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The Effect of the Conversion of an Airport into a Public Park on Housing Rents

도심 공항의 시민 공원으로의 전환이 주변 주택 임대 가격에 미치는 영향

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< Abstract >

본 연구는 이중차이모델 (Difference-in-differences)을 이용하여 도심 내 공항 시설 및 부지의 시민 공원으로의 전환이 부지 주변 주택 임대 가격에 미치는 영향을 분석한다. 이를 위해 우리는 독일 베를린의 대규모 도심 재생 사업의 하나인 Temfelhofer Feld 사례를 살펴본다. 공원으로의 전환 전후 6년간 (2007년 5월 - 2013년5월) 조사 된 53,158개의 아파트 임대 호가를 기반으로 한 실증 분석 결과는 공항 시설 및 부지의 시민 공원으로의 전환은 전환 부지 주변 지역 내에서 아파트 임대 호가에 긍정적인 영향을 미치는 것으로 나타났다. 이러한 가격 상승효과는 부지와의 거리가 증가할수록 감소하는 패턴을 나타냈다. 아파트 임대 호가는 전환된 부지와의 거리에 따라 4km 이내에서 최대 2.8%까지 증가하였다. 이러한 결과는 밀집 된 대도심내의 공원과 같은 오픈 스페이스는 거주민들에게 선호되는 시설임을 보여 준다.

주 제 어 : 이중차이분석, 헤도닉 가격 모델, 아파트 임대 호가, 오픈 스페이스
Keyword : Difference-in-differences, Hedonic Price Model, Apartment Asking Rent, Open Space

I. Introduction

Rapid urban expansion and related adverse effects such as air pollution, noise and traffic congestion increases the importance and preference of open spaces in the urban area. In addition, as the general quality of life improves, amenities such as parks and natural areas become a significant factor in the choice of residential community. Recently, interest in urban regeneration is rising along with the expansion of such social trend in urban and housing policy in the Seoul metropolitan area. The concept can be partly defined by urban redevelopment accompanied with preservation of open space and ecological land use resources.

In order to make appropriate decisions regarding the provision of open space and design, the value of open space needs to be investigated carefully. In this paper, we examine the effect of the conversion of an urban area filled with disamenities into a public park on housing values through a case of urban regeneration in Berlin, Germany.

The case we examine in this study is Tempelhofer Feld. The site was one of the major airports in

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Berlin, situated in the south-central Berlin borough of Tempelhof-Schöneberg. In 1923, Tempelhof airport was built on the site by the Ministry of Transport. Tempelhof airport, however, closed all operations in October 2008, and the city of Berlin turned the 3,860,000m^2 of the central urban area into an open space for public use. This unique background of the case provides good testing grounds to examine how the conversion of the central urban area into an open space has an impact in the local housing market.

A number of papers provide empirical evidence of the positive impact of open spaces on housing values (e.g., Cheshire and Sheppard, 1995; Bolitzer and Netusil, 2000; Irwin, 2002; Smith et al., 2002; Anderson and West, 2006). In general, there are several benefits that open spaces provide including opportunities for recreation, fitness and education and various ecological benefits such as improved air quality (Anderson and West, 2006). These advantages of open space may be more magnified within a residential context, especially in dense urban area, by providing pleasant views, beautiful urban landscape or simply the absence of negative externalities associated with the crowded urban environment (Irwin, 2002). The existence of open space may also add prestige to the community and neighbourhood. Such expected positive externalities would give rise to a constellation of expectation of the increase in housing values among the market participants, and these, in turn, lead to bidding up property values near open space.

We focus on isolating such various expected positive externalities by means of capitalisation effects into housing values. At the heart of our empirical strategy, we assume that all the externalities are embedded in the value of the property, so that the willingness to pay for open space can be principally inferred from spatial variation in surrounding housing values (Ahlfeldt and Kavetsos, 2014). In particular, this study focuses on the impact on housing rents. Increase in property value relative to comparable neighbourhoods can be reflective of a higher willingness to pay by housing renters who are likely to move from one local community to another to maximise their utility from local amenities (Tiebout, 1956). In this paper, we shed light on the overall effect of the conversion of disamenities in central urban area into a public park on housing rents and the willingness to pay of local renters.

Quantifying whether and what degree these benefits exist is, however, not a trivial task. The key of the empirical strategy to ascertain the conversion effect is a separation of the price effects associated with the conversion from other price effects caused by endogenous housing characteristics, various locational features and other exogenous shocks. In order to control for such empirical challenges, we use a difference-in-differences (DID) model. The quasi-experimental approach essentially compares housing rents in the impact area that is deemed to be affected by the conversion with those in the control area that is less likely to be affected by the conversion, over two time periods – before and after the conversion. As the price effects are inferred from spatial variation in surrounding housing values, the separation of the impact and control area is based on the proximity to the conversion site. The DID is useful to control for biases which are inherent in a cross-sectional valuation framework, primarily related to the possible omission of significant variables correlated with the conversion effect (Gibbons and Machin, 2005; Ahlfeldt and Kavetsos, 2014; Pope and Pope, 2015). As to the extent that some of the location characteristics are unobservable, a part of the conversion effects can be erroneously captured if it is identified from a comparison of housing rents across space alone.

Using 53,158 of rich property data on apartment asking rents, the empirical results based on the DID analysis suggest that the conversion of an airport into a public park has a significant and positive impact on asking rents in proximity to the conversion site with the price gradient with respect to distance to the site. On average, asking rents of apartments located within 4km from the conversion site increase up to 2.8% relative to those of comparable apartments in 4-5km area, which is deemed to be not affected by the conversion.

The rest of this paper is structured as follows. Section 2 provides background information on the case of Tempelhofer Feld. Section 3 describes methodology and Section 4 data. Section 5 presents the empirical results and Section 6 a conclusion.

II. Tempelhofer Feld

Situated in the south of Berlin, in the district of Tempelhof-Schöneberg, Tempelhof, the former airport site, is now used as a public park. The site of 3,860,000m^2 is one of the most massive urban open spaces within Europe and the world. The airport was closed in October 2008, due to the expected opening of the new airport in the south of Berlin, the Berlin Brandenburg Airport. Until then the airport has served the city for more than 80 years as a reliable gate to the world. Built as an international airport, the site has seen various reconstructions, especially during the Nazi regime in the 1930s and 40s. These have led the airport to serve as one of the largest airports in the world at that time and for many years after. During the cold war, the airport had become prominent again in the late 1940s when the Soviets blocked the access to West Berlin. The only chance to support the remaining 2 million inhabitants at that time was by bringing food and supplies to the city by the established airlift.

After discontinuance of the flight operations in Tempelhof, the buildings and the airfield remained untouched, except for the parts which have been let out. Some events, such as fairs or concerts took place in the hangars and on the field. However, the park remained closed to the public to a more considerable extent.

It took nearly two years until May 2010, when the airfield officially opened for public usage. Before the opening, a range of protests took place, where residents and protest groups criticised the city government for not allowing to use the airfield as a public park or recreation area. These protests culminated in police clashes in front of the entrance of the park when some hundred protesters tried to enter the airfield. Due to these events, the public sentiment was polarised severely, so the city council opened the park to the public at the end.

However, the strict and unyielding handling of the former city-government had intensified the political issues associated with the airfield after the official opening. Questioning on use of the site as a public park, the city council considered selling plots to investors in 2014.

<Table 1> Key timelines and milestones

Date	Milestones
October 1923	Designation of Tempelhof as an airport by the Ministry of Transport
December 2007	Final decision of close of Tempelhof Airport by the Federal Administrative Court of Germany
October 2008	Close of Tempelhof airport
May 2010	Open the airfield for public usage officially and name the public park as “Tempelhofer Feld”

Furthermore, housing rents had increased continuously in Berlin due to the housing shortage and the influx of refugees and other national and international inhabitants. However, the residents had blocked changes of the usage and protested the council's plan on selling the plots. Activist groups also started a petition against the change of use. Residents and visitors were afraid of gentrification that the privatisation of the area would lead to an inflow of higher income people and investors, and, in turn, result in increase in house prices and rents. Finally, the referendum on the usage change was conducted in 2014, and Berlin's citizens decided to keep using the field as a public park. The area has a 6km cycling, skating and jogging trail, a 25,000m^2 of BBQ area and a dog-walking field covering about 40,000m^2 and public area for all visitors.

III. Methodology

1. Baseline hedonic price model

As a baseline model, we adopt the conventional notion of hedonic analysis that "goods are valued for their utility-bearing attributes or characteristics (Rosen, 1974, p.34)." In this framework, a housing rent is estimated as a function of all observable characteristics of the house. We infer the conversion effect from spatial variation of apartment rents surrounding the site. Therefore, the proximity of a property to the conversion site is a key variable. The measurements for the proximity are based on two types of distances from a property to the boundary of the site – the linear distance and the radius ring distances which are consecutive and mutually exclusive. Two hedonic equations are specified according to the two types of distance as follows:

$$log(P_{it}) = c + \alpha D_{it} + \sum_k \beta_k H_{itk} + \sum_q \delta_q Q_{itq} + \sum_l \zeta_l L_{itl} + \epsilon_{it} \quad (1)$$

$$log(P_{it}) = c + \sum_r \gamma_r R_{itr} + \sum_k \beta_k H_{itk} + \sum_q \delta_q Q_{itq} + \sum_l \zeta_l L_{itl} + \epsilon_{it} \quad (2)$$

where P is an asking rent of an apartment unit, i indexes an apartment unit and t is the (monthly) time in which an asking rent is given. D and R are the linear distance and radius ring distance dummies between an apartment unit and the conversion site respectively. H represents hedonic variables accounting for property characteristics where k is the number of the hedonic variables. Q and L are quarterly time dummies and location dummies where q and l are the number of the time and the location dummies respectively. ε is an independently and identically distributed error term. A semi-logarithm form is applied in this study as it allows the value added to vary proportionally with the explanatory variables and the coefficient estimated can be simply interpreted as a measure of percentage change (Malpezzi, 2003; Sirmans et al., 2005).

The main coefficients of interest here are the ones associated with the price effect due to the proximity to the conversion site. The first one α in Equation (1) is associated with the linear distance effect which estimates the marginal effect as locating further away from the conversion site by one kilometre. The second one γ in Equation (2) is associated with the non-linear distance effects which estimate asking rents in the impact area relative to the control area.

We set the study area with a threshold at 5km from the conversion site which is based on preliminary hedonic models with distance dummy variables indicating the proximity of a property to the site. The empirical application with the threshold provides the best model performance. After looking at the spatial distribution of the properties and ensuring an even number of observations within each distance ring, a 1km ring interval is set within 5km of the study area. The measurement defines a total of five rings. For the impact area, the first four radius ring areas are used (i.e., within 4km from the conversion site), while the farthest radius ring area (i.e., 4-5km from the conversion site) forms the control area.

2. Time varying conversion effects

In the second step of the analysis, we identify the conversion effect over time. The baseline model is extended to incorporate an additional interaction term that is the product of the distance variable and the yearly time dummy variable[1]. The time varying conversion effects are estimated relative to the base year, which we set to 2010 when the site is opened as a public park officially. The extended models are given as:

$$log(P_{it}) = c + \alpha D_{it} + \sum_{y=2007, y \neq 2010}^{y=2013} \eta_y (D_{it} \times Y_{ity}) + \sum_k \beta_k H_{itk} + \sum_q \delta_q Q_{itq} + \sum_l \zeta_l L_{itl} + \epsilon_{it} \quad (3)$$

$$log(P_{it}) = c + \sum_r \gamma_r R_{itr} + \sum_{y=2007, y \neq 2010}^{y=2013} \theta_y (R_{itr} \times Y_{ity}) + \sum_k \beta_k H_{itk} + \sum_q \delta_q Q_{itq} + \sum_l \zeta_l L_{itl} + \epsilon_{it} \quad (4)$$

where $(D \times Y)$ is a product of the linear distance variable and the yearly time dummy variable for each property. $(R \times Y)$ is a product of the radius ring distance dummy variable and the yearly time dummy variable for each property. The coefficients η and θ quantify the price effects due to the proximity to the conversion site each year relative to the base year. With the coefficients estimated, we can effectively form indices to evaluate relative trends of the price effects (McMillen and McDonald, 2004; Immergluck, 2009; Ahlfeldt and Kavetsos, 2014).

3. The conversion effects in DID analysis

In the third step of the analysis, the baseline model is extended by an additional DID interaction term as follows:

$$log(P_{it}) = c + \alpha D_{it} + \iota PC_{it} + \lambda (D_{it} \times PC_{it}) + \sum_k \beta_k H_{itk} + \sum_q \delta_q Q_{itq} + \sum_l \zeta_l L_{itl} + \epsilon_{it} \quad (5)$$

$$log(P_{it}) = c + \sum_r \gamma_r R_{itr} + \iota PC + \sum_r \mu_r (R_{itr} \times PC_{it}) + \sum_k \beta_k H_{itk} + \sum_q \delta_q Q_{itq} + \sum_l \zeta_l L_{itl} + \epsilon_{it} \quad (6)$$

where PC is a post-conversion dummy variable which equals to one if an asking price is given after the conversion of the site into a public park (i.e., May 2010). λ is the DID estimator for the linear distance based conversion effect which reflects changes in average asking rents with increase in the distance to the site by one kilometre after the conversion. μ is the DID estimator for the non-linear distance based conversion effect which reflects changes in average asking rents within the impact area relative to the control area after the conversion. By comparing two areas over the same time periods, the DID estimator quantifies the conversion effects while controlling for erroneously attributing effects due to omitted variable bias from unobserved heterogeneity that remain fixed over time (Gibbons and Machin, 2005; Pope and Pope, 2015).

1) Application of quarterly time dummy variables provides statistically insignificant coefficients for most of the interaction variables due to sparse observations in each period.

<Table 2> Variable description

Variable	Description
Dependent Variable	
(Log) Price	(Logarithm of) Asking rent per year of a single apartment unit
Independent Variable	
Size	Net floor area of an apartment unit in square metres
Rooms	Number of rooms
Age	Difference in years between the year of asking rent of the given apartment unit and the year of construction of the apartment building
Age squared	Square of the age
Balcony$^+$	Equal to one if an apartment unit has a balcony and zero otherwise
Parquet floor$^+$	Equal to one if an apartment unit has a parquet floor and zero otherwise
Fitted kitchen$^+$	Equal to one if an apartment unit has a fitted kitchen and zero otherwise
Lift$^+$	Equal to one if an apartment building has a lift and zero otherwise
Garden$^+$	Equal to one if an apartment building has a garden and zero otherwise
First-time use$^+$	Equal to one if an apartment unit is first-time used and zero otherwise
Central heating$^+$	Equal to one if an apartment building has a central heating system and zero otherwise
Rehabilitation$^+$	Equal to one if an apartment unit is rehabilitated and zero otherwise
Attic$^+$	Equal to one if an apartment unit has an attic and zero otherwise
Need of rehabilitation$^+$	Equal to one if a need of rehabilitation of an apartment unit is reported by a renter and zero otherwise
Under-floor heating$^+$	Equal to one if an apartment unit has an underfloor heating system and zero otherwise
Cellar$^+$	Equal to one if an apartment building has a cellar and zero otherwise
Marble$^+$	Equal to one if an apartment unit has a marble and zero otherwise
Stove heating$^+$	Equal to one if an apartment unit has a stove heating and zero otherwise
Store room$^+$	Equal to one if an apartment unit has a store room and zero otherwise
Furnished$^+$	Equal to one if an apartment unit is furnished and zero otherwise
Attic storey$^+$	Equal to one if an apartment unit has an attic storey and zero otherwise
In use of renovation$^+$	Equal to one if an apartment unit is in use of renovation and zero otherwise
Quarter$^+$	Quarterly time dummy variable, equal to one if an asking rent is asked in the respective quarter and zero otherwise
Location$^+$	Location dummy variable, equal to one if an apartment building is located in the respective district and zero otherwise
Distance	Linear distance in kilometres from an apartment unit to the boundary of the conversion site
Ring1$^+$	Equal to one if an apartment unit is located within a 1km radius from the boundary of the conversion site and zero otherwise
Ring2$^+$	Equal to one if an apartment unit is located between 1km and 2km radius from the boundary of the conversion site and zero otherwise
Ring3$^+$	Equal to one if an apartment unit is located between 2km and 3km radius from the boundary of the conversion site and zero otherwise
Ring4$^+$	Equal to one if an apartment unit is located between 3km and 4km radius from the boundary of the conversion site and zero otherwise
Ring5$^+$	Equal to one if an apartment unit is located between 4km and 5km radius from the boundary of the conversion site and zero otherwise
Post-conversion$^+$	Equal to one if an asking rent is given after May 2010 (official opening of the site as a public park and naming "Tempelhofer Feld") and zero otherwise
D_year	Interaction term, Distance times yearly time dummy variable
R_year$^+$	Interaction term, Ring(1 to 5 respectively) times yearly time dummy variable
D_Post-conversion	Interaction term, Distance times Post-conversion
R_Post-conversion$^+$	Interaction term, Ring(1 to 5 respectively) times Post-conversion

Note: $^+$dummy variable

IV. Data

We focus on the conversion effect on apartment rents near the conversion site. We use data provided by the research department of Jones Lang LaSalle (JLL) in Berlin. JLL is one of the largest real estate service providers in Germany. Unfortunately, actual contract rents are only partially accessible with limited information in Berlin. Transactions of apartments need to be documented in the public record by the notary. These records are managed confidently by the committee of valuation experts. To our knowledge, there is no comparable dataset available regarding the rent market of Berlin, which consists of actual contract rents.

Data we use in this study consist of asking rents for apartments in Berlin. The usage of asking rents for the Berlin market is uncritical since tenants and landlords do not re-negotiate the advertised rent before the lease agreement is signed. We can, therefore, be sure that at least in the majority of cases, the asking rent represents the contract rent. For additional information describing property specific characteristics, property data are obtained from online platforms covering the residential property market in Berlin: ImmobilienScout24 and ImmoWelt.

We conduct our analysis on a sample of 53,158 observations after excluding observations with missing values for key characteristics. Our data include the usual parameters that explain house price variation in most hedonic housing studies (e.g., size, age and number of rooms) as well as information on the type of apartment. In addition, a set of quarterly time dummy variable is included to control for the temporal heterogeneity such as market conditions that are common to the study area (Wooldridge, 2010). A set of local jurisdictional boundary dummies at a borough level (‘*Bezirke*’ in German, 12 *Bezirkes* in Berlin) is also included to control for the regional heterogeneity. Several interaction variables are included in the DID analysis, following a standard DID estimation procedure. A list of the variables used in the empirical analysis and their definitions is provided in Table 2.

V. Empirical results

1. The baseline hedonic model results

Complete empirical results from our baseline hedonic models are presented in Table A1 in the Appendix. The model fit of the data is reasonable across all specifications, explaining over 80% of the variation. Most of the hedonic variables show the expected signs and significant at the 0.01 level. For example, apartment asking rents tend to increase with the size of the property and number of rooms, whereas as an apartment is getting old, the property tends to be rented at a lower price. The marginal aging effect tends to increase although the marginal effect is almost zero economically. The result also show that existence of convenient facilities is positively correlated with asking rents such as a balcony, fitted kitchen, lift, garden, attic, cellar and storeroom. Aesthetic aspects of a property have a positive impact on housing values; asking rents of apartments which have parquet floor, marble and attic storey are higher than which have not respectively.

For comparison purposes, we split the study period into two sub-periods, pre- and post-conversion periods, to compare asking rents before and after the conversion within a cross-sectional hedonic framework. The pre-conversion period defines for 36 months from May 2007 to April 2010 and the post-conversion period for 36 months from May 2010 to April 2013. Summary statistics of observations in the two periods are presented in Table 3. We find that an average

<Table 3> Descriptive statistics of variables

Variable	Pre-opening (N=33,839)				Post-opening (N=19,319)			
	Mean	Std..Dev.	Min	Max	Mean	Std.Dev.	Min	Max
Asking rent per year (Euro)	5798.81	3981.10	900	67753	7348.50	5146.53	779.52	180000
Size	74.18	32.10	12	350	76.72	34.70	10	800
Rooms	2.39	1.06	0	35	2.45	1.05	0	11
Age	66.03	36.57	0	454	68.87	39.58	0	263
Balcony$^+$	0.63	0.48	0	1	0.55	0.50	0	1
Parquet floor$^+$	0.10	0.29	0	1	0.07	0.25	0	1
Fitted kitchen$^+$	0.42	0.49	0	1	0.38	0.49	0	1
Lift$^+$	0.17	0.38	0	1	0.11	0.32	0	1
Garden$^+$	0.12	0.32	0	1	0.10	0.29	0	1
First-time use$^+$	0.12	0.32	0	1	0.11	0.32	0	1
Central heating$^+$	0.72	0.45	0	1	0.51	0.50	0	1
Rehabilitation$^+$	0.21	0.41	0	1	0.15	0.36	0	1
Attic$^+$	0.10	0.30	0	1	0.09	0.28	0	1
Need of rehabilitation$^+$	0.00	0.02	0	1	0.00	0.02	0	1
Underfloor heating$^+$	0.02	0.14	0	1	0.02	0.14	0	1
Cellar$^+$	0.43	0.50	0	1	0.42	0.49	0	1
Marble$^+$	0.00	0.05	0	1	0.00	0.04	0	1
Stove heating$^+$	0.01	0.10	0	1	0.00	0.07	0	1
Store room$^+$	0.04	0.20	0	1	0.03	0.16	0	1
Furnished$^+$	0.01	0.07	0	1	0.01	0.08	0	1
Attic storey$^+$	0.04	0.19	0	1	0.04	0.19	0	1
In use of renovation$^+$	0.02	0.15	0	1	0.02	0.13	0	1

Note: $^+$dummy variable

asking rents for the post-conversion period is higher than for the pre-conversion period although property characteristics are comparable in general over the two periods.

Table 4 represents the summary of regression results associated with the proximity to the conversion site. The results suggest that asking rents for apartments near the conversion site were already lower than comparable apartments located further away from the site before the site is conversed into a public park. The linear distance effect (Column (1)) shows that asking rents tend to increase with distance to the conversion site by 1% for each kilometre. We also find the price decreasing pattern with the radius ring distance measurement (Column (2)); asking rents for apartments are approximately 3% lower in the three closest radius ring areas from the conversion site and 0.4% lower in the fourth radius ring area respectively, compared to comparable apartments in the control area. However, Columns (3) and (4) show the same patterns of the price effects associated with the proximity to the conversion site even after the conversion. In other words, the results in this framework suggest a negative effect of the conversion on housing rents. However, the estimation is likely to be biased for the conversion effect as the cross-sectional framework reflects differences in a price level, but not price trend. In other words, the causal linkage between changes in asking rents and the conversion of

<Table 4> Summary of regression results for pre-and post-conversion period

Effect	Log of asking rent			
	Pre-conversion period		Post-conversion period	
	(1)	(2)	(3)	(4)
Linear distance	0.010***		0.007***	
	(0.000)		(0.001)	
Ring1 (0-1km)		-0.035***		-0.017***
		(0.002)		(0.003)
Ring2 (1-2km)		-0.031***		-0.026***
		(0.002)		(0.002)
Ring3 (2-3km)		-0.033***		-0.023***
		(0.002)		(0.002)
Ring4 (3-4km)		-0.004***		-0.002
		(0.001)		(0.002)
Ring5 (4-5km)		Reference		Reference
Constant	3.397***	3.445***	3.468***	3.499***
	(0.005)	(0.005)	(0.005)	(0.004)
Hedonic controls	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Location fixed effects	Yes	Yes	Yes	Yes
Observations	33,839	33,839	19,319	19,319
(adj)R-squared	0.831	0.832	0.821	0.821
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1				

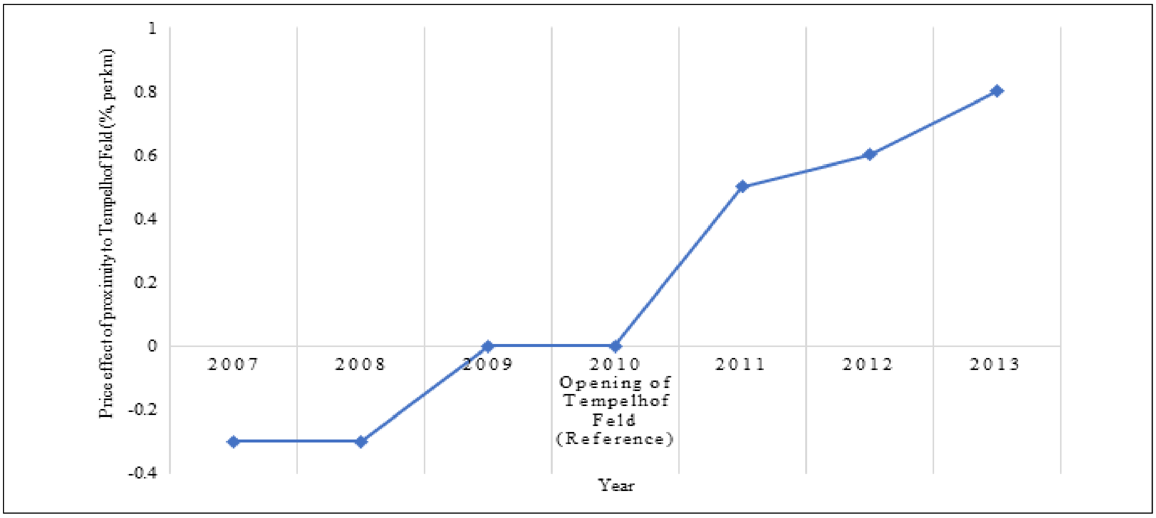
Note: 1) Robust standard errors in brackets. 2) A coefficient of ring distance (dummy variable) indicates an effect in percentage based on [exp (coefficient)-1] by Halvorsen and Palmquist (1980).

the site is not reflected appropriately in this framework (Gibbons and Machin, 2005; Tu, 2005). Therefore, we use a DID approach in order to cover the problem.

2. Time varying conversion effects

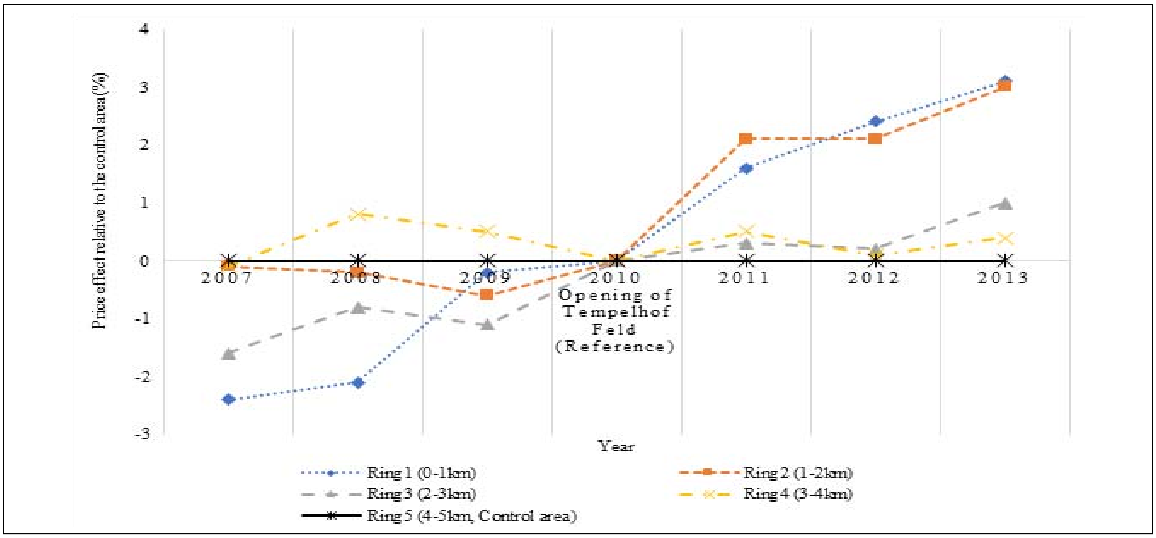
On the basis of coefficients for the time varying estimates, η and θ in Equations (3) and (4), Figures 1 and 2 depict the conversion effects as the effects on asking rents over time. In both cases, the plots reveal an evident trend reversion in 2010 (only except for Ring4 in which a part of the coefficients are not statistically significant). Before 2010, asking rents for apartments located near the conversion site tend to be lower than comparable apartments located further away from the site. However, we observe a relatively sharp and persistent increase in asking rents at proximate locations starting in 2010, with a notable peak in 2011. These represent plausible market reactions in light of the timeline of the conversion (i.e., official opening of the park). Figures 1 and 2 suggests that asking rents at close locations increase by up to 5% on average within the 5km of study area relative to the base year (2010). The price effect trends suggest that the housing market responds immediately after the conversion of the site into a public park and then keeps the momentum for a period of time.

<Figure 1> Time varying effects based on the linear distance



Note: The estimated coefficients are multiplied by -1 so that an increase in index reveals a positive proximity effect.

<Figure 2> Time varying effect based on radius ring distances



Note: The estimated coefficients for Ring4 in 2012 and 2013 are not statistically significant.

3. The conversion effect in the DID analysis

The general notion of the DID estimation in this study is to compare changes in asking rents occurring in the impact area (within 4km from the conversion site) and the control area (4-5km from the conversion site) before and after the conversion of the site (i.e., official opening of a public park). We set the intervention date to May 2010 to divide the 'before and after' period that is evidenced by the findings from the time varying effects of the conversion. The summary of empirical results is shown in Table 5. The fit to the data is reasonable for both the linear and non-linear radius ring distance specifications, explaining about 83% of the variation. The results of the DID estimates suggest the existence of the significant positive effect of the conversion of the site into a public park, and the effect is highly associated with the proximity to the site. The linear distance based effect in Column (1) shows that asking rents tend to decrease by locating further away from the conversion site by 0.6% for each kilometre. In other words, given the increasing price trends after 2010 from the time varying effects, asking rents experience less of an increase when apartments are located further away from the site, to be more exact, 0.6% less appreciation for each kilometre. Cumulated over the 4km impact area, this corresponds to an asking rent increase of about 2.4% for apartments adjacent to the conversion site relative to otherwise comparable apartments at the outer fringe of the study area.

The result is roughly in line with the estimated conversion effects based on the radius ring distances in Column (2). The results suggest that an average asking rents of apartments within 1km from the conversion site increase about 2.8% more than comparable apartments located in 4-5km away from the conversion site after the conversion into a public park. Notably, this is the biggest positive effect within the impact radius ring area. In addition, we find positive price effects in the second and third closest radius ring areas. Asking rents for apartments located in 1-2km and 2-3km from the conversion site experience an increase of 1.4% and 1.3% respectively, when compared to the control area. Although the estimated effects show a decreasing pattern with distance in general that is in line with the linear distance based effect, the price effect pattern indicates some degree of non-linearity, with apartments at closer distances gaining disproportionally. No significant price effect is observed beyond 3km from the conversion site.

Overall, the results clearly support the existence of positive and significant impact of the conversion of an airport into a public park on housing rents. Asking rents for apartments surrounding the public park experience a significant increase after the usage of the site is turned from airport into public park. The estimated positive effect is a compound effect of the conversion; the price effect could be resulted from the closure of disamenity (i.e., airport) as well as the opening of amenity (i.e. park). However, it is difficult to clearly disentangle one effect from the other opposite effect in a DID framework which goes beyond the scope of this research.

The spatial variation of the conversion effect is quite clear. The effects tend to decrease with distance from the conversion site, suggesting that the conversion effects matter for apartments located in direct proximity to the site. The interpretation of the main empirical results in this study, therefore, could be based on a partial equilibrium model (McMillen and McDonald, 2004). The positive externalities caused by the conversion have a significant impact only within the study area of 4km from the conversion site; asking rents in the vicinity of the conversion site adjust, but the general equilibrium effects on the rest of the metropolitan area can be ignored. Based on the average asking rents for the respective sample period, we calculate the expected price changes of an apartment unit due to the conversion. The premium of the conversion on asking rents for an apartment unit within 1km amounts to about 174 Euros wherein the price effect is economically biggest.

The price effect estimated in this study is generally lower than the open space price effect in other empirical studies. This might be related to the speciality of this case; there had been dispute over usage of the open space between local residents during the study period; in addition, the opportunity cost of 'not developing central urban area' has been risen by the local government. These may reduce expectation of

<Table 5> Difference-in-differences estimates for the conversion effect

Effect	Log of asking rent	
	(1)	(2)
Linear distance	-0.006***	
	(0.001)	
Ring1 (0-1km)		0.028***
		(0.003)
Ring2 (1-2km)		0.014***
		(0.002)
Ring3 (2-3km)		0.013***
		(0.002)
Ring4 (3-4km)		-0.003
		(0.002)
Ring5 (4-5km)		Reference
Constant	3.414***	3.467***
	(0.004)	(0.003)
Hedonic controls	Yes	Yes
Time fixed effects	Yes	Yes
Location fixed effects	Yes	Yes
Linear distance effect	Yes	No
Ring effects	No	Yes
Post-conversion effect	Yes	Yes
Observations	53,158	53,158
(adj)R-squared	0.833	0.834
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1		

Note: 1) Robust standard errors in brackets. 2) A coefficient of ring distance (dummy variable) indicates an effect in percentage based on [exp (coefficient)-1] by Halvorsen and Palmquist (1980).

housing value growth, leading to relatively low capitalisation effect of open space.

VI. Conclusion

This study employs a large sample of apartment asking rents to estimate the impact of the conversion of central urban area into a public park on housing value in the local housing market. We investigate an urban regeneration project as a natural experiment in central urban area in Berlin, Germany. The empirical results based on the DID analysis suggest that the conversion of airport site into a public park has a positive impact on asking rents in proximity to the conversion site with the price gradient with respect to distance to the site. On average, asking rents for apartments located within 1km from the conversion site increase approximately 2.8% relative to those of comparable apartments in 4-5km area, which is deemed to be not affected by the conversion. The premium is also found in 2-3km and 3-4km areas by about 1.4% and 1.3% respectively. Our results thus provide strong evidence that a vast open space in dense urban area is highly valued by neighbouring residents.

Our findings open an avenue for potential policy recommendations. If open space such as ecological park impact positively on the intrinsic value of a neighbourhood, then the expectation that urban regeneration projects including preservation of ecological land use resources and open spaces will contribute to the neighbourhood (re)vitalisation can be justified, especially in the dense urban area.

A critical question, however, is arisen from the cost with regard to the regeneration. Given our main results that only apartments in the vicinity of the project site experience the price premium, a distributional conflict can arise if costs are spread equally across taxpayers in the metropolitan area (Ahlfeldt and Kavetsos, 2014). Moreover, homeowners and landlords benefit from increase in rents, while renters may be more than compensated for the advantages of the conversion by an increase in rent levels which can potentially cause the gentrification (Ahlfeldt, 2011). Therefore, substantial policy attention needs to be accompanied by a general plan for an urban regeneration project.

The usage of asking rents is one of limitations in this study. Given the nature of housing rent process in the Berlin housing market, we assume the low possibility of difference between asking rents and contract rents. However, it cannot be completely ruled out that further negotiations can affect contract rents.

Finally, it is important to note that the aggregated effects estimated in this study should be interpreted as a case-specific effect rather than a global effect. The effects, especially associated with the preferences of the market participants in the local housing market, are likely to be different in the heterogeneous social contexts.

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Appendix

<Table A1> Regression results for the baseline hedonic model

Variables	Log of asking rent			
	Pre-conversion period		Post-conversion period	
	(1)	(2)	(3)	(4)
Size	0.005***	0.005***	0.004***	0.004***
	(0.000)	(0.000)	(0.000)	(0.000)
Rooms	0.013***	0.013***	0.018***	0.018***
	(0.001)	(0.001)	(0.001)	(0.001)
Age	-0.001***	-0.001***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
Age squared	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Balcony+	0.015***	0.016***	0.011***	0.011***
	(0.001)	(0.001)	(0.001)	(0.001)
Parquet floor+	0.032***	0.030***	0.023***	0.023***
	(0.002)	(0.002)	(0.003)	(0.003)
Fitted kitchen+	0.039***	0.039***	0.024***	0.023***
	(0.001)	(0.001)	(0.002)	(0.002)
Lift+	0.009***	0.009***	0.003	0.003
	(0.001)	(0.001)	(0.002)	(0.002)
Garden+	0.011***	0.012***	0.009***	0.010***
	(0.001)	(0.001)	(0.002)	(0.002)
First-time use+	0.049***	0.049***	0.044***	0.044***
	(0.001)	(0.001)	(0.002)	(0.002)
Central heating+	-0.005***	-0.004***	-0.009***	-0.009***
	(0.001)	(0.001)	(0.002)	(0.002)
Rehabilitation+	0.018***	0.018***	0.013***	0.013***
	(0.001)	(0.001)	(0.002)	(0.002)
Attic+	0.012***	0.013***	0.006**	0.006***
	(0.002)	(0.002)	(0.002)	(0.002)
Need of rehabilitation+	-0.077***	-0.079***	0.053	0.050
	(0.021)	(0.021)	(0.037)	(0.037)
Under-floor heating+	0.076***	0.077***	0.065***	0.065***
	(0.003)	(0.003)	(0.005)	(0.005)
Cellar+	-0.000	0.000	-0.001	-0.000
	(0.001)	(0.001)	(0.002)	(0.002)
Marble+	0.041***	0.038***	0.062***	0.061***
	(0.009)	(0.009)	(0.017)	(0.017)
Stove heating+	-0.061***	-0.061***	-0.026***	-0.026***
	(0.005)	(0.005)	(0.010)	(0.010)
Store room+	0.023***	0.022***	0.011***	0.011***
	(0.002)	(0.002)	(0.004)	(0.004)
Furnished+	0.056***	0.058***	-0.015*	-0.014
	(0.007)	(0.007)	(0.009)	(0.009)
Attic storey+	0.036***	0.036***	0.013***	0.013***
	(0.002)	(0.002)	(0.004)	(0.004)
In use of renovation+	-0.026***	-0.027***	-0.024***	-0.024***
	(0.003)	(0.003)	(0.005)	(0.005)
Constant	3.397***	3.445***	3.468***	3.499***
	(0.005)	(0.005)	(0.005)	(0.004)
Time fixed effects	Yes	Yes	Yes	Yes
Location fixed effects	Yes	Yes	Yes	Yes
Linear distance effect	Yes	No	Yes	No
Ring effects	No	Yes	No	Yes
Observations	33,839	33,839	19,319	19,319
(adj)R-squared	0.831	0.832	0.821	0.821

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Note: 1) +denotes the dummy variable. 2) Robust standard errors in brackets. 3) A coefficient of dummy variable indicates an effect in percentage based on [exp (coefficient)-1] by Halvorsen and Palmquist (1980).

<Table A2> Regression results for the DID estimation

Variables	Log of asking rent	
	(1)	(2)
Size	0.004***	0.004***
	(0.000)	(0.000)
Rooms	0.015***	0.015***
	(0.001)	(0.001)
Age	-0.001***	-0.001***
	(0.000)	(0.000)
Age squared	0.000***	0.000***
	(0.000)	(0.000)
Balcony+	0.014***	0.014***
	(0.001)	(0.001)
Parquet floor+	0.030***	0.029***
	(0.001)	(0.001)
Fitted kitchen+	0.033***	0.033***
	(0.001)	(0.001)
Lift+	0.007***	0.006***
	(0.001)	(0.001)
Garden+	0.010***	0.011***
	(0.001)	(0.001)
First-time use+	0.047***	0.047***
	(0.001)	(0.001)
Central heating+	-0.007***	-0.007***
	(0.001)	(0.001)
Rehabilitation+	0.016***	0.016***
	(0.001)	(0.001)
Attic+	0.010***	0.010***
	(0.001)	(0.001)
Need of rehabilitation+	-0.045**	-0.047**
	(0.018)	(0.018)
Under-floor heating+	0.071***	0.072***
	(0.003)	(0.003)
Cellar+	-0.001	-0.001
	(0.001)	(0.001)
Marble+	0.046***	0.043***
	(0.008)	(0.008)
Stove heating+	-0.056***	-0.056***
	(0.004)	(0.004)
Store room+	0.020***	0.019***
	(0.002)	(0.002)
Furnished+	0.028***	0.029***
	(0.005)	(0.005)
Attic storey+	0.028***	0.029***
	(0.002)	(0.002)
In use of renovation+	-0.026***	-0.026***
	(0.003)	(0.003)
Constant	3.414***	3.467***
	(0.004)	(0.003)
Time fixed effects	Yes	Yes
Location fixed effects	Yes	Yes
Linear distance effect	Yes	No
Ring effects	No	Yes
Post-conversion effect	Yes	Yes
DID controls	Yes	Yes
Observations	53,158	53,158
R-squared	0.833	0.834
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1		

Note: 1) + denotes the dummy variable. 2) Robust standard errors in brackets. 3) A coefficient of dummy variable indicates an effect in percentage based on [exp (coefficient)-1] by Halvorsen and Palmquist (1980).