Testing for the existence of office submarkets: a comparison of evidence from two cities

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Abstract

Most conceptual and applied economic models of the structure of urban office markets have been developed from traditional location theory. In their basic form, these models tend to posit a trade off between accessibility and space. In the light of changing business practices and decentralisation, however, some authors have noted that the influence of agglomeration economies on the locational dynamics of commercial property markets may be declining. In this paper, we seek to undertake an indirect test of the power of intraurban office location theory. The paper is developed in two stages. In the first part, we examine the theoretical case for the existence of submarkets in urban office markets and outline the implications of submarket existence for traditional office location theory. In the second part of the paper, using data from Edinburgh and Glasgow, we undertake empirical tests for submarket existence. A comparison of the results from the two city markets provides limited evidence of the existence of spatial submarkets and suggests that markets might take different spatial forms depending on the urban context. The paper concludes by highlighting the need to account for the complex structure of urban property markets in developing models for property appraisal, taxation and land use planning purposes.

1. Introduction

Generally conceptual and applied economic models of the structure of urban office markets have been developed from traditional location theory (Parr and Reynolds-Feighan, 2000). In their basic form, these models tend to posit a trade off between accessibility and space. However, in the light of changing business practices and decentralisation, some authors have noted that the influence of agglomeration economies on the locational dynamics of commercial property markets may be declining (Ball *et al*, 1998, Gibson and Lizieri, 1997; Egan and Nield, 2000). This raises questions about the underlying assumption that urban property markets are unitary, equilibrating entities. Instead it seems possible that office markets may be more usefully characterised as a set of quasi-independent submarkets (Dunse and Jones, 1997; Hendershott *et al*, 1997).

In this paper, we seek to undertake an indirect test of the validity of intraurban location theory as a means of conceptualising the structure of urban office markets. The paper is developed in two stages. In the first part, we examine the theoretical case for the existence of submarkets in urban office markets and outline the potential implications of submarket existence for traditional office location theory. In the second part of the paper, using data from Edinburgh and Glasgow, we undertake empirical tests for submarket existence. Following the procedure developed by Schnare and Struyk (1976) and subsequently extended by Bourassa *et al* (1999a; 1999b) the test consists of four steps. In step one, market-wide hedonic models are parameterised for each of the case study cities. In step two, submarkets are constructed from both prior knowledge and a statistical procedure based on a combination of principal components factor analysis and duster analysis. In step three, a number of submarket specific equations are estimated. In the final stage the implicit rental estimates in each submarket are compared with those of the market-wide models.

In the concluding section we highlight the conflicting results from the two city markets. While the Glasgow case study seems to confirm the existence of spatial and structural submarkets in metropolitan office markets, the Edinburgh analysis suggests the existence of a unitary market consistent with neo-classical location theory. Comparison across cities suggests that submarket systems are likely take different spatial and structural forms depending on the urban context. The paper concludes by highlighting the need to account for the complex structure of urban property markets in developing models for property appraisal, taxation and land use planning purposes.

2. Theoretical background

In standard urban and real estate economics texts, office location decisions are shown to be influenced by factor costs, transport and communications costs, the quality of the urban environment and agglomeration economies (Ball et al, 1998; Evans, 1985). At the intraurban level a number of behavioural studies have demonstrated the advantages of central locations (see, for example, Goddard, 1975). The desire for central locations has tended to push up rents in the central business district (CBD). This effect has been effectively captured in neo-classical models of the office location decision which show a trade off between access to the CBD and space. These models highlight the existence of a negative bid-rent gradient. The tractability of ‘delayering’ and other trends in business practices.

There are also good reasons to believe that the structure of the market may be complicated by both the characteristics of office property as an economic commodity (that is, its heterogeneity, spatial immobility and durability) and the existence of a range of market imperfections including the existence of high transaction costs and information asymmetries. Arguably, because of long adjustment lags on both the supply and demand side of the market, the single market price associated with a stable equilibrium may be elusive (even in the long run). It is possible that, in reality, the market will be somewhere on the dynamic path towards equilibrium but may never reach that state because further exogenous shocks will redirect the adjustment process. The frictions that inhibit this equilibrating process may give rise to differential prices (even for a standardised office unit) in different parts of the market. The system by which price differences are arbitraged away can be stalled in a number of ways. On the demand side, demanders may have different preferences and business requirements which direct them towards particular subsets of the stock (Powers, 1993). On the supply side, the stock can be thought of as being comprised of a set of 'property types'. As Morrison (1994) shows, for example, the office stock in Glasgow is characterised by clusters of similar properties that can be traced by the period in which they were constructed.

The interaction between segmented demand and the differentiated stock (supply) of office units can lead to the co-existence of a number of (quasi)independent submarkets. Excess demand for a particular office type would push rents up in that specific submarket. Although there will be linkages between submarkets, as renters switch from one to another as changing requirements or availability dictates, rent movements will be some extent independent. This market structure can give rise to a spatial distribution of rental values that is quite different in form from that derived from location theory. Indeed, research by Dunse and Jones (1997) provides evidence of office submarket existence in Glasgow. This study shows that rental differences can be observed between submarkets construc ted on the basis of local authority planning regulations and agents' perceptions.

If this explanation is accurate it may be more useful to conceptualise urban property markets in terms of a set of quasi-independent submarkets. Following Grigsby et al (1963) a submarket would comprise of all properties considered close substitutes by potential purchasers or renters. Submarket existence would be revealed by the presence of significant differences in the rental paid for a (hypothetical) standardised unit of property.

Similar issues have been addressed in studies of the structure of urban housing markets (see *inter alia* Schnare and Struyk, 1976; Ball and Kirwan, 1977; Maclennan *et al*, 1987; Bourassa *et al*, 1999b). In a recent review article, Watkins (1998) shows that eighteen out of twenty studies, undertaken in a range of international property markets, have shown evidence of the existence of housing submarkets and have questioned the validity of location theory as a conceptual framework for housing market models. In the empirical section of this paper we seek to replicate these studies. We argue that our tests for submarket existence in the Edinburgh and Glasgow office markets can be interpreted as an indirect test of location theory and, in particular, the notion of unitary metropolitan markets.

3. Data and research method

In the previous section we argued that the segmentation of supply and demand and the independence of each submarket could lead to differential prices being paid for a standard quality office unit in different parts of the market. If this pattern of rents were observed this would challenge the existence of the standard negatively sloped bid-rent curve. This has been tested for urban housing markets previously. In this literature, the procedure for testing for submarket existence at a single point in time was introduced by Schnare and Struyk (1976) and has been employed by *inter alia* Dale-Johnson (1982), Munro (1986) and Watkins (1998a). By replicating this process, it is possible to compare the ability to describe market outcomes of a model which takes account of a submarket existence and a standard market wide hedonic equation.

The test procedure involves four stages. First, hedonic office rent functions are estimated for the entire market and for each potential market segment in order to compare the submarket specific rent paid for a 'standard' office unit. Second, submarkets are defined using alternative means of clustering comparable office units. Third, a chow test is computed to establish whether significant differences exist between submarkets[1]. Fourth, a weighted standard error is

[1] The formula for the Chow test is as follows: $F=[(RSS_c - RSS_i - RSS_j) / (K - 1)]/[(RSS_i + RSS_j) / (n + m - 2(k + 1)]$ where n and m are the number of observations in the two sub-samples i and j and RSS_c is the residual sum of squares of the combined model. The RSSs are found by estimating the equation three times, once for each of the

calculated for the submarket model[2]. This acts as a further 'common sense' test of the significance of rent differences for standard office units in different submarkets, and also allows us to compare the effect on the accuracy of the rental value models when different submarket definitions and stratification schemes are compared.

In order to undertake the tests described above, data were collected for two case study areas: Edinburgh and Glasgow. Glasgow and Edinburgh lie approximately 50 miles apart and are located upon the west and east coast of central Scotland respectively. They are Scotland's two largest cities and act as national, regional and local administrative centres.

Edinburgh has a population 441,600 and is the capital city. It houses the newly devolved parliament. Unemployment is at the relatively low rate of 5.2% with a high proportion of the population employed in the financial and business services, 18.5%, compared with only 12.9% within the manufacturing sector (Knight Frank, 1998). Overall the business structure of the local economy is dominated by activities such as law, business administration and education (Lloyd and Black, 1995). As Gibb (1997) points out, despite the adverse property market effects of significant traffic problems, the city and its agencies emphasise the quality of life aspects associated with the city.

In recent years, the Edinburgh office market has been experiencing a wave of major development in both the traditional central core and in Edinburgh Park, a business park located to the west of the city. The City's historic New Town features a stock of offices located within Georgian townhouses which are generally considered to inflexible and outmoded (Gibb, 1997, Dunse *et al*, 2000).

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subsamples and once for the pooled sample. The F-statistic which is calculated is compared with the critical value F_{cv} which is distributed as $F_{cv} \sim F(K+1, n+m-2(k+1))$.

[2] The formula for the standard error test is as follows:

$$SE_c^2 = \frac{N_1 - k_1 - 1}{\Sigma (N_j - K_j - 1)} SE_1^2 + \frac{N_2 - k_2 - 1}{\Sigma (N_j - K_j - 1)} SE_2^2 + \ldots\ldots\ldots + \frac{N_J - k_J - 1}{\Sigma (N_j - k_j - 1)} SE_J^2$$

where Nj is the number of transactions in the jth submarket, kj is the number of explanatory variables in the jth submarket equation and there are j submarkets.

Glasgow has a population of 681,500 and acts as a regional centre. The unemployment rate is higher (at 8.1% in 1998) and a higher percentage of the population is engaged in manufacturing, 17.9%, compared with 11.8% employment within the financial and business sector (Knight Frank, 1998). Gibb (1997) notes that, despite being a regional centre, Glasgow and many of the surrounding areas suffer from some of the highest levels of multiple deprivation in the UK.

The Glasgow office market is characterised by a mix of Victorian space which sits alongside more recent speculative developments (Gibb, 1997). To the (inner) west of the city centre, office space is available in converted Georgian townhouses. This area has been experiencing a return to residential use in recent years[3].

The data used in this study is a subset of a database maintained by Scottish Property Network (SPN) at the University of Paisley. This database comprises a comprehensive core of all individual office properties in Scotland, together with information on asking rents and property characteristics including size, quality, age, and condition. This basic data set has been augmented by the addition of distances to key points of accessibility and location quality indicators. Initially, a total of 759 asking rent observations[4] for new lettings, located within Glasgow and Edinburgh were collected spanning the period 1992-1998. However, after checking the data for inaccuracies and missing variables the number of observations was reduced to a figure of 539. Table 1 illustrates the distribution of the transactions across each city per year. The table shows that stock availability has varied over time. Notably, Glasgow peaks in 1994 while Edinburgh has a more even distribution. There are few transactions in either city before 1994.

[3] For further information, see Turok (1999) for an overview of local economic conditions and trends in the two cities.

[4] Clearly there will be differences between asking rents and actual transaction rents. However, asking rents are used for three reasons. First, although some transactions data is insufficient to support the econometric modelling work. Second, as Brown et al (2000) explain, often transactions data can be distorted by lease terms. This complication is removed when using asking rents. Third, a range of housing market studies in the UK have argued that asking price/rent data is better than no data. (See Cheshire and Sheppard, 1989; 1995; Henneberry, 1999; Orford, 1999 for examples of work in this tradition).

Table 1: The distribution of observations by year and city

Year	**Number of Observations**		
	Glasgow	***Edinburgh***	***Total***
1992	0	2	**2**
1993	0	9	**9**
1994	145	30	**175**
1995	45	47	**92**
1996	57	34	**91**
1997	35	47	**82**
1998	63	25	**88**
Total	**345**	**194**	**539**

The information obtained on the transaction, physical and location characteristics is described in Table 2.

Table 2: Definition of the physical and locational variables

Transaction	
Rent	Asking rent per square metre
Year	Year of transaction
Physical & Quality	
Size	Gross Internal Area measured in square metres
Age	Categorised into five age bands; Before 1960, 1960-69, 1970-79,1980-89 and 1990 onwards
Attribute Quality	Categorised into three measures; poor, good and excellent
Condition	Categorised into four measures of condition; poor, fair, good and excellent
Location	
Distance To A Central Point	Straight-line distance in metres to a central point within the city centre
Distance To Nearest Railway Station	Is the suite located within 250 metres of a major railway station?

The majority of the physical and quality variables have been converted into dummy variables by way of binary coding. Details of these are given in Appendix 1, Tables A1.1 – A1.3.

In our dataset, location is measured in three dimensions. First, straight-line distance (*CP*) is recorded from a central point within each city. For Glasgow this central point is defined as St. Vincent Street which has traditionally been regarded as the most accessible point in the city. During the period when trams were operating in the city of Glasgow this is the street where all the tramlines crossed. In Edinburgh the most accessible point is generally regarded as being George Street. Second, the proximity to public transport is recorded. Both Glasgow and Edinburgh have a high proportion of commuters both within each city catchment area and between both Glasgow and Edinburgh. In this study a dummy variable (*Rail*) measures whether the office suite is located within 250 metres of a railway station[5]. Third, a dummy variable measures whether the office suite lies within an area regarded as prestigious to office occupiers. To determine this we relied upon real estate agents interviews and market reports (see Knight Frank, 1998; Ryden, various; Hillier Parker, 1990).

Overall the variables comprise a comprehensive set of office attributes. While there are a few potentially important characteristics that are absent (such as the internal layout) it is likely that they are subsumed within the age and attribute quality variables.

4. City-wide hedonic models for Edinburgh and Glasgow

The first step in the test procedure outlined above requires that we estimate a hedonic model for each city-wide office market. In constructing these models we seek to ensure that they are consistent with theory and are technically robust. As such, before discussing the interpretation of the models, we briefly outline the expected size and magnitude of the estimated coefficients, the treatment of multicollinearity, and the choice of functional form.[6]

[5] There is a regular express service operating at fifteen minute intervals between the cities.
[6] At this point, we do not discuss the elimination of spatial heteroskedasticity. As Bajic (1985) notes this can be minimised by spatially segmenting the data set. Clearly this is undertaken in constructing office submarkets in section five of the paper. As such we do not report the diagnostic tests here.

Table 3: Expected signs of the explanatory variables

Coefficient	Expected Sign
PSIZE	-ve
AGE1	-ve
AGE2	-ve
AGE3	-ve
AGE4	-ve
ATT_G	+ve
ATT_E	+ve
COND_G	+ve
COND_P	-ve
COND_E	+ve
CP	-ve
RAIL	+ve

Table 3 indicates the expected signs of each coefficient based on theoretical considerations. For instance, given a discount for quantum, we would expect a negatively signed coefficient on the size variable. It is anticipated that the Age variables would also have a negative impact. Similarly 1960's buildings are of poor design, construction and aesthetic appearance and would be expected to have the greatest negative impact on rent. The quality and condition variables (except the variable representing poor condition) would on the other hand be expected to have a positive impact on rents.

In estimating the models, the problem of multicollinearity often diminishes the reliability of the estimated coefficients. As such, an important first step in the modelling process is to check that the independent variables are not highly correlated with each other. The correlation matrices for the both Glasgow and Edinburgh are reported in Appendix 2, Tables A2.1-A2.2. Following Mark and Goldberg (1984), we interpret the absence of any correlation coefficients in excess of 0.7 to imply that multicollinearity is not a major concern[7].

In both city models, linear and logarithmic transformations were tested. The result showed that the linear functional form provided the most theoretically consistent and plausible models for both cities when judged against our apriori expectations of the signs and magnitudes of the

[7] Powe *et al* (1995), Hoesli *et al* (1997) and others explain that it is impossible to completely eliminate multicollinearity from hedonic functions. As such it is best practice to minimise the inter-relationships.

coefficients[8]. Although this differs from the findings of several of the US studies (see Mills, 1992; Glascock *et al*, 1990), it is consistent with the only published UK hedonic office rental model (Dunse and Jones, 1998).

Tables 4 and 5 report the results of the hedonic regressions for each city. In interpreting these results, the constant provides a useful reference point. In these specifications, the constant represents some minimal form of accommodation, namely a 1990 office in fair condition with a relatively limited package of attributes (including toilets, lifts, reception area etc). The relative magnitudes of the coefficients are broadly consistent with market evidence. In Glasgow the constant implies that the minimal rent for this form of building is approximately £95/m2 compared with approximately £104/m2 in Edinburgh.

[8] Cassel and Mendelsohn (1985) argue that, if several alternative functional forms perform similarly, it is legitimate to use pragmatic criteria, including theoretical consistency, to choose the best form.

Table 4: Glasgow City Wide Hedonic Model

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.784	.614	.600	13.6136

ANOVA	Sum of Squares	df	Mean Square	F	Sig.
Regression	97977.364	12	8164.780	44.055	.000
Residual	61529.710	332	185.330		
Total	159507.074	344			

Coefficients(a)

Model	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	T	Sig.
(Constant)	95.534	3.684		25.934	.000
PSIZE	1.558E-02	.005	.120	3.065	.002
AGE1	-7.578	3.482	-.106	-2.176	.030
AGE2	-9.261	4.189	-.103	-2.211	.028
AGE3	-32.727	3.781	-.482	-8.656	.000
AGE4	-14.477	3.130	-.324	-4.625	.000
ATT_G	7.893	1.946	.173	4.056	.000
ATT_E	14.515	2.061	.325	7.044	.000
COND_G	9.895	1.809	.225	5.469	.000
COND_P	3.874	2.553	.057	1.517	.130
COND_E	12.404	4.651	.110	2.667	.008
CP	-2.816E-03	.001	-.186	-4.923	.000
RAIL	6.483	1.764	.134	3.676	.000

Dependent Variable: RENTM2

Unusually the year of the transaction is not significant in either model[9]. This is perhaps surprising given the considerable increase in market activity in Edinburgh since the opening of the Scottish Parliament. It is possible that this is a quirk of the data rather than evidence of a stagnant market. Indeed this runs against the evidence put forward by local agents in both cities. One likely explanation is that the asking rents used in this study do not contain the full information about the transaction. It is also possible that they represent the agents opening offer around which the two parties will negotiate. In addition the parties may negotiate other

[9] These models are estimated on data pooled across years. Despite expectations that there might be rental appreciation over the study period, chow test results suggest that, when the regression equations are estimated for each year, the implicit price estimates are equal. This finding was cross-checked by entering year dummies into the model. Again there was no evidence of a significant effect. These results are available from the authors.

incentives such as rent free periods which lead to the appearance of a high headline rent. In poorer market conditions the agents may still ask for a high rent but are more willing to negotiate down and/or offer other incentives. Consequently the use of asking rents can introduce differential bias in different market conditions.

Table 5: Edinburgh City Wide Hedonic Model

Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.745	.555	.526	12.8655

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	37435.890	12	3119.658	18.847	.000
Residual	29959.474	181	165.522		
Total	67395.364	193			

Coefficients

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	T	Sig.
(Constant)	104.236	6.012		17.339	.000
PSIZE	-3.406E-04	.006	-.004	-.057	.955
AGE1	-6.812	10.682	-.037	-.638	.524
AGE2	-12.040	12.903	-.065	-.933	.352
AGE3	-28.920	10.700	-.157	-2.703	.008
AGE4	-14.340	5.012	-.234	-2.861	.005
ATT_G	4.424	2.232	.111	1.982	.049
ATT_E	13.638	2.784	.324	4.899	.000
COND_G	8.492	2.330	.201	3.644	.000
COND_P	1.659	2.953	.029	.562	.575
COND_E	16.279	5.090	.218	3.198	.002
CP	-2.940E-03	.001	-.230	-3.379	.001
RAIL	11.358	2.162	.304	5.253	.000

Dependent Variable: RENTM2

The Glasgow model generates some other slightly unusual results. For example, the size of the office unit is significant, but has an unexpected sign. Evidence from historic market reports however show that there has been a supply shortage of larger floor plates and that there is a premium attached to floor area in Glasgow (Ryden, various).

Nevertheless the models provide several intuitively appealing insights. The age variable for example acts as a proxy for missing characteristics such as layout and construction. In both cities the age variables are generally significant. One exception, however, is in Edinburgh where the implicit rental premiums of the newer properties are not significantly different from the 1990s building represented by the constant. It seems that occupiers see properties of a newer vintage to be close substitutes to each other and do not make adjustments in price for age. The other age variables, however, suggests that as the property ages there is a greater reduction in rent. This variable also picks up the influence of obsolescence and depreciation in certain forms of building. In both cities the age 3 variable (1960 – 1969) shows the greatest negative impact on rents. In fact, rents decrease by approximately £30 per squared metre in each city when

The attribute score variables are significant and take the expected sign for both city wide models. This suggests that, as the property becomes better equipped, there will be a positive effect on the rent. In the Edinburgh market a greater premium is paid for properties with an excellent attribute quality. This may reflect a shortage of good quality space.

Property condition appears to be fairly important in both models. The results show that a premium is paid for properties in good and excellent condition. Properties in poor condition, however, do not appear to be penalised in rental terms when compared against properties in fair condition.

Similarly the location measures are significant in both cities. In line with standard location theory, rents diminish from a central point. In fact the slopes of the bad-rent curves are similar in each city. This can be interpreted as evidence of the continuing importance of face-to-face contact among office occupiers and the strong influence of agglomeration economies. The dummy variable indicating proximity to a railway station is also important and may reflect interaction with other parts of the regional economies and between both cities.

Overall, these equations compare tolerably with other published hedonic functions and provide reasonable explanatory power and theoretical consistency. The analysis highlights the significance of age, location, quality and condition in the determination of office rents.

5. Classifying submarkets

The data are stratified into submarkets using two distinct methods. The first approach is based on prior knowledge of the city property markets and produces a simple submarket structure which incorporates the influence of locational characteristics. This classification scheme is based on the premise that geographically contiguous properties may be considered relatively close substitutes by potential tenants. These dimensions were generated in consultation with local market actors, and with reference to market reports produced by the property profession and urban planners (Hewines, 2000). The Glasgow market is sub-divided into three city centre submarkets, a peripheral segment and a further compartment in the Park area. Edinburgh is comprised of two city centre sub-areas, a peripheral segment and a Leith submarket.

Tables 6 and 7 below outline the structural characteristics of offices in the *a priori* spatial submarkets for both Glasgow and Edinburgh. The mean property size, distance from the central point and unit rent are given. Similarly, the modal property characteristics are identified.

Table 6 Structural characteristics of offices in the 5 *a priori* submarkets in Glasgow

	1 Mean/ mode	2 Mean/ Mode	3 Mean/ Mode	4 Mean/ Mode	5 Mean/ Mode
PSIZE	188	256	173	173	166
CP	166	272	343	1,079	3,767
RENTM2	111	101	92	93	74
CT	4	4	8	6	4
PCOND	4	4	6	6	6
FINTY	7	5	7	5	7
ST	1	1	1	4	4
AGE	5	5	4	5	5
ATTRIB	6	7	5	3	1

Table 6 shows relatively little difference in the average size of unit in each spatial submarket. It also shows that, in line with location theory, rental values decline with distance form the city centre.

Table 7 shows a less obvious relationship between average rental values and distance from the central business district. Despite relative homogeneity in average construction type and age across spatial submarkets, there are marked differences in the average size of units.

Table 7 Structural characteristics of offices in the 4 *a priori* submarkets in Edinburgh

	1 Mean/ mode	2 Mean/ Mode	3 Mean/ Mode	4 Mean/ mode
PSIZE	180	133	115	200
CP	864	1,173	3,175	1,552
RENTM2	104	99	94	103
CT	6	6	4	6
PCOND	6	6	6	6
FINTY	7	7	3	7
ST	4	4	4	4
AGE	5	5	5	5
ATTRIB	4	5	1	6

The second approach used in the construction of submarkets seeks to eliminate the possibility that researcher bias or mis-perception may introduce errors into the process. Following the innovative statistical approach devised by Bourassa *et al* (1999a) and deployed in Bourassa *et al* (1999b), we combine Principal Components Analysis (PCA) and cluster analysis techniques in a two stage process. In stage 1 of this procedure, PCA is undertaken on a set of eight property characteristics. This produces a limited set of uncorrelated factors which, together, retain most of the variance or information contained in the original variables and assigns a factor score to each property. As Bourassa et al (1999a) argue this identifies the underlying dimensions that characterise and differentiate property submarkets (see also Dale-Johnston, 1982; Maclennan and Tu, 1996; Watkins, 1999). In the second stage the weighted factor scores are used to cluster properties into office submarkets. Cluster analysis is a procedure generally used to assign individual observations to groups that are similar in character. The application of this technique in property market analysis has been increasing rapidly in recent years. Hoesli et al (1997a) and Jackson (forthcoming), for example, have employed the technique to group local property markets in the UK. In this study, the submarkets are formed using the K-means clustering method.

The structural variables used in the analysis are defined as follows[10]:

PSIZE	The floor area of the *i*th office.
CT	Construction type (there are 11 defined construction types).
PCOND	Property condition.
FINTY	Finish type (shell, fitted, decorated, high specification etc).
ST	Office subtype (modern, traditional, serviced, office park)
AGE	Age band (1990 onwards, 1980-1989, 1970-1979, 1960-1969 and pre 1960).
ATTRIB	Attribute score. For features which include lighting type, heating type, lifts, ventilation, security, car parking and so on.
CP	Distance from the defined 'central point' of the city centre

By undertaking principal components factor analysis the eight variables are reduced to a smaller number of underlying factors that describe variation in property type. The principal components analysis identifies common factors that yield an eigenvalue variance greater than one (Norusis, 1988). Theoretically the analysis could yield seven factors that meet this criterion. In this case, two factors are identified for Glasgow and three for Edinburgh. The results of the factor analysis are shown below in Table 8.

[10] Following Dale-Johnson (1982) care has been taken to take account of a full range of structural and locational characteristics whilst, as far as possible, using a different set of variables form those used in the hedonic modelling stage.

Table 8: Results of Principal Components Analysis

		1	2	3	Eigenvalues	Percentage Of Variance Explained	Communality
Glasgow	PSIZEM	-0.5495	0.2550	-	2.5894	36.9917	0.3670
	CT	-0.5171	0.3130	-	1.0595	15.1357	0.3654
	PCOND	0.5250	0.3109	-	0.9122	13.0310	0.3723
	FINTYLK	0.2223	0.8854	-	0.7802	11.1459	0.8334
	ST	0.8239	-0.0410	-	0.7019	10.0269	0.6806
	AGE	0.7413	-0.0969	-	0.5675	8.1073	0.5589
	ATTRIBS	-0.6832	-0.0695	-	0.3893	5.5616	0.4715
Edinburgh	PSIZEM	-0.4503	0.0769	0.7319	2.5088	35.8400	0.7443
	CT	0.6955	-0.2079	0.5052	1.3679	19.5419	0.7821
	PCOND	0.2421	0.7947	0.0473	1.0654	15.2195	0.6923
	FINTYLK	0.2592	0.7688	0.1686	0.7429	10.6130	0.6866
	ST	0.8133	-0.2045	0.1030	0.6157	8.7962	0.7138
	AGE	0.8785	-0.1547	0.0939	0.4137	5.9104	0.8045
	ATTRIBS	-0.5133	-0.1749	0.4738	0.2855	4.0790	0.5186

From the Glasgow data we identify two underlying components in the seven variables. The first loads heavily on property sub-type and age and might therefore be referred to as a 'structural' factor. The second loads heavily on property condition and finish type and can be interpreted as a 'quality' factor. From the Edinburgh data, three underlying components are identified in the seven variables. The first loads heavily on sub-type, age and construction type and is similar to the 'structural' factor identified for Glasgow. The second component is loads most heavily on finished type and property condition and can again be interpreted as a 'quality' measure. The third component is related primarily to property size. This underlying component is peculiar to Edinburgh and there is no equivalent for Glasgow.

These factors are then subject to K-means cluster analysis. In total, as we highlight above, there are five a priori spatial submarkets in Glasgow and four in Edinburgh. These numbers of divisions or dimensions are taken as a working hypothesis and the cluster analysis is performed on the basis that there are five clusters in Glasgow and four in Edinburgh.

a priori submarkets a majority of the observed transactions are drawn in by separate clusters. Properties in cluster 4 are over-represented by units located 'Park area' submarket while properties in cluster 5 are over-represented by those located in the 'outer city [11].

The Edinburgh observations that were grouped in all four of the *a priori* submarkets are distributed fairly evenly between two of the four clusters. The observations of two of the clusters (clusters 2 and 3) are highly represented in the 'peripheral' spatial submarket (submarket 4).

The statistically produced submarket classification thus seems to suggest that office submarkets possess both structural and physical characteristics. This accords well with theory since we might expect that a majority of office users seek functional offices in a general location while a minority will value location above all other factors. For example, office occupiers in the financial and service sectors are likely to value the functional attributes of offices rather than their precise locational attributes. Meanwhile, firms of professionals such as lawyers, accountants and surveyors are likely to be attracted to particular parts of a city, or submarkets, that are associated with professional firms.

Tables 9 and 10 below outline the structural characteristics of offices as grouped in the structural clusters. As before, the mean property size, distance from the central point the modal property characteristics are identified.

[11] Full results are available from the authors.

Table 9 Structural characteristics of offices in the 5 clusters in Glasgow

	1 Mean/ Mode	2 Mean/ mode	3 Mean/ mode	4 Mean/ mode	5 Mean/ Mode
PSIZE	267	305	237	123	71
CP	513	3,911	387	782	4,422
RENTM2	109	71	98	89	72
CT	8	1	8	4	4
PCOND	4	4	6	6	3
FINTY	4	2	7	7	7
ST	1	1	1	4	4
AGE	5	5	4	5	5
ATTRIB	7	4	4	1	0

On average, cluster 2 in Glasgow contains the largest units and also has those which are located at a distance from the city centre. These properties typically have the lowest rent per square meeting. Clusters 4 and 5 contain the smallest, with a larger representation of peripheral units in cluster 5. The highest rental values and centrally located units are grouped in clusters 1 and 3.

The Edinburgh clusters exhibit higher average distances from the central business district. Larger high value units are grouped in cluster 3 while smaller high value units are represented in cluster 1. On average, the lowest value properties are found in cluster 2

Table 10 Structural characteristics of offices in the 4 clusters in Edinburgh

	1 Mean/ Mode	2 Mean/ mode	3 Mean/ Mode	4 Mean/ mode
PSIZE	271	145	1,873	134
CP	3,586	1,333	1,600	999
RENTM2	116	97	116	102
CT	1	6	4	6
PCOND	5	6	4	4
FINTY	3	7	4	2
ST	1	4	1	4
AGE	1	5	1	5
ATTRIB	6	5	8	4

6. Testing for submarket existence

In this section of the paper we present the results of the final stages of the test procedure. First, we estimate the submarket specific regression equations. Second, these equations are then examined, using Chow tests and the weighted standard error test, for evidence of significant differences in the implicit rents paid in each submarket.

6.1 Submarket models

Table 11 summarises the explanatory power and significant variables for each submarket model. It should be noted that, as Dale-Johnson (1982) explains, the coefficients are relatively unimportant when testing for submarket existence. It is clear that the significant variables, signs and magnitudes will vary from submarket to submarket. As such, the exact parsimonious specification of each submarket specific model is likely to differ. This would only be of interest if we were trying to explain the determination of rental values in each submarket. The standard format reported here, however, is more useful in meeting the requirement of computing the Chow test for parameter equality which is, in turn, used to infer whether differential implicit rents (and submarkets) exist.

Notwithstanding the fact that we are not directly interested in the estimated coefficients, however, some useful insights can be extracted from the submarket specific models. For example, when the Glasgow and Edinburgh *a priori* models are compared the most obvious difference are the significance of the accessibility measures. In Glasgow this only appears to be significant in one submarket whereas in Edinburgh accessibility is significant in all submarkets except one. This may be a reflection of the geographical layout of each city. Glasgow city centre office market is relatively compact and concentric and this enables easy access within the city. A decision to occupy a suite in a non-city centre office submarket appears to discard access as an important quality. However the Edinburgh city centre office market is long and narrow in layout which makes access by foot difficult and leads to greater reliance on other forms of transport.

In all submarkets, in both cities, quality and condition variables are significant, while age appears to have an increasingly important effect as we move away from the city centre. This is perhaps an indirect measure of the importance of the city centres. Investors and developers concentrate considerable resources in developing and refurbishing city centre properties in order to counteract the impact of depreciation and obsolescence.

Table 11: Significant Variables in Each Submarket

Glasgow *A Priori* Submarket	**N**	**Adj. R^2**	**Significant Variables**	**No. of Variables**
City Centre Core	79	0.44	Att_E, Cond_G	2
City Centre Mid	77	0.57	Psize, Age3, Age4, Att_G, Att_E, Cond_G, Rail	7
City Centre Outer	48	0.69	Age1, Age3, Cond_P, Cond_E	4
Park Area	96	0.37	Age1, Age2, Age4, Att_G, Att_E, Cond_G	6
Peripheral	45	0.54	Psize, Att_E, Cond_G	3

Glasgow *Cluster* Submarket	**N**	**Adj. R^2**	**Significant Variables**	**No. of Variables**
1	84	0.57	Psize, Att_E, Cond_G, Cond_P, CP, Rail	6
2	89	0.49	Age3, Age4, Att_G, Att_E, Cond_E	5
3	60	0.51	Age1, Att_E, Cond_G, CP	4
4	56	0.17	Att_G, Att_E, Rail	3
5	56	0.80	Psize, Age2, Age3, Cond_G, Cond_E, Rail	6

Edinburgh *A Priori* Submarket	**N**	**Adj. R^2**	**Significant Variables**	**No. of Variables**
City Centre Core	28	0.50	Cond_G, Rail	2
City Centre Other	70	0.36	Psize, Att_E, CP	3
Leith	8	0.62	Att_G, Cond_G	2
Peripheral	88	0.61	Age3, Age4, Att_E, Cond_G, CP, Rail	6

Edinburgh *Cluster* Submarket	**N**	**Adj. R^2**	**Significant Variables**	**No. of Variables**
1	2			
2	75	0.43	Att_E, Cond_G, CP, Rail	4
3	17	0.994	Psize, Age1, Age3, Age4, Att_G, Att_E, Cond_G, Cond_E, CP, Rail	10
4	100	0.39	Att_G, Att_E, Cond_E, CP, Rail	5

6.2 Tests for price differences

These equations were then tested for parameter equality. Table 12 shows the results of the Chow tests on the *a priori* constructed submarkets in Glasgow. The results show evidence of (submarket 2). The results are not transitive but it seems that a unitary market exists across the three city centre segments (submarkets 1, 2 and 3), and the Park area (submarket 4) form a submarket that is distant from the Peripheral area (submarket 5).

Table 12: Chow Test Results for Glasgow A Priori Segmentation Scheme

Pooled Segments	Chow Test Result
1 with 2	1.80
1 with 3	1.65
1 with 4	0.92
1 with 5	1.76
2 with 3	1.14
2 with 4	0.96
2 with 5	1.36
3 with 4	1.89
3 with 5	2.61
4 with 5	1.50

Table 13 shows the results of the parameter equality tests for the a priori defined spatial submarkets in Edinburgh. Although there appears to be a statistically significant difference between the rents paid in the 'city centre core' (submarket 1) an

(submarket 2), this difference is not repeated when rents in submarket 1 are compared to those in Leith or 'Peripheral' areas (submarkets 3 and 4). On the basis of this evidence, it is difficult to conclude that there is any evidence of the existence of spatially distinct submarkets in the Edinburgh office market.

Table 13: Chow Test Results for Edinburgh A Priori Segmentation Scheme

Pooled Segments	Chow Test Result
1 with 2	2.01
1 with 3	0.57
1 with 4	0.83
2 with 3	0.37
2 with 4	0.98
3 with 4	0.22

The statistically constructed submarkets produce similar results when tested for parameter equality. Table 14 summarises the chow test results for the Glasgow ‘clusters’. After standardising for differences in characteristics and location, it appear that significant variations in rents are paid in the ‘high rent/central’ cluster (cluster 1) when compared to the ‘smaller/central’ grouping (cluster 3). Significant rent variations are also observed between the tral’ cluster and ‘small/low rent/peripheral’ cluster (clusters 3 and 5). However, the structure of the submarket system is not clear, despite some limited evidence that cluster 3 may represent a distinct submarket.

Table 14: Chow Test Results for Glasgow Statistically Constructed Segmentation Scheme

Pooled Segments	Chow Test Result
1 with 2	1.34
1 with 3	2.30
1 with 4	1.58
1 with 5	1.07
2 with 3	1.39
2 with 4	0.38
2 with 5	1.93
3 with 4	1.09
3 with 5	3.36
4 with 5	1.59

Table 15 summarises the chow test results on the statistically constructed clusters in Edinburgh[12]. Again the evidence of submarket existence is limited. There appears to be some suggestion that rental differences exist between clusters 1 and 2 but these differences do not exist when rents in both clusters are compared with those in cluster 3.

Table 15: Chow Test Results for Edinburgh Statistically Constructed Segmentation Scheme

Pooled Segments	Chow Test Result
1 with 2	2.23
1 with 3	0.52
2 with 3	1.71

The chow test results show only limited evidence of submarket existence. These results are consistent with the weighted standard error tests summarised in Tables 16 and 17. This test was proposed by Schnare and Struyk (1976) as a 'common sense' test of the evidence of rent variation. The test is based on the premise that the segmented models, which take account of submarket existence, should lead to a reduction in the standard error of the rent estimates when compared with the standard market-wide hedonic model. There is no strict guidance on the size of the reduction in the standard error required as evidence of significant overall variability in rental values. Dale-Johnson (1982), for example, suggests a five per cent reduction is required, while Munro (1986) and Schnare and Struyk (1976) employ a ten per cent threshold.

Both of the Glasgow submarket systems tested pass the weighted standard error test on the five per cent threshold. Despite the difficulty in interpreting the chow tests results, the statistically based submarket specification produces the greatest reduction is standard error. Neither of the schemes show evidence of submarket existence in Edinburgh.

[12] These tests are performed on only three clusters because the small sample size precluded the estimation of a regression equation for the fourth cluster.

Table 16: Weighted Standard Error Test Results for Glasgow

	% Change in SE
Apriori Segmented Model	5.69
PCA/CA Segmented Model	6.66

Table 17: Weighted Standard Error Test Results for Edinburgh

	% Change in SE
Apriori Segmented Model	-0.1
PCA/CA Segmented Model	2.49

The Glasgow findings are less conclusive than those produced in earlier research (Dunse and Jones, 1997). Dunse and Jones found a reduction of greater than twenty per cent in the standard error for several segmentation schemes. In part the difference in results may reflect the differences in the length of the study period. The period covered by Dunse and Jones' data may be insufficiently lengthy to capture the effects of spatial arbitrage and a relatively sluggish market adjustment process.

The Edinburgh results may be indicative of the influence of significant developments outside the urban core. Large-scale development in Edinburgh Park and other non-central locations may have had a dampening effect on rental values in central locations and as such, they may have contributed to the observed (after standardisation) equalisation of rents across the city. As we acknowledge, after controlling for attribute differences, however, this is slightly surprising in the light of agents' perceptions that the location of the Scottish Parliament has driven rents upwards in central areas. It may be, of course, that these affects have not fed through fully by the end of the end of the study period.

It is also possible to interpret the results as evidence of the differential impacts of supply-side constraints. For example, one can argue that, because the Edinburgh office market is subject to severe supply side constraints, office occupiers are more likely to consider non-central locations as substitutes. In effect this is a form of spatial arbitrage operating through demander responses to supply-side constraints. By comparison the Glasgow market is relatively open and free from stock constraints. Office occupiers are able to locate in any one of a large number of office parks scattered throughout the periphery and the wider urban connurbation. It is possible that the absence of stock constraints as tight as those in Edinburgh has prevented non-central rental values from being bid up to the same level of those paid in the city centre submarkets.

7. Conclusions

The spatial variation in urban property values is generally attributed to the influence of physical attributes of the stock in different parts of the city. Economists have developed two approaches to dealing with this variation in property values. First, markets can be conceptualised in terms of being composed of a set of inter-related submarkets each of which may exhibit different price or rental values. Second, following the insights of Alonso (1964), Muth (1969) and the New Urban Economics, price and rental differences are explained through trade-off theories of locational choice.

Submarkets were introduced as an important analytical tool in local property market analysis by a group of US housing economists in the 1950s and 1960s (see Rapkin et al, 1953; Grigsby, 1963). These researchers argued that the special characteristics of real property were such that the stock could usefully be delineated in terms of the extent to which a particular property was likely to represent a relatively close substitute to alternative properties when considered by potential purchasers or renters. Implicitly it was assumed that both the location of the property and the bundle of attributes available would determine the extent of substitutability. Consequently local markets would be comprised of a system of inter-related submarkets.

Despite the intuitive appeal of this conceptual model, the developments in mainstream location theory proved to be the more influential in informing applied property market studies. Importantly, the theoretical model of land use and of the spatial structure of property markets is based on the existence of unitary urban systems which tend towards a stable equilibrium state and largely eliminates the possibility of submarket existence.

To date, however, there have been few empirical tests of the utility of these alternative conceptual models when applied to commercial property markets. As such, in this paper, using data from two cities, we set out to empirically test the existence of submarkets in urban office markets. We argue that this analysis provides an indirect test of locations theory and, in particular, the underlying assumption that office markets operate as well functioning, unitary entities.

The results of our empirical examination of alternative submarket structures in the cities of Glasgow and Edinburgh produce conflicting results. The evidence suggests that submarkets may exist in Glasgow. There is no evidence, however, to show submarket existence in Edinburgh. Although, of course, it is possible that the submarket system that exists may differ in form from those tested. The results of the Glasgow analysis show little difference in the performance of the submarket model based on agents' knowledge compared with a more complex structure constructed from a combination of statistical procedures.

These results highlight several important points. First, some metropolitan office markets may exhibit complex submarket structures which, if ignored in modelling work, can introduce errors into the exercise. Other cities, however, may reasonably be treated as unitary markets. For the city of Edinburgh, for example, it appears that neo-classical location theory retains considerable power in explaining the spatial and rental structure of the office market. Second, where they exist, the structure of submarkets may be identified adequately from local agents' market knowledge. It seems clear, however, that submarket structures may vary in form across cities.

Despite these mixed results, however, it seems clear that the existence of unitary urban property markets needs to be tested empirically. The model fits some metropolitan markets better than others. Although the evidence from UK office markets is less compelling than that derived from studies of the residential sector, further research into the structure and operation of local commercial property markets is required. It is clear that local market models can be usefully used in a range of practical and policy relevant exercises. For instance, parallel studies of urban housing markets clearly indicate that the submarket structure must be accommodated in modelling work in order to minimise estimation error. This has shown to be particularly important when using statistical techniques in estimating property values for appraisal or taxation purposes (Adair et al, 1996; Watkins, 1999; Bourassa et al, 1999b; Dunse et al, 2000) or in monitoring the impact of demand pressures on price levels for land use planning purposes (Hancock and Maclennan, 1989). Before this can be done, however, researchers need to overcome the significant data limitations that inhibit local commercial property market analyses (Jones, 1995).

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Appendix 1

Table A1.1: Binary Coding of Age Bands

Age Band	Age1	Age2	Age3	Age4
1990 – onwards	0	0	0	0
1980 – 1989	1	0	0	0
1970 – 1979	0	1	0	0
1960 – 1969	0	0	1	0
Before 1960	0	0	0	1

Table A1.2: Binary Coding of Office Condition

Condition	Cond_P	Cond_G	Cond_E
Poor	1	0	0
Fair	0	0	0
Good	0	1	0
Excellent	0	0	1

Table A1.3: Binary Coding of Office Attribute Quality

Attribute Quality	Att_G	Att_E
Poor	0	0
Good	1	0
Excellent	0	1

Appendix 2

Table A2.1: Correlations for Glasgow Data

	RENTM2	YR94	YR95	YR96	YR97	YR98	ATT_P	ATT_G	ATT_E	COND_G	COND_P	COND_E	AGE1	AGE2	AGE3	AGE4	AGE5	CP	RAIL
RENTM2	1.000	.199	.053	-.153	-.010	-.146	-.450	.014	.416	.427	-.192	.254	.415	.241	.124	-.361	-.222	-.420	.285
YR94	.199	1.000	-.330	-.379	-.286	-.402	-.193	.001	.183	.286	-.156	.109	.123	.083	.029	.048	-.171	-.145	.025
YR95	.053	-.330	1.000	-.172	-.130	-.183	-.050	.112	-.061	.040	.052	-.031	.089	-.045	.009	-.002	-.028	-.128	.133
YR96	-.153	-.379	-.172	1.000	-.149	-.210	.079	.053	-.127	-.167	.088	-.088	-.112	-.072	-.015	.112	.046	.134	-.077
YR97	-.010	-.286	-.130	-.149	1.000	-.159	-.055	-.052	.104	-.094	-.090	.034	-.072	.014	-.005	-.090	.095	-.022	-.074
YR98	-.146	-.402	-.183	-.210	-.159	1.000	.258	-.109	-.140	-.166	.139	-.054	-.070	-.010	-.026	-.098	.125	.185	-.017
ATT_P	-.450	-.193	-.050	.079	-.055	.258	1.000	-.465	-.502	-.340	.122	-.098	-.164	-.160	-.037	.003	.214	.244	-.033
ATT_G	.014	.001	.112	.053	-.052	-.109	-.465	1.000	-.533	.076	.002	-.074	-.048	.009	-.050	-.017	.059	-.089	.032
ATT_E	.416	.183	-.061	-.127	.104	-.140	-.502	-.533	1.000	.250	-.119	.166	.204	.144	.084	.014	-.262	-.146	.000
COND_G	.427	.286	.040	-.167	-.094	-.166	-.340	.076	.250	1.000	-.288	-.160	.141	.181	.092	-.101	-.177	-.176	.045
COND_P	-.192	-.156	.052	.088	-.090	.139	.122	.002	-.119	-.288	1.000	-.071	-.080	-.029	-.091	.277	-.071	.177	-.031
COND_E	.254	.109	-.031	-.088	.034	-.054	-.098	-.074	.166	-.160	-.071	1.000	.417	.135	-.050	-.071	-.261	-.010	.086
AGE1	.415	.123	.089	-.112	-.072	-.070	-.164	-.048	.204	.141	-.080	.417	1.000	-.106	-.080	-.112	-.414	-.140	.197
AGE2	.241	.083	-.045	-.072	.014	-.010	-.160	.009	.144	.181	-.029	.135	-.106	1.000	-.086	-.120	-.443	-.122	.034
AGE3	.124	.029	.009	-.015	-.005	-.026	-.037	-.050	.084	.092	-.091	-.050	-.080	-.086	1.000	-.091	-.336	-.013	-.018
AGE4	-.361	.048	-.002	.112	-.090	-.098	.003	-.017	.014	-.101	.277	-.071	-.112	-.120	-.091	1.000	-.471	.182	-.114
AGE5	-.222	-.171	-.028	.046	.095	.125	.214	.059	-.262	-.177	-.071	-.261	-.414	-.443	-.336	-.471	1.000	.046	-.055
CP	-.420	-.145	-.128	.134	-.022	.185	.244	-.089	-.146	-.176	.177	-.010	-.140	-.122	-.013	.182	.046	1.000	-.295
RAIL	.285	.025	.133	-.077	-.074	-.017	-.033	.032	.000	.045	-.031	.086	.197	.034	-.018	-.114	-.055	-.295	1.000

Table A2.2: Correlations for Edinburgh Data

	RENTM2	YR92	YR93	YR94	YR95	YR96	YR97	YR98	ATT_P	ATT_G	ATT_E	COND_G	COND_P	COND_E	AGE1	AGE2	AGE3	AGE4	AGE5	CP	RAIL
RENTM2	1.000	.046	.071	.082	.130	-.030	-.247	.035	-.336	-.029	.403	.218	-.051	.418	.421	-.034	-.031	-.110	-.300	-.264	.472
YR92	.046	1.000	-.023	-.044	-.058	-.047	-.058	-.039	-.085	.038	.053	.055	.117	-.027	-.028	-.010	-.010	-.010	.035	-.076	-.005
YR93	.071	-.023	1.000	-.094	-.125	-.102	-.125	-.085	-.083	-.048	.143	.035	.215	-.059	-.062	-.023	.220	-.023	-.006	.045	.111
YR94	.082	-.044	-.094	1.000	-.242	-.197	-.242	-.164	-.035	-.023	.063	.133	.359	-.058	-.009	.097	.097	-.044	-.043	.016	.006
YR95	.130	-.058	-.125	-.242	1.000	-.261	-.320	-.217	-.052	-.058	.120	.045	-.212	.281	.307	-.058	-.058	.061	-.244	.029	.031
YR96	-.030	-.047	-.102	-.197	-.261	1.000	-.261	-.177	.032	.028	-.065	.094	-.091	-.124	-.129	.087	-.047	-.047	.112	-.019	-.105
YR97	-.247	-.058	-.125	-.242	-.320	-.261	1.000	-.217	.144	-.007	-.152	-.256	-.139	-.103	-.111	-.058	-.058	.061	.113	.014	-.065
YR98	.035	-.039	-.085	-.164	-.217	-.177	-.217	1.000	-.037	.095	-.059	-.020	-.004	.020	-.048	-.039	-.039	-.039	.080	-.056	.088
ATT_P	-.336	-.085	-.083	-.035	-.052	.032	.144	-.037	1.000	-.575	-.502	-.209	.007	-.096	-.191	-.085	-.085	-.085	.246	-.100	-.116
ATT_G	-.029	.038	-.048	-.023	-.058	.028	-.007	.095	-.575	1.000	-.420	.086	.074	-.142	-.108	-.071	-.071	-.071	.163	-.061	.041
ATT_E	.403	.053	.143	.063	.120	-.065	-.152	-.059	-.502	-.420	1.000	.141	-.086	.257	.326	.169	.169	.169	-.445	.176	.085
COND_G	.218	.055	.035	.133	.045	.094	-.256	-.020	-.209	.086	.141	1.000	-.224	-.160	.014	-.061	.055	.055	-.029	-.122	-.066
COND_P	-.051	.117	.215	.359	-.212	-.091	-.139	-.004	.007	.074	-.086	-.224	1.000	-.101	-.105	.117	-.038	-.038	.076	.016	.075
COND_E	.418	-.027	-.059	-.058	.281	-.124	-.103	.020	-.096	-.142	.257	-.160	-.101	1.000	.642	-.027	-.027	-.027	-.519	.111	.213
AGE1	.421	-.028	-.062	-.009	.307	-.129	-.111	-.048	-.191	-.108	.326	.014	-.105	.642	1.000	-.028	-.028	-.028	-.823	.190	.105
AGE2	-.034	-.010	-.023	.097	-.058	.087	-.058	-.039	-.085	-.071	.169	-.061	.117	-.027	-.028	1.000	-.010	-.010	-.301	.299	-.107
AGE3	-.031	-.010	.220	.097	-.058	-.047	-.058	-.039	-.085	-.071	.169	.055	-.038	-.027	-.028	-.010	1.000	-.010	-.301	.233	-.107
AGE4	-.110	-.010	-.023	-.044	.061	-.047	.061	-.039	-.085	-.071	.169	.055	-.038	-.027	-.028	-.010	-.010	1.000	-.301	.320	-.005
AGE5	-.300	.035	-.006	-.043	-.244	.112	.113	.080	.246	.163	-.445	-.029	.076	-.519	-.823	-.301	-.301	-.301	1.000	-.445	-.016
CP	-.264	-.076	.045	.016	.029	-.019	.014	-.056	-.100	-.061	.176	-.122	.016	.111	.190	.299	.233	.320	-.445	1.000	-.367
RAIL	.472	-.005	.111	.006	.031	-.105	-.065	.088	-.116	.041	.085	-.066	.075	.213	.105	-.107	-.107	-.005	-.016	-.367	1.000