The impact of the announcements of the Feyenoord City project on nearby house prices: a case study on announcement effects

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Abstract

During the last fifteen years in Rotterdam, several proposals for a new Feyenoord stadium have been made. None of these stadium proposals have reached the construction phase. The newest and the most concrete proposal is the Feyenoord City project. Feyenoord City is a proposed megaproject that uses the development of a new stadium as the main driver for an enormous urban redevelopment in Rotterdam South. The political and social impacts of Feyenoord City are clear. However, financial consequences in the form of changes in house prices remain unclear for Dutch mega-urban area redevelopments. As empirical studies have shown, the announcement of such megaprojects can lead to changes in surrounding house prices. Plan and policy-makers are unaware of or neglect such financial consequences. Furthermore, the announcement of a megaproject is not a one-day event and can be seen as a process. A difference-in-differences hedonic model is used to capture changes in house prices after three announcements near and within the project area. What sets this thesis apart from other studies is the focus on the announcement details instead of pure hedonic modeling. The results are therefore partly explained in light of the project's timeline. The results show that the announcement effects are very local. The hedonic models find a negative price effect within the project area after the publication of the start document of the zoning plan for inspection. The most interesting finding is that a positive price effect is found between 500-750 meters after all three announcements. In other words, a premium is paid for houses between 500-750 meters after the three announcement dates.

Keywords: **House prices, announcement effects, anticipation, difference-in-differences, hedonic price model**

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1. Introduction

The announcement of large urban redevelopment projects leads to all sorts of effects as the plans and the designs are discussed within the public and may potentially generate speculative behavior in the housing market (Shiller, 2003). An example of such a large-scale redevelopment project is Feyenoord City, which is currently one of the biggest proposed urban redevelopment projects in The Netherlands with a total development sum of 1.5 billion euros (NOS, 2017). This redevelopment in Rotterdam South covers an area of 79.47 hectares and should create new aesthetic icons along the Maas (OMA, 2019). Due to the relatively high development sum and the size of the project area, the project can be classified as a mega-project. The project location is located along the Maas river in Rotterdam-South, which is one of the densest residential areas in Rotterdam (OMA, 2019). Feyenoord City covers multiple developments with the development of a new football stadium as the most important element of the project. In the project proposal the currently existing stadium, the Kuip, will be transformed into a housing complex. Next to that, thousands of new housing units, and tens of thousands of square meters of hotel, retail, office, catering space are proposed (OMA, 2019).

Large-scale redevelopment proposals and announcements come with both positive and negative attention in local and national media. Likewise for Feyenoord City. There are concerns of local politicians about the financial feasibility of the business case and the financial contribution of the municipality to the project (Liukku & Potters, 2018). In July 2020, the Court of Audit published a report in which it critically questioned the urgency and the public interest in spending 40 million euros of public resources on the Feyenoord City project (NOS, 2020). The announcements in which the project location was communicated and in which the concept of the Masterplan was made public resulted in worried residents that live within the project area and in the surrounding neighborhoods. Outcomes of a survey show that residents that live within the project area have concerns that noise pollution, parking issues, traffic congestion, and safety issues may arise as a result of Feyenoord City (RTVRijnmond, 2016; NOS, 2017; Potters, 2017). On the other hand, the project aims to generate spillover effects to surrounding neighborhoods with a detailed social-economic program, with a focus on job creation, sustainability, sport, and lifestyle (OMA, 2019). One of the objectives of the project is to add two new icons to the area with a new stadium and tidespark (getijdenpark), which are expected to be large attractions that will put the project area on the map (OMA, 2019). This could as well be an economic boost for surrounding neighborhoods and potentially impact house prices. Since the large social and political impact that the project announcements generated for residents, politicians, and journalists, it is interesting to find out if these project expectations and concerns are reflected in house prices within and outside the project area. This is by measuring the impact of the announcements of the Feyenoord City project on house prices within and in the surrounding of the project area. The results of this study could inform plan and policy-makers about the potential financial consequences that announcements of such a mega-project could lead to within and in the surrounding of the project area. This with financial consequences in the form of changing house prices due to the announcements of the mega-project. This is important since policy-makers often limit their focus to the social and political impact of megaproject announcements but are unaware or neglect the potential impact on house prices due to the announcement. The focus of this research is to study ex-ante announcement effects for the large-scale redevelopment project Feyenoord City on house prices. Ex-ante announcement effects arise before the construction of the project.

1.1 Literature review

There are multiple studies available on the impact of the announcement of mega-projects on house prices. These studies look at the effects of the announcement of megaprojects on nearby house prices due to anticipation (speculative behavior) on higher or lower future expected house prices by traders. These are so-called announcement or anticipation effects studies. However, these studies are all studying mega-projects that were proposed outside the Netherlands. One of these studies is the study of Hyun & Milcheva (2019), who investigated the announcement and cancellation effect of the Yongsan International business district project on surrounding apartment prices by applying a difference-in-differences hedonic methodology. In this study, a distinction is made between three study periods; pre-announcement period, post-announcement period, and a post-cancellation period (Hyun & Milcheva, 2019). Results show that in the post-announcement period apartments within 0.5 km of the project site were sold for 7.3% more than apartments further away. Furthermore, the size of this house price premium decreased with distance. The cancellation announcement harms apartment prices and erodes the premium of apartments within 0.5 km with 5.2% (Hyun & Milcheva, 2019). Kavetsos (2012) studied the impact of the London Olympics announcement on house prices nearby the Olympic Park. The organization of a big event may lead to gentrification and thus higher residential property prices in a neighborhood. Kavetsos (2012) applied a difference-in-differences model based on boroughs showing an increase of approximately 3.3% in house prices in the host boroughs following the announcement. The model based on proximity suggests that every additional mile away from the Olympic stadium, house price premium decreases by 0.4% (Kavetsos, 2012). Kavetsos (2012) also included the impact of housing type on house prices in his model but did not study if the impact of the announcement on house prices varies per housing type. Immergluck (2009) studied the announcement effects of the Atlanta Beltline mega-project on house prices within and outside the project area. Immergluck (2009) argues that the announcement of such a big project is rather a process instead of a one-day event. Therefore it is impossible to state a date on which the project was announced. Instead of using a hedonic difference-in-differences approach, Immergergluck (2009) used a standard hedonic pricing model. In this study, the impact of the announcement of the Atlanta Beltline is discussed in relationship with the publication of news articles over time about the project (Immegluck, 2009). The regression results show that after the announcement significant price premiums were paid for houses with a relatively low value which were occupied by low-income households. This increase in value is translated into higher property taxes, which may trigger the displacement of low-income households and the introduction of gentrification (Immergluck, 2009). The studies of Hyun & Milcheva (2019), Kavetsos (2012), Immegluck (2009) found a positive impact of the announcement of mega-projects and stadium developments on house prices. However, an opposite negative effect on house prices due to the announcement is also possible. This is indicated in the research of Dehring et al. (2007), who found out that the announcement of an American Football stadium development in Arlington (Texas, US) had a negative impact on house prices. Dehring et al. (2007) used in their difference-in-differences model various announcement dates and accumulated announcement dates to measure the impact of the announcement on house prices. The studies described above find both positive and negative impacts of the announcement of mega-projects on nearby house prices as a result of anticipation by traders. Persuasive storytelling about the project's plan and design determines whether traders will anticipate on higher or lower future expected house prices after the project announcement. Persuasive storytelling creates awareness, perceptions, attitudes, of people about the project and its design (van Dijk, 2011). These perception frames and, attitudes of people about the project may then lead to anticipation of people on future expected house prices after the project announcement.

1.2 Research problem statement

Based on previous research we can presume that the announcements of urban redevelopment projects may affect house prices (Hyun & Milcheva, 2019; Kavetsos, 2012; Immergluck; 2009). However, the impact of the announcement of urban redevelopment projects on house prices has never been studied in the context of mega-urban area redevelopment projects in the Netherlands. This is not surprising, since these mega-projects are rare in a small country as the Netherlands is. The political and social impacts of the announcements of megaprojects like Feyenoord City are clear. The financial consequences in the form of changes in house prices remain unclear for Dutch mega-urban area redevelopments. Plan and policy-makers are unaware of or neglect such financial consequences. Furthermore, most studies with the exemption of Dehring et al. (2007) only study the impact of the first official announcement of area developments on surrounding house prices. This first official announcement is in multiple cases the location decision (Dehring et al., 2007). However, the official publication of the Masterplan of a mega-project and its impact on house prices has never been studied before to the best of my knowledge. Additionally, most studies spend quite some time on modeling but not much on the announcement details. Therefore, this paper will bring in a detailed timeline with all decisive announcements of the project that may have impacted house prices. **The fundamental aim of this thesis is to capture changes in house prices after several announcements of the Feyenoord City project.** In this paper, three different announcement dates based on a detailed time timeline are used to capture the price changes. The first announcement date is 18 March 2016 on which the location decision was made public. The second date is 5 January 2018 on which the start document of the Feyenoord City zoning plan was made available for inspection. The third date is 17 October 2019 on which the definitive version of the Masterplan was presented to the municipal council by the Board of Mayor and Alderman. This third date can be seen as the publication of the definitive version of the Masterplan.

Central research question: **What is the impact of the announcements of the Feyenoord City project on house prices within and nearby the project area?**

Sub questions:

1. What are the drivers and mechanisms that lead to changes in house prices after the announcement of mega-projects?
2. To what extent do the announcements of Feyenoord City lead to a negative price effect on house prices within the project area?
3. To what extent do the announcements of Feyenoord City affect house prices in the vicinity of the project area?
4. How do the effects of the announcements of Feyenoord City on house prices deviate over distance?

NVM data in the software Real Works is used to get data on all relevant housing transactions that have taken place within and in the surrounding of the Feyenoord City project area over the period 2014-2020.

The first research question is a theoretical question that will be answered by studying existing literature on the drivers and mechanisms behind this so-called "announcement effect" and how this may affect house prices. One can think of literature on speculative behavior and anticipation behavior. The last three last sub-questions will be answered with the use of a difference-in-differences hedonic model. In a difference-in-differences model the project area and the target area are compared with a control area before and after all three announcement dates. The target area is defined as the area in close proximity of the project area (within 1,000 meters), and where an effect on house prices is expected as a result of the announcement of Feyenoord City. The control area is located at a greater distance from the project area and can be defined as the area where no effect on house prices is expected as a result of the announcement of Feyenoord City.

1.3 Outline

The thesis is outlined as follows. Chapter 2 includes the theoretical framework that forms the foundation of the research. Chapter 2 elaborates on relevant scientific theories such as market efficiency, the bid-rent model, capitalization theories, and theories on speculative behavior and anticipation. Furthermore, the first research question is answered in the last section of chapter 2.

Chapter 3 includes a detailed case and timeline description of all important events related to the Feyenoord City project. Section 3.2 discusses the difference-in-differences methodology and elaborates on the three empirical models that are specified in the same section. The last section of chapter 3 gives an overview of the data cleaning process and summarizes all relevant descriptive statistics that flow from the analysis.

Chapter 4 describes the results that flow from the three empirical difference-in-differences models. Chapter 4 answers whether the three announcements of the Feyenoord City project led to changes in house prices within and nearby the project area. Furthermore, an answer is given to the question of whether the effects on house prices decay over distance. Thus, the aim of chapter 4 is to answer research questions 2 to 4. The last section of chapter 4 includes a sensitivity analysis to test the robustness of the results. Chapter 5 aims to explain the findings that flow from the three difference-in-differences models. The dissertation ends with a conclusion in chapter 6, in which the most important findings are summarized, and recommendations for further research are given.

1.4 Conceptual Model

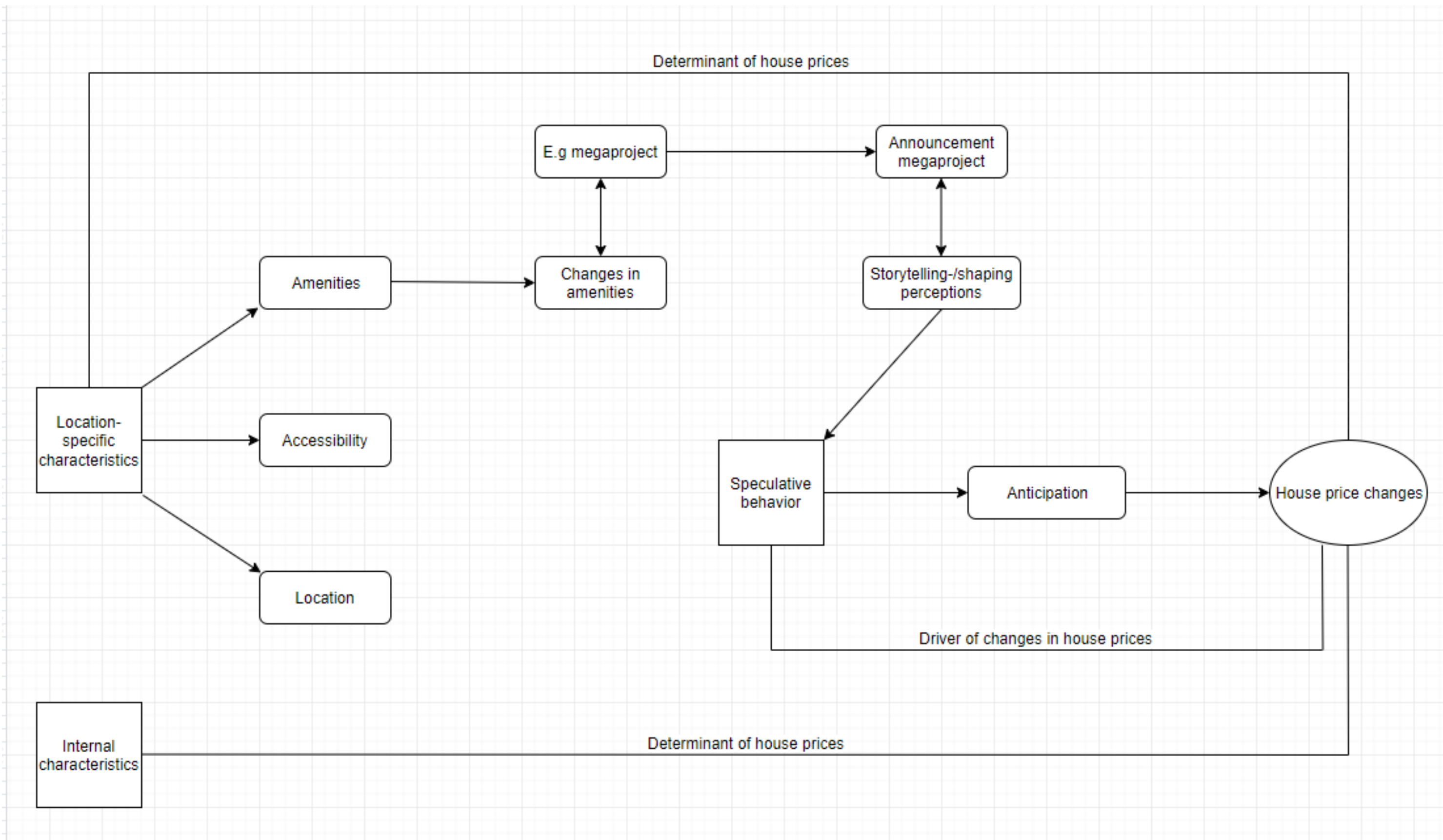

Figure 1.1 Conceptual model

Figure 1.1 displays the conceptual model that gives a schematic overview of the theoretical framework which is covered in chapter 2. Location-specific characteristics and internal characteristics are the main determinants that shape house prices (Glaeser et al., 2001). Changes in amenities in the surrounding of houses such as a the arrival of a new megaproject may change house prices. Studies show that the announcement of megaprojects may change house prices via speculative behavior and anticipation (Kavetsos, 2012). Storytelling-/shaping perception can be seen as the mechanisms behind speculative behavior (Van Dijk et al., 2011). All the components in the conceptual model in figure 1.1 are treated in detail in the next chapter.

2. Theoretical framework

This chapter elaborates on the theories that form the foundation for the conceptual model and this paper. The first sections of this chapter describe market efficiency in the real estate market and the classical urban economic theories. Section 2.3 gives a detailed explanation of speculative behavior and anticipation as results of announcements. Furthermore, the answer of the first research question is given in section 2.3.

2.1 Efficiency of the housing market

Traditional trading theories are largely driven around the concept of market efficiency. In traditional trading economics, the basic assumption is that all available information is being capitalized in the object that is being traded in the market (Evans, 2008). Buyers and sellers are in possession of all available information and act based on this information. Thus, buyers and sellers act based on full information in the market. In efficient markets, newly available information is immediately being capitalised into prices, which explains price changes over time (Harvey and Jowsey, 2004; Evans, 2008). Efficient markets are often also called explicit markets since the good itself is explicitly traded. The real estate market and more specifically the housing market cannot be classified as an efficient market but as an implicit market (Evans, 2008; Rosen, 1974). In implicit markets, the trade is made based on the implicit characteristics of a good. This indicates that the goods that are being traded on implicit markets have unique characteristics. Residential property can be classified as an heterogeneous good with unique location-specific and internal characteristics (Wilkinson, 1973). Internal characteristics of residential property including the number of rooms and unit size cannot explain property prices without taking location-specific factors into account. (Cheshire and Sheppard, 1995; Wilkinson, 1973). This since location-specific characteristics like neighborhood and environmental quality shape residential property prices (Wilkinson, 1973). Each real estate object is unique due to its fixed location with varying location-specific and internal characteristics. This makes the settling of the price for real estate objects far more problematic than for explicit goods (Evans, 2008). Since each real estate object is unique, it is not possible to determine the price of a good as it is done in explicit markets. The price of real property can be set by first determining a price schedule for all individual characteristics from which then the total price for real property can be set (Rosen, 1974;

Evans, 2008). Rosen (1974) is seen as the pioneer in price schedule with the development of the hedonic model which reveals the implicit prices for each characteristic of real property.

2.2 The capitalization of location, accessibility, and amenities in land and property prices.

Classical urban economic theories discuss the relationship between location, land rents. The founding father of the theory of demand and land rents is Ricardo (1817). The Ricardian rent theory is concerned with explaining the relationship between agricultural land and land rents. In the Ricardian rent theory, the supply of land is fixed, which has the consequence that land rent can only be determined by demand. In the Ricardian theory, land rents are determined by the price of agricultural products, for example, corn. This means that high land rents are caused by a high price of corn and not vice versa. The Ricardian theory is further expanded by the bid rent theory of Von Thünen, which adds location as another determinant of land rents. According to Von Thünen, the agricultural land pattern and land rents (bid rents) around the city are determined by competitive bidding among farmers. The bid rent that the farmers can offer for land is determined by the market price of an agricultural product minus transportation costs and production costs. Since transportation costs are lower at land near the marketplace in the city, it is expected that the highest bid rents are offered for land just outside the city.

Alonso (1960) extended the bid rent theory of Von Thünen and developed a rent theory for the urban setting. In the urban rent theory of Alonso (1960) the marketplace is replaced by the Central Business District (CBD) as a central point in the city. The CBD is the location in the city that provides the greatest accessibility to services, amenities, and clients. The exact location of urban land uses like commercial, industrial and residential uses is determined by the factors; business volume (or income), operation costs, and transportation costs. Since business volume and costs differ per urban sector (land use), the maximum bid rent that these urban sectors can offer varies considerably. Next to that, the business volume and costs of urban sectors also vary per location (Alonso, 1960). The result of the urban theory of Alonso (1960) is a bid rent curve with a typical land use pattern with a large representation of commercial uses in inner cities and residential uses in the suburbs. Commercial functions like retail and office tend to be at locations in the CBD for the simple reason that these firms need high turnover rates per sq m^2 for their operations, which can only be achieved at the CBD due to the great accessibility to clients and amenities (Alonso, 1960). The high demand of the commercial sector for central locations results in high bid rents paid in the CBD. In the residential sector, households seek to balance lower commuting costs and greater accessibility versus cheaper land and more space (Alonso, 1960). As a consequence, the location of households is much more fragmented over the city.

The classical urban models display the significance of location and accessibility as a determinant of land prices. Brueckner (1999) presented an amenity-based theory of location by income, which demonstrates that the relative location of different income groups depends on the spatial pattern of amenities over a city. In cities where the center has a strong amenity advantage over the suburbs, high-income groups tend to live in the center due to their higher marginal valuation of amenities. This strong amenity advantage over the suburbs is reflected in higher house and property prices in the city center (Brueckner, 1999). Urban amenities are seen as crucial drivers of the attractiveness and the economic prosperity of cities, especially high-income groups who are attracted to amenities (Glaeser et al., 2001).

Multiple studies have further investigated the effect of the accessibility and availability of amenities on nearby house prices. Alhfeldt and Kavetsos (2014) studied the effects of new sports stadiums developments in London on nearby house prices. For the new Wembley stadium property prices rose by approximately 15%. Daams et al. (2016) studied the effects of natural amenities on nearby house prices and found out that homebuyers pay a premium of 16% within 0.5 kilometers of attractive natural amenities. Several studies have a specific focus on the redevelopment of disamenities and their effect on nearby property prices. Van Duijn et al. (2016) looked at the effects of the redevelopment of abandoned industrial heritage sites on nearby house prices. Furthermore, Zhang et al. (2020) studied the effects of the redevelopment of deteriorated shopping centers on nearby house prices. Van Duijn et al. (2016) and Zhang et al. (2020) both find positive external effects of the redevelopment of disamenities on nearby house prices.

2.3 Speculative behavior and anticipation

In the rational expectation real estate models of Alonso (1964) and Poteba (1984) demand in the housing market is determined by macroeconomic factors, which include national income, rents, interest rates, and demographic characteristics. In the short and middle term, house prices may show large fluctuation that cannot be explained by macroeconomic factors (Zheng *et al.*, 2017). These fluctuations can be explained by changes in internal characteristics and location-specific characteristics including changes in amenities and accessibility to these amenities as explained in the previous sections. However, there is another factor that can explain these housing price fluctuations and that is speculative behavior (Zheng et al., 2017). Speculative behavior is shaped by heterogeneity and bounded rationality among investors (Chiarella et al., 2014). In inefficient markets as the real estate market, the market consists of boundedly rational traders that have heterogeneous expectations about future price developments and asset returns

(Chiarelle et al., 2014; Föllmer et al., 2005). Since each trader aims to maximize its return, given the limited market information and heterogeneous expectations, investors may anticipate on particular future events that may lead to future housing price growth (Zheng et al., 2017). Such future events can be macro-economic events and policies such as the lowering of interest rates or mortgage interest deductibility (Shiller, 2009; 2015). Macro-economic events such as the lowering of interest rates may result in a real estate market boom with a sharp increase in house prices (Shiller, 2009; 2015). Real estate market booms or significant price changes may also occur on a more local scale triggered by urban development projects. House prices near the project area may already rise before the construction and completion of the project (Schwarz et al., 2006). This is since traders expect that house prices will be higher after the completion of the project. Therefore traders will anticipate as early as possible on these expected higher future house prices. As soon after news becomes available in which the announcement of the project is made publicly, house prices are expected to respond due to the anticipation and speculative behavior of traders (Hyun and Milcheva, 2019). Schwarz et al. (2006) designed a graphical visualisation (*fig 2.2*) of the possible impact that a project may have on nearby house prices. As shown in figure 2.2, an increase in house prices may occur after the announcement of the project. The second jump in house prices is expected at the start of the construction of the project. The expected jump in house prices after the start of the project is predicted to be higher than the jump in house prices after the announcement. This since the uncertainty about whether the project will be implemented is taken away. However, multiple empirical studies have proven that house prices near the project area also may decrease after the start of the construction due to the disruption of the construction work (Henneberry, 1998; Dehring et al., 2007). The third increase in house prices is expected after the completion of the project. The expected increase in house prices after the completion of the project is predicted to be linear over time since the spillover effects, such as neighborhoods changes, can take several years. This thesis will specifically focus on the expected price changes due to anticipation of traders after the announcement of the project. Thus, this thesis will focus on the first expected price jump in the graphical visualisation of Schwarz et al. (2006).

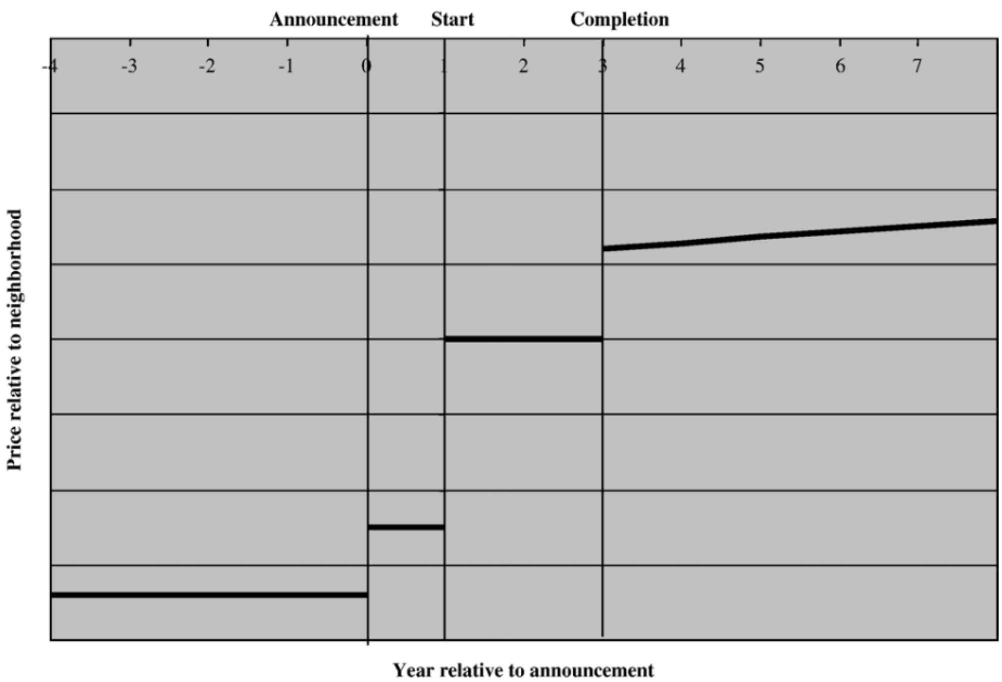

Figure 2.2 Possible impact of a project on nearby house prices over time

2.4 Storytelling and shaping perceptions

This section will provide the answer to the first subquestion mentioned in section 1.2. The previous section points out that traders may already anticipate expected future higher house prices after the announcement of the project. Therefore price changes may already occur after the announcement of the project. Traders will only anticipate if they expect future higher house prices. In the case that traders expect future higher house prices, traders must have positive attitudes and perceptions about the project plan. How are these positive attitudes and perceptions of traders about the project plan shaped? Storytelling, and using planning as persuasive storytelling shape attitudes of people towards plans (Throgmorton, 2003; van Dijk, 2011). Designs are an integral part of persuasive storytelling. The role of and is seen as the main driver behind anticipation. A design translates ambitions into spatial visualisation. More importantly, designs create awareness of the physical spatial reality of an area where people live (van Dijk 2011). This means that designs can visualize what an area is in the current situation and may become in the future. Designs can visualize opportunities, strengths, and weaknesses of an area. Thus, designs create awareness of the physical spatial reality, which is affecting local attitudes, and perceptions of people (van Dijk, 2011). In simpler words, designs enter the mental constructions (frames) about an area and change the perceptions of people about that area. Since perceptions of reality alter over time, designs can help to reframe perceptions of people. The extent to which designs reframe the perceptions of people varies due to the fact people are rather driven by emotions than by rational considerations. Although, it is possible to identify a couple of factors that influence the impact of designs on the perceptions of people: (1) who is the creator of the design, (2) which authority is willing to execute the design, and what are its power resources, (3) what is the purpose and the intention of the creator and the executor (van Dijk, 2011). Next to that, people easily misinterpret the meaning and the purpose of a design because the language that planners use in their communication may be complicated to the public (van Dijk, 2011; Throgmorton, 2003). Therefore planners should be careful in what language plans are communicated to the public. Furthermore, both formal and informal communication change the perceptions of people. Thus, the official communication by planners to the public and the discussions among people about designs are both changing perceptions about an area. Finally, persuasion occurs when the storytelling creates positive attitudes, behavior, and perceptions about a plan (design) and when people are willing to adopt the narrative that is being told (van Dijk, 2011; Throgmorton, 2003). Planning as storytelling is not only persuasive but as well constitutive (Throgmorton, 2003). This means that the story that designs and plans tell should strongly affect communities, culture, and character.

2.5 Hypotheses

The last two sections explain that people may speculate and anticipate on future higher expected house prices after the announcement of a project. Positive attitudes and perceptions about a project are shaped by storytelling, and determince whether anticipation takes place. To answer the first research question, the main driver of changing house prices after the announcement is speculative behavior. The mechanisms behind speculative behavior are attitudes and perceptions that are shaped by storytelling. To find out whether speculative behavior has led to changes in house prices after the announcements of Feyenoord City, subquestions 2 to 4 are formulated. The studies of Schwartz (2006), Hyun & Milcheva (2019), and Kavetsos (2012) have shown that house prices around the project area may rise after the announcement of projects. Furthermore, these studies find out that these external effects or announcement effect decay at greater distance from the project area. Finally, survey results have shown that residents that live within the project area of Feyenoord City have concerns about a range of issues that may arise during and after the construction of the project (RTVRijnmond, 2016; NOS, 2017; Potters, 2017). Therefore a negative price effect is expected on house prices within the project after the Feyenoord City announcements. Th following hypotheses can be formulated:

1. House prices within the project area suffer a negative price effect after the Feyenoord City announcements.
2. House prices around the project area increase after the Feyenoord City announcements.
3. Effects on house prices as a result of the announcements of Feyenoord City decay over distance.

3. Methodology

Chapter 3 starts with a detailed timeline description of previous stadium plans and Feyenoord City. Section 3.2 describes the technicalities of the difference-in-differences method, which is used in the hedonic pricing models. The three difference-in-differences hedonic models are defined and explained in subsection 3.2.1. The last section gives an overview of the descriptive statistics and the data management & cleaning process.

3.1 Case Study

In Rotterdam, the need for a new football stadium is used as a driver for a mega area redevelopment in the south of the city. The visions and ambitions for this area redevelopment and stadium development are brought together in the proposed urban redevelopment project Feyenoord City. The project area covers a long, outstretched urban area of 79.74 hectares along the Maas river, see figure 3.1. The project area can be subdivided into 8 sub-areas that each have a unique development plan (OMA, 2019). The new football stadium forms the hotspot in the project design. Proposed infrastructure in other sub-areas, including a new road network, streetcar routes, and a redeveloped train station, connect the new stadium with surrounding neighborhoods and the city center. The infrastructure developments that the project proposes will improve the accessibility of the project area and surrounding neighborhoods with the rest of Rotterdam and the region (OMA, 2019). The existing football stadium, de Kuip, will be redeveloped in a multi-functional sports park with space for living, athletics, greenery, and cultural activities (OMA, 2019). Another sub-area is the Veranda, which is a new residential district with high-rise buildings. Other sub-areas include the development of recreational parks directly next to the waterfront in which nature and ecology come together. The building program includes 3.550 housing units, 14,750 m^2 gross hotel space, 15,900 m^2 gross office space, 13,550 m^2 gross hospitality space, 17,600 m^2 retail space, 129,850 m^2 gross sports space (OMA, 2019). Besides a building program, the project further includes a social-economic program that aims to stimulate inhabitants of Rotterdam-South to participate in society by involving them in the development of the project, helping inhabitants to get jobs, and promoting a healthy lifestyle.

3.1.2 Timeline stadium discussion and Feyenoord City

Discussions about a new football stadium in Rotterdam have already lasted for almost two decades. Earlier project proposals didn't come further than the drawing table. In February 2007, the municipality presented an ambitious vision in which it presented 13 "Very Important Projects". One of these "Very Important Projects" is a new football stadium (RTVRijnmond, 2017). In September 2008, three potential locations for the new stadium were presented. A location along the Maas river with a stadium with a capacity of 75.000 people was given the preference. 2.5 years later, in January 2011, the municipal council ordered to investigate the renovation of the Kuip as an alternative to the new construction of a stadium (RTVRijnmond, 2011). The financial crisis and the weak financial position of the municipality led to resistance and finally the rejection of the proposal for a mega stadium project along the Maas river. Two plans remained, the reconstruction of the Kuip and a new stadium next to the Kuip. The municipal council communicated that it has a preference for a renovation plan. However, the board of Feyenoord and Stadion Feyenoord both stressed the importance of a new stadium for the financial position of the football club (RTVRijnmond, 2017). Between August 2012 and January 2015 various project proposals were made by two construction consortia VolkerWessels and BAM. Another proposal was made by the foundation 'Red de Kuip', a foundation that consists of local entrepreneurs. In 2014, preference was given to BAM and Red the Kuip that both propose renovation and construction. New construction is not seen as an option at that time due to the high project costs of the VolkerWessels proposal (RTVRijnmond, 2017). This with some resistance from the Feyenoord and Stadion Feyenoord board that had always stressed the importance of new construction for its financial position. In March 2015, the board of Feyenoord canceled negotiations with BAM about the renovation proposal due to high construction costs. In December 2015, the board of Feyenoord presented again its wish for a new stadium instead of renovation (RTVRijnmond, 2017). In January 2016, the municipality announced three potential locations for a new stadium. On 18th March 2016, the municipality chooses de Veranda location along the Maas, which is approximately the same location as that of the first proposal in 2008 (RTVRijnmond, 2016). The plans for Feyenoord City were presented on 30 November 2016 in a concept-version of a Masterplan and the business case (RTVRijnmond, 2016). The support of the municipal council for the Feyenoord City project grew throughout 2017. This is in contrast to the view of inhabitants and Feyenoord supporters that had severe critique on the financial feasibility, the mobility plan, and the reduced view (RTVRijnmond, 2018). The start document for the zoning plan and environmental impact assessment was published on 5 January 2018 (FeyenoordCity, 2018). Throughout 2018 the proposed project suffered some setbacks due to local elections, higher projected costs, and hesitation by the municipal council and the board of Feyenoord (RTVRijnmond, 2018). After months of delay, the updated version of the business case was published on 21 February 2019 (RTVRijmond, 2019). The final version of the Masterplan was presented to the municipal council on 17 October 2019. This is followed by approval of the municipal council on the adjusted project proposal on 29 November 2019 (RTVRijnmond, 2019). The design version of the zoning plan was published on 28 February 2020 (Ruimtelijkeplannen, 2021). The decisive decision about the project implementation was planned for July 2020. However, the decisive decision was delayed till the end of 2021 due to the heavy financial impact of COVID-19 on the football club Feyenoord and Stadion Feyenoord (RTVRijnmond, 2020). Next to that, the search for additional financers, rising construction costs, the need for an updated business case led to hesitation by all involved parties. On 9 July 2020, the Court of Audit published a report in which it critically questioned the urgency and the public interest of spending 40 million euros of public resources on the project (NOS, 2020). In the same month, the final design of the new stadium was presented by the architects. The definite version of the zoning plan was approved by the municipal council on 17 December 2020 (Ruimtelijkeplannen, 2021). Figure 3.2 display a timeline including all important events around the stadium proposals during the last 15 years.

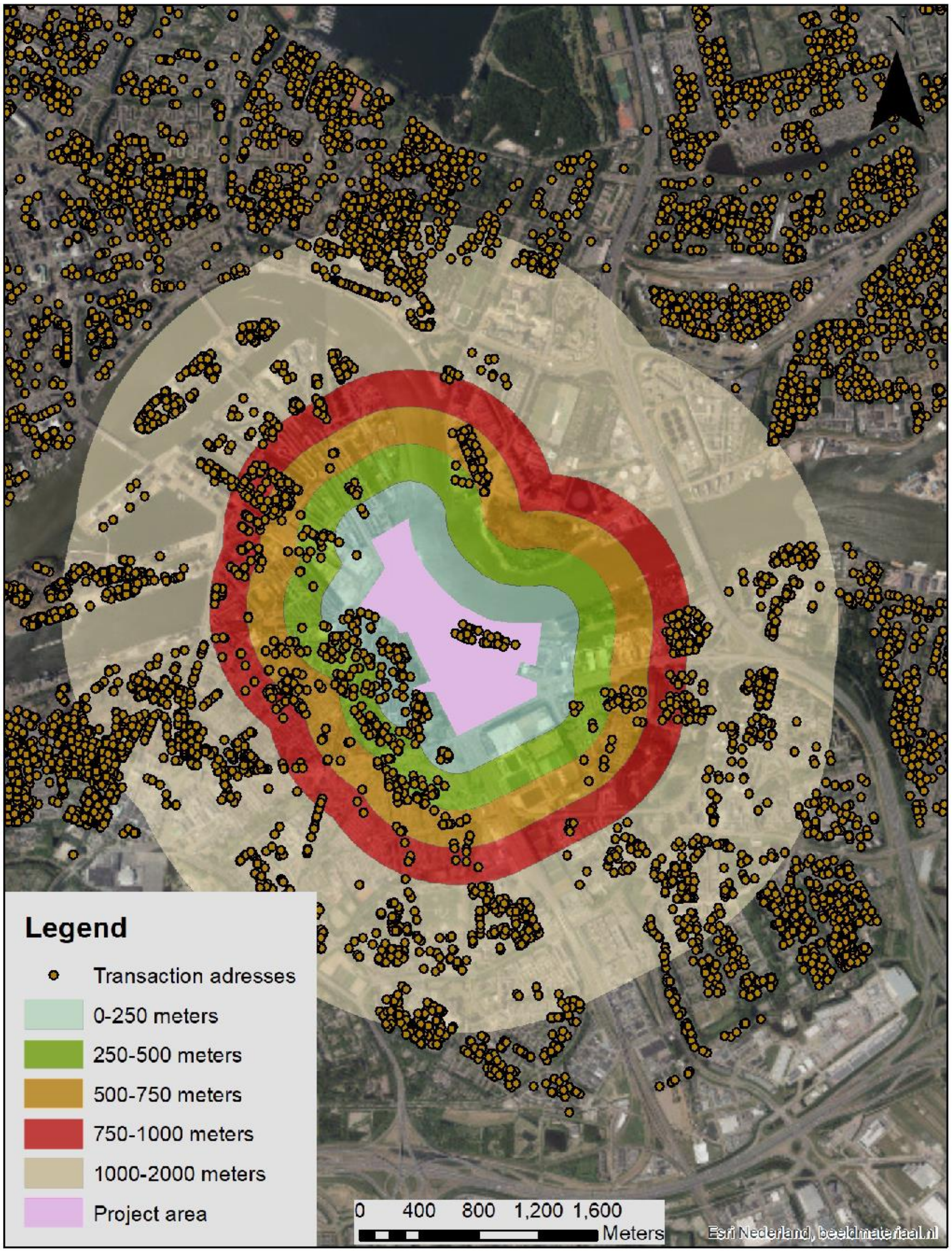

Figure 3.1 Project area and its surrounding (transaction addresses yellow dots)

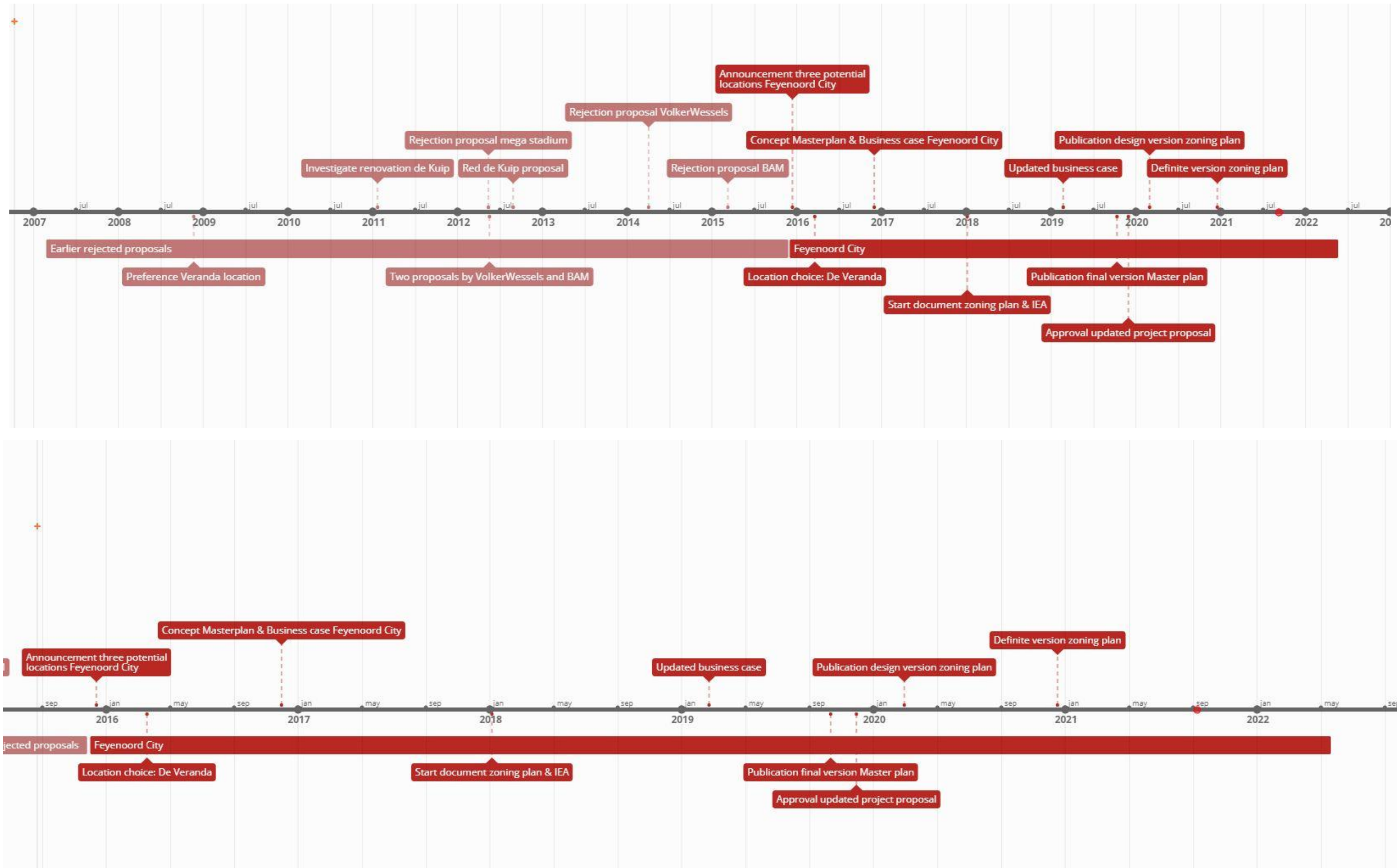

Figure 3.2 Timeline stadium file: events related to previous stadium plans in slightly red color, and events related to Feyenoord City in dark red color

3.2 Method

This thesis investigates the so-called announcement or anticipation effects of the Feyenoord City project. The fundamental aim of this thesis is to capture the change in surrounding house prices after the announcements of the Feyenoord City project. Announcement or anticipation effects can be seen as external housing market effects. Most empirical studies investigate external effects by applying a first-stage hedonic model developed by Rosen (1974) or a modified form of the hedonic model. Since the housing market is implicit, the trade is based on implicit characteristics of a house. The price of a house can be determined by setting a price schedule for all internal and external characteristics of a house. The hedonic model (1974) reveals the implicit prices for each characteristic of a house. In other words, it reveals the contribution of one characteristic on the total price. In the hedonic model, the implicit prices of characteristics are estimated in a regression analysis in which the total house price is regressed on a set of internal and external characteristics. The hedonic model of Rosen (1974) has been further expanded over the decades to satisfy a wider set of research aims. One of these research aims is to find differences in house prices across space and time. These differences across space and time can be captured with a difference-in-differences methodology (van Duijn et al, 2016). The DID design fits our research aim due to the fact that this thesis capture house price changes across space and time. This since the aim of this thesis is to capture changes in house prices after the announcements (time) of Feyenoord City within and nearby the project area (space). The difference-in-differences (DID) application is a variation of the hedonic model by Rosen (1974) and is applied in the studies of van Duijn et al. (2016), Dehring et al. (2007), Hyun & Milcheva, (2019), and Ahlfeldt & Kavetsos (2014). A difference-in-differences design studies the differential effect of a treatment on a target group versus a control group. The received treatment in this thesis is the changed house price due to the announcement of the project. Based on the studies of Hyun & Milcheva (2019) and Ahlfeldt & Kavetsos (2014) it is expected that the effect of the announcement of the project on house prices starts to vanish at increasing distance from the project area. Nearby transactions are therefore put in the target area since these transactions are exposed to announcement effects (treatment). In contrast, the control area is the area that receives no treatment and where no announcement effects are expected, thereby leading to no effects on house prices. The radius of the target area varies significantly across different studies and is project-specific. Kavetsos (2012) observed a 5% price increase in house prices within 4,800 meters of the Olympic Park after the announcement of the London Olympic games. In comparison, Van Duijn et al. (2016) applied a smaller target area of 1.000 meters to study the external effects of industrial redevelopment. Defining the correct treatment area is seen as a process of trial and error (van Duijn et al., 2016; Hyun & Milcheva, 2019). Van Duijn et al. (2016)

applied a strategy in which first a rather large treatment area was chosen to ensure that no treated housing transaction was put in the control group. From here, the strategy was to work to a smaller treatment area. To indicate whether a housing transaction took place within or outside the target area a dummy variable is created. Additionally, an assumption in the DID is that the characteristics of the control and target area are comparable. Van Duin et al. (2016) and Zhang et al. (2020) applied a matching procedure in which different neighborhoods were assigned a propensity score based on characteristics. The propensity scores were estimated based on probit and logit regression. Since one target and control area is included in this study, a comprehensive matching procedure is unnecessary. To check whether the target and control area have comparable characteristics the descriptive statistics of both areas are generated. Furthermore, a DID design is fit for comparisons over distance and time. This is crucial since the aim of the thesis is to measure whether the effect on house prices after the announcements varies with distance. Since three announcement dates will be observed in this study, it is necessary to generate three dummies that indicate whether a transaction took place before or after the announcement date.

3.2.1 Empirical model

The empirical models in the studies of Zhang (2020) and Van Duijn et al. (2016) form the bases of the following difference-in-differences hedonic baseline price model that is created to capture the house price changes after the announcements of Feyenoord City:

$$\log(P_{itd}) = \beta_0 + \beta_1 G_i + \beta_2 Ti + \beta_3 G_i A_t + \beta_4 T_i A_t + \sum_{c=1}^{C} \varphi X_{cit} + \Gamma z + \varepsilon_{it} \quad (1)$$

where $\log(P_{itd})$ is the logarithm of the transaction price of property *i* in sale year *t* and within a certain distance of the project area; G_i is a dummy variable taking the value 1 if the transacted property is located inside the project area; T_i is a dummy variable taking the value 1 if the transacted property is located within the target area; GA_I is a dummy variable taking the value 1 if property $_i$ is located inside project area and is transacted after the announcement, zero otherwise; TA_t is a dummy variable taking the value 1 if property *i* is located within the target area and is transacted after the announcement, zero otherwise. X_{cit} are control variables that include internal property characteristics of property *I* in year *t*; Z represents postal areas to take account of area-fixed effects. The coefficients to be estimated are β_{0-4}, φ, Γ.

The variables G_i, T_i, G_iA_t, T_iA_t, are respectively the dummies “BEFORE_A_project_area”, “BEFORE_A_target_area”, “AFTER_A_project_area”, “AFTER_A_target_area”, which are seen as the key variables in the model specification. The coefficients of G_I (BEFORE_A_project_area), and T_I

(BEFORE_A_target_area) measure the price difference between project/target area and the control area before the announcements of Feyenoord City. The coefficients of G_iA_t (AFTER_A_project_area) and T_iA_t (AFTER_A_target_area) measure external housing market effects in the form of changes in house prices due to the announcements of Feyenoord City. The target area is set up to a distance up to 1,000 meters from the boundaries of the project area.

To capture whether the changes in house price after the project announcement vary with distance (fourth research question) a second model is estimated:

$$\log(P_{itd}) = \beta_0 + \beta_1 G_i + \beta_2 T_i + \beta_4 G_i A + \beta_5 T_i A_t + \tau_1 T_i D_i + \tau_2 T_i D^2_i + \tau_3 T_i A_t D_i + \tau_4 T_i A_t D_i^2 + \sum_{c=1}^{C} \varphi X_{cit} + \Gamma z + \varepsilon_{it} \qquad (2)$$

where D_i is the euclidean distance between the location of the transacted property and the boundary of the project area; D^2_i denotes the euclidean distance in squared form; The coefficient to be estimated are $\beta_{0\text{-}5}$, $\tau_{1\text{-}4}$, φ, Γ. Model specification (2) includes several interaction variables, that include time and distance, to capture the price changes in house prices due to the announcement of the project in a more comprehensive form. The following interaction variables that include the variable distance are generated; (1) BEFORE_A_target_area * distance = $T_i * D$, (2) AFTER_A_target_area * distance = $T_iA_t * D$. The interaction between dummy "BEFORE_A_target_area" and distance allow us to observe how these price differences between the target area and control area vary with distance before the announcements. Secondly, the dummy "AFTER_A_target_area" is interacted with the variable distance to capture whether the external effect (the announcement) on house prices varies with distance. Furthermore, BEFORE_A_target_area is interacted with distance^2 to observe if price differences across distance are non-linear between target and control area before the announcements. The last dummy variable is the interaction variable AFTER_A_target_area * distance^2 that takes account of non-linear external effects on house prices across distance.

$$\text{Log}(P_{itd}) = \beta_0 + \beta_1 G_i + \beta_2 G_i A + \delta_1 R_F T_i + \delta_2 R_F T_i A_t + \sum_{c=1}^{C} \varphi X_{cit} + \Gamma z + \varepsilon_{it} \qquad (3)$$

In alternative model specification (3) we split the target area of 1,000 meters in four distances ring dummies that each have a radius of 250 meters. The four distance ring dummies of 250 meters are shown in figure 3.1. The control area is left intact. The alternative model specification (3) measures the non-linearity of the effect of the project announcements on house prices across distance in a different way than distance^2. In this way, the alternative model specification (3) checks the robustness of the estimations of model specification (2).

3.3 Data

For the analysis, a micro-level dataset on housing transactions is used. The dataset is owned by the Dutch Association of Real Estate Agents and Appraisers and is obtained via the software RealWorks. The dataset contains 41,919 housing transactions recordings in the municpal area of Rotterdam, Capelle aan den IJssel en Krimpen aan den IJsel between January 2014 and December 2020. Many of the addresses of these transactions are visible in figure 3.1. The dataset includes for each transaction recording an extensive range of structural and location-specific characteristics. Before the analysis can be performed, the euclidian distance between the boundary of the Feyenoord City project area and the location of each transaction outside the project area needs to be calculated. The euclidian distances are calculated in the Geographic Information System software QGIS and ArcMap. First, each address is transformed to XY-coordinates in QGIS by a geocoding matching tool. The geocoding tool matched all addresses successfully with an XY coordinate. Transformation to XY coordinates ensures spatially visibility of the location of each transaction. After the project area is drawn in ArcMap, the distances are calculated by using Geographic Information tools. Spatial selection tools in ArcMap are used to identify transactions within the project area. The euclidean distances for transactions located in the project area are set at 0 meters. Furthermore, transaction recordings with a transaction price below 50,000 euros or above 1,500,000 euros are removed. Lastly, all transaction recordings beyond 2,000 meters of the project area are dropped. The remainder of the data management and cleansing process is presented in Appendix A.

After the cleansing process, a total of 5,096 transaction recordings are left. From these 5,096 transaction recordings, 1,302 transactions are located in the target area and 3,579 recordings in the control area. As mentioned in section 3.2, an assumption in the DID design is that the target and control group are identical. Based on a comparison of the characteristics of multiple in distance varying target and control groups, a control group between 1,000-2,000 meters is selected. A control area between 1,000 and 2,000 meters displays identical characteristics with a target area between 0-1,000 meters (table 3.2). As a consequence transactions beyond 2,000 meters are dropped. The chosen target area is smaller than in the studies of Kavetsos (2012) and Hyun & Milcheva (2013) and can be justified by the fact that Dutch cities like Rotterdam are more compact than urban conglomerations as London and Seoul. Furthermore, in the period 2014-2020 multiple (large) redevelopment projects in Rotterdam were undertaken in close proximity of each other. Examples of projects that were undertaken in this period are the Markthal and the redevelopment of the Coolsingel area. To ensure that we measure a price change due to the announcements of Feyenoord City and not the effects of other projects, a smaller target area is necessary. As a result, the effect on house prices due to the Feyenoord City announcements will cover a smaller area than the announcement effects in the studies of Kavetsos (2012) and Hyun & Milcheva (2013). Another argument that justifies the decision of a smaller control area is the geographical location of the project area in Rotterdam South. A control area beyond 2,000 meters area would include a considerable amount of transactions within the city center. In comparison, the target consists predominantly of pre-World War II neighborhoods. By choosing a research area up to 2,000 meters both target and control areas include pre-World War II neighborhoods. In table 3.2, the characteristics of both the target and control areas are given. The average transaction price in the target area is 239,244 euros, which is slightly lower (7.5%) than in the control area. However, a lower average transaction price in the target area is explained by location differences and can be dealt with by adding local spatial fixed effects. A rather interesting statistic is the small proportion of houses in the target area built in the period 1945-1959. This can be explained by the fact that Rotterdam South, in which the research area is located, remained intact during the bombings in World War 2. Thereby causing no need for major rebuilding compared to Rotterdam Center. Rebuilding and renovations in the target area occurred during the second half of the 1990s and early 2000s. Furthermore, between 0-3.2 % of the transacted housing stock in the target and control area was constructed in the 1970s. In the 1970s the municipality of Rotterdam enforced an urban renewal scheme in which a significant proportion of the Rotterdam housing stock was renovated instead of rebuilt (Visscher, 2019). Neighborhoods like Feijenoord, Afrikaanderwijk, Bloemhof, all part of the research area, were included in this urban renewal scheme. Important structural housing characteristics as living surface, housing volume, rooms are identical between the target and control area. The exact characteristics of the project area can be found in Appendix C.

Table 3.2: Descriptive statistics total area, target area, and control area

	Total area 0-2,000 meters)		Target area (0-1,000 meters)		Control area (1,000-2000 meters)	
	mean	sd	mean	sd	mean	sd
Dependent variable						
Transaction price	252,664	152,743	239,244	113,121	257,269	163,910
Structural characteristics						
Living space (m^2)	100.831	35.248	104.564	31.508	99.495	37.091
Housing volume	303.337	123.982	314.562	115.176	299.705	128.968
rooms	3.718	1.196	3.858	1.223	3.693	1.204
bedrooms	2.459	1.096	2.660	1.144	2.399	1.092
Days on the market	140.913	287.459	130.607	236.552	143.130	294.598
Housing type						
Semi-detached (1=yes)	0.012	0.107	0.008	0.087	0.013	0.113
Geschakeld (1=yes)	0.013	0.114	0.035	0.185	0.006	0.076
Corner house	0.058	0.234	0.073	0.260	0.056	0.230
Row house	0.193	0.395	0.265	0.441	0.177	0.382
Detached	0.008	0.089	0.008	0.092	0.008	0.091
Ground floor apartment (1=yes)	0.063	0.243	0.065	0.247	0.066	0.248
Upper floor apartment (1=yes)	0.148	0.355	0.104	0.305	0.169	0.375
Gallery flat (1=yes)	0.116	0.320	0.157	0.364	0.103	0.304
Maisonnette (1=yes)	0.062	0.241	0.065	0.246	0.057	0.232
Porch flat (1=yes)	0.301	0.459	0.199	0.399	0.319	0.466
Other (1=yes)	0.026	0.159	0.022	0.145	0.026	0.159
Construction period						
Before 1901 (1=yes)	0.040	0.195	0.002	0.039	0.056	0.230
1901-1929 (1=yes)	0.101	0.301	0.137	0.344	0.094	0.291
1930-1944 (1=yes)	0.127	0.333	0.098	0.298	0.145	0.352
1945-1959 (1=yes)	0.044	0.205	0.022	0.148	0.054	0.227
1960-1969 (1=yes)	0.135	0.342	0.050	0.218	0.175	0.380
1970-1979 (1=yes)	0.023	0.149	0.000	0.000	0.032	0.177
1980-1989 (1=yes)	0.060	0.238	0.074	0.261	0.059	0.236
1990-1999 (1=yes)	0.160	0.366	0.262	0.440	0.108	0.311
2000-2009 (1=yes)	0.170	0.376	0.188	0.391	0.138	0.345
After 2010 (1=yes)	0.140	0.347	0.167	0.373	0.139	0.346
N	5,096		1,302		3,579	

4. Results

This chapter will describe the results of the three difference-in-differences price models specified in chapter 3. This chapter aims to capture the price change in house prices after the announcement of Feyenoord City based on a project area, a target area of 0-1,000 meters, and a control area of 1,000-2,000 meters. First, the results of the baseline model (1) are described, followed by model (2) and alternative model specification (3) that both try to capture whether the external effect (the announcement) on house prices also varies with distance. In the final section, a sensitivity analysis is performed on the alternative model specification to test the robustness of the results.

4.1 Main difference-in-differences models

Table 4.1 shows the coefficients and standard errors of the key variables in our baseline model (1). Table 4.1 consists of four different columns, which display the results of multiple variations on the main specification of our baseline model. Column 1 presents the naïve specification of the baseline model and only consists of the key variables and time fixed effects in the form of year dummies. The adjusted R-square is limited to 12.0%. In column 2, structural characteristics and housing type dummies are added to the baseline model, which increases the adjusted R-square up to 67.5%. Column 3 adds four digital postal code dummies to control spatial-fixed effects. The adding spatial-fixed effect to the baseline model leads to an adjusted R-square of 83.7%. In column 4, construction period dummies are added to the baseline model. The specification in column 4 is the preferred version of the baseline model since all control variables are added.

The coefficients of all control variables in the baseline model are presented in Appendix D. The coefficients of the year dummies follow the increasing house price trend in the Dutch real estate sector with house prices in 2020 $(\exp_{(0.0635)}-1)\cdot 100$ = 63.5% higher than in 2014. Furthermore, the baseline model (1) captures interesting results for the construction period dummies. Houses constructed before 1901 were sold for $(\exp_{(-0.155)}-1)\cdot 100$ = -15.5% less than houses constructed in the period 2010-2020. In comparison, houses constructed in the period 1960-1969 were sold for $(\exp_{(-0.344)}-1)\cdot 100$ = -34.4% less than houses constructed in the period 2010-2020. A possible explanation could be a difference in building styles.

Table 4.1 shows that in the preferred specification (4) of the baseline model the coefficients of the variables ‘’BEFORE_A project_area’’ and “BEFORE_A_target_area’’ are respectively positive (0.141) and

Table 4.1: Estimation results baseline model (1) target area 0-1,000 meters and control area 1,000-2,000 meters

	(1)	(2)	(3)	(4)
Sample	<2,000 meters	<2,000 meters	<2,000 meters	<2,000 meters
Target area	0-1,000 meters	0-1,000 meters	0-1,000 meters	0-1,000 meters
Control area	1,000-2,000 meters	1,000-2,000 meters	1,000-2,000 meters	1,000-2,000 meters
Before A project area	0.128***	0.0952***	0.290***	0.141***
	(0.0375)	(0.0249)	(0.0281)	(0.0272)
After A1 project area	-0.0367	-0.0129	-0.0353	-0.0379
	(0.0468)	(0.0302)	(0.0258)	(0.0249)
After A2 project area	0.0399	-0.0248	-0.0762***	-0.0707***
	(0.0437)	(0.0297)	(0.0256)	(0.0247)
Before A target area	-0.187***	-0.112***	-0.103***	-0.131***
	(0.0313)	(0.0195)	(0.0177)	(0.0167)
After A1 target area	0.141***	0.0790***	0.0381*	0.0197
	(0.0406)	(0.0261)	(0.0224)	(0.0202)
After A2 target area	0.230***	0.0564**	0.0404**	0.0290
	(0.0383)	(0.0237)	(0.0199)	(0.0180)
After A3 target area	0.252***	0.119***	0.0362	0.0534**
	(0.0462)	(0.0301)	(0.0246)	(0.0224)
Year fixed effects (7)	YES	YES	YES	YES
Structural characteristics (13)	NO	YES	YES	YES
4 digital postal code dummies (26)	NO	NO	YES	YES
Construction periods (10)	NO	NO	NO	YES
Observations	5,096	5,096	5,096	5,096
R-squared	0.120	0.675	0.837	0.867

Note: Dependent variable is ln(transaction price). Announcement date 1: 18 march 2016, Announcement date 2: 5 January 2018, Announcement date 3: 17 October 2019
Coefficients control variables in Appendix D, Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

negative (-0.131). The coefficients of both variables are significant at the 1%-level in specifications (1) to (4). Before the announcements of Feyenoord City houses within the project area were sold for $(\exp_{(0.141)}-1)\cdot 100$ = 14.1% more than houses located between 1,000 and 2,000 of the project area. In comparison, a coefficient of -0.131 indicates that houses within the first 1,000 meters of the project area were already selling for a lower price, $(\exp_{(-0.131)}-1)\cdot 100$ = -13.1%, than houses located between 1,000-2,000 meters. The dummy variable “AFTER_A1_project_area” is insignificant in all four specifications and the insignificance of the dummy variable “AFTER_A1_target_area” is limited to specification (4). Since specification (4) is the preferred baseline model, the conclusion is that the location decision (announcement 1) did not lead to changes in house prices in the project and target area (0-1,000 m). In other words, the estimations of the baseline model (1) show that the location decision did not have any effect on house prices. The coefficient of “AFTER_A2_project_area” is negative and significant at the 1% level in the last two specifications. After the publication of the start document of the zoning plan (announcement 2) house prices within the project area experienced a relative decline of $(\exp_{(-0.0707)}-1)\cdot 100$ = -7.07%. In contrast, the coefficient of “AFTER_A2_target_area” is insignificant in preferred specification 4. Indicating that the publication of the start document of the zoning plan for inspection did not have any impact on house prices within the first 1,000 meters of the project area. The variable “AFTER_A3_target_area” is significant and positive. The coefficient of “AFTER_A3_target_area” shows a positive house price effect of $(\exp_{(0.0534)}-1)\cdot 100$ = 5.34% for houses in the target area after the publication of the definite version of the Masterplan. In other words, after announcement 3 houses within the target area experienced a relative increase of 5.34% in house prices compared to houses between 1,000 and 2,000 meters. Unfortunately, due to a lack of transactions in the project area after announcement 3, the coefficients of After_A3_project_area cannot be estimated. An overview of the number of transactions for all AFTER variables can be found in APPENDIX C.

Table 4.2 presents the estimation results of various specifications of model (2). This model is created to find out whether the announcement effects differ over distance (sub-question 4). Again, the coefficients of the control variables are listed in Appendix D. What differentiates model (2) from the baseline model (1) is the addition of a distance component. As a consequence, model (2) includes 8 extra interaction variables with a distance component. Specification (4) of model (2), which includes all control variables, has an R-square of 86.7% and is, therefore, the preferred model. The estimation results of specification (4) of model (2) are described below. The estimation results for variables that measure the external effects within the project area are similar to results for these variables in the baseline model (1). Almost equivalent to the baseline model, specification 4 of model (2) shows that after the publication of the start document of the zoning plan (announcement 2) house prices within the project area experienced a negative price effect of $(\exp_{(-0.0705)}-1)\cdot 100$ = -7.05%. The coefficient "Before_A_target_area" is similar to the baseline model significant at the 1%-level and has a negative sign.

In contrast to the baseline model, specification (4) of model (2) estimates a stronger effect of "Before_A_target_area" on (log)transaction price than in the baseline model. The coefficients of specification (4) in table 4.2 imply that before the announcements house prices within the first 1,000 meters of the project area were sold for $(\exp_{(-0.227)}-1)\cdot 100$ = -22.7% less than houses between 1,000 and 2,000 meters. The variables "BEFORE_A_target_area * distance" and "BEFORE_A_target_area * distance^2" are non-significant, indicating that house prices before the announcements did not vary with distance within the first 1,000 meters of the project area. Table 4.2 reports that in the preferred specification (4) all AFTER variables for announcements 1 and 3 are non-significant. Thereby leading to the inference that house prices within the 1,000 meters were not affected by the location-decision (announcement 1) and the publication of the Masterplan by the Board of Mayor and Alderman. Table 4.2 shows that in specification (4) the coefficient of the variable "AFTER_A2_target_area" is significant at the 5%-level and has a positive sign. This implies that after the publication of the start document of the zoning plan for inspection (announcement 2) houses within the first 1,000 meters of the project area experienced a relative increase of $(\exp_{(0.0514)}-1)\cdot 100$ = 5.14% in house prices compared to houses further away. The two interaction variables "AFTER_A2_target_area * distance" and "AFTER_A2_target_area * distance^2" are both insignificant. The premium of 5.14% after announcement 2 does not change linearly or non-linearly at a greater distance of the project area.

The second sub-question can be answered based on the baseline model and model (2). House prices within the project area are changing after the announcements. Houses within the project area experienced a negative price effect of approximately -7.05% after the publication of the start document of the zoning plan for inspection (announcement 2). However, this negative price effect is only limited to the period after announcement 2. The third and fourth sub-question cannot be answered by the first two models. This is since the specifications of the baseline model (1) and model (2) show inconsistent results for all AFTER variables related to announcements 2,3 in the target area. The coefficient of the variable "AFTER_A2_target_area" is insignificant in the baseline model but is significant with a positive sign in model (2). For "AFTER_A3_target_area" this is complete the opposite with a significant coefficient in the

Table 4.2: Estimation results model (2), target area 0-1,000 meters and control area 1,000-2,000 meters

	(1)	(2)	(3)	(4)
Sample	<2,000 meters	<2,000 meters	<2,000 meters	<2,000 meters
Target area	0-1,000 meters	0-1,000 meters	0-1,000 meters	0-1,000 meters
Control area	1,000-2,000 meters	1,000-2,000 meters	1,000-2,000 meters	1,000-2,000 meters
Before A1 project area	0.129***	0.0922***	0.289***	0.151***
	(0.0375)	(0.0246)	(0.0286)	(0.0274)
After A1 project area	-0.0377	-0.0139	-0.0352	-0.0375
	(0.0468)	(0.0299)	(0.0258)	(0.0249)
After A2 project area	0.0392	-0.0232	-0.0761***	-0.0705***
	(0.0437)	(0.0294)	(0.0256)	(0.0247)
Before A target area	-0.642***	-0.481***	-0.0986	-0.227***
	(0.0967)	(0.0580)	(0.0727)	(0.0571)
Before A target area * distance	0.00130***	0.00114***	-0.000106	6.52e-05
	(0.000356)	(0.000225)	(0.000247)	(0.000201)
Before A target area * distance^2	-7.51e-07**	-7.15e-07***	1.33e-07	9.47e-08
	(3.05e-07)	(1.97e-07)	(2.03e-07)	(1.71e-07)
After A1 target area	0.0790	0.111	0.00551	-0.00382
	(0.125)	(0.0838)	(0.0782)	(0.0586)
After A1 target area * distance	0.000537	-9.37e-05	0.000217	0.000146
	(0.000472)	(0.000317)	(0.000295)	(0.000239)
After A1 target area * distance^2	-6.23e-07	3.49e-08	-2.23e-07	-1.51e-07
	(4.13e-07)	(2.79e-07)	(2.57e-07)	(2.18e-07)
After A2 target area	0.475***	0.198***	0.0580	0.109**
	(0.110)	(0.0702)	(0.0659)	(0.0514)
After A2 target area * distance	-7.37e-05	-0.000295	5.70e-05	-0.000244
	(0.000414)	(0.000277)	(0.000259)	(0.000211)
After A2 target area * distance^2	-4.44e-07	9.20e-08	-1.17e-07	1.52e-07

	(3.69e-07)	(2.47e-07)	(2.25e-07)	(1.90e-07)
after_A3_target area	0.802***	0.318***	0.00665	0.0341
	(0.132)	(0.0891)	(0.0844)	(0.0671)
After_A3 target area * distance	-0.00124**	-0.000557	0.000193	0.000101
	(0.000520)	(0.000377)	(0.000343)	(0.000283)
After A3 target area * $distance^3$	4.47e-07	3.22e-07	-1.94e-07	-8.21e-08
	(4.62e-07)	(3.39e-07)	(3.03e-07)	(2.58e-07)
Year fixed effects (7)	YES	YES	YES	YES
Structural characteristics (13)	NO	YES	YES	YES
4 digital postal code dummies (26)	NO	NO	YES	YES
Construction periods (10)	NO	NO	NO	YES
Observations	5,096	5,096	5,096	5,096
R-squared	0.132	0.681	0.837	0.867

Note: Dependent variable is ln(transaction price). Announcement date 1: 18 march 2016, Announcement date 2: 5 January 2018, Announcement date 3: 17 October 2019
Coefficients control variables in Appendix D, Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

baseline model and an insignificant coefficient in model (2). A possible explanation for the inconsistency in the significance of the coefficients of these variables is that the external effects are far more local. These very local announcement effects cannot be measured in a specification that is based on a target area of 1,000 meters. Alternative model (3) is used to detect these potential local announcement effects since it is a more flexible version of model (2). Similar to model (2), alternative model (3) aims to capture whether the announcement effects vary with distance. Different from model (2), alternative model (3) is divided into four distance ring dummies for each announcement. The specification of alternative model (3) estimates the changes in house prices due to the announcements in each distance ring dummy. In this way, very local announcement effects can be captured.

Table 4.3 shows the coefficients of the distance ring dummies in alternative model (3). The R-squared in specification (4) is 86.9%, which makes it again the preferred specification. The coefficients of the control variables can be found in Appendix D. The coefficients for all variables related to the project area are consistent with the results in the baseline model (1) and model (2).

Before the location decision house prices within the project area were $(\exp_{(0.145)}-1)\cdot 100$ = 14.5% higher than house prices between 1,000 and 2,000 meters of the project area. Specification (4) of the alternative model also estimates a negative price effect of $(\exp_{(-0.0690)}-1)\cdot 100$ = -6.90% after the publication of the start document of the zoning plan for inspection (announcement 2). Next to that, table 4.3 reports for all four BEFORE distance ring dummies negative significant coefficients at the 1%-level in specification (4). This indicates that similar to the baseline model (1) and model (2), that before the announcements houses within the first 1,000 meters of the project area were sold for a relatively lower price than houses located further away.

The coefficients of the several distance ring dummies confirm the suspicion of very local announcement effects and provide the answer to sub-question 3 and 4. After all three announcements, a significant effect with a positive sign is measured between 500-750 meters of the project area. Distance ring dummy "AFTER_A1_target_area" (500-750 meters) and "AFTER_A3_target_area" (500-750 meters) are significant at the 1% level. The variables "AFTER_A2_target_area" (500-750 meters) has a significance level of 5%. After the location decision (announcement 1) houses were sold for a premium of $(\exp_{(0.0874)}-1)\cdot 100$ = 8.74% between 500-750 meters of the project area. Similarly, after announcements 2 and 3 houses between 500-750 meters of the project area experienced a relative increase of respectively $(\exp_{(0.0643)}-1)\cdot 100$ = 6.43% and $(\exp_{(0.0145)}-1)\cdot 100$ = 14.5% in houses prices compared to houses between 1,000 and 2,000 meters. The characteristics of the ring dummy 500-750 meters can be found in Appendix

D. All other distance ring dummies are non-significant with the exemption of distance ring dummy "AFTER_A2_target_area" (0-250m). After the publication of the start document of the zoning plan (announcement 2), houses between 0-250 meters of the project experienced an increase of $(\exp(0.0792)-1)\cdot 100 = 7.92\%$ in house prices compared to houses between 1,000 and 2,000 meters. In other words, houses between 0-250 meters of the project area experienced a positive house price effect of 7.92%. The alternative model (3) is capable of estimating very local announcement effects between 500-750 meters, and between 0-250 meters for announcement 2.

Table 4.3: Estimation results alternative model (3), target area 0-1,000 meters and control area 1,000-2,000 meters

	(1)	(2)	(3)	(4)
Sample	<2,000 meters	<2,000 meters	<2,000 meters	<2,000 meters
Target area	0-1,000 meters	0-1,000 meters	0-1,000 meters	0-1,000 meters
Control area	1,000-2,000 meters	1,000-2,000 meters	1,000-2,000 meters	1,000-2,000 meters
Before A project area	0.129***	0.0684***	0.270***	0.145***
	(0.0376)	(0.0256)	(0.0282)	(0.0272)
After A1 project area	-0.0383	-0.0122	-0.0334	-0.0372
	(0.0469)	(0.0310)	(0.0256)	(0.0248)
After A2 project area	0.0397	-0.0116	-0.0731***	-0.0690***
	(0.0438)	(0.0305)	(0.0254)	(0.0246)
Before A target area (0-250 m)	-0.447***	-0.352***	-0.140***	-0.204***
	(0.0705)	(0.0388)	(0.0491)	(0.0387)
Before A target area (250-500 m)	-0.301***	-0.207***	-0.130***	-0.225***
	(0.0753)	(0.0448)	(0.0484)	(0.0400)
Before A target area (500-750 m)	-0.149***	-0.0423	-0.122***	-0.146***
	(0.0412)	(0.0268)	(0.0272)	(0.0251)
Before A target area (750-1,000 m)	-0.0762*	-0.0479*	-0.0719***	-0.0825***
	(0.0439)	(0.0262)	(0.0249)	(0.0246)
After A1 target area (0-250 m)	0.134	0.121**	0.0445	-0.00500
	(0.0858)	(0.0545)	(0.0569)	(0.0413)
After A1 target area (250-500 m)	0.0705	-0.0558	-0.0411	-0.00150
	(0.0927)	(0.0599)	(0.0556)	(0.0474)
After A1 target area (500-750 m)	0.288***	0.153***	0.147***	0.0874***
	(0.0521)	(0.0330)	(0.0334)	(0.0296)
After A1 target area (750-1,000 m)	-0.0196	-0.0184	-0.0534	-0.0409
	(0.0610)	(0.0372)	(0.0338)	(0.0328)
After A2 target area (0-250 m)	0.311***	0.156***	0.0934**	0.0792**
	(0.0785)	(0.0478)	(0.0464)	(0.0367)

After A2 target area (250-500 m)	0.459***	0.0627	-0.0154	0.0126
	(0.0894)	(0.0520)	(0.0474)	(0.0388)
After A2 target area (500-750 m)	0.299***	0.0723**	0.123***	0.0643**
	(0.0474)	(0.0324)	(0.0324)	(0.0282)
After A2 target area (750-1,000 m)	0.0197	-0.00430	-0.0331	-0.0119
	(0.0578)	(0.0325)	(0.0289)	(0.0278)
After A3 target area (0-250 m)	0.671***	0.314***	0.0438	0.0415
	(0.0942)	(0.0647)	(0.0542)	(0.0436)
After A3 target area (250-500 m)	0.418***	0.0585	-0.00934	0.0105
	(0.0971)	(0.0955)	(0.0771)	(0.0615)
After A3 target area (500-750 m)	0.190***	0.130***	0.139***	0.145***
	(0.0705)	(0.0370)	(0.0384)	(0.0342)
After A3 target area (750-1,000 m)	0.0488	0.0442	-0.0269	0.0155
	(0.0701)	(0.0404)	(0.0319)	(0.0334)
Year fixed effects (7)	YES	YES	YES	YES
Structural characteristics (13)	NO	YES	YES	YES
4 digital postal code dummies (26)	NO	NO	YES	YES
Construction periods (10)	NO	NO	NO	YES
Observations	5,096	5,096	5,096	5,096
R-squared	0.136	0.685	0.842	0.869

Note: Dependent variable is ln(transaction price). Announcement date 1: 18 march 2016, Announcement date 2: 5 January 2018, Announcement date 3: 17 October 2019
Coefficients control variables in Appendix D, Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.2 Sensitivity analysis

The alternative model (3) estimates very local announcement effects after all three announcement dates. To test the robustness of the estimations of the alternative model (3) a sensitivity analysis is performed. In a sensitivity analysis, conditions in the model are changed to test whether the estimated coefficients remain stable. Additionally, sensitivity analysis is used to determine the exact size of the target area. The specification of the alternative model (3) which includes all control variables is used in the sensitivity analysis. The condition that is changed in the alternative model (3) is the coverage of the control area.

Table 4.4 shows the estimation results for alternative model (3) with all control variables included. Column 1 reports the estimation results of the specification based on a control area between 1,000-2,000 meters. Columns 2, 3 show the estimation results of the specifications of the alternative model (3) based on control areas of respectively 1,000-1,500 meters, and 1,000-2,500 meters. In all three specifications, the target area is within 1,000 meters of the project area. Table 4.4 reports an R-squared of over 86% for all three specifications. The estimated coefficients are largely consistent between all three specifications, which confirms the robustness of the estimations. The largest deviations in estimated coefficients can be found in the dummy "BEFORE_A_project_area". The estimated coefficient in specification 2 is half of the estimated coefficient in specification 3. The main explanation for this major difference in estimated coefficients is that specification 3 is based on a control group between 1,000 and 2,500 meters and therefore includes various housing transactions within the city center that have higher transaction prices than houses in between 1,000 and 2,000 meters from the project area. Table 4.4 reports roughly equal significance levels, coefficients, and standard errors for AFTER distance ring dummies between 500-750 meters. Furthermore, all AFTER distance ring dummies between 500-750 meters have a positive direction. Some deviations can be found in AFTER_A2_target_area (500-750m), which significance is limited to the 10%-level in specification 2. Nonetheless, the standard errors in all three specifications of "AFTER_A2_target_area" (500-750m) are identical. The significance levels and standard errors are roughly equal for "AFTER_A3_target_area" (500-750m). Although, a difference of $(\exp_{(0.175\text{-}0.145)}-1)\cdot 100 = 3.0\%$ is reported between specification 1 and 2. Table 4.4 shows that the distance ring dummy "AFTER_A3_target_area" (500-750m) has the same direction in all three specifications. Next to that, the coefficients and standard errors remain identical across all specifications.

Since no effects on house prices can be observed between 750-1000 meters, it is arguable that the initial chosen target of 1,000 meters is too large. A target area up to 750 meters would be sufficient enough to capture changes in house prices due to the announcement of Feyenoord City.

Tabe 4.4: Estimation results sensitivity analysis

	(1)	(2)	(3)
Sample	<2,000 meters	<1,500 meters	<2,500 meters
Target area	0-1,000 meters	0-1,000 meters	0-1,000 meters
Control area	1,000-2,000 meters	1,000-1,500 meters	1,000-2,500 meters
Before A project area	0.145***	0.109***	0.199***
	(0.0272)	(0.0340)	(0.0241)
After_A1_project area	-0.0372	-0.0135	-0.0344
	(0.0248)	(0.0256)	(0.0239)
After_A2_project area	-0.0690***	-0.0699***	-0.0662***
	(0.0246)	(0.0253)	(0.0240)
Before A target area (0-250 m)	-0.204***	-0.169***	-0.197***
	(0.0387)	(0.0376)	(0.0388)
Before A target area (250-500 m)	-0.225***	-0.213***	-0.214***
	(0.0400)	(0.0390)	(0.0390)
Before A target area (500-750 m)	-0.146***	-0.117***	-0.146***
	(0.0251)	(0.0250)	(0.0244)
Before A target area (750-1,000 m)	-0.0825***	-0.0455*	-0.0837***
	(0.0246)	(0.0239)	(0.0240)
After A1 target area (0-250 m)	-0.00500	0.0107	0.00839
	(0.0413)	(0.0390)	(0.0417)
After A1 target area (250-500 m)	-0.00150	0.0358	-0.00759
	(0.0474)	(0.0476)	(0.0459)
After A1 target area (500-750 m)	0.0874***	0.102***	0.0919***
	(0.0296)	(0.0286)	(0.0286)
After A1 target area (750-1,000 m)	-0.0409	0.00334	-0.0316
	(0.0328)	(0.0309)	(0.0321)
After A2 target area (0-250 m)	0.0792**	0.0797**	0.0915**
	(0.0367)	(0.0364)	(0.0360)

After A2 target area (250-500 m)	0.0126	0.0402	0.000846
	(0.0388)	(0.0380)	(0.0378)
After A2 target area (500-750 m)	0.0643**	0.0517*	0.0787***
	(0.0282)	(0.0272)	(0.0271)
After A2 target area (750-1,000 m)	-0.0119	-0.00309	0.00228
	(0.0278)	(0.0268)	(0.0267)
After A3 target area (0-250 m)	0.0415	0.0649	0.0613
	(0.0436)	(0.0439)	(0.0424)
After A3 target area (250-500 m)	0.0105	0.0534	0.0118
	(0.0615)	(0.0551)	(0.0598)
After A3 target area (500-750 m)	0.145***	0.175***	0.153***
	(0.0342)	(0.0360)	(0.0342)
After A3 target area (750-1,000 m)	0.0155	0.0549*	0.0407
	(0.0334)	(0.0312)	(0.0325)
Year fixed effects (7)	YES	YES	YES
Structural characteristics (13)	YES	YES	YES
4 digital postal code dummies (26)	YES	YES	YES
Construction periods (10)	YES	YES	YES
Observations	5,096	3,114	8,683
R-squared	0.869	0.880	0.885

Note: Dependent variable is ln(transaction price). Announcement date 1: 18 march 2016, Announcement date 2: 5 January 2018, Announcement date 3: 17 October 2019. Coefficients control variables in Appendix D, Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5. Discussion

The following chapter provides explanations for the results that flow from the difference-in-differences models in chapter 4. The models in chapter 4 are able to capture price changes after the three announcements of Feyenoord City. The estimation results of the empirical models prove that external effects in the form of announcement effects impacted house prices within and close to the project area. The results are in line with the theoretical model of Schwartz (2006), in which it is emphasized that house prices near the project area may rise before the construction of the project. In inefficient markets such as the Rotterdam real estate market, the market consists of boundedly rational buyers and sellers that have heterogeneous expectations about future price developments and asset returns (Chiarelle et al., 2014; Föllmer et al., 2005). Since each buyer and seller aims to maximize its return, given the limited market information and heterogeneous expectations, investors may anticipate on particular future events that may lead to future housing price growth (Zheng et al., 2017). The empirical models in this thesis show that buyers and sellers expect higher house prices in the proximity of Feyenoord City after realisation the project. Buyers and sellers, therefore, anticipated on these expected future higher house prices near Feyenoord City after the announcements. This resulted in higher house prices around the project area after the announcements.

For house prices within the project area, the expectations are the opposite of the house price expectations around the project area. Buyers and sellers expect lower house prices within the project area after the realisation of Feyenoord City. Buyers and sellers, therefore, anticipate on future expected lower house prices within the project area. The result is a negative price effect of -6.9% (table 4.3) for houses within the project area after the publication of the start document of the zoning plan for inspection (announcement 2). The finding that houses within the project area experience a relative decline in house prices is not a shock and is in line with the expectations. As mentioned in the introduction of chapter 1, survey results show that residents who live within the project area are rather skeptical about Feyenoord City. There are serious concerns about noise pollution, parking & congestion, and planning damage during and after the construction of Feyenoord City (Potters, 2017). These concerns together with a lack of communication of stakeholders towards residents are a possible explanation for a decline in house prices within the project area after announcement 2. The perceptions and attitudes of residents that live within the project area are rather negative, which is the result of poor storytelling and communication about Feyenoord City towards these residents. Van Dijk (2011) and Throgmorton (2003) emphasized that good storytelling can lead to positive attitudes, perceptions about project designs and plans. In the case of Feyenoord City, storytelling and communication were inadequate and incapable of eliminating the above-mentioned concerns of residents within the project area. Due to all these concerns, residents within the project area expected lower house prices after the realisation of Feyenoord City. This resulted in anticipation of people on these future lower house prices and thus a decrease in house prices within the project area after the publication of the start document of the zoning plan for inspection (announcement 2). This is not the first thesis that finds a negative price effect on house prices due to the announcement of a project. The study of Dehring et al. (2007) also observes a decline in house prices after one of the announcements about a stadium development. However, the study of Dehring et al. (2007) finds a decline in house prices nearby the project area and not within the project area. One question that remains to be answered is the following: why is a decrease in house prices within the project area limited to the period after announcement 2 and not observed after the location decision (announcement 1). The answer to this question has to do with stadium plans that have never reached the planning stage. The project area of Feyenoord City, called the Veranda, was also chosen as the project location in an earlier stadium plan in 2009. However, this earlier stadium plan never reached the final design & planning phases. For already more than a decade, the Veranda location is seen as the most preferred location for a new Feyenoord stadium. As a result, the decision to choose the Veranda as the location for Feyenoord City was not seen as a surprise for residents of the Veranda. This explains the inability of the models to capture a price change within the project area after the location decision. Earlier stadium plans never enforced legal preparations, the publication of the start document of the zoning plan (announcement 2) for inspection could therefore be seen as a large event. The start of legal preparations also increases the probability that a project will reach the construction phase. The increased probability of the actual implementation of the project probably explains the anticipation of people on lower expected future house prices within the project area after announcement 2.

The alternative model (3) confirms that the announcement effects of Feyenoord City are rather local. The results deviate from the empirical studies of Kavetsos (2012), Hyun & Mylcheva (2019), and Immergluck (2009), who captured price changes after the project announcements up to several kilometers. Based on the estimations of alternative model (3), after all three announcements houses between 500-750 meters experienced an increase between 6.45%-14.5% (table 4.3) in house prices compared to houses between 1,000 and 2,000 meters. But what is the explanation for the relative increase in house prices between 500-750 meters after all three announcement dates? An explanation is that surplus of the project, defined as the difference between the positive external and negative effects of Feyenoord City, is much greater for houses between 500-750 meters than houses in closer proximity and within the project area. Houses located between 500-750 meters from the project area can benefit from a great range of new facilities and opportunities such as retail facilities, restaurants, bars, parks, and job opportunities, while negative effects such as noise pollution, traffic congestion, parking issues, and planning damage remain limited at this distance. Furthermore, a relative increase in house prices is observed between 0-250 meters compared to houses between 1,000-2,000 meters after announcement date 2. The exact reason for a price increase between 0-250 meters after the publication of the start document of the zoning plan remains rather vague.

The empirical results of this study provide important insights for the working field of planning and real estate. To this point, the financial consequences of the announcements of megaprojects were largely unclear or neglected by policy-makers. This thesis shows that the announcement of a megaproject, such as Feyenoord City may impact house prices via speculative behavior and anticipation. Another important result is that this thesis proves that the announcement of megaprojects is rather a process than a one-day event. This is since the empirical models capture significant house prices changes after all three announcement dates. The empirical results of this thesis create awareness among policymakers about the financial consequences of announcements of megaprojects. This could stimulate policymakers, planners, and real estate developers to focus more on storytelling which is the driver behind speculative behavior.

6. Conclusion

The financial consequences of the announcements of Feyenoord City in the form of changes in house prices are explored in this thesis. The estimation results of the empirical models provide insights to plan and policymakers about so-called anticipation or announcement effects that lead to changes in house prices. This thesis aimed to capture changes in house prices after three announcements of Feyenoord City. Difference-in-differences hedonic price models were used, similar to the models applied in the study of Zhang et al. (2020) and Van Duijn et al. (2016). In this thesis, four research questions and three corresponding hypotheses were formulated. The following bullets provide an answer to each research question.

1. What are the drivers and mechanisms that lead to changes in house prices after the announcement of mega-projects?
    - The main driver behind house prices changes after the announcements of megaprojects is speculative behavior. Storytelling which shapes perceptions and attitudes about plans is seen as the mechanism behind speculative behavior.
2. To what extent do the announcements of Feyenoord City lead to a negative price effect on house prices within the project area?
    - House prices within the project area declined by 6.9% after the announcement of the start document of the zoning plan for inspection (announcement 2). Hypothesis 1 (section 2.5) is can therefore not be rejected.
3. To what extent do the announcements of Feyenoord City affect house prices in the vicinity of the project area?
    - The announcement effects on house prices nearby the project area are very local. After all three announcements houses between 500-750 meters experienced an increase of 6.45%-14.5% after the three studied announcements of Feyenoord City compared to houses between 1,000 and 2,000 meters. Hypothesis 2 (section 2.5) can therefore not be rejected.
4. How do the effects of the announcements of Feyenoord City on house prices deviate over distance?
    - The announcement effects of Feyenoord City do deviate over distance. Significant announcement effects can be found between 500-750 meters of the project area after all three announcements. A somewhat weaker announcement effect is found between 0-250 meters of the project area after announcement 2. At other distances, no announcement effects are found. Hypothesis 3 can therefore not be rejected.

Limitations and further research

Besides the interesting estimation results, this thesis faces certain limitations that relate to the methodology and data management. One of the limitations is that this thesis is a case study. Therefore it is difficult to make generalized statements that will apply to other megaprojects. Other limitations are the result of a lack of data in the transaction year 2020. The effect of the publication of the definite version of the Masterplan by the Board of Mayor and Alderman on house prices within the project area could not be estimated by the difference-in-differences models due to a lack of transactions within the project area with a transaction date after October 2019. However, it was possible to capture a change in house prices within and nearby the project area after the publication of the start document of the zoning plan. Nonetheless, no explanation can be found for an increase in house prices within 250 meters of the project area after the publication of the start document of the zoning plan.

Further research can be done on the effect of the approval of zoning plans by the municipal council on house prices. The estimation results of this thesis show that the publication of the start document of the Feyenoord City zoning plan for inspection led to changes in house prices. The definite version of a zoning plan has even more implications for the living environment and provides more legal certainty than a start document. To my best knowledge, the effect of the approval of zoning plans on house prices has never been studied before. If the project proposal of Feyenoord City would be implemented then it would be interesting to see whether house prices changed after the full completion of the project.

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APPENDIX A – DO-FILE* STATA

```
// Browse to folder containing the dataset and open the file

cd "C:\Users\Mehdi\Documents\Documents\Real Estate Studies\Master Thesis\Data\Stata\excel"
import delimited "NVMdataFeyenoordCitydefinitief.csv"

//transform to numerical variables, destring
destring parcelsurface, replace
destring externalstoragespace, replace
destring otherinternalspace, replace
destring gebouwgebbuitenruimte, replace
destring livingroom, replace

//cleaning postal codes
tabulate postalcodearea
drop if postalcodearea==4 | postalcodearea==8

//recoding typeofhouse
tabulate typeofhouse
encode typeofhouse, gen(housingtype)
tabulate housingtype, nolab
recode housingtype 2=2 3/4=4 1/5=1 8=19 17/18=18 10=19, gen(housingtype_c)
tabulate housingtype_c
recode housingtype_c 4=4 2/6=6 12=12 11/13=13 16=19, gen(housingtype_d)
tabulate housingtype_d

//generate building period dummies
gen construction_before_1901 = (constructionyear < 1901)
gen construction_1901_1929 = (constructionyear > 1900 & constructionyear < 1930)
gen construction_1930_1944 = (constructionyear > 1929 & construction year < 1945)
gen construction_1945_1959 = (constructionyear > 1944 & construction year < 1960)
gen construction_1960_1969 = (constructionyear > 1959 & constructionyear < 1970)
gen construction_1970_1979 = (constructionyear > 1969 & construction year < 1980)
gen construction_1980_1989 = (constructionyear > 1979 & construction year < 1990)
gen construction_1990_1999 = (constructionyear > 1989 & construction year < 2000)
gen construction_2000_2009 = (constructionyear > 1999 & constructionyear < 2010)
gen construction_after_2010 = (constructionyear > 2009)

// data cleaning, means dropping outliers
drop if missing(transactionprice)
```

```
drop if transactionprice < 50000
drop if transactionprice > 1500000

drop if rooms < 1 | rooms > 8
drop if livingsurface < 25
hist livingsurface
drop if constructionyear==0 | constructionyear > 2020

drop if distance > 2000

//Generate natural logarithm of transaction price
hist transactionprice
gen lntransactionprice = ln(transactionprice)
drop if missing(lntransactionprice)

//creating Target dummy
gen projectarea = distance < 10
gen target = ( distance > 10 & distance < 1000)

//creating buffer distance dummies
gen bufferprojectgebied = distance <10
tabulate bufferprojectgebied
gen buffer250 = (distance >10 & distance <250)
tabulate buffer250
gen buffer250500 = (distance >249 & distance <500)
tabulate buffer250500
gen buffer500750 = (distance >499 & distance <750)
tabulate buffer500750
gen buffer7501000 = (distance >749 & distance <1000)
tabulate buffer7501000

//formatting dates
gen transactionyear = substr(salesdate,-4,.)
gen transactiondateDMY=date(salesdate,"DMY")
format transactiondateDMY %td
destring transactionyear, replace
tabulate transactionyear

drop if transactionyear==2021

//creating announcement dummies alternative
gen announcement1= transactiondateDMY> td(18mar2016) & transactiondateDMY <=   td(5jan2018)
```

```
tabulate announcement1
gen announcement2=  transactiondateDMY> td(5jan2018) &  transactiondateDMY <=  td(17oct2019)
tabulate announcement2
gen announcement3=  transactiondateDMY> td(17oct2019)
tabulate announcement3

//creating distance^2
gen distancesq = distance^2

//creating interaction variables
//creating interaction variables target * the four announcement dates
gen TA1 = target * announcement1
tabulate TA1
gen TA2 = target * announcement2
tabulate TA2
gen TA3 = target * announcement3
tabulate TA3
gen PA1 = projectarea * announcement1
tabulate PA1
gen PA2 = projectarea * announcement2
tabulate PA2
gen PA3 = projectarea * announcement3
tabulate PA3

// interaction variable target * distance | target * distance^2
gen TD = target * distance
gen TDsq = target * distancesq

//interaction variables target * announcement * distance | target * announcement * distance^2
gen TAD1 = target * announcement1 * distance
gen TAD2 = target * announcement2 * distance
gen TAD3 = target * announcement3 * distance

gen TAD1sq = target * announcement1 * distancesq
gen TAD2sq = target * announcement2 * distancesq
gen TAD3sq = target * announcement3 * distancesq


// After announcement buffers
gen beforebuffer250 = target * buffer250
gen beforebuffer500= target * buffer250500
gen beforebuffer750= target * buffer500750
```

```
gen beforebuffer1000= target * buffer7501000

gen afterbuffer2501= target * announcement1 * buffer250
tabulate afterbuffer2501
gen afterbuffer5001= target * announcement1 * buffer250500
tabulate afterbuffer5001
gen afterbuffer7501= target *announcement1 *buffer500750
tabulate afterbuffer7501
gen afterbuffer10001= target *announcement1* buffer7501000
tabulate afterbuffer10001

gen afterbuffer2502= target * announcement2 * buffer250
tabulate afterbuffer2502
gen afterbuffer5002= target * announcement2 * buffer250500
tabulate afterbuffer5002
gen afterbuffer7502= target *announcement2 *buffer500750
tabulate afterbuffer7502
gen afterbuffer10002= target *announcement2* buffer7501000
tabulate afterbuffer10002

gen afterbuffer2503= target * announcement3 * buffer250
tabulate afterbuffer2503
gen afterbuffer5003= target * announcement3 * buffer250500
tabulate afterbuffer5003
gen afterbuffer7503= target *announcement3 *buffer500750
tabulate afterbuffer7503
gen afterbuffer10003= target *announcement3* buffer7501000
tabulate afterbuffer10003

//descriptive statistics
generate tweeondereenkap = housingtype_d==1
generate geschakeld = housingtype_d==4
generate hoekwoning = housingtype_d==6
generate tussenwoning = housingtype_d==7
generate vrijstaand = housingtype_d==9
generate bovenwoning = housingtype_d==12
generate benedenwoning = housingtype_d==13
generate gallerijflat = housingtype_d==14
generate maisonnette = housingtype_d==15
generate portiekflat = housingtype_d==18
generate other = housingtype_d==19
```

```
//generating publication tables which include descriptive statistics
estpost sum transactionprice livingsurface volumehouse rooms bedrooms daysonthemarket
tweeondereenkap geschakeld hoekwoning tussenwoning vrijstaand benedenwoning bovenwoning
gallerijflat maisonnette portiekflat other construction_before_1901 construction_1901_1929
construction_1930_1944 construction_1945_1959 construction_1960_1969 construction_1970_1979
construction_1980_1989 construction_1990_1999 construction_2000_2009 construction_after_2010

esttab, cell((mean(fmt(%9.3f)) sd(fmt(%9.3f)))) nonumber nomtitle
esttab using descriptivesfeyenoordcitytotal.rtf, cell((mean(fmt(%9.3f)) sd(fmt(%9.3f)))) nonumber
nomtitle

estpost sum transactionprice livingsurface volumehouse rooms bedrooms daysonthemarket
tweeondereenkap geschakeld hoekwoning tussenwoning vrijstaand benedenwoning bovenwoning
gallerijflat maisonnette portiekflat other construction_before_1901 construction_1901_1929
construction_1930_1944 construction_1945_1959 construction_1960_1969 construction_1970_1979
construction_1980_1989 construction_1990_1999 construction_2000_2009 construction_after_2010 if
target==1

esttab, cell((mean(fmt(%9.3f)) sd(fmt(%9.3f)))) nonumber nomtitle
esttab using descriptivesfeyenoordcitytargetarea.rtf, cell((mean(fmt(%9.3f)) sd(fmt(%9.3f)))) nonumber
nomtitle

estpost sum transactionprice livingsurface volumehouse rooms bedrooms daysonthemarket
tweeondereenkap geschakeld hoekwoning tussenwoning vrijstaand benedenwoning bovenwoning
gallerijflat maisonnette portiekflat other construction_before_1901 construction_1901_1929
construction_1930_1944 construction_1945_1959 construction_1960_1969 construction_1970_1979
construction_1980_1989 construction_1990_1999 construction_2000_2009 construction_after_2010 if
projectarea==1

esttab, cell((mean(fmt(%9.3f)) sd(fmt(%9.3f)))) nonumber nomtitle
esttab using descriptivesfeyenoordcityprojectarea.rtf, cell((mean(fmt(%9.3f)) sd(fmt(%9.3f)))) nonumber
nomtitle

estpost sum transactionprice livingsurface volumehouse rooms bedrooms daysonthemarket
tweeondereenkap geschakeld hoekwoning tussenwoning vrijstaand benedenwoning bovenwoning
gallerijflat maisonnette portiekflat other construction_before_1901 construction_1901_1929
construction_1930_1944 construction_1945_1959 construction_1960_1969 construction_1970_1979
construction_1980_1989 construction_1990_1999 construction_2000_2009 construction_after_2010 if
distance > 500 & distance < 750
```

```
esttab, cell((mean(fmt(%9.3f)) sd(fmt(%9.3f)))) nonumber nomtitle
esttab using descriptivesfeyenoordcity500750.rtf, cell((mean(fmt(%9.3f)) sd(fmt(%9.3f)))) nonumber nomtitle

estpost sum transactionprice livingsurface volumehouse rooms bedrooms daysonthemarket tweeondereenkap geschakeld hoekwoning tussenwoning vrijstaand benedenwoning bovenwoning gallerijflat maisonnette portiekflat other construction_before_1901 construction_1901_1929 construction_1930_1944 construction_1945_1959 construction_1960_1969 construction_1970_1979 construction_1980_1989 construction_1990_1999 construction_2000_2009 construction_after_2010 if target==0 & projectarea==0

esttab, cell((mean(fmt(%9.3f)) sd(fmt(%9.3f)))) nonumber nomtitle
esttab using descriptivesfeyenoordcitycontrolarea.rtf, cell((mean(fmt(%9.3f)) sd(fmt(%9.3f)))) nonumber nomtitle

//renaming variables
rename projectarea before_A_P
rename PA1 after_A1_P
rename PA2 after_A2_P
rename PA3 after_A3_P
rename target before_A_T
rename TA1 after_A1_T
rename TA2 after_A2_T
rename TA3 after_A3_T

rename TD before_A_TD
rename TAD1 after_A1_TD
rename TAD2 after_A2_TD
rename TAD3 after_A3_TD
rename TDsq before_A_TDsq
rename TAD1sq after_A1_TDsq
rename TAD2sq after_A2_TDsq
rename TAD3sq after_A3_TDsq


//Regression analysis DID
ssc install outreg2
//Regressions Baseline model (1)

//Baseline model with year only// PA3 cannot be added due to a lack of cases with value 1 (just 10), will lead to biased results if included
reg lntransactionprice before_A_P after_A1_P after_A2_P before_A_T after_A1_T after_A2_T
```

```
after_A3_T i.transactionyear, r
estat vif
outreg2 using baselineyear.doc, label

//Baseline model with year, structural characteristics
reg lntransactionprice before_A_P after_A1_P after_A2_P before_A_T after_A1_T after_A2_T
after_A3_T livingsurface bedrooms daysonthemarket tweeondereenkap geschakeld hoekwoning
tussenwoning vrijstaand benedenwoning bovenwoning gallerijflat portiekflat other i.transactionyear, r
estat vif
outreg2 using baselineyearstruct.doc, label

//Baseline model with year, structural, postalcode
reg lntransactionprice before_A_P after_A1_P after_A2_P before_A_T after_A1_T after_A2_T
after_A3_T livingsurface bedrooms daysonthemarket tweeondereenkap geschakeld hoekwoning
tussenwoning vrijstaand benedenwoning bovenwoning gallerijflat portiekflat other i.postalcodearea
i.transactionyear, r
estat vif
outreg2 using baselineyearstructpost.doc, label

//Baseline model with year, structural, postalcode, construction dummies
reg lntransactionprice before_A_P after_A1_P after_A2_P before_A_T after_A1_T after_A2_T
after_A3_T livingsurface bedrooms daysonthemarket tweeondereenkap geschakeld hoekwoning
tussenwoning vrijstaand benedenwoning bovenwoning gallerijflat portiekflat other
construction_before_1901 construction_1901_1929 construction_1930_1944 construction_1945_1959
construction_1960_1969 construction_1970_1979 construction_1980_1989 construction_1990_1999
construction_2000_2009 i.postalcodearea i.transactionyear
estat hettest

reg lntransactionprice before_A_P after_A1_P after_A2_P before_A_T after_A1_T after_A2_T
after_A3_T livingsurface bedrooms daysonthemarket tweeondereenkap geschakeld hoekwoning
tussenwoning vrijstaand benedenwoning bovenwoning gallerijflat portiekflat other
construction_before_1901 construction_1901_1929 construction_1930_1944 construction_1945_1959
construction_1960_1969 construction_1970_1979 construction_1980_1989 construction_1990_1999
construction_2000_2009 i.postalcodearea i.transactionyear, r
estat vif
outreg2 using baselineyearall.doc, label
predict myResiduals
sktest myResiduals

//correlations
corr before_A_P after_A1_P after_A2_P before_A_T after_A1_T after_A2_T after_A3_T livingsurface
bedrooms daysonthemarket tweeondereenkap geschakeld hoekwoning tussenwoning vrijstaand
```

```
benedenwoning bovenwoning gallerijflat portiekflat other construction_before_1901
construction_1901_1929 construction_1930_1944 construction_1945_1959 construction_1960_1969
construction_1970_1979 construction_1980_1989 construction_1990_1999 construction_2000_2009
i.transactionyear i.postalcodearea

//Model 2 with distance and distance^2
//Model 2 year only
reg lntransactionprice before_A_P after_A1_P after_A2_P before_A_T before_A_TD before_A_TDsq
after_A1_T after_A1_TD after_A1_TDsq after_A2_T after_A2_TD after_A2_TDsq after_A3_T
after_A3_TD after_A3_TDsq i.transactionyear, r
outreg2 using Model2year.doc, label

//Model 2 year, structural
reg lntransactionprice before_A_P after_A1_P after_A2_P before_A_T before_A_TD before_A_TDsq
after_A1_T after_A1_TD after_A1_TDsq after_A2_T after_A2_TD after_A2_TDsq after_A3_T
after_A3_TD after_A3_TDsq livingsurface bedrooms daysonthemarket tweeondereenkap geschakeld
hoekwoning tussenwoning vrijstaand benedenwoning bovenwoning gallerijflat portiekflat other
i.transactionyear, r
outreg2 using Model2yearstructural.doc, label

//Model 2 year, structural, postalcode
reg lntransactionprice before_A_P after_A1_P after_A2_P before_A_T before_A_TD before_A_TDsq
after_A1_T after_A1_TD after_A1_TDsq after_A2_T after_A2_TD after_A2_TDsq after_A3_T
after_A3_TD after_A3_TDsq livingsurface bedrooms daysonthemarket tweeondereenkap geschakeld
hoekwoning tussenwoning vrijstaand benedenwoning bovenwoning gallerijflat portiekflat other
i.postalcodearea i.transactionyear, r
outreg2 using Model2yearstructuralpostal.doc, label

//Model 2 with year, structural, postalcode, corstruction dummies
reg lntransactionprice before_A_P after_A1_P after_A2_P before_A_T before_A_TD before_A_TDsq
after_A1_T after_A1_TD after_A1_TDsq after_A2_T after_A2_TD after_A2_TDsq after_A3_T
after_A3_TD after_A3_TDsq livingsurface bedrooms daysonthemarket tweeondereenkap geschakeld
hoekwoning tussenwoning vrijstaand benedenwoning bovenwoning gallerijflat portiekflat other
construction_before_1901 construction_1901_1929 construction_1930_1944 construction_1945_1959
construction_1960_1969 construction_1970_1979 construction_1980_1989 construction_1990_1999
construction_2000_2009 i.postalcodearea i.transactionyear, r
estat vif
outreg2 using Model2all.doc, label

corr projectarea PA1 PA2 target TD TDsq TA1 TAD1 TAD1sq TA2 TAD2 TAD2sq TA3 TAD3 TAD3sq
tweeondereenkap geschakeld hoekwoning tussenwoning vrijstaand benedenwoning bovenwoning
gallerijflat maisonnette portiekflat other construction_before_1901 construction_1901_1929
```

```
construction_1930_1944 construction_1945_1959 construction_1960_1969 construction_1970_1979
construction_1980_1989 construction_1990_1999 construction_2000_2009 construction_after_2010
transactionyear

//Alternative model
//Alternative model year only
reg lntransactionprice before_A_P after_A1_P after_A2_P beforebuffer250 beforebuffer500
beforebuffer750 beforebuffer1000 afterbuffer2501 afterbuffer5001 afterbuffer7501 afterbuffer10001
afterbuffer2502 afterbuffer5002 afterbuffer7502 afterbuffer10002  afterbuffer2503 afterbuffer5003
afterbuffer7503 afterbuffer10003 i.transactionyear, r
outreg2 using alternativemodelyear.doc, label

//Alternative model year, structural
reg lntransactionprice before_A_P after_A1_P after_A2_P beforebuffer250 beforebuffer500
beforebuffer750 beforebuffer1000 afterbuffer2501 afterbuffer5001 afterbuffer7501 afterbuffer10001
afterbuffer2502 afterbuffer5002 afterbuffer7502 afterbuffer10002  afterbuffer2503 afterbuffer5003
afterbuffer7503 afterbuffer10003 livingsurface rooms daysonthemarket tweeondereenkap geschakeld
hoekwoning tussenwoning vrijstaand benedenwoning bovenwoning gallerijflat portiekflat other
i.transactionyear, r
outreg2 using alternativemodelyearstructural.doc, label

//Alternative model year, structural, postalcode
reg lntransactionprice before_A_P after_A1_P after_A2_P beforebuffer250 beforebuffer500
beforebuffer750 beforebuffer1000 afterbuffer2501 afterbuffer5001 afterbuffer7501 afterbuffer10001
afterbuffer2502 afterbuffer5002 afterbuffer7502 afterbuffer10002  afterbuffer2503 afterbuffer5003
afterbuffer7503 afterbuffer10003 livingsurface rooms daysonthemarket tweeondereenkap geschakeld
hoekwoning tussenwoning vrijstaand benedenwoning bovenwoning gallerijflat portiekflat other
i.postalcodearea i.transactionyear, r
outreg2 using alternativemodelyearstructpost.doc, label

//Alternative model year, structural, postal code, construction dummies
reg lntransactionprice before_A_P after_A1_P after_A2_P beforebuffer250 beforebuffer500
beforebuffer750 beforebuffer1000 afterbuffer2501 afterbuffer5001 afterbuffer7501 afterbuffer10001
afterbuffer2502 afterbuffer5002 afterbuffer7502 afterbuffer10002  afterbuffer2503 afterbuffer5003
afterbuffer7503 afterbuffer10003 livingsurface rooms daysonthemarket tweeondereenkap geschakeld
hoekwoning tussenwoning vrijstaand benedenwoning bovenwoning gallerijflat portiekflat other
construction_before_1901 construction_1901_1929 construction_1930_1944 construction_1945_1959
construction_1960_1969 construction_1970_1979 construction_1980_1989 construction_1990_1999
construction_2000_2009 i.postalcodearea i.transactionyear, r
estat vif
outreg2 using alternativemodelall.doc, label
```

APPENDIX B – OLS ASSUMPTIONS

Assumption 1: The error term has a conditional mean of zero

To fulfill this assumption a constant term is added in the difference-in-differencess model. In that way, a non-zero mean will be absorbed by the constant term, which will result in residuals with a mean of zero.

Assumption 2: Homoscedacity

This assumption means that the error terms should have equal variance and should show no signs of heteroscedasticity. The presence of heteroscedasticity is detected by executing the Breusch and Pagan test for the various models. The Breusch and Pagan test shows a significant P-level below 1%, see figure below. This indicates that there is heterogeneity in the models. To deal with heterogeneity in our data, robust standard errors are added to the models. Robust standard errors are standard errors estimated that have been modified to deal with heterogeneity.

```
. estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of lntransactionprice

         chi2(1)      =    55.54
         Prob > chi2  =   0.0000
```

Figure B1 Breusch-Pagan test for heteroscedasticity

Assumption 3: No autocorrelation

To fulfill the assumption of no residual autocorrelation spatial and time-fixed effects are added in the model as control variables. This is important since transaction data can contain trends over time.

Assumption 4: There is no multicollinearity in the regression model

Multicollinearity occurs in the model when there is a strong correlation between two or more independent (X) variables. Stata erases housing type "other" and construction period "after2010" in the regression analysis due to multicollinearity issues. To detect the cause of this multicollinearity problem, a correlation matrix is generated and studied. The correlation matrix shows signs of imperfect multicollinearity. This means that the multicollinearity issue is caused by several categories in housing type and construction period. After executing several models with different categories for housing type, I find out that this multicollinearity issue is caused by housing type category 'maisonnette'. The housing type 'maisonnette' is indirectly left out of the analysis and used as the reference category. The same is done for the construction period category 'after2010', which is also used as reference category. Furthermore, the Variance Inflation Factor (VIF) is calculated to detect for strong correlation between the independent variables (X). A VIF above 10 is a sign of strong multicollinearity. The VIF for bedrooms is above 10, which is caused by a strong correlation with the variable ‘rooms’. The variable bedrooms i therefore not used in the models.

	before~P	afte~1_P	afte~2_P	before~T	afte~1_T	afte~2_T	afte~3_T	living~e	bedrooms	dayson~t	tweeon~p	gescha~d	hoekwo~g	tussen~g	vrijst~d	benede~g	bovenw~g	galler~t
before_A_P	1.0000																	
after_A1_P	0.6055	1.0000																
after_A2_P	0.6279	-0.0167	1.0000															
before_A_T	-0.1229	-0.0744	-0.0772	1.0000														
after_A1_T	-0.0580	-0.0351	-0.0364	0.4713	1.0000													
after_A2_T	-0.0694	-0.0420	-0.0436	0.5643	-0.0913	1.0000												
after_A3_T	-0.0373	-0.0226	-0.0234	0.3033	-0.0491	-0.0587	1.0000											
livingsurf~e	-0.0021	-0.0087	-0.0028	0.0620	0.0069	0.0542	0.0715	1.0000										
bedrooms	-0.0433	-0.0331	-0.0247	0.1079	0.0387	0.0678	0.1221	0.5591	1.0000									
daysonthem~t	0.0186	0.0033	-0.0402	-0.0210	0.0160	-0.0780	-0.0437	0.0289	-0.0684	1.0000								
tweeondere~p	0.0047	-0.0138	0.0141	-0.0213	-0.0013	-0.0050	-0.0086	0.0836	0.0970	0.0257	1.0000							
geschakeld	-0.0242	-0.0147	-0.0152	0.1141	0.0286	0.0890	0.1195	0.1325	0.0004	0.0040	-0.0125	1.0000						
hoekwoning	-0.0439	-0.0316	-0.0263	0.0367	0.0129	0.0218	0.0628	0.1011	0.1963	-0.0179	-0.0269	-0.0287	1.0000					
tussenwoning	-0.0952	-0.0621	-0.0568	0.1070	0.0395	0.0470	0.1441	0.3180	0.4434	-0.0443	-0.0529	-0.0564	-0.1216	1.0000				
vrijstaand	-0.0189	-0.0114	-0.0119	0.0026	-0.0163	0.0218	0.0222	0.1278	0.0726	0.0155	-0.0097	-0.0104	-0.0224	-0.0440	1.0000			
benedenwon~g	-0.0505	-0.0330	-0.0280	0.0050	-0.0057	0.0062	-0.0368	-0.0890	-0.1146	-0.0039	-0.0281	-0.0300	-0.0646	-0.1270	-0.0234	1.0000		
bovenwoning	-0.0463	-0.0133	-0.0464	-0.0733	-0.0226	-0.0285	-0.0549	-0.0477	-0.0687	0.0535	-0.0451	-0.0481	-0.1037	-0.2039	-0.0376	-0.1083	1.0000	
gallerijflat	-0.0240	-0.0361	-0.0003	0.0753	0.0389	0.0350	-0.0429	-0.1787	-0.1826	-0.0162	-0.0391	-0.0417	-0.0899	-0.1767	-0.0326	-0.0939	-0.1508	1.0000
portiekflat	0.1494	0.0944	0.0984	-0.1306	-0.0546	-0.0764	-0.0844	-0.2234	-0.2774	0.0118	-0.0711	-0.0758	-0.1633	-0.3210	-0.0591	-0.1705	-0.2738	-0.2373
other	0.0391	0.0284	0.0259	-0.0169	-0.0020	-0.0004	-0.0219	0.0829	-0.0056	-0.0153	-0.0177	-0.0189	-0.0407	-0.0800	-0.0147	-0.0425	-0.0683	-0.0592
constru~1901	-0.0426	-0.0258	-0.0268	-0.1144	-0.0522	-0.0672	-0.0361	0.1008	-0.0235	-0.0279	0.0438	-0.0234	-0.0076	-0.0381	-0.0070	0.0589	0.0936	-0.0577
constru~1929	-0.0703	-0.0426	-0.0441	0.0712	0.0269	0.0358	0.0313	0.0478	0.0561	-0.0083	0.0308	0.0071	0.0112	0.0658	0.0792	0.1300	0.1043	-0.1150
constru~1944	-0.0801	-0.0485	-0.0503	-0.0507	-0.0526	-0.0234	0.0484	-0.1437	0.0214	-0.0040	0.0413	-0.0389	0.0257	0.0433	-0.0080	0.1599	0.1127	-0.1380
constru~1959	-0.0450	-0.0273	-0.0283	-0.0620	-0.0256	-0.0355	-0.0159	-0.1486	-0.0750	0.0030	-0.0232	-0.0247	-0.0166	-0.0757	0.0128	0.0033	0.0130	-0.0356
constru~1969	-0.0831	-0.0503	-0.0522	-0.1463	-0.0713	-0.0615	-0.0570	-0.2648	-0.0489	-0.0023	-0.0214	-0.0356	-0.0152	-0.0888	-0.0035	-0.0863	-0.0908	0.1924
constru~1979	-0.0320	-0.0194	-0.0201	-0.0894	-0.0421	-0.0505	-0.0271	0.0065	-0.0194	-0.0010	-0.0165	0.0055	0.0407	-0.0013	0.0304	-0.0342	0.0178	0.0312
constru~1989	-0.0532	-0.0322	-0.0334	0.0327	0.0327	-0.0009	-0.0020	-0.1124	-0.0175	-0.0220	-0.0044	-0.0220	0.0283	-0.0113	-0.0228	-0.0016	0.0101	0.0422
constru~1999	0.1352	0.0946	0.0915	0.1638	0.0823	0.0322	0.0066	0.0304	-0.0165	-0.0054	-0.0121	-0.0362	-0.0215	-0.0256	-0.0332	-0.0449	-0.0972	0.1057
constru~2009	0.2425	0.1344	0.1458	0.0278	0.0173	0.0341	-0.0169	0.1690	-0.0062	0.0270	-0.0100	-0.0340	-0.0481	-0.1051	-0.0291	-0.0576	-0.0332	0.0338
transactio~r	-0.0150	-0.0484	0.0878	0.0304	-0.0808	0.2474	0.2581	0.0026	0.1181	-0.2520	0.0455	0.0576	0.1027	0.1137	0.0289	-0.0257	-0.0829	-0.0320
postalcode~a	0.1566	0.0948	0.0983	-0.0860	-0.0467	-0.0311	0.0079	-0.1935	0.0960	0.0007	0.0412	-0.0190	0.1104	0.0666	0.0190	-0.0411	-0.1671	0.0681

	portie~t	other	con~1901	con~1929	con~1944	con~1959	con~1969	con~1979	con~1989	con~1999	con~2009	transa~r	postal~a
portiekflat	1.0000												
other	-0.1075	1.0000											
constru~1901	-0.0304	0.0172	1.0000										
constru~1929	-0.1546	-0.0140	-0.0680	1.0000									
constru~1944	-0.1312	-0.0181	-0.0775	-0.1278	1.0000								
constru~1959	0.1075	-0.0291	-0.0436	-0.0718	-0.0818	1.0000							
constru~1969	0.1152	-0.0360	-0.0804	-0.1325	-0.1510	-0.0849	1.0000						
constru~1979	-0.0285	-0.0167	-0.0310	-0.0511	-0.0583	-0.0327	-0.0604	1.0000					
constru~1989	-0.0014	-0.0260	-0.0515	-0.0849	-0.0968	-0.0544	-0.1004	-0.0387	1.0000				
constru~1999	0.0469	0.0161	-0.0885	-0.1459	-0.1663	-0.0934	-0.1724	-0.0665	-0.1105	1.0000			
constru~2009	0.0871	0.0961	-0.0921	-0.1518	-0.1729	-0.0972	-0.1793	-0.0692	-0.1149	-0.1974	1.0000		
transactio~r	-0.0431	-0.0043	-0.0181	0.0207	0.0700	-0.0351	0.0668	-0.0185	-0.0318	-0.0821	-0.0646	1.0000	
postalcode~a	-0.0348	-0.0125	-0.1931	-0.0545	0.2263	0.0140	0.1667	-0.0366	-0.1622	-0.0823	0.0325	0.1818	1.0000

Figure B2 Correlation matrix

Assumption 5: Normally distributed error terms

The skewness and kurtosis test for normality has a P-value of 0.00 for both skewness and kurtosis, which indicates that the data does not have a normal distribution. For larger samples normality can be seen as given due to the central limit theorem. Since the adjusted dataset includes over 5,096 cases, the dataset is large enough to assume that the violation of the normality assumption will not bias the results.

Skewness and kurtosis tests for normality

				Joint test	
Variable	Obs	Pr(skewness)	Pr(kurtosis)	Adj chi2(2)	Prob>chi2
myResiduals	5,096	0.0000	0.0000	155.63	0.0000

APPENDIX C– Additional descriptive statistics

Table C1: descriptive statistics project area and target area 500-750 meters

	Total area (0-2,000 meters)		Project area (0 meters)		Target area (500-750 meters)	
	mean	sd	mean	sd	mean	sd
Dependent variable						
Transaction price	252,664	152,743	253,930	71,002	253,953	98,659
Structural characteristics						
Living space (m^2)	100.831	35.248	100.479	20.664	104.102	27.133
Housing volume	303.337	123.982	295.828	78.647	310.845	106.033
rooms	3.718	1.196	3.288	0.649	3.819	1.390
bedrooms	2.459	1.096	2.233	0.582	2.619	1.326
Days on the market	140.913	287.459	166.423	417.994	127.730	239.227
Housing type						
Semi-detached (1=yes)	0.012	0.107	0.014	0.118	0.018	0.132
Geschakeld (1=yes)	0.013	0.114	0.000	0.000	0.066	0.249
Corner house (1=yes)	0.058	0.234	0.009	0.096	0.091	0.288
Row house (1=yes)	0.193	0.395	0.014	0.118	0.321	0.467
Detached (1=yes)	0.008	0.089	0.000	0.000	0.004	0.066
Ground floor apartment (1=yes)	0.063	0.243	0.005	0.068	0.035	0.185
Upper floor apartment (1=yes)	0.148	0.355	0.070	0.255	0.093	0.291
Gallery flat (1=yes)	0.116	0.320	0.079	0.270	0.177	0.382
Maisonnette (1=yes)	0.062	0.241	0.126	0.332	0.031	0.173
Porch flat (1=yes)	0.301	0.459	0.628	0.484	0.142	0.349
Other (1=yes)	0.026	0.159	0.056	0.230	0.022	0.147
Construction period						
Before 1901 (1=yes)	0.040	0.195	0.000	0.000	0.000	0.000
1901-1929 (1=yes)	0.101	0.301	0.000	0.000	0.071	0.257
1930-1944 (1=yes)	0.127	0.333	0.000	0.000	0.042	0.201
1945-1959 (1=yes)	0.044	0.205	0.000	0.000	0.002	0.047
1960-1969 (1=yes)	0.135	0.342	0.000	0.000	0.009	0.094
1970-1979 (1=yes)	0.023	0.149	0.000	0.000	0.000	0.000
1980-1989 (1=yes)	0.060	0.238	0.000	0.000	0.157	0.364
1990-1999 (1=yes)	0.160	0.366	0.395	0.490	0.274	0.447
2000-2009 (1=yes)	0.170	0.376	0.605	0.490	0.223	0.417
After 2010 (1=yes)	0.140	0.347	0.000	0.000	0.221	0.416
N	5,096		215		452	

Table C2: Number of transactions after the three announcements in the project and target area

Interaction variables	*N*
AFTER_A1_project_area	*81*
AFTER_A2_project_area	87
AFTER_A3_project_area	10
AFTER_A1_target_area	361
AFTER_A2_target_area	502
AFTER_A3_target_area	156

APPENDIX D – Estimation results including control variables

Table D1: Estimation results baseline model (1) including estimations for control variables

	(1)	(2)	(3)	(4)
Sample	<2,000 meters	<2,000 meters	<2,000 meters	<2,000 meters
Target area	0-1,000 meters	0-1,000 meters	0-1,000 meters	0-1,000 meters
Control area	1,000-2,000 meters	1,000-2,000 meters	1,000-2,000 meters	1,000-2,000 meters
Before A project area	0.128***	0.0952***	0.290***	0.141***
	(0.0375)	(0.0249)	(0.0281)	(0.0272)
After A1 project area	-0.0367	-0.0129	-0.0353	-0.0379
	(0.0468)	(0.0302)	(0.0258)	(0.0249)
After A2 project area	0.0399	-0.0248	-0.0762***	-0.0707***
	(0.0437)	(0.0297)	(0.0256)	(0.0247)
Before A target area	-0.187***	-0.112***	-0.103***	-0.131***
	(0.0313)	(0.0195)	(0.0177)	(0.0167)
After A1 target area	0.141***	0.0790***	0.0381*	0.0197
	(0.0406)	(0.0261)	(0.0224)	(0.0202)
After A2 target area	0.230***	0.0564**	0.0404**	0.0290
	(0.0383)	(0.0237)	(0.0199)	(0.0180)
After A3 target area	0.252***	0.119***	0.0362	0.0534**
	(0.0462)	(0.0301)	(0.0246)	(0.0224)
living surface		0.0127***	0.00855***	0.00770***
		(0.000240)	(0.000202)	(0.000190)
bedrooms		-0.0888***	-0.0167***	-0.00819*
		(0.00708)	(0.00507)	(0.00449)
days on the market		-0.000102***	-3.52e-05***	-4.57e-05***
		(1.44e-05)	(1.08e-05)	(9.63e-06)
semi-detached		0.111**	0.263***	0.234***
		(0.0445)	(0.0379)	(0.0334)
geschakeld		0.00951	0.251***	0.151***
		(0.0448)	(0.0379)	(0.0337)
corner house		0.0980***	0.212***	0.179***
		(0.0223)	(0.0188)	(0.0170)

row house	0.0799***	0.135***	0.111***
	(0.0188)	(0.0151)	(0.0139)
detached	0.211***	0.438***	0.469***
	(0.0485)	(0.0465)	(0.0496)
ground floor apartment	0.0151	0.0196	0.0425**
	(0.0249)	(0.0183)	(0.0170)
upper floor apartment	0.110***	0.0309**	0.0465***
	(0.0203)	(0.0147)	(0.0135)
gallery flat	0.0475**	0.0438***	0.0267**
	(0.0194)	(0.0146)	(0.0128)
porch flat	0.161***	0.109***	0.0822***
	(0.0172)	(0.0133)	(0.0117)
other	0.188***	0.203***	0.180***
	(0.0319)	(0.0243)	(0.0221)
construction before 1901			-0.155***
			(0.0215)
construction 1901-1929			-0.339***
			(0.0157)
construction 1930-1944			-0.319***
			(0.0147)
construction 1945-1959			-0.292***
			(0.0210)
construction 1960-1969			-0.344***
			(0.0160)
construction 1970-1979			-0.361***
			(0.0223)
construction 1980-1989			-0.272***
			(0.0151)
construction 1990-1999			-0.112***
			(0.0127)
construction 2000-2009			-0.0600***
			(0.0121)
Postalcode area = 3061		-0.254***	-0.285***

			(0.0858)	(0.0855)
Postalcode area = 3062			-0.106	-0.163**
			(0.0702)	(0.0708)
Postalcode area = 3063			-0.214***	-0.319***
			(0.0689)	(0.0688)
Postalcode area = 3064			-0.556***	-0.744***
			(0.0793)	(0.0830)
Postalcode area = 3071			-0.266***	-0.478***
			(0.0679)	(0.0689)
Postalcode area = 3072			-0.0668	-0.344***
			(0.0689)	(0.0703)
Postalcode area = 3073			-0.691***	-0.805***
			(0.0716)	(0.0712)
Postalcode area = 3074			-0.649***	-0.731***
			(0.0710)	(0.0709)
Postalcode area = 3075			-0.656***	-0.745***
			(0.0713)	(0.0711)
Postalcode area = 3076			-0.762***	-0.795***
			(0.0697)	(0.0703)
Postalcode area = 3077			-0.569***	-0.679***
			(0.0712)	(0.0710)
Postalcode area = 3078			-0.639***	-0.711***
			(0.0703)	(0.0700)
Postalcode area = 3079			-0.675***	-0.753***
			(0.0702)	(0.0703)
Postalcode area = 3081			-0.799***	-0.889***
			(0.0705)	(0.0703)
Postalcode area = 3083			-0.646***	-0.819***
			(0.0763)	(0.0744)
transactionyear = 2015	0.0644**	0.0241	0.0525***	0.0335**
	(0.0326)	(0.0193)	(0.0155)	(0.0144)
transactionyear = 2016	0.173***	0.110***	0.140***	0.134***
	(0.0342)	(0.0209)	(0.0162)	(0.0151)

transactionyear = 2017	0.186***	0.229***	0.333***	0.323***
	(0.0324)	(0.0195)	(0.0147)	(0.0138)
transactionyear = 2018	0.321***	0.387***	0.477***	0.463***
	(0.0309)	(0.0188)	(0.0142)	(0.0134)
transactionyear = 2019	0.429***	0.473***	0.576***	0.564***
	(0.0310)	(0.0183)	(0.0143)	(0.0134)
transactionyear = 2020	0.604***	0.519***	0.637***	0.635***
	(0.0384)	(0.0247)	(0.0194)	(0.0178)
Constant	12.04***	10.88***	11.49***	11.93***
	(0.0260)	(0.0286)	(0.0744)	(0.0762)
Observations	5,096	5,096	5,096	5,096
R-squared	0.120	0.675	0.837	0.867

Note: Dependent variable is ln(transaction price). Announcement date 1: 18 march 2016, Announcement date 2: 5 January 2018, Announcement date 3: 17 October 2019.
Reference categories are maisonnette (housing type), and 2014 (transaction year) Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table D2: Estimation results model (2) including estimations for control variables

	(1)	(2)	(3)	(4)
Sample	<2,000 meters	<2,000 meters	<2,000 meters	<2,000 meters
Target area	0-1,000 meters	0-1,000 meters	0-1,000 meters	0-1,000 meters
Control area	1,000-2,000 meters	1,000-2,000 meters	1,000-2,000 meters	1,000-2,000 meters
Before_A1 project area	0.129***	0.0922***	0.289***	0.151***
	(0.0375)	(0.0246)	(0.0286)	(0.0274)
After_A1 project area	-0.0377	-0.0139	-0.0352	-0.0375
	(0.0468)	(0.0299)	(0.0258)	(0.0249)
After_A2_project area	0.0392	-0.0232	-0.0761***	-0.0705***
	(0.0437)	(0.0294)	(0.0256)	(0.0247)
Before A target area	-0.642***	-0.481***	-0.0986	-0.227***
	(0.0967)	(0.0580)	(0.0727)	(0.0571)
Before A target area * distance	0.00130***	0.00114***	-0.000106	6.52e-05
	(0.000356)	(0.000225)	(0.000247)	(0.000201)
Before A target area * distance^2	-7.51e-07**	-7.15e-07***	1.33e-07	9.47e-08
	(3.05e-07)	(1.97e-07)	(2.03e-07)	(1.71e-07)
After_A1_target area	0.0790	0.111	0.00551	-0.00382
	(0.125)	(0.0838)	(0.0782)	(0.0586)
After_A1 target area * distance	0.000537	-9.37e-05	0.000217	0.000146
	(0.000472)	(0.000317)	(0.000295)	(0.000239)
After A1 target area * distance^2	-6.23e-07	3.49e-08	-2.23e-07	-1.51e-07
	(4.13e-07)	(2.79e-07)	(2.57e-07)	(2.18e-07)
After A2 target area	0.475***	0.198***	0.0580	0.109**
	(0.110)	(0.0702)	(0.0659)	(0.0514)
After A2 target area * distance	-7.37e-05	-0.000295	5.70e-05	-0.000244
	(0.000414)	(0.000277)	(0.000259)	(0.000211)
After A2_target area * distance^2	-4.44e-07	9.20e-08	-1.17e-07	1.52e-07
	(3.69e-07)	(2.47e-07)	(2.25e-07)	(1.90e-07)
After_A3_target area	0.802***	0.318***	0.00665	0.0341
	(0.132)	(0.0891)	(0.0844)	(0.0671)
After_A3 target area * distance	-0.00124**	-0.000557	0.000193	0.000101

	(0.000520)	(0.000377)	(0.000343)	(0.000283)
After A3 target area * distance^3	4.47e-07	3.22e-07	-1.94e-07	-8.21e-08
	(4.62e-07)	(3.39e-07)	(3.03e-07)	(2.58e-07)
living surface		0.0127***	0.00854***	0.00768***
		(0.000238)	(0.000203)	(0.000190)
bedrooms		-0.0868***	-0.0166***	-0.00801*
		(0.00707)	(0.00508)	(0.00449)
days on the market		-9.58e-05***	-3.48e-05***	-4.37e-05***
		(1.43e-05)	(1.08e-05)	(9.63e-06)
tweeondereenkap		0.0913**	0.263***	0.240***
		(0.0437)	(0.0379)	(0.0332)
geschakeld		-0.0130	0.254***	0.166***
		(0.0466)	(0.0389)	(0.0341)
hoekwoning		0.0817***	0.212***	0.186***
		(0.0222)	(0.0190)	(0.0171)
tussenwoning		0.0633***	0.134***	0.116***
		(0.0189)	(0.0152)	(0.0141)
vrijstaand		0.195***	0.438***	0.466***
		(0.0489)	(0.0464)	(0.0510)
benedenwoning		0.0158	0.0190	0.0437**
		(0.0249)	(0.0183)	(0.0170)
bovenwoning		0.105***	0.0312**	0.0498***
		(0.0203)	(0.0147)	(0.0136)
gallerijflat		0.0317	0.0439***	0.0289**
		(0.0194)	(0.0146)	(0.0129)
portiekflat		0.156***	0.109***	0.0850***
		(0.0171)	(0.0133)	(0.0118)
other		0.186***	0.204***	0.183***
		(0.0319)	(0.0244)	(0.0222)
construction before 1901				-0.162***
				(0.0214)
construction 1901-1929				-0.347***
				(0.0158)

construction 1930-1944		-0.330***
		(0.0150)
construction 1945-1959		-0.303***
		(0.0211)
construction 1960-1969		-0.358***
		(0.0162)
construction 1970-1979		-0.373***
		(0.0224)
construction 1980-1989		-0.280***
		(0.0152)
construction 1990-1999		-0.120***
		(0.0128)
construction 2000-2009		-0.0662***
		(0.0122)
Postalcode area = 3061	-0.254***	-0.288***
	(0.0860)	(0.0859)
Postalcode area = 3062	-0.106	-0.164**
	(0.0705)	(0.0717)
Postalcode area = 3063	-0.214***	-0.312***
	(0.0692)	(0.0698)
Postalcode area = 3064	-0.556***	-0.750***
	(0.0795)	(0.0839)
Postalcode area = 3071	-0.267***	-0.481***
	(0.0682)	(0.0698)
Postalcode area = 3072	-0.0670	-0.354***
	(0.0692)	(0.0712)
Postalcode area = 3073	-0.692***	-0.810***
	(0.0718)	(0.0721)
Postalcode area = 3074	-0.648***	-0.673***
	(0.0771)	(0.0759)
Postalcode area = 3075	-0.656***	-0.742***
	(0.0716)	(0.0721)
Postalcode area = 3076	-0.762***	-0.792***

			(0.0699)	(0.0712)
Postalcode area = 3077			-0.569***	-0.692***
			(0.0717)	(0.0721)
Postalcode area = 3078			-0.638***	-0.719***
			(0.0705)	(0.0710)
Postalcode area = 3079			-0.675***	-0.755***
			(0.0704)	(0.0712)
Postalcode area = 3081			-0.799***	-0.889***
			(0.0707)	(0.0712)
Postalcode area = 3083			-0.647***	-0.820***
			(0.0765)	(0.0753)
transactionyear = 2015	0.0612*	0.0217	0.0526***	0.0341**
	(0.0323)	(0.0190)	(0.0155)	(0.0144)
transactionyear = 2016	0.172***	0.109***	0.140***	0.134***
	(0.0341)	(0.0207)	(0.0162)	(0.0151)
transactionyear = 2017	0.186***	0.231***	0.333***	0.325***
	(0.0323)	(0.0194)	(0.0147)	(0.0138)
transactionyear = 2018	0.320***	0.387***	0.477***	0.464***
	(0.0308)	(0.0187)	(0.0142)	(0.0134)
transactionyear = 2019	0.426***	0.475***	0.576***	0.567***
	(0.0309)	(0.0181)	(0.0143)	(0.0135)
transactionyear = 2020	0.601***	0.522***	0.636***	0.638***
	(0.0384)	(0.0245)	(0.0195)	(0.0178)
Constant	12.04***	10.88***	11.49***	11.93***
	(0.0258)	(0.0283)	(0.0747)	(0.0771)
Observations	5,096	5,096	5,096	5,096
R-squared	0.132	0.681	0.837	0.867

Note: Dependent variable is ln(transaction price). Announcement date 1: 18 march 2016, Announcement date 2: 5 January 2018, Announcement date 3: 17 October 2019.
Reference categories are maisonnette (housing type), and 2014 (transaction year) Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table D3: Estimation results alternative model (3) including estimations for control variables

	(1)	(2)	(3)	(4)
Sample	<2,000 meters	<2,000 meters	<2,000 meters	<2,000 meters
Target area	0-1,000 meters	0-1,000 meters	0-1,000 meters	0-1,000 meters
Control area	1,000-2,000 meters	1,000-2,000 meters	1,000-2,000 meters	1,000-2,000 meters
Before A project area	0.129***	0.0684***	0.270***	0.145***
	(0.0376)	(0.0256)	(0.0282)	(0.0272)
After_A1_project area	-0.0383	-0.0122	-0.0334	-0.0372
	(0.0469)	(0.0310)	(0.0256)	(0.0248)
After_A2_project area	0.0397	-0.0116	-0.0731***	-0.0690***
	(0.0438)	(0.0305)	(0.0254)	(0.0246)
Before A target area (0-250 m)	-0.447***	-0.352***	-0.140***	-0.204***
	(0.0705)	(0.0388)	(0.0491)	(0.0387)
Before A target area (250-500 m)	-0.301***	-0.207***	-0.130***	-0.225***
	(0.0753)	(0.0448)	(0.0484)	(0.0400)
Before A target area (500-750 m)	-0.149***	-0.0423	-0.122***	-0.146***
	(0.0412)	(0.0268)	(0.0272)	(0.0251)
Before A target area (750-1,000 m)	-0.0762*	-0.0479*	-0.0719***	-0.0825***
	(0.0439)	(0.0262)	(0.0249)	(0.0246)
After A1 target area (0-250 m)	0.134	0.121**	0.0445	-0.00500
	(0.0858)	(0.0545)	(0.0569)	(0.0413)
After A1 target area (250-500 m)	0.0705	-0.0558	-0.0411	-0.00150
	(0.0927)	(0.0599)	(0.0556)	(0.0474)
After A1 target area (500-750 m)	0.288***	0.153***	0.147***	0.0874***
	(0.0521)	(0.0330)	(0.0334)	(0.0296)
After A1 target area (750-1,000 m)	-0.0196	-0.0184	-0.0534	-0.0409
	(0.0610)	(0.0372)	(0.0338)	(0.0328)
After A2 target area (0-250 m)	0.311***	0.156***	0.0934**	0.0792**
	(0.0785)	(0.0478)	(0.0464)	(0.0367)
After A2 target area (250-500 m)	0.459***	0.0627	-0.0154	0.0126
	(0.0894)	(0.0520)	(0.0474)	(0.0388)
After A2 target area (500-750 m)	0.299***	0.0723**	0.123***	0.0643**

	(0.0474)	(0.0324)	(0.0324)	(0.0282)
After A2 target area (750-1,000 m)	0.0197	-0.00430	-0.0331	-0.0119
	(0.0578)	(0.0325)	(0.0289)	(0.0278)
After A3 target area (0-250 m)	0.671***	0.314***	0.0438	0.0415
	(0.0942)	(0.0647)	(0.0542)	(0.0436)
After A3 target area (250-500 m)	0.418***	0.0585	-0.00934	0.0105
	(0.0971)	(0.0955)	(0.0771)	(0.0615)
After A3 target area (500-750 m)	0.190***	0.130***	0.139***	0.145***
	(0.0705)	(0.0370)	(0.0384)	(0.0342)
After A3 target area (750-1,000 m)	0.0488	0.0442	-0.0269	0.0155
	(0.0701)	(0.0404)	(0.0319)	(0.0334)
living surface		0.0133***	0.00906***	0.00817***
		(0.000249)	(0.000209)	(0.000201)
rooms		-0.0917***	-0.0372***	-0.0261***
		(0.00646)	(0.00475)	(0.00445)
days on the market		-8.58e-05***	-3.43e-05***	-4.50e-05***
		(1.41e-05)	(1.06e-05)	(9.62e-06)
semi-detached		0.0807*	0.258***	0.237***
		(0.0419)	(0.0369)	(0.0330)
geschakeld		-0.0566	0.214***	0.136***
		(0.0499)	(0.0382)	(0.0347)
corner house		0.0849***	0.221***	0.192***
		(0.0218)	(0.0186)	(0.0170)
row house		0.0731***	0.147***	0.122***
		(0.0187)	(0.0150)	(0.0139)
detached		0.186***	0.432***	0.456***
		(0.0517)	(0.0472)	(0.0508)
ground floor apartment		0.0199	0.0153	0.0374**
		(0.0252)	(0.0182)	(0.0168)
upper floor apartment		0.107***	0.0321**	0.0480***
		(0.0200)	(0.0144)	(0.0133)
gallery flat		0.0159	0.0304**	0.0167
		(0.0193)	(0.0145)	(0.0127)

porch flat	0.147***	0.101***	0.0774***
	(0.0172)	(0.0131)	(0.0116)
other	0.166***	0.189***	0.172***
	(0.0321)	(0.0241)	(0.0219)
construction before 1901			-0.169***
			(0.0210)
construction 1901-1929			-0.344***
			(0.0157)
construction 1930-1944			-0.326***
			(0.0151)
construction 1945-1959			-0.297***
			(0.0210)
construction 1960-1969			-0.352***
			(0.0161)
construction 1970-1979			-0.372***
			(0.0223)
construction 1980-1989			-0.280***
			(0.0152)
construction 1990-1999			-0.123***
			(0.0127)
construction 2000-2009			-0.0800***
			(0.0122)
Postalcode area = 3061		-0.212**	-0.257***
		(0.0831)	(0.0832)
Postalcode area = 3062		-0.0718	-0.135**
		(0.0664)	(0.0675)
Postalcode area = 3063		-0.194***	-0.294***
		(0.0651)	(0.0654)
Postalcode area = 3064		-0.531***	-0.718***
		(0.0772)	(0.0809)
Postalcode area = 3071		-0.238***	-0.450***
		(0.0639)	(0.0654)
Postalcode area = 3072		-0.0381	-0.324***

			(0.0648)	(0.0668)
Postalcode area = 3073			-0.686***	-0.798***
			(0.0675)	(0.0677)
Postalcode area = 3074			-0.578***	-0.624***
			(0.0735)	(0.0717)
Postalcode area = 3075			-0.619***	-0.708***
			(0.0676)	(0.0679)
Postalcode area = 3076			-0.723***	-0.760***
			(0.0658)	(0.0669)
Postalcode area = 3077			-0.528***	-0.655***
			(0.0674)	(0.0678)
Postalcode area = 3078			-0.598***	-0.683***
			(0.0663)	(0.0666)
Postalcode area = 3079			-0.638***	-0.720***
			(0.0663)	(0.0669)
Postalcode area = 3081			-0.763***	-0.856***
			(0.0666)	(0.0669)
Postalcode area = 3083			-0.616***	-0.790***
			(0.0731)	(0.0716)
transactionyear = 2015	0.0623*	0.0248	0.0549***	0.0355**
	(0.0324)	(0.0188)	(0.0154)	(0.0144)
transactionyear = 2016	0.174***	0.116***	0.141***	0.134***
	(0.0341)	(0.0207)	(0.0162)	(0.0151)
transactionyear = 2017	0.186***	0.237***	0.334***	0.324***
	(0.0323)	(0.0195)	(0.0146)	(0.0138)
transactionyear = 2018	0.321***	0.388***	0.480***	0.464***
	(0.0308)	(0.0184)	(0.0141)	(0.0134)
transactionyear = 2019	0.424***	0.474***	0.577***	0.567***
	(0.0309)	(0.0178)	(0.0142)	(0.0134)
transactionyear = 2020	0.604***	0.537***	0.641***	0.639***
	(0.0384)	(0.0243)	(0.0194)	(0.0179)
Constant	12.04***	10.95***	11.51***	11.94***
	(0.0259)	(0.0291)	(0.0704)	(0.0726)

Observations	5,096	5,096	5,096	5,096
R-squared	0.136	0.685	0.842	0.869

Note: Dependent variable is ln(transaction price). Announcement date 1: 18 march 2016, Announcement date 2: 5 January 2018, Announcement date 3: 17 October 2019. Reference categories are maisonnette (housing type), and 2014 (transaction year) Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table D4: Estimation results of the senstivity analysis including estimations for control variables

	(1)	(2)	(3)
Sample	<2,000 meters	<1500	<2500
Target area	0-1,000 meters	0-1,000 meters	0-1,000 meters
Control area	1,000-2,000 meters	1,000-1,500 meters	1,000-2,500 meters
Before A project area	0.145***	0.109***	0.199***
	(0.0272)	(0.0340)	(0.0241)
After_A1_project area	-0.0372	-0.0135	-0.0344
	(0.0248)	(0.0256)	(0.0239)
After_A2_project area	-0.0690***	-0.0699***	-0.0662***
	(0.0246)	(0.0253)	(0.0240)
Before A target area (0-250 m)	-0.204***	-0.169***	-0.197***
	(0.0387)	(0.0376)	(0.0388)
Before A target area (250-500 m)	-0.225***	-0.213***	-0.214***
	(0.0400)	(0.0390)	(0.0390)
Before A target area (500-750 m)	-0.146***	-0.117***	-0.146***
	(0.0251)	(0.0250)	(0.0244)
Before A target area (750-1,000 m)	-0.0825***	-0.0455*	-0.0837***
	(0.0246)	(0.0239)	(0.0240)
After A1 target area (0-250 m)	-0.00500	0.0107	0.00839
	(0.0413)	(0.0390)	(0.0417)
After A1 target area (250-500 m)	-0.00150	0.0358	-0.00759
	(0.0474)	(0.0476)	(0.0459)
After A1 target area (500-750 m)	0.0874***	0.102***	0.0919***

	(0.0296)	(0.0286)	(0.0286)
After A1 target area (750-1,000 m)	-0.0409	0.00334	-0.0316
	(0.0328)	(0.0309)	(0.0321)
After A2 target area (0-250 m)	0.0792**	0.0797**	0.0915**
	(0.0367)	(0.0364)	(0.0360)
After A2 target area (250-500 m)	0.0126	0.0402	0.000846
	(0.0388)	(0.0380)	(0.0378)
After A2 target area (500-750 m)	0.0643**	0.0517*	0.0787***
	(0.0282)	(0.0272)	(0.0271)
After A2 target area (750-1,000 m)	-0.0119	-0.00309	0.00228
	(0.0278)	(0.0268)	(0.0267)
After A3 target area (0-250 m)	0.0415	0.0649	0.0613
	(0.0436)	(0.0439)	(0.0424)
After A3 target area (250-500 m)	0.0105	0.0534	0.0118
	(0.0615)	(0.0551)	(0.0598)
After A3 target area (500-750 m)	0.145***	0.175***	0.153***
	(0.0342)	(0.0360)	(0.0342)
After A3 target area (750-1,000 m)	0.0155	0.0549*	0.0407
	(0.0334)	(0.0312)	(0.0325)
Living surface	0.00817***	0.00758***	0.00798***
	(0.000201)	(0.000253)	(0.000184)
Rooms	-0.0261***	-0.0136***	-0.0122***
	(0.00445)	(0.00520)	(0.00356)
Days on the market	-4.50e-05***	-4.58e-05***	-4.23e-05***
	(9.62e-06)	(1.11e-05)	(7.65e-06)
tweeondereenkap	0.237***	0.172***	0.217***
	(0.0330)	(0.0456)	(0.0220)
geschakeld	0.136***	0.0938***	0.0645***
	(0.0347)	(0.0360)	(0.0231)
hoekwoning	0.192***	0.168***	0.176***
	(0.0170)	(0.0206)	(0.0135)
tussenwoning	0.122***	0.130***	0.120***
	(0.0139)	(0.0167)	(0.0112)

vrijstaand	0.456***	0.295***	0.280***
	(0.0508)	(0.0745)	(0.0529)
benedenwoning	0.0374**	0.00579	0.0712***
	(0.0168)	(0.0209)	(0.0131)
bovenwoning	0.0480***	0.0445***	0.0326***
	(0.0133)	(0.0157)	(0.0106)
gallerijflat	0.0167	-0.00191	0.0328***
	(0.0127)	(0.0140)	(0.0108)
portiekflat	0.0774***	0.0328***	0.0702***
	(0.0116)	(0.0123)	(0.00960)
other	0.172***	0.179***	0.178***
	(0.0219)	(0.0255)	(0.0167)
construction_before_1901	-0.169***	-0.0172	-0.197***
	(0.0210)	(0.0409)	(0.0183)
construction_1901_1929	-0.344***	-0.455***	-0.320***
	(0.0157)	(0.0200)	(0.0121)
construction_1930_1944	-0.326***	-0.420***	-0.323***
	(0.0151)	(0.0202)	(0.0112)
construction_1945_1959	-0.297***	-0.426***	-0.324***
	(0.0210)	(0.0388)	(0.0121)
construction_1960_1969	-0.352***	-0.434***	-0.366***
	(0.0161)	(0.0267)	(0.0120)
construction_1970_1979	-0.372***	-0.339***	-0.339***
	(0.0223)	(0.0332)	(0.0179)
construction_1980_1989	-0.280***	-0.352***	-0.305***
	(0.0152)	(0.0208)	(0.00960)
construction_1990_1999	-0.123***	-0.129***	-0.146***
	(0.0127)	(0.0157)	(0.00939)
construction_2000_2009	-0.0800***	-0.0994***	-0.0893***
	(0.0122)	(0.0148)	(0.00808)
Postalcode area = 3011			0.398***
			(0.0152)
Postalcode area = 3012			0.391***

			(0.0149)
Postalcode area = 3016			0.510***
			(0.0269)
Postalcode area = 3061	-0.257***		0.213***
	(0.0832)		(0.0168)
Postalcode area = 3062	-0.135**		0.464***
	(0.0675)		(0.0176)
Postalcode area = 3063	-0.294***		0.295***
	(0.0654)		(0.0163)
Postalcode area = 3064	-0.718***		-0.121***
	(0.0809)		(0.0195)
Postalcode area = 3065			0.373***
			(0.0502)
Postalcode area = 3071	-0.450***	-0.195***	0.129***
	(0.0654)	(0.0174)	(0.0147)
Postalcode area = 3072	-0.324***	-0.190***	0.234***
	(0.0668)	(0.0240)	(0.0162)
Postalcode area = 3073	-0.798***	-0.477***	-0.235***
	(0.0677)	(0.0217)	(0.0200)
Postalcode area = 3074	-0.624***	-0.314***	-0.0828***
	(0.0717)	(0.0284)	(0.0291)
Postalcode area = 3075	-0.708***	-0.424***	-0.149***
	(0.0679)	(0.0231)	(0.0188)
Postalcode area = 3076	-0.760***	-0.391***	-0.166***
	(0.0669)	(0.0250)	(0.0169)
Postalcode area = 3077	-0.655***	-0.311***	-0.124***
	(0.0678)	(0.0294)	(0.0167)
Postalcode area = 3078	-0.683***	-0.338***	-0.119***
	(0.0666)	(0.0242)	(0.0164)
Postalcode area = 3079	-0.720***	-0.423***	-0.140***
	(0.0669)	(0.0238)	(0.0158)
Postalcode area = 3081	-0.856***	-0.487***	-0.297***
	(0.0669)	(0.0246)	(0.0177)

Postalcode area = 3083	-0.790***		-0.312***
	(0.0716)		(0.0190)
Postalcode area = 3084			0.0236
			(0.0529)
Postalcode area = 3085			-0.187***
			(0.0195)
transactionyear = 2015	0.0355**	-0.00501	0.0335***
	(0.0144)	(0.0178)	(0.00983)
transactionyear = 2016	0.134***	0.0706***	0.142***
	(0.0151)	(0.0191)	(0.0102)
transactionyear = 2017	0.324***	0.267***	0.319***
	(0.0138)	(0.0182)	(0.00910)
transactionyear = 2018	0.464***	0.437***	0.461***
	(0.0134)	(0.0177)	(0.00904)
transactionyear = 2019	0.567***	0.526***	0.564***
	(0.0134)	(0.0175)	(0.00905)
transactionyear = 2020	0.639***	0.573***	0.628***
	(0.0179)	(0.0246)	(0.0125)
Constant	11.94***	11.73***	11.34***
	(0.0726)	(0.0389)	(0.0249)
Observations	5,096	3,114	8,683
R-squared	0.869	0.880	0.885

Note: Dependent variable is ln(transaction price). Announcement date 1: 18 march 2016, Announcement date 2: 5 January 2018, Announcement date 3: 17 October 2019. Reference categories are maisonnette (housing type), and 2014 (transaction year) Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1