EBS Business School

EBS Universität für Wirtschaft und Recht

Impact of Large-scale Residential Construction Projects on Land Values

Real Estate Economics

Author: Jan Hendrik Lukowski

1st Supervisor: Prof. Jan Mutl, PhD

2nd Supervisor: Prof. Dr. Joachim Zietz

Table of Contents

Table of Contents i
1. Introduction 1
2. Background 2
2.1. Previous Work 2
2.2. Projects under Current Study 6
3. Data and Methodology 11
3.1. Baseline Models 12
3.2. Impact Analysis 13
3.3. Description of Data 14
4. Empirical Results 22
4.1. Baseline Models 22
4.2. Impact Analysis 27
5. Discussion and Implications 33
5.1. Discussion 33
5.2. Implications 35
6. Conclusion 36
References 38

Abstract

This paper investigates how the announcement of three different large-scale residential construction projects impacts land values of multi-story residential buildings in Hamburg, Germany. Applying a difference-in-difference approach the study finds that land values within a radius of 1,500 m may experience either positive or negative effects. The impact depends critically on how the projects are expected to change the existing amenities and disamenities. We uncover price changes in land values spanning from -4% to +22%. The study shows that projects with an overlapping area of impact should be considered in one regression and that projects that are located far from one another can be analyzed in one or in separate regressions.

Keywords: Large-scale construction projects, land values, exogenous shocks, Hamburg

Acknowledgments - I would like to thank Prof. Jan Mutl, PhD and Prof. Dr. Joachim Zietz for their valuable suggestions, supervision and support.

1. Introduction

The impact of large-scale construction projects on property prices is a well-researched topic. The real estate literature on price effects has examined both the actual impact of sports arenas (Ahlfeldt & Maennig, 2007; Dehring et al., 2007; Tu, 2005) and the announcement of the Olympic Games (Kavetsos, 2011; McKay & Plumb, 2001). The existing literature on large-scale construction projects contains research on the risks attached to the construction process (Zou et al, 2007; Bing et al., 2005; Zavadskas et al., 2010), the design process (Chapman, 1998), and the factors that influence both the construction time and the costs of developing part of a city (Kaming et al., 1997). Numerous studies have analyzed the price effects of construction projects, but no study has focused as ours on the price impact of large-scale residential housing projects. In particular, it has not been investigated how, when, or within which radius home prices are affected by such projects.

Using data from the Committee of Valuation Experts (Gutachterausschuss für Grundstückswerte), panel data of land values for Hamburg, Germany, from 2010 to 2016 are examined. A difference-in-difference approach with varying distance buffers is used to capture the effect of the announcement of three large-scale residential construction projects on land values in close proximity. The three housing developments we consider differ considerably in terms of scale, location, and usage. The perspective that we gain from the associated range of price responses enables us to make a credible attempt to generalize our findings and, thereby, to provide a basis for the assessment of other large-scale residential construction projects. The paper also shows that it is sensible to analyze large-scale residential construction projects that are located close to one another jointly rather than in separate regressions.

The pattern of impact of large-scale residential construction projects on land values depends on how they affect existing neighborhood amenities and disamenities. Projects like (1) *Quartier an der Friedensallee* that redevelop a plot of land with similar usage generate a positive impact between 300 to 1,200 m in the first two years following the announcement, but no impact in close proximity; this suggests that expected amenities and disamenities may neutralize one another. After the start of construction works, the effect of disamenities, such as noise pollution, outweighs the effect of amenities. Real estate developments like (2) *Neue Mitte Altona* that eliminate substantial disamenities and are expected to create many amenities have a strong positive effect within a distance of 1,200 m. Projects that eliminate positive amenities, generate new amenities, and create disamenities, such as (3) *Pergolenviertel*, have a positive impact within 0 to 1,200 m. The findings of this paper show that projects with an overlapping area of impact should be considered in one regression and that projects that are located far from one another can be analyzed in separate regressions.

The paper is organized as follows: Section 2 reviews the literature on price effects and describes the residential housing developments that are analyzed in this study. Section 3 introduces the data and methodology. Results are described in Section 4 and discussed in Section 5. Section 6 concludes and provides limitations and suggestions for further research.

2. Background

2.1. Previous Work

The literature on price effects has investigated the impact on real estate prices of various shocks, including prominently the construction of sports arenas (Ahlfeldt & Maennig, 2007; Baade, 1990; Dehring et al., 2007; Tu 2005). Tu (2005) was the first to analyze the impact of sport stadiums on real estate prices and found that single family houses were positively impacted by the development of the *FedEx Field Stadium* in Maryland within a radius of 4 km. However, the timing as well as the scale of the impact differed based on distance. The price for houses within a 2.5 km to 4 km radius of the stadium improved during the development and prices within a radius of 2.5 km increased after the stadium was opened. Tu (2005) argues that homes close to the stadium were directly affected by the construction activities and the associated disamenities during the construction period. Moreover, Tu (2005) observes that the impact on housing values declines with increasing distance to the stadium.

Ahlfeldt & Maennig (2007) analyzed the impact of the multi-functional sports arenas *Velodrom* and *Max-Schmeling-Arena* on land values in Berlin, Germany. They found a positive impact within a radius of 3,000 m. However, the results differ depending on how planning authorities addressed potentially negative externalities. The presence of the *Velodrom* raised land values, but at a declining rate with increasing distance. Land values within 1,000 m to the *Velodrom* increased by 7.5%. In contrast, the impact of *Max-Schmeling-Arena* on land values in the 0-1,000 m distance range was zero. Land values at a distance of 1,000 – 2,000 m increased by 4.1%. Ahlfeldt & Maennig (2007) suggest that problems caused by fans, traffic congestions, and inaccurate expectations about travel patterns of visitors could explain the results for the *Max-Schmeling-Arena*. According to Ahlefeldt & Maennig (2007) traffic congestion problems could have been avoided by providing an underground car-park.

The results suggest that the quality of the architecture and the urban design of sports arenas affect the desirability of adjacent residential locations in important ways.

Dehring et al. (2007) examined the impact on residential house prices of the announcement of a National Football League stadium development in the cities of Dallas and Arlington in Texas. The National Football League's *Dallas Cowboys* searched for a new host location in the Dallas-Fort Worth area. The development of the stadium was supposed to be financed by local sales taxes in the county of construction. Following the initial announcement to build the stadium in Dallas, residential property values increased in the city of Dallas, while they fell in the rest of the county given that the whole county was supposed to pay for the construction of the stadium. This effect reversed after the construction was abandoned. Thereafter, it was announced that the stadium would be built in Arlington instead. Subsequently, prices in Arlington fell by 1.5%, which was approximately equal to the anticipated household sales tax burden. This finding was interpreted by Dehring et al. (2007) that the announcement of the construction of the stadium in Arlington had an amenity effect equal to zero.

Feng & Humphreys (2008) analyzed the impact of two sports stadiums on residential property values. The results show that the presence of the *Nationwide Arena*, home of the *Columbus Blue Jackets*, and *Crew Stadium*, home of the *Columbus Crew* had a significant positive effect on adjacent houses up to a distance of 1,500 m. Housing values increased by 1.75% with every 10% decrease in distance from the house to the *Nationwide Arena*. The average increase in house value for houses within a radius of 1.5 km from *Nationwide Arena* was $2,214 and the aggregated willingness to pay for proximity was $222 million. The willingness to pay for proximity to *Crew Stadium* was lower. Housing values increased by 1.4% with every 10% decrease in distance to the *Crew Stadium*. The aggregated willingness to pay for proximity within 1,500 m to *Crew Stadium* was $35 million. The differences in impact between the two stadiums was explained by Feng & Humphreys as follows: (1) *Nationwide Stadium* is located in the downtown area of the city of Columbus and *Crew Stadium* is located on the outskirts; (2) *Nationwide Stadium* is a multi-purpose arena used primarily by a National Hockey League team; *Crew Stadium* hosts soccer games, which have less popular appeal than hockey; (3) *Nationwide Stadium* hosts more games than *Crew Stadium*.

Baade & Dye (1990) analyzed the impact of sport arenas of professional sports teams on income in nine metropolitan areas. The paper found that the presence of a new or renovated stadium has no significant impact on area income in eight out of the nine cases. The results were explained by the possibility that renovating or building stadiums might bias local development towards low-wage jobs.

Ellen et al. (2001) studied the impact of two New York City homeownership programs on surrounding property values. The programs intended to promote homeownership in low- and moderate-income communities by offering tax benefits, insurance on high loan-to-value mortgages, below-market interest rates, and by providing incentives for financial institutions to offer mortgage loans. The programs supported the construction of single-family row homes built on large, vacant tracts of city owned land and the construction of a greater variety of housing types on smaller parcels. Projects with up to 400 units were developed. Prices of properties in buffers of 150 m, 300 m, and 600 m surrounding the sites were compared to prices outside those buffers but still in the same ZIP code. The study found that prices within the 150 m buffer around the projects increased immediately after completion; in the 300 m buffer, they increased within one and two years after completion and, in the 600 m buffer, the increase was realized three years after completion. The price differential between the average price in the ZIP code and the lower prices of properties around the projects analyzed shrank by 7.2%, 6.3%, and 3.5% for the 150 m, 300 m and 600 m buffers, respectively. The impact decreased with the distance from the projects. Ellen et al. (2001) identify three major reasons for the positive externalities: (1) The transformation of vacant or derelict areas into well-maintained, pleasant homes; (2) the migration of relatively higher-income residents to the neighborhoods; (3) a higher rate of homeownership, which in itself may generate greater neighborhood stability, better upkeep, and more community activism.

Galster et al. (2004) found that the announcement of creating eleven small-scale supportive housing units in Denver, between 1989 and 1995, had a positive impact on house prices within a radius of 300 to 600 m. The small-scale supportive units housed mentally ill, physically handicapped, and frail elderly individuals. Galster et al. (2004) explain the positive impact with two theories: (1) Providers of supportive housing often acquired vacant, sometimes deteriorated facilities, which previously generated negative externalities. (2) Developers had been searching for buildings located in lower value areas to stretch their scarce resources as far as possible.

Ahlfeldt & Maennig (2010) analyzed the impact of landmarks on condominium transaction prices in Berlin, Germany. Landmarks are defined as buildings of historical heritage or sophisticated architecture. The study finds that residential property prices are affected within a radius of 600 m. The impact diminishes with distance and has a maximum price effect of up to 2.8% in proximity of 100 m. The results suggest that the potentially negative effects of development constraints and maintenance obligations that are typically associated with historical buildings may be more than canceled out by the advantages of heritage buildings. Potentially positive effects include lower taxes, the intangible values of prestige, and the unobserved characteristics of historic importance or aesthetic appeal (Ahlfeldt & Maennig, 2010).

Ahlfeldt & Mastro (2012) found that homebuyers are willing to pay for closeness to iconic architectural structures. Oak Park, a village adjacent to the West Side of Chicago, Illinois, was the study area. The area contains 24 residential structures designed by the world-famous American architect Frank Lloyd Wright, many designated landmarks, as well as three preservation neighborhoods. The study identified a premium of up to 8.5% for homes within 50 m of a house designed by Wright and a 5% premium for houses within a radius of 50 - 250 m. Ahlfeldt & Mastro (2012) argue that the innovative architecture, the uniqueness of the design, higher associated visual utility, as well as prestige associated with the prominence of the architect created such high positive external price effects.

Brandt et al. (2013) analyzed the impact of houses of worship on property prices in Hamburg, Germany, and discovered positive externalities within a distance of 1,000 m. A premium of 4.6% was identified for houses located within a distance of 100 m to 200 m. The impact of mosques did not differ from the effect of other houses of worship. Moreover, the study found that church bell ringing did not have a significantly negative impact on surrounding residential properties.

The literature uses various approaches for measuring the timing of the treatment effect and the corresponding price reactions to exogenous shocks. Dehring et al. (2007), Galster et al. (2004), Ahlfeldt & Kavetsos (2012), and McMillen & McDonald (2004) argue that price reactions take place within months of the first announcement of the development. This argument is supported by McKay & Plumb (2001), who argue that the announcement of the Olympic Games in Barcelona 1992 was a determinant of property price increases in the months following the announcement. In contrast, Gibbons & Machin (2005) and Ellen et al. (2001) claim that price effects occur only after the improvement has taken place. Tu (2005) argues that real estate prices within close proximity (2.5 km) improve after the development has taken place and that, in contrast, prices of properties within 2.5 – 4 km appreciate already within months after the announcement of the development. Tu (2005) explains the phenomenon with disamenities, such as noise and air pollution caused by the construction, that neutralize the positive effects in close proximity.

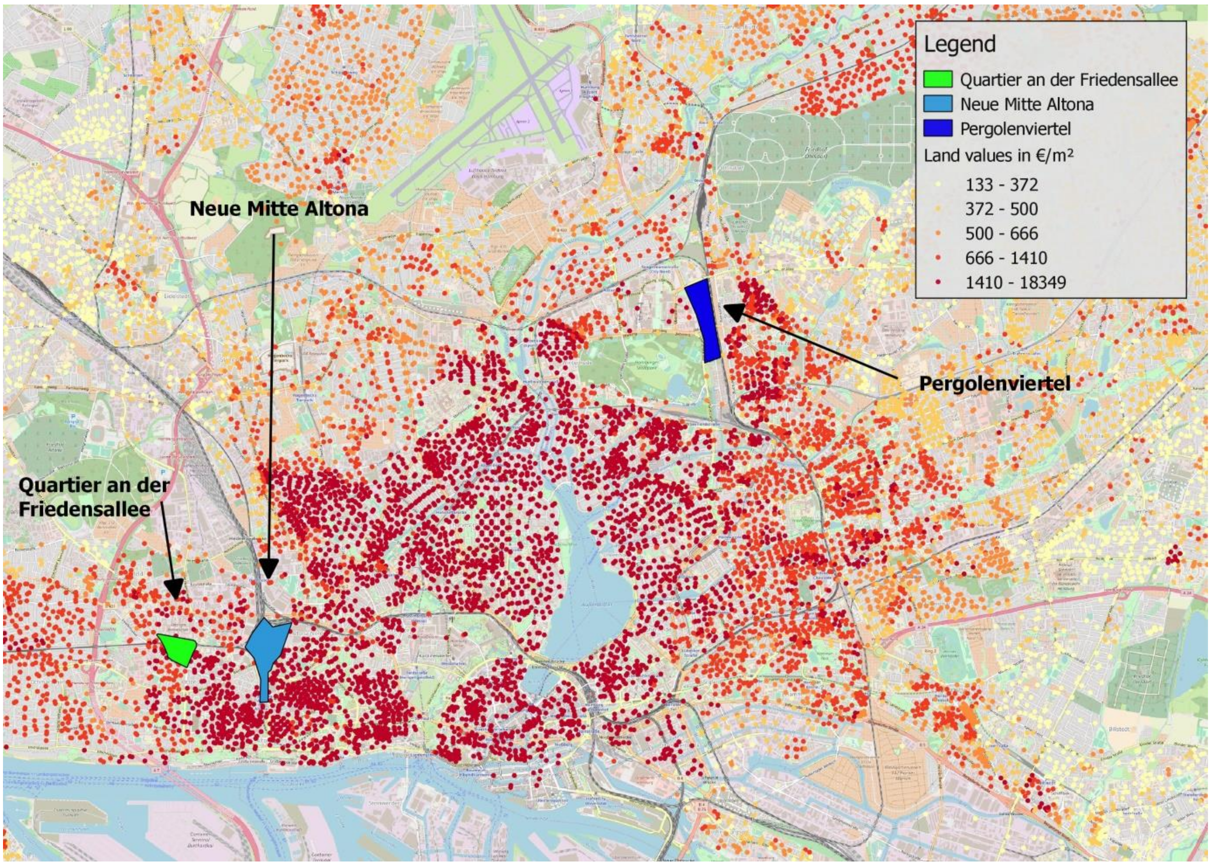
2.2. Projects under Current Study

This research uses data from the city of Hamburg, which covers an area of 755 km² and had 1,810,438 inhabitants on 31 July 2016 (Statistikamt Nord, 2016). This makes Hamburg the second largest city in Germany in terms of size and population.

The three large-scale construction projects analyzed are *Quartier an der Friedensallee* (QF), *Neue Mitte Altona* (NMA), and *Pergolenviertel* (PV). QF and NMA are located west of the city-center in the neighborhoods Ottensen and Altona-Nord. PV is located to the north-east of the city-center in the neighborhood Winterhude. All three projects carry a mandate to include publicly subsidized housing units, with the percentage varying between 33% and 60%.

The Hamburg senate started a publicly subsidized housing program in 2011. The aim of the program is to subsidize the annual construction of 2,000 rental units with rental and occupancy restrictions to improve the housing supply for people with low and middle incomes. In 2017, the program was expanded to 3,000 dwellings annually. Families with children, students, or seniors are supported by this initiative. The subsidized housing law of Hamburg (Hamburgische Wohnraumförderungsgesetz) determines what should be considered a low- and a middle-income household and who is eligible to participate in the program (Behörde für Stadtentwicklung und Umwelt, n.d.). The rent for apartments for people with low-incomes is fixed at 6.4 € per m², for people with middle-incomes it is set at 8.5 € per m² for 15, 20, or 30 years. The rent can be increased only every two years by a predetermined amount. The city of Hamburg supports the construction of social housing by offering developers attractive loans or subsidies. Moreover, certain plots of land are only sold to developers on the condition that they include a minimum share of publicly subsidized housing units (Behörde für Stadtentwicklung und Umwelt, n.d.).

Figure 1: Scaled map of land values for apartment buildings in Euros per sqm for Hamburg in 2016.



Before the development of QF, the 8.5 hectare area consisted mainly of office, commercial, industrial, and residential buildings. The development plan calls for the construction of 1,200 residential dwellings (1/3 rental apartments, 1/3 condominiums, 1/3 publicly subsidized housing units), offices for 1,500 people, commercial premises for 30 local craft shops, as well as service providers, day care centers, playgrounds, and green-spaces. An underground carpark is planned for the entire development. The area is divided into three parts, which are developed by four different real estate developers. The first part (*Kolbenhöfe*) is realized by *Rheinmetall Immobilien AG*, who will build 420 dwellings, offices, and buildings for small commercial usage. The second part (*Euler Hermes compound*) is developed by *Quantum Immobilien AG*. It includes 460 apartments and a new headquarters for the company *Euler Hermes*. The third part (*Henkel Schwarzkopf compound*) is developed by *ABG Allgemeine Bauträger GmbH* and *Köhler und von Bargen Immobilien*. It calls for the construction of 260 apartments, buildings for commercial and office usage as well as a day care center (Behörde für Stadtentwicklung und Umwelt, n.d.). The timeline for the development is outlined in Table 1.

Table 1: Timeline of the development *Quartier an der Friedensallee*

Date	***Quartier an der Friedensallee***
June 2013	Start of the urban planning competition Kolbenhöfe
December 2013	Announcement of the winner of the urban planning competition Kolbenhöfe
February 2015	Start of the urban planning competition Henkel Schwarzkopf & Euler Hermes site
August 2015	Announcement of the winner of the urban planning competition Henkel Schwarzkopf & Euler Hermes site
January 2016	Publication of the development plan Kolbenhöfe
August 2016	Start of preliminary construction work
April 2017	Publication of joint concept for all three sites
January 2018	Start of construction work
2023	Planned completion of development

(Behörde für Stadtentwicklung und Umwelt, n.d.)

The NMA project covers 75 hectares and consists of 3,500 dwellings (1/3 of them rental apartments, 1/3 condominiums, and a 1/3 publicly subsidized housing), offices, day care centers, and educational institutions. Evenly distributed over the NMA area will be retail stores and restaurants. The dwellings will take up 26 hectares; eight hectares in the center will be used for a park with recreational and sports facilities as well as a playground. Green spaces will be distributed across the entire area. Buildings of historical heritage will be preserved and included in the redevelopment project. Cycling tracks, a car-sharing facility, and public transportation will be included in the project; the objective is to make owning a personal car unnecessary.

The project is developed in two phases: 1,600 dwellings will be constructed on a former freight depot; 1,900 dwellings will be built on an area that is currently occupied by the long-distance train station *Altona* and associated railway tracks. The second construction phase is planned to start in 2024 after the long-distance train station *Altona* has been relocated to its new location Diebsteich. The winners of the urban planning competition are: (1) the *André Poitier's architects*, (2) the city planner *RIBA*, (3) and the landscape planer *ARBOS*. The draft of the winners provided the basis for the Masterplan *Mitte Altona* (Behörde für Stadtentwicklung und Umwelt, n.d.). The timeline for the project is provided in Table 2.

Table 2: Timeline of the development *Neue Mitte Altona*

Date	***Neue Mitte Altona***
July 2010	Start of the urban planning competition
January 2011	Announcement of the winner of the urban planning competition
September 2012	The Senate of Hamburg passes the master plan
September 2013	Finalization of an open space competition
January 2014	Publication of the development plan
July 2014	Deutsche Bahn AG decided to relocate the long-distance train station Altona to the railway station Diebsteich
September 2014	The Senate of Hamburg passes the development plan
November 2014	Ground breaking ceremony of 1st development phase
June 2015	City of Hamburg acquires the land of the Bahnhof Hamburg-Altona from Deutsche Bahn AG
February 2016	Start of construction work
2024	Start of second development phase

(Behörde für Stadtentwicklung und Umwelt, n.d.)

The PV project will be constructed on 27 hectares of an area currently occupied by 330 small-scale private garden plots. The majority of the small-scale private garden plots are kept intact or relocated. Eight hectares will be used for 1,400 dwellings (60% publicly subsidized housing), six hectares for small-scale private garden plots, open space with playgrounds, and parks (Bezirksamt Hamburg-Nord, 2015). Sport facilities will be located on seven hectares. Health care services, facilities for elderly people, small stores, restaurants, cafes, and three day care centers will be included in the new development. Residential space for 200 students will be created. Additionally, car-sharing and bike-sharing facilities, a bike repair shop, and the close proximity to the railway stations *Alte Wöhr* and *Rübenkamp* offer alternative ways of transportation (Bezirksamt Hamburg-Nord, 2015). The area is located next to the large city park (Stadtpark) of Hamburg, which covers 150 hectares. The project is divided into ten parts, with a different developer for each (Gesellschaft für Stadt- und Regionalanalysen und Projektentwicklung mbH, 2017). The timeline for PV is provided in Table 3.

Table 3: Timeline of the development *Pergolenviertel*

Date	***Pergolenviertel***
April 2010	Start of the urban development framework planning
June 2011	Presentation of the urban development framework plan
March 2012	Start of the urban planning competition
May 2012	Announcement of the winner of the urban planning competition
2013	Publication of progress from planning committee
July 2014	Public layout of the development plan
July 2015	Publication of the development plan
November 2016	Start of preliminary construction work
October 2017	Start of construction work

(Gesellschaft für Stadt- und Regional- analysen und Projektentwicklung mbH, 2017)

The three large-scale residential developments analyzed differ in terms of size, location, as well as previous and future usage. The unique characteristics and differences of the three projects allow for transferring the findings to various other large-scale residential construction projects. In order to be able to transfer the findings of this study to other projects, one has to consider the differences in the micro- and macroeconomic environment of the individual projects.

The QF project is characterized by the redevelopment of an area with similar usage, including dwellings, offices as well as commercial premises. The NMA project involves (a) the elimination of disamenities in the form of industrial facilities and railway tracks and (b) the construction of dwellings, offices, parks, as well as new infrastructure, including as retail stores, restaurants, educational institutions, and day care centers. The PV project is characterized by the construction of dwellings with a high share of publicly subsidized housing (60%) and infrastructure, such as health care services, facilities for elderly people, small stores, restaurants, cafes, and day care centers. PV is located in a green area surrounded by parks and water that has previously been occupied by small-scale private garden plots.

3. Data and Methodology

The paper uses land values (Bodenrichtwerte) calculated by the Committee of Valuation Experts (Gutachterausschuss für Grundstückswerte). Land values represent the value of one square meter of land at the end of the corresponding year for a fixed location. Land values are determined for the entire state of Hamburg, except for the island of Neuwerk, which is located 120 km from the center of the city. Land values represent the average characteristics of a parcel of land.[1] From 2010 onwards, the Committee of Valuation Experts determines land values on an annual basis by statistically evaluating all transactions during the reported period. Land values are calculated for different types of usage, which include, amongst others, industrial, office, residential, or agricultural use (Landesbetrieb Geoinformation und Vermessung, 2010). Land values with a value of zero are removed. This leaves 21,650 land values per annum for the period between 2010 and 2016.

A hedonic price model is created that explains land values according to their characteristics. Distance buffers and time dummies are introduced to capture the effect of the three large-scale construction projects on land values in close proximity to the project. The announcement of the projects is selected as the time of treatment. It is assumed that the publication of the winner of the urban planning competition is the first treatment to affect land values. The aim of the urban planning competition is to establish the basic framework for the development of the area. The draft from the urban planning competition is further developed when the master plan for the area is created.

For the QF project, the announcement of the winner of the urban planning competition for the first development phase (Kolbenhöfe) in December 2013 is identified as the time of treatment. This date is selected because the publication of the winner of the urban planning competition reduces risk and uncertainty and shows relatively accurately what the area will look like and how it will be used. In addition, with the announcement of the winner, the new development of the entire site Friedensallee was initiated. Furthermore, in 2013 it has been communicated that other parts of the area will also be redeveloped. For the NMA and the PV projects, the announcement of the winner of the urban planning competition in January 2011 and in May 2012, are selected as the treatment times. The frequent publication of more detailed information regarding the developments in the years after the first treatment times is assumed to result in price effects in the following years.

---

[1] A parcel is a small area of land with predefined borders.

3.1. Baseline Models

The empirical strategy is to first develop two baseline models. These models differ in terms of the estimation methodology used. The model represented by Equation (1) uses a standard panel fixed-effects regression with time-fixed effects and clustering at the level of the land value.

$$(1) \qquad \ln(Y_{it}) = \beta NEIGH_{it} + \gamma_t + \alpha_i + \varepsilon_{it}$$

The dependent variable is the natural logarithm of land value *i* in year *t*. Various neighborhood characteristics[2] are represented by $NEIGH_{it}$ and measure the association of land values with changes in demographic characteristics across districts over time. The β is the associated vector of regression coefficients. The term γ_t *r*epresents time-fixed effects, the term α_i unit fixed effects. The error term is represented by ε_{it}. The model represented by Equation (2) employs pooled OLS, again with time-fixed effects and with clustering at the level of the land value.

$$(2) \qquad \ln(Y_{it}) = \beta NEIGH_{it} + \delta STRUCT_i + \mu ACCESS_i + \sigma POLLU_i + \gamma_t + \varepsilon_{it}$$

Time-invariant structural, accessibility, and pollution variables[3] are represented by $STRUCT_i$, $ACCESS_i$, and $POLLU_i$, respectively. They are used as substitutes for the panel fixed-effects that are represented by α_i in model 1.

---

[2] Annual population data that vary by neighborhood over time come from the Statistikamt Nord (2016).

[3] Structural, accessibility, and pollution variables on the land values parcel level are generated using GIS information about Hamburg.

3.2. Impact Analysis

To analyze the impact of the three large-scale residential construction projects on land values, land values are compared before and after the treatments. This approach was applied before, e.g., by Ahlfeldt & Maennig (2007), Dehring et al. (2007), and Tu (2005). This paper follows the approach of Dehring et al. (2007), who test the effect of multiple instead of just one announcement on property prices. In other words, the impact of various shocks instead of one shock on land values will be analyzed. Applying a difference-in-difference method, land values that are within a radius of 1,500 m to the large-scale construction projects (treatment group) are compared to land values outside of this radius (control group) for the period between 2010 and 2016. Differences across land values vicinity that are not changing over time, such as location, are controlled for by fixed effects at the level of the individual parcels. In addition, we control for variables that are changing over time, such as population density. The model represented by Equation (3) applies a panel fixed-effects regression[4] to capture the effect of the announcement of the large-scale residential construction projects on land values:

$$\ln(Y_{it}) = \sum_{k} \sum_{s} \sum_{b} \tau_{ksb} \; D_{ksbit} + \beta NEIGH_{it} + \gamma_t + \alpha_i + \varepsilon_{it} \qquad (3)$$

The model represented by Equation (1) is complemented in Equation (3) by adding treatment dummies ($\sum_k \sum_s \sum_b \tau_{ksb} \; D_{ksbit}$), where k represents geographical distance, s time (year), and b the project. The associated vector of coefficients is represented by τ_{ksb} and the treatment dummies by D_{ksbit}. All variables that are constant over time are captured by the unit fixed effects α_i.

[4] A fixed effects regression is applied to test the impact because it is more robust than a pooled OLS regression in the sense that it can better control for time-invariant variables.

3.3. Description of Data

The next paragraphs first define structural variables, then neighborhood characteristics, accessibility variables, pollution variables, time dummies, and distance dummies. The variable *FSI* (floor space index) captures the ratio of a building's total floor space to the size of the plot of land on which it is located. As suggested by Ahlfeldt & Maennig (2007), the *FSI* is included as an independent variable. A structural dummy variable categorizing whether a variable is located within an official re-development area (*ReDevA*) is created to correct land values for potentially systematic price differences.

Neighborhood characteristics are represented by demographic attributes, such as age (*Elderly / Young*) or *Immigration*. These demographic variables are also used by Brandt & Maennig (2007) as well as Brandt et al. (2013). The proportion of elderly people *(Elderly)* above the age of 65 within one neighborhood serves as an indicator of income. In addition, the proportion of young people (*Young*) below the age of 18 serves as a proxy for families with children (Ahlfeldt, 2011). Ahlfeldt and Brandt (2011) state that the proportion of immigrant people (*Immigration*) is strongly related to land values. Tu (2005) uses it as an indicator of neighborhood quality and his study finds that the proportion of immigrant people is negatively associated with prices. The variable *Population_Density* may also serve as an indicator for neighborhood quality (Tu, 2005). Less populated neighborhoods are preferred over more densely populated areas. The proportion of people that is unemployed (*Unemployment*) is added to identify neighborhoods that are less desirable (Ahlfeldt, 2011).

Accessibility variables, such as the distance to the next supermarkets (*Dist_Supermarket*), the airport (Dist_Airport), central business district (*Dist_CBD*), sub-centers (*Dist_SubCenter*), public transport (*Dist_Station*), educational institutions (*Dist_School* / *Dist_Uni*), or day care centers (*Dist_DayCare*), capture the proximity to amenities (Alonso, 1964). Distances to natural amenities, such as to the lake Alster or the river Elbe (*Dist_Water*), or a view on the Alster or Elbe (*View_water*) are also included. Poudyal et al. (2009) argue that the proximity to and size of urban parks (*Att_Park*) have a small but significant positive effect on property values. Therefore, a variable to measure the attractiveness of parks is included. The variable weighs the distance to the closest park and its size.[5] Furthermore, variables that capture the number of restaurants, bars, cafes (*Catering_200*), and houses of worship (*Worship_200*)

[5] $Att\_Park_i = \frac{1}{d_{ij}} A_j$. The straight-line distance between the centroid of the block structure i and the park j is given by d_{ij} and the area of the park is represented by A_j.

within a radius of 200 m are included. The variable employment gravity (*Jobs_30min*) describes how many jobs can be reached from a location within 30 minutes by public transportation (Landesbetrieb Geoinformation und Vermessung Hamburg, 2012). A categorical variable is included to capture the effect of each neighborhood (*Neighborhood*).

Pollution characteristics are represented by the variables for airport noise (*Area_1* / *Area_2*), traffic noise (*Main_Road* / *Speed_30*), and distance to railway tracks (*Tracks_200*). As outlined by previous research (Ahlfeldt & Maennig, 2007; Debrezion et al., 2011) the proximity to railway tracks or roads can influence land values due to noise pollution. Debrezion et al. (2011) find a negative effect of distance to railway lines, due to noise effects. Within a radius of 250 m around railway tracks property prices are 5% lower compared to locations further away than 500 m. As major parts of QF, NMA, and PV are currently located in or next to an area that is occupied with railway tracks these could bias the results of the analysis. This possible bias can be eliminated by introducing mutually exclusive distance dummy variables. The variable *Tracks_200* measures whether land values are located within a distance of 200 m from over ground railway tracks. The dummy variables *Area_1* and *Area_2* describe whether land values are located within an airport entry lane. The variables *Main_road* and *Speed_30* identify whether land values are located next to a main road or a street with speed limit of 30 kmh.

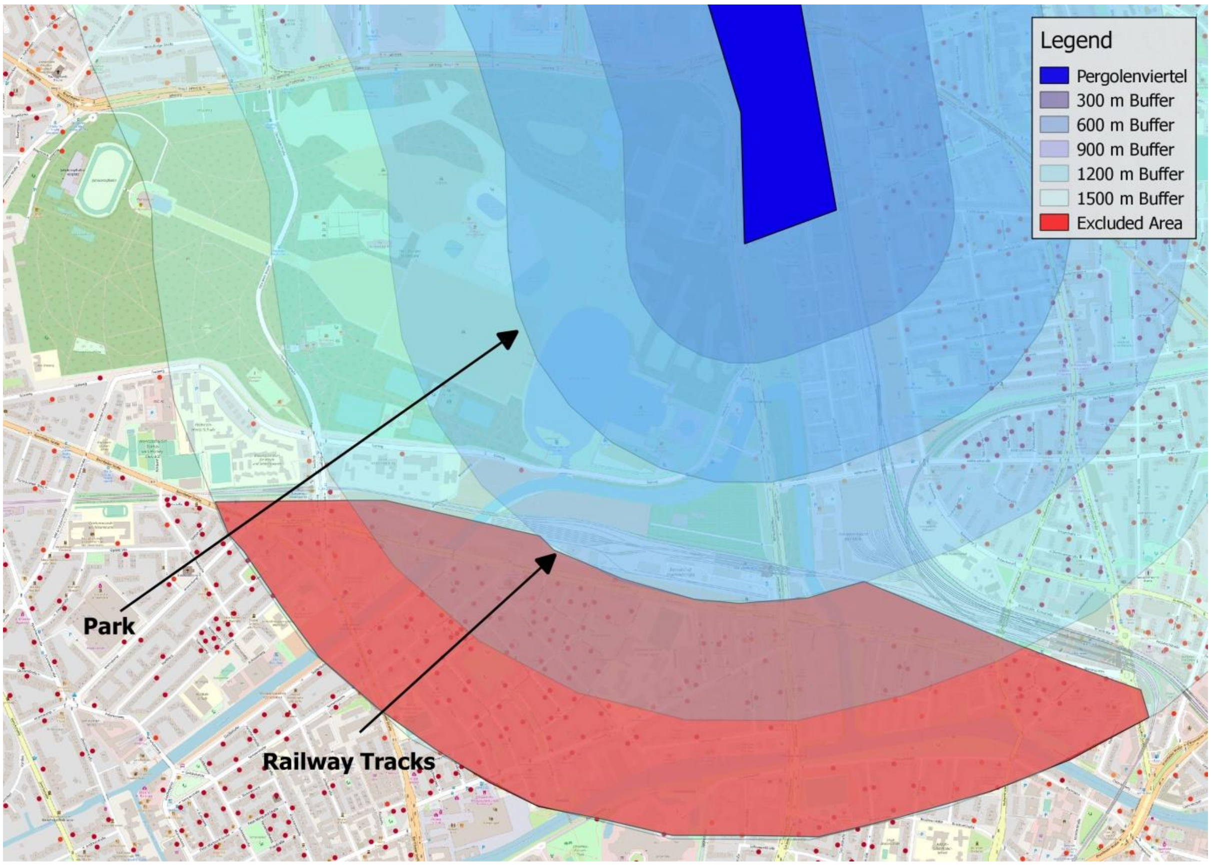
To account for time fixed effects seven dummy variables are introduced, of which each represents December 31st of each year between 2010 and 2016 (*D_2010*, *D_2011*, *D_2012*, *D_2013*, *D_2014*, *D_2015*, *D_2016*). The date December 31st 2010 is the base category that is omitted. These dummy variables force the same time varying effect on all cross-section units and therefore accounts for macro effects that affects all units in a similar way.

For each project (QF, NMA, and PV), five distance buffers (*Dist_QF_X*, *Dist_NMA__X*, *Dist_PV_X*) are generated, which cover distances in multiples of 300 m (0 - 300m, 300 - 600m, etc). For large projects, Ahlfeldt & Maennig (2007) found significant results up to distances of 3 km, Tu (2005) for distances up to 4 km, and Kavetsos (2011) for distances up to 5 km. The relevant distances tend to be significantly shorter for smaller urban projects. For supportive housing, Galster et al. (2004) found significant results up to a distance of 300 m to 600 m; for cell phone base stations, Brandt & Maennig (2012) identified significant impacts only within a radius of 100 m; for houses of worship, the impact appears limited to 100 to 200 m (Brandt et al. 2013). Considering the scale of the projects, it is assumed that exogenous shocks only have an impact in close proximity.

The impact on the following distance buffers: 0-0.3, 0.3-0.6, 0.6-0.9, 0.9-1.2, 1.2-1.5, 0-0.5, 0.5-1.0, 1.0-1.5; 0-0.9, 0-1.2; 0-2.0 km is tested and the best fit of the model appears to be for five distance rings each 300 m within a radius of 1.5 km.

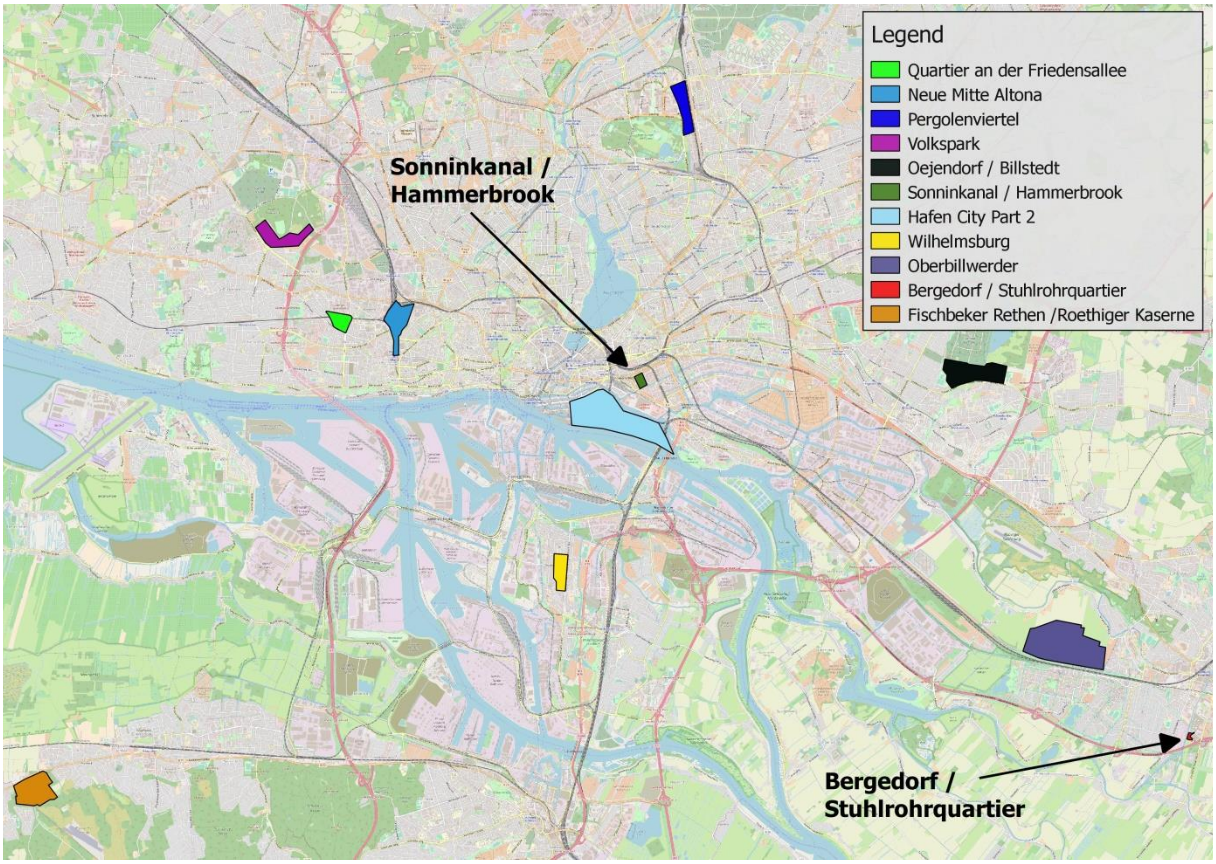
For PV, land values between 900 m and 1,500 m southwest of the project are excluded because they are separated by a park and by railway tracks from the project and are, therefore, probably not impacted. The excluded area can be seen in Figure 2 (marked in red). This approach follows Hess & Almeida (2007), who argue that the actual walking distance (along the street network) versus the perceived proximity (measured by straight-line distance) reveals that the results are statistically more significant in the network distance than the straight-line distance model. Consequently, the railway tracks create a barrier and separate the areas of impact.

Figure 2: Scaled map of apartment house land values, 300 m, 600 m, 900 m, 1,200 m, 1,500 m distance buffers around the large-scale residential construction project *Pergolenviertel*, and the excluded area.



During the time horizon considered, there were more large-scale residential construction projects planned or under way in Hamburg than the three that are explicitly considered. Each is likely to impact the surrounding land values. Since these areas are part of the control group for each of the 3 residential projects we focus on in this study, we use a set of separate dummy variables to account for the price impact of these other projects. The dummy variables measure the impact on land values within a distance of 900, 1,200, and 1,500 m around the developments for each year following the first treatment. The publication of the winner of the urban planning competition is selected as the date of the announcement. The following projects are included in the analysis: (1) Volkspark with 2,200 dwellings; announced on 16.11.2016; (2) Oejendorf/Billstedt with 1,400 dwellings; announced on 28.01.2016; (3) Wilhelmsburg with 2,200 dwellings; announced on 20.07.2016; (4) Sonninkanal/Hammerbrook with 2,000 dwellings; announced on 22.12.2011; (5) Hafen City part 2 with 2,800 dwellings; announced constantly after 2007; (6) Oberbillwerder with 7,000 dwellings; announced on 25.05.2018; (7) Bergedorf with 1,100 dwellings; announced on 15.01.2017; (8) Fischbeeker Rethen/Roethinger Kaserne with 5,000 dwellings; announced on 30.09.2016. The projects are displayed in Figure 3.

Figure 3: Map of large-scale residential construction projects in Hamburg between 2010 and 2018.



The variables used in this paper are summarized in Table 4. The level of measurement identifies at what level a variable differs, within land value parcels or across neighborhoods.

Table 4: Summary statistics of dependent and independent variables from 2010 to 2016 (151,550 observations)

Variable	**Definition**	**Level of Measurement**	**Mean**	**Std. Dev.**	**Min**	**Max**
		Dependent variable				
Land_Value	Land value, typical value of land in Euro per sqm in a parcel	Parcel	902	1,197	100	23,509
		Structural variables				
FSI	Corresponding floor space index	Parcel	1.005	0.889	0.5	10
ReDevA	Dummy variable: 1, if the parcel is located in a redevelopment area, 0 otherwise	Parcel	0.01	0.099	0	1
		Neighborhood characteristics				
Elderly	Proportion of people in a neighborhood (Stadtteil) that are at least 65 years old	Neighborhood	0.213	0.065	0.03	0.43
Young	Proportion of people in a neighborhood that are 18 years old or younger	Neighborhood	0.17	0.047	0.052	0.048
Immigration	Proportion of immigrant people in a neighborhood	Neighborhood	0.138	0.083	0.016	0.791
Population_Density	Population per km^2	Neighborhood	4,854	3,784.20	42	19,014
Unemployment	Proportion of the unemployed to the workforce (15 to under 65)	Neighborhood	0.051	0.0216	0.008	0.15
Neighborhood	ID of the corresponding neighborhood	Neighborhood	51	23.6	1	101
		Accesibility variables				
Jobs_30min	Number of jobs that can be reached within 30 min by public transport	Parcel	136,190	43,918	74,939	255,000
Dist_CBD	Straight-line distance to CBD in meter	Parcel	9,121	4,457	52	24,119
Dist_SubCenter	Straight-line distance to nearest sub center according to zoning plan in meters	Parcel	2,328	1,804	10	10,691
Dist_Station	Straight-line distance to nearest subway or light-rail transit station in meters	Parcel	1,126	1,015	8	9,756
Dist_Water	Straight-line distance to main bodies of “Alster” or “Elbe”	Parcel	4,219	3,031	13	14,712
View_water	1, if the “Alster” or “Elbe can be seen from the parcel, 0 otherwise	Parcel	0.005	0.07	0	1
Att_Park	Att_Park_i represents the attractiveness of the park from the perspective of the inhabitants of a structural parcel	Parcel	837	10,200	0.092	790,745

Dist_DayCare	Straight-line distance to nearest day care center in meters	Parcel	391	252	0	3,361
Dist_School	Straight-line distance to nearest school in meters	Parcel	440	314	3	3,519
Dist_Uni	Straight-line distance to nearest university in meters	Parcel	7,317	4,460	15	22,420
Dist_Airport	Straight-line distance to the airport terminals	Parcel	9,462	5,010	59	29,286
Dist_Supermarket	Straight-line distance to the nearest supermarket	Parcel	601	484	1	4,504
Catering_200	Number of bars, restaurants, pubs, fast food restaurants, food courts or biergartens within 200 meter distance	Parcel	2.7	6.9	0	85
Worship_200	Number of houses of worship within 200 meter distance	Parcel	0.2	0.6	0	6
Pollution characteristics						
Area_1	1, if the parcel is located in airport noise area_1, 0 otherwise	Parcel	0.0016	0.04	0	1
Area_2	1, if the parcel is located in airport noise area_2, 0 otherwise	Parcel	0.026	0.16	0	1
Main_Road	1, if the parcel is located directly next to a main road according to zoning plan, 0 otherwise	Parcel	0.13	0.34	0	1
Speed_30	1, if the parcel is located directly next to a road with a speed limit of 30km/h, 0 otherwise	Parcel	0.67	0.47	0	1
Tracks_200	1, if the parcel is located within 200m of a railway track, 0 otherwise	Parcel	0.16	0.37	0	1
Time varying variables						
D_2010	1, if the land value refers to the 31st Dec. 2010, 0 otherwise	Parcel	0.125	0.33072	0	1
D_2011	1, if the land value refers to the 31st Dec. 2011, 0 otherwise	Parcel	0.125	0.33072	0	1
D_2012	1, if the land value refers to the 31st Dec. 2012, 0 otherwise	Parcel	0.125	0.33072	0	1
D_2013	1, if the land value refers to the 31st Dec. 2013, 0 otherwise	Parcel	0.125	0.33072	0	1
D_2014	1, if the land value refers to the 31st Dec. 2014, 0 otherwise	Parcel	0.125	0.33072	0	1
D_2015	1, if the land value refers to the 31st Dec. 2015, 0 otherwise	Parcel	0.125	0.33072		1
D_2016	1, if the land value refers to the 31st Dec. 2016, 0 otherwise	Parcel	0.125	0.33072	0	1
Distance large-scale construction projects						
Dist_QF	Straight-line distance to the real estate developmet project Friedensalle	Parcel	10,548	5,495	0	28,749
Dist_QF_0_300	Dummy variable for all land values within 300 meters around the project Friedensalle	Parcel	0.0037	0.061	0	1

Dist_QF_300_600	Dummy variable for all land values within 300 to 600 meters around the project Friedensalle	Parcel	0.0057	0.075	0	1
Dist_QF_600_900	Dummy variable for all land values within 600 to 900 meters around the project Friedensalle	Parcel	0.006	0.077	0	1
Dist_QF_900_1200	Dummy variable for all land values within 900 to 1,200 meters around the project Friedensalle	Parcel	0.0077	0.087	0	1
Dist_QF_1200_1500	Dummy variable for all land values within 1,200 to 1,500 meters around the project Friedensalle	Parcel	0.0084	0.091	0	1
Dist_QF_0_1500	Dummy variable for all land values within 0 to 1,500 meters around the project Friedensalle	Parcel	0.0316	0.175	0	1
Dist_NMA	Straight-line distance to the real estate development project Neue Mitte Altona	Parcel	9,657	5,215	0	27,474
Dist_NMA_0_300	Dummy variable for all land values within 300 meters around the project Neue Mitte Altona	Parcel	0.0064	0.08	0	1
Dist_NMA_300_600	Dummy variable for all land values within 300 to 600 meters around the project Neue Mitte Altona	Parcel	0.0117	0.108	0	1
Dist_NMA_600_900	Dummy variable for all land values within 600 to 900 meters around the project Neue Mitte Altona	Parcel	0.0119	0.108	0	1
Dist_NMA_900_1200	Dummy variable for all land values within 900 to 1,200 meters around the project Neue Mitte Altona	Parcel	0.0097	0.098	0	1
Dist_NMA_1200_1500	Dummy variable for all land values within 1,200 to 1,500 meters around the project Neue Mitte Altona	Parcel	0.013	0.113	0	1
Dist_NMA_0_1500	Dummy variable for all land values within 0 to 1,500 meters around the project Neue Mitte Altona	Parcel	0.0527	0.223	0	1
Dist_PV	Straight-line distance to the real estate developmet project Pergolenviertel	Parcel	7,875	4,621	0	25,266
Dist_PV_0_300	Dummy variable for all land values within 300 meters around the project Pergolenviertel	Parcel	0.0019	0.044	0	1
Dist_PV_300_600	Dummy variable for all land values within 300 to 600 meters around the project Pergolenviertel	Parcel	0.0048	0.069	0	1
Dist_PV_600_900	Dummy variable for all land values within 600 to 900 meters around the project Pergolenviertel	Parcel	0.0068	0.082	0	1

Dist_PV_900_1200	Dummy variable for all land values within 900 to 1,200 meters around the project Pergolenviertel	Parcel	0.0102	0.101	0	1
Dist_PV_1200_1500	Dummy variable for all land values within 1,200 to 1,500 meters around the project Pergolenviertel	Parcel	0.0113	0.106	0	1
Dist_PV_0_1500	Dummy variable for all land values within 0 to 1,500 meters around the project Pergolenviertel	Parcel	0.0351	0.184	0	1
Dist_Volkspark_0-X	Dummy variable for all land values within 0 to 900, 1,200, 1,500 meters around the large-scale residential construction project Volkspark for year x	Parcel	0.0147	0.12	0	1
Dist_ Oejendorf/Billstedt_0-X	Dummy variable for all land values within 0 to 900, 1,200, 1,500 meters around the large-scale residential construction project Oejendorf for year x	Parcel	0.0168	0.128	0	1
Dist_ Wilhelmsburg_0-X	Dummy variable for all land values within 0 to 900, 1,200, 1,500 meters around the large-scale residential construction project Wilhelmsburg for year x	Parcel	0.0114	0.106	0	1
Dist_ Sonninkanal/Hammberbrook_0-X	Dummy variable for all land values within 0 to 900, 1,200, 1,500 meters around the large-scale residential construction project Hammerbrook for year x	Parcel	0.0179	0.133	0	1
Dist_Hafencity_0-X	Dummy variable for all land values within 0 to 900, 1,200, 1,500 meters around the large-scale residential construction project Hafencity for year x	Parcel	0.028	0.165	0	1
Dist Fischbeker Rethen/Roettiger_Kaserne_0-X	Dummy variable for all land values within 0 to 900, 1,200, 1,500 meters around the large-scale residential construction project Roettiger Kaserne for year x	Parcel	0.0035	0.059	0	1

4. Empirical Results

We first discuss our two baseline hedonic models. Then the impact of the three large-scale construction projects will be compared in separate and joint regressions. All regressions will be analyzed using distance buffers up to 900 m, 1,200 m, and 1,500 m.

4.1. Baseline Models

Table 5 includes our two baseline hedonic price models. These models differ in terms of the estimation methodology used. Model 1 uses a standard panel fixed-effects regression with time-fixed effects and clustering at the level of the land value (Equation 1). Model 2 employs pooled OLS, also with time-fixed effects and with clustering at the level of the land value (Equation 2). The key difference to Model 1 lies in the fact that the panel fixed-effects for the land value parcels are replaced with a large number of variables that identify unique, time-invariant characteristics of each parcel and of the neighborhoods that the parcels are located in.

Table 5: Baseline model

Variable	**Model 1**	**Model 2**
	Panel fixed effects clustering at level of land value	**Pooled OLS with distance dummies clustering at the level of the land value**
Dependent variable		
Log (Land_value)		
Independent variables		
Constant	7.205***	9.484***
	(0.071)	(0.163)
Structural variables (time invariant)		
Log (FSI)		0.435***
		(0.010)
Redeva		0.030
		(0.020)
Neighborhood characteristics		
Log (Elderly_>65_years (%))	-0.119***	-0.119***
	(0.006)	(0.006)
Log (Young_<18_years (%))	0.106***	0.106***
	(0.007)	(0.007)
Log (Immigration (%))	0.051***	0.051***
	(0.003)	(0.003)
Log (Population_density)	-0.134***	-0.134***
	(0.008)	(0.008)
Log (Unemployment)	-0.002	-0.002

	(0.002)	(0.002)
Accessibility variables (time invariant)		
Log (Jobs_30min)		-0.076***
		(0.006)
Log (Dist_CBD)		-0.104***
		(0.023)
Log (Dist_Subcenter)		-0.054***
		(0.004)
Log (Dist_Station)		-0.034***
		(0.003)
Log (Dist_Water)		-0.143***
		(0.006)
View_Water		0.424***
		(0.031)
Att_Park		0.000
		(0.000)
Log (Dist_Daycare)		-0.005**
		(0.002)
Log (Dist_School)		0.000
		(0.002)
Log (Dist_Uni)		-0.080***
		(0.012)
Log (Dist_Airport)		0.140***
		(0.012)
Log (Dist_Supermarket)		-0.015***
		(0.002)
Catering_200		-0.000
		(0.001)
Worship_200		0.009***
		(0.003)
Pollution characteristics (time invariant)		
Area_1		-0.235***
		(0.038)
Area_2		-0.085***
		(0.012)
Main_Road		-0.059***
		(0.005)
Speed_30		0.021***
		(0.003)
Tracks_200		-0.040***
		(0.004)
Time fixed effects		
Dummy_2011	0.115***	0.115***
	(0.001)	(0.001)
Dummy_2012	0.272***	0.272***
	(0.001)	(0.001)
Dummy_2013	0.340***	0.340***

	(0.001)	(0.001)
Dummy_2014	0.412***	0.412***
	(0.001)	(0.001)
Dummy_2015	0.433***	0.433***
	(0.001)	(0.001)
Dummy_2016	0.563***	0.563***
	(0.001)	(0.001)
District dummies	No	Yes
No. observations	151,550	151,550
R^2	0.846	0.940
R^2adjusted	0.846	0.939

*The log of all land values of Hamburg between 2010 and 2016 is the dependent variable. 2010 is the base year for the time fixed effects. The areas marked as redevelopment areas have not changed between 2010 and 2016. The standard errors are indicated in parentheses. * significance at the 10% level ** significance at the 5% level *** significance at the 1% level.*

The results of Model 2 will be described and interpreted in the following section to get a sense of what variables that are fixed over time drive land values in Hamburg.

The results of the baseline hedonic model show the expected signs. The *floor space index (FSI)* has a strong positive effect on land values. The *FSI* value captures the ratio of a building's total floor space to the size of the plot of land on which it is located. Consequently, if the *FSI* value increases, the plot of land is worth more and the land value increases. The variable indicating whether a land value is situated within a redevelopment area or not (*ReDevA*) is not statistically significant. The insignificance can be explained by the fact that the land values that are located within a redevelopment area were already adjusted by the Committee of Valuation Experts (Gutachterausschuss für Grundstückswerte) before 2010, the beginning of our current sample.

The proportion of residents above *65* (*Elderly*) has a negative association with land values. People above 65 tend to have a lower average income; the negative signs of the coefficient indicate that people above 65 tend to live in areas with lower land values (Behörde für Stadtentwicklung und Wohnen, 2011). The proportion of inhabitants that are 18 or younger (*Young*) has a strong positive association with land values, indicating that families tend to concentrate in areas with higher land values. The proportion of immigrants (*Immigration*) also has a positive coefficient. As families with children, immigrants tend to live in more densely populated areas, which have higher land values. The signs of the coefficient for P*opulation-Density* are negative, suggesting that neighborhoods with higher population density are not preferred. This finding can be supported by Ahlfeldt & Maennig (2010) who found that higher population density has a statistically significant and negative association with condominium prices. Furthermore, Beckmann (1969) found that, with increasing income, people tend to move to areas with lower population density. The proportion of unemployed people (*Unemployment*) has no statistically significant association with land values.

The accessibility of jobs within 30 minutes (*Jobs_30min*) is statistically highly significant and has a somewhat surprising negative coefficient. Land values tend to decrease by 7.6% across neighborhoods if the number of jobs that is accessible by public transport within 30 minutes increases by 1 percent. As found by Osland & Thorsen (2008), property values do not necessarily increase with a smaller distance from the CBD and the availability of jobs. The negative coefficient could be explained by the preference to live in less densely populated areas (Ahlfeldt & Maennig, 2010; Beckmann, 1969). The Distance to the CBD (*Dist_CBD*), the distance to subcenters (*Dist_SubCenters*), the distance to the next station (*Dist_Station*), and the distance to the water (*Dist_Water*) are highly significant statistically and the coefficients have negative signs. The results mean that land values are lower if the distance to these amenities increases. These negative effects have first been explained by Alonso (1964) who developed a model to account for the accessibility requirements to the city center. According to Alonso, each plot of land has its own bid rent curve depending on its location and accessibility to the city center. The bid rent curve varies for the same parcel of land depending on the type of land use, such as housing, commercial, or industry.

Whether one has a view on the Alster or Elbe (*View_Water*) is highly significant statistically and has a strong positive association with land values. The distance to schools (*Dist_School*) is not significant statistically, most likely because schools are relatively evenly distributed across Hamburg and, therefore, not any longer identified as local amenities. This was suggested by Ahlfeldt & Maennig (2007) in a similar context. The attractiveness of parks (*Att_Park*) is also not significant statistically, which indicates that this variable has no amenity effect. This result is in accordance with the findings of Ahlfeldt & Maennig (2010) for condominium prices. The independent variables distance to the next daycare center (*Dist_DayCare*), university (*Dist_Uni*) and supermarket (*Dist_Supermarket*) are highly significant statistically with negative coefficients, which suggests land values are lower further away from these amenities. Positive amenities such as the good accessibility could outweigh negative amenities such as noise, traffic, and parking issues and explain the effect. The distance to the airport (*Dist_Airport*) in Hamburg is statistically significant with a positive coefficient. The result indicates that land values located further away from the airport are worth more. Negative amenities such as noise pollution could outweigh positive amenities and explain the effect. The number of bars, cafes, and restaurants (*Catering_200*) within a distance of 200 m around land values is not statistically significant. The even distribution of such amenities across Hamburg could explain the insignificance of this variable. The number of houses of worship within 200 m (*Worship_200*) has a positive effect on land values. This finding replicates the results of Brandt et al. (2014) who identified premiums of 4.6% for properties within a distance of 100 to 200 m to houses of worship. They also found that churches maintain to have a positive effect even after they have been deconsecrated. Houses of worship could be perceived as landmarks and explain this finding. As argued by Ahlfeldt & Maennig (2010), landmarks tend to have positive external effects on surrounding property prices.

Pollution characteristics are represented by the five variables *Area_1*, *Area_2*, *Main_Road*, S*peed_30*, and *Tracks_200*. All variables are highly significant statistically and suggest that more noise reduces land values. The negative impact of the airport approach path *Area_1* and *Area_2* is similar to that shown by Lipscomb (2003), as is the negative effect of main roads on land values. The positive effect on land values of a speed limit of 30 km/h is tied to reduced air and noise pollution. Above-ground rail tracks within a distance of 200 m (*Tracks_200*) negatively impact land values.

The results of the time fixed effects analysis show how land values for multi-story residential buildings have appreciated compared to the base year 2010. Land values have increased by 12.2%[6] in 2011 compared to 2010 and by 75.6% in 2016 compared to 2010. Land values have appreciated the most between 2011 and 2012 (14.1%) and the least between 2014 and 2015 (1.5%). These results are similar to those of the Immobilienmarktbericht Hamburg 2017 (Gutachterausschuss für Grundstückswerte Hamburg, 2017).

The baseline models show the expected signs for the data set. The absence of anomalies is an important result, which suggests that the panel data can be usefully applied to analyze the impact of the three residential construction projects in the next section.

---

[6] For the regression output in log-linear form, the attribute coefficients can be interpreted as percentage changes. The large changes adjustment formula is used for changes larger than 10%. For a parameter estimate b the percentage effect is equal to $(e^b - 1)$ (Halvorsen & Palmquist, 1980).

4.2. Impact Analysis

In this section first a pooled OLS regression with clustering at the level of the land value parcels is applied to compare the different models using the Akaike (AIC) and the Bayesian information criteria (BIC) in Table 6. The best models of fit will be selected and analyzed using fixed effects in Table 7.

To analyze the impact of the large-scale residential construction projects on land values, we define the area of impact as the neighborhood 1,500 m around these projects. Five distance dummies are used, each covering an additional distance of 300 m from 0 to 1,500 m. In the regressions other large-scale construction projects in Hamburg (Volkspark, Oejendorf, Wilhelmsburg etc.) are controlled for with one dummy variable for each year. The regressions differ in terms of the number of treatment dummies as well as the number of control dummies. For the regression QF_0_1500 the treatment dummies measure the impact 1,500 m around the project QF and the control dummies measure the impact around the other large-scale residential construction projects from 0 to 1,500 m, for the regression QF_0_1200 from 0 to 1,200 m, and for the regression QF_0_900 from 0 to 900 m. For the separate regressions (QF_0_X, NMA_0_X, and PV_0_X) the other two projects, for example NMA and PV for the regression QF_0_X, are included with one distance dummy for every year following the first treatment. Neighborhood characteristics, time fixed effects, and neighborhood identifiers are included in the models. All regressions contain 151,550 observations.

Table 6: Comparison of AIC values, BIC values, and R^2adjusted

		QF	**NMA**	**PV**	**QF_NMA**	**QF_NMA_PV**
1,500 m	AIC	61443	61294	61367	60961	60685
	BIC	63002	62972	62975	62807	62800
	R^2a	0.873	0.873	0.873	0.873	0.874
1,200 m	AIC	59217	58961	59232	58848	58831
	BIC	60737	60559	60801	60595	60777
	R^2a	0.875	0.875	0.875	0.875	0.875
900 m	AIC	59416	58942	59097	59245	59229
	BIC	60895	60481	60606	60883	61006
	R^2a	0.875	0.875	0.875	0.875	0.875

The AIC value is the lowest for the accumulated regression QF_NMA_PV_0_1200, which makes it the preferred model. Moreover, the regression QF_NMA_PV_0_1200 has the highest R^2 (0.8748) for all regressions up to 1,200 m.

After the preferred model has been selected, panel fixed effects is applied to compare the regressions with distance buffers up to 1,200 m. The output of the regressions is summarized in Table 7. The first three columns represent the results if the QF, NMA, and PV projects are analyzed in three separate regressions. Each of these regressions contains a detailed set of treatment variables for the project under study. Other large-scale building projects in Hamburg are included via binary control variables, with a single control variable for each of these other projects per year after the first announcement. The remaining two columns show the estimated project impact (a) if the QF and NMA projects are analyzed jointly in a single regression and (b) if, alternatively, the QF, NMA, and PV projects are analyzed jointly in one regression. Again, the other large-scale residential construction projects in Hamburg are included with a single dummy variable for each project for each year in all 5 regressions of Table 7.

Considering all separate regression together and comparing them to the accumulated regressions, the models are very similar in their fit. The fit of the separate regressions improves in the joint regression. Land values around QF are positively impacted in the accumulated regression QF_NMA_PV_0_1200 in 2013 and 2014 between 300 and 1,200 m. The effect varies between 1.5% and 6.7%. The impact is the strongest from 0 to 300 m and then constantly declines. In 2015 land values between 0 and 300 m and in 2016 land values between 0 and 1,200 m are negatively impacted. The effects vary between -1.9% and -3.6%. For NMA land values are positively impacted between 0 and 1,200 m. In the period between 2012 and 2016, the effect is the strongest from 0 to 300 m and then constantly declines. The impact varies between 3.2% and 22.4%. Concerning the effect of PV, land values within the distance of 0 to 1,200 m increased from 2012 to 2013. Land values located from 0 to 900 m improved between 2014 and 2016. The impact varies between 2.9% and 13.5%.

Table 7: Impact of Quartier an der Friedensallee, Neue Mitte Altona, Pergolenviertel

Variable	**QF_0_1200**	**NMA_0_1200**	**PV_0_1200**	**QF_NMA_0_1200**	**QF_NMA_PV_0_1200**
			Dependent variable		
Log (Land_value)					
			Independent variables		
Constant	2.823***	2.826***	2.826***	2.825***	2.827***
	(0.087)	(0.087)	(0.087)	(0.087)	(0.087)
			Treatment variables QF		
Treat_QF_2013_0_300	-0.055			0.011	0.011
	(0.010)			(0.010)	(0.010)
Treat_QF_2013_300_600	0.066***			0.067***	0.067***
	(0.009)			(0.009)	(0.009)
Treat_QF_2013_600_900	0.053***			0.050***	0.050***
	(0.009)			(0.009)	(0.009)
Treat_QF_2013_900_1200	0.036***			0.030***	0.030***
	(0.007)			(0.006)	(0.006)
Treat_QF_2014_0_300	-0.015			-0.008	-0.008
	(0.008)			(0.008)	(0.008)
Treat_QF_2014_300_600	0.035***			0.036***	0.036***
	(0.007)			(0.007)	(0.007)
Treat_QF_2014_600_900	0.031***			0.028***	0.028***
	(0.007)			(0.006)	(0.006)
Treat_QF_2014_900_1200	0.021***			0.015**	0.015**
	(0.007)			(0.006)	(0.006)
Treat_QF_2015_0_300	-0.034***			-0.028***	-0.027***
	(0.005)			(0.006)	(0.006)
Treat_QF_2015_300_600	0.001			0.002	0.003
	(0.005)			(0.005)	(0.005)
Treat_QF_2015_600_900	0.001			-0.002	-0.001
	(0.005)			(0.005)	(0.005)
Treat_QF_2015_900_1200	-0.002			-0.007	-0.007
	(0.007)			(0.006)	(0.006)
Treat_QF_2016_0_300	-0.042***			-0.036***	-0.036***
	(0.005)			(0.005)	(0.005)
Treat_QF_2016_300_600	-0.020***			-0.019***	-0.019***
	(0.004)			(0.004)	(0.004)
Treat_QF_2016_600_900	-0.015***			-0.018***	-0.018***
	(0.004)			(0.004)	(0.004)
Treat_QF_2016_900_1200	-0.016**			-0.022***	-0.022***
	(0.007)			(0.006)	(0.006)
			Treatment variables NMA		
Treat_NMA_2011_0_300		0.200***		0.200***	0.200***
		(0.003)		(0.003)	(0.003)
Treat_NMA_2011_300_600		0.202***		0.202***	0.202***
		(0.002)		(0.002)	(0.002)
Treat_NMA_2011_600_900		0.192***		0.192***	0.192***

	(0.002)	(0.002)	(0.002)
Treat_NMA_2011_900_1200	0.185***	0.185***	0.185***
	(0.003)	(0.003)	(0.003)
Treat_NMA_2012_0_300	0.197***	0.197***	0.197***
	(0.005)	(0.005)	(0.005)
Treat_NMA_2012_300_600	0.185***	0.185***	0.185***
	(0.003)	(0.003)	(0.003)
Treat_NMA_2012_600_900	0.157***	0.157***	0.156***
	(0.003)	(0.003)	(0.003)
Treat_NMA_2012_900_1200	0.144***	0.144***	0.144***
	(0.004)	(0.004)	(0.004)
Treat_NMA_2013_0_300	0.134***	0.135***	0.135***
	(0.006)	(0.006)	(0.006)
Treat_NMA_2013_300_600	0.114***	0.113***	0.112***
	(0.005)	(0.005)	(0.005)
Treat_NMA_2013_600_900	0.083***	0.084***	0.084***
	(0.004)	(0.004)	(0.004)
Treat_NMA_2013_900_1200	0.063***	0.063***	0.063***
	(0.009)	(0.009)	(0.009)
Treat_NMA_2014_0_300	0.109***	0.109***	0.109***
	(0.006)	(0.006)	(0.006)
Treat_NMA_2014_300_600	0.087***	0.085***	0.085***
	(0.027)	(0.004)	(0.004)
Treat_NMA_2014_600_900	0.057***	0.058***	0.057***
	(0.004)	(0.004)	(0.004)
Treat_NMA_2014_900_1200	0.031***	0.032***	0.032***
	(0.009)	(0.009)	(0.035)
Treat_NMA_2015_0_300	0.134***	0.133***	0.133***
	(0.006)	(0.006)	(0.006)
Treat_NMA_2015_300_600	0.115***	0.114***	0.114***
	(0.004)	(0.004)	(0.004)
Treat_NMA_2015_600_900	0.090***	0.091***	0.091***
	(0.004)	(0.004)	(0.004)
Treat_NMA_2015_900_1200	0.061***	0.062***	0.062***
	(0.008)	(0.008)	(0.008)
Treat_NMA_2016_0_300	0.156***	0.155***	0.155***
	(0.006)	(0.006)	(0.006)
Treat_NMA_2016_300_600	0.135***	0.135***	0.135***
	(0.004)	(0.004)	(0.004)
Treat_NMA_2016_600_900	0.115***	0.115***	0.115***
	(0.003)	(0.003)	(0.003)
Treat_NMA_2016_900_1200	0.083***	0.084***	0.083***
	(0.008)	(0.008)	(0.008)
Treatment variables PV			
Treat_PV_2012_0_300		0.076***	0.076***
		(0.004)	(0.004)
Treat_PV_2012_300_600		0.074***	0.074***

			(0.004)		(0.004)
Treat_PV_2012_600_900			0.061***		0.061***
			(0.007)		(0.007)
Treat_PV_2012_900_1200			0.046***		0.046***
			(0.009)		(0.009)
Treat_PV_2013_0_300			0.127***		0.127***
			(0.012)		(0.012)
Treat_PV_2013_300_600			0.124***		0.125***
			(0.007)		(0.007)
Treat_PV_2013_600_900			0.108***		0.108***
			(0.010)		(0.010)
Treat_PV_2013_900_1200			0.063***		0.063***
			(0.013)		(0.013)
Treat_PV_2014_0_300			0.120***		0.120***
			(0.011)		(0.011)
Treat_PV_2014_300_600			0.106***		0.106***
			(0.007)		(0.007)
Treat_PV_2014_600_900			0.069***		0.069***
			(0.008)		(0.008)
Treat_PV_2014_900_1200			0.01		0.01
			(0.011)		(0.011)
Treat_PV_2015_0_300			0.073***		0.073***
			(0.006)		(0.006)
Treat_PV_2015_300_600			0.062***		0.062***
			(0.005)		(0.005)
Treat_PV_2015_600_900			0.035***		0.035***
			(0.008)		(0.008)
Treat_PV_2015_900_1200			-0.011		-0.011
			(0.011)		(0.011)
Treat_PV_2016_0_300			0.075***		0.076***
			(0.006)		(0.006)
Treat_PV_2016_300_600			0.058***		0.059***
			(0.005)		(0.005)
Treat_PV_2016_600_900			0.029***		0.029***
			(0.008)		(0.008)
Treat_PV_2016_900_1200			-0.020*		-0.020*
			(0.012)		(0.012)
Neighborhood characteristics	Yes	Yes	Yes	Yes	Yes
Yearly control dummies for other large-scale residential construction projects	1200	1200	1200	1200	1200
Time fixed effects	Yes	Yes	Yes	Yes	Yes
No. observations	151,550	151,550	151,550	151,550	151,550
R^2 (within)	0.8444	0.8445	0.8445	0.8455	0.8446

A panel fixed effects estimator is applied. The log of all land values of Hamburg between 2010 and 2016 is the dependent variable. Time-varying variables are included to describe neighborhood characteristics. 2010 is the base year for the time fixed effects. Treatment dummies for other large-scale residential construction projects *have been included in the regression. The following large-scale residential construction projects have been included: Volkspark, Oejendorf/Billstedt, Wilhelmsburg, Sonninkanal/Hammerbrok, Hafen City Part 2, and Fischbeker Rethen/Roettiger Kaserne. The standard errors are indicated in parentheses. * significance at the 10% level ** significance at the 5% level *** significance at the 1% level.*

Comparing the findings of the separate regressions to the regressions that contain more than one project, two differences stand out: (1) the results of QF and NMA differ between the individual and the combined regressions; (2) the impact of the PV project in the separate regression is very similar to that in the combined regression. The coefficients of the separate regression QF_0_1200 compared to the joint regression QF_NMA_0_1200 diverge mostly between -0.6 and +0.6% points. All coefficients that are significant in one of the two regressions are also significant in the other regression. The regression NMA_0_1200 in comparison to the combined regression QF_NMA_0_1200 diverges between -0.2 and +0.1% points. All coefficients of the treatment dummies that are relevant for the separate regression for NMA are also significant for the joint regression. To summarize, the regression QF_0_1200 shows more of a treatment effect when run in isolation than the regression NMA_0_1200.

Considering that QF and NMA have an overlapping area of impact and that PV is located far away from the other two projects, the following conclusions can be drawn: When analyzing the effect of exogenous shocks with overlapping areas of impact during the same period of time, the impact of both shocks should be considered together in one combined regression with detailed impact dummy variables. Including only a single yearly control dummy for projects with an overlapping area of impact is likely to distort the impact of the overlapping projects. However, exogenous shocks with areas of impact that are located far away from one another can be analyzed in separate regressions.

5. Discussion and Implications

5.1. Discussion

In this section the results of the accumulated regression for QF, NMA, and PV within the distance buffers up to 1,200 m are discussed and interpreted. The impact of the projects is assumed to have been caused by the publication of the winner of the urban planning competition. Land values are affected in the years following the first announcement. The three developments differ in their impact. All projects have a positive impact between 300 and 1,200 m. Only NMA and PV also have a positive impact within the 0 to 300 m distance buffer. QF is the only project out of these three that also has a negative effect on land values.

The announcement of the large-scale residential construction project QF, firstly, has no significant positive effect on land values within the 0 to 300 m distance buffer and then a negative impact. The positive impact of newly created amenities appears to be neutralized and then outweighed by disamenities, such as construction noise. Similar findings are also reported by Ahlfeldt & Maenning (2007) and Brandt et al. (2014), who shows that the effect of disamenities can outweigh or weaken the effect of newly created amenities. This argument can further be supported by Galster et al. (2004), who state that reactions to exogenous shocks can cancel each other out, and by Lipscomb (2003), who argues that, for any distance, property prices are inversely related to noise. Moreover, according to Tu (2005) the price of land values within close proximity will be positively affected after the construction is finished. Consequently, land values within close proximity to QF could just appreciate after construction has been completed. In contrast, NMA and PV have their strongest impact within the distance of 0 to 300 m. Regarding NMA and PV, the elimination of disamenities, such as a long-distance train station, train tracks, or an industrial area, exceeds the negative impact of disamenities that are caused by the construction.

The effect of NMA and PV on surrounding land values continually declines up to a distance of 1,200 m. These findings are similar to those of Kavetsos (2011), who found that the impact decreases with increasing distance. The impact of the three developments on surrounding land values is stronger in the first years after the first treatment and declines or disappears thereafter. In the years following the first treatment the projects are further developed and more information is published. The number of unknowns decreases, and the effect of the projects has already been largely reflected in the land values. The project QF has a negative impact on land values within a distance of 0 to 300 m and 0 to 1,200 m in the third (2015) and fourth year (2016) following the first treatment. The publication of the winner of the urban planning competition for the remaining parts of the site in 2015 and the start of construction works in 2016 could have caused the negative effects.

The results of the analysis in Table 7 are not surprising and can be explained by the differences between the large-scale construction projects. Before the redevelopment of the plot of land on which QF is located, office, residential as well as commercial buildings were already present. PV is located on land on which small-scale private gardens were present before. The construction of the project does not only create amenities, but also reduces amenities. The high treatment effect for NMA compared to QF and PV can be explained by the amenities as well as disamenities that are created or removed (Lipscomb, 2003). According to Glaeser et al. (2001), the success of cities depends more on the cities' role as centers of consumption rather than as centers of production. Their study found that high amenity cities have grown faster than low amenity cities. Moreover, rents have gone up faster than urban wages, suggesting that the demand for living in cities has risen for reasons beyond rising wages. The construction of NMA turns a plot on which a long-distance train station, railway tracks and industry were located into an area with green space, new educational centers, restaurants, stores, and improved infrastructure. The impact on land values around NMA is stronger than it is for QF and PV, because QF and PV reduce fewer disamenities and generate fewer amenities (Galster et al., 2004). This argument can further explain the weaker impact around QF. Additionally, the larger scale of NMA (3,500 dwellings) compared to PV (1,400 dwellings) could explain the stronger impact of NMA. The lower proportion of publicly subsidized housing of NMA (33%) compared to PV (60%) could be an additional explanation for the stronger effect. Locations with a high percentage of publicly subsidized housing are mostly viewed as less desirable (Schwartz et al, 2006).

The relatively strong treatment effect of NMA on land values can be explained by two arguments: (1) The land values around the project were relatively low compared to the neighborhood Hamburg-Altstadt. In 2010 the average land value within a radius of 300 m around QF was 875 €, around NMA it was 1,324 €, and for PV it was 611 €. In contrast, the price for one square meter of land for multi-story residential buildings in the neighborhood Hamburg-Altstadt was 4,000 € in 2010. (2) The high impact could also be explained by the characteristics of land values. Land values explain the price for one square meter of land. When developing real estate the price of the land is only one factor that will later determine the price of the property. Consequently, property prices could have been less affected than land values.

5.2. Implications

The effect of large-scale construction projects on land values depends on many factors. On the one hand, the development or improvement of amenities as well as the elimination of disamenities can increase location desirability. On the other hand, elimination of amenities or the generation of disamenities can result in a fall in prices. The improved reputation of a neighborhood through large-scale constructions or the change in the supply of housing can have an impact. The three large-scale residential developments analyzed differ in terms of size, location as well as previous and future usage. The unique characteristics and differences of the three projects allow for transferring the findings to other large-scale residential construction projects. In order to be able to transfer the findings of this study to other projects, one has to consider differences concerning the micro- and macroeconomic environment of the individual projects.

The QF project is characterized by the redevelopment of an area with similar usage including dwellings, offices as well as commercial premises and is therefore helpful in providing guidance for similar projects. The project has a positive impact on land values between 300 to 1,200 m and no or a negative impact in close proximity, indicating that amenities and disamenities neutralize one another in short distance.

The NMA project is characterized by the elimination of disamenities, such as industrial facilities or railway tracks; the construction of dwellings, offices, parks, as well as infrastructure, such as retail stores, restaurants, educational institutions, or day care centers. The development has a strong positive effect within a distance of 1,200 m. The effect is the strongest within the 0 to 300 m distance buffer and decreases thereafter. The elimination of disamenities such as train tracks or an industrial area clearly exceeds the negative impact of disamenities caused by the construction.

The PV project is characterized by the construction of dwellings with a high share of publicly subsidized housing (60%) and infrastructure, such as health care services, facilities for elderly people, small stores, restaurants, cafes, or day care centers. PV is located in a green area surrounded by parks and water that was previously occupied by small-scale private garden plots. PV has a positive impact on land values within a distance of 0 to 1,200 m. The elimination of amenities weakens the positive effect of the project.

The results of this investigation are relevant for policy makers, developers, investors, and home owners. For investors it could be profitable to invest in land or multi-story residential buildings in proximity to the project. However, before investing the impact of the announced project on its surrounding should be evaluated. Only projects for which the positive effect of amenities is larger than the negative effect of disamenities may be profitable. Moreover, Hiller (1998) argues that hosting a major event can lead to gentrification of a neighborhood. In this case the construction of a large-scale project can increase real estate prices and trigger or accelerate gentrification of neighborhoods. Consequently, politicians should consider the possible effect of developments to address consequences such as pollution or gentrification.

6. Conclusion

This paper contributes to the discussion on the impact of exogenous shocks on real estate prices. Numerous studies have analyzed the price effects of construction projects, but no study has focused as this paper on the impact of large-scale residential housing projects. A difference-in-difference approach is applied to measure the price differential between land values for multi-story residential buildings located in close proximity and those located at a distance from the announced large-scale residential construction projects.

The results of this study show that the pattern of impact depends on how neighborhood characteristics, such as amenities and disamenities, are affected, spanning from -4 to +22% changes in land values. When transferring the results of this paper to other large-scale construction projects one should focus on the impact of the developments on amenities, the previous and subsequent usage, supply and demand, and the influence on the image of neighborhoods.

Moreover, this paper makes a methodical contribution by analyzing if large-scale residential construction projects that are located close to one another should be analyzed in separate regressions or in one joint regression. The findings of this paper show that projects with an overlapping area of impact should be considered in one regression and that projects that are located far from one another can be analyzed in one or in separate regressions.

One should note that the pre and post announcement time periods are analyzed in this study. Further analyzing the price of properties after they have been constructed would add to the results. As mentioned by Tu (2005), noise and other disamenities that arise during the construction phase could have prevented rising property prices; yet the same properties may experience price increases after construction work is completed. A three step analysis (before announcement, after announcement-during construction, after construction) as conducted by Dehring et al. (2007) would round out the findings. The construction of *Neue Mitte Altona* results in the relocation of the long-distance railway station Altona. The impact of the new location of the station and therefore new distance to it in the future has not been considered in this analysis. Considering the impact of the relocation of the train station could improve the results of this paper (Tu, 2005). Furthermore, the analysis in this study is based on land values; conducting the analysis again with transaction data could improve or verify the results of this study. Additionally, extending the model beyond the time period from 2010 to 2016 could control for spillover effects or pre-existing trends. Including additional socio-economic data could improve the explanatory power of the model.

References

Ahlfeldt, G. M. (2011). If Alonso was right: Modeling accessibility and explaining the residential land gradient. *Journal of Regional Science*, 51(2): 318-338.

Ahlfeldt, G. M., & Kavetsos, G. (2014). Form or function?: the effect of new sports stadia on property prices in London. *Journal of the Royal Statistical Society: Series A*, 127(1) 169-190.

Ahlfeldt, G. M., & Maennig, W. (2007). Impact of sport arenas on land values: evidence from Berlin. *International Association of Sports Economists Working Paper No. 07-03*.

Ahlfeldt, G. M., & Maennig, W. (2009). Arenas, Arena Architecture and the Impact on Location Desirability: The Cas of 'Olympic Arenas' in Prenzlauer Berg, Berlin. *Urban Studies Journal*, 46(7) 1343-1362.

Ahlfeldt, G. M., & Maennig, W. (2010). Substitutability and Complementarity of Urban Amenities: External Effects of Built Heritage in Berlin. *Real Estatae Economics*, V38,2: pp. 285–323.

Ahlfeldt, G., & Mastro, A. (2012). Valuing Iconic Design: Frank Lloyd Wright Architecture in Oak Park, Illinois. *Housing Studies*, Vol. 27, No. 8, 1079-1099.

Alonso, W. (1964). *Location and Land Use.* Cambridge: Harvard University Press.

Baade, R. A., & Dye, R. F. (1990). The impact of stadium and professional sports on metropolitan area development. *Growth and change*, *21*(2), 1-14.

Beckmann, M. J. (1969). On the distribution of urban rent and residential density. *Journal of Economic Theory*, *1*(1), 60-67.

Behörde für Stadtentwicklung und Umwelt. (n.d.). *Überblick Planungsprozess.* Retrieved July 30, 2018, from hamburg.de: http://www.hamburg.de/ausblick-verfahren/

Behörde für Stadtentwicklung und Wohnen. (2011, July 04). *Vertrag für Hamburg - Wohnungsneubau*. Retrieved June 20, 2018, from hamburg.de: http://www.hamburg.de/contentblob/2962850/00c53036a511cd01a9113c37beecf5dd/data/vertrag-fuer-hamburg.pdf

Behörde für Stadtentwicklung und Wohnen. (2012, September). *Masterplan.* Retrieved July 30, 2018, from hamburg.de: http://www.hamburg.de/masterplan/

Bezirksamt Hamburg-Nord. (2015, May). *Pergolenviertel: Gestalterisches Leitbild – Kurzfassung.* Retrieved July 30, 2017, from forum-pergolenviertel.de: http://www.forum-pergolenviertel.de/wp-content/uploads/2015/07/A-2015-05-03569_Anlage-5-Gestaltungsleitfaden-Pergolenviertel.pdf

Bing, L., Akintoye, A., Edwards, P. J., & Hardcastle, C. (2005). The allocation of risk in PPP/PFI construction projects in the UK. *International Journal of project management*, *23*(1), 25-35.

Brandt, S., & Maennig, W. (2010). Perceived Externalities of Cell Phone Base Stations – The Case of Property Prices in Hamburg, Germany. *Hamburg Contemporary Economic Discussions no. 39*.

Brandt, S., Maennig, W., & Richter, F. (2013). Do places of worship affect housing prices? Evidence from Germany. *Hamburg Contemporary Economic Discussions no. 48*.

Burnham, K. P., & Anderson, D. R. (2004). Multimodel inference: understanding AIC and BIC in model selection. *Sociological methods & research*, *33*(2), 261-304.

Chapman, R. J. (1998). The role of system dynamics in understanding the impact of changes to key project personnel on design production within construction projects. *International Journal of Project Management*, *16*(4), 235-247.

Debrezion, G., Pels, E., & Rietveld, P. (2011). The impact of rail transport on real estate prices: an empirical analysis of the Dutch housing market. *Urban Studies*, *48*(5), 997-1015.

Dehring, C. A., Depken, C. A., & Ward, M. R. (2007). The impact of stadium announcements on residential property values: evidence from a natural experiment in Dalls-Fort Worth. *Contemporary Economic Policy*, 627–638.

Ellen, I. G., Schill, M. H., Susin, S., & Schwartz, A. E. (2001). Building homes, reviving neighborhoods: Spillovers from subsidized construction of owner-occupied housing in New York City. *Journal of Housing Research*, 185-216.

Feng, X., & Humphreys, B. R. (2008). Assessing the economic impact of sports facilities on residential property values: A spatial hedonic approach. *International Association of Sports Economists*, *5143*(08).

Freie und Hansestadt Hamburg. (2013). *Öffentliche und Soziale Einrichtungen Hamburg.* Retrieved June 21, 2018, from geodienste.hamburg.de: https://geodienste.hamburg.de/DE_HH_WFS_INSPIRE_A3_6_Versorgungswirtschaft?REQUEST=GetCapabilities&SERVICE=WFS

Gesellschaft für Stadt- und Regional- analysen und Projektentwicklung mbH. (2017, April). *Protokolle Planungsbeirat und Forum Pergolenviertel.* Retrieved July 30, 2018, from forum-pergolenviertel.de: http://www.forum-pergolenviertel.de/downloads/

Gibbons, S., & Machin, S. (2005). Valuing rail access using transport innovations. *Journal of Urban Economics*, 57, 148-169.

Glaeser, E. L., Kolko, J., & Saiz, A. (2001). Consumer city. *Journal of economic geography*, *1*(1), 27-50.

Gutachterausschuss für Grundstückswerte Hamburg (2017). ImmobiliePVrktbericht Hamburg 2017. Retrieved November 19, 2018, from daten-hamburg.de: http://daten-hamburg.de/infrastruktur_bauen_wohnen/immobiliePVrktberichte/IMB2017.pdf

Halvorsen, R., & Palmquist, R. (1980). The interpretation of dummy variables in semilogarithmic equations. *American economic review*, *70*(3), 474-475.

Hamburg Bezirksamt Altona. (2010, August). *Altona plant: Zukunft gemeinsam gestalten.* Retrieved July 31, 2018, from hamburg.de: http://www.hamburg.de/contentblob/2317374/6d874e68713cfe111b9c59317a15b3ff/data/flyer-altona-plant.pdf

Hamburger Verkehrsverbund GmbH. (2014, September). *HVV-Haltestellennamen mit Koordinate (Hamburg).* Retrieved June 19, 2018, from govdata.de: https://www.govdata.de/web/guest/suchen/-/details/hvv-haltestellennamen-mit-koordinate-hamburg

Hess, D. B., & Almeida, T. M. (2007). Impact of proximity to light rail rapid transit on station-area property values in Buffalo, New York. *Urban studies*, *44*(5-6), 1041-1068.

Hiller, H. H. (1998). Assessing the impact of mega-events: a linkage model. *Current issues in tourism*, 1(1), 47-57.

Kaming, P. F., Olomolaiye, P. O., Holt, G. D., & Harris, F. C. (1997). Factors influencing construction time and cost overruns on high-rise projects in Indonesia. *Construction Management & Economics*, *15*(1), 83-94.

Kavetsos, G. (2012). The Impact of the London Olympics Announcement on Property Prices. *Urban Studies*, 49(7) 1453–1470.

Lipscomb, C. (2003). Small cities matter, too: the impacts of an airport and local infrastructure on housing prices in a small urban city. *Review of Urban & Regional Development Studies*, *15*(3), 255-273.

McMillen, D. P., & McDonald, J. F. (2004). Reaction of house prices to a new rapid transit line: Chicago's Midway Line. *Real Estate Economics*, 32, 463-486.

Osland, L., & Thorsen, I. (2008). Effects on housing prices of urban attraction and labor-market accessibility. *Environment and Planning*, A, volume 40, pp. 2490-2509.

Poudyal, N. C., Hodges, D. G., & Merrett, C. D. (2009). A hedonic analysis of the demand for and benefits of urban recreation parks. *Land Use Policy*, 26: 975–983.

Schwartz, A. E., Ellen, I. G., Voicu, I., & Schill, M. H. (2006). The external effects of place-based subsidized housing. *Regional Science and Urban Economics*, *36*(6), 679-707.

Statistikamt Nord. (2012). *Bevölkerungsdaten von 2011 nach Stat. Gebieten.* Hamburg: Statistikamt Nord.

Statistikamt Nord. (2016, November 21). *Hamburger Stadtteil-Profile und interaktive Karten.* Retrieved June 17, 2018, from statistik-nord.de: https://www.statistik-nord.de/zahlen-fakten/regionalstatistik-datenbanken-und-karten/hamburger-stadtteil-profile-und-interaktive-karten/

Statistikamt Nord. (2018, July 11). Bevölkerungsdaten von 2010 bis 2016 nach Stat. Gebieten. Hamburg: Statistikamt Nord.

Technische Universität Hamburg. (2016). *Kennzahlen 2016*. Retrieved June 20, 2018, from tuhh.de: https://www.tuhh.de/tuhh/uni/informationen/kennzahlen.html

Tu, C. C. (2005). How Does a New Sports Stadium Affect Housing Values? The Case of FedEx Field. *Land Economics*, 81(3):379-395.

Universität Hamburg. (2017, February 08). *Zahlen und Fakten*. Retrieved June 20, 2018, from uni-hamburg.de: https://www.uni-hamburg.de/uhh/profil/fakten.html

Zavadskas, E. K., Turskis, Z., & Tamošaitiene, J. (2010). Risk assessment of construction projects. *Journal of civil engineering and management*, *16*(1), 33-46.

Zou, P. X., Zhang, G., & Wang, J. (2007). Understanding the key risks in construction projects in China. *International journal of project management*, *25*(6), 601-61