbourhood characteristics also have an impact on house prices. Visser and Van Dam (2008) study the effects of environmental characteristics in the neighbourhood on residential property value variation in the Netherlands. They consider characteristics within the close proximity (50 metres) such as public parks, the quality of buildings, open space and industrial lands. The study uses a hedonic model that uses price per square meter and compares these across different residential environment characteristics. The study finds that houses in green, open areas are valued significantly higher. Conversely, prices of houses that are in the proximity of disamenities, which can be industrial lands or highways, are affected negatively. The effects of industrial lands on house prices are researched more in depth by De Vor and De Groot (2011). They estimate the impact of distance to industrial sites on residential property values for the Randstad and Noord-Brabant. A hedonic price function is used, using distances to nearest industrial site. They find that the presence of an industrial site has a significantly negative effect on the price of houses nearby.

Industrial sites can also have positive externalities for houses in the vicinity. These effects have been studied in more detail for the market in the United States by O'Keefe (2004) and Ham et al. (2011; 2018) where they estimate the impact of Enterprise Zones (EZs) on property values. They find that properties in the vicinity of EZs can sell for more than 10% more than properties not in the vicinity of these EZs. An important note, however, is that Enterprise Zones are focused on the market in the United States. As zoning policies are less strict in the United States, industrial real estate does not have as clear restrictions as to where they can locate as in the Netherlands. Therefore, Enterprise Zones are the closest comparison to industrial sites as we know them in The Netherlands.

These studies all examine the effect of existing facilities on house prices. There is limited research concerning the effect of new industrial sites on nearby existing residential properties except for the work of Currie et al. (2015). Their research focuses on the opening and closing of toxic plants nearby houses and the effect on the prices of these houses in the United States. The study shows that houses within one mile tend to decrease by 11 percent when the plants open and increase by 1.5 percent when the plants close. Unlike the studies focused on the Netherlands, the study by Currie et al. (2015) focuses on plants with clear health and safety risks for the environment, which will not be the case for all industrial sites in the Netherlands.

1.3 Research problem statement

I will build upon the effects of industrial sites on house prices, studied by De Vor and De Groot (2011). However, different to De Vor and De Groot (2011), I will use a difference-in-difference approach to study the effect of development of new industrial sites on existing residential areas nearby, instead of existing industrial sites on residential areas. Currently, there is little research that studies the effect of new development of industrial sites on the house prices of existing residential areas. As priory mentioned, the study by Currie et al. (2015) has shown that development of disamenities, albeit of another kind, does have a negative effect on prices of existing properties. With the development of over 300 industrial sites since 2008 in the Netherlands (IBIS, 2021), and the still growing industrial property market in the Netherlands (CBRE, 2020), this will be interesting to study, and the results of this study may bring external effects to light that not yet have been considered.

The primary research aim of this study is to get a better understanding of how home purchasers perceive the development of industrial sites. Therefore, my central research question will be: *What is the effect of the development of industrial sites on nearby house prices?*

The potential effect of the development of such sites is estimated from the difference in purchase prices of nearby residential properties before and after development and inside and outside of the target area of the industrial sites making use of hedonic models. These hedonic models may give an insight in the implications of the development of industrial sites on housing prices, making my primary research question: *What impact does the development of industrial sites have on the prices of nearby houses?*

Rosen, in 1974, introduced a hedonic model that uses the housing prices as a bundled good and makes it possible to disentangle house prices into different locational and structural characteristics. All characteristics are given weight, and the hedonic model will determine the weight. I will use the development of industrial sites as a dummy variable in this hedonic model to compare the price levels of target groups and control groups. The target group consists of the houses sold in the proximity of these industrial sites after the development, and the control group is the houses sold before this development and the houses sold in the region of the development but not in the target area. I will consider whether prices after development significantly change from before the development. I expect the disamenities to have a negative effect on the location factors of the property and the location factors to have a positive effect on demand in houses, which has a positive effect on house prices.

Furthermore, I will estimate the extent to which the development of the industrial site will influence the nearby housing prices. To study the extent of the potential externality effect of industrial sites on the prices of nearby houses, I will use a multiple regression analysis. I use a hedonic pricing model and use dummy variables as spatial controls. I will compare the prices of houses and will control for building year, living area, plot size and the type of house. The spatial extent of this potential externality effect is unknown and thus I will use target areas up to a relatively large treatment range of 2 kilometers, similar to Daams et al. (2019), Schwartz et al. (2005) and Brooks and Lutz (2019) and will allow for these effects to vary across space within these parameters. I will use a difference-in-differences method, similar to Zhang et al. (2019), using the house sales within these parameters as the target group and the sales of houses outside of this area as the control group. The second difference will be before the development and after the development. For the data input, I will use the NVM database for the house sales and access the IBIS database for the location and development year of the industrial sites.

My second research question will be: *What is the effect of the intensity of allowed industry on residential house prices?* In my analysis I will use industrial sites with different environmental zones, indicating the intensity of business that is allowed to be conducted. I will compare the effects of different environmental zones to estimate if there is a difference in the impact on house prices in the vicinity. The effects measured by this will be included in the location amenities in the conceptual model as there are possible heterogeneous effects for different environmental zones.

My third research question will be: *What is the effect of the development of industrial sites on house prices in different areas?* In my analysis, I will differentiate between rural and peripheral areas, and I will compare the results to see whether the effects of the development of industrial sites are heterogeneous between the two areas. Studies by Daams et al. (2019), Visser and Van Dam (2008), and De Vor and De Groot (2011) have all found heterogeneous effects between rural and peripheral areas. Therefore, heterogeneous effects can be expected.

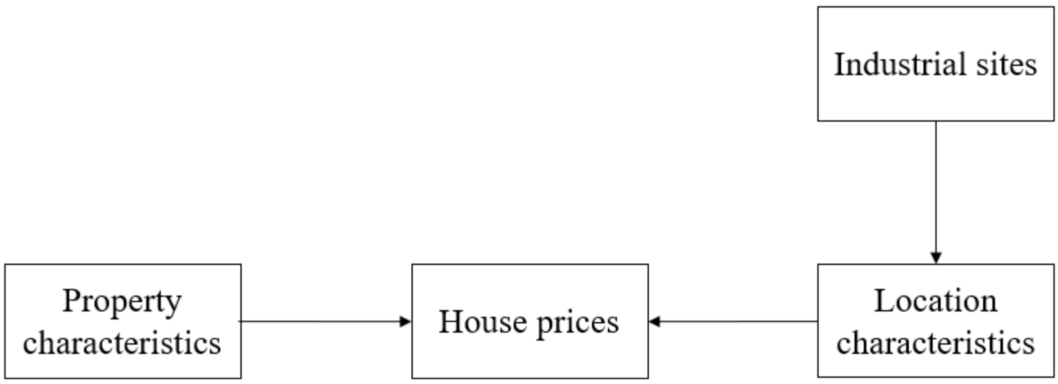

Figure 1. Conceptual model explaining the relationship of property characteristics and location characteristics, including nearby industrial sites, on house prices.

The remainder of this paper is organized as followed. Section 2 describes the theoretical background of (dis)amenity effects, industrial lands, and development effects to support my hypothesis'. Section 3 will introduce the data and the methodology I use in my analysis and show the descriptive statistics, and section 4 will present the outcome of the results. In section 5 I propose various sensitivity analyses and in section 6 I will discuss the outcomes of the results and sensitivity analyses. Section 7 concludes.

2. THEORY

2.1 Buyers' willingness to pay and house value

To study the impact of (negative) externalities, hedonic price models are proposed (Rosen, 1974). The work of Rosen provides a theoretical foundation for the way heterogeneous goods are priced. For the market value of properties consider $P = f(Z)Z$ where P is the price of a certain property, that is determined by the characteristics, Z, of the property, where location amenities such as industrial sites also are considered. The vector of prices corresponding to Z is given by $f(Z)$ where economies of scale and complementarities between the attributes of property X make that f depends on Z. The assumption for the model $P = f(Z)Z$ is that both f and Z are well known by all parties. This will be the case when markets are transparent, and the attributes of X are traded directly. Harding et al. (2003) discuss that f still holds when markets are sufficiently thick, even when markets are not transparent the attributes of X are not traded directly. With thick markets, in equilibrium $X(Z_1|Z_2)$, where Z_1 is a single attribute of property X and Z_2 are all other attributes, is traded between the highest bid of the buyer and the lowest offer of a seller where the lowest offer of a seller is the lowest willingness to sell. This suggests that the shadow price of Z_1 is well defined and is given by $f(Z_1|Z_2)=\delta X(Z_1|Z_2)/\delta Z_1$.

2.2 Time-constant amenity effects

Heterogeneity in properties and property prices may come from time-constant amenities, either positive or negative, in the proximity. First, the positive effects. Amenities in the proximity of residential properties may influence the house values and result in higher values. A positive effect can be caused by the proximity of natural amenities (open spaces, parks, and green spaces) in low density areas, and natural amenities such as natural parks and open space increase the value of houses in the area (Visser and Van Dam, 2008). The quality of the parks here also has an impact on the effect on house values. The study by Rouwendal and Van der Straaten (2008) considers parks in various cities in the Randstad in The Netherlands and find that the least impact of the parks is measured in Amsterdam, where the quality of the parks is also the lowest.

Industrial sites can have positive effects on surrounding residential areas (De Vor and De Groot, 2011). Infrastructure in the area will improve, and the industrial site will increase economic activities and consequently occupational demand. These effects are theoretical, but no empirical evidence is found. In the United States, these effects are, however, found for Enterprise Zones (EZ). These EZ's are created to agglomerate businesses and create values and jobs in the surrounding areas (O'Keefe, 2004). The difference with the Netherlands is that the businesses on these EZ's are also allowed to establish on other lands but are incentivized with subsidies to locate on these EZ's. In the Netherlands industrial activities are only allowed to be conducted on industrial sites and the nature of the industry is also often more polluting than the businesses located on these EZ's. However, the effect of an increase in economic activity still holds and businesses that in the United States will locate on EZ's will also locate on industrial sites in the Netherlands, along with other industrial real estate. The areas surrounding these EZs profit from the establishment of the enterprise zones. Among these effects is a significant growth of jobs, a significant decline in unemployment and a decline in poverty rates (O'Keefe, 2004; Couch et al., 2005; Busso et al., 2013; Ham et al., 2011; Ham et al,. 2018).

The occupational demand, which can be caused by industrial sites or EZs, will lead to higher house prices. People base their location decision mainly on the accessibility of jobs, as transport costs are considered and capitalized into house prices (Alonso, 1964; Brueckner, 1987). The public and private investments made to construct industrial sites even capitalize more pronounced in house prices in areas with strict regulatory constraints (Hilber, 2017). As the Netherlands has very strict regulatory constraints with zoning policies, the increases in occupational demand due to industrial sites can be expected to capitalize into house prices.

Secondly, negative effects will also affect house prices. Whereas amenities may bring positive effects, disamenities can bring negative effects. Undesirable facilities that are expected to impose health- and amenity risks will result in lower house values in the surrounding area (Farber, 1998). The negative effects on house values diminish with increasing distance, so that properties that are located further away from the negative externalities have a higher property value than properties in the proximity of these facilities. For example, waste facilities, landfills and hazardous manufacturing facilities reduce property values in the vicinity. The impact of these facilities is heterogeneous across different areas, where the effect is stronger in thin housing markets of rural areas than in urban areas, which can be explained by the existing diversity of a city. In a city, high density areas reduce house values and the presence of disamenities, such as industrial land or highways, reduce house values (Visser and Van Dam, 2008). Noise pollution is another factor that can cause lower house values (Dekkers and Van der Straaten, 2009). The effect of aircraft noise pollution in the area around Schiphol Airport on house prices shows a reduction in house values in the area compared to houses not located in the Schiphol area. The noise pollution controls for all other sources of traffic noise and aircraft noise pollution shows the largest negative effect.

Although De Vor and De Groot (2011) indicated that industrial sites can in principle have positive effects, they find that the proximity to industrial sites has a statistically significant negative effect on house prices. Houses in the Netherlands, more specifically the Randstad area and the province of Noord-Brabant, located within 1093 meters of an industrial site, have a lower value due to the negative externalities of living in the proximity of these industrial sites. These externalities have a strong negative effect on the house values within the proximity of 1093 meters but beyond this point the effect concavely decreases until the price differences fade out. This concludes the amenity effects; an overview of the amenity effects can be found in table 1.

Table 1. Summarizing amenity effects on property prices

Author and year	Amenity effect on house prices	+/-
Debrezion et al. (2007)	Railway stations	+
Dekkers and Van der Straaten (2009)	Airports	-
Farber (1998)	Health- and safety risks	-
O'Keefe (2004)	Enterprise Zones	+
Rouwendal and Van der Straaten (2008)	Open parks	+
Visser and Van Dam (2008)	Natural amenities	+
De Vor and De Groot (2011)	Industrial lands	-

Note: Table summarizes all literature used on amenity effects, with the amenity mentioned and the found effect.

2.3 Effect of opening of new industrial sites

Amenity effects also occur when these are not consistent through time but change over time. The development or redevelopment of amenities in the vicinity can affect house prices. A positive effect on house values is found when inner-city shopping centers are redeveloped near residential areas (Zhang et al., 2019). Using a difference-in-differences method, properties are compared whether they are located near the redevelopment and whether a redevelopment has occurred. Whenever a redevelopment has taken place, properties near the shopping center increase on average by 1.43% just after development.

Consistent with the effects of existing Enterprise Zones, a positive effect on house prices exists when an Enterprise Zone is developed. When an Enterprise Zone is established, prices of neighboring properties can increase from a low of 20% to a high of 60% (Krupka and Noonan, 2009), or increase by as much as $100,000 (Hanson, 2009). The reason for this increase in house prices is largely attributed to business activity and economic growth (Krupka and Noonan, 2009). Large elasticities are found between the incentives of Enterprise Zones and business activity (Bartik, 1991).

There are also negative effects on house prices when the disamenity has an industrial character. When a toxic plant is developed and opened, house values in the proximity of these developments decrease (Currie et al., 2015). Currie et al. (2015) find that external effects such as toxic air pollutants can last up to 1 mile from the plant. House prices are significantly negatively affected by the opening of these plants, such that when a plant opens, the house prices in the vicinity decrease with approximately 11%. However, house prices are largely unaffected when a plant closes, suggesting that health risks still continue to influence house prices. The externalities caused by toxic sites are however more severe than with other papers on industrial real estate such as De Vor and De Groot (2011) or Enterprise Zones (O'Keefe, 2004; Couch et al., 2005; Busso et al., 2013; Ham et al., 2011; Ham et al., 2018). Also, different to De Vor and De Groot (2011), the paper by Currie et al. (2015) considers the openings and closings of industrial sites, which give a much clearer image of the effect of the (dis)amenity effects as it ensures less omitted variables are considered.

While enterprise zones and transport related amenities can have a positive effect on house prices (O'Keefe, 2004; Debrezion et al., 2007; Hanson, 2009; Krupka and Noonan, 2009). I expect the effect of negative externalities caused by the noise pollution (Dekkers and Van der Straaten, 2009) and effects of industrial sites found by De Vor and De Groot (2011) to have a stronger impact on the effect of development of industrial sites on nearby house prices. Therefore, in my analysis I expect the development of new industrial sites to have a negative effect on house prices in the proximity.

3. DATA & METHOD

3.1 Land use planning context

Planning and development of industrial sites in the Netherlands is determined by the zoning of the municipality. As the Netherlands is densely populated, the development of these industrial lands can take up to several years and to ensure that no shortages in industrial land will exist, spatial planners are provided with the *Bedrijfslocatiemonitor* (BLM) to have a clear idea of future demand for industrial land on account of production activity (CPB, 2002). The BLM provides forecasts from data for industrial sites and office space. The BLM does this with a model based on three variables. First, the growth rate of employment, based on CPB-scenarios of the long-term economic development. Second, assumptions about the future relation between employment and industrial sites. And third, assumptions about the development of use of space per employee. If the BLM subsequently indicates that more industrial land is needed, municipalities will change the zoning policies of the areas they deem fit for industrial land, which are subject to complaints from surrounding neighborhoods (Louw and Bontekoning, 2007). This should reduce negative externalities for surrounding neighborhoods. Additionally, as in many other Western countries, post-war spatial planning focuses on single-function approaches (De Vor and De Groot, 2011). This results in large-scale areas being assigned a single function such as industrial, retail, farming, or housing. These single function areas will then often be separated by open space buffers between the functions. However, as cities are expanding due to the rising density in the Netherlands (Worldbank, 2019), these buffers may fade, and industrial sites will locate closer to residential areas.

The space needed between industrial sites and residential or mixed-use areas are indicated with the classification of environmental zoning (milieuzonering) assigned to every industrial site ranging from 1 to 6. Industrial sites with an environmental zone of 1 can be located from 10 meters of a residential area and industrial sites with an environmental zone of 6 cannot be located closer than 1.500 meters from a residential area. These environmental zones are based on the activities that can be conducted in the area and are based on the negative externalities that they bring, such as noise, smell, dust, and external safety. In my analysis, I include industrial sites with environmental zones 4 and 5. In practice, this means that there needs to be at least 200 meters between the industrial site and a residential area and 100 meters between an industrial site and a mixed area. With regards to noise, this translates to an allowed 55 decibel at 50 meters from the edges of the industrial site.

Industrial sites however do not only bring negative externalities, but they are also considered as a vital part of the local economic policies of local authorities (Louw and Bontekoning, 2007). Consequently, local authorities ensure that enough industrial land is provided for immediate sale when interested parties enquire to the local authorities. This makes that approximately 74% of total area of industrial land is supplied by local authorities (Segeren et al., 2005; Louw and Bontekoning., 2007). These policies have resulted in an increase in industrial sites from 3,544 in 2007 to 3,885 in 2021. In total, 3,163 hectares of industrial sites have been added to the stock of the Netherlands since 2007.

3.2 Data

The data I use in this study comes from two sources. First, the data of industrial sites in the Netherlands comes from the Dutch Industrial Sites Database, IBIS (Integraal Bedrijventerrein Informatie Systeem), which is owned by Interprovinciaal Overleg, an independent association representing the 12 provinces of the Netherlands. The database contains information on the characteristics of the industrial sites in terms of size, environmental permits, and plot issuance. Second, the property sales data is provided by the Dutch Association of Real Estate Agents, NVM (Nederlandse Coöperatieve Vereniging van Makelaars), which covers approximately 70% of total residential transactions in the Netherlands. The database contains detailed information about the properties, including asking price, transactions price, type of property, floor space, plot size, year built, and so on.

In my analysis, I combine the two datasets. Both the databases are geo-referenced, this means that by using geographical information systems (GIS) techniques, I can merge the datasets and calculate distances between the transactions and the polygons of the industrial sites. The polygons of industrial sites are drawn in GIS based on their actual size and location, and they reduce measurement error in the distance calculation, this is particularly important as industrial sites are often large.

The selection of the industrial sites is based on the following criteria: First, the IBIS database contains 71 industrial sites that have started development in the period of 2008 to 2018 and I excluded all industrial sites with an environmental zoning (*milieuzone*) of less than 4. Environmental zones with a zoning of 3 or less are expected not to cause extreme externalities and can therefore be located within 100 meters of a residential area. Consequently, I decided to only use industrial sites with an environmental zone of 4 or higher. The IBIS database also includes plans for industrial sites where most development has not started yet but zoning has been determined for the area. Therefore, I have decided to drop the industrial zones of insignificant size, less than 10 hectares of development, and only include industrial size where more than 10 hectares has been developed. Lastly, I excluded all cases that did not have residential areas within the target area of 2,000 meters, as these industrial sites would not have any effect on the outcome of my results. This results in 11 industrial sites developed between 2010 and 2014 with an average developed area of 21.47 hectares, eight industrial sites have an environmental permit of 4 and the other three industrial sites have an environmental permit of 5, an overview of the industrial sites can be seen in table 2. A map of all industrial sites can be found in Appendix A. Figure A1 in Appendix A also shows that the industrial sites in Nieuwegein and Vianen overlap in their target areas. Both industrial sites have started development in 2010, therefore I expect that the target areas still hold.

Table 2. Industrial sites

Industrial site	City	Hectare built	Hectare site	Start year	Environmental zone
Het Klooster	Nieuwegein	33.78	105	2010	4
Gaasperwaard	Vianen	18.43	33	2010	4
Dallen II	Veendam	13.08	33	2010	4
De Copen	Lopik	25	35	2011	4
DocksNLD	’s-Heerenberg	10.68	34.77	2012	4
Poort van Dronten	Dronten	11.90	108	2011	5
Businesspark ML	Echt-Susteren/Sint Joosten	34.38	47.48	2013	4
Kempisch Bedrijventerrein	Hapert	39.64	106.18	2010	4
Reg. Bedrijvenpark Laarakker	Haps	18.62	57.53	2012	5
Afbouw Haven	Waalwijk	11.20	37	2014	5
Businesspark Aviolanda	Hoogerheide	20.44	29	2011	4

Note: These are the 11 industrial sites that I have used in my analysis. They are constructed between 2010 and 2014, have a developed area of 11.20 to 39.64 hectares and have an environmental zone of 4 or 5.

The selection of residential transactions is based on the following: First, I have excluded the 1st and 99th percentile of the absolute sales price and of the price per square meter to exclude outliers in the data. I have included sales that are in the proximity of the development of industrial sites and that have been sold in the two years prior to, and two years after the year of development of the industrial site. This results in a total number of transactions of 8,045. The database featured 14 different house types. I have categorized them into four types, based on similarities in types and statistics. The four types now are apartments, detached houses, townhouses, and one-family homes.

A summary of the descriptive statistics of the transactions of residential properties used in my analysis is shown in table 3. As shown, my analysis covers a wide range of residential properties, ranging from 25 square meters to 400 square meters and sold from €87,000 to €635,000. The average floor space is 120 square meters with a standard deviation of 35.32, and the average transaction price is €217,000 with a standard deviation of €85,339. Sales of the properties range from 2007 to 2016, and as shown, approximately 57% of sales happened after redevelopment. 7.3% of sales have occurred within 1 km of the development and 33.2% of sales have occurred within 2 km of the development. An overview of observations per industrial site ex ante and ex post can be found in table 4.

Table 3. Descriptive statistics residential transactions

	Observations	Mean	Sd	Min	Max
Property characteristics					
Price (EUR, absolute)	8,045	217,100	85,339	87,000	635,000
Price (EUR, per square meter)	8,045	1,789	456	816	3333
Living area (in square meters)	8,045	120	35.32	25	400
Plot size (in square meters)	8,045	288	448	0	5710
Building period					
1500-1905	175	0.02			
1906-1930	348	0.04			
1931-1944	156	0.02			
1945-1959	335	0.04			
1960-1970	1,324	0.16			
1971-1980	2,362	0.29			
1981-1990	1,459	0.19			
1991-2000	1,137	0.14			
> 2001	749	0.09			
House type					
Apartments	1,558	0.19			
Detached	553	0.07			
Townhouses	296	0.04			
One family house	5,638	0.70			
Industrial site characteristics					
Distance to industrial site	8,045	3,274	2,687	158.34	17,143
After development (1=Yes)	8,045	0.57	0.49	0	1
Distance within 1 km (1=Yes)	8,045	0.07	0.26	0	1
Distance within 2 km (1=Yes)	8,045	0.33	0.47	0	1

Note: The total 8,045 observations are split in 9 building periods, 4 house types, and 57% is sold after development and 33% is sold in the target area.

Table 4. Observations per industrial site, before and after development

Industrial site	Observations	
	Ex ante	Ex post
Het Klooster	1,116	1,047
Gaasperwaard	262	259
Dallen II	389	357
De Copen	78	138
DocksNLD	267	502
Poort van Dronten	497	611
Businesspark ML	102	209
Kempisch Bedrijventerrein	166	279
Reg. Bedrijvenpark Laarakker	197	335
Afbouw Haven	310	741
Businesspark Aviolanda	67	116

Note: Although differences in observations per industrial site, sufficient observations are found both ex ante and ex post every development.

3.3 Hedonic regression model

To conduct my analysis, I use a hedonic pricing model to estimate the relationship between new development of industrial sites and house prices. The dependent variable is the log of the transaction price. The model is as follows:

$$log(P_i) = \beta_0 + \beta_1 LivingArea_i + \beta_2 PlotArea_i + \textstyle\sum_{p=2}^{4} \beta_p PropertyType_{ip} +$$
$$\textstyle\sum_{T=2}^{9} \beta_T BuildingPeriod_{iT} + \sum_{t=2}^{10} \beta_t SaleYear_{it} + \sum_{c=2}^{54} \beta_c City_{ic} + \mathcal{E}_i \qquad (1)$$

In the regression specifications of this study, *i* represents the specific property, β_0 represents the constant and all other β's represent the parameters that are to be estimated, and $\mathcal{E}_i$ represents the error term. In the baseline model $LivingArea_i$ is the living area in square meters of the property. $PlotArea_i$ is also measured in square meters and represents the total plot size of the property. $PropertyType_{ip}$ is a vector of 4 dummies of property types, taking a value of 1 if property type *p, these are categorized as apartments, detached houses, townhouses and one family houses,* and 0 otherwise. $BuildingPeriod_{iT}$ is a vector of 9 dummies of building periods, ranging from before 1905 to periods from 2000, taking the value of 1 is building period *T* and 0 otherwise. $SaleYear_{it}$ is a vector of 10 dummies, taking the value of 1 if the property is sold in sale year *t* and 0 otherwise. $City_{ic}$ is a vector of 54 dummies, taking the value of 1 if the property is located in city *c* and 0 otherwise. Ordinary Least Squares (OLS) is used to estimate the relationship and is widely used in real estate research (Sirmans et al., 2005).

$$log(P_i) = \beta_0 + \beta_1 LivingArea_i + \beta_2 PlotArea_i + \textstyle\sum_{p=2}^{4} \beta_p PropertyType_{ip} +$$
$$\textstyle\sum_{T=2}^{9} \beta_T BuildingPeriod_{iT} + \sum_{t=2}^{10} \beta_t SaleYear_{it} + \sum_{c=2}^{54} \beta_c City_{ic} + \beta_3 Target_i + \beta_4 Post_i +$$
$$\beta_5 Target_i \times Post_i + \beta_6 Target_i \times Post_i \times Distance_t + \mathcal{E}_i \; (2)$$

My goal is to identify the external effects caused by the development of an industrial site on nearby house prices. Therefore, I add $Target$ and $Post$ in model 2. $Target$ is a dummy variable that indicates whether a property i is located within the target area surrounding a developed industrial site (more on the target area is described below). $Post$ indicates whether a property i has sold in the period after development of the industrial site, taking the value 1 if it is, and 0 otherwise. The characteristics of the property that were present in model 1 are still added to model 2. The key independent variable in my difference-in-difference approach is $Target_i \times Post_i$. I use this variable to investigate the effects of development of industrial sites on house prices in the target area. This variable captures the difference between properties located in the target area and properties in the control area interacted with properties that are sold after development compared to properties sold before development. Finally, I interact $Target_i \times Post_i$ with $Distance_t$ to create $\beta_6 Target_i \times Post_i \times Distance_t$. Here distance measures the distance between the transaction of a property i and the nearest industrial site. Interacted with $Target_i \, X \, Post_t$ this variable investigates the effect of living further away from an industrial site within the target area.

I have investigated the effects of $Target_i \times Post_i \times Distance_t$ on different models. The effects of distance to industrial sites on price disappear for properties located approximately 2,000 meters from the nearest industrial site. In Appendix B, I present the results of the distance models. Based on this finding, the preferred model will be the model with the target area of 2,000 meters. Later I will test the robustness of my target area by using the target areas found by De Vor and De Groot (2011) and Currie et al. (2015).

In Appendix B, I show the summary statistics of the target group and the control group separately. There are more observations in the control areas, as the control area is frequently located more centrally in the cities. The transaction price differs marginally in all target groups from the control groups. But differences between groups are in all three cases not more than a fifth of the standard deviation. A difference-in-difference methodology assumes that the development of the price in the target group and the control group is identical. As can be seen in figure B1 in Appendix B, prices of the target groups and control groups follow the same lines.

4. RESULTS

In this section, I report the estimation results of the difference-in-difference models specified in 3.2. In my analysis, I investigate whether there are external effects on house prices of the new development of industrial sites, and the magnitude of the external effects. To come to this analysis, I execute the model in different steps, following the example of De Vries (2015), as can be seen in table C1 in the appendix. First, I only include the key independent variables for my analysis. Then I add the property characteristics, including the living area, the building type, the building period, and the plot size. Next, I add the transaction characteristics, which include the year of the sale. Hereafter, I add the location characteristics, which include the city of the property. Finally, I add the characteristics of the industrial site, which include the size of the industrial site and the size of the developments on the industrial site.

The results of my preferred model can be found in table 5. The first model is the simplest version of the model and only includes the key variables and their interactions. As can be seen the R^2 of the 1st model is very low. This confirms the importance of the control variables that I add in the following models. In the fourth model, all control variables are added. The variable of Target, indicating what the effect is on the house price if the property is in the target area, is negative in all models when control variables are added but turns insignificant in the fourth model when location characteristics are added. The variable of Post, indicating whether the transaction has taken place after development of the industrial site, is negative and significant at the 10% level in the fourth model. The key variable for my analysis Target X Post, indicating the effect of development of industrial sites on house prices, is positive and significant in the fourth model. The coefficient is 0.0375, suggesting that properties that are sold after the new development of an industrial site in the target area sell for approximately 3.75% more compared to the control group. The coefficient of my key variable is significant and positive for all model specifications. The variable Target X Distance, indicating the effect of distance, in meters, to industrial sites on house prices, is insignificant when most control variables are added.

Industrial sites are heterogeneous in characteristics and can therefore affect the impact of the variables on house prices. Therefore, in model 5, I have included the size of the industrial sites and the developed area of the industrial sites to see whether this affected the coefficients of the variables. As can be seen, the change in coefficients is minimal and the significance does not change in any of the variables. The coefficient of size of the industrial sites is positive but insignificant in the models.

Table 5. 2,000-meter target area results

VARIABLES	(1)	(2)	(3)	(4)	(5)
Target area (1=Yes)	-0.0852***	-0.0689***	-0.0679***	-0.0302***	-0.0300***
	(0.0126)	(0.00837)	(0.00819)	(0.00692)	(0.00692)
Post development (1=Yes)	-0.0556***	-0.0640***	0.000204	-0.0169*	-0.0169*
	(0.00962)	(0.00634)	(0.00860)	(0.00969)	(0.00969)
Target X Post (1=Yes)	0.279***	0.118***	0.0929***	0.0361**	0.0375**
	(0.0342)	(0.0227)	(0.0224)	(0.0182)	(0.0182)
Target X Post X Distance	-0.000173***	-4.21e-05***	-3.64e-05**	-1.17e-05	-1.30e-05
	(2.22e-05)	(1.47e-05)	(1.45e-05)	(1.20e-05)	(1.20e-05)
Property characteristics	No	Yes	Yes	Yes	Yes
Transaction characteristics	No	No	Yes	Yes	Yes
Location characteristics	No	No	No	Yes	Yes
IS characteristics	No	No	No	No	Yes
Observations	8,045	8,045	8,045	8,045	8,045
Adjusted R^2	0.02	0.58	0.60	0.77	0.77

Note: Dependent variable is the logarithm of the transaction price. Property characteristics include the living area, the building type, the building period, and the plot size. Transaction characteristics, which include the year of sale. Location fixed effects include the city the property is in, in total 54 fixed effect variables. Industrial site characteristics include the size of the industrial site and the size of the developments on the industrial site. Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5. SENSITIVITY ANALYSIS

In this section, I will provide additional analyses to test my findings under different circumstances. First, I will test my findings under different target areas, to use the same target areas used by De Vor and De Groot (2011) and Currie et al. (2015). Second, I will test my findings only for industrial sites with an environmental zone of 5 and I will exclude the industrial sites with an environmental zone of 4. And third, I will test my findings for heterogeneity between rural areas and peripheral areas.

5.1 Target area

In table 6 below, I compare the results of the fifth specification of the model, to account for any heterogeneity in industrial sites, of target groups of 1,000 meters and 1,600 meters to the preferred model with a target group of 2,000 meters. The variable of Target is negative for the areas all models, though only significant for the 1,600-meter target area and the 2,000-meter target area. The variable of Post was significant at the 10% level in the preferred model but turns insignificant for the other two target areas, however the coefficient and standard error are much in line with the preferred model. The variable of Post does however not make a difference in target and control group. Based on this, similar results were expected. My key variable of Target X Post is positive in all models but only significant for the 2,000-meter target area. The coefficient is 0.0286 in the 1,600-meter target area, compared to 0.0375 in the preferred model. The variable Target X Post X Distance is insignificant in all three target areas, however, the sign is consistently negative.

Table 6. Results across different target areas

VARIABLES	(1) 1,000-meter	(2) 1,600-meter	(3) Preferred model (2,000-meter)
Target area (1=Yes)	-0.00905	-0.0238***	-0.0300***
	(0.0121)	(0.00736)	(0.00692)
Post development (1=Yes)	-0.0115	-0.0151	-0.0169*
	(0.00950)	(0.00955)	(0.00969)
Target X Post (1=Yes)	0.00772	0.0286	0.0375**
	(0.0153)	(0.0230)	(0.0182)
Target X Post X Distance	-9.98e-07	-6.79e-06	-1.30e-05
	(5.52e-06)	(1.83e-05)	(1.20e-05)
Property characteristics	Yes	Yes	Yes
Transaction characteristics	Yes	Yes	Yes
Location characteristics	Yes	Yes	Yes
IS characteristics	Yes	Yes	Yes
Observations	8,045	8,045	8,045
Adjusted R^2	0.77	0.77	0.77

Note: Dependent variable is the logarithm of the transaction price. Property characteristics include the living area, the building type, the building period, and the plot size. Transaction characteristics, which include the year of sale. Location fixed effects include the city the property is in, in total 54 fixed effect variables. Industrial site characteristics include the size of the industrial site and the size of the developments on the industrial site.
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.2 Environmental zones

In my preferred model, I analyze the effect of the new development of industrial sites on house prices. In this model I use industrial sites with an environmental zone of 4 and 5. As explained in chapter 3, industrial sites with an environmental zone of 5 allows for heavier industrial activities than industrial sites with an environmental zone of 4. Therefore, the expected external effects are higher for the industrial sites with a zone of 5. In the first column of table 7, I have only included the industrial sites with this zoning, leaving 2,691 observations. As expected from the heavier industrial activities, the variable Target turns significant at the 5% level and is still negative with a coefficient of -0.0668, suggesting that properties sold in the target area sell for approximately 6,7% less than properties in the control area. The variable Post was significant and negative in the preferred model but by only including industrial sites with an environmental zone of 5, the sign changes and becomes insignificant. The key variable also turns insignificant but is still positive however with a smaller coefficient. The variable Target X Post X Distance is still negative and insignificant. Thus, by only including the industrial sites with an environmental zone of 5, there are less significant results than by including all industrial sites, though the effect remains the same.

Table 7. Environmental zones of 5

VARIABLES	(1) Only environmental zone 5	(2) Preferred model, both environmental zone 4 and 5
Target area (1=Yes)	-0.0668**	-0.0300***
	(0.0276)	(0.00692)
Post development (1=Yes)	0.00400	-0.0169*
	(0.0203)	(0.00969)
Target X Post (1=Yes)	0.00719	0.0375**
	(0.0166)	(0.0182)
Target X Post X Distance	-3.61e-06	-1.30e-05
	(2.16e-05)	(1.20e-05)
Property characteristics	Yes	Yes
Transaction characteristics	Yes	Yes
Location characteristics	Yes	Yes
IS characteristics	Yes	Yes
Observations	2,691	8,045
Adjusted R^2	0.746	0.77

Note: Dependent variable is the logarithm of the transaction price. Property characteristics include the living area, the building type, the building period, and the plot size. Transaction characteristics, which include the year of sale. Location fixed effects include the city the property is in, in total 54 fixed effect variables. Industrial site characteristics include the size of the industrial site and the size of the developments on the industrial site.
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.3 Rural heterogeneity

To further test the robustness of my results, I will test the heterogeneity of my results for rural areas and peripheral areas, as Visser and Van Dam (2008), Dekkers and Van der Straaten (2009), and De Vor and De Groot (2011) found a difference in results for rural and peripheral areas. In my results, I have taken the industrial sites of Het Klooster, Gaasperwaard and Afbouw Haven as rural areas, and the others as peripheral areas. The results can be found in table 8. As can be seen in the tables, the results for the peripheral areas are more significant than for the rural areas. The variable of Target is only significant at the 10% level in the most complete model for the peripheral areas with a coefficient of -0.0372, suggesting that properties in the target areas in peripheral areas sell for approximately 3.7% less than properties outside of the target areas in peripheral areas. The preferred model has no significant results. For the rural areas, there are no significant results either. For the variable of Post, significant negative results are found at the 1% level in peripheral areas but not for rural areas. This suggests that peripheral areas react stronger to the development of industrial sites. The effect of the key variable Target X Post is stronger and significant for peripheral areas but insignificant for rural areas. This confirms existing literature that the diversity of the rural areas diminishes the effect of new amenities. For the variable Target X Post X Distance, consistent in all three models no significant results are found. I have performed a Chow test and the results from the Chow-test on differences between rural and peripheral areas are significant (Table C3.2 in Appendix C). Based on these results, it can be concluded that there are significant differences in the effects of the development of industrial sites on nearby house prices in rural areas and peripheral areas.

Table 8. Regression model of only rural areas

VARIABLES	(1) Rural areas	(2) Peripheral areas	(3) Preferred model
Target area (1=Yes)	0.0210	-0.0372*	-0.0300***
	(0.0218)	(0.0208)	(0.00692)
Post development (1=Yes)	0.0272	-0.0383***	-0.0169*
	(0.0354)	(0.0134)	(0.00969)
Target X Post (1=Yes)	0.0155	0.0309**	0.0375**
	(0.0105)	(0.0129)	(0.0182)
Target X Distance	-2.81e-05	-8.98e-06	-1.30e-05
	(1.76e-05)	(1.65e-05)	(1.20e-05)
Property characteristics	Yes	Yes	Yes
Transaction characteristics	Yes	Yes	Yes
Location characteristics	Yes	Yes	Yes
IS characteristics	Yes	Yes	Yes
Observations	3,735	4,310	8,045
Adjusted R^2	0.778	0.763	0.77

Note: Dependent variable is the logarithm of the transaction price. Property characteristics include the living area, the building type, the building period, and the plot size. Transaction characteristics, which include the year of sale. Location fixed effects include the city the property is in, in total 54 fixed effect variables. Industrial site characteristics include the size of the industrial site and the size of the developments on the industrial site. Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

6. DISCUSSION

The findings of my analysis, that the new development of industrial site can lead to an increase in house prices in the vicinity, are surprising and in contrast with existing literature on industrial sites in The Netherlands. Earlier literature has found that industrial sites are seen as a disamenity and result in lower house prices. De Vor and De Groot (2011) find that properties located in the proximity of industrial sites are valued lower than properties not located in the proximity of industrial sites. Visser and Van Dam (2008) also find the contrary, where the vicinity of industrial land would lead to a decrease in property values. However, these studies use *existing* industrial sites and the study of De Vor and De Groot (2011) assume that the industrial sites cause the lower house prices and do not discuss the possibility that these prices were also lower prior to the development of the industrial sites. As discussed in section 3, Dutch zoning policies are meant to ensure that new developments will not bring negative externalities. This could mean that industrial sites will be developed in areas with lower house values and that the industrial sites do not cause the results found by De Vor and De Groot (2011), but that the house prices were already lower before development.

The Dutch zoning policies may explain why the findings of my analysis are not negative and not in line with existing literature of industrial sites in the Netherlands as municipalities already try to exclude all negative externalities caused by new developments. My findings suggest that because of the strict zoning policies, whenever a new industrial site is developed, no negative externalities are experienced in surrounding areas and house values therefore do not decrease. The study conducted by Currie et al. (2015) is the only study containing negative externalities after the development of new industrial sites. Still, the cases in that study use heavy industry that can lead to larger negative externalities, and such planning would not be allowed in the Netherlands.

The question remains, why industrial sites would have a positive effect on house prices, as the results of my analysis have indicated. The findings by O'Keefe (2004), Couch et al. (2005), Busso et al. (2013), Ham et al. (2011), and Ham et al. (2018) suggest that the development of industrial sites can lead to an increase in property values, due to a growth in jobs, decline in unemployment, decline in crime rate, and improvement of infrastructure. However, these effects are not studied in the Netherlands and are only confirmed for Enterprise Zones in the United States, where the stimulants for companies to establish their businesses in these areas is stronger than for companies on industrial sites in The Netherlands and zoning policies are less strict. Therefore, externalities, positive as well as negative, can have larger effects. However, the increase in economic activity still affects the surrounding areas in The Netherlands and can possibly have led to higher house prices.

A limitation to my analysis is that the findings of my analysis cannot be generalized for the entire Dutch market, as I have only used the results of 11 different cases, which may be endogenous as local authorities will plan the zoning of industrial sites in areas where residential properties should not experience negative externalities. A broader study would need the following aspects; first, if the closings of industrial sites would be considered, this could lead to interesting insights into the development of house prices following these closings. This can be conducted in a similar manner as Currie et al. (2015), who found that house prices reacted positively to the closing of toxic industrial sites. Second, a broader study can use deeper insights into the planning policy per case and investigate the reasons why a municipality chose a specific location for the development of such industrial sites.

7. CONCLUSION

The main aim of this study is to estimate the impact of the development of new industrial sites on the price of nearby houses for the market of the Netherlands. Using a hedonic pricing model and a difference-in-difference approach the external effects of the development of 11 industrial sites between 2010 and 2014 were analyzed. The industrial sites are located through the whole of the Netherlands, from the North of the Netherlands in Veendam, to the South of The Netherlands in Echt-Susteren. The externalities caused by the development of these industrial sites is estimated using various dummies indicating whether a property has sold prior to or after development and whether a property was sold in the target area of these industrial sites. These estimations were controlled for property characteristics, location characteristics, transaction characteristics, and characteristics of the industrial sites. In accordance with previous studies related to Enterprise Zones, the results in my study show that the development of industrial sites has a positive effect on the prices of houses in the vicinity as houses in the target area, sold after development of the industrial site sell for 3.75% more than houses in the control group.

However, the findings of this study are contradictory to prior studies conducted on the house prices in The Netherlands, where industrial lands and sites were found to have a negative effect on nearby house prices. The outcomes of my study suggest that the positive externalities such as the increase in occupation and the improvement of infrastructure, outweigh the negative externalities such as the noise and air pollution caused by the activities of companies on the industrial sites. While I cannot control for all concerns, such as the endogeneity concerns caused by location and planning of the development, the sensitivity analysis has shown that the findings of my analysis become insignificant under certain circumstances. Still, the direction of the effects does not change when sensitivity analysis are conducted with regards to the distance of the target area, the environmental zoning of the industrial site, and the difference between rural and peripheral areas.

For future research, the extent of noise- and air pollution could be measured and considered in the models to determine the target area more accurately. In this study, I have estimated the extent of these effects with the findings of other studies, but these factors can be heavily localized due to location characteristics. In a larger study, one could also focus on the development of industrial sites with an environmental zone of 6 to 6.2, which contains the highest intensity of industrial activities that are allowed in the Netherlands, such as steel mills. In the limited dataset that I have used in my study, I did not have access to the development of such sites, but these sites are expected to bring the most negative externalities in terms of air pollution. Future research can also investigate the effect of the closing of industrial sites to observe whether a similar effect is found whenever an industrial site is closed. Also, deeper insights into the thought process of municipalities concerning the planning and location of industrial site developments can similarly provide interesting insights to this area of research.

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APPENDIX

APPENDIX A. MAPS OF INDUSTRIAL SITES AND TARGET AREAS

Figure A1. Map of Industrial Sites "Het Kloosten" and "Gaasperwaard".

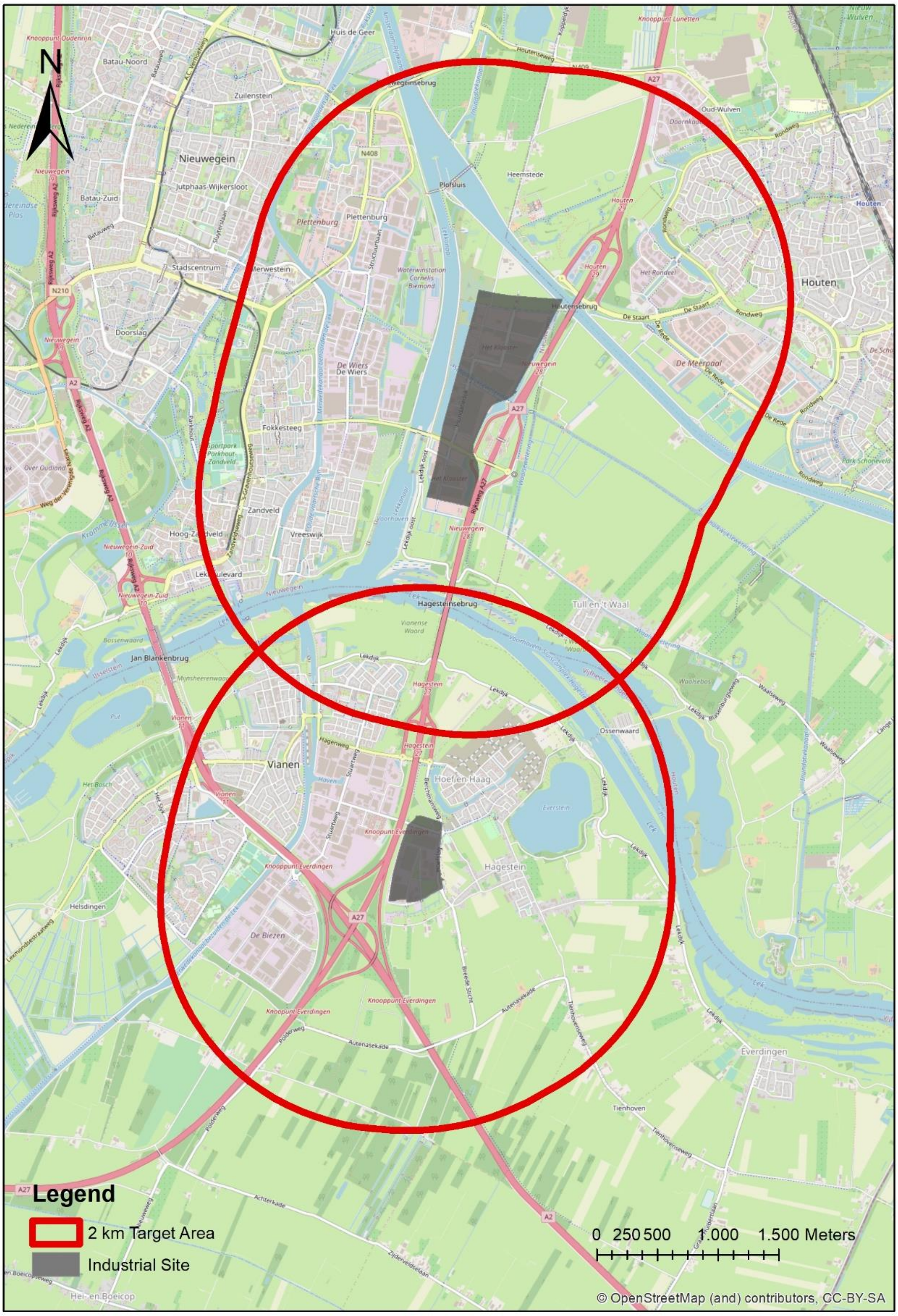


Figure A2. Map of Industrial Site “DALLEN II”.

Figure A3. Map of Industrial Site “De Copen”.

Figure A4. Map of Industrial Site "DocksNLD".

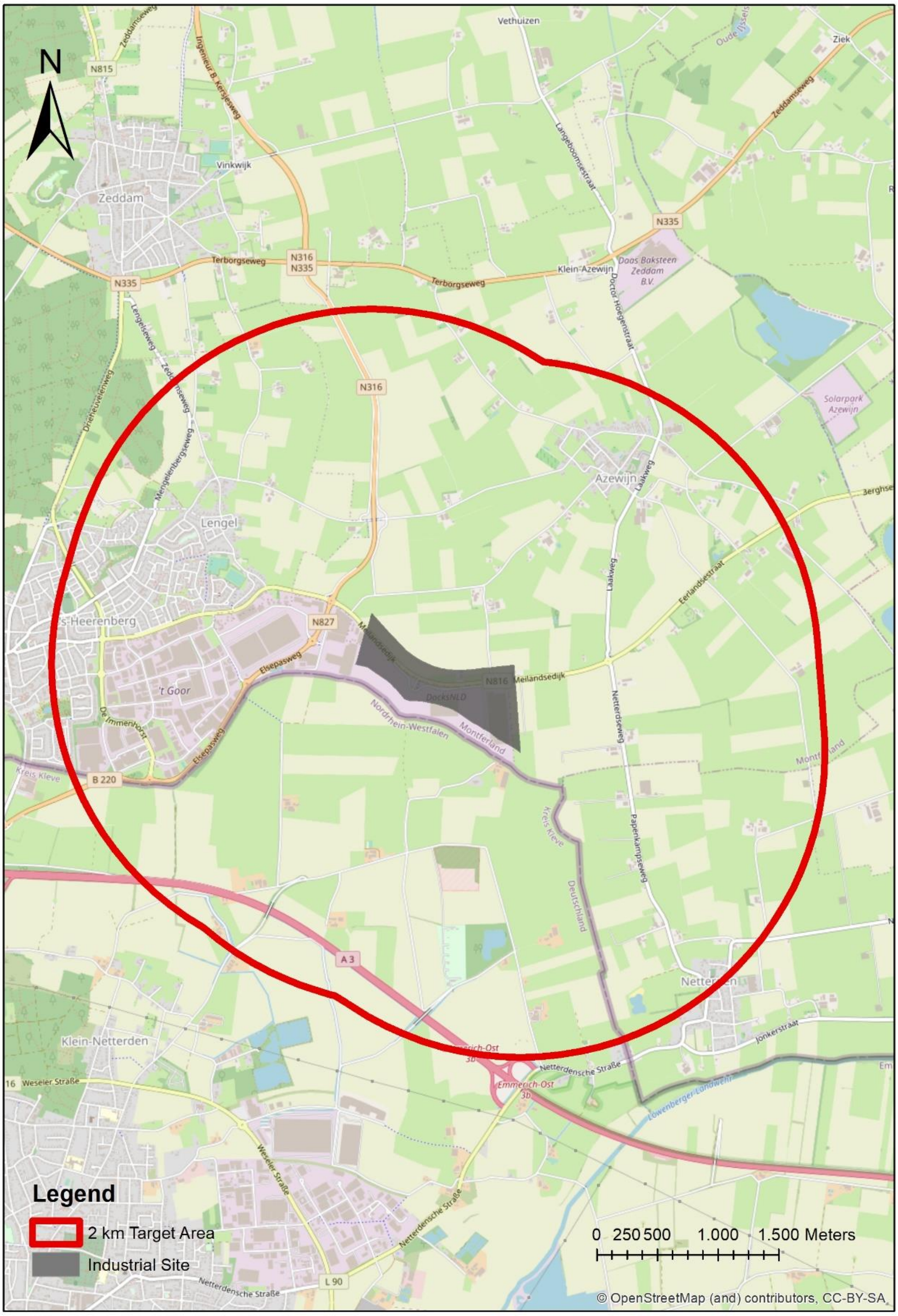


Figure A5. Map of Industrial Site “Poort van Dronten”

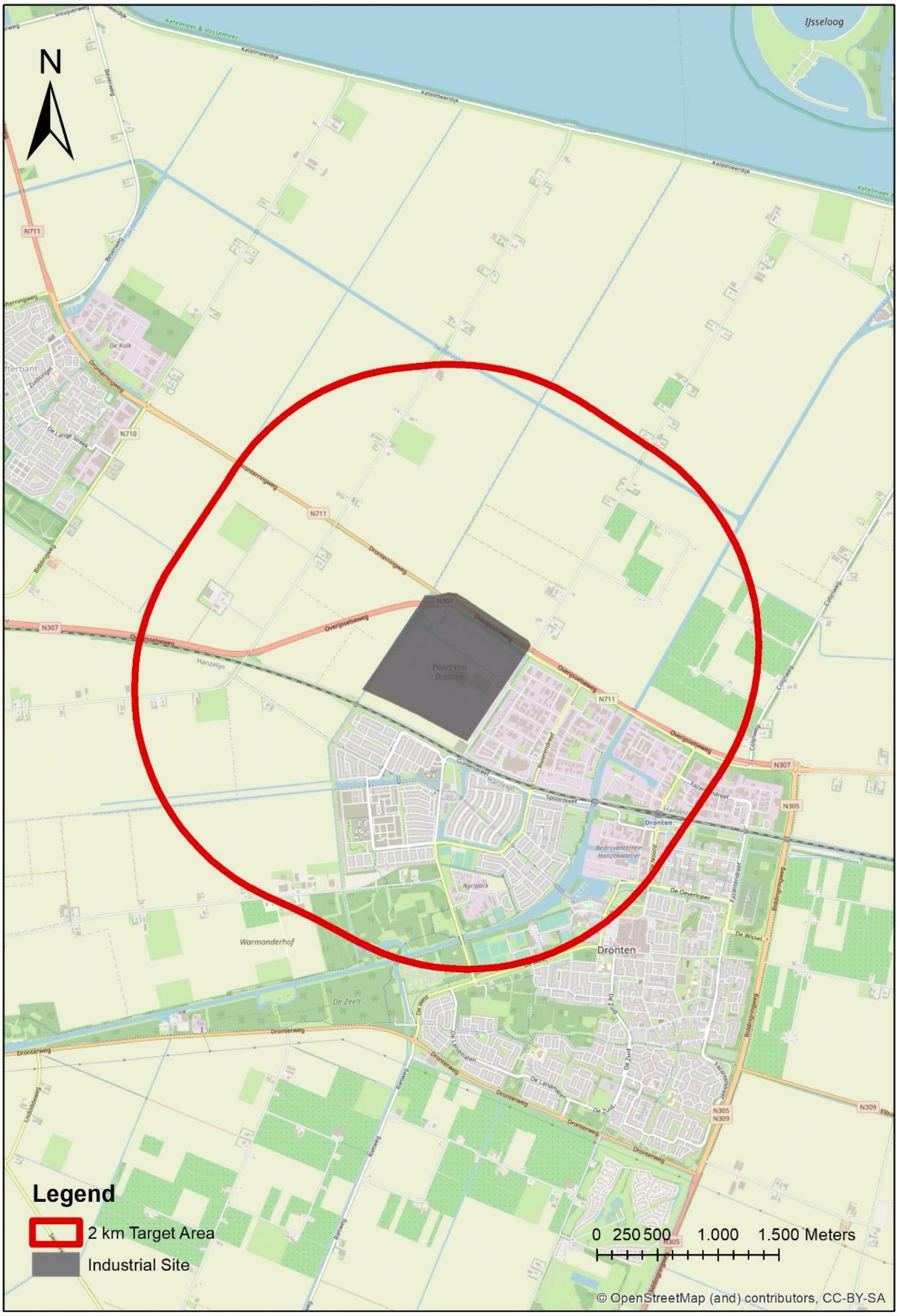


Figure A6. Map of Industrial Site “Businesspark ML”.

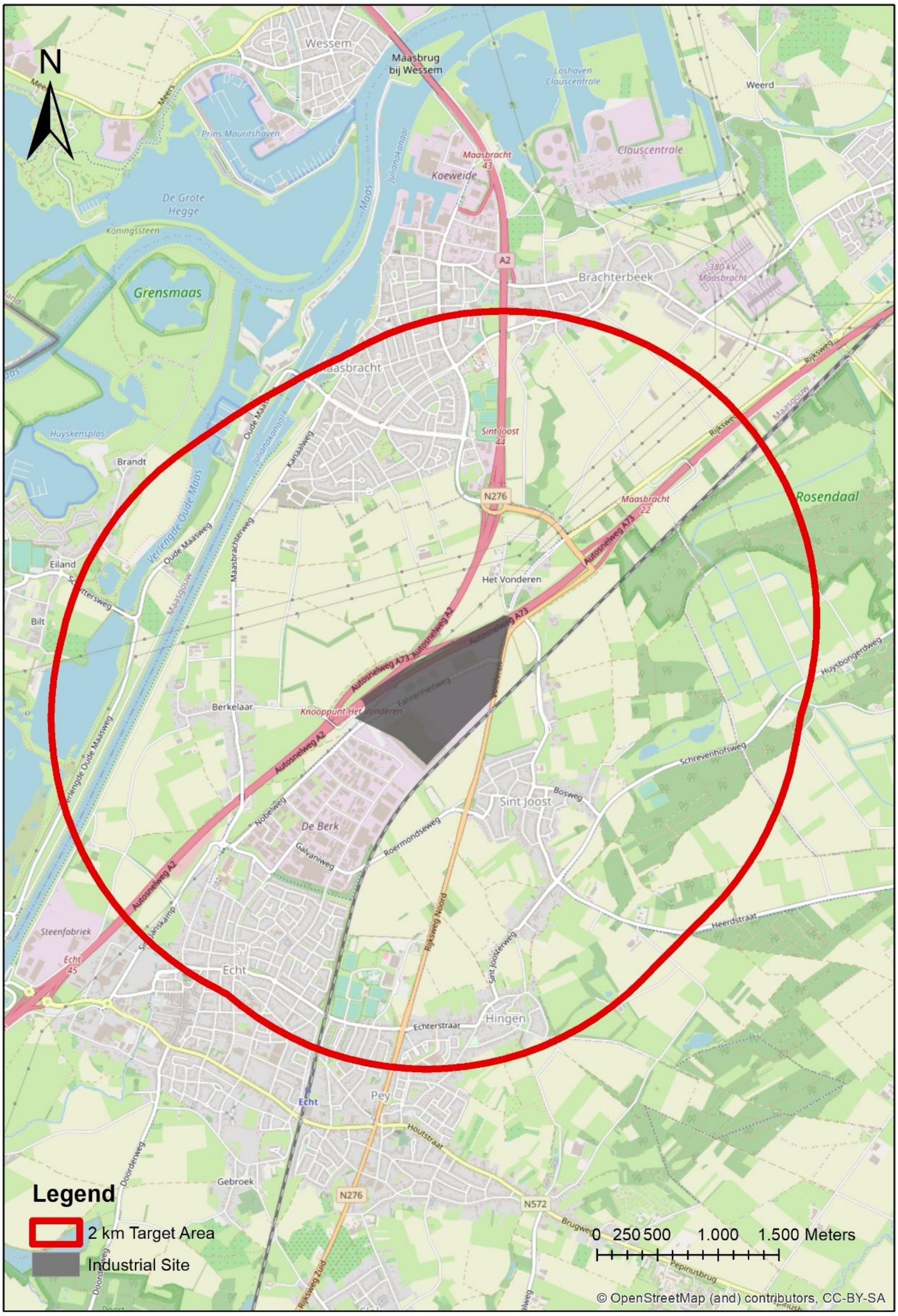


Figure A7. Map of Industrial Site “KEMPISCH BEDRIJVENPARK”.

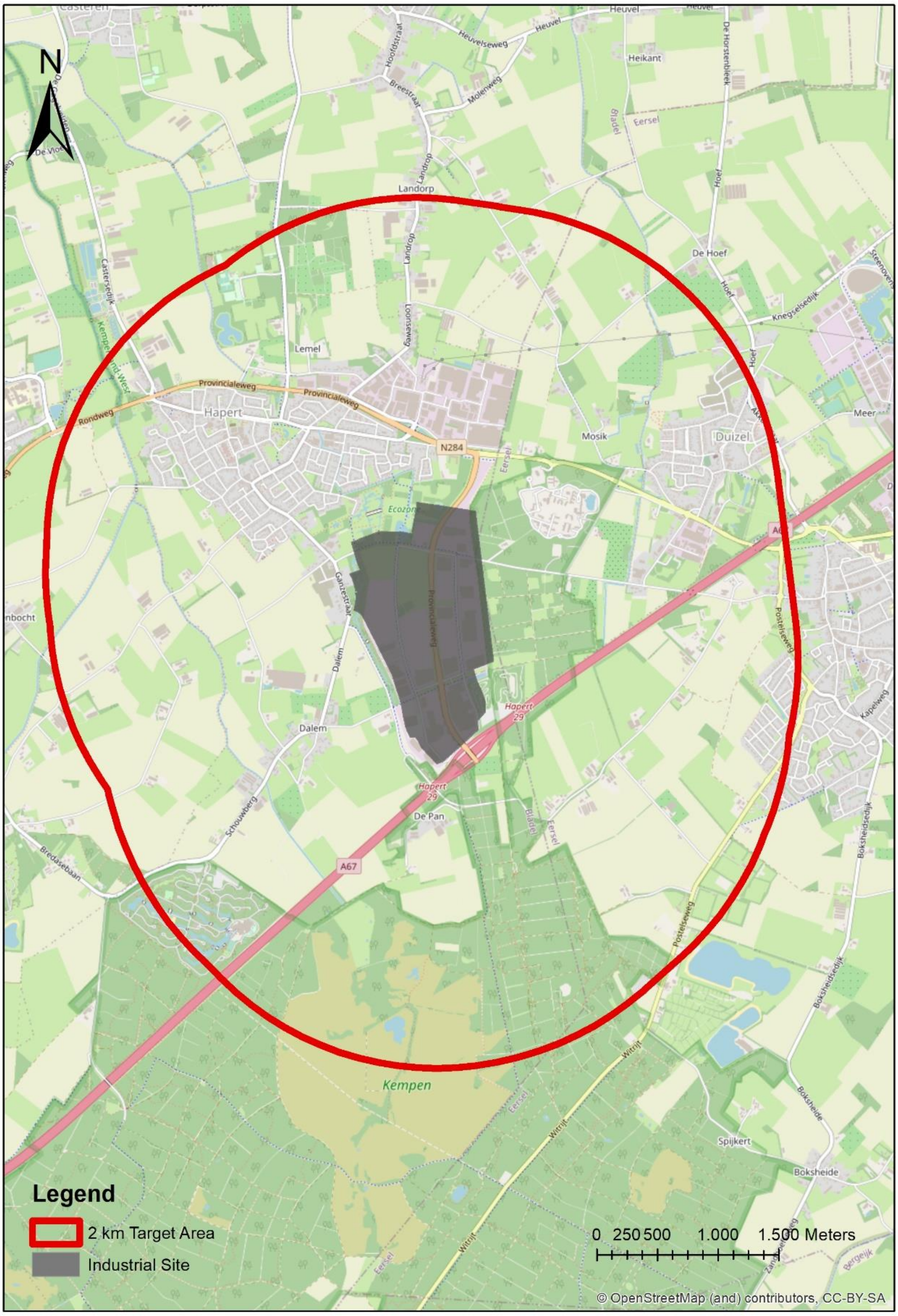


Figure A8. Map of Industrial Site “REGIONAAL BEDRIJVENPARK LAARAKKER”.

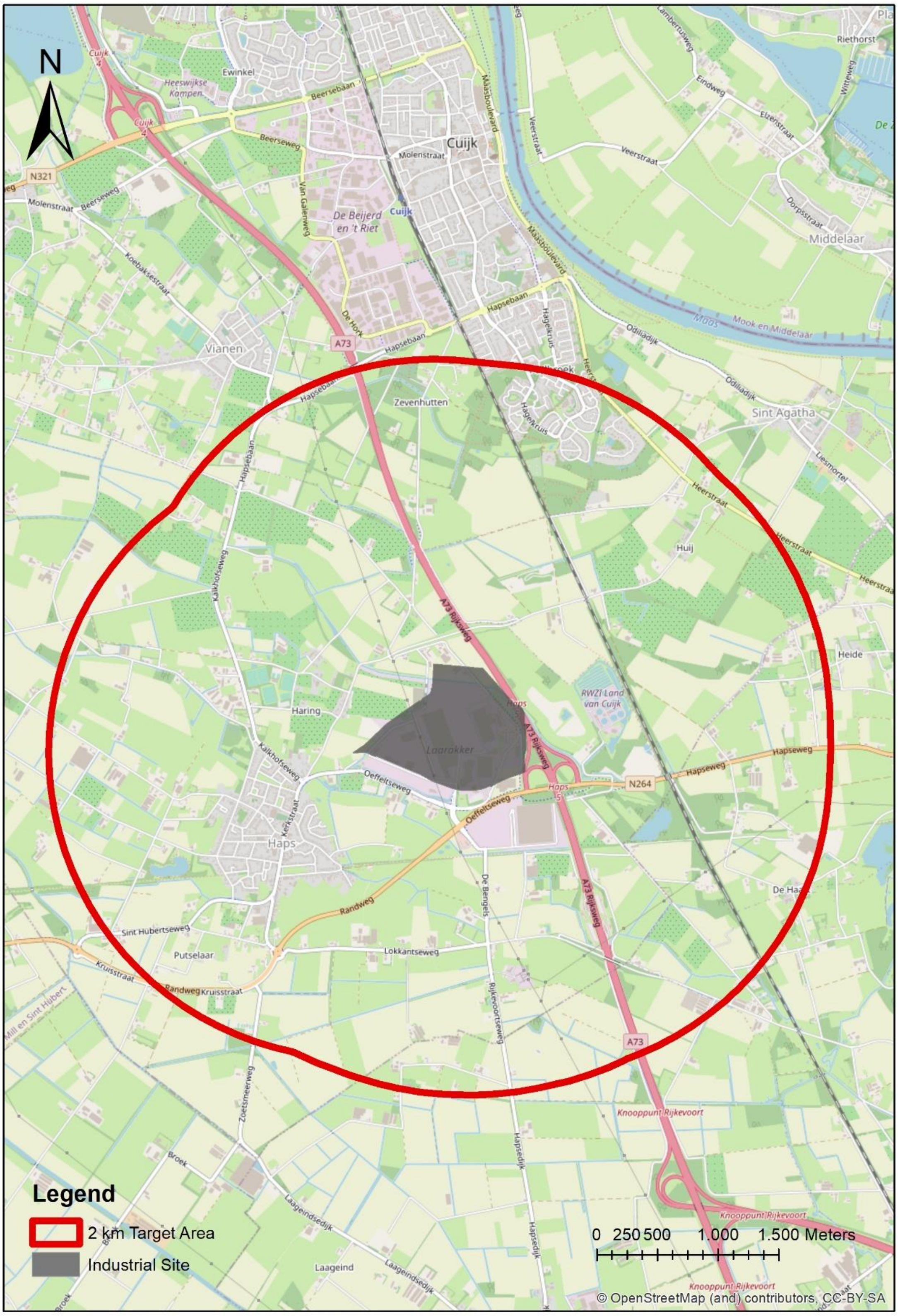


Figure A9. Map of Industrial Site “AFBOUW HAVEN I tm VI”.

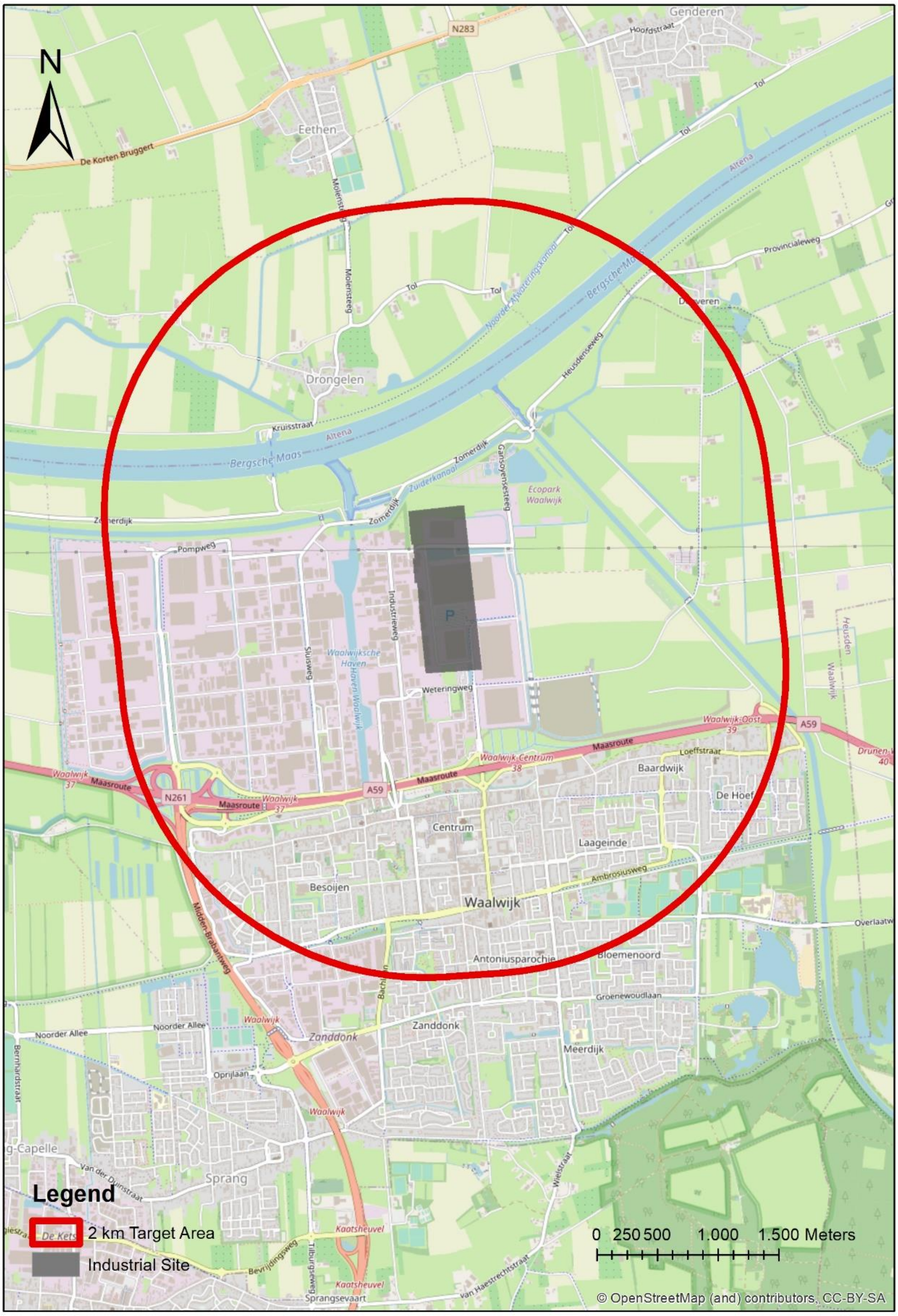
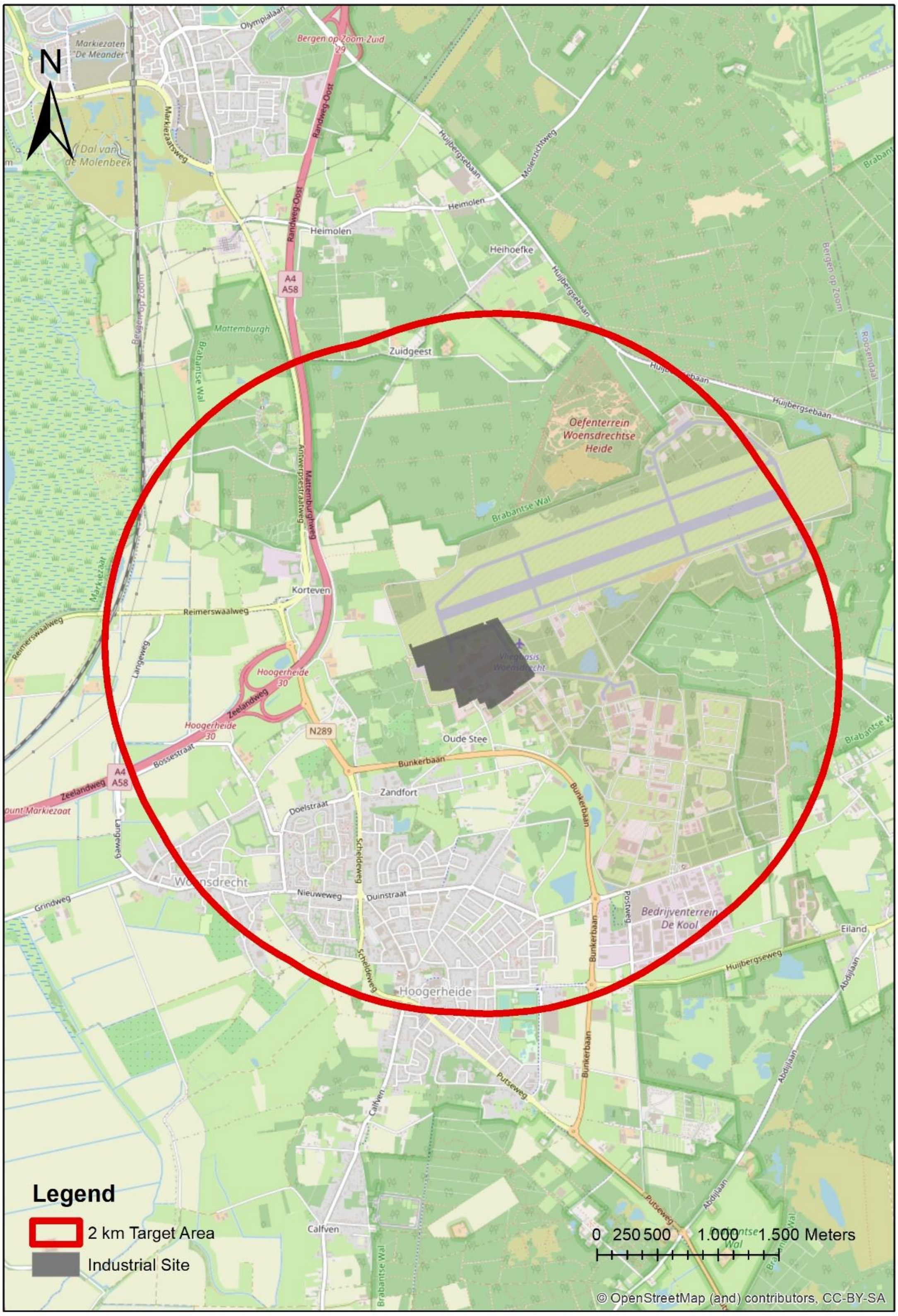


Figure A10. Map of Industrial Site “Businesspark Aviolanda”.



APPENDIX B. DESCRIPTIVE STATISTICS

Table B1. Industrial site effect per distance category.

Distance	(1) Coef. (Std error)	Distance	Coef. (Std error)	Distance	Coef. (Std error)
250-500	0.223* (0.123)	500-1000	-0.0501 (0.0442)	500-1000	-0.0521*** (0.0174)
500-700	0.173*** (0.0459)	1000-1600	-0.101** (0.0445)	1000-2000	-0.101*** (0.0199)
700-850	0.0519* (0.0296)	1600-2000	-0.152*** (0.0458)	<2000	-0.0212 (0.0166)
850-1000	-0.0985*** (0.0275)	2000-3000	-0.0841* (0.0446)		
1000-1200	-0.0104 (0.0269)	<3000	-0.0398 (0.0450)		
1200-1400	-0.0640*** (0.0214)				
1400-1600	-0.0561*** (0.0175)				
1600-1800	-0.120*** (0.0178)				
1800-2000	-0.0787*** (0.0206)				
2000-2500	-0.210* (0.0194)				
2500-3000	-0.113 (0.0131)				
3000-4000	0.0156 (0.0143)				
<4000	-0.000486 (0.0123)				

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Dependent variable is the logarithm of price, controls were used similar to the preferred model. As can be seen in the models above, in all specified distance categories the significance disappears around the 2000-meter mark. Reference categories used are the distances smaller than the first mentioned distance.

Table B2. Build-up of models.

	Regression models				
	1	2	3	4	5
Transaction within target area of IS.	X	X	X	X	X
Transaction after development	X	X	X	X	X
Transaction in target area and after development	X	X	X	X	X
Distance to industrial site in meters in the target area	X	X	X	X	X
Property characteristics		X	X	X	X
Transaction characteristics			X	X	
Location characteristics				X	X
Industrial site characteristics					X
R^2	1,5%	58,5%	60,6%	77,5%	77,5%

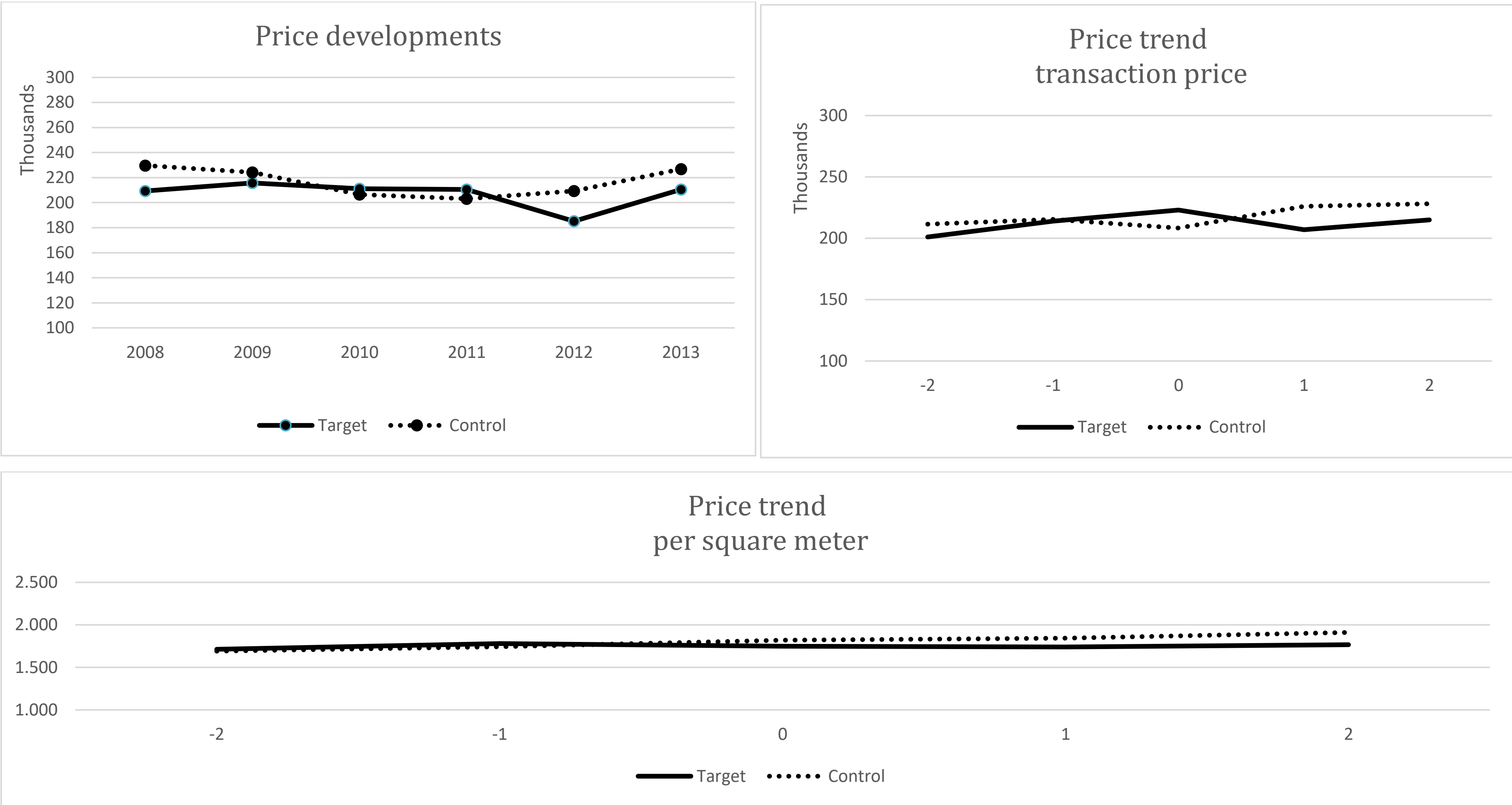
Note: x = Added to the model. Dependent variable is the logarithm of the transaction price. Property characteristics include the living area, the building type, the building period, and the plot size. Transaction characteristics, which include the year of sale. Location characteristics include the city the property is in. Industrial site characteristics include the size of the industrial site and the size of the developments on the industrial site.

Table B3. Descriptive statistics compared between target group and control group.

	Target area, 0-2000m				Control area, >2000m			
	Mean	Sd	Min	Max	Mean	Sd	Min	Max
Property characteristics								
Price (EUR, absolute)	209835.8	85252.93	87000	635000	220699.6	85159.97	87500	635000
Price (EUR, per square meter)	1751.865	481.1099	816	3314	1807.311	442.5627	816	3333
Living area (in square meters)	119.0653	35.51894	34	400	120.6669	35.22217	25	350
Plot size (in square meters)	249.194	329.314	0	4330	306.54	494.6843	0	5710
Building period								
1500-1905	.035272	.1845012	0	1	.0150558	.1217861	0	1
1906-1930	.0724203	.2592311	0	1	.0288104	.1672889	0	1
1931-1944	.0378987	.1909871	0	1	.010223	.1006003	0	1
1945-1959	.0469043	.2114736	0	1	.0390335	.1936926	0	1
1960-1970	.1812383	.3852878	0	1	.1563197	.3631919	0	1
1971-1980	.2675422	.4427606	0	1	.3065056	.4610851	0	1
1981-1990	.1365854	.3434735	0	1	.2035316	.4026619	0	1
1991-2000	.0900563	.2863161	0	1	.1667286	.372768	0	1
> 2001	.1320826	.338644	0	1	.0737918	.2614561	0	1
Observations		2,665				5,380		

Note: Descriptive statistics of observations of the control group are compared to the target group and as can be seen the differences are marginal.

Figure B5. Price development of control and target group



Note: Lines above demonstrate that the prices of the target group, as well as the control group follow roughly the same price developments over the years. Suggesting that apart from the effects caused by the variables, no major differences exist between the target group and the control group. On the Y-Axis is the average transaction price in euros. The X-Axis demonstrate the year the average was taken from.

APPENDIX C. RESULTS

Table C1. Build-up of models.

	Regression models				
	1	2	3	4	5
Transaction within target area of IS.	X	X	X	X	X
Transaction after development	X	X	X	X	X
Transaction in target area and after development	X	X	X	X	X
Distance to industrial site in meters in the target area	X	X	X	X	X
Property characteristics		X	X	X	X
Transaction characteristics			X	X	
Location characteristics				X	X
Industrial site characteristics					X
R^2	1,5%	58,5%	60,6%	77,5%	77,5%

Note: x = Added to the model. Dependent variable is the logarithm of the transaction price. Property characteristics include the living area, the building type, the building period, and the plot size. Transaction characteristics, which include the year of sale. Location characteristics include the city the property is in. Industrial site characteristics include the size of the industrial site and the size of the developments on the industrial site.

Table C2. Chow-test values and significance levels

Variables	df	F	P>F
Rural/peripheral	2	2.103026	0.000

Note: Chow test is performed between rural and peripheral areas and a significant difference is found