intelligent space

The relationship between urban street configuration and office rent patterns in Berlin

MODELLING THE PATTERNS OF RENTS

PhD Thesis by Dr. Jake Desyllas

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About this thesis

This thesis presents a study of the influence of urban street configuration on the pattern of commercial office rents in Berlin. The hypothesis is that there is a relationship between the two, and that the alteration of the street network with reunification has precipitated a spatial reorganisation of office rents.

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8 MODELLING THE PATTERN OF RENTS

8.1 Introduction

Thus far, a spatial analysis of Berlin's development has shown how the reunification of the city changed the spatial structure of the street grid. A sample of office leases has been studied and the pattern of location rents has been represented. This has shown a clear change in location rent that relates to the pattern of integration.

In the previous chapter, the spatial pattern of location rents taken from a sample of real leases was represented using objective techniques. This showed that the pattern of rents in Berlin has changed dramatically since the fall of the wall, with the prime area shifting from West Berlin to the East. It was argued that simple interpolation of the dependent variable (isopleth analysis) is not sufficient to model such a change in the spatial pattern of rents as that has occurred in Berlin. Rather, a distinction has been made between the representation of the dependent variable and the *modelling* of its determination. In order to be able model change in rents, an *independent* spatial variable is required that reflects the change in the value of locations that occurred with reunification.

The visual similarity between the pattern of spatial integration in the axial maps and the pattern of rents shown in the previous chapter has already been noted. Axial Map 5.1 and Axial Map 5.2 (on page 165 above) that show the change to Berlin's global integration structure that occurred with reunification appear to predict the rise in the location rent value of Mitte and decline of the Western CBD area with respect to the city as a whole that occurred in the years following reunification. In this chapter, a statistical model of the determination of rents will be presented to show how far the space syntax measures do correlate with location rents and therefore the extent to which it is possible to use such measures to help build an explanatory model of rent patterns in Berlin. The purpose of this model is to explore the relationship between street configuration and rent pattern.

The main tool that will be used to model rent determination in this chapter will be Multiple Regression Analysis (MRA). This tool allows for the creation of a model of the determination of rent prices using both spatial and non-spatial explanatory variables. In chapter 6 it was shown that only time was found to exert a significant effect on rent in the non-spatial MRA (section 6.5 on page 217). However it was also seen that the build quality variable did not have the expected sign and the possibility of colinearity with location was suggested, as had been found in other studies (section 2.8.3 on page 72 of the literature review). In this chapter

the role of building quality will be reassessed by looking at this variable in relation to location in a number of ways. The spatial differences in rent and build quality will be investigated on a year by year basis to take out the effect of time. Build quality will also be included in the regression models to see whether the inclusion of a spatial variable shows a different role for build quality that might have been undetectable in the location-blind MRA because of colinearity between build quality and location. Finally, samples of rents in new buildings only will be considered, as will samples of rents in old buildings only. .

Location will also be evaluated in a number of ways. As the representation of location rents in chapter 7 showed such a marked shift from West to East, the distribution of rent values in different areas will be compared. Using a year by year analysis, changes between West and Eastern rents can be traced with some control for the time variable.

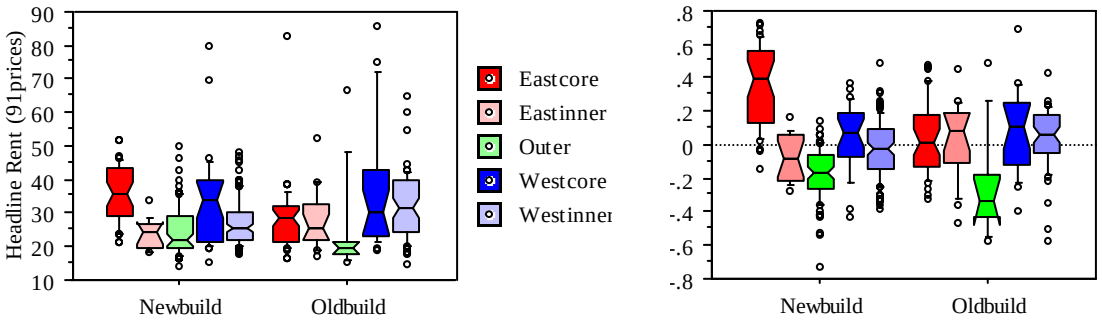
MRA will be used both with the non-spatial and spatial variables together. This analysis will be applied to the whole sample and then East and West Berlin separately, in order to evaluate the differences in the importance of both spatial and non-spatial variables in rent determination for these sub-samples. The last stage of the analysis will be to look at the relationship between the spatial model and the 'location rents' variables calculated in chapter 6 in more detail. This will be undertaken firstly by applying regression analysis to the 'location rent' with the spatial variables and then by using location rent to consider the relationship between the spatial core of the city and the more peripheral locations.

8.2 Analysis of rents by Area

Figure 8.1 below show box plots of the distribution of rent both by building quality and by area for the whole sample. The definition of areas has been taken from the agents' dasymetric maps (see page 172 above). East and west cores correspond to the two areas of highest rent (not just the 1A streets). 'East inner' and 'west inner' correspond to the areas outside these cores but inside the S-Bahn ring. 'Outer' denotes all areas outside the S-Bahn ring (East and West). The box plots show the 10^{th}, 25^{th}, 50^{th} 75^{th} and 90^{th} percentiles of the headline rent for the areas in question. The notches show the 95% confidence interval for the median values. The absolute values of rents are shown on the left (Figure 8.1a) and the location rents are shown on the right (Figure 8.1b). These are the residual values from the log-linear regression of headline rents with time of Figure 6.29b on page 222.

When the data is split by area, the role of build quality is shown to be quite different to that found in the location blind MRA of chapter 6. Leases in outer areas have the lowest median

values of all kinds and the *old* buildings in the outer areas can be seen to have lower values than *new*. The biggest differential between new and old appears to be in the eastern core. The highest median values overall are for leases in *new* buildings in the eastern core. The difference between the rents in these buildings and the other samples is even greater in the location rent values of Figure 8.2b on the right below. However, the relationship between build quality and price within the Western core is not so clear. The second highest median value for headline rent is the new buildings in the West Berlin core. However, for location rents the second highest median is the old buildings in the western core and the 75th and 95th percentiles of headline rents for this sample are also higher than the other leases. To understand this result, the changing relationship between rents, build quality and location has to be unpacked for the time period studied.



(a) Headline Rents

(b) Location Rents

Figure 8.1: box plot of rents by area and build type for all headline rent (left) and residual headline rent (right)

8.3 Analysis of Rents Year By Year

In order to control for the time variable, Figure 8.2 to Figure 8.8 show the rent by area for each of the years 1991 to 1997 separately. Although the samples are not large enough to carry out multiple regressions for in each year, the averages and distribution of values for each area in each year can be examined using these box plots. Figure 8.2 of 1991 below shows the difference between rents in the west core and in the western inner areas for old buildings but the sample is too small to make the box notches (representing 95% confidence intervals) significantly different. The size of the whiskers for old buildings in East Berlin shows the large range in the rents achieved in these buildings. Classifying the data in this way reveals that the extreme variability of the sample rents that had been noted for the early year of 1991 was in renovated buildings in the former east. This may reflect the volatility of the market as rents were just about to peak (as was shown in both the agents reports in section 5.4 on page 167 and in the analysis of the study sample in section 6.5.1 on page 219). It may also reflect

the fact that the market did not yet really *know* how to value leases in the East. The *re-valuing* of location after reunification was just getting underway.

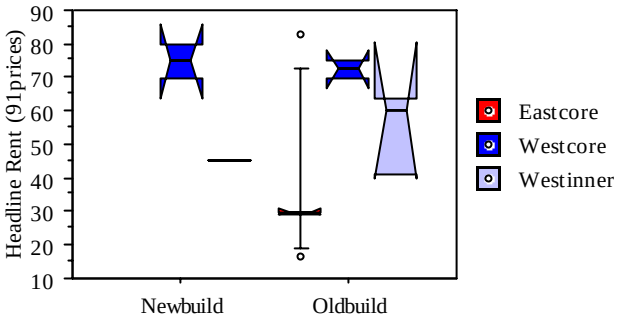
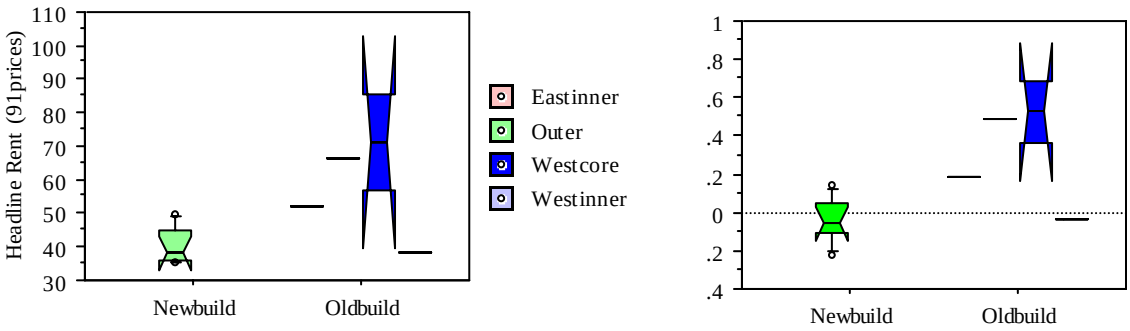


Figure 8.2: 1991 rents by area box plot[37]

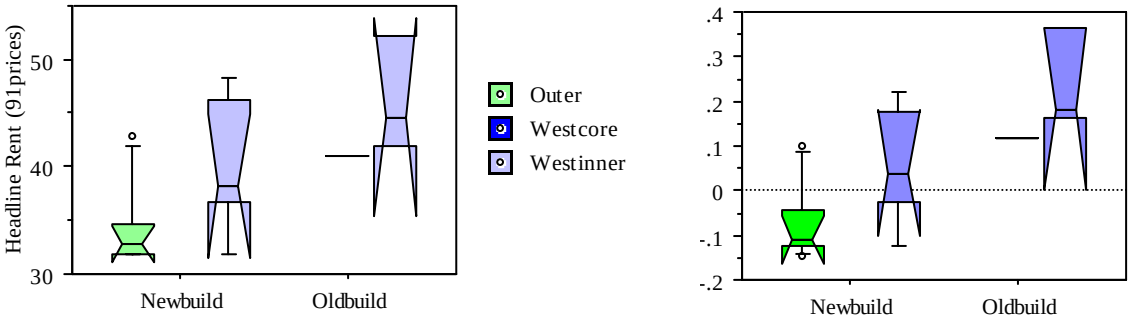
Figure 8.3 below shows the pattern for 1992. The median value for old buildings in the western centre is much higher than that for outer areas, but the sample sizes are again too small to make any more significant differences according to area. This is also the case for 1993 (Figure 8.4 below). The range is much smaller and the rents are much lower in this year. These characteristics, as well as the small sample size in 1993 reflects the fact that this was both the first year of declining rents and the worst year of the economic recession in Germany (Economist Intelligence Unit 1994). Most of the leases that were let were in the inner city in West Berlin. It is interesting to note that rents on leases in old buildings in this area were higher than in new buildings. This may reflect more fine scale spatial differences between old and new for these leases but the large error bands again make it difficult to draw conclusions from this sub-sample.

[37] location rents are not available for 1991 because the residual values were not calculated in that year, as was explained in chapter 6.



(a) Headline Rents (b) Location Rents

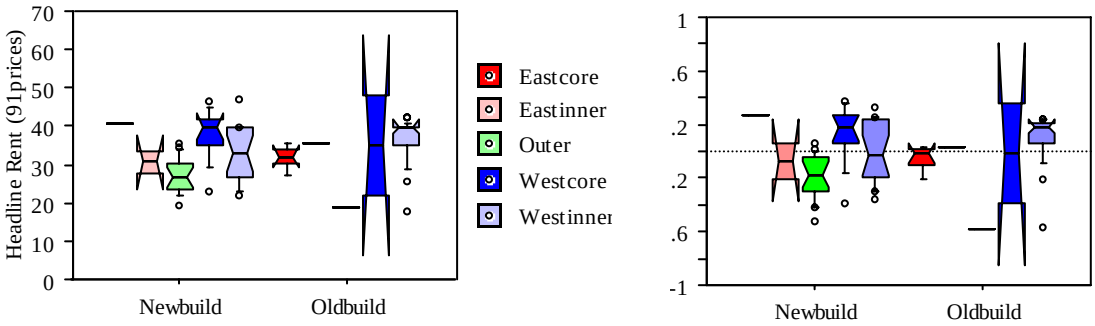
Figure 8.3: 1992 Rents by area box plots



(a) Headline Rents (b) Location Rents

Figure 8.4: 1993 rents by area and build quality

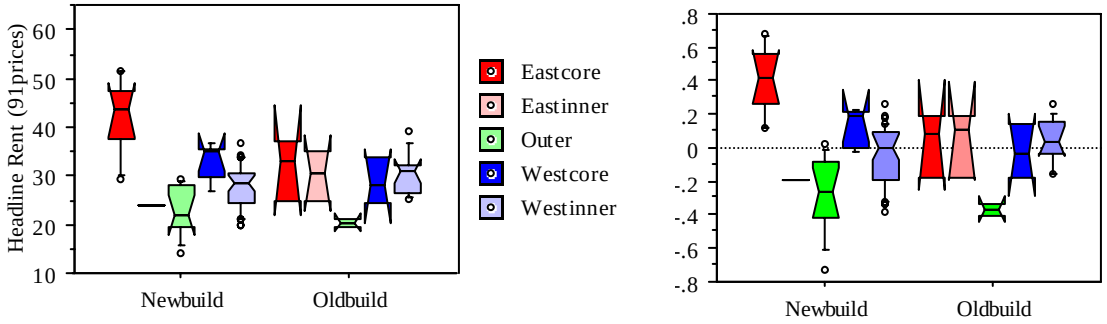
Figure 8.5 below shows the box plots for 1994 rents. During this year, the highest rents in new buildings were still in the Western core, although there were not yet enough leases in new buildings in the East to make a proper comparison. This reflects the fact that the new wave of supply had not yet been completed. Leases in outer areas have the lowest median values of all kinds.



(a) Headline Rents (b) Location Rents

Figure 8.5: 1994 rent by area and build quality for all leases (left) and JLW leases (right)

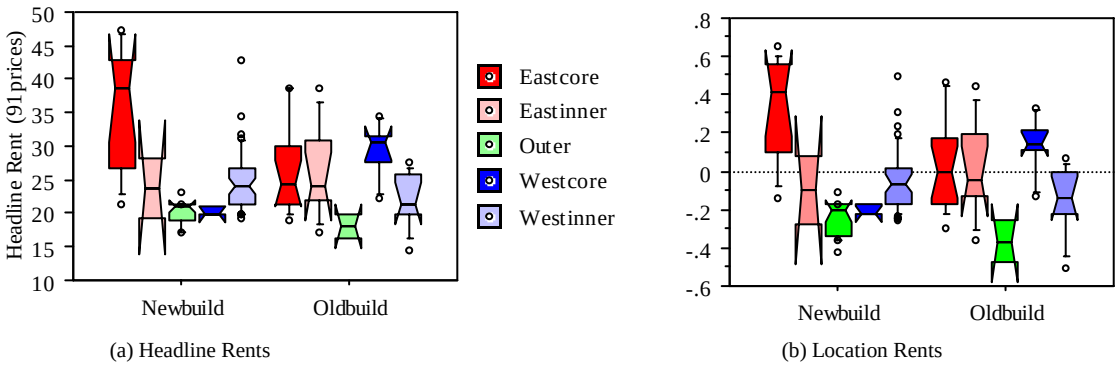
In the year 1995 an important change occurred. In this year the new buildings in the East have overtaken those in the West as the highest value leases as can be seen in Figure 8.6 below. This is a statistically significant margin, as can be seen from the 95% confidence bands on Figure 8.6. By 1995 many new buildings in the Eastern core were completed, such as the Friedrichstadtpassagen on Friedrichstraße (Map 5.7 on page 184) and it is buildings such as these that are being reflected in the high values of the leases. The second highest median level of leases is for new buildings in the Western core. The leases in old buildings in the Eastern core also have the highest average (median) rents of all leases in old buildings in the sample for 1995, but the differences among old buildings is not statistically significant. Outer areas again show the lowest median values and there is no significant differentiation between new and old.



(a) Headline Rents (b) Location Rents

Figure 8.6: 1995 rent by area and build quality for all leases (left) and JLW leases (right)

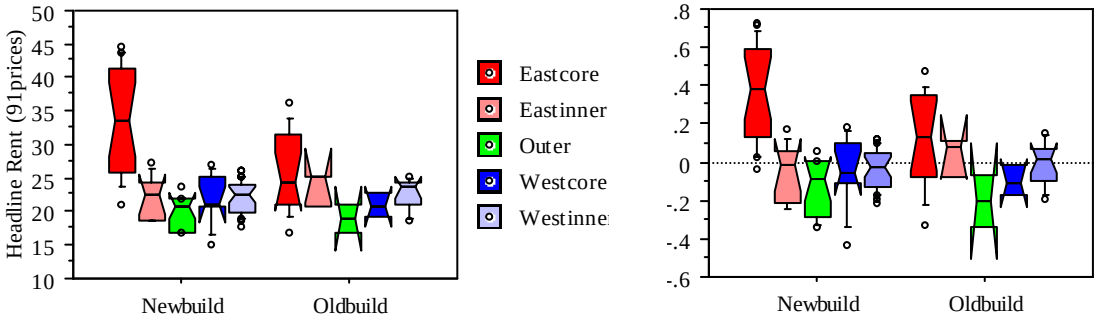
For 1996 the absolute value of new buildings in the Western core has sunk considerably to a median value of DM20, whereas the new buildings of the Eastern core have fallen much less severely to a median value of around DM33, as can be seen in Figure 8.7 below. The new buildings in the Western centre had particularly low levels in this year- lower than old buildings in the *same* area by a statistically significant margin. Indeed old buildings in the Western CBD had relatively high rents compared to the sample as a whole, with the second highest median value after new buildings in the eastern core. It is as if the market did not value new buildings against old buildings in the West in the same way as it did in the East. The differential between rents in the eastern core and the eastern inner area is much greater for leases in new buildings than for those in old ones.



(a) Headline Rents (b) Location Rents

Figure 8.7: 1996 rent by area and build quality for all leases (left) and JLW leases (right)

For the last year of the sample (shown in Figure 8.8 below) the new buildings in the eastern core can again be seen to have a significantly higher median value than any other area. The old buildings in the Eastern core also have a higher 90th percentile than all others and a higher median value than any other except the old buildings in the eastern inner city, although these differences in the median are not statistically significant. For leases in the Western CBD values are particularly low both in new and old buildings. There is no longer a significant difference between the median values of the western core and those in outer areas.



(a) Headline Rents (b) Location Rents

Figure 8.8: 1997 rent by area and build quality box plot for all leases (left) and JLW leases (right)

These year by year statistics using box plots for building types in different areas and over time have shown a number important features:

- There is a relationship between location and rent, even with these crude area splits as a proxy for location. The central areas are consistently higher than the outer area.
- Within central areas, a shift in the location of prime values has taken place over time, with new buildings in the core of East Berlin commanding higher values after 1995.

- There is a statistically significant difference between new and old buildings, but it is only visible when the buildings of different types are compared within small spatial areas (limiting the influence of the location variable). The relationship is positive, with new buildings commanding higher rents, although old buildings in central West Berlin do appear to be exceptional.

8.3.1 The spatial distribution of effective rent percentages

In chapter 7, the percentage of effective rents was mapped for all leases for which this data was available to see if a spatial pattern could be discerned (Map 7.9 on page 241) but none could be found. Figure 8.9 shows the percentage of effective rents split by area. The problem of a much smaller sample size for effective rents is again raised in this analysis. However, some characteristics are notable. The lowest median value as well as the greatest range in effective rent percentages is for new buildings in the eastern core. These reflect the later dip in effective rents for new buildings that was shown in Figure 6.23 of chapter 6. In the later period of 1996 and 1997, more incentives were given in new buildings, and these were particularly concentrated in the eastern centre. When the effective rent percentage in old buildings is compared, the difference between the areas is not significant, as can be seen on the right hand box plot.

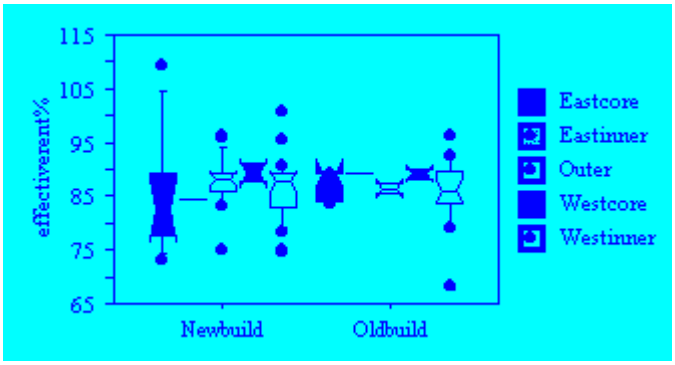


Figure 8.9: Effective rent percentages for 5-year leases in Berlin 1991-1997

8.4 Multiple Regression Analysis

The descriptive statistics in the previous section have confirmed the shift in rents to the East that was found in the rent representations of chapter 7. They have also confirmed the suspicion that the relationship between building quality and rent is a *positive* one, once the

influence of location has been controlled by comparing buildings within a limited area[38]. It is now time to test the ability of the independent spatial measures to capture this spatial differentiation of rents. Non-spatial measures were previously excluded in order to produce a location rent for visualisation of rent patterns. These non-spatial measures will now be analysed with the spatial measures together, to evaluate the importance of each factor in determining rent prices.

8.4.1 MRA for All Berlin

Table 8.1 below[39] shows a number of MRA models for leases in the whole Berlin sample. The first model uses the main variables from the leases and global integration of divided Berlin, whilst the second uses reunified integration. The comparison is telling: the only two values to reach statistical significance in terms of the p value in both models are the time of letting (leasebeginmonthcode) and global integration. However, *reunified* integration is more powerful than divided integration (t=9.354 compared to t=2.490 for divided). Reunified integration is the most powerful spatial variable overall, although the second best spatial measure is the local one of K3, probably because it picks up the importance of both the Western centre from the earlier years and Mitte after 1995. It is interesting to note that the new measure K3 is more effective than the more complex measure of local integration used in previous space syntax studies.

Build quality has a negative coefficient in the model with divided integration but a *positive* sign with those for reunified integration and K3 (it is also less significant with their inclusion). This result, along with the role of old buildings in the Western core shown in section 8.2 above, points towards a problem of colinearity of spatial variables with the build

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[38] When Adair evaluated the use of Multiple Regression Analysis to look at property values, he found that the technique was useful in evaluating the influence of non-spatial variables, but only for small areas (Adair and McGreal 1987). This is because the location variable needs to be controlled, and this can either be done by selecting small areas to analyse, or by quantifying locaiton as an independent variable itself. This thesis is aimed at developing the latter technique with measures of location, but the approach of limiting the area has also been explored in this section.

[39] The reference letter at the left of each regression summary refers to the tables of Appendix E: Summary of Multiple Regression Models, where these results are represented.

quality variable. In fact, the sample of leases in old buildings is slightly more integrated than the sample in old buildings (with a mean global integration of 1.153 compared to 1.076).

Reference	Dependent	Count	Num. Missing	R	R Squared	Adjusted R Squared	RMS Resid		Intercept	Lease begin month code	Ln Floor space	Contract length	Build Quality Dum	Divided Global Integration	Reunif Global Integration	K 3
B	Ln Headline rent 1991-1997	284	138	.610	.372	.361	.239	Coefficient	3.773	-.011	-.013	.002	-.056	.286		
								Std. Error	.173	.001	.016	.007	.032	.115		
								Std. Coeff.	3.773	-.587	-.043	.019	-.088	.126		
								t-Value	21.824	-11.626	-.804	.357	-1.720	2.490		
								P-Value	<.0001	<.0001	.4222	.7213	.0866	.0134		
C	Ln Headline rent 1991-1997	300	122	.694	.481	.473	.216	Coefficient	3.101	-.013	-.011	.006	.012		.921	
								Std. Error	.144	.001	.014	.006	.028		.098	
								Std. Coeff.	3.101	-.699	-.037	.050	.019		.439	
								t-Value	21.551	-14.949	-.809	1.085	.410		9.354	
								P-Value	<.0001	<.0001	.4189	.2789	.6821		<.0001	
D	Ln Headline rent 1991-1997	300	122	.676	.457	.448	.222	Coefficient	3.806	-.011	-.001	2.743E-4	.001			.002
								Std. Error	.107	.001	.015	.006	.029			2.735E-4
								Std. Coeff.	3.806	-.615	-.002	.002	.001			.385
								t-Value	35.422	-13.422	-.042	.045	.026			8.378
								P-Value	<.0001	<.0001	.9669	.9639	.9795			<.0001
E	Ln Headline rent 1991-1997	420	2	.701	.491	.488	.208	Coefficient	3.311	-.012					.574	.001
								Std. Error	.090	.001					.095	2.570E-4
								Std. Coeff.	3.311	-.669					.278	.202
								t-Value	36.889	-18.160					6.035	4.581
								P-Value	<.0001	<.0001					<.0001	<.0001

Table 8.1: MRA models for All Berlin

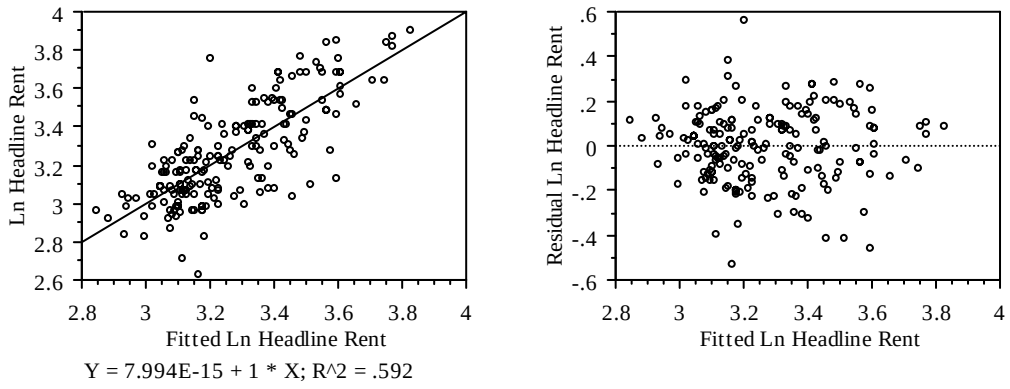
8.5 West Berlin

In Chapter 7 maps of location rents in Berlin created from the JLW lease data were presented. In Map 7.2 of location rents for the whole period, an interesting pattern of two centres was shown. This pattern was compared with the spatial analysis of Berlin, particularly Axial Map 5.1 of divided Berlin and Axial Map 5.2 of the reunified city. It was suggested that the patterns of rent in West and East Berlin appeared to correspond to different spatial structures: the western peak in rents related to the spatial structure of divided Berlin whereas the Eastern centre related to the spatial structure of reunified Berlin. It is now possible to test whether there is a difference in the determinants of rent patterns in West and East Berlin by looking at which spatial variables are more important in each half.

In light of the problems found with the use of the build quality variable as a dummy in multiple regression described in the previous section, the samples of new and old buildings will also be looked at seperately.

8.5.1 New Buildings in West Berlin

For the sample of new buildings in West Berlin, the strongest MRA for Ln Headline rent has been found with the leasebeginmonthcode (most important) and the *divided* global integration, as can be seen in Table 8.2 on page 263 below. The R squared for this model is .592 (adjusted .587) and the scatterplot of the fitted variable against the dependent variable can be seen in Figure 8.10a below left. Figure 8.10b below right shows the scatterplot for the fitted values against the residuals and no clear pattern can be seen to the values unexplained by the model. No other variables attain statistical significance when included in the same MRA or alternative models.



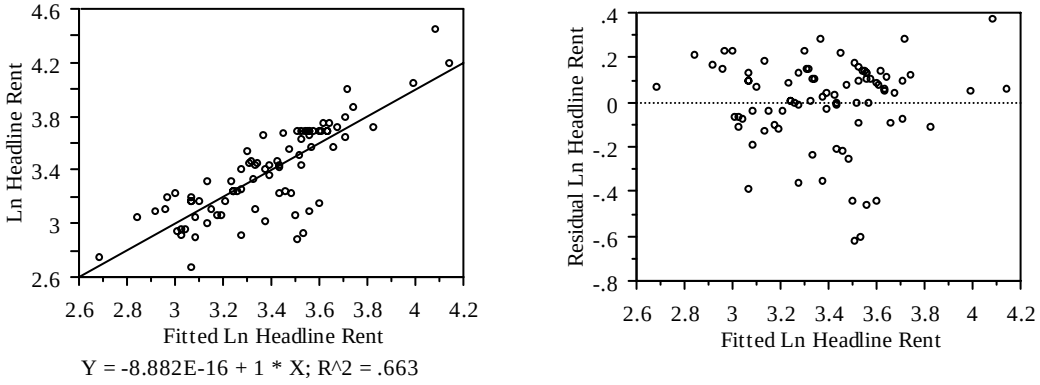
(a) Fitted Vs Dependent (b) Fitted Vs Residual

Figure 8.10 (a & b): Scatterplots from the MRA for rent in West Berlin new buildings

As other studies have tested both log and linear models, each MRA was also tested with the linear headline rent as the dependent variable. The MRA for new buildings in West Berlin was slightly stronger in a linear model (when the dependent is not logged). As can be seen in Table 8.2 below, the strongest linear model for new buildings in West Berlin reached an R squared of .603 (adjusted .599). The variables for this linear model were also time and divided integration.

8.5.2 Old Buildings in West Berlin

Although divided global integration also proved more important than reunified integration for old buildings in East Berlin, the strongest MRA was actually found with the more local spatial variable of K3. In this model floorspace was also found to play a statistically significant role, with the expected negative sign. The relationship between the fitted values of the model and rent values are shown in Figure 8.11 below:



(a) Fitted Vs Dependent (b) Fitted Vs Residual

Figure 8.11 (a & b): MRA for Ln Headline Rent in West Berlin old Buildings

Reference	Dependent	Count	Num. Missing	R	R Squared	Adjusted R Squared	RMS Resid		Intercept	Lease begin month code	Divided Global Integration	K3	Ln Floor space
F	West Berlin Old Build Ln Headline Rent	83		.776	.602	.592	.215	Coefficient	3.308	-.015	.824		
								Std. Error	.372	.001	.317		
								Std. Coeff.	3.308	-.710	.189		
								t-Value	8.882	-9.785	2.599		
								P-Value	<.0001	<.0001	.0111		
G	West Berlin Old Build Ln Headline Rent	83	0	.819	.672	.659	.197	Coefficient	4.367	-.015		.003	-.074
								Std. Error	.198	.001		.001	.028
								Std. Coeff.	4.367	-.732		.270	-.169
								t-Value	22.086	-11.276		4.162	-2.615
								P-Value	<.0001	<.0001		<.0001	.0107
H	West Berlin New Build Ln Headline Rent	193		.769	.592	.587	.166	Coefficient	3.373	-.013	.651		
								Std. Error	.100	.001	.095		
								Std. Coeff.	3.373	-.751	.323		
								t-Value	33.845	-16.000	6.872		
								P-Value	<.0001	<.0001	<.0001		
I	West NewBuild Unlogged	193		.777	.603	.599	4.713	Coefficient	31.322	-.370	17.959		
								Std. Error	2.827	.022	2.687		
								Std. Coeff.	31.322	-.763	.309		
								t-Value	11.081	-16.498	6.683		
								P-Value	<.0001	<.0001	<.0001		

Table 8.2: MRA models for West Berlin

8.6 East Berlin

8.6.1 New Buildings in East Berlin

The strongest regression model for headline rents in new buildings in East Berlin was with global integration for *reunified* Berlin and lease commencement date, which has a correlation coefficient of R squared .580 (adjusted .556). In this model the most important variable is reunified integration (t=8.069), the second most important is time (the leasebeginmonthcode with t=-6.119) and there is a small positive role for contract length (t=2.301). The scatterplot in Figure 8.12 below shows the relationship between the fitted values of the model and the dependent variable. If the sample is controlled to remove the first years of market adjustment, the relationship is even stronger. The strongest correlation for East Berlin was to take the sample of new buildings in East Berlin after 1995 alone. This takes out the confusion of the earlier years just after reunification, when the market was just establishing itself. It shows R squared of .605 (adjusted to .576) with the same variables.

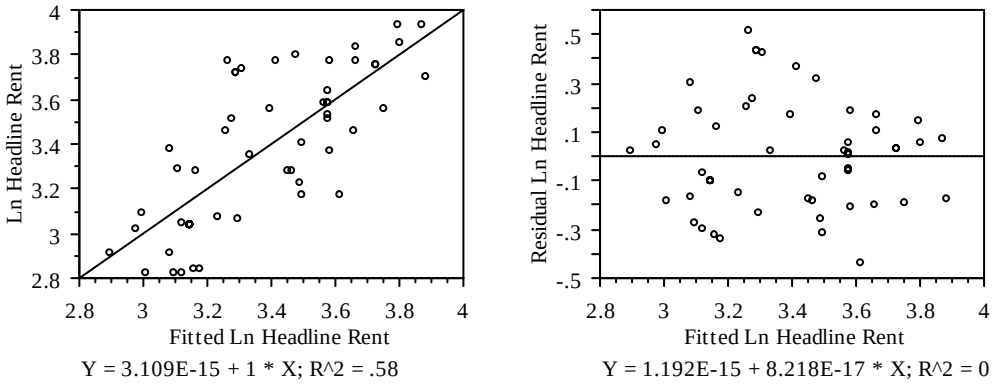


Figure 8.12: MRA for Ln Headline Rent new buildings in East Berlin 1992-1997

Figure 8.13 shows a weakness of the MRA model. The relationship between each of the independents and the residuals of the MRA should not exhibit any pattern, but the relationship between the model shows vertical strips of residual values. This is because the space syntax analysis is not able to provide location measures that are differentiated along an axial line. Rents do differ along lines, as can be seen in the residual, but the location measure does reproduce this level of detail. Consequently a pattern can be seen in the relationship between reunified global integration and the residual value not predicted by the MRA. This suggests that the spatial analysis requires more detail than that provided by axial lines in order to reflect the spatial characteristics of rent.

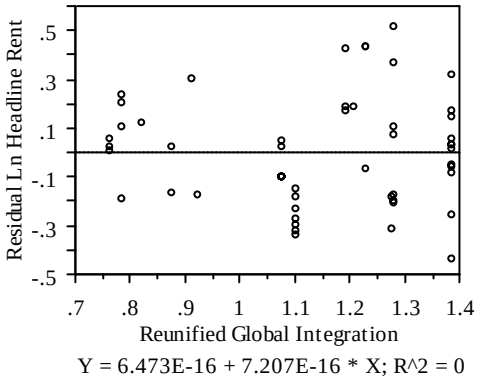


Figure 8.13: Reunified Global integration Vs residual of MRA for Ln Headline Rent new buildings in East Berlin 1992-1997

8.6.2 Old Buildings in East Berlin

The variables that have been found to determine rents in old buildings in East Berlin are the *leasebeginmonthcode* and the reunified global integration, as can be seen in the summary of Table 8.3 below. Unlike new build in East Berlin, time is slightly more important in the rent determination than the spatial integration factor for old buildings (t=-4.7 compared to t=3.794). The regression is slightly improved in a linear model (r squared=.381, adjusted r squared=.356).

There is a major outlier in rent for old buildings in East Berlin, as can be seen in the plot of fitted against dependants in Figure 8.14 below. This case has been investigated. For reasons of confidentiality the address and the rent cannot be specified, but it was a letting from a Government department very early in 1992 (at the peak of the cycle). In one sense, this outlier may represent a category of transactions that are different to normal ones, as the government department may have less knowledge of the market or be acting without the same commercial constraints as other companies. However, it was not excluded because it did not violate any of the criteria for sample selection that were laid out in section 3.2.1.3 (page 81). The criteria for lease selection were designed as a test of the market valuation of locations and to the extent to which state agencies are involved in the market, they also have an influence on the market. But to note the effect, the removal of this outlier decreases the correlation to Rsquared=.345 (adjusted .305).

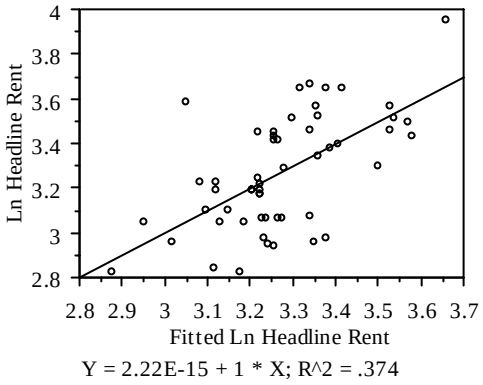


Figure 8.14: MRA for Ln Headline Rent Old buildings in East Berlin 1992-1997

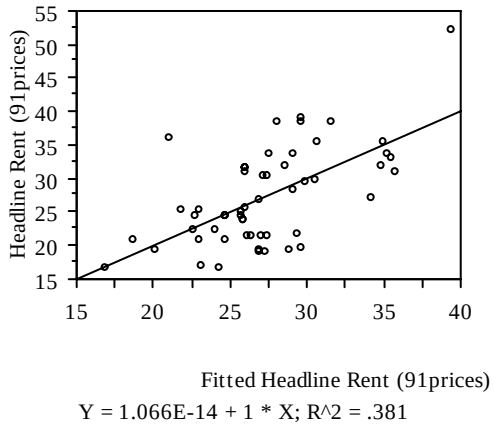


Figure 8.15: MRA for East Berlin old unlogged

Reference	Dependent	Count	Num. Missing	R	R Squared	Adjusted R Squared	RMS Resid		Intercept	Lease begin month code	Reunified Global Integration	Contract length
J	East Berlin Old Build Ln Headline Rent	54	0	.612	.374	.349	.206	Coefficient	2.658	-.009	.984	
								Std. Error	.322	.002	.259	
								Std. Coeff.	2.658	-.532	.429	
								t-Value	8.257	-4.700	3.794	
								P-Value	<.0001	<.0001	.0004	
K	East Berlin Old Build Unlogged Headline Rent	54	0	.617	.381	.356	5.796	Coefficient	15.112	-.280	24.587	
								Std. Error	9.053	.055	7.296	
								Std. Coeff.	15.112	-.570	.379	
								t-Value	1.669	-5.065	3.370	
								P-Value	.1012	<.0001	.0014	
L	East Berlin new build Ln Headline Rent	55	35	.762	.580	.556	.226	Coefficient	2.110	-.017	1.827	.044
								Std. Error	.279	.003	.226	.019
								Std. Coeff.	2.110	-.859	1.101	.262
								t-Value	7.574	-6.119	8.069	2.301
								P-Value	<.0001	<.0001	<.0001	.0255
M	East Berlin new build unlogged Headline Rent	55	35	.754	.568	.543	6.914	Coefficient	-10.061	-.471	55.224	1.434
								Std. Error	8.523	.083	6.927	.586
								Std. Coeff.	-10.061	-.803	1.103	.283
								t-Value	-1.180	-5.640	7.972	2.447
								P-Value	.2433	<.0001	<.0001	.0179

Table 8.3: MRA models for East Berlin

Table 8.4 below shows the residual statistics for each regression model used.

Model	# >= 0	# < 0
All Berlin with Divided Integration	131	153
All Berlin Reunified Integration		
All Berlin K3	156	144
All Berlin Reunified and K3	214	206
West Berlin Old Build Ln Rent	45	38
West Berlin Old Build Ln Rent 2 (K)	48	35
West Berlin Old Build Unlogged Rent	40	43
West Berlin New Build Ln Rent	101	92
West Berlin New Unlog rent	93	100
East Berlin Old Build Ln Rent	24	30
East Berlin Old Build Unlogged Rent	22	32
East Berlin New Build Ln Rent	28	27
East Berlin New Build Unlogged Rent	26	29

Table 8.4: Residual Statistics for all MRA models

8.7 Time and Location in rent determination

The key results of the Multiple Regression Analyses presented above are that the pattern of rents in Berlin can be modelled with the variables of time and global integration. Only the '*leasebeginmonthcode'* (which represents the point in time at which a lease was agreed relative to the market trend) and the urban morphological variable of *global integration* (that relates to the global structure of the town) that are important. It has not been possible to show a statistically significant influence for the other lease variables in rent determination.

8.7.1 'Bucking' the time trend

In this section, the role of time in rent determination in East and West Berlin is evaluated more closely as the process of market change over time has been so pronounced in Berlin. In Figure 8.16 below, the relationship between time and headline rent (logged) is shown for West Berlin (left) and East Berlin (right) The samples in each are split between new and old buildings. The differences in these regressions reflect the previous findings of the differences in t-values for time within the MRAs. Rents in West Berlin were influenced greatly by time in the period under analysis. Over half the variation in rents for new buildings in West Berlin the period 1992 1997 can be explained by the decline in the market without any reference to location (r squared .548 for the new buildings in black on the left-hand scatter of Figure 8.16).

The trend is even stronger for old buildings in West Berlin, for which over 60% of the variation in rents can be explained by time alone. For the sample of leases in East Berlin, time is a much less important variable. Although the trend in rents downwards over the period studied is still notable in East Berlin, the relationship is much weaker. Time can explain only about 13% of the variation in rents for old buildings and only 5% for new buildings for East Berlin in the same time period.

This result points towards a difference between East and West Berlin that was shown in the shifting pattern of location rents in Map 7.3 and Map 7.4 of the previous chapter. Rents in buildings in East Berlin have been more successful in 'bucking the trend' of rent in recession, with a less marked fall in their average values. This is what underlay the relative shift in value patterns.

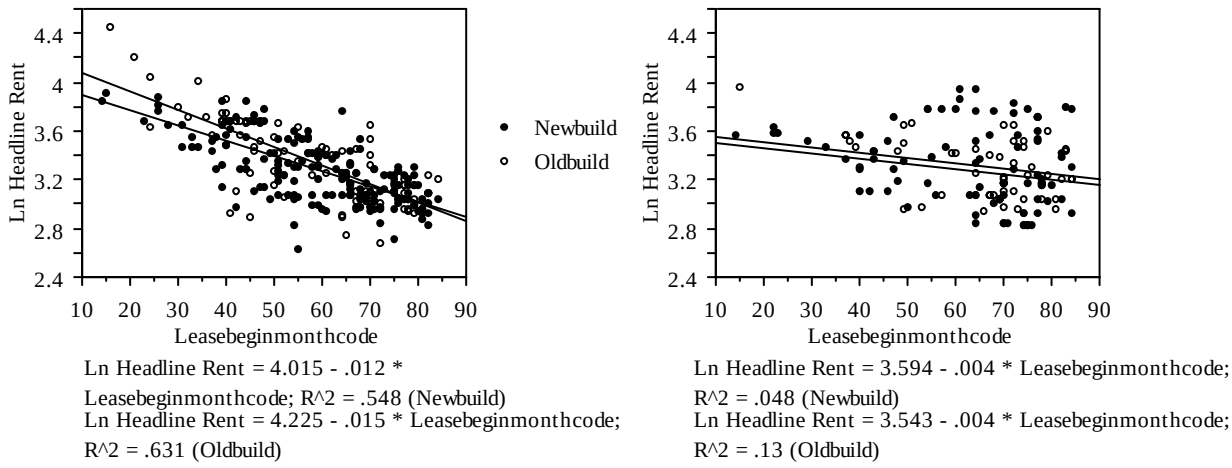


Figure 8.16: The relationship between time and Ln headline rent in West Berlin (left) and East Berlin (right) for new and old buildings.

8.7.2 The Location Factor

Having looked at the differences in the importance of time for West and East Berlin, the spatial measures of location can be plotted against the variable of location rent. This shows the performance of the spatial analysis presented in chapters 4 and 5 in accounting for the pattern of location rents that was presented in chapters 6 and 7. Figure 8.17 below shows the relationship between the best overall spatial predictor of rents for West Berlin (divided global integration) and the location rents in new and old buildings. For both new and old buildings, the relationship is highly significant ($p<.0001$) but quite weak. Only 17% of the variation in rents for new buildings can be directly explained with *divided* integration and 11% of the variation for old buildings.

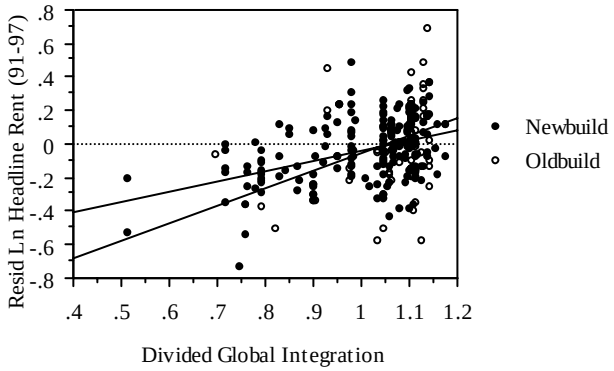
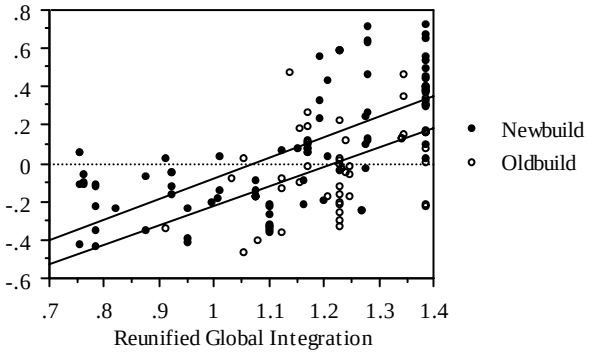


Figure 8.17: Divided Global Integration and Location rents in West Berlin

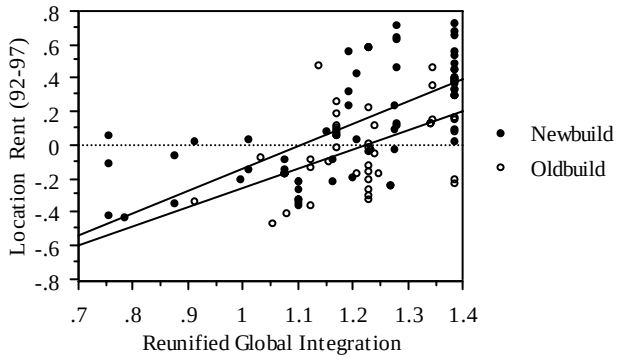
For East Berlin, rents are much more predictably spatially ordered and the measure of reunified global integration is the most effective predictor. Figure 8.18 below shows the linear

regression model for location rents of leases in East Berlin using reunified global integration. For new buildings, around 45% of the variation in location rents can be explained in the simple regression model using the measure of reunified global integration. Location rents in old buildings are less predictable, with only 23.7% of the variation explained by the model. Both the regressions for new and old buildings are highly significant ($p<.0001$). The relationships are even stronger if the period after 1994 is viewed alone, as in Figure 8.19 below. Excluding the earlier years brings the r-squared correlation co-efficient[40] for new buildings to .451 and for old buildings to .283.



Resid Ln Headline Rent (91-97) = -1.234 + 1.013 * Reunified Global Integration; R^2 = .237 (Oldbuild)
Resid Ln Headline Rent (91-97) = -1.145 + 1.068 * Reunified Global Integration; R^2 = .445 (Newbuild)

Figure 8.18: Reunified Global Integration and Location rents in East Berlin



Resid Ln Headline Rent (92-97) = -1.479 + 1.337 * Reunified Global Integration; R^2 = .451 (Newbuild)
Resid Ln Headline Rent (92-97) = -1.397 + 1.146 * Reunified Global Integration; R^2 = .283 (Oldbuild)

Figure 8.19: Reunified Global integration and Location rents in East Berlin 1994-1997

[40] The improvement in the correlation holds true even if the adjusted r squared values are used. For Figure 8.18, the adjusted values are .222 for old build and .438 for new build. For Figure 8.19 they are .267 and .443 respectively.

8.8 The Changing Pattern of Location Rents in Berlin

Having shown that the global integration structure of the city appears to provide the best correlate for location rents, it is now possible to use global integration as a tool with which to understand the relationship between rents in the core and the periphery of the city over time. In the literature review chapter, Alonso's representation of rent values in the core and periphery were shown in his discussion of the possibility of multiple peaks in rent (see Figure 2.6 on page 50). However, the Alonso model was limited by the use of distance to the CBD as a spatial determinant as this was the only measure he suggested as an independent spatial variable in the theoretical model of rent and land use determination.

In this section integration will be used as an independent spatial variable to compare geographically disparate locations that have similar characteristics with respect the city as a whole by splitting the sample into 10 percentiles of global integration. Rather than using the dasymetric areas created by the property agents' reports (for which the methodological basis of their definition is unclear) this is a truly independent method of grouping by location that is reproducible for any city. Table 8.5 below shows the count of lines within each 10-percentile range of the frequency distribution for global integration in Berlin. Relatively few of the lines in the city are in the top 10-percentile range (only 3.7% of all lines). The sample size for leases in new and old buildings within each of these percentiles is shown in Figure 8.20 below.

From (>=)	To (<)	Count	Percent
.453	.546	367	3.665
.546	.639	946	9.448
.639	.732	2080	20.773
.732	.826	2204	22.011
.826	.919	1426	14.241
.919	1.012	1488	14.861
1.012	1.106	928	9.268
1.106	1.199	429	4.284
1.199	1.292	132	1.318
1.292	1.386	13	.130
	Total	10013	100

Table 8.5: Frequency Distribution for Reunified Global Integration

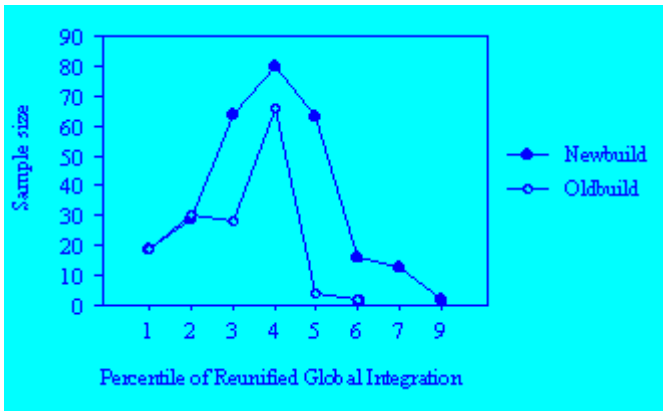


Figure 8.20: sample size in new and old buildings within reunified global integration percentiles

Figure 8.21 below shows the average location rent in each percentile group. As is to be expected from the importance of integration within the MRA, there is a falling away in location rent from the core (global integration band 1) to the periphery.

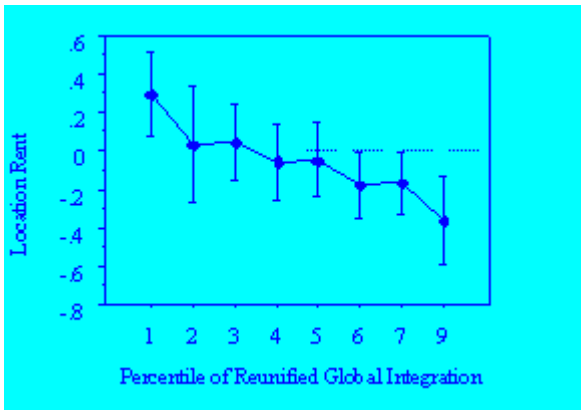


Figure 8.21: location rent split by reunified global integration band

It could be argued that this pattern of location rent is comparable one to the Alonso model of rents falling away from the CBD. After all, rents fall away from the core of global integration in a similar fashion. If a mirror image of Figure 8.21 was placed on the left hand side, it would look similar to the Alonso rent diagrams (see Figure 2.6 on page 50). However, the use of an independent analysis of space to provide the location variable and not the pattern of land uses is fundamentally different to the Alonso model because it allows the changing structure of rents to be evaluated without reference to the land use pattern. The analysis is not restricted by the simplifying assumptions of the distance to CBD view of location.

The importance of this difference between the independent measure of spatial structure and the distance from CBD measure used in previous studies can be demonstrated by looking at

the changing pattern of rents over time with the same integration bands, as in Figure 8.22 below. Within the period directly after reunification, the remaining importance of the Western CBD in rent patterns can be seen as a 'bump' at around band 3 of integration. Although it was outside the core of global integration from the moment of reunification, the Western CBD at band 3 was the peak of rent values in Figure 8.22a of rents between 1992 and 1994 (left).

The pattern in Figure 8.22b (right) shows rents from 1995 to 1997. In this figure the peak is at band 1 and the location rent falls more evenly away to the peripheral bands. The Western CBD no longer causes a 'bump' in the pattern of rents from the spatial centre. This is another expression of the shift of rents in line with the spatial reorganisation of the city. The rent pattern has 'normalised' around the new spatial structure.

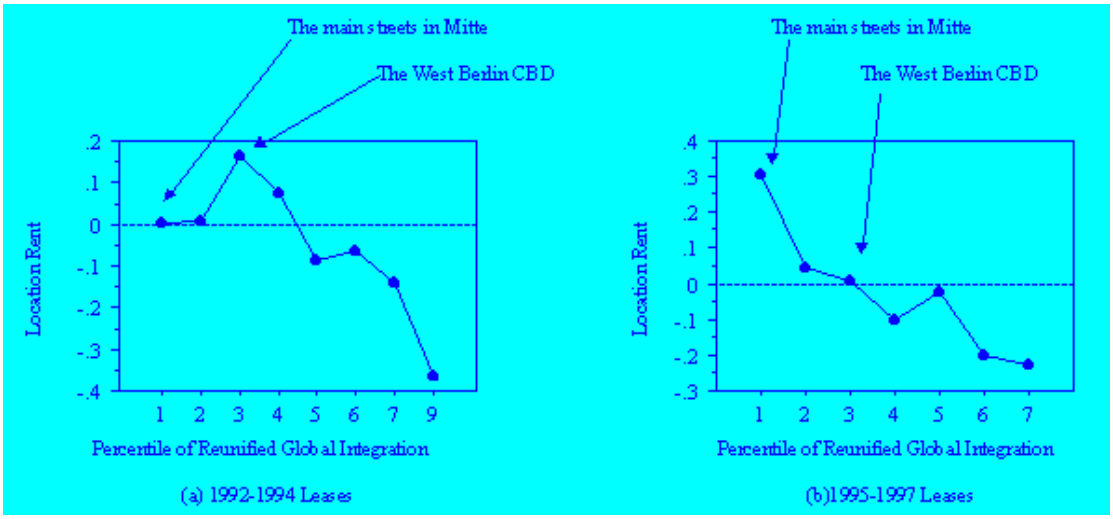


Figure 8.22: Location rent by global integration band for 1992-94 (left) and 1995-97 (right)

The bands can also be further split to show the difference between new and old buildings in East and West Berlin, as was undertaken in the MRA above. The distinction between new and old buildings in West Berlin is complicated by the peculiarities of the sample there, as has been discussed above. However, for East Berlin the build quality variable does capture something structural about the market, as can be seen in Figure 8.23 below. The differentiation between new and old buildings that occurs at the centre can be seen in the divergence of mean location rent values for rents in East Berlin (the left hand graphic of Figure 8.23 below). The kinds of trade-offs between building quality and location centrality that are discussed in general theoretical terms in the Alonso model could be investigated graphically using such techniques. Office space in a new building in East Berlin located in the 3rd percentile of global integration might be comparable on this basis with a space in an old building in the prime first percentile range of integration.

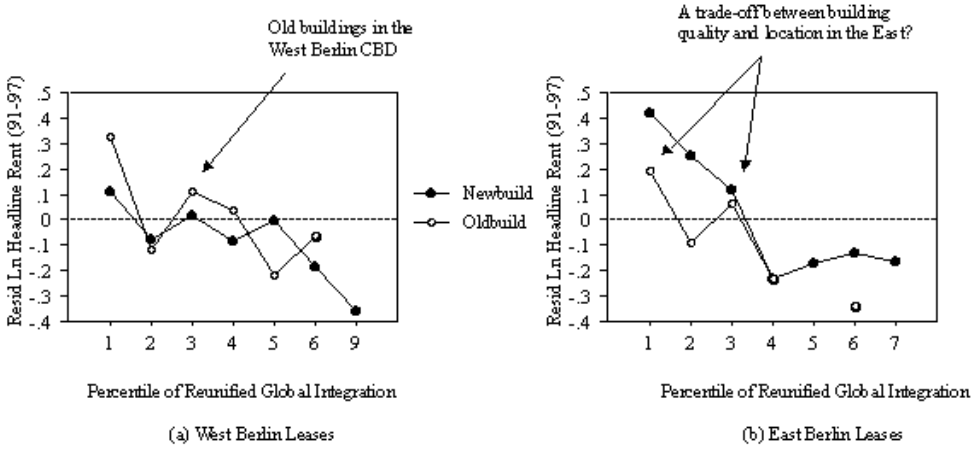


Figure 8.23: location rent in new and old buildings by reunified global integration band for West (left) and East (right)

8.8.1 Spatial Differences in the fluctuation of rents

The integration bands can also be used to examine differences in the fluctuations in rent in the centre of the city compared to the more peripheral locations. This can be seen in the range of location rents shown in Figure 8.24 below. The maximum fluctuation can be seen to occur in the core of the city and ripple out towards the edge. The standard deviation is also greater in the centre, although the results reflect a small number of cases in the sample at global integration band 9 (only 2 cases) which leads to a standard deviation that is actually only the difference between two cases (and is consequently meaningless). A much larger sample size is needed to test these differences. However, a hypothesis from the initial findings is that not only are rents higher in more integrated locations but the range and deviation over the economic cycle may also be greater in the core than it is in the periphery. It seems that there is a 'ripple out' effect in rents.

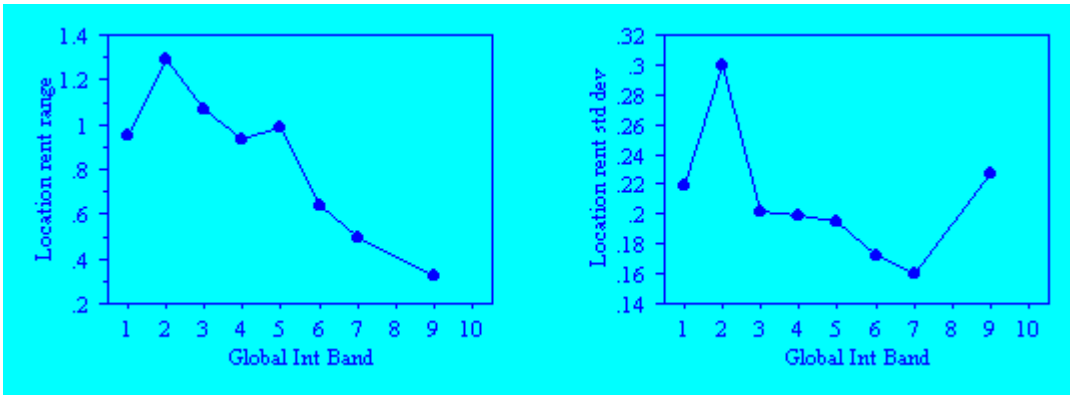


Figure 8.24: Fluctuations in location rent by global integration band

8.9 Discussion: the decline and rise of centres

The statistical analysis has shown that the significant variables in rent determination for Berlin are time and space. In other words, the date that a lease was signed and its location within the city are overwhelmingly important in rent determination, and other variables such as building quality, lease length and unit size do not exert a statistically significant effect. The conclusion to be drawn from this is not that the influence of other variables in rent determination is minor per se, but rather that their influence in Berlin in the period under study cannot be detected outside the effect of location and time. The purpose of testing the other variables with location was to see whether the pattern of rent that seems to be related to the location within the city was actually owing to the hidden influence of other variables. It is never possible to rule out an influence of untested variables on the results, but it is possible to state that those tested in this study cannot be said to account for the spatial pattern of rents.

However, the roles of time and space in the determination of rents in Berlin during the study period are more complex than might be expected, because the models chart the decline of one centre and the rise of another. The strongest variable in the determination of West Berlin rents is time, with a negative relationship. The second strongest variable is the integration values from *divided* Berlin, which correlate with rents positively. Other non-spatial variables and reunified integration are not significant for Western rents. Thus the rents in West Berlin have been falling steadily through time and have been spatially organised around the old pre-unification pattern of integration. The two variables found to determine rents for leases in East Berlin are integration and time, however, it is the *reunified* pattern of integration that is found to be most significant. Reunified integration is actually more important than the time variable. The regression is a messier one but it is still highly significant.

This means that rather than a 'shift' in the location of the CBD gradually Eastwards, what has taken place in Berlin is actually the decline of one centre and the concomitant rise of another. Rents within the West Berlin CBD have remained organised spatially around those streets that were most integrated during division, but have plummeted with the recession. In the East of the city, the new market in office space has evolved a spatial organisation that relates to the new geography of reunified Berlin. This centre has 'bucked' the time trend quite effectively during recession, falling only marginally in absolute average prices and gaining in location rent relative to the rest of the city. The period under investigation is one of a shift from one equilibrium of spatial structure and rent patterns to another and it is the change to the spatial structure that occurred first.

Having completed this more detailed statistical modelling of rent values, the next chapter will summarise the findings of this thesis and draw out the conclusions that result from it.

8.10 Summary

Statistics split by area and year by year were used to explore the shift in rents to the Eastern Mitte area over time that was found in the rent representations of chapter 7. They also confirmed the suspicion that the relationship between building quality and rent is a *positive* one, once location has been controlled for by looking at samples of rent in small areas and by including space syntax measures of location in regression models.

Multiple regression analyses were used to isolate the influence of each variable for rents in East and West Berlin and in new and old buildings. A distinction was found between the determinants of rent in West and East Berlin. Whereas rents in the west were spatially organised towards the pattern of integration for divided Berlin, those in the East were organised around the pattern for reunified Berlin. The relationship between time and location in determining rent was different between West and East. The most important determinants of rents in new buildings in west Berlin is the time, as they fell with the recession. In East Berlin, differences in rents in new buildings are most determined by spatial location, with time of secondary importance.