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Award-Winning Architecture and Urban Revitalization: The Case of "Olympic Arenas" in Berlin-Prenzlauer Berg

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JEL Classification Codes: L83, R31, R53, R58

Keywords: Stadium Impact, Stadium Architecture, Gentrification, Hedonic Regression, Spatial Autocorrelation

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1 Introduction

Coming along with a unique stadium construction boom, economic impact of new stadium development has become a more and more controversially discussed issue. Politicians addressing the citizens' civic pride by spending plenty of public money on subsidizing major stadium projects usually rely on the same argumentation. They affirm that expenditures will turn out to be good investments due to creation of construction jobs and attraction of businesses and tourists leading to stimulation of spending in the community and increasing tax revenues. Critics oppose that positive expectations are usually based upon unrealistic assumptions about multiplier effects, underestimation of substitution effects and neglection of opportunity costs (Baade 1996, Coates and Humphreys 2000, Noll and Zimbalist 1997, Rosentraub 1997, Zaretsky 2001). Econometric

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ex-post evaluation has long supported scepticism regarding the economic benefits of new stadium projects since hardly positive and even negative impacts of sports stadiums were found on income (Baade 1988, Baade and Dye 1990, Coates and Humphreys 1999), employment (Baade and Sanderson 1997) and wages (Coates and Humphreys 2003). Only relatively few studies had identified positive impacts such as on employment (Baim 1990) or rents (Carlino and Coulson 2004) on city or MSA level so far. Siegfried and Zimbalist (2006) provide a more detailed discussion on why sports facilities fail to stimulate local economies.

The debate, however, might fall short. Critics themselves emphasize that stadiums and corresponding franchises are relatively small "businesses" compared to major cities or metropolitan areas and that impacts therefore have to be limited (Rosentraub 1997). On the same time empirical studies usually make use of aggregated data on city or MSA level instead of focusing on more reasonable areas for which impact might be expected. As a consequence the perspective of residents living in closer proximity to the stadium has largely been neglected in the empirical literature, most probably due to difficulties in obtaining and handling adequate data. However, only empirical analysis on neighbourhood-scale may assess whether new stadiums may be looked as key-determinants for processes of gentrification, particularly in economically deprived neighbourhoods. With only few exceptions (Davies 2006, Melaniphy 1996) this question has rarely been addressed in scholars' discussion.

Neighbourhood activists tend to oppose new stadium construction arguing that they expect emerging traffic congestions and fan-crowds to adversely affect property values in vicinity to the new stadium. Contrary to these expectations, Tu (2005), who was the first to empirically analyse stadium construction from an homeowners´ perspective by making use of transaction data on single-family properties, found a clearly positive impact on property prices when investigating the impact of FedEx Field in Prince Georges County, Maryland.

This paper addresses the question of how new sports facilities affect their neighbourhoods in more detail. We conduct hedonic and differences-in-differences analysis of a comprehensive set of highly disaggregated data to assess the socioeconomic impact of three sport arena projects realised during the 1990th in downtown Berlin, Germany which were developed within a area of urban renewal and explicitly designed to contribute to a process of revitalization. Our results in general support positive expectations towards stadium impacts while general neighbourhood activists´ concerns about congestion problems turn out to be well-founded when not appropriately addressed by planning authorities.

The remainder of this article is organized as follows. In the next section we present both projects in more detail, and put emphasize on their architectonical particularities. Section 3 and 4 discuss our data and empirical strategy and methodological issues. In section 5 we present our empirical results and provide an interpretation. The final section concludes and gives an outlook.

2 Velordom and Max-Schmeling-Arena

The two sports complexes under investigation are Max-Schmeling-Arena and Velodrom/Swiming-Arena, both located in Prenzlauer Berg, a district within former Eastern Berlin. All arenas played a role in the unsuccessful bid of Berlin for the Olympics of 2000, running since the late eigthies. Max-Schmeling-Arena should have hosted boxing competitions while Velodrom and Swimming-Arena were intended to serve as venues for Olympic track cycling and aquatics.. To simplify matters we speak of Velodrom in the following, which is the much larger of the two Arenas, when referring to Velodrom and Swiming-Arenae. Initianally all arenas have been designed to be state-of-the-art and to fulfil all standards for international, esp. Olympic competitions.

The ideas of the arenas have to be understood on the background of the aspirations in Berlin of the early nineties, shortly after the fall of the wall. The German Parliament decided that Berlin would become the capital city of unified Germany and economic prospects were still seen to be rosy. Building activity was at high levels. Large residential areas formerly belonging to East-Berlin started to be revitalized. Many 1990th Berlin-projects like the government district and the large office and retail areas around Potsdamer Platz and Friedrichstrasse have become internationally prominent. It was the time of extraordinary projects.

At the end of an international competition the first-price for the Velodrom was awarded to Dominique Perrault, an architect who just began to be an international “shooting-star” due to the spectacular design of his new French National Library. In contrast, the group of young architects around Jörg Joppien and Albert Dietz was still internationally unknown when entrusted with the design of Max-Schmeling-Arena. Nevertheless, both architectural designs share the same basic idea. Instead of placing monolithic blocks into the densely populated residential areas and threatening the fragile urban equilibrium of the quarters, they decided for a sensitive approach. They reduced the visible building volumes by sinking the facilities into earth and embedding the visible parts into park landscapes as recreational spaces. The architectonical quality of the remaining visible parts and their appealingly designs fit well to the ambitions of originality in Berlin at that time (Adam 1997, Argenti 2000, Mandrelli 1994, Meyer 1997, Myerson and Hudson 2000, Perrault and Ferré 2002).

The arenas had already been under construction for a couple of months when the IOC in 1993 announced that Olympic Games 2000 would be carried out in Sydney. Subsequent to this decision building costs had to be reduced and architects and engineers were called to re-design arenas to meet all requirements of true multi-purpose Arenas. Notwithstanding the arenas kept extraordinary dimensions. The roof of the Velodrom, with a diameter of 142 and a clear span of 115.2 m is one of the largest of its kind. It was built of more than 3500 tons of steel, in these terms comparing the famous Eiffel Tower in Paris (Mandrelli 1994, NN 1997). Since Velodrom has been carved up to 17 meters into earth it is virtually invisible from common street level. After accessing a plateau, however, an impressive sight is offered to the visitor. Within a park formed by 450 apple trees, the visitor suddenly catches sight of Velodrom and swimming Arena which exceed the surface-level by no more than one meter.

Although less impressive in terms of moved earth or built in material, the architectural concept of Max-Schmeling Arena is special as well. Deutz and Joppien convinced the jury with the idea of spanning a green bridge from Wedding two Prenzlauer Berg, thereby not only providing additional green spaces for a very densely populated area, but also symbolically linking the two districts which had formerly been divided by Berlin Wall. The whole complex is embedded into a heap of World War II rubble with two thirds of its volume lying below street level. The building has a tripartite structure consisting of a major Arena which forms the centre and is flanked by two aisles hosting additional sports facilities. Only the middle part is covered by a conventional roof made of steel while the two aisles´ tops are covered with greenery. Being walkable and smoothly descending into street level, they fit into the surrounding park landscape dominated by the Mauerpark, one of Berlin's larger inner-city recreational spaces.

Both projects have been decorated with important architectural awards. In 1999 the Jury of the German Architectural Award decided to award the second prize to Dominique Perreault's plans for the Velodrom. The only one to outperform Perreault was no one less than Daniel Liebeskind with his plans for the Jewish Museum Berlin. Two years later the exemplary design and function of Max-Schmeling-Arena was honoured by winning an IOC/IAKS Gold medal. This price, sponsored by the International Olympic Committee and the International Association for Sports and Leisure Facilities is the only international architectural prize explicitly awarded to sports and leisure facilities in operation.

Velodrom and Max-Schmeling-Arena are not only comparable in terms of architectonical quality and concept, which also includes a radical low-energy philosophy, but also in terms of size. The former has a capacity of 11500 spectators while latter accommodates up to 10000 spectators in its main Arena. Moreover, both complexes also host a wide range of sports facilities used for purposes of non-professional sports. Accessibility by means of public transportation was an important determinant for choice of both locations. Velodrom is immediately accessible by tram and the circular line of suburban railway network (S-Bahn). Another station of the same line lies within an 800 meter distance ring surrounding Max-Schmeling-Arena where four more underground and various tram stations can be found. No further improvement of transport infrastructure was needed.

The projects had been finished in 1997 (Max-Schmeling-Arena) and 1999 respectively (Velodrom). They were financed by state funds and planned and carried out by a building-property company found by the Senate and Chamber of Deputies of Berlin. Overall expenditures were at $118 Million (205 Million DM, price basis $$) for the Max-Schmeling-Arena while construction of Velodrom the adjoining Swimming Arena together summed up to over $295 Million (545 Million DM) (Myerson and Hudson 2000, Perrault and Ferré 2002).[1] These projects would hardly have been realized in these dimensions if ordered by club owners or managers just aiming at private profitability. The attempt to generate positive external effects by providing valuable recreational spaces and sports facilities for the resident population, by creating landmarks which should signal a clear new departure in that urban area and which might attract sight-seeing tourists obviously were decisive.

3 Data and Data Mangement

Our study area covers the whole area of Berlin, capital city of Germany, which on July 30, 2006 had 3,399,511 inhabitants and a spatial extent of approximately 892 square kilometres. For reasons that will be discussed in the section below, we use standard land values (Bodenrichtwerte), assessed by the local Committee of Valuation Experts, (Gutachterausschuss) as our primary endogenous variable. Standard land values are given in values per square meters for zones of similar use and valuation (Bodenrichtswertszonen) and are assessed on the base of statistical evaluation (including elimination of outliers) of all transactions during the respective reporting period. Assessed values shall reveal market values for undeveloped properties within the corresponding zone of valuation and refer to the typical density of development provided in form of area-typical FSI (floor-space-index) values.[2] The FSI, also called floor space ratio (FSR), represents the ratio of buildings´ total floor area to the size of the corresponding plot of land. To account for individual zoning regulations, adjustment coefficients are provided which allow revaluation to plots' particular FSI-numbers. Additionally, each standard land value is assigned to a particular kind of land use, indicating whether the respective area is characterized by major retail and business activity, industrial or residential use. Beside of just providing market transparency in deregulated markets, standard land val-

[1] Dollar values have been calculated based on the average exchange rates during the years of completion. For Max-Schmeling-Arena the average 1997 exchange rate of 1.7348 DM per dollar has been applied while values referring to the Velodrom complex rely to the average 1999 exchange rate of 1.0658 Euros per Dollar and 1.95583 DM per Euro.

[2] More information on sources and the process of collection of standard land values can be found in the data appendix.

ues provided by the Committees of Valuation Experts play a role in determining tax burden related to property ownership.

The study period covered in this paper ranges from December 31, 1992, the first year for which data is available for districts formerly belonging to GDR, to January 1, 2006, the date for which most recent data was available when the analysis was conducted. We analyse data refereeing to the official statistical block structure of Berlin as defined in December 2005, the most disaggregated level available at the Statistical Office of Berlin. All data accords to the official definition after which Berlin consists of 15,937 statistical blocks with a median surface area covering less than 20,000 square meters, indeed corresponding to a typical inner-city block of houses. The mean population of 12,314 populated blocks was 271 (median 135) by the end of 2005.[3] To facilitate analysing this highly disaggregated dataset we employed GIS-tools and a projected GIS-map of the official statistical block structure which helped to bring the geographic dimension into our analysis. GIS information was available on public infrastructure like schools, playgrounds and railway stations enabling us to generate impact variables which we discuss in more detail in the section below.[4] Information on locational attributes like proximity to water spaces or over-ground railway tracks could be retrieved by making use of official block-ID-coding. Furthermore we use data on motor vehicle registrations and a set of population data on block-level including various demographic characteristics from Statistical Office of Berlin.

The data on land prices is not available in a directly applicable digital form. Therefore information on land values, density of development and land use has to be entered manually. Above all, block-level information at the Statistical Office is quite expensive so that, due to financial and time constraints, we were forced to restrict our data collec-

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[3] Especially in the outer areas of Berlin blocks of much larger spatial extent have been defined. However such blocks typically cover recreational areas like parks, forest and lakes which are undeveloped and unpopulated and therefore remain unconsidered in our estimations.

[4] All GIS-maps were provided by the Senate Department of Urban Development (Senatsverwaltung für Stadtentwicklung) and are based on "The City and Environment Information System" of the Senate Department. (Kartengrundlage: Informationssystem Stadt und Umwelt der Senatsverwaltung für Stadtentwicklung)

tion to years 1992, 2000 and 2005.[5] Given the constraints, we believe this is a feasible choice since it allows us to develop a comprehensive model for present Berlin as well as to compare trends during pre- and post-completion periods.

Mapping and geographic computation like calculation of surface-area, determination of blocks´ centroids or creation of impact variables like impact-area dummies or distance-variables was conducted using ArcInfo 9.0. To create spatially lagged variables and related scatter plots we employed GeoDa 0.9.5-I as recommended by Anselin (2003).

4 Empirical Strategy, Data and Methodological Discussion

Our empirical strategy basically consists of two steps. First we develop a hedonic pricing model explaining today's land value pattern of Berlin which we extend by a set of dummy and distance variables capturing impacts of our subject arenas on land values. In the second step we use a differences-in-differences setup to assess whether determined impact areas systematically experienced changes in growths rates after arenas´ completion and whether these changes are consistent with our cross-sectional findings.

Hedonic models are commonly applied in real estate and urban economics since they allow treating real estate commodities as bundles of attributes whose implicit prices can be estimated using multiple regression techniques. Examples for the application of hedonic pricing models in urban economic literature include construction of house indicies (Can and Megbolugbe 1997, Mills and Simenauer 1996, Munneke and Slade 2001) as well as assessment of impact of quality of public services provision like transport infrastructure (Bowes and Ihlanfeldt 2001, Gatzlaff and Smith 1993) or school quality (Mitchell 2000) and numerous other issues like group homes (Colwell, et al. 2000), churches (Caroll, et al. 1996) or even supportive housing (Galster, et al. 2004). However, with the exception of Tu (2005), hedonic analysis of data on property values has still not been applied to assess the impacts of sports stadiums´ construction.

[5] In general all data strictly refers to December 31 of the corresponding year. Although officially referring the January 1 of 2001 and 2006, standard land values provided in these atlases have been assessed based on data collected during reporting periods 2000 and 2005.

Following (Galster, et al. 2004) we adopt the basic idea that any real estate's particular characteristic can be described by its structural attributes [S] and a set of attributes capturing the neighbourhood [N] and local public services [L] it is exposed to (Muellbauer 1974, Rosen 1974):

$$H = f([S],[N],[L]) . \quad (1)$$

H stands for the aggregated value of attribute characteristic which translates into a market value or sales price (*P*) following a particular functional relationship

$$P = g(H). \quad (2)$$

In urban and real estate economics literature it has become common sense to assume this relationship to be log-linear. This specification has the great advantage to allow for non-linear relationship between prices and attribute values while being more intuitively interpretable than other non-linear models. Given a change of one unit in attribute's value the attribute's coefficient reveals the percentage impact on property value. For coefficient values smaller than 10 percent this rule may even be applied to dummy-variables (Ellen, et al. 2001).[6] Following Tu (2005) the relationships illustrated in (1) and (2) can be formulated more precisely in form of a regression equation

$$ln(P) = \alpha + \beta_1 S_1 + \ldots + \beta_i S_i + \gamma_1 N_1 + \ldots + \gamma_j N_j + \delta_1 L_1 + \ldots + \delta_k L_k + \varepsilon \quad (3)$$

where i, j and k represent the number of included structural *(S)*, neighbourhood *(N)* and locational *(L)* public services attributes, β, γ and δ are coefficients on attributes and ε is an error term.

Theory does not ultimately determine which variables in particular have or have not to enter an appropriate hedonic model specification. In recent publications much attention has been paid to the characteristics of the real estate units (Ellen, et al. 2001, Galster, et al. 2004, Heikkila, et al. 1989, Tu 2005). To compare property-transactions it is necessary to carefully correct every single transaction for a complete set of unit characteris-

[6] For larger coefficient values it is strongly recommended to apply a simple formula providing a much better approximation. For a parameter estimate b the percentage effect is equal to ($e^b - 1$) (Halvorsen and Palmquist 1980)

tics in order to make data comparable. Indeed, as noted by Heikkila, et al. (1989), a feasible correction for unit characteristics finally gives the analysis a character of referring to land values instead of property prices. As we directly focus on land values as the endogenous variable we are allowed to largely abstract from unit characteristics and even the prize-lot size relationship.[7] We pay more attention to other factors and develop a model which describes Berlin's land value pattern through a comprehensive set of explanatory variables covering land use, accessibility indicators, natural endowments, public services provision and neighbourhood variables representing density and composition of resident population.

In our hedonic model explaining standard land values of 2006[8], we capture land use by dummy-variables identifying blocks where considerable amount of either retail or business activity takes place or which are mainly used for industrial purposes.[9] The remaining blocks consequently represent residential areas. We enter a variable representing the typical block-FSI-value (Floor Space Index). We allow for a quadratic term since land value is expected to be a decreasingly increasing function of FSI, allowing for the underlying functional form of FSI-adjustment coefficients which we primarily estimated for purposes discussed in the data appendix.

Locational characteristics are captured by a set of distance variables reflecting accessibility and proximity to locational amenities. Following Von Thünen and Alsonso (1964), the traditionally most important accessibility indicator is distance to CBD (e.g. (Cheshire and Sheppard 1995, Dubin and Sung 1990, Heikkila, et al. 1989, Isakson 1997, Jordaan, et al. 2004).

In contrast to the usual assumption of one single CBD the gridded rent surface represented in figure 2 visualizes that Berlin is characterised by a concept of duo-centricity.

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[7] Lot size was typically found to have a concave functional impact on land values (Colwell and Munneke 1997, Colwell and Sirmans 1993)while later it was found to possibly take a convex structure within metropolitan areas´ central business districts (CBD) (Colwell and Munneke 1999).

[8] Standard land values of 2006 are assessed on the base of transactions occurred during the reporting period year 2005.

[9] The Committee of Valuation Experts provides information on land use for all land values. A detailed description of data sources is provided in the data appendix.

This characteristic emerged during the 1920th and was strengthened during the period of division (Elkins and Hofmeister 1988). Modelling Berlin as a typical monocentric city could lead to biased estimates (Dubin and Sung 1990). To deal with Berlin's duo-centric structure we decided to rely on the official definition of Berlin's Senate Department for Urban Development (Senatsverwaltung für Wirtschaft Arbeit und Frauen 2004). As consequence our main accessibility measure consists of great circle distance to *either* CBD-West *or* CBD-East.[10]

We believe to make a valuable contribution to land-gradient discussion since there is still little empirical evidence available for land-gradient behaviour in European and in particular German cities.[11] Our contribution is further enriched by choosing a specification that allows land-gradient to vary across land uses. Of course, great circle distance to CBD is only a rough accessibility-proxy. In fact, the degree to which transportation infrastructure is developed in distinct neighbourhoods may have an additional impact on effective accessibility. Impact of public transit on property prices has been subject to investigation by Gatzlaff and Smith (1993) and by Bowes and Ihlanfeldt (2001) who also discussed related sources of negative externalities. We capture the impact of public transportation network on rent pattern by introducing great circle distances to metro and suburban railway stations. To capture externalities created by noise of railroads, which were found to have a negative impact on property values (Cheshire and Sheppard 1995, Debrezion, et al. 2006), we add great-circle-distances to over-ground railway tracks. By the same way we consider the effects of proximity to bodies of water like lakes and rivers which represent natural locational amenities and are expected to be a major determinant for the emergence of high-quality residential areas in particular. We also include proximity to playgrounds and schools which provide additional information on neighbourhood's supply with public services infrastructure.

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[10] We defined CBD-West as a point-theme centred on Breitscheidplatz, the place where the Kaiser-Wilhelm Memorial Church stands on. CBD-East was defined in the same way as the crossroads of Friedrichstrasse and Leipziger Strasse. Centrality of this point is highlighted by the nearby metro-station called Downtown (Stadtmitte).

[11] One of the few existing studies provides evidence for Munich and supports theoretical implications (Polensky 1974).

As other indicator of neighbourhood quality we add population density and - as e.g. Dubin / Sung (1990) and Tu (2005) - shares of foreign people. We also consider shares of other potential low-income groups like older people beyond the age of 65 years and young professionals and students aged between 18 and 27 years. To assess whether there are any systematic impacts related to the presence of family households with children we introduce shares of population below the age of 6, from 6 to 15, and from 15 to 18 as proxy-variables.

In recent publications authors have also attempted to control for location by the use of large sets of dummy-variables representing locational fixed effects (Ellen, et al. 2001, Galster, et al. 2004, Galster, et al. 1999, Tu 2005). We take over that idea and introduce a dummy for West-Berlin to account for potential East-West heterogeneity. We interact this dummy with the complete set of explanatory variables to allow for heterogeneity of all implicit attribute prices.

Spatial dependence may lead to spatial autocorrelation violating the assumption of zero-correlation between residuals, leading to inefficient OLS-estimates and biased test-scores. More intuitively we may imagine spatial dependence to be the result of spatial spill-over effects representing external effect of surrounding areas. One straightforward explanation for the presence of spatial dependence in property prices and rents is that during the process of assessment preceding any property-transaction, buyer and seller consider previous transactions occurred in the immediate vicinity. Can and Megbolugbe (1997) add a spatial autoregressive term to the set of explanatory variables representing a distance weighted average of sales prices that had occurred prior to the transaction within a determined neighbourhood to deal with the existence of such spatial spill-over effects.[12] In our specification a standard land value (P_i) given for a particular block is not only determined by block's attributes but also by the values (P_j) of a nearby block j. To determine the value of the spatially lagged variable for subject block *i*, we weight land value of neighbouring block *j* with spatial weight $w_{ij} = (1/d_{ij})/\sum_j(1/d_{ij})$, where d_{ij}

[12] Since assessed standard land values all refer to the same point in time we do not have to define any relevant pre-transaction period to be considered.

represents the inverse of distance between centroids of blocks *i* and *j*. The spatial lag value for block *i* consequently takes the form:

$$Spatial\_Lag_i = \sum_j [(1/(1/d_{ij})/\sum_j (1/d_{ij})]P_j \qquad (4)$$

After having decided for a spatial weight-matrix using inverse distances weights the spatial extent surrounding properties are to be defined. Can and Megbolugbe (1997) find a 3000 meter distance ring to be superior considering only the three nearest properties. Tu (2005) reproduced the Can-Megbolugbe specification using a 1.8 mile radius which approximately corresponds to the 3000 meter specification. Due to resource constrains Galster, Tatian and Smith (2004) only tested the effectiveness of distinct range-specifications for a small subset of their transaction data. However, in terms of goodness of fit (R^2) they found no considerable impact and finally decided to exclude the spatial lag term. To test which of the specification proposed by Can and Megbolugbe (1997) would match best our model and data requirements we calculated inverse distance matrixes for both specifications and found that taking into account land values of three nearest blocks is superiour. Figures 3a and 3b show Moran scatter plots for logarithm of land values of 2006. The right-hand plot based on a distance-matrix capturing three nearest blocks clearly exhibits the more linear relationship, revealing that this specification captures spatial dependence to a larger extend. This is also confirmed by a Moran's I coefficient of larger magnitude.[13]

The introduction of spatially lagged variables does not only affect residuals correlation but has also positive effects on the overall explanatory power of the model. This additional advantage of spatially extended models is the result of omitted attributes being most likely correlated across space. However, especially in light of the large explanatory power of the chosen spatial lag variable, which is revealed by Moran´s I coefficient close to one, we emphasise that the explanatory power of our overall model specification depends only to a minor extend on the introduction of the lag-term. In table 2 we compare the performance of our final hedonic baseline-regression (1) with the performance when omitting the lag-term (3). An R^2 of close to 90% indicates that our specifica-

[13] Comparing the effects of different spatial weight matrixes on nominal values yields similar results. We provide scatter-plots of logarithms since we use log-values as endogenous variable.

tion would still perform well in terms of explanatory power when neglecting spatial dependence. However, the improvements in residuals´ quality following the spatial model extension are impressive. In figures 4a and 4b we plot residuals corresponding to model specifications (1) and (3) of table 2 into three dimensional spaces. It is apparent that the residual surface of the spatially extended model corresponds better to what one would expect to be spatial white noise.[14, 15] After all, our model specification can be expressed in the following way:

$$
\begin{aligned}
ln(P) = {} & \alpha + \beta_1 Business + \beta_2 Industry + \beta_3 West \\
& + STRUCT\ a_1 + LOC\ a_2 + NEIGH\ a_3 \\
& + (Business \times STRUCT)\ b_1 + (Business \times LOC)\ b_2 \\
& + (Business \times NEIGH)\ b_3 \\
& + (Industry \times STRUCT)\ c_1 + (Industry \times LOC)\ c_2 \\
& + (Industry \times NEIGH)\ c_3 \\
& + (West \times SRUCT)\ d_1 + (West \times LOC)\ d_2 + (West \times NEIGH)\ d_3 \\
& + \gamma\ Spatial\_Lag + \varepsilon
\end{aligned} \tag{5}
$$

where *ln*(*P*) stands for standard land values taken into logarithm, *Business*, *Industry* and *West* are dummy variables capturing land use and spatial heterogeneity, *STRUCT*, *LOC* and *NEIGH* are vectors of structural, locational and neighbourhood characteristics and Spatial_Lag is the spatial autoregressive term discussed above. Greek and small case letters represent the set of coefficients to be estimated and ε is an error term. In table 1 we provide a more detailed description of components. Attribute variables have been interacted with dummy variables to allow implicit prices to vary across space and land use.

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[14] We would like to note that these residual surfaces also serve as a useful tool when eliminating incomprehensively outlying extreme values. The most western block lying completely isolated and contiguous to Berlin's boundaries within a forest, turned out show an extremely large residual. This indicated that our model, largely calibrated to inner-city areas, does not sufficiently well explain the valuation of a totally isolated and very remote area. We consequently decided to exclude the observation.

[15] To check for robustness we considered numerous lag-term specifications, including two, four, five and six nearest blocks as well as a specification which considered all blocks within a 1500 meter distance ring. However, Morane scatter plots and coefficients of determination (R^2) both suggested that the finally chosen specification performed best in terms of capturing spatial spill-over effects.

To capture any irregularities in land value pattern that might be attributable to the presence of Velodrom and Max-Schmeling-Arena we subsequently introduce dummy variables representing mutually exclusive distance rings surrounding our study-arenas and distance-impact variables representing great circle distances from blocks' centroids to subject arenas. We allow for quadratic terms in distances and interact dummy- with distance-variables in order to identify the most appropriate functional form.

Traditional hedonic cross-sectional analysis provides detailed information on any irregularities in price patterns that may be attributable to distance to arenas. To supplement the traditional cross-sectional analysis with time dimension we employ a difference-in-difference approach (Ellen, et al. 2001, Galster, et al. 2004, Galster, et al. 1999, Redding and Sturm 2005, Tu 2005). Galster, Tatian and Pettit (2004) provide an excellent survey about the appropriate application of differences-in-differences estimations while three interesting diff-in-diff specifications are briefly discussed and applied by Ellen, Schill, Susin and Schwartz (2001).

Finally attention has to be paid to the definition of treatment and control area. Berlin, since re-unification, is experiencing overwhelming changes in spatial structure and distinct socioeconomic developments across districts. Processes of gentrification and catch-up, particularly within selected eastern districts and border-close areas, are opposed by segregation and ongoing decline in other parts. The functional re-activation of the traditional eastern CBD, extensive migration and immigration of people belonging to distinct social milieus from and into particular boroughs all complicate assessing feasible counterfactuals. These processes are of special importance for this analysis since both subject arenas have been constructed in Prenzlauer Berg, one of 23 boroughs according to pre-2001 legal definition[16] and a borough that is not at all representative for Berlin in terms of resident population's composition. Figures 5a and 5b give an idea of how demographic structure changed after re-unification and how particular it has become in comparison to the rest of Berlin. The figures reflect a major process of gentrification in Prenzlauer Berg and comes together with immigration of relatively young pro-

[16] End of 2001, 23 boroughs have been merged to 12 boroughs of approximately same population size.

fessionals usually in search of the particular urban lifestyle and scenic spirit for which Prenzlauer Berg has recently become recognized.

As a consequence we decide to restrict our dynamic – not the static – analysis to the area of Prenzlauer Berg which ensures that we deal with a study area that has been hit by overall socioeconomic shocks in almost the same way. Moreover, since Prenzlauer Berg lies more or less along a concentric distance ring around CBD-East we do not have to care about potential bias caused by control and treatment areas being asymmetrically hit by CBD-East's re-emergence.

As noted above, the basic idea behind our differences-in-differences approach will be to test for possible structural breaks in relative growth trends within arena impact-areas and whether they are consistent with our cross-sectional findings. We therefore compare growth trends in land values within areas in immediate proximity of Max-Schmeling Arena to those of the control area that still lies within the comparable neighbourhood defined as the district of Prenzlauer Berg. Moreover we will make use of highly disaggregated population data to test for significant impacts on resident population and composition. As in the hedonic analysis al our data strictly refers to block level.

We decide to follow a specification similar to the one used by Redding and Sturm (2005). In our baseline differences-in-differences specification we pool average block growth rates of either population *or* land values over the periods of 1992-2000 and 2000-2005, the former representing the development period while the latter stands for the post-completion period. We regress average growth rates ($Growth_{it}$) on a set of time dummies (Pre_t, $Post_t$), two area impact dummies ($Velo_i$, MS_i) denoting blocks that lie within an impact area, and two post-area interactive terms between the arena-impact dummies ($Velo_i$, MS_i) and the $Post_t$ dummy representing the post-completion period:

$$\begin{aligned} Growth_{it} &= \alpha_1 \Pr e_t + \alpha_2 Post_t + \beta_1 Velo_i + \beta_2 MS_i \\ &\quad + \gamma_1 (Post_i \times Velo_i) + \gamma_2 (Post_i \times MS_i) + \varepsilon_{it} \end{aligned} \tag{6}$$

By choosing this specification unobserved block fixed effects in population or land value levels are differentiated out. The coefficients α_1 and α_2 on time dummies represent average growth rates for control blocks and control for common overall impacts on district level. Area-impact dummies capture area-specific deviation in rates of growth during both periods. In this particular model-specification β_1 and β_2 reflect the differences in average rates of growth between impact areas and the control area for the pre-completion period. Finally the interactive terms capture impacts on relative growth rates following completion. γ_1 and γ_2 represent the changes in differences between growth rates of impact areas and the control area after completion. Positive values for γ_1 and γ_2 provide strong evidence for a positive impact on average growth rates in close arena proximity during post-completion period. Put shortly we estimate difference-in-differences as we difference between areas *and* time.

In contrast to most comparable projects, distinct development of land valuation may not be attributed to improvements in public transportation infrastructure following stadium construction. Both sites were chosen due to their extraordinary transport linkages making subsequent improvements obsolete. However, there is at least one source of potential bias remaining. Prices assessed by the Committee of Valuation Experts refer to typical legal densities of development represented by FSI-values. To assure that changes in legal building densities do not bias our estimates, we normalize land values to a FSI of 1.5, a value that approximately represents the average density of development within the study area. The process of normalization is described more detailed in the data appendix.

5 Empirical Results

5.1 Current Land Value Pattern

Our baseline hedonic model represented in column (1) of table 2 performes satisfactory. The overall explanatory power is impressive and virtually all coefficients show signs that one would intuitively expect. Since the key-objective of this study lies in an assessment of the impacts of Velodrom and Max-Schmeling-Arena we pass on providing a detailed interpretation. However, even if this model has just an instrumental character in this paper, we believe that it provides most valuable insight on the particular spatial structure of Berlin and evidence for impacts of various attributes. The interested reader will find a brief discussion in the appendix.

We consider the general neighbourhood of each subject arena to be the area covered by a distance ring of 5000 meters radius which proved to be useful even in the case of larger Fedex Field (Tu (2005). To capture neighbourhood fixed-effects we create two (0,1) dummy variables denoting all blocks lying within this areas. In our first approach to assess arenas´ impacts we introduce two sets of mutually exclusive distance rings surrounding both arenas, again represented by dummy-variables. For each arena, four 1000 meter radius rings, the first ranging from 0 to 1000 meters, the second from 1000 to 2000 meters, etc. are added to capture differences in effects across distance. The results of this basic impact model are represented column (1) of table 3. To check for robustness we also conduct individual estimations of arena impacts represented in columns (2) and (3).[17]

Both neighbourhood effects show negative coefficient values indicating that arenas are located in relatively undervalued areas. Coefficients estimates for distance rings ranging from 2000 to 4000 meters remained insignificant indicating no systematic difference to the general neighbourhood. In contrast, coefficients for the 1000 to 2000 meter distance ring have positive values of similar size and are both statistically significant at conventional levels. These coefficient estimates suggest a positive arena impact of around three and a half percent within both concentric areas. At immediate proximity, however, results differ substantially for Velodrom and Max-Schmeling-Arena. In the case of Velodrom the impact-effect increases to approximately 7.5% while the coefficient on the 0 to 1000 meter dummy for Max-Schmeling-Arenae is not significantly different from zero. These result suggest a positive impact of Velodrom on land values which decreases with distance and disappears within the 2000 to 3000 meters ring. Contrary, for Max-Schmeling-Arena positive impact was only found at a distance of 1000 to 2000 meters, implying an impact on land values that first increases and then decreases with distance and, again, disappears after 3000 meters.

Although both arenas are situated in a general neighbourhood in which properties appear to sell at a discount, this discount does not increase with proximity to arenas as in the case of FedEx Field. Contrary, within the general neighbourhood, arenas have, if

[17] Results for individual and simultaneous estimation show the same general pattern.

any, significantly positive impacts. In immediate proximity to Velodrom, for instance, positive impacts even overweight the general neighbourhood disadvantages.

To confirm these results and to find the most appropriate functional form of arena-impact, we introduced distance-based variables and set up two series of hedonic models represented in tables 4a and 4b. Our results suggest that impacts are limited to a distance of 3000 meters. We consequently omit the 3000 to 4000 meter dummy in following models. As suggested by Tu (2005), three distinct model specifications are tested. Table 4a represents results for Velodrom while table 4b reproduces estimations for Max-Schmeling-Arena. In column (1) of both tables we repeat table 3 specification omitting the insignificant *3000-4000m* dummy. Column (2) tests for a linear impact of distance to arena. We therefore substitute the *0-1000m* and *1000-2000m* dummies by an interactive term consisting of the *0-3000m* dummy interacted with distance to subject arena. Column (3) specification allows for a quadratic term to account for non-linear effects, in particular for the potentially parabolic functional form of Max-Schmeling-Arena's impact.

Results of tables 4a and 4b are as suggested by the picture drawn by table 3. For Velodrom, we find a highly significant linear distance-rent relationship. The quadratic distance term remains statistically insignificant. For Max-Schmeling-Arena, in contrast, specification (3) clearly provides the better fit. Both interactive distance terms are significant, revealing that relative rent pattern shows the suggested parabolic form. Having identified the appropriate functional form for each arena we finally estimate coefficients for both arenas assuming linear rent-distance relationship for Velodrom and the quadratic specification for Max-Schmeling-Arena. Level-effects are now omitted for Max-Schmeling-Arena since the corresponding dummy had remained statistically insignificant in specification (3) of table 4b.[18] Estimation results for our final hedonic specification are represented in table 5. We illustrate these results graphically in figure 6 where we have plotted the relative land value gradients based on the corresponding coefficient estimates.

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[18] We only omit the 0-3000m dummy for Max-Schmeling-Arena. Neighbourhood fixed effects are still captured two 0 – 5000 meters area dummies.

To provide a better spatial impression of both overlapping arena-impacts we plotted residuals´ differences between our final hedonic impact specification (table 5) and the hedonic baseline specification of table 4(1) into three dimensional space (figure 7). It can be shown that residuals´ differences correspond to estimated arena impacts. Assume that

$$ln(P) = \alpha + BASE\ \beta + \varepsilon \tag{7}$$

represents our hedonic baseline specification and

$$ln(P) = \alpha + BASE\ \beta + VELO\ \gamma + MS\ \delta + \mu \tag{8}$$

is our final hedonic impact specification, where *BASE* is a vector of attribute variables included in our baseline model, *VELO* is a vector of impact variables related to Velodrom and *MS* is the same for Max-Schmeling-Arena. β, γ and δ represent sets of coefficients to be estimated and ε and μ stand for the error terms. Taking differences yields:

$$\varepsilon - \mu = VELO\ \gamma + MS\ \delta \tag{9}$$

In our econometric specification this relationship effectively corresponds to taking differences between residuals in order to visualize the additional explanatory power provided by the introduction of impact variables.

Figures 6 and 7 demonstrate how irregularities found in land value pattern are spatially attributable to the locations of Max-Schmeling-Arena and Velodrom. For both arenas we found consistent pattern of impacts at distance-ranges from 1500 to 3000 meters. Impacts are positive, decrease with distance and disappear after 3000 meters. If these positive impacts were indeed attributable to the presence of our subject arenas, one would intuitively expect location premium to be highest in immediate proximity since positive external effects should lose intensity with increasing distance. While this story fits perfectly into our estimation results for Velodrom, it conflicts with the effects estimated for the immediate vicinity of Max-Schmeling-Arena.

However, the estimated pattern of impact becomes more conclusive when countervailing externalities are considered (Galster, et al. 2004). Instead of assuming the existence of just one positive (or negative) externality, (various) positive *and* negative externalities should be considered. Assuming that distinct externalities differ in ranges, seizes and signs, externalities might cancel out eachother within a certain distance range while at other distances one of the externalities might dominate. As previously discussed, Velodrom and Max-Schmeling-Arena are comparable in terms of utilization, architectonical quality, overall installed size and provision of new recreational spaces suggesting that positive externalities should largely be comparable. The distinct impacts are most probably caused by the presence of negative externalities of limited range exclusively surrounding Max-Schmeling-Arena. In particular, two major sources of negative externalities potentially surround Max-Schmeling-Arena. First, in contrast to Velodrom, Max-Schmeling-Arena is home of two sports clubs of supra-regional importance.[19] The regular presence of highly involved aficionados may represent a source of noise, crime and similar disturbances that might adversely affect residents´ willingness to pay for living spaces. Another typical concern are congestion problems generated by spectators. Particularly in the case of Max-Schmeling-Arena the lack of additional Arena parking capacities in one of the most densely populated areas of Berlin has led to increasing scarcity of parking lots. We will come back to this issue later on. Before, we will shed light on the question whether the relative rent pattern is not only *spatially* attributable to the location of both subject areas but also *temporally* attributable to the time of construction, respectively completion.

5.2 Comparing Relative Growth Performances

Our baseline differences-in-differences specification basically compares relative trends of growth for two study areas before and after arenas' completion while controlling for overall shocks. If Velodrom and Max-Schmeling-Arena had a positive impact on locational attractivity, this would be reflected in a change in relative growth performances following completion. As previously discussed we restrict our study area to Prenzlauer Berg due to homogeneity considerations. We split Prenzlauer Berg into three parts, two treatment areas, each one defined as a 1000 meter distance rings surrounding an arenas

[19] Resident teams are the basketball team of "Alba Berlin" and the handball team of "Füchse Berlin".

and the control group consisting of the remaining area. Locations of Velodrom and Max-Schmeling-Arena and the surrounding distance rings are visualized in figure 8.

The first columns of fables 6a and 6b present the results of our baseline difference-in-differences in normalized land values and population. To check for robustness, estimations are repeated with reduced sample-sizes. In the second columns of table 6a and 6b relative rates of growth for blocks in close proximity of Velodrom are compared to those lying within the surrounding 1000-2000 meters distance ring. The third columns (represent analogical estimates for Max-Schmeling-Arena. More robustness checks are represented in table 9. Column (1) shows estimation results for standard land values while column (2) provides estimates for an enlarged study area. Our baseline results prove to be robust for variation of sample-size with normalization of land values having only a minor effect on regression's outcome.

As initially noted, both Max-Schmeling-Arena and Velodrom were decided to be developed in the post-unification state of euphoria when Berlin was still expected to rapidly regain pre-war importance. While this short period was also accompanied by a boom in real estate markets, the following disillusion regarding the general economic perspectives of Berlin led to markets soon entering a trajectory-path towards a lower equilibrium. The significant negative coefficients on time dummies in all estimations reveal that, despite of all processes of gentrification, Prenzlauer Berg was hit by this process of overall depreciation.

Depreciation becomes visible in figure 9 where we graph indices of mean price development based on the estimates represented in column (1) of table 6a.[20] Standard land values in Prenzlauer Berg in average decreased by approximately 40% from 1992 to 2005. The negative coefficient on *Velo* reveals that the treatment area around Velodrom performed still inferior during the development period. After completion we observe a positive impact on relative growth rates which is represented by the positive coefficient on *Post x Velo* interactive dummy. The implication is that the impact area of Velodrom after completion experienced growth rates that in average were 1.4 percentage points

[20] Max-Schmeling-Arena is not considered in this figure due to insignificant estimates of corresponding impact coefficients.

higher than in the counterfactual case of pre-completion relative trends having continued. Since pre-completion growth rates and post-completion impact sum to a positive value we even observe small signs of recovery. Both recovery and the counterfactual are already noticeable in figure 9, however, effects become more visible in figure 10 where differences between indices of mean land values have been plotted.[21]

Figure 10 also graphs differences between indices of mean population which turn out have developed contrarily to prices. This graph was plotted based on estimates represented in column (1) of table 6b suggesting relative population within Velodrom treatment area to have grown during the development period. Contrary to prices, population-growth has been affected negatively by arena's completion. Since the coefficient estimate on *Post x Velo* exceeds the one on *Velo* in magnitude, mean population has declined relatively to the control area during the post-development period. Column (1) also indicates that overall population in Prenzlauer Berg first declined and than recovered. Figure 11, which is also based on the results represented in column (1) of table 6b, shows that population of Prenzlauer Berg in 2005 had approximately regained its 1992 size confirming that our estimation results are in line with effective development visualized in figure 5b. The directly opposed development of relative prices and population within Velodrom impact-area is in line with our cross-sectional findings that suggested a negative relationship between prices and population density. The straightforward explanation is that residents willing to pay more for their accommodations usually do not only demand better living space in terms of structural and locational attributes, but also more space for living. The effects become even more conclusive when taking into account that before development of Velodrom the corresponding site was occupied by Werner-Seelenbinder-Arena, a multifunctional sports-area comparable to Velodrom in terms of size and utilization (but not in architectural quality).[22] The decline of locational attractivity following the removal of Werner-Seelenbinder-Arena did not come to an end until Velodrom and Swiming-Arenae were completed.

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[21] Graphs should be interpreted carefully. Indices of mean land values refer to 1992 scale, in real terms recovery is smaller.

[22] It had a capacity of 10000 spectators and was utilized various purposes, also including cycle racing, concerts.

As in hedonic analysis, empirical results of differences-in-differences estimates for the case of Max-Schmeling-Arena are more ambiguous. In column (1) of table 6a both coefficients on relative pre-completion growth and post-completion impact are not statistically significant at conventional levels. This may be little surprising for pre-completion trend since there was no major shock affecting rent equilibrium such as the removal of the previously existent stadium within the vicinity of Velodrom, however, for the post-completion period one would intuitively expect Max-Schmeling-Arena to have had a significantly (positive) effect on rents.

In order to directly assess relative trends for the post-completion period, we slightly alter our specification as we substitute baseline impact dummies *Velo* and *MS* by interactive terms *Pre x Velo* and *Pre x MS*. Consequently, the coefficients on post-completion interactive dummies no longer reveal impacts on relative trends, but relative post-completion trends themselves. Results are presented in table 7 and show a weakly significant positive relative trend for the impact area of Max-Schmeling-Arena after completion. Trends having changed from "insignificantly positive" to "significantly positive" after completion, of course, provide less evidence for a positive impact than significant impact factors found in table 6 for the area of Velodrom. Moreover, results represented in column (2) of table 7 indicate that, in comparison to the corresponding 1000-2000 meters distance ring, the impact area of Max-Schmeling-Arena experienced neither a significant post-impact *nor* a significantly positive post-trend.

These results are puzzling, not only in light of the findings for Velodrom, but particularly when impact on resident population is considered. Estimates on population impacts are represented in column (1) of table 6b. In contrast to prices we observe a statistically significant impact on population in a way that negative relative growth performance during development period becomes positive after completion. Based on these estimates we graph indices of mean population for the impact areas of Velodrom, Max-Schmeling-Arena and the control group of Prenzlauer Berg in figure 11. Apparently, mean population in the vicinities of Max-Schmeling-Arena and Velodrom reacted oppositely to arena-development. After completion, population trends show convergence while the counterfactuals indicate how population would have developed if pre-completion trends of divergence had remained effective.

The puzzle of positive impacts on population together with insignificant impacts on prices is in line with previous cross-sectional findings. We found irregularities that most likely are to be explained by the presence of negative externalities exclusively surrounding Max-Schmeling-Arena: the presence of highly involved fan-groups and problems related to congestion, in particular scarcity of parking lots. We address the latter in more detail, since this issue could have been accounted for more easily by planning authorities.

5.3 Socioeconomic Impacts

The district of Prenzlauer Berg is characterized by a large late-19th century building stock which was in desolate conditions after the period of division. As described above, arenas under investigation were designed to serve as positive local amenities and sources of positive externalities for the respective neighborhoods. Since the district belongs to the most densely populated areas of Berlin, much attention was played to avoid increasing volume of traffic to neutralize the intended positive effects for the residents. So one of the main objectives postulated during the planning process was to guarantee a share of close to 100% of spectators arriving by means of public transportation. Both sites were chosen explicitly under consideration of good local transportation infrastructure which has already been described in more detail. To further increase relative attractiveness of public transit and to minimize incentives for spectators to arrive by car, planning authorities decided not to provide additional parking facilities.[23] However, despite of reasonably low attractiveness of individual transportation a considerable amount of visitors continuously arrives by car. For Max-Schmeling-Arena, an expertise ordered by the local district authorities came to the conclusion, that between 20 and 60 percent of spectators were arriving by car, depending on the kind of event ($$reference$$). As a consequence, an undeveloped plot of land close to Velodrom was transformed into a car-park in order to address upcoming congestion problems. Since no comparable reserve spaces were available in close proximity to Max-Schmeling-Arena, increasing scarcity of parking lots has soon led to infuriation among the resident popula-

[23] In fact, the original plans for Max-Schmeling-Arena included an underground car park. These plans were abandoned after Berlin's bid for the Olympics 2000 was rejected by the IOC (Meyer 1997).

tion. Construction of multi-storey car parks was considered, but projects turned out to be hardly financeable and no appropriate location could be found. The lack of plausible solutions brought forth curios solution attempts to deal with the problem. To keep spectators from arriving by car, the senate department (unsuccessfully) even tried to confuse drivers by not installing traffic signs indicating the way to Max-Schmeling-Arena (Meyer 1997). No solution is expected to be found in close future.

The parking scarcity potentially affected prices by keeping away car owning households, which potentially belong to relatively higher income groups. Unfortunately, no records on registrations are available for years previous to 2000 so that our analysis is limited to the post-completion period. To figure out whether any particular pattern in residents´ automobile stock is observable we use a slightly altered diff-in-diff specification. In model (1) of table 8 we regress per capita car registrations on dummies representing years 2000 and 2005 and a set of year times impact-area interactive terms. As one would expect considering the processes of ongoing gentrification, overall car stock has significantly increased between years 2000 and 2005. However, the only significant coefficient on impact dummies is the one on the post-completion interactive term for Max-Schmeling-Arena which indeed is negative in sign, although only weakly statistically significant. Thought, due to data-limitations, we were unable to check for pre-completion trends which could have provided additional valuable insights, the results fairly well support our presumption. While in year 2000 car stock within impact area of Max-Schmeling-Arena was more or less comparable to the one of the control area, half a decade later per capita car registrations in average have turned out to be approximately one third below average. At the same time car stock of residents living close to Velodrom developed inline with the one of the control group.

Of course, the socioeconomic dimensions of stadium impact do not only cover effects on residents´ car stock but also impacts on composition of resident population: Specific groups will be attracted by challenging urban developments in their neighborhood to a different degree. We will focus on the two population groups which have shown the most striking growth during the study period, foreign population and the age group of 27-45-year-olds who dramatically gained in importance since unification. One might expect the latter to react most flexible to changes in locational attractivity and to be relatively free of constraints in locational choice on the other. Moreover, this group covers the stereotype of new Prenzlauer Berg resident who immigrates to Berlin in search of a scenic metropolitan live-style, being particularly receptive for the appealing appearance and individual architectural concepts of both projects.

To get an impression of changes in composition of residents over time we employ an approach similar to the one used for automobile registrations. Shares of population are regressed on the same set of dummy-variables which we supplement by a 1992-year dummy and two non-interacted area-impact dummies. Coefficients on interactive terms now represent changes in differences between shares within and outside of impact areas relative to 1992. Estimates represented in column (3) of table 7 reveal that foreign population of Prenzlauer Berg has considerably increased following unification. However, with the exception of *Post-Completion x MS* interactive term all coefficients on impact dummies remain statistically insignificant on conventional levels. Given the findings that the impact area of Max-Schmeling-Arena is one of relatively lower valuation compared to other areas of Prenzlauer Berg, this provides a piece of evidence for foreign population still having to care more for expenditures´ and therefore being specifically attracted by the locational discount probably caused by problems of congestion.

Column (2) results for the group of 27-45-year-olds are illustrated in figure 12. Average shares within the impact-area of Velodrom start from below-average level and decrease further relatively to control group during the period of development. Although the coefficient on the *Post-Completion x Velo* term is still negative, it is smaller in magnitude compared to the coefficient on the corresponding term for the time of completion. This implies that after completion shares relative to control group have increased. In contrast, the neighborhood of Max-Schmeling-Arena shows significantly larger shares even before development, however, with average differences remaining unchanged during the development period and increasing after completion. So independently from the development of prices, overall population growth and/ or problems related to congestion, both impact neighborhoods managed to attract more people belonging to this age group after completion than other areas of Prenzlauer Berg. These findings are confirmed by results displayed in column (3) of table 9 where our baseline setup is applied to check for impacts on relative growth trends in population belonging to this particular group.

Although at the fist glace there is a negative impact of Velodrom's completion on growth rates, this impact is still smaller in magnitude than the one on overall population represented in column (2) of table 6. Comparing relative rates of growth of overall population with growth rates of 27-45-year-olds yields smaller rates for the latter before and larger rates after completion.

Taking into account that the process of gentrification in Prenzlauer Berg is largely driven by immigration of people belonging to this age-group we conclude that development of both arenas and surrounding spaces has acted as a motor of district revitalization not only by giving Prenzlauer Berg a new representative face and improving locational attractivity but also by particularly attracting those new residents which ultimately gave the district its present vital character.

6 Conclusion

This paper contributes to the debate on how stadium construction affects regional economic development by providing an empirical analysis on the role of new stadiums to serve as urban development measures for deprived inner-city areas. Two multifunctional sports complexes in Berlin-Prenzlauer Berg were chosen explicitly under consideration of their outstanding architecture and potential to improve neighborhood quality. Additionally to be comparable in terms of size, architectural concept and utilization, Velodrom and Max-Schmeling-Arena offered the advantage of having been developed at the same time and within the same general neighborhood.

Application of GIS-techniques and highly disaggregated data allowed to develop a cross-sectional hedonic model capturing the full range of structural and locational attributes as well spatial spill-over effects. Within this model, which covers the whole surface area of Berlin, irregularities in relative land value pattern on regional level were spatially attributed to the location of subject arenas. To confirm findings an alternative approach was employed which compared relative growth trends within impact-neighborhoods before and after completion to a previously determined control-area. Both approaches yielded basically the same results. While the presence of Velodrom had a positive impact on land valuation and consequently must have improved neighborhood's quality, Max-Schmeling-Arena did so only in more than close proximity.

The additional analysis of socioeconomic variables allows for developing more comprehensive interpretations and providing more precise policy implications. Results suggest that Max-Schmeling-Arena´s failure to appreciate immediate neighborhood's valuation is not necessarily attributable to noisy fans prowling the streets or to an inadequate or unappealing appearance. Indeed, positive effects on locational attractivity appear more likely to have been neutralized by congestion problems which could have been avoided by providing additional parking capacities within an underground car park.

However, our results also suggest that if importance is attached to appropriate choice of location and adequate design of arenas and surrounding urban spaces, positive effects on neighborhoods are to be expected. After all, both subject arenas apparently have succeeded in increasing demand for living space in close proximity, although this was not accompanied by increasing rents in the case of Max-Schmeling-Arena. The fact that the group of young professionals which plays a key-role in revitalization of Prenzlauer Berg apparently feels attracted by the presence of both arenas provides additional evidence for appealingly designed arenas to be an appropriate instrument to boost processes of gentrification in deprived inner-city neighborhoods.

We recommend future analyses of impacts of stadium construction to be conducted in particular with respect to the quality of architecture and urban design of the considered venues. Moreover, much more research is needed to precisely assess socioeconomic impacts of stadium construction on small regional scale. To address the question whether cities should pay for sports facilities or not (Zaretsky 2001), we emphasize that the answer largely depends on the kind of stadium that is being proposed. Is it to be developed within a neighborhood that might be expected to be gentrified? Have potential sources of negative externalities been satisfactory dealt with? And most important, is the project itself really promising in playing the role of a valuable locational amenity?

A Data Appendix

We collected data on standard land values, FSI-values and land use as determined by zoning regulations from atlases of standard land valuation (Bodenrichtwertatlanten) (Senatsverwaltung 1993, 2001, 2006). These atlases are being published by the local Committee of Valuation Experts in Berlin in intervals of one to four years since 1967.

Local Committees of Valuation Experts had been established throughout Germany to provide market transparency in real estate markets which finally returned to work according to common principles of market economies during the late 1950th. Before, German real estate markets had undergone a period of intense regulation which started in WWI with first rental fee regulation and cumulated in 1936 during the period of "third Reich" in a general price stop for all real estate assets. After WWII, regulation initially continued since scarcity of living spaces made public provision and allocation inevitable. The Committee of Valuation Experts in Berlin was established in 1960 when the major price-restrictions implemented in 1936 finally had been abolished.

Data collection was conducted by assigning values represented in atlases of standard land valuation to a block-ID-key-variable determined by the official block structure as defined in December 2005. If for the surface area corresponding to one particular block more than one value was provided by an atlas of standard land valuation we averaged over the highest and the lowest value within the respective block-area. Rent data has been collected individually for blocks which were not used for purely residential purposes. For pure residential areas, in contrast, we chose to collect rent data at a lower level of geographic disaggregation since variation is typically much smaller. We finally decided to collect rent data at the level of statistical areas (Statistische Gebiete). Since Berlin consists of 195 statistical areas, it is ensured that rent data for residential areas can still be regarded as being sufficiently disaggregated to draw a comprehensive picture. Aggregation to area-level was done by averaging over the highest and lowest standard land values within the respective statistical area. To guarantee that averages represent a feasible proxy of overall area valuation a threshold for the ratio of maximum to minimum land value was introduced. If the maximum value took a value of more than twice as much as the minimum value, then the extreme values were entered individually and averages were taken over the reaming blocks until the ratio had fallen below the value of two. This had to be done in only very few cases since generally maximum and minimum values turned out to lie very close to each other. So this short cut allowed accelerating data entry enormously while losses in quality of data remained limited to a reasonable degree. However, for the particular area of interest consisting of Prenzlauer Berg and the adjoining statistical areas, rent data was entered at maximum level of disaggregation for all kind of land uses.

The Committee of Valuation Experts assesses standard land values with respect to area-typical densities of development which are represented by FSI-values. To make sure that changes in valuation are not attributable to modified zoning regulation but indeed reflect changes in locational attractivity we normalized all standard land values used for differences-in-differences estimates to a FSI-value of 1.5, a value that approximates the average for the area of Prenzlauer Berg. To normalize values we made use of FSI adjustment coefficients (GFZ Umrechnungskoeffizienten) provided in the respective atlases of standard land valuation. We used coefficients given for areas of mixed use, which, according to the recommendation of the Committee of Valuation Experts, are to be obtained by averaging coefficients given for residential areas and those provided for office and retail areas. Division of a given standard land value by an adjustment coefficient corresponding to the given area-typical FSI yields the value that a plot of land had if legal density of development corresponded to the FSI base value determined in the particular table of adjustment coefficients. Such a table may easily be adjusted to any feasible base value, which we chose to be equal to 1.5.

The Committee of Valuation Experts was neither willing to offer information on the underlying function of adjustment coefficients nor on the corresponding process of assessment. However, we were able to estimate the functional relationship between given FSI-values and coefficients provided by the adjustment table with an R squared of 1.0. Estimation results suggest a concave impact of FSI on land valuation which is perfectly inline with theory and the empirical results suggested by our cross-sectional hedonic estimates. Having found the underlying functional form, adjustment coefficients could be determined and applied individually for all blocks and all years, thereby eliminating potential impact of changing FSI-values.

B Baseline Hedonic Model Appendix

Estimation results represented in table 2 are largely inline with intuitive expectation and provide valuable insights about the nature of impact of various attributes on property prices. While the interested reader may deduce his own conclusions on any coefficient of particular interest, we focus on some of the results which we believe to be most striking.

The theoretically predicted negative distance-rent relationship was found to be much larger for the western part of the city. Considering that theoretical prediction is based on neo-classical reasoning this result is little surprising since the implicit assumptions are hardly transferable to non-market economies. Making a long story short, Alonso's bid-rent theory (1964) is simply not applicable to markets where bidding is not allowed. The significantly negative coefficient on *West x Dist_Cent* may thus be interpreted as evidence for the persistence of different spatial equilibriums emerged during times of division. This finding is particularly striking in light of the ongoing debate about the existence of multiple equilibria in spatial distribution of economic activity.

Land gradient was not only found to vary across space but also across land use. For residential and industrial areas centrality clearly matters in the expected way. However, the significantly positive coefficient on *Business x Dist_Cent* reveals the relative locational premium business users are willing to pay is not linked to distance to CBD to the same extent. Apparently, remoteness is less problematic for business use which may be explained by the fact that business, particularly retailers, may find considerable market access even in suburban areas. In contrast, for residents there is no equivalent alternative to the CBD when attempting to enjoy various specialized services. Future research should investigate this issue by considering more carefully sub-centers as determinants of residential property-values and the role market access plays for the choice of business location.

Coefficients on public transportation variables also show an interesting pattern. In the western part of Berlin proximity to suburban railway station appears to have a significantly larger impact on property valuation than in the eastern part while for metro stations the opposite is true. We believe that this pattern is at least partially attributable to the fact that the metro network in the western part is developed to a higher degree than in the eastern part where the network of suburban railway system dominates.[24] The implication is that residents' willingness to pay locational premiums decreases when getting accustomed to a particular kind of public infrastructure. If a particular service is provided relatively evenly across town, residents do no longer recognize it as a local amenity. Proximity to metro and suburban railway station has a significantly larger impact on rents paid for business real estates, indicating that connection to public transportation infrastructure is a major determinant for market access. Schools and playgrounds turn out have virtually no impact on residential property prices within both parts of the city. This reveals that overall provision with that kind of infrastructure is sufficient to be regarded as negligible by residents. However, there is still room left for further research explicitly focusing on impacts of different types and quality of schools.

Composition and density of population affects property prices more or less uniformly in both parts of the city. As expected, population density has a negative impact on area valuation which is significantly stronger within the western part of the city. The coefficient on shares of foreigners is also significantly negative confirming the income disadvantages which had initially been assumed. This impact was not found to be significantly different for both parts of the city. Another group of residents which turn out to concentrate in areas of relatively lower valuation are the 18 to 27 year-olds. This is intuitively plausible since these groups largely consist of trainees and student who already left home but still are confronted with serious budget constraints. In contrast, older people beyond the age of 65 apparently experience no major concentration in economically deprived neighborhoods, at least according to the results suggested by the spatially extended model. Income disadvantages, if existent, are not large enough to considerably affect their choice of location. The coefficient on share of population below the age of six, which has been used as a proxy for families with young children, is significantly positive. Assuming that parents with children of this age are still relatively young and far away from their income peaks, on may conclude that either people belonging to

[24] Even before Berlin's division the largest part of metro network had lain within the western part of the city. However, after separation this imbalance still gained in strength. Since the suburban railway network was managed by the eastern Municipal Transport Services, western authorities decided to focus on the improvement of metro infrastructure.

higher income groups tend to have children or, more realistic, parents with young children take special care to chose privileged neighborhoods for their children to grow up.

We believe that estimation results presented above are reliable since the set of explanatory variables is comprehensive, spillovers have feasibly been considered and the overall explanatory power of the model is high.

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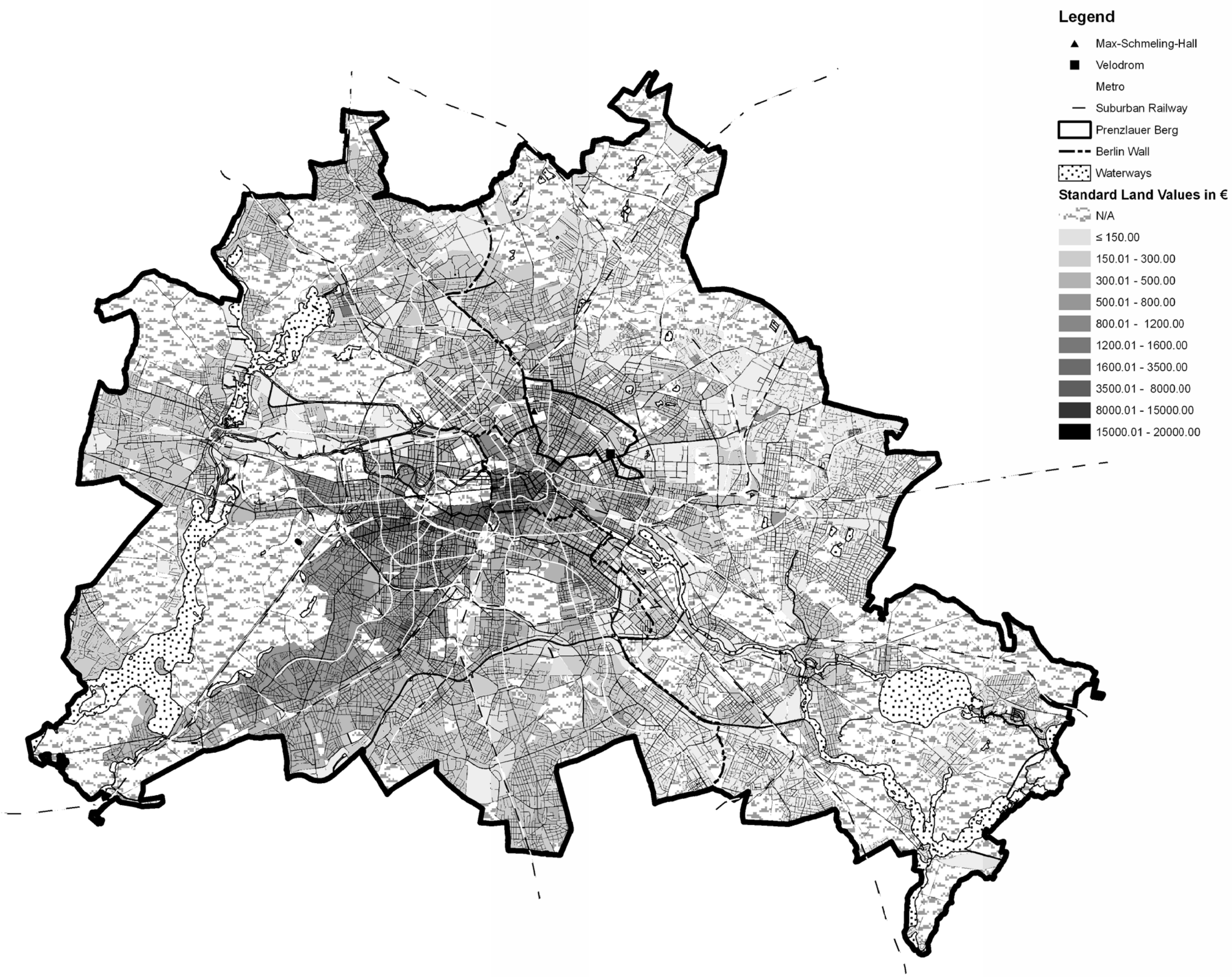
Figure 1 – Standard Land Values 2005



Notes: Map was created on the base of the "City and Environment Information System" of the Senate Department.
(Kartengrundlage: Informationssystem Stadt und Umwelt der Senatsverwaltung für Stadtentwicklung)

Figure 2 – Rent Surface: Standard Land Values in Berlin 2005

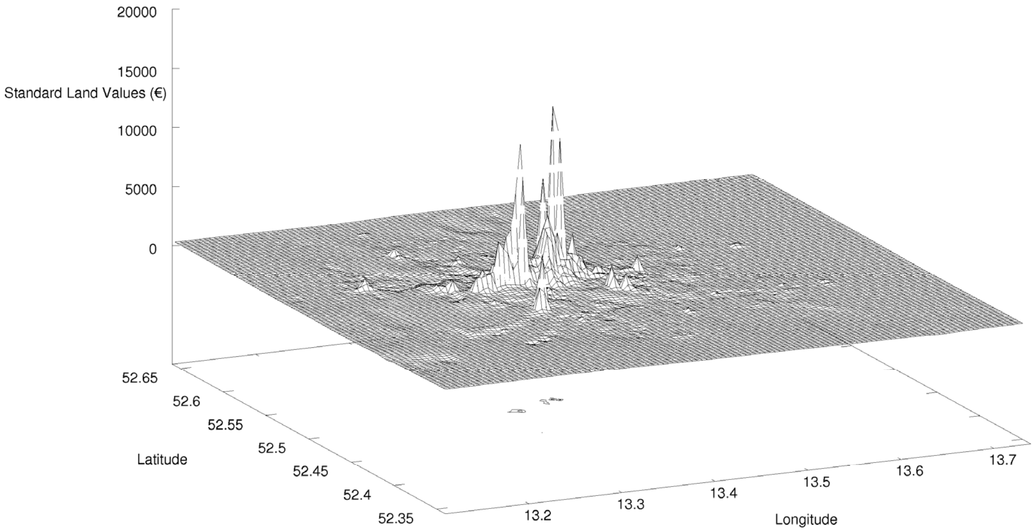


Figure 3a – Spatial Dependence with 3000 meter Specification

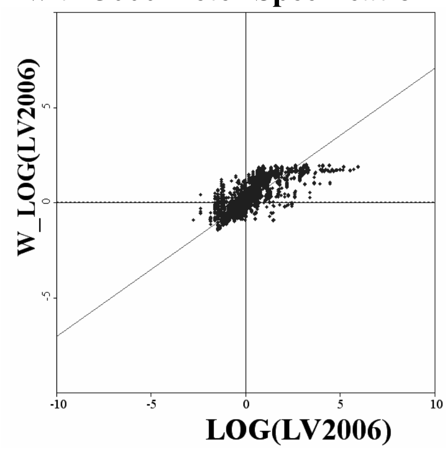
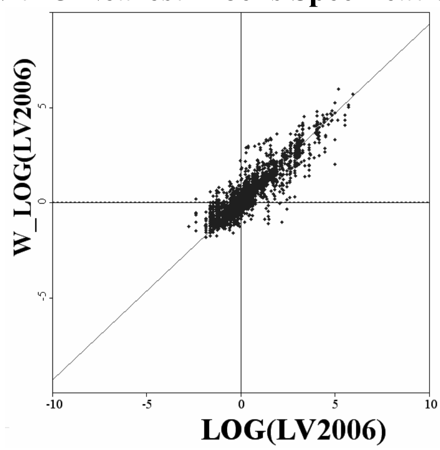


Figure 3b – Spatial Dependence with 3 Nearest Blocks Specification



Notes: LOG(LV2006) are standard land values of Berlin for 2006 taken into logarithm. W_LOG(LV2006) are the corresponding spatial lag values calculated on the base of the respective spatial weight matrix. Moran's I test statistics are 0.7051 for the specification represented in figure 3a and 0.9346 for figure 3b specification

Figure 4a – Gridded Residual Surface without Spatial Extension

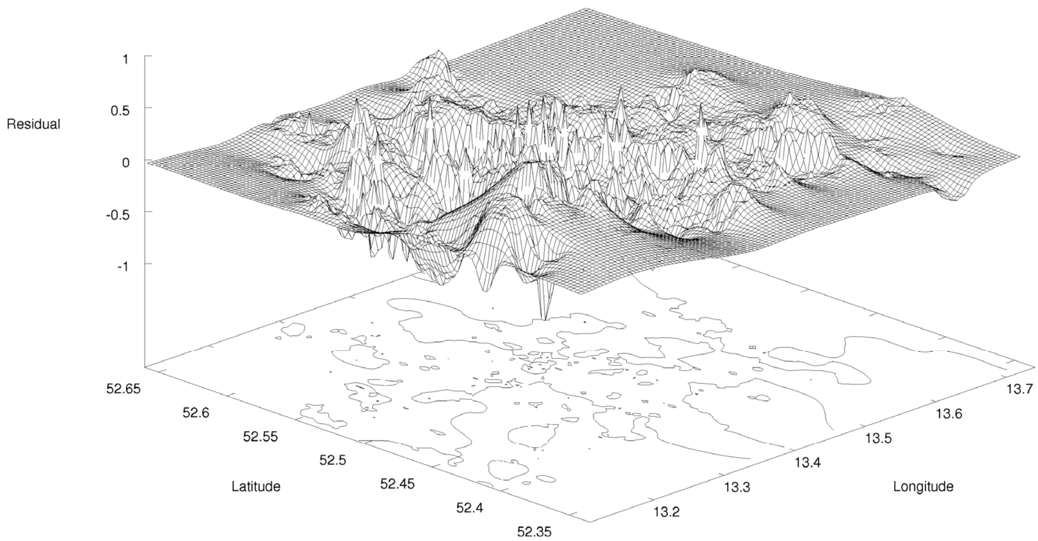


Figure 4b – Gridded Residual Surface of Spatially Extended Model

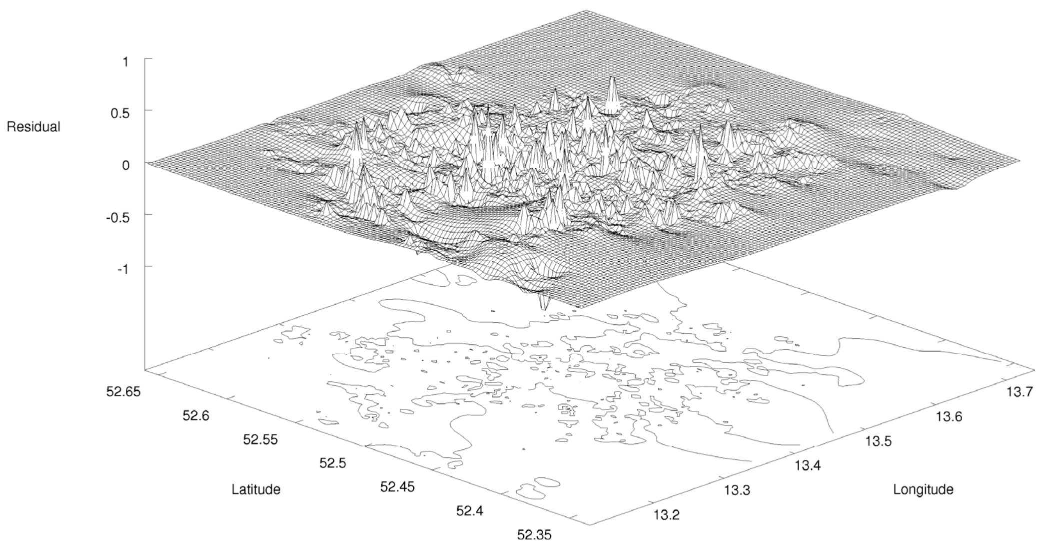


Figure 5a – Population of Prenzlauer Berg and Berlin 2005

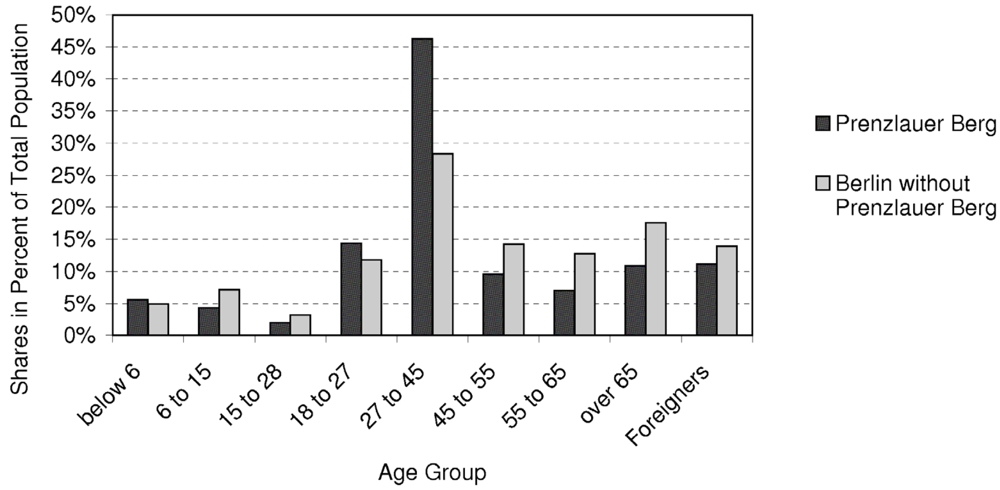
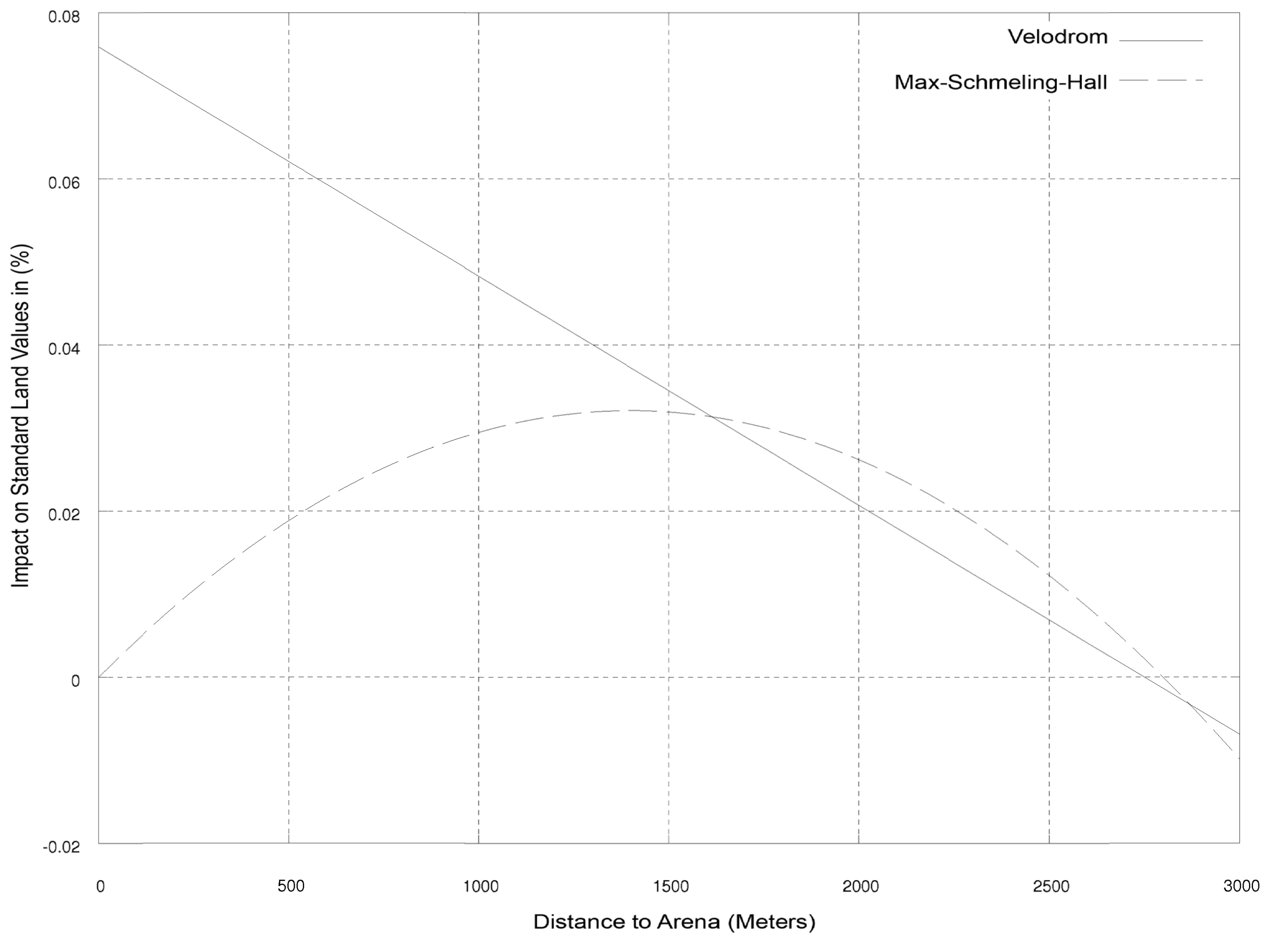


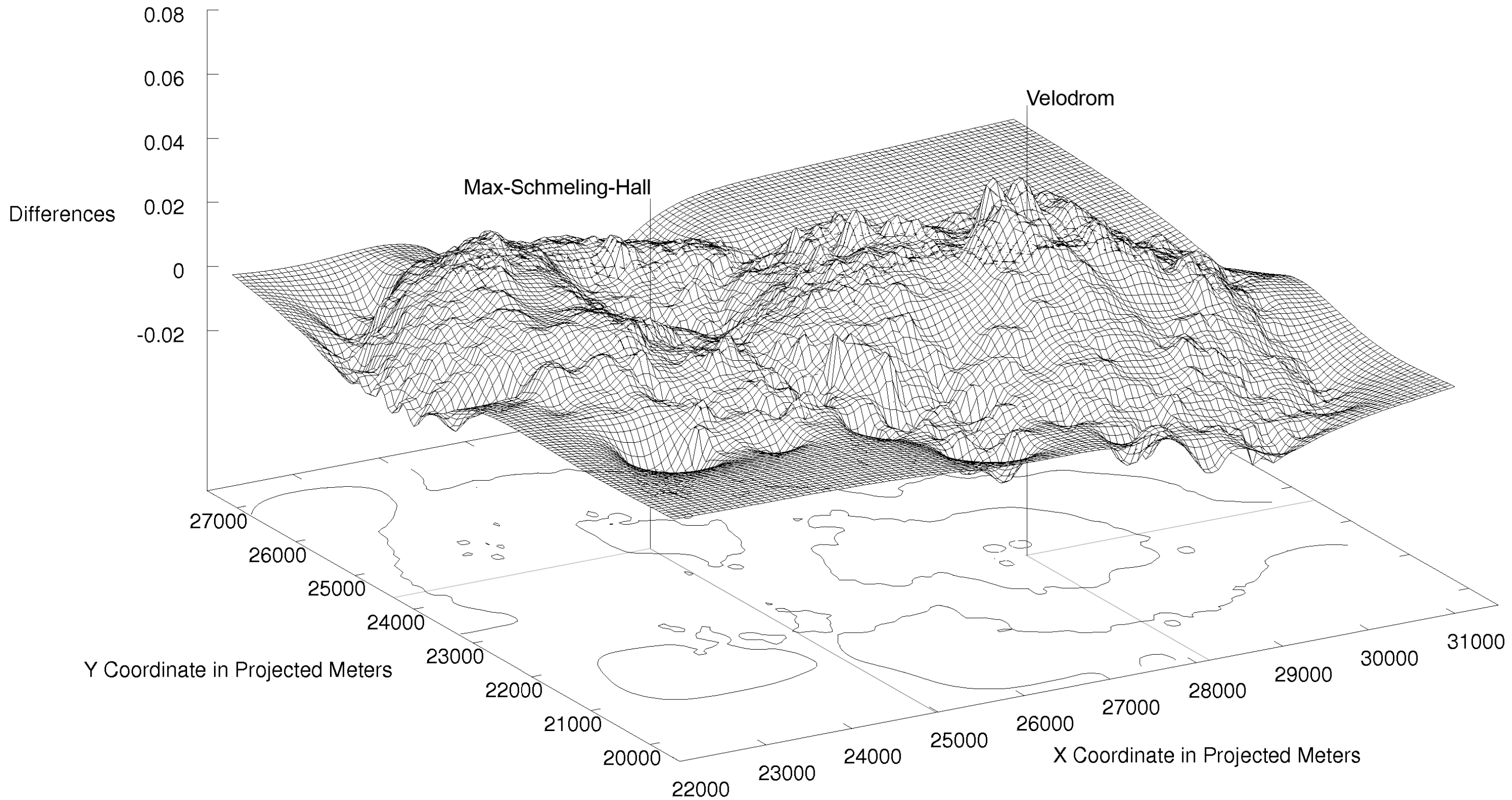
Figure 5b – Population of Prenzlauer Berg by Age Groups 1992-2005

Figure 6 – Estimated Impact Of Velodrom and Max-Schmeling-Arena on Standard Land Values



Notes: The graphs displayed in this figure are the graphical illustrations of coefficient estimates represented in table 5.

Figure 7 – Estimated Impact of Velodrom and Max-Schmeling-Arena on Standard Land Values



Notes: This plot represents the gridded surface of residuals' differences between our hedonic baseline specification and the final impact model. It covers the estimated area of impact for both arenas. Coordinates are given in projected meter units of the "Soldner" coordinate system which is used by the Senate Department of Berlin. The origin of this coordinate system is the most soutwestern point of Berlin.

Figure 8 – Prenzlauer Berg

Notes: Map was created on the base of the "City and Environment Information System" of the Senate Department. (Kartengrundlage: Informationssystem Stadt und Umwelt der Senatsverwaltung für Stadtentwicklung)

Figure 9 – Indices of Mean Standard Land Value

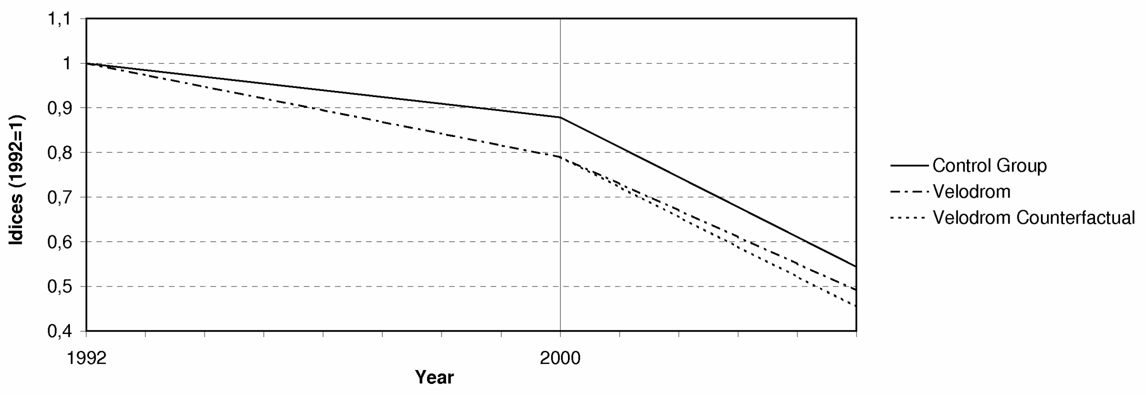


Figure 10 – Differences in Indices for Velodrom Impact Area

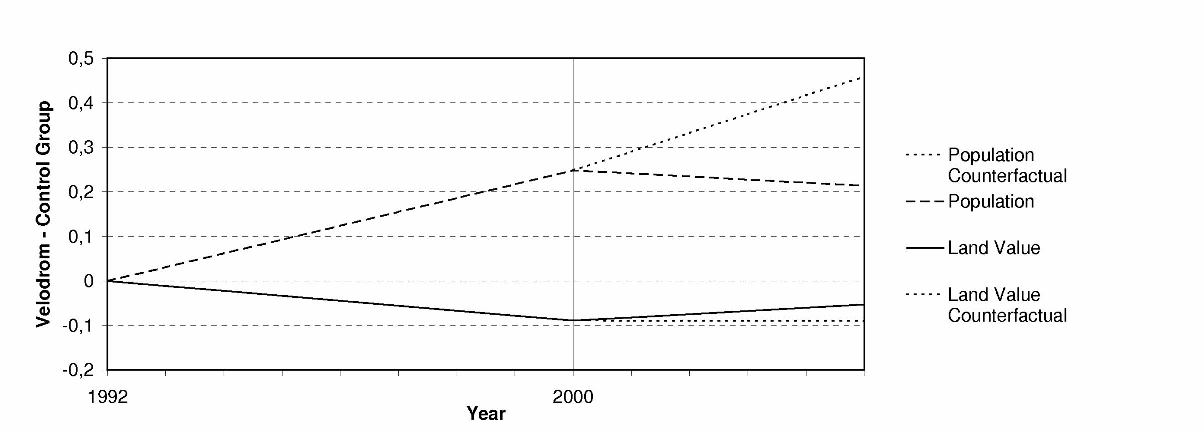


Figure 11 – Indices of Mean Population

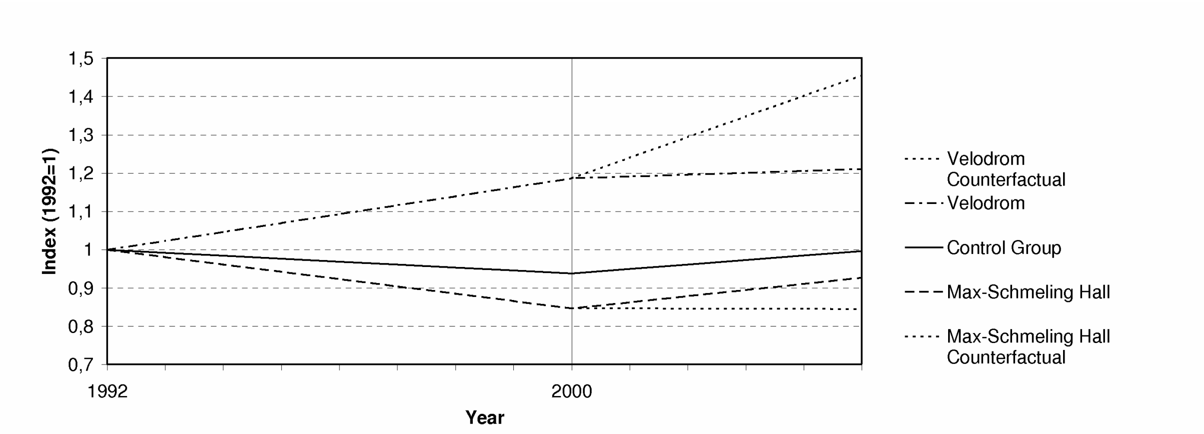


Figure 12 – Shares of 27 to 47 years-olds relative to Control Area

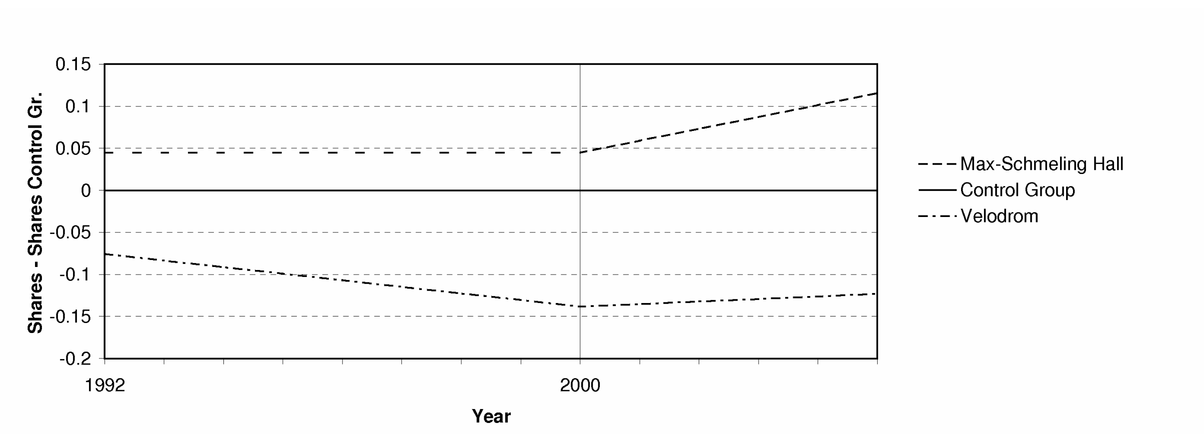


Table 1 – Description of Variables and Abbreviations

Variable	Description
	In Hedonic Regressions
Business	Dummy variable; 1 for bocks where a considerable amount of retail and/or office activity takes place
Industry	Dummy variable; 1 for bocks where land is at least partially used for industrial purposes
West	Dummy variable; 1 for block lying within the area of former West-Berlin
FSI	Floor-Space-Index: Quotient of full storey-area and plot-area
FSI²	Floor-Space-Index squared
Dist_Cent	Shortest great circle distance to CBD East or West in meters
Dist_Metro	Great circle distance to next metro-station in meters
Dist_Suburban	Great circle distance to next suburban railway-station in meters
Dist_Water	Great circle distance to next water space in meters (lake or river)
Dist_Schools	Great circle distance to next school in meters
Dist_Play	Great circle distance to next playground in meters
Dist_Rail	Great circle distance to over-ground railway tracks in meters
Pop_Share_Sub6	Share of population below the age of 6
Pop_Share_6_15	Share of population of age group: 6 to 15 years
Pop_Share_15_18	Share of population of age group: 15 to 18 years
Pop_Share_18_27	Share of population of age group: 18 to 27 years
Pop_Share_65plus	Share of population above the age of 65
Pop_Density	Population density (inhabitants per square meter)
Share_Foreigners	Share of foreign population
Share_Male	Share of male population
Spatial_Lag	Spatial autoregressive term as described in the methodology section
STRUCT	Vector of structural characteristics including FSI and FSI²
LOC	Vector of locatioal characteristics including Dist_Cent, Dist_Metro, Dist_Suburban, Dist_Water, Dist_Schools, Dist_Play, Dist_Rail
NEIGH	Vector of neighbourhood characteristics including Pop_Share_Sub6, Pop_Share_6_15, Pop_Share_15_18, Pop_Share_18_27, Pop_Share_65plus, Pop_Density, Share_Foreigners, Share_Male

Variable	Description (Continued)
	In Differences-in-Differences Estimates
Pre	Dummy variable; 1 for observation period before completion of Velodrom and Max-Schmeling-Arena (years 1992-2000)
Post	Dummy variable; 1 for observation period after completion of Velodrom and Max-Schmeling-Arena (years 2000-2005)
Velo	Dummy variable; 1 for blocks lying within a 1000 meter distance ring surrounding Velodrom
MS	Dummy variable; 1 for blocks lying within a 1000 meter distance ring surrounding Max-Schmeling Arena
Velo2000	Dummy variable; 1 for blocks lying within a 2000 meter distance ring surrounding Velodrom
MS2000	Dummy variable; 1 for blocks lying within a 2000 meter distance ring surrounding Max-Schmeling Arena

Table 2 – Baseline Empirical Results of Hedonic Analysis

	(1) Land Value (Log)	(2) Land Value (Log)	(3) Land Value (Log)
Intercept	1.419380*** (0.067685)	1.409932*** (0.069337)	4.770188*** (0.013161)
Business	-0.476554*** (0.178338)	-0.555828*** (0.206850)	0.049848 (0.226227)
Industry	-0.201496*** (0.052465)	-0.659793*** (0.184922)	-0.483550*** (0.072417)
West	0.677466*** (0.038296)	0.678161*** (0.041387)	2.105208*** (0.032986)
FSI	0.241159*** (0.016054)	0.250090*** (0.015889)	0.702962*** (0.014560)
FSI^2	-0.025354*** (0.005085)	-0.030463*** (0.004964)	-0.056465*** (0.005059)
Dist_Cent	-0.00000438*** (0.000000587)	-0.00000444*** (0.000000599)	-0.0000179*** (0.00000084)
Dist_Metro	-0.00000211*** (0.000000625)	-0.000018*** (0.000000659)	-0.00000865*** (0.00000118)
Dist_Suburban	-0.0000113*** (0.00000341)	-0.0000104*** (0.00000362)	-0.0000485*** (0.00000392)
Dist_Water	-0.0000118*** (0.00000201)	-0.0000113*** (0.000002)	-0.0000415*** (0.00000253)
Dist_Schools		0.000000299 (0.0000041)	
Dist_Play		-0.0000019 (0.00000302)	
Dist_Rail	0.0000122*** (0.00000327)	0.0000117*** (0.0000034)	0.0000468*** (0.0000042)
Pop_Share_Sub6	0.062190** (0.025417)	0.054859** (0.025282)	0.103997** (0.051869)
Pop_Share_6_15		0.006943 (0.019842)	
Pop_Share_15_18		-0.006325 (0.024015)	
Pop_Share_18_27	-0.046841*** (0.0057)	-0.040212** (0.019973)	-0.235991*** (0.034376)
Pop_Share_65plus		-0.026906** (0.013406)	
Pop_Density	-0.737185*** (0.0012)	-0.705164*** (0.225787)	-0.846712*** (0.253823)
Share_Foreigners	-0.085958*** (0.018556)	-0.059999* (0.035007)	-0.096806*** (0.030934)
Share_Male		0.006376 (0.017495)	
Business x FSI	0.355788*** (0.104214)	0.371846*** (0.110039)	0.138966 (0.129089)
Business x FSI^2	-0.030011* (0.015922)	-0.027947* (0.016820)	0.024650 (0.019060)
Business x Dist_Cent	0.0000499*** (0.00000637)	0.0000534*** (0.00000699)	0.0000783*** (0.0000114)
Business x Dist_Metro	-0.0000304* (0.0000161)	-0.0000435** (0.0000167)	-0.000119*** (0.0000187)

Baseline Empirical Results of Hedonic Analysis (Continued)

Business x Dist_Suburban	-0.000064* (0.0000347)	-0.0000927* (0.0000532)	-0.000188*** (0.0000442)
Business x Dist_Water	0.0000402*** (0.0000127)	0.0000430*** (0.0000129)	0.0000240 (0.0000153)
Business x Dist_Schools		-0.00000580 (0.0000806)	
Business x Dist_Play		-0.0000188 (0.0000885)	
Business x Dist_Rail		0.0000512 (0.0000498)	
Business x Pop_Share_Sub6		-0.235726 (0.202178)	
Business x Pop_Share_6_15	-0.577296** (0.273710)	-0.476419 (0.315174)	-0.864808*** (0.256952)
Business x Pop_Share_15_18		-0.105855 (0.353263)	
Business x Pop_Share_18_27	-0.288284*** (0.102699)	-0.228749** (0.100348)	-0.421970* (0.244511)
Business x Pop_Share_65plus		0.178150 (0.139387)	
Business x Pop_Density	-2.547692*** (0.907527)	-2.555855*** (0.882346)	-2.082144* (1.211372)
Business x Share_Foreigners	0.188215*** (0.058839)	0.182792*** (0.068185)	0.360568*** (0.107345)
Business x Share_Male		-0.014353 (0.089939)	
Industry x FSI		0.103909 (0.137109)	
Industry x FSI^2		0.018786 (0.031367)	
Industry x Dist_Cent		0.0000161** (0.00000693)	
Industry x Dist_Metro		0.0000401 (0.0000285)	
Industry x Dist_Suburban	-0.0000862** (0.0000339)	-0.0000768* (0.0000456)	-0.0000303 (0.0000407)
Industry x Dist_Water		-0.00000984 (0.0000211)	
Industry x Dist_Schools	-0.000180* (0.000105)	-0.000111 (0.000107)	0.0000422 (0.000150)
Industry x Dist_Play	0.000354*** (0.000117)	0.000240* (0.000126)	0.000281* (0.000167)
Industry x Dist_Rail		0.0000387 (0.0000645)	
Industry x Pop_Share_Sub6	0.780610** (0.352927)	0.530378 (0.361221)	0.204225 (0.408747)
Industry x Pop_Share_6_15		0.050427 (0.390445)	
Industry x Pop_Share_15_18		0.018953 (0.200147)	
Industry x Pop_Share_18_27	0.344214** (0.352927)	0.312817** (0.129166)	0.469512*** (0.160178)
Industry x Pop_Share_65plus		-0.098714 (0.126594)	

Baseline Empirical Results of Hedonic Analysis (Continued)

Industry x Pop_Density		2.107667 (2.572701)	
Industry x Share_Foreigners		-0.077971 (0.078824)	
Industry x Share_Male		0.140772 (0.089877)	
West x FSI	-0.268710*** (0.020125)	-0.263000*** (0.020561)	-0.851855*** (0.023213)
West x FSI²	0.039513*** (0.004624)	0.038739*** (0.004887)	0.121320*** (0.006546)
West x Dist_Cent	-0.0000317*** (-0.00000194)	-0.0000319*** (0.00000196)	-0.000103*** (0.00000193)
West x Dist_Metro	0.0000236*** (0.00000186)	0.0000236*** (0.00000198)	0.0000727*** (0.00000309)
West x Dist_Suburban	-0.00000769* (0.00000398)	-0.00000815* (0.00000421)	-0.0000322*** (0.00000556)
West x Dist_Water	0.00000979*** (0.00000236)	0.00000963*** (0.00000234)	0.000038*** (0.00000359)
West x Dist_Schools		0.00000277 (0.00000764)	
West x Dist_Play		0.0000497*** (0.00000863)	
West x Dist_Rail	-0.0000302*** (0.00000430)	-0.0000307*** (0.00000445)	-0.0000842*** (0.00000682)
West x Pop_Share_Sub6		0.032696 (0.052924)	
West x Pop_Share_6_15		-0.028291 (0.034885)	
West x Pop_Share_15_18	-0.156947*** (0.040899)	-0.145205*** (0.048004)	-0.432046*** (0.093982)
West x Pop_Share_18_27		-0.035878 (0.041474)	
West x Pop_Share_65plus		0.020985 (0.024180)	
West x Pop_Density	-0.595791*** (0.297937)	-0.549493* (0.302441)	-3.295263*** (0.404408)
West x Share_Foreigners		-0.032307 (0.041970)	
West x Share_Male	-0.134591*** (0.025066)	-0.141145*** (0.032014)	-0.311987*** (0.047581)
Spatial_Lag	Yes	Yes	
Block Sample	Berlin	Berlin	Berlin
Observations	11184	11184	11184
R^2	0.966127	0.966472	0.893846
Adjusted R^2	0.966002	0.966255	0.893465

Notes: Model (1) represents our baseline hedonic model, which we obtain after stepwise deletion of statistically insignificant variables of the full model specification (2). In (3) we repeat our baseline regression omitting the spatial lag-variable. The dependent variable is the natural logarithm of standard land values in all models. Independent variables are described in table 1. Standard errors (in parenthesis) are heteroscedasticity robust. * denotes significance at the 10% level; ** denotes significance at the 5% level; *** denotes significance at the 1% level.

Table 3 – Empirical Results of Baseline Impact-Models

	(1) Land Value (Log)		(2) Land Value (Log)	(3) Land Value (Log)
Impact Area	Velodrom	Max-Schmeling	Velodrom	Max-Schmeling
0-1000m	0.076287***	-0.014916	0.047019***	-0.025293
	(0.018011)	(0.019143)	(0.002779)	(0.018605)
1000-2000m	0.037178***	0.035705***	0.020877***	0.025153***
	(0.012739)	(0.012628)	(0.011617)	(0.011895)
2000-3000m	0.002686	-0.005757	0.013639*	-0.004855
	(0.013498)	(0.013051)	(0.212798)	(0.013132)
3000-4000m	0.009350	-0.018397	0.007239	-0.014858
	(0.010437)	(0.012352)	(0.010420)	(0.012130)
Neighbourhood	-0.013436*	-0.033593***	-0.017581**	-0.030855***
	(0.007272)	(0.007023)	(0.007344)	(0.006849)
Spatial Lag	Yes		Yes	Yes
Block Sample	Berlin		Berlin	Berlin
Observations	11184		11184	11184
R-squared	0.966402		0.966168	0.966329

Notes: The basic model is the same as in (1) of table 2. To reduce table-size we only display variables indicating impact of either Velodrom or Max-Schmeling-Arena. Log of standard land values is the endogenous variable in models (1) – (3). 0-1000m, 1000-2000m, 2000-3000m, 3000-4000m are dummy variables taking the value of 1 for blocks lying within corresponding one kilometre distance rings surrounding the respective arena, and 0 otherwise. Neighbourhood is defined in the similar way capturing general neighbourhood-effects within a 0-5000 meters distance ring. In (1) impact variables for both arenas entered the model simultaneously while in (2) and (3) impact of each arena is estimated individually. Standard errors (in parenthesis) are heteroscedasticity robust. * denotes significance at the 10% level; ** denotes significance at the 5% level; *** denotes significance at the 1% level.

Table 4a – Empirical Results of Alternative Models for Velodrom

	(1) Land Value (Log)	(2) Land Value (Log)	(3) Land Value (Log)
Impact Area	Velodrom	Velodrom	Velodrom
0-1000m	0.073995*** (0.019412)		
1000-2000m	0.034716** (0.012383)		
0-3000m	-0.001965 (0.012383)	0.075524*** (0.021105)	0.121969*** (0.036593)
0-3000m x Distance		-0.0000289*** (0.00000934)	-0.0000893** (0.0000422)
0-3000m x Distance²			0.0000000165 (0.0000000112)
Spatial Lag	Yes	Yes	Yes
Neighbourhood-Effects	Yes	Yes	Yes
Block Sample	Berlin	Berlin	Berlin
Observations	11184	11184	11184
R^2	0.966398	0.966377	0.966384

Notes: The basic model is the same as in (1) of table 1. We capture effects of Max-Schmeling-Arena by introducing the full set of dummy-variables represented in column (3) of table 3. To reduce table-size we only display variables indicating impact of Velodrom. Log of standard land values is the endogenous variable as in the tables above. 0-1000m, 1000-2000m, and 0-3000 m are dummy-variables representing multiple distance rings as defined as in table 3. Distance is defined as the distance from each blocks centroid to the corresponding arena, in meters. Neighbourhood-effects are defined as in table 3. Standard errors (in parenthesis) are heteroscedasticity robust. * denotes significance at the 10% level; ** denotes significance at the 5% level; *** denotes significance at the 1% level.

Table 4b – Empirical Results of Alternative Models for Max-Schmeling-Arena

	(1) Land Value (Log)	(2) Land Value (Log)	(3) Land Value (Log)
Impact Area	Max-Schmeling	Max-Schmeling	Max-Schmeling
0-1000m	-0.009482 (0.021002)		
1000-2000m	0.041065*** (0.015273)		
0-3000m	0.003211 (0.013001)	0.030773 (0.023960)	-0.049672 0.041028
0-3000m x Distance		-0.00000718 (0.0000111)	0.000100** (0.0000505)
0-3000m x Distance²			-0.0000000301** (0.0000000147)
Spatial Lag	Yes	Yes	Yes
Neighbourhood-Effects	Yes	Yes	Yes
Block Sample	Berlin	Berlin	Berlin
Observations	11184	11184	11184
R^2	0.966390	0.966342	0.966365

Notes: The basic model is the same as in (1) of table 2. We capture effects of Velodrom by introducing the full set of dummy-variables represented in column (2) of table 3. To reduce table-size we only display variables indicating impact of Max-Schmeling-Arena. All variables are the same as in table 4a. Standard errors (in parenthesis) are heteroscedasticity robust. * denotes significance at the 10% level; ** denotes significance at the 5% level; *** denotes significance at the 1% level.

Table 5 – Empirical Results of Final Hedonic Specification

	(1) Land Value (Log)	
Impact Area	Velodrom	Max-Schmeling
0-3000m	0.073160*** (0.021013)	
0-3000m x Distance	-0.0000276*** (0.00000953)	0.0000459** (0.0000206)
0-3000m x Distance²		-0.0000000164** (0.00000000826)
Spatial Lag	Yes	
Neighbourhood-Effects	Yes	
Block Sample	Berlin	
Observations	11184	
R^2	0.966337	

Notes: The basic model is the same as in model (1) of table 2. To reduce table-size we only display variables indicating impact of Velodrom and Max-Schmeling-Arena. All variables are the same as in tables 4a and 4b. Standard errors (in parenthesis) are heteroscedasticity robust. * denotes significance at the 10% level; ** denotes significance at the 5% level; *** denotes significance at the 1% level.

Table 6a – Baseline Empirical Results of Differences-in-Differences Estimations

	(1) Land Value Growth (normalized)	(2) Land Value Growth (normalized)	(3) Land Value Growth (normalized)
Pre	-0.015986*** (0.001629)	-0.024398*** (0.002594)	-0.019716*** (0.002134)
Velo	-0.013058*** (0.004531)	-0.007790* (0.004526)	
MS	0.001106 (0.003254)		-0.004917 (0.003810)
Post	-0.091492*** (0.000503)	-0.091875*** (0.000687)	-0.089706*** (0.000989)
Post x Velo	0.014007*** (0.005149)	0.012233** (0.005223)	
Post x MS	0.001254 (0.003510)		0.006035 (0.004020)
Block Sample	Prenzlauer Berg	Velo2000	MS2000
Observations	681	552	617
R-squared	0.783802	0.585762	0.674038

Notes: Until 2001, Berlin was legally subdivided into 23 boroughs, one of which was Prenzlauer Berg. Prenzlauer Berg consists of 394 statistical blocks forming the basis of our panel. Endogenous variables are growth rates in normalized land values for 1992-2000 and 2000-2006. Land values had been normalized to account for varying legal building densities. The procedure of normalization is documented in the technical appendix. Velo and MS are dummies which take the value of 1 if a block lies within a 1000 meter distance ring surrounding the corresponding arena and 0 otherwise. In columns (2) and (3) we restrict our sample to blocks lying either within a 2000 meter distance ring surrounding Velodrom (Velo2000) or Max-Schmeling-Arena (MS2000). Areas corresponding to reduced samples and impact areas are graphically illustrated in figure 8. Pre is a dummy variable denoting the period of 1992-2000 while Post stands for the period of 2000-2005. Standard errors (in parenthesis) are heteroscedasticity robust. * denotes significance at the 10% level; ** denotes significance at the 5% level; *** denotes ignifycance at the 1% level.

Table 6b – Baseline Empirical Results of Differences-in-Differences Estimations

	(1) Population Growth	(2) Population Growth	(3) Population Growth
Pre	-0.007937*** (0.002737)	-0.009671*** (0.002466)	-0.007975** (0.003122)
Velo	0.029556** (0.013552)	0.024902** (0.009937)	
MS	-0.012601*** (0.004551)		-0.012564*** (0.004793)
Post	0.012211*** (0.002966)	0.011167*** (0.002021)	0.013981*** (0.004364)
Post x Velo	-0.037704** (0.014752)	-0.028526*** (0.010827)	
Post x MS	0.018675*** (0.006356)		0.016867** (0.007274)
Block Sample	Prenzlauer Berg	Velo2000	MS2000
Observations	500	335	319
R-squared	0.101701	0.087257	0.128767

Notes: Variables and samples are the same as in table 6b with the exception of the endogenous variable which is growth in population. Standard errors (in parenthesis) are heteroscedasticity robust. * denotes significance at the 10% level; ** denotes significance at the 5% level; *** denotes ignifycance at the 1% level.

Table 7 – Relative Growth Trends after Completion

	(1) Land Value Growth (normalized)	(2) Land Value Growth (normalized)
Post	-0.091492***	-0.089706***
	(0.000503)	(0.000989)
Post x Velo	0.000949	
	(0.002444)	
Post x MS	0.002360*	0.001117
	(0.001316)	(0.001284)
Block Sample	Prenzlauer Berg	MS2000
Observations	681	617
R-squared	0.783802	0.674038

Notes: Model (1) and (2) alters from (1) respectively (3) of table 6a just by interacting area impact dummies with the Pre (completion) dummy. Since these model specifications necessarily produce the same results for the pre-completion period as in table 7 we only display coefficient estimates for the post-completion period. Standard errors (in parenthesis) are heteroscedasticity robust. * denotes significance at the 10% level; ** denotes significance at the 5% level; *** denotes significance at the 1% level.

Table 8: Socioeconomic Impacts

	(1) Automobile Registrations per capita	(2) Share of Population Age Group 27-45	(3) Share of Foreign Population
Announcement		0.288035***	0.042793***
		(0.009105)	(0.010194)
Velo		-0.075549***	-0.005447
		(0.018075)	(0.024566)
MS		0.044898***	-0.013562
		(0.010369)	(0.010448)
Completion	0.302456***	0.413837***	0.100654***
	(0.014210)	(0.010916)	(0.012542)
Completion x Velo	0.483191	-0.062643**	0.021553
	(0.451340)	(0.026661)	(0.026661)
Completion x MS	-0.013570	0.016764	0.011156
	(0.029717)	(0.018604)	(0.017233)
Post-Completion	0.376395***	0.429537***	0.114324***
	(0.061908)	(0.011368)	(0.008864)
Post-Completion x Velo	0.633512	-0.047593*	-0.009512
	(0.684611)	(0.027120)	(0.040447)
Post-Completion x MS	-0.120498*	0.070722***	0.029747**
	(0.065474)	(0.016974)	(0.014736)
Block Sample	Prenzlauer Berg	Prenzlauer Berg	Prenzlauer Berg
Observations	517	751	751
R-squared	0.020987	0.322404	0.060846

Notes: Prenzlauer Berg, Veloand MS are defined as in table 6a. Announcement is a dummy which takes the value of 1 in year 1992, the year when winner of architectural competition where chosen, and 0 otherwise. Completion and Post-Completion similarly denote years 2000 and 2005. Standard errors (in parenthesis) are heteroscedasticity robust. * denotes significance at the 10% level; ** denotes significance at the 5% level; *** denotes significance at the 1% level.

Table 9 – Empirical Results for Alternative Approaches

	(1) Land Value Growth (not normalized)	(2) Land Value Growth (normalized)	(3) Population Growth Age Group: 27-45
Pre	-0.014142***	-0.024913***	0.033584***
	(0.001649)	(0.001684)	(0.002921)
Velo	-0.013736***	-0.007275*	0.011844
	(0.004253)	(0.004070)	(0.012342)
MS	-0.000738	0.000279	-0.010206
	(0.003263)	(0.003575)	(0.007075)
Post	-0.091577***	-0.090678***	0.032093***
	(0.000732)	(0.000671)	(0.003792)
Post x Velo	0.015102***	0.010520**	-0.029629*
	(0.005018)	(0.004829)	(0.016676)
Post x MS	0.004709	0.001809	0.040916***
	(0.003710)	(0.003728)	(0.015021)
Block Sample	Prenzlauer Berg	Prenzlauer Berg and adjoining areas	Prenzlauer Berg
Observations	644	1201	491
R-squared	0.762233	0.602338	0.044299

Notes: Sample Prenzlauer Berg is the same as in Table 6a. Prenzlauer Berg is one of 23 boroughs into which Berlin had been subdivided until 2000. At the next stage of disaggregation Berlin, since reunification, consists of 195 statistical areas, which sum up to boroughs. In column (2) we use an enlarged block sample including all statistical areas that immediately adjoin Prenzlauer Berg. It includes areas of following boroughs: Wedding, Friedrichshain, Mitte and Lichtenber. Variables are defined as in table 6a. Column (1) represents estimation results for unmodified standard land values as officially reported by the Gutachterausschuss. Standard errors (in parenthesis) are heteroscedasticity robust. * denotes significance at the 10% level; ** denotes significance at the 5% level; *** denotes significance at the 1% level.

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