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The Train has Left the Station: Real Estate Price Effects of Mainline Realignment in Berlin*

Abstract: While there is an increasing body of literature testing for a correlation between access to regional markets and economic activity, little evidence is available for market access being of causal importance for economic development. This paper investigates the impact of exogenous variation in access to cities and regions on an urban scale. We study the case of Berlin where the western central business district unexpectedly became disconnected from long-distance railway connections. A combined hedonic and difference-in-difference approach is employed to show that property transaction prices within areas identified to experience a particularly strong decline in accessibility are reduced by approximately 22% after announcement of a new transport plan. We show that this treatment effect is not attributable to effects other than variation of access to cities and regions.

Keywords: Market access variation, hedonic model, difference-in-difference, railway system, Berlin
JEL classification: R11, R12, R21, R40, R53, R58

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1 Introduction

Persistent divergence in regional economic activity and income is an obvious reality though it contradicts the implications of neoclassical growth theories that predict convergence. Common explanations refer to differences in natural endowment or the quality of institutions while the new economic geography literature emphasizes the role of market access in shaping patterns of economic activity. Accordingly, regions may benefit from good access to other regions' markets due to reduced cost for firms supplying customers and raised availability of goods for consumers (CRAFTS, 2005). Theory has shown that processes of cumulative

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causation may lead to a stable equilibrium where income and economic activity are concentrated in regional agglomerations (FUJITA, KRUGMAN, & VENABLES, 1999; HELPMAN, 1997; KRUGMAN, 1991). Empirical tests for a spatial wage structure have recently confirmed these implications on a regional scale for the U.S. (HANSON, 2005), Europe (NIEBUHR, 2006), Germany (BRAKMAN, GARRETSEN, & SCHRAMM, 2004) and Italy (MION, 2004). In a cross-country analysis, REDDING & VENABLES (2004) provide evidence for the geography of market access being a significant determinant for worlds' income differentials. However, the common weakness of these studies is that they cannot ultimately reject that the prosperity of some regions may be attributable to factors other than good access to markets, such as common good institutions or natural endowments.

REDDING & STURM (2006) exploit Germany's division after World War II and its unification in 1990 as a natural experiment to provide evidence for the causal importance of market access for economic development. Following separation, West German cities close to the borders became isolated from large parts of their formerly well-integrated hinterlands and suffered from a disproportional loss of market access compared to those cities farther from the border. REDDING & STURM apply a difference-in-difference approach to show that the adverse economic performance of border-cities is completely attributable to the loss of market integration. Since West Germany can be considered to have been an institutionally homogenous region and cities are not likely to have experienced major changes in natural endowment during the period of observation, the standard alternative explanations for uneven distribution of economic activity can be rejected.

Natural experiments involving exogenous variation in regional market access of similar strength to Germany's division are fairly rare and, in the few cases that may exist, availability of appropriate data at sufficiently disaggregated level over a sufficiently long period may seriously constrain research. However, if accessibility to other regions' markets significantly impacts on economic performance of regions and cities then, within cities, areas close to transportation links like highways and mainline train stations should benefit particularly from regional integration. This paper aims at investigating the impact of an exogenous variation in access to regions on an urban scale by exploiting the major mainline railway network restructuring in Berlin, Germany, following the city's unification. It brings together two strands of research which focus either on regional market integration as described above or on the role of metropolitan accessibility for the attractiveness of urban location (AHLFELDT, 2007a, 2007b; BOWES & IHLANFELDT, 2001; DAMM, LERNER-LAM, & YOUNG, 1980; DEBREZION, PELS, & RIETVELD, 2006; GATZLAFF & SMITH, 1993; VESSALI, 1996). With firms and residents bidding out each other for attractive urban locations (ALONSO, 1964), real estate prices prove to be a feasible indicator for identifying attractive areas characterized by high economic activity. The major advantage of analyzing the impact of access to regional markets on an urban scale is that any impact on patterns of economic activity is expected to be observable much earlier than it would be on the aggregated level of cities or regions, due to rapid adjustment of unregulated real estate markets. Since real estate markets have proven to react in anticipation of amenity effects (DEHRING, DEPKEN, & WARD, 2007), impact may even be detectable right after announcement, which further reduces the length of the study period potentially required to assess significant effects.

Thus, if we observe areas experiencing a strong decline (increase) in access to mainline connections, we would also expect an amenity effect to capitalize on property prices. In the case of Berlin, areas in proximity to mainline stations along the newly developed north-south track are expected to benefit at the expense of areas surrounding the mainline stations along the old east-west track which should experience a strong decline in significance. “Bahnhof Zoo”, which lies in the middle of the urban core and the center of economic activity of the western part of the city, was Berlin's most important mainline station until the inauguration of the newly developed central station left it completely disconnected from mainlines. The intensity of realignment exceeded the original plans and could, therefore, hardly be anticipated by real estate markets before the ultimate announcement. Hence, for these areas, we expect a significant impact on real estate prices particularly driven by a loss of location desirability due to decreasing regional integration.

In the next sections we present the major restructuring of Berlin's mainline railway network in more detail and introduce into our data. In section 4 we develop our empirical strategy that tests for a change in price differentials between potentially positively and negatively affected areas following the announcement and effective implementation of the new railway concept. Sections 5 and 6 present our empirical results and conclusions.

2 The New Transport Plan for Unified Berlin

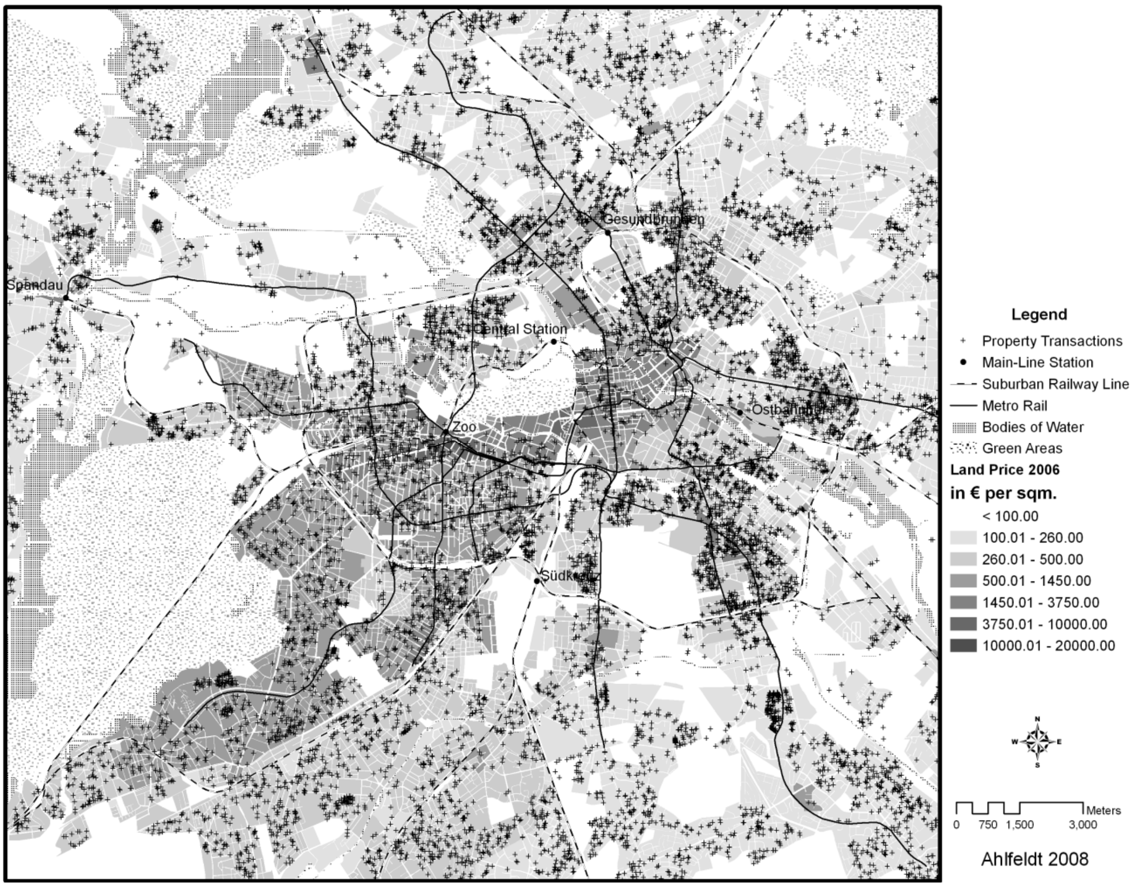
Due to the adverse economic performance within the Soviet zone of occupation and the remote isolated location of West Berlin during the period of division, Berlin's rail infrastructure was found to be in need of modernisation after Germany's unification. Services had been carried out to relatively small stations within both parts of the city. At the beginning of the 1990s, it was decided to implement a completely new concept for connecting Berlin to Germany's rail network. The key element of this concept was the development of a new north-south railway track, including a tunnel for the downtown section. The intersection of the new north-south with the old east-west track was chosen to be the location of Berlin's new central station which was timely inaugurated for the football world championship in 2006. The station was designed by the prominent architecture firm GMP and involved investments that amounted to approximately €1 billion for facilities and feeder lines. In total, the modernisation of Berlin's railway tracks cost over €4 billion (HOPS & KURPJUWEIT, 2007). The new central station, representing one of Europe's largest and most modern interchange stations, and the huge investment amounts stand exemplarily for the post-unification euphoria at the beginning of the 1990s' when Berlin's economic perspectives were still regarded very positively. Two more mainline stations were developed along the new railway track at the intersections with the inner ring line: "Gesundbrunnen" in the north and "Südkreuz" in the south. Moreover, at the western periphery of Berlin, "Bahnhof Berlin-Spandau" was considerably extended and modernized.

Originally, the main purpose of the development of new stations along the north-south track was to provide additional transport capacities in order to disburden the existing mainline stations “Bahnhof Zoo” and “Ostbahnhof” which had served as central stations within the formerly separated parts of the city. In particularly “Bahnhof Zoo”, which after unification became Berlin’s most frequented station due to its centrality and good connections to the urban railway network, was considered to be undersized in light of only three platforms and a total of 150,000 passengers served per day. Although the original idea was to allocate transport capacities more or less equally among the two mainlines, the Deutsche Bahn AG at the beginning of July 2005 announced that with implementation of the new transport plan on March 28, 2006, the vast majority of long distance trains would cross Berlin on the newly developed north-south line (HASSELMANN, 2005). Against the opposition of various business and passenger lobbies it was decided that the remaining trains approaching and leaving the new Central Station via the east-west track would no longer stop at “Bahnhof Zoo” thereby reducing its significance to a regional dimension. The decline in significance of “Bahnhof Zoo” and “Ostbahnhof” was not only accompanied by a corresponding increase for stations “Gesundbrunnen” and “Südkreuz” along the northern and southern lines, but also for “Bahnhof Berlin-Spandau” where the frequency of train stops was increased to compensate the western parts of Berlin for the ‘closure’ of “Bahnhof Zoo”. Figures 1 and 2 show the exact locations of all mainline stations considered in this paper.

3 Data

This study considers property transactions which occurred between January 1, 2003, and December 31, 2007. Since the definitive mainline concept was announced at the beginning of July 2005, we have obtained a symmetric sample with equally long pre- and post-announcement periods. Our record of property transactions within the study period includes 23,188 transactions of which 6,167 lie within the areas which are identified to be potentially affected by changes in mainline accessibility in section 4. Transaction data provided by the COMMITTEE OF VALUATION EXPERTS IN BERLIN (2007) includes the usual parameters such as age, floor space, plot area and storeys as well as information on land use, condition, plot shape, building type, location characteristics and contract details including information on buyer, seller, type of agreement and tax privileges among other things. Figure 1 shows the distribution of property transactions which occurred within our study period for the relevant map excerpt. Figure 1 also illustrates the average cost of land represented by standard land values for 2006 assessed by the Committee of Valuation Experts in Berlin (SENATSVERWALTUNG FÜR STADTENTWICKLUNG BERLIN, 2006a).

Fig. 1 Land Valuation and Distribution of Property Transactions



Notes: Map created on the basis of the Urban Environmental Information System.

Source: COMMITTEE OF VALUATION EXPERTS IN BERLIN (2007), SENATSVERWALTUNG FÜR STADTENTWICKLUNG BERLIN (2006b).

Transactions are geo-referenced by application of GIS tools and analyzed within the framework of 15,937 official statistical blocks, the highest level of disaggregation for which data is available at the statistical office. The statistical blocks have a median surface area of less than 20,000m^2, approximately the size of a typical inner-city block of houses. The mean population of the 12,314 populated blocks at the end of 2006 was 271 (median 135). Referring to the framework of statistical blocks we obtain data on population, and suburban and metro railway stations and network from the Senate Department which we merge with a detailed electronic map of Berlin's 557,500 buildings within a GIS environment. We rely on daily mainline train stops which are provided by the DB STATION & SERVICE AG (2008) for all mainline stations before and after realignment to assess the relative importance of stations within the network.

4 Empirical Strategy

Our empirical strategy basically consists of three steps. First, we spatially aggregate the share of daily mainline connections per station and the areas it has access to, according to the old and the new transport concept, to obtain an accessibility indicator. On the basis of the change in accessibility we identify the areas and numbers of residents that are potentially affected strongly (weakly) in a positive or negative way. In the second step, we test for changes in price differentials between identified areas employing a combined hedonic and difference-in-difference approach. In the last step, we check whether any observed treatment effect may be explained by the change in accessibility or if other factors are likely to account for changes in location desirability. Our specification ignores the effects of improved accessibility to other regions at the city level due to an increased number of long-distance connections. Instead it isolates the intra-urban impact on relative accessibility in order to assess whether potentially benefiting areas experience an increase in attractiveness relative to those areas affected by a decline in accessibility.

4.1 Mainline Accessibility Indicator

Some features have to be addressed in order to determine urban areas that are potentially affected by the implementation of the new transport plan. In total, six mainline stations are considered that are either approached by long-distance trains according the new, the old or both transport plans. These stations are of very distinct importance and are affected to a different degree by the restructuring. Moreover, special care has to be taken when assessing the areas that are potentially served by these stations. A standard approach relying on straight-line or road distance measures would implicitly assume that residents either walk to mainline stations or make use of individual transport. However, Berlin is obviously too large to allow a large share of residents to walk to the relevant mainline station and we have reasonably to assume that the vast majority will either make use of individual transport for the whole journey to another city or use public transport to get to their station of arrival or departure. These particularities are addressed by developing an accessibility indicator that takes into account the relative importance of stations within the network and the access residents have to these stations through the combined suburban and metro railway network.[1] Residents are strictly assumed to walk to the nearest suburban or metro rail station and to then choose the shortest way through the combined urban railway network. Stated briefly, our accessibility indicator spatially aggregates the relative importance of mainline stations from residents' perspective.

Relative importance of mainline stations is determined on the basis of daily mainline connections. Each station receives an importance weight according to its share of total connections. Table 1 shows daily mainline connections and the corresponding importance weights before and after realignment.

Tab. 1 Daily Long-Distance Connections

Station	Connections (old)	Connections (new)	Importance Weight (old)	Importance Weight (new)
Central Station	0	174	0	100
Gesundbrunnen	0	40	0	23
Ostbahnhof	164	90	100	52
Spandau	66	111	36	64
Südkreuz	0	82	0	47
Zoo	164	0	100	0

Source: DB STATION & SERVICE AG (2008)

[1] The combined Berlin metro and suburban railway network consists of 275 stations and has a length of 475km. Yearly passenger numbers add to approximately 790 million (2006). [URL: www.oepnv-berlin.de (07/01/11)]

The importance weight (IW) of 100, given for Berlin's central station, implies that a resident has access to all long-distance trains stopping in Berlin once they have entered the facilities. Of course, outside the station's facilities there is need to account for transport costs for travelling to a mainline station and the fact that residents choose between mainline stations that offer distinct connections. Thus we need an indicator that considers both proximity to stations and the hierarchy of stations within the network. In the economic geography literature there is a long tradition which dates back to HARRIS (1954) in representing access to markets by distance weighted sum of population. For instance, let P_i be region's *i* population, then

$$PP_i = \sum_j P_j \exp\left(-a\, d_{ij}\right) \quad (1)$$

is region's *i* population potentiality (PP_i), where P_j is the population of region *j*, *a* is a distance decay factor implicitly determining transport costs and d_{ij} is the distance between regions *i* and *j*. AHLFELDT (2007a) develops an approach allowing for spatial aggregation on the basis of public transportation networks which we modify to spatially aggregate importance weights displayed in Table 1.

First, a mainline accessibility indicator is calculated for all urban railway stations. Importance weights are spatially aggregated analogically to equation 1.

$$MAS_{nt} = \sum_m IW_{mt} \exp\left(-a\, d_{mn}\right) \quad (2)$$

where MAS_{nt} is the mainline accessibility indicator for urban railway station *n* in period *t*, IW_{mt} is the importance weight of mainline station *m* in period *t*, *t* denotes the periods before and after restructuring and d_{mn} is the shortest network distance between urban railway station *n* and mainline station *m*. Residents are assumed to walk to the nearest urban railway station, thus MAS_{nt} is discounted on the basis of straight-line distance to reflect corresponding transport costs.

$$MA_{it} = \sum \quad IW_{mt} \exp(-a\, d_{mn}))\exp\left(-b\, d_{in}\right) \quad (3)$$

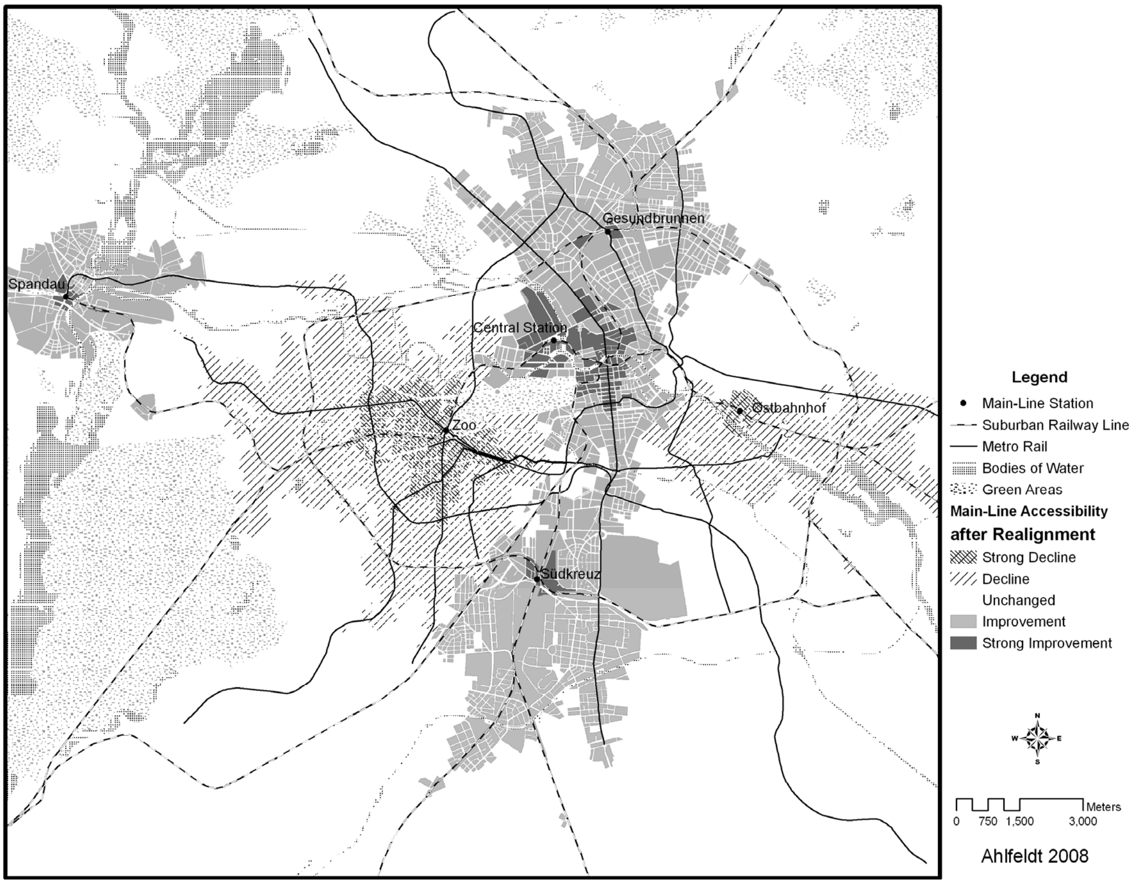
where MA_{it} is mainline accessibility for statistical block *i* in period *t*, *b* is a distance decay parameter and d_{in} is the straight-line distance between the urban railway station *n* and block's *i* geographic centroid. Since transport costs associated with walking may reasonably be assumed to be higher compared to those a resident is confronted with once he enters the train due to much lower velocity, *b* has to take a larger value than *a* to allow for a stronger spatial discount. Parameters *a* and *b* are assumed to take the values of 0.5 and 2 corresponding to transport costs associated with train rides and walking as defined in the literature (AHLFELDT, 2007a). Since all mainline stations also serve as stations within the urban railway network, areas adjoining a mainline station automatically receive the respective importance weight discounted on the basis of transport cost defined for walking speed.

Change in mainline accessibility (MA_{id}) is represented by the difference between MA_{it} values before (MA_{ipre}) and after (MA_{ipost}) restructuring railway realignment.

$$MA_{id} = MA_{ipost} - MA_{ipre} \quad (4)$$

Figure 2 shows areas that are potentially positively and negatively affected by the new transport plan. We distinguish between areas that are strongly and weakly affected. Areas with MA_d values larger (smaller) than 15 (-15) are considered to be strongly affected in a positive (negative) way while areas with values between -1.5 and 1.5 are not considered to experience a considerable impact.

Fig. 2 Changes in Mainline Accessibility Following Realignment



Notes: Map created on the basis of the Urban Environmental Information System.
Source: SENATSVERWALTUNG FÜR STADTENTWICKLUNG BERLIN (2006b).

The pattern of impact corresponds to intuitive expectations. Areas along the new north-south line experience an increase at the expense of Berlin's western and eastern downtown areas. The neighborhood of "Bahnhof Berlin-Spandau" also potentially benefits from the station's increase in significance. Areas in close proximity to "Bahnhof Zoo" and Central Station are obviously affected to a particularly high degree. The area of strong and weak decline surrounding "Bahnhof Zoo" is notably large, which can be explained by the strength of shock as well as by the station's good integration into the urban transportation network. Relying on highly disaggregated block-level population data, these results can be employed to assess the number of residents affected by the new transport plan.

Tab. 2 Residents Affected by the New Transport Plan

Residents Affected	Strongly	Weakly	In Total
Positively	6,667	467,175	473,842
Negatively	56,479	389,728	446,207
Net Effect	-49,812	77,447	27,635

Source: Authors' own calculations.

Results presented in Table 2 are ambivalent. While in total the net impact on all residents that are potentially affected by the new railway concept is positive, this result is driven by a large number of residents that only weakly benefit from increase in accessibility. When only the residents who experience a strong impact are considered, the balance is fairly negative. Less than 7,000 inhabitants benefit remarkably from the restructuring while almost 50,000 are worse off. This negative net effect can be explained by the facts that the new Central Station neighborhood is still largely undeveloped and that the station has not yet been adequately connected into the urban transport network.

4.2 Empirical Model

We employ a combined hedonic model and difference-in-difference specification similar to DEHRING, DEPKEN & WARD (2007) to test for the amenity effect of having quick access to other cities and regions. Our basic model tests for an increase in price differential between positively and negatively affected areas. Since real estate markets may react in anticipation of changes in attractiveness of location, our test for impact distinguishes between periods before and after announcement as well as after effective implementation.

As we do not track value of houses over time, we need to correct property transactions for housing characteristics. We follow the standard practice adopting a hedonic approach to correct for various housing and transaction characteristics. There is a rich body of literature applying hedonic models in various contexts. Examples of hedonic house pricing models include construction of house indices (CAN & MEGBOLUGBE, 1997; MILLS & SIMENAUER, 1996; MUNNEKE & SLADE, 2001), impact assessment of quality of public services (BOWES & IHLANFELDT, 2001; GATZLAFF & SMITH, 1993), school quality (MITCHELL, 2000), group homes (COLWELL, DEHRING, & LASH, 2000), churches (CAROLL, CLAURETIE, & JENSEN, 1996), aircraft noise (AHLFELDT & MAENNIG, 2007a; NELSON, 2004), impact of stadium construction (AHLFELDT & MAENNIG, 2007b; TU, 2005) and announcement (DEHRING, DEPKEN, & WARD, 2007) or even supportive housing (GALSTER, TATIAN, & PETTIT, 2004) and monument protection (AHLFELDT & MAENNIG, 2008). SIRMANS, MACPHERSON & ZIETZ (2005) provide a review and meta-analysis of recent hedonic pricing studies. Most of available hedonic price studies rely on data on single-family houses, which have the advantage of being fairly homogenous. Since our sample considers property transactions within downtown areas, we include a number of additional features to account for downtown building's heterogeneity additional to standard attributes like plot size, floor area, number of storeys and features like elevator, basement and underground car park. These include building type, root type, condition and location within the block of houses (e.g. frontage or backyard). We also consider whether a property is occupied or free and contract details (information on buyer and seller) that may influence sales price. Moreover, an ample set of dummy variables captures land use, location characteristics and quality. The full list of considered variables can be taken from Table A1.

Besides including information location characteristics and quality provided in the record of property transactions, we control for location by inclusion of a set of location fixed effects. Our empirical model considers 1,548 statistical block fixed effects using a great deal of information. While neighborhood fixed effects allow for mean-shifting, we also allow variance to vary across space by clustering standard errors on statistical blocks, thereby addressing possible problems of spatial autocorrelation (AHLFELDT & MAENNIG, 2008; DEHRING, DEPKEN, & WARD, 2007).

Our baseline empirical model takes the following form:

$$log(P_p) = \alpha + FEATURE_p\, a + \beta_1 ANN_p + \beta_2 IMP_p + \beta_3 POS_p$$

$$+\beta_4 POS_p \times ANN_p + \beta_5 POS_p \times IMP_p + \varepsilon_p \quad (5)$$

$$\text{where } \varepsilon_p = \theta_p + \varphi_p$$

where P_t is sales price of property transaction *p*, $FEATURE_p$ is a vector of housing, contract and location characteristics, POS_p is a dummy taking the value of 1 for transactions occurring within potentially positively affected areas, and ANN_p as well as IMP_p are dummy variables denoting whether a transaction occurred after the announcement or implementation of the new railway concept. Greek and lower case letters represent the set of coefficients to be estimated and ε_p is a composite zero-mean error term allowing for neighborhood fixed effects (θ_p) and a random component (φ_p). All estimations include a daily time trend and monthly dummy variables.

Since we restrict our sample to the areas identified to experience a considerably positive or negative change in accessibility as defined in Figure 2, POS_p accounts for the average price differential between properties selling within areas potentially positively and negatively affected before initial announcement. Consequently, significant estimation coefficients on ANN_p x POS_p or IMP_p x POS_p indicate a change in price differential after announcement or implementation.

In the second step we allow impact to vary across strongly and weakly affected areas. Therefore we introduce dummy variables representing strongly positively ($STPOS_p$) and negatively ($STNEG_p$) affected treatment areas as defined in Figure 2. Also interacting these dummies with time dummies, our extended difference-in-difference specification takes the following form:

$$log(P_p) = \alpha + FEATURE_p\, a + \beta_1 ANN_p + \beta_2 IMP_p + \beta_3 POS_p$$
$$+ \beta_4 POS_p \times ANN_p + \beta_5 POS_p \times IMP_p$$
$$+ \gamma_1 STPOS_p + \gamma_2 STPOS_p \times ANN_p + \gamma_3 STPOS_p \times IMP_p \quad (6)$$
$$+ \delta_1 STNEG_p + \delta_2 STNEG_p \times ANN_p + \delta_3 STNEG_p \times IMP_p + \varepsilon_p$$
$$\text{where } \varepsilon_p = \theta_p + \varphi_p$$

Again, Greek and lower case letters represent the set of coefficients to be estimated and ε_p is a composite zero-mean error term. Coefficients on interactive terms included in this extended specification represent the impact that strongly affected areas experience following announcement and implementation relative only to the surrounding weakly affected areas.

To verify that any treatment effect indicated by significant coefficients on interactive terms is indeed attributable to a change in accessibility, we introduce mainline accessibility as defined in equation (3) into our estimated model. If treatment effects stand in a causal relationship to railway realignment, then significant treatment coefficients should substantially shift towards zero or even be rendered insignificant by inclusion of our accessibility indicator. Otherwise changes in attractiveness of location would more likely be attributable to other factors than altered access to cities and regions.

5 Empirical Results

Full estimates corresponding to baseline specification (5) are presented in Table A1 in the appendix. Most results for hedonic control variables are intuitively plausible and in line with expectation. Prices increase with floor space and plot area while, in contrast to most studies, no significantly negative impact is found for buildings' age. Since dummy variables capturing condition are highly statistically significant and show the expected signs, our results suggest that condition rather than age determines real estate sales prices. All other attributes being equal, properties located on corners realize premiums while those located in backyards sell at discount. Buildings' utilization also proves to be an important price determinant. Business and retail houses realize considerable premiums as do hotels, guesthouses, retirement and care homes. Buildings occupied by research institutes, hospitals or medical centers are particularly expensive due to the need for specific features and equipment. In contrast, buildings with less intense use like parking lots and public administration buildings realize relatively lower prices. Features like an underground car park or an extended flat increase market value while large proportions of secondary structures have price depreciating effects. External characteristics may also significantly impact on sales prices as adverse effects of selected roof types suggest. Considering results on type of buyer and seller, it is remarkable that properties appear to be undervalued when sold and overvalued when bought by housing associations demonstrating their non-profit orientation.

Results for our difference-in-difference estimators are presented in Table 3. Column (1) shows results for our baseline specification corresponding to equation (5). Coefficients on interactive terms are not statistically significant at conventional levels, indicating that neither after announcement nor after implementation is there a systematic change in price differential observable between the larger neighborhoods served by station that ascent or descent in the network hierarchy.

Tab. 3 Empirical Results for Difference-in-Difference Estimates

	(1) log(Price)	(2) Log(Price)	(3) Log(Price)
ANN	0.0858 (0.0542)	0.1229** (0.0564)	0.2005*** (0.0640)
IMP	0.1647*** (0.0514)	0.1738*** (0.0542)	0.1729*** (0.0541)
POS	0.0978 (0.5464)	0.0031 (0.5104)	0.0438*** (0.5317)
POS x ANN	0.0249 (0.0618)	-0.0228 (0.0637)	-0.1705* (0.0886)
POS x IMP	0.0095 (0.0563)	-0.0067 (0.0598)	0.0088 (0.0600)
STPOS		2.1250** (0.9659)	1.8012 (0.9845)
STPOS x ANN		0.2384 (0.2093)	0.0295 (0.2136)
STPOS x IMP		-0.0991 (0.1621)	-0.0914 (0.1690)
STNEG		1.3899*** (0.5416)	1.0335* (0.5697)
STNEG x ANN		-0.2390** (0.1191)	0.0295 (0.2136)
STNEG x IMP		-0.0324 (0.1231)	0.0407 (0.1233)
MA			0.0146** (0.0062)
Observations	6167	6167	6167
R squared	0.9429	0.9432	0.9434

Notes: To save space, only results for diff-in-diff estimators are displayed. Full results are presented in Table A1. Endogenous variable is log of sales prices in all models. Exogenous variables are defined as in equation (5) and (6). All models include a daily time trend, monthly dummy variables and statistical block fixed effects. Standard errors (in parenthesis) are heteroscedasticity robust and clustered on statistical blocks. * denotes significance at the 10% level, ** denotes significance at the 5% level, *** denotes significance at the 1% level.

In column (2), results are presented for our extended difference-in-difference model specification defined in equation (6). While for weakly affected areas there are again no significant effects observable, our extended specification reveals that areas which are identified to experience a strong decline in mainline accessibility are also affected by a significant decline in location desirability capitalizing into transaction prices. Interestingly, this effect occurs after announcement while effective implementation apparently does not lead to an additional impact. The estimated coefficient suggests that respective areas experience an average decline in sales prices of approximately 21.8%.[2] Relying on standard land values per square meter assessed by the Committee of Valuation Experts in Berlin (SENATSVERWALTUNG FÜR STADTENTWICKLUNG BERLIN, 2006a) and the effectively built-up area, this estimate can be used to approximate the aggregated impact on land valuation (*AI*).

$$AI = \sum_{\mathrm{i}} \exp{(\delta_2 - 1)} \times BA_i \times SLV_i \quad (7)$$

where δ_2 is the estimated coefficient on *STNEG x ANN* represented in column (2) of Table 3, BA_i is the total building area within statistical block *i* and SLV_i is the standard land value provided for the respective block.[3] According to our estimates, negative impact on land valuation amounts to approximately €1,300 million. The strength of the effect is comprehensive considering that these areas largely belonging to the central business district (CBD) of Berlin's western part, which is characterized by particularly high land values and is occupied by users who can be assumed to depend particularly strongly on access to cities and regions. In any case, these results highlight that access to other regions is not only an important determinant for economic activity and attractiveness of location on a regional level, but also on an urban scale.

However, we find no effect of similar statistical significance for areas that potentially benefit mostly from the new transport plan. There are at least three explanations accounting for this phenomenon. First, in contrast to the decline in significance experienced by "Bahnhof Zoo" and "Ostbahnhof", which could not be anticipated by real estate markets before the final announcement of the new railway concept, inauguration of the new stations was scheduled in the early 1990s. The additional relative increase in attractiveness driven by an unexpected decline

[2] In semi-log models, for a parameter estimate *b* the percentage effect is equal to 100 exp(*b* – Var(*b*)/2) – 1) (HALVORSEN & PALMQUIST, 1980; KENNEDY, 1981).

[3] Standard Land Values are assessed by the Local Committee of Valuation Experts on the basis of statistical evaluation of all transactions occurred during reporting period.

of attractiveness of competing urban areas might have been too small to generate significant impacts. Second, the areas in proximity to the new central station, which potentially benefit mostly from the new railway concept, may be not very receptive for the increase in accessibility. Placed on a strip of land formerly occupied by the Berlin Wall, the station, despite its geographic centrality, is located within a largely undeveloped area and is only connected to the urban railway network through the suburban east-west line. Last, from a more technical perspective, potential price effects might have failed to reach the level of statistical significance due to a relatively small number of property transactions in the central station neighborhood (cp. Figure 1).

In column (3) of Table 3 we introduce an accessibility indicator as defined in equation (3) into our extended difference-in-difference specification to reveal whether the treatment effect for strongly negatively affected areas can be explained by an anticipated change in accessibility. Therefore, mainline accessibility MA_p is set equal to MA_{ipre} for property transaction *p* occurring within block *i* during the period before announcement and MA_{ipost} respectively, when the transaction was realized after announcement. In line with expectations, the coefficient on *MA* is significantly positive. At the same time, the treatment coefficient on *STNEG x ANN* is no longer significantly different from zero. Although the respective treatment coefficient for benefiting areas (*STPOS x ANN*) is not statistically significant at conventional levels and might therefore only be interpretable, if at all, very carefully, it is notable that inclusion of *MA* also reduces this coefficient remarkably in size. Since the treatment coefficient for strongly negatively affected areas is rendered insignificant after controlling for accessibility, we can largely reject that the negative impact on location desirability following announcement of the new transport plan is attributable to factors other than access to cities and regions. No additional impact being observable indicates that markets adjusted in anticipation to a new spatial equilibrium. After all, our results provide strong support for the idea of access to regions being of causal importance for economic development.

6 Conclusion

This study adds to the urban economics and economic geography literature in basically three points. First, this study exploits one of the relatively few cases where natural instruments provide a source of exogenous variation in access to cities and regions. Second, it brings together two strands of research that focus either on the importance of market links between regions or the role of accessibility within metropolitan areas. We show that access to cities and regions not only impacts on economic activity at aggregated regional levels, but also on intra-urban attractiveness of location. Third, our results suggest that free markets may adjust in anticipation of changes in regional accessibility.

Our findings confirm the results of REDDING & STURM (2006) who demonstrate the causal role market access plays in shaping patterns of economic activity by exploiting exogenous variation in market access of West German cities following World War II and Germany's unification. Although the advantages of this approach are obvious, little empirical evidence is available so far due to difficulties in encountering appropriate natural experiments and adequate data for a sufficiently long period. However, this study shows that on intra-urban scale, real estate markets adjust rapidly to announced changes in regional accessibility, substantially reducing the observation period necessary to detect impact. We exploit the relatively rare occasion of complete urban railway realignment which also includes the unique feature where a CBD loses its central station. Evidence suggests that the mechanisms emphasized by new economic geography also apply to urban scale and that urban patterns of economic activity are essentially shaped by regional integration. Employing a combined hedonic and difference-in-difference strategy, we find a significant treatment effect indicating that property transaction prices in average decreased by approximately 22% within areas that are strongly negatively affected by realignment. This treatment effect can be explained completely by an empirical accessibility indicator taking into account frequency of long-distance connections and mainline stations' accessibility by public transport. No significant effects are found for areas benefiting from realignment, which is attributable either to the undeveloped neighborhood and adverse connection to public transport of the new central station compared to the former central station, an insufficient momentum of surprise, or too few property transactions in proximity to the new central station.

Our results are also of relevance from a practical urban planning perspective. Good access to long-distance connections apparently has a positive, although localized, impact on the economic prosperity of a business district. Thus, the strategy of embedding the new central station as an anchor-structure into a business district about to be developed may successfully contribute to the economic recuperation of the currently abandoned site which was formerly occupied by Berlin Wall. However, our results also suggest that the district does not benefit explicitly from the closure of "Bahnhof Zoo". In light of the negative net effect on strongly affected residents and the large decline in aggregated land valuation, the positive effect of reduced travel time to the new central station appears quite limited. Moreover, it is doubtable that the negative impact may easily be reversed since new spatial equilibriums, once established, tend to remain persistent (REDDING & STURM, 2006; REDDING, STURM, & WOLF, 2007).

Appendix

Tab. A1 Full Empirical Results (I-VI)

	(1) log(Price)	(2) Log(Price)	(3) Log(Price)
ANN	0.0858 (0.0542)	0.1229** (0.0564)	0.2005*** (0.0640)
IMP	0.1647*** (0.0514)	0.1738*** (0.0542)	0.1729*** (0.0541)
POS	0.0978 (0.5464)	0.0031 (0.5104)	0.0438*** (0.5317)
POS x ANN	0.0249 (0.0618)	-0.0228 (0.0637)	-0.1705* (0.0886)
POS x IMP	0.0095 (0.0563)	-0.0067 (0.0598)	0.0088 (0.0600)
STPOS		2.1250** (0.9659)	1.8012 (0.9845)
STPOS x ANN		0.2384 (0.2093)	0.0295 (0.2136)
STPOS x IMP		-0.0991 (0.1621)	-0.0914 (0.1690)
STNEG		1.3899*** (0.5416)	1.0335* (0.5697)
STNEG x ANN		-0.2390** (0.1191)	0.0295 (0.2136)
STNEG x IMP		-0.0324 (0.1231)	0.0407 (0.1233)
MA			0.0146** (0.0062)
Bad Location Quality	-0.1613 (0.1543)	-0.1664 (0.1517)	-0.1824 (0.1502)
Medium Location Quality	-0.1106 (0.0992)	-0.1058 (0.0992)	-0.1158 (0.0970)
Good Location Quality	-0.0454 (0.2390)	-0.0356 (0.2406)	-0.0470 (0.2387)
Excellent Location Quality	-0.2592 (0.2576)	-0.2475 (0.2587)	-0.2554 (0.2567)
Downtown Location	0.1702 (0.4791)	0.1729 (0.4706)	0.1559 (0.4776)
Primary Center	0.1528 (0.2262)	0.0992 (0.2174)	0.0903 (0.2146)
Downtown Periphery	0.0263 (0.1568)	0.0295 (0.1537)	0.0337 (0.1504)
Secondary Centre	0.2185 (0.1869)	0.1947 (0.1918)	0.1910 (0.1923)

Tab. A1 Full Empirical Results (II-VI)

Regional Center	0.4501 (0.36219)	0.4542 (0.3657)	0.4640 (0.3632)
Local Center	0.0502 (0.1237)	0.0446 (0.1243)	0.0561 (0.1230)
Minor Business Location	0.0383 (0.1015)	0.0515 (0.1045)	0.0521 (0.1038)
Predominant Land Use: Commercial	0.1652 (0.1774)	0.1823 (0.1807)	0.1776 (0.1802)
Local Building Structure: Industrial	-0.4608 (0.4683)	-0.4408 (0.4695)	-0.4446 (0.4739)
Local Building Structure: Apartment Complexes	0.0131 (0.0745)	0.0167 (0.0748)	0.0126 (0.0741)
Local Building Structure: Old Buildings (1870-1914)	-0.0125 (0.0684)	-0.0152 (0.0687)	-0.0166 (0.0678)
Local Building Structure: 1920s-30s Buildings	-0.1144 (0.2290)	-0.1081 (0.2315)	-0.1023 (0.2324)
Local Building Structure: 1950s-60s Buildings	-0.2010* (0.1035)	-0.1988* (0.1045)	-0.2033** (0.1032)
Local Building Structure 1970s-90s Buildings	0.1456 (0.1512)	0.1462 (0.1520)	0.1449 (0.1517)
Mixed Zone Dominated by Residential Use	-0.0344 (0.0834)	-0.0339 (0.0843)	-0.0353 (0.0838)
Local Building Structure: One/Two Family Houses	-0.1317 (0.1436)	-0.1306 (0.1440)	-0.1457 (0.1408)
Homestead Settlement	0.8720*** (0.0806)	0.8739*** (0.0793)	0.8890*** (0.0785)
Mixed Use Zone	-0.0771 (0.1039)	-0.0797 (0.1035)	-0.0810 (0.1040)
Local Building Structure: Village-like	0.5803* (0.3310)	0.5429* (0.3292)	0.5205 (0.3262)
Property Location: Frontage	0.1387 (0.1130)	0.1337 (0.1121)	0.1451 (0.1178)
Property Location: at Corner	0.3299*** (0.1180)	0.3261*** (0.1174)	0.3357*** (0.1231)
Property Location: Multiple Frontages	0.1236 (0.1519)	0.1083 (0.1506)	0.1212 (0.1544)
Property Location: Demoted	0.5773 (0.4754)	0.5555 (0.4651)	0.5667 (0.4668)
Property Location: Backyard	-0.3975** (0.1557)	-0.3791** (0.1507)	-0.3594** (0.1521)
Plot Area (m^2)	0.0001** (0.0000)	0.0001** (0.0000)	0.0001** (0.0000)
Plot Area (m^2) squared	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)

Tab. A1 Full Empirical Results (III-VI)

Small House	-0.1034 (0.2471)	-0.1302 (0.2445)	-0.0823 (0.2456)
One/Two Family House	0.2747 (0.1769)	0.2600 (0.1768)	0.2905 (0.1782)
Townhouse	0.3035 (0.2530)	0.2926 (0.2586)	0.3131 (0.2593)
Villa	0.3459* (0.1985)	0.3376* (0.2011)	0.3568* (0.2015)
Multi Family House	0.4515** (0.1764)	0.4307** (0.1778)	0.4561** (0.1782)
Other Type of Residential House	0.7023* (0.3663)	0.6347* (0.334)	0.6711* (0.3446)
Residential and Business House	0.6558*** (0.1771)	0.6361*** (0.1781)	0.6598*** (0.1788)
Business House	0.8967*** (0.1919)	0.8725*** (0.1926)	0.8983*** (0.1929)
Retail House	0.8332*** (0.2613)	0.8152*** (0.263)	0.8366*** (0.2617)
Mixed Commercial Use	0.3444 (0.3562)	0.3552 (0.3541)	0.3808 (0.3512)
Warehouse	0.0146 (0.4116)	-0.0319 (0.4105)	-0.0039 (0.4139)
Industrial Administrative House	0.4903 (0.3603)	0.4104 (0.3256)	0.4565 (0.3321)
Industrial Building	0.4893 (0.3462)	0.4731 (0.3461)	0.4892 (0.3539)
Hotel	0.9831*** (0.3204)	0.9895*** (0.3187)	1.0259*** (0.3201)
Guesthouse	0.5772*** (0.2016)	0.5546*** (0.2042)	0.5871*** (0.207)
Retirement or Care Home	0.8019*** (0.2552)	0.7791*** (0.2567)	0.8282*** (0.2561)
Club or Amusement Hose	-0.1708 (0.2305)	-0.2038 (0.2297)	-0.1943 (0.2163)
Sports or Multifunctional Arena	-0.2635 (0.3452)	-0.2952 (0.3420)	-0.3091 (0.3294)
Bowling or Tennis Hall	0.9070*** (0.2453)	0.8959*** (0.2469)	0.9158*** (0.2474)
School	0.0425 (0.7046)	-0.0119 (0.7088)	-0.0315 (0.6725)
Public Administrative Building	-0.9594** (0.4333)	-1.0496** (0.4618)	-1.052** (0.4671)
Research Institute	3.2624*** (0.8359)	3.2206*** (0.8396)	3.2607*** (0.8326)
Cultural Institution	-0.2473 (0.2660)	-0.3081 (0.2506)	-0.2998 (0.2601

Tab. A1 Full Empirical Results (IV-VI)

Filling Station	0.5785*** (0.2031)	0.5656*** (0.2055)	0.5985*** (0.2056)
Car Park	-0.6194*** (0.2265)	-0.6647*** (0.2377)	-0.6401*** (0.2379)
Railway Station	-8.3303*** (1.9693)	-8.4296*** (1.9861)	-8.3452*** (1.9698)
Hospital	2.3517*** (0.5996)	0.1781 (0.6226)	0.1971 (0.6189)
Medical Center	1.5132*** (0.1986)	1.4716*** (0.2008)	1.5368*** (0.2013)
Military Facilities	0.2996 (0.7051)	0.3294 (0.7042)	0.3382 (0.6997)
Floor Space (m²)	0.0003*** (0.0000)	0.0003*** (0.0000)	0.0003*** (0.0000)
Floor Space (m²) squared	0.0000*** (0.0000)	0.0000*** (0.0000)	0.0000*** (0.0000)
Flat Roof	-0.0409 (0.0421)	-0.0395 (0.0419)	-0.0445 (0.042)
Pent Roof	-0.1102** (0.0487)	-0.1075** (0.0489)	-0.1108** (0.0492)
Span Roof	-0.1008** (0.0424)	-0.1022** (0.0424)	-0.1032** (0.0426)
Berlin Roof	-0.0370 (0.0400)	-0.0371 (0.0400)	-0.0372 (0.0399)
Hipped Roof	0.0275 (0.0521)	0.0271 (0.0521)	0.0261 (0.0517)
Mansard Roof	-0.0418 (0.073)	-0.0438 (0.0729)	-0.0476 (0.0735)
Domed Roof	-0.1563* (0.0862)	-0.1426 (0.0883)	-0.1415 (0.0896)
Arched Roof	-0.019 (0.3311)	-0.0272 (0.3336)	-0.0148 (0.3294)
Extended Flat	0.1029*** (0.0235)	0.1041*** (0.0237)	0.1048*** (0.0236)
Age (Years)	-0.0012 (0.0020)	-0.0012 (0.0020)	-0.0013 (0.0019)
Age (Years) squared	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
Condition: Good	0.3844*** (0.0426)	0.3854*** (0.0431)	0.3886*** (0.0428)
Condition: Bad	-0.4397*** (0.0383)	-0.4361*** (0.0384)	-0.4362*** (0.0383)
Elevator	0.0169 (0.0319)	0.0176 (0.0317)	0.0162 (0.0318)
Basement	0.0421 (0.0287)	0.0431 (0.0285)	0.0415 (0.0287)

Tab. A1 Full Empirical Results (V-VI)

Underground Car Park	0.61*** (0.2363)	0.6114*** (0.2330)	0.5899** (0.2341)
Typical Legal Land Use: Commercial	0.0531 (0.0699)	0.0683 (0.0703)	0.0664 (0.0698)
Typical Legal Land Use: Industrial	-0.2724 (0.1794)	-0.2733 (0.1805)	-0.2669 (0.1785)
Seller: Company Consti-tuted Under Civil Law	0.1268*** (0.0421)	0.1294*** (0.0422)	0.1296*** (0.042)
Seller : Federal Republic of Germany	-0.1891 (0.138)	-0.1867 (0.1378)	-0.1755 (0.1366)
Seller: State of Berlin	-0.3974*** (0.139)	-0.3985*** (0.1448)	-0.4038*** (0.1456)
Seller: Public Funds	-0.6406 (1.006)	-0.6757 (1.0013)	-0.6865 (1.0019)
Seller: Non-Profit Housing Association	-0.3097*** (0.045)	-0.3071*** (0.0452)	-0.3087*** (0.0452)
Seller: Public Authority	-0.2165 (0.1461)	-0.2109 (0.1495)	-0.2117 (0.1501)
Seller: Real Estate Fund	0.1293 (0.2165)	0.1658 (0.2252)	0.1676 (0.2293)
Seller: Insurance Company	-0.1613 (0.1577)	-0.1495 (0.1533)	-0.1791 (0.1595)
Seller: Other Legal Person	0.0622** (0.0251)	0.0636** (0.0251)	0.0607** (0.025)
Seller: Religious Community	-0.0859 (0.193)	-0.0784 (0.1911)	-0.072 (0.1924)
Seller: Diplomatic Mission	-0.1814** (0.0814)	-0.2024 (0.1280)	-0.2121* (0.1274)
Seller: Public Housing Association	-0.2181* (0.1239)	-0.2163* (0.1235)	-0.2123* (0.1252)
Buyer: Company Consti-tuted under Civil Law	0.0343 (0.0392)	0.0303 (0.0386)	0.03 (0.0387)
Buyer: Federal Republic of Germany	1.2004 (1.1359)	1.2682 (1.2011)	1.2532 (1.1843)
Buyer: State of Berlin	0.5222 (0.3180)	0.6527** (0.2628)	0.5938* (0.3048)
Buyer: Public Funds	0.4185 (0.3893)	0.398 (0.3868)	0.3907 (0.3822)
Buyer: Non-Profit Housing Association	0.6404** (0.3210)	0.6515** (0.3186)	0.6472** (0.3239)
Buyer: Public Authority	-0.0624 (0.2129)	-0.0878 (0.2174)	-0.0948 (0.2175)
Buyer: Real Estate Fund	0.2770 (0.2354)	0.2774 (0.2277)	0.2877 (0.2301)
Buyer: Insurance Company	0.2353*** (0.0295)	0.2325*** (0.0295)	0.2352*** (0.0294)

Tab. A1 Full Empirical Results (VI-VI)

Buyer: Other Legal Person	0.0482 (0.0944)	0.0486 (0.0963)	0.0465 (0.0961)
Buyer: Religious Community	-0.2244* (0.1269)	-0.2344* (0.1241)	-0.2473* (0.1266)
Buyer: Diplomatic Mission	0.6987*** (0.0695)	0.6974*** (0.0693)	0.6993*** (0.0686)
Buyer: Public Housing Association	-0.0283 (0.0839)	-0.0279 (0.0836)	-0.03 (0.0839)
Property is not Occupied by Renter	-3.0461** (1.2254)	-2.9880** (1.2431)	-2.987** (1.247)
Share of Secondary Structure at Sales Price (%)	0.2353*** (0.0295)	0.2325*** (0.0295)	0.2352*** (0.0294)
Observations	6167	6167	6167
R squared	0.9429	0.9432	0.9434

Notes: Endogenous variable is log of sales prices in all models. All models include a daily time trend, monthly dummy variables and statistical block fixed effects. Standard errors (in parenthesis) are heteroscedasticity robust and clustered on statistical blocks. * denotes significance at the 10% level, ** denotes significance at the 5% level, *** denotes significance at the 1% level.

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