RICS

RESEARCH FOUNDATION

The Cutting Edge 2000

The determinants of industrial rents

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ISBN 1-84219-031-8

The Determination of Rents of Industrial Property in a Sub-regional Context

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Presented at the RICS Cutting Edge Research Conference, 2000

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ABSTRACT

This purpose of this paper is to consider the spatial variation in industrial property rents across a sub-region and to assess the source of this variation. A first step is to review the nature of urban systems and relevant models of location theory. Based on this theoretical base a framework for an examination of the pattern of rents is established. The influence of a local CBD is seen within an urban hierarchy of the provision of business services and labour accessibility. This gives rise to a series of testable hypotheses:

1. intra urban rent gradients from the town centre will be dependent on urban size
2. key regional access points are a strong influence on the spatial pattern of rents
3. nearness to motorway junctions will create a rent premium.

Hedonic regression modelling is applied to test these hypotheses. This technique has been widely applied in the housing and office markets. The research is based on the sub-region of Scotland known as Strathclyde: it includes Greater Glasgow and its hinterland which has number of free-standing towns. The empirical analysis is unable to fully establish the first of the hypotheses but regional central access points and nearness to motorway junctions are shown to be significant.

Introduction

This purpose of this paper is to assess the spatial variation in industrial property rents and assess the source of this variation. A first step is to review the nature of urban systems and relevant models of location theory. Based on this theoretical base a framework for an examination of the spatial pattern of rents is established. Hedonic regression modelling is applied to test a range of hypotheses. This technique has been widely applied in the housing and office markets, and recently by Brown et al(1999) to intra-urban variation in industrial property rents. This paper represents a further development from this paper by examining the determinants of industrial rents within a sub-regional perspective. A secondary function of the paper is to see to what extent clustering of firms leads to higher rental values.

The paper begins with an appraisal of industrial location theory and the implications for the spatial pattern of industrial rents. This is followed by an exposition of hedonic analysis. A review of the current literature applying hedonic analysis to industrial markets is then undertaken. The empirical study is based on the sub-region of Scotland known as Strathclyde: it includes Greater Glasgow and its hinterland which includes a number of free-standing towns. A brief outline of its industrial market precedes a description of the data and the research method. In the penultimate section we discuss our empirical analysis and the final section highlights the key findings and conclusions.

Agglomeration Economies, Location Theory and the Urban System.

Neo-classical or Weberian location theory evolved around cost minimisation triangles (Moses,1958). In these models optimum location evolves around the cost of materials and transportation costs: exogenous changes in costs can lead to alterations in the input mix of raw materials or to a new location. A serious limitation is that land /property rents are not included in the model, and so do not influence the location decision. McCann(1995) also more generally criticises these models for having an incomplete production function which renders them devoid of any real world economic meaning despite their mathematical consistency. As a result they are

> "meaningless as a basis for discussing why we observe that particular types of firm producing particular products exhibit particular types of locational behaviour" (McCann,1995, p568).

An alternative neo-classical view of the determination of industrial location is given by the role of externalities. Within this model firms are attracted to locations by the externalities available. These include the geographical concentration of similar industries enabling specialist subcontractors, or complementary firms, for example in business services, and a pool of skilled specialist labour (and associated education facilities) to develop.

Gordon and McCann(2000) review other models of industrial clustering, distinguishing between the classic agglomeration model, the industrial complex model where firms group as part of the production process and a network of firms which is derived from a sociological perspective. It is only the classical agglomeration model where the benefits will be capitalised in local rental values.

Intra-urban location theory originates with Alonso's land use model (Alonso, 1964). It implicitly assumes agglomeration economies in the city centre. It is based on a city located on a featureless plain where land use is allocated to the highest bidder in a competitive land market. In this uni-nodal city the central business district (CBD) is the point of maximum accessibility where business revenue is at a maximum and costs (other than land costs) are minimised. Differences in the optimum locations of industrial and commercial land uses relate directly to the responsiveness of revenue and costs to distance from the centre. It is presumed that revenues fall and costs rise with distance from the CBD. The local industrial property market is defined by those locations where industrial users outbid other land users.

Di Pasquale and Wheaton (1996) develop a more sophisticated approach. In their stylised nineteenth century city the CBD is replaced with a central shipment/transportation terminal. All firms are initially assumed to produce identical products and using the same production process have equal outputs. There is no factor substitution so that the plot size and buildings are fixed for each firm, and output per acre is fixed.

In this model the rent for buildings is fixed but the land rent per acre varies with location. Revenue and production costs are spatially invariant and given a competitive land market land rents in equilibrium will exactly compensate for transport costs which rise with distance from the transportation terminals. In this way a rent gradient is formed. When the assumption of identical production processes is relaxed the model can be extended to groups of identical firms or land uses. This leads to a range of potential different rent gradients. The land market is presumed to be competition, allocating land use on the basis of the highest rent.

Both Alonso (1964) and Di Pasquale and Wheaton (1996) models above lead to similar outputs, notably a declining rent gradient from the CBD. A major distinction in their assumptions is that while Di Pasquale and Wheaton presume revenue is spatially constant Alonso has revenue decreasing with distance from the CBD. Logically the Alonso model would lead to a steeper distance decay gradient.

In the twentieth century there has been a considerable process of urban industrial change. Three different processes have contributed to this - de-industrialisation, decentralisation and decongestion. De-industrialisation is a consequence of traditional industries declining in the face of international competition and the globalisation of markets. Cities that had a high concentration of this type of industry have suffered severe economic decline. However, this structural explanation for decline will vary widely between cities, depending on the nature of their traditional industries.

Decentralisation involves the movement of manufacturing industries to better locations outside city core areas. The reasons for this include lower inter-urban transport costs with the introduction of new transport and delivery technologies and the increasing requirement for land due to changing production and storage requirements. This has encouraged industry to move to decentralised locations where there is plentiful supply of land and easy access to the national motorway networks. Other factors have also contributed to a decline in the requirement for industries to be close to core city areas. Technological change has weakened the agglomeration economies of many cities. Transport costs and the need for large pools of labour have also declined as a result of:

1 miniaturisation of products;
2 the introduction of new lightweight materials;
3 a reduced number of moveable parts in machinery;
4 the increased use of electronics, as opposed to mechanical, parts and processes

The globalisation of industry and markets has reinforced these trends further. The creation of large multi-national companies has helped to increase the average size of an industrial plant and therefore increase industrial land requirements.

Decongestion is the decentralisation of manufacturing industries to suburban locations or locations at the periphery of the city. Decongestion is distinct from decentralisation because it occurs strictly within the urban setting. It is a form of extended suburbanisation that involves an intra-urban move as opposed to an inter-urban move. It is however a consequence of the same forces that cause decentralisation.

How do these factors affect the models outlined above? Industry generally serves regional or national markets and hence revenue will not vary according to spatial location within a city. This is accordance with the Di Pasquale and Wheaton model rather than Alonso's. Industrial change means that the spatial structure of costs has changed over time. Distribution costs were originally minimised at central locations near rail and sea terminals. With the advent of the use of containers and trucks, together with the development of inter-urban road networks, distribution costs are now minimised at peripheral locations accessible to the national road network. Di Pasquale and Wheaton argue that this has led to an almost flat industrial rent gradient. However, with revenue constant throughout the city, and costs falling with distance from a central point, the rent gradient is logically upward sloping. However, this is intuitively an incomplete argument, for example it ignores the benefits of access to business services in the city centre.

It is therefore necessary to return to the basic intra-urban model. The general trends in transportation costs noted above can either be incorporated by changing the assumption about the transport cost distance function or by introducing additional nodal points of accessibility. These may or may not be subservient to the CBD node. This latter approach is more appropriate on a theoretical basis as it is unlikely that transport costs will decline uniformly with distance from the CBD.

The analysis so far has assumed production costs are constant across an industrial property market area. However, it is possible that labour costs could be lower at or near the CBD because this is an attractive location to potential workers who can benefit from the social agglomeration economies nearby and the use of an intra-urban transport network centring on the CBD. Hence labour turnover is lower and recruitment easier in central locations. Similarly there are potential manufacturing agglomerations away from a central location. It is possible to see industrial rent surfaces with a series of peaks at nodal points close to motorway junctions, for example.

From a sub-regional perspective rental structures reflect and extend these forces. The influence of a local CBD may be seen within an urban hierarchy of the provision of business services and labour accessibility. Key points of accessibility take a macro scale encompassing say motorway interceptions, and regional airports. This gives rise to a series of testable hypotheses:

1. intra urban rent gradients from the town centre will be dependent on urban size
2. key regional access points will a strong influence on the spatial pattern of rents
3. nearness to motorway junctions will create a rent premium.

Characteristics of Industrial Property

An industrial property as a heterogeneous good that can be defined by a vector of characteristics or attributes that relate to its location, physical accommodation and tenure rights. The attributes in turn can be subdivided into the following components:

Physical Accommodation

Capacity and Internal Accessibility

At its most basic this is the floor area of the industrial unit, although it will also be influenced by any constraints, for example a cellular layout, the building's structure places on design and layout. Modern industrial units normally provide the greatest flexibility in this regard by the provision of open plan floor plates and high eaves height to allow the unobstructed operation of vehicles within the unit.

Internal services

The quality of industrial space is not easy to define. There is a considerable range of potential internal services that add value although to different degrees. These include the electrical wiring, lighting, heating and security systems. These are not considered in the analysis below.

Physical structure

The cladding and standard of the exterior and structure are important both to the image the occupier is trying to project, and to subsequent repair and maintenance expenditure. A major influence is the age of the building, for example pre-1960's buildings are mainly of solid construction with a large number of load bearing walls.

Tenure Rights

Generally commercial property has been let on a standard institutional 25 year lease with the tenant responsible for repairs and maintenance. However industrial property is generally let on more flexible lease terms with the tenant responsible for internal repairs and insurance only. Clearly the structure of the lease terms will have an impact on the agreed rent.

This classification of industrial characteristics provides a framework for the subsequent empirical analysis. However, this review also indirectly draws out the importance of age as a crucial determinant of many of these characteristics, especially physical structure. Hence in the empirical analysis age is included in its own right.

Location

Each location represents a series of spatial relationships within the urban system. There is a hierarchy of importance given to each of these relationships. Industrial location theory discusses the role of location with respect to distances or transport costs to inputs (or supply areas) and markets (Parr,1993; Smith,1989). But as we have seen intra-urban location in terms of distance from the urban centre and motorway junction are also important.

Hedonic Analysis

Property is an example of a heterogeneous good consisting of a bundle of attributes. Its value is dependent upon many characteristics associated with that property such as size, age, a range of quality attributes and lease terms. Hedonic theory enables us to estimate the implicit price of each attribute by relating the rent of the industrial unit to its individual attributes:

Rent =f(location, physical accommodation, tenure rights)

Rosen (1974) formalised the structural interpretations of the hedonic method. He hypothesised that heterogeneous "goods are valued for their utility-bearing attributes or characteristics" (Rosen 1974, p1) where the hedonic price is the implicit price of each attribute associated with that good.

Each characteristic contributes to the value of the accommodation, but cannot be separated and traded individually. Rosen's interpretation purports that the price paid for a particular property is the sum of the implicit prices that the market gives to the different characteristics associated with that property. Hence with information on property prices and attributes it is possible, using regression analysis, to derive the implicit price of each attribute, the hedonic price, and the relative importance each attribute has in determining the overall price of the property.

An industrial unit is an example of a heterogeneous good consisting of a bundle of attributes, each of which are integral to the industrial unit. Each industrial user is assumed to derive profit directly from the property characteristics and chooses the industrial unit (bundle of characteristics) which maximises profits. In this framework each industrial unit is completely defined by a vector of characteristics described above which encompass location and physical characteristics. Thus suppose the industrial unit, *z*, is composed of *n* attributes:

$$(z_1, \ldots\ldots\ldots\ldots, z_n) \qquad \textbf{(1)}$$

Equation (1) is the vector of n attributes for which price or rent (in our case) depends. The rent of the industrial unit, *z*, will depend upon the quantities of the various attributes for which *z* is composed. The rent can be expressed as some function R(*z*). Thus:

$$R(z) = f(z_{,}, z_2 \ldots\ldots z_n) \qquad \textbf{(2)}$$

R(*z*) is the rent of the industrial unit and the z_i's are the individual characteristics. By differentiating R(*z*) with respect to its i^{th} characteristic, z_i, the market equilibrium price function for z_i, that is implicit in R(*z*) can be derived.

$$R_i = \frac{dR(z)}{dz_i} \qquad \textbf{(3)}$$

Empirical testing of this involves obtaining a price measure, $R(z_k)$, the corresponding z_i's for the k^{th} property, and estimating the hedonic equation using regression analysis.

$$R(z_k) = b_0 + \sum_{i=1}^{n} b_i z_{ik} + e_i \qquad \textbf{(4)}$$

Equation (4) is a general hedonic price function for both linear and non-linear representations of equation (2). The implicit price functions may be increasing, decreasing or constant depending on the functional form of R(*z*).

The measurement of the implicit prices of the different attributes of the hedonic model raises questions about the correct model specification. Unfortunately, hedonic theory gives no indication of the best functional form to use. Whether the hedonic model specifies a log-linear or a linear estimate will influence the interpretation of the results generated. For example a log-linear format will estimate demand elasticities, whereas a linear format estimates the price values attached to the different attributes. It would appear from the housing literature that the method used to identify model specification is often assessed purely by *"empirical experimentation"* (Forrest (1991, p233)). In practice the appropriate format for model specification can be determined by two approaches. A pragmatic approach simply identifies which set of results generated produces the best fit (as revealed by the R squared or the adjusted R squared) and provides the most consistent and plausible models (as revealed by the sign and significance of the independent variables). At a more complex level a quadratic Box-Cox transformations may be used. In the housing literature this technique has improved the methodology for selecting the appropriate functional form, however a review of the outcomes of the Box-Cox transformation is by no means conclusive. A number of studies support the semi-log form, others the linear form and other studies produce a variety of outcomes such as a square root form. Dhrymes (1971) provides an interesting insight on the subject when he states that:

> *"the clustering of data (characteristics of housing) can restrict the range of the sample such that it covers only a relatively small proportion of the (hypothetical price surface. If such is the case, it would not be unreasonable for many functional forms to be an equally good approximation to the true (and more complicated) surface over that range."*

In general, hedonic modelling is open to criticism on the grounds that the theory involves a substantial simplification of a complex system. The model assumes equilibrium throughout the property market and no inter-relationship between the price of attributes. The effect of this is that the implicit price for an additional attribute is equal across all areas and property types. Arguably, in the light of market imperfections, disequilibrium could be a more realistic assumption but the data required for this form of modelling places this out with the scope of most research. Despite these failings, the technique has been widely applied to housing market analysis and has become well established. In defence of hedonic analysis, Freeman (1979, p155) argues that hedonic technique "*seems to pass the appropriate tests about as well, or as poorly, as any empirical technique (in economics)*".

Industrial Hedonic Studies

Hedonic price modelling of industrial property has been principally confined to a few studies undertaken in the United States. Hoag (1980) uses industrial property in an attempt to develop an index of real estate value and return. He uses a sample 463 transacted prices spanning a five-year period between 1973 and 1978. The study tests the significance of property characteristics, national and regional economic indicators and location variables. Location variables were found to be significant, although the paper fails to define what these variables actually measure. Unusually he discards these variables in the final model, despite their statistical significance, and retains the economic indicators instead.

Ambrose (1990) recognised that, apart from the work of Hoag, there was a lack of research into the application of multiple regression analysis to industrial property values. This study purely concentrates on property specific factors and ignores location variables. The data is located in a highly concentrated area of metropolitan of Atlanta and hence it is argued that there will be no location bias. The study tests a series of property characteristics which include; size, office space, ceiling height, number of drive-in doors, number of high docking doors, presence of a railway siding, presence of sprinklers and building age. Using a linear form all of these variables produced the expected sign and were significant at the 10% level.

Fehribach et al (1993) recognises the shortcomings of the work of Ambrose and Hoag. This study extends the work by taking account of location specific variables. The study area consists of two counties in the Dallas/Fort Worth area. The dependent variable in this study is the sales price for the industrial building which is regressed against eleven independent variables which include physical attributes, economic and financial indicators and location variables. The two key location variables were the county the property was located in and the distance from the main airport. The results of the study highlight the statistical significance of these and other physical and economic variables.

Lockwood et al (1996) extend the development of location measurements compared to the others. Again the analysis is based on Fort Worth/Dallas. Four measures are tested; distance to the CBD, distance to the airport, distance to the nearest major road and access to the rail network. Despite the use of a different technique the results confirm the findings of the earlier studies. The major findings of this study indicate that local market conditions, physical characteristics and location of the property are the primary sources of value for industrial property. However the location variable, distance to the CBD, was not significant.

A study by Brown et al (1999) of Glasgow found that physical attributes are unimportant except for size: values fall with increasing size of property, demonstrating a quantum effect with increasing size. 1960s properties suffer from lower values probably reflecting the poor construction methods and aesthetics of these buildings. Location within the city appears to have a major influence upon the rent. All variables included are significant. A negative rent gradient from the city centre is found suggesting that as the distance increases from the city centre rent reduces by 1.2% per kilometre. However, the effect while significant suggests a very shallow rent gradient and of more significance of distance to the nearest motorway junction is also upheld. This is the most significant location variable and second only to size band. After using the algorithm that minimised the standard error of the regression equation a maximum distance of 2.4km was found to be the best measure. The coefficient suggests that as the junction is approached from the boundary limit of 2.4km the rent increase is 12.4% per kilometre[5]. This is an entirely logical result since a location close to the junction will not only be more accessible but also more prestigious in terms of visibility from the road. Finally, the location relative to the River Clyde is also significant. Being located to the North of the River Clyde causes a reduction in rent by approximately 6.5%; this result reflects the poorer transport links to the North of the city. This paper represents a spatial extension of that paper.

Study Area and Data

The chosen study area is Glasgow and its surrounding hinterland accounting for much of the mainland area covered by the former Strathclyde Regional Council. Glasgow is Scotland's largest city situated on the west coast of central Scotland. It serves as a major provincial industrial, office and retail centre. Glasgow has experience considerable de-industrialisation and decentralisation of industry over the last three decades. The city has suffered from a severe decline in shipbuilding and many of the dock areas have been redeveloped for housing and offices. Industry is now predominantly light engineering, electronics and other service industries. There is approximately 9.6m sq m of industrial space on industrial estates in the former Strathclyde Region which represents 9640 units wit an average size of 893 sq m.

The analysis is based on the database developed by the Scottish Property Network (SPN) at the University of Paisley which comprises a comprehensive core of all individual industrial properties in Scotland, together with information on market availability and transactions. The database in particular records information on asking rents, property characteristics which include age and type. To this basic data a range of distances linked to key points of accessibility have been added.

A total of 3180 asking rent observations for new lettings, located within recognised industrial estates were collected spanning the period 1994-2000. This is equivalent to 1.6 sq m of industrial space with an average size of 508 sq m. Table 1 shows the distribution of transactions per year.

Table 1 Number of Transactions per Year

Year	No. of Transactions
1994	816
1995	220
1996	388
1997	378
1998	604
1999	687
2000	87

Each record has information on the transaction, physical and location characteristics which are described in Table 2 below.

Table 2 Variable Descriptions

Transaction	Description
Rent	Asking rent per square metre
Year	Year of transaction
Physical	
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
Use	Categorised into five uses; manufacturing, managed workshop, warehousing studio workshop and hi-tech space (see Appendix for a full description)
Location	
Distance To Nearest Town	Straight-line distance in metres to nearest Principal Town centre (population > 20,000)
Distance To Nearest Motorway Junction	Straight-line distance in kilometres to the nearest motorway junction or trunk road.
Distance to Nearest Major Accessibility Point	Straight Line distance to either the nearest airport, Glasgow City centre or major transport interchange.
Travel to Work Area (TTWA)	Identifies the TTWA that each unit is located within.

The hedonic price model is estimated using regression analysis in which the dependent variable is the asking rent per square metre. The independent variables are drawn from the data on attributes noted above, and many are expressed as dummy variables in a binary code.

Physical Accommodation and Use

Age is our principal variable describing the physical accommodation. This variable acts as a proxy for a number of physical factors that have followed definite trends over time. Layout and construction type are often dependent upon the materials and technology at the time of construction and these have often become obsolete through time. Hence the age variable captures this information. Condition would also be an ideal variable however this measure although included in the original data set proved to inaccurate and unreliable.

A separate variable measures the principal use that the industrial unit is put to. These are manufacturing, studio workshops, warehousing, managed workspace and high tech space. A full description of the definitions is given in the Appendix.

Location

Location of each industrial unit is defined in four dimensions. First, by distance from a central point within the nearest principal town (defined as town with a population of greater than 20,000); second, by the distance to the nearest major trunk road/ motorway junction; and third, by the travel to work area (TTWA) that each suite is located in. There are six (approximate) TTWAs in this study: they do not completely coincide with official definitions because data availability necessitated amalgamation.. Finally, the fourth dimension is the shortest distance to the nearest major accessibility point. Three such points have been identified within the former Strathclyde area.

First, let us consider the distance to the nearest airport. There are two international airports in the area, Prestwick in Ayrshire and Glasgow. Second, the distance to Glasgow city centre and finally the distance to the major transport interchange located to the east of the region which joins the M8 running east/west, the M73 to the North and The M74 to the south. Originally, separate variables measured these distances but these were found to be highly correlated. Hence the variable was redefined measuring the shortest distance to each of these points. This approach assumes that only occupiers who want to be located close to any of these accessibility points will be willing to pay a premium for it. For example by locating to the East, being close to the transport interchange is probably more important to the occupier than being near an airport. On the other hand locating to the West it is more likely that proximity to the airport is more important than the transport interchange.

Overall the variables comprise a comprehensive set of industrial attributes. While there are a few potential characteristics that are absent from our original discussion on the nature of industrial accommodation it is possible to argue that they are subsumed within the age variable. We do not have any information on the lease terms. However the definition of the rent variable is the asking rent and to a large extent this avoids the problems of incorporating lease terms.

Analysis and Results

Hedonic regression analysis has no definitive view on the functional form of the equation or its components. A number of models were tested including linear and semi-log functional forms. Neither of these performed particularly well in terms of both explanatory power and plausibility of the coefficients. The log-linear form worked best and these are the results that are reported. A series of dummy variables are used for age band, year and use type where appropriate.

The regression analysis is first applied to the whole sub-region and then to individual TTWAs as proxies to local labour market areas. Ideally we would have preferred to use a framework of industrial property market areas as set out in Dunse et al (1998) but data limitations prevented this. Instead TTWAs as the next level of aggregation enable us to assume constant labour costs within the sub-areas and thereby neutralise the influence of local labour costs on rents. Subsequent regressions also consider dis-aggregations based on property use type and size banding

The main reference point of a hedonic equation is the constant. This represents a minimum level of accommodation by which the coefficients can be compared. In our models this is an industrial unit built before 1960 for manufacturing (this varies depending upon the level of dis-aggregation).

Hedonic Models by TTWA

The results of this analysis are presented in Tables 3 and 4. The adjusted R^2 vary considerably across each market area although generally the explanatory power is improved, except forNorth Ayrshire and Renfrewshire/Iverclyde. Generally the coefficient magnitudes and sign are as a priori expected: rents increase with newness of the property and decline per sq m with size. The size variable is negative indicating that a discount is expected for quantum. Compared to the constant which represents a pre-1960's building a greater premium is paid for newer properties. 1960-1969 buildings are not significantly different from the constant. The age variable gives a strong indication of the level of depreciation and obsolescence in this early stock. A modern building commands up to 40% more rent when compared against pre 1970's. The type of property is significant in some of the areas with a considerable premium paid for hi-tech space in Lanarkshire.
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Accessibility is also a very important determinant of rent in these models, although the importance each varies through out the region. For example TTWA 5 represents the areas of Inverclyde and Renfrew which are both within close vicinity of Glasgow airport. The coefficient suggests that the rent gradient is very steep and a considerable premium is paid for proximity to the airport. TTWA 6 represents the areas of South and North Lanarkshire and in this instance proximity to the transport interchange is highly significant. In all TTWAs, except Lanarkshire proximity to a motorway junction is highly significant: this reflects the fact that most locations in this area have good motorway links.

Proximity to the nearest principal town centre is significant and negative except for Greater Glasgow. As discussed earlier a positive gradient would be expected if revenue was spatially constant, and costs fell away with distance from the town centre. The reverse might occur where nearness to the city centre would aid the availability of business services and accessibility to labour. Although the signs are negative suggesting a central location is generally important the coefficients are only significant for the two Ayrshire TTWAs. Thus nearness to the principal town is of negligible influence in Dunbartonshire, Lanarkshire and Renfrewshire. TTWA 4, which centres on Glasgow, has a unexpected positive and significant rent gradient and conflicts with Brown et al (1999). This sign probably arises because of averaging across town centres in the TTWA which includes Glasgow, East Kilbride and Cumbernauld.

Table 4 lists the five most significant variables in each model based on the size of the standardised B coefficients. These show that size, age and location are consistently the most significant variables adding the greatest explanation to each model. However, the order of importance varies across TTWAs. Accessibility is most important in south and east Ayrshire which is the most remote TTWA to the motorway network. In north Ayrshire age and location dominate. Size is the most important contributing determinant in Dunbartonshire, Lanarkshire and Greater Glasgow. In Renfrewshire/ Inverclyde year on the market is an important contributor reflecting recent rental growth trends.

Hedonic Models by Size Band

Table 5 represents the results dissagregated by five size bandings, (0-199, 200-499, 500-999, 1000-2999 and 3000+). The adjusted R^2 are lower for these regressions. Size continues to a negative coefficient although it declines in significance as the size band increases. Age bands are consistently significant across all size bands. Location within a particular TTWA can be important with lower values outside Greater Glasgow, especially in Ayrshire. Location with respect to a motorway junction is most important for the lowest three sizebands whilst nearness to the central access point is significant across all size bands. Table 6 highlights that age (especially whether built after 1990) and location with regard to a motorway junction are the most important variables.

Hedonic Models by Use Type

Finally the data was split into two principal uses, manufacturing and warehousing. The models, shown in Table 7, are not significantly different from each other producing similar R^2 and coefficient signs and magnitudes. Age, location and size variables are nearly all significant. Table 8 shows that the two age bands since 1980 and nearness to a motorway junction are the principal determinants of rent for these two use types..

Conclusions

The paper began by reviewing the theoretical basis for the role of location on the rents of industrial property. This gives rise to a series of testable hypotheses:

1. Urban rent gradients from the town centre will be dependent on urban size
2. Regional central access points will have a strong influence on the spatial pattern of rents
3. Nearness to motorway junctions will create a rent premium

The empirical analysis was based on the former administrative region of Strathclyde which encompasses a range of settlement including the Clydeside conurbation, free-standing towns and rural areas. The analysis has not been able to fully establish the first of these hypotheses because the coefficients on nearness to the principal town centre have been small and tend to reflect the local geography of settlements within TTWAs. Regional central access points have a strong influence on peripheral locations/ TTWAs. And distance to these points is significant in all but one TTWA. Similarly nearness to motorway junction is significant for all but one TTWA particularly well served by motorway links.

The analysis suffered from difficulties in specifying location variables because of collinearity. Further research is needed on the definition of these variables. Overall the research found consistent and expected results, and was able to quantify the influence of the different determinants of industrial rents.

Table 3 Results of Hedonic Regression Models for each TTWA

	Market Wide	TTWA 1	TTWA 2	TTWA 3	TTWA 4	TTWA 5	TTWA 6
(Constant)	4.96**	10.96**	15.69**	5.19**	4.27**	4.87**	5.98**
Size	-0.14**	-0.19**	-0.06**	-0.12**	-0.16**	-0.16**	-0.17**
Nearest Motorway Junction	-0.07**	-0.27**	-0.64**	-0.04**	-0.10**	-0.27**	-0.01
Nearest Principal Town	0.03**	-0.04*	-0.06*	-0.14	0.07**	-0.03	-0.01
Nearest Central Access Point	-0.04**	-0.40**	-0.54**	0.06	-0.04**	-0.24**	-0.17**
Age 1960-69	-0.03	-0.13	0.12	0.02	0.04	-0.03	-0.03
Age 1970-79	0.12**	0.38**	0.34**	0.23**	0.13**	0.03	-0.02
Age 1980-89	0.15**	0.30**	0.33**	0.26**	0.14**	0.05	0.15**
Age 1990 - on	0.25**	0.41**	0.49**	0.21**	0.25**	0.14**	0.23**
Workshop/Studio	-0.04	0.04			0.24**	0.32	-0.14
Warehousing	0.01	0.06	-0.10**	-0.16**	0.03**	-0.03	0.03
Managed Work Space	0.34**				0.38**		0.20
Hi-tech Space	0.16**	0.45	0.03	0.13**	0.17**	-0.09	0.43**
YEAR94	-0.05	0.08	-0.08**			-0.15**	0.00
YEAR95	-0.02	0.16*	-0.05	-0.11	0.06	-0.25**	0.11
YEAR96	-0.04	0.09	-0.11**	0.01	0.02	-0.21**	0.07
YEAR97	-0.03	-0.07	-0.08	-0.09	0.09**	-0.18**	0.09
YEAR98	-0.04		-0.07*	-0.03*	0.06**	-0.20**	0.08
YEAR99	0.02	0.06		-0.09	0.10**		0.00
YEAR00	0.02	0.25*	0.11	-0.03	0.07	-0.03	-0.14
No. of Obs.	3180	190	285	143	1620	398	544
Standard Error	0.27	0.28	0.20	0.18	0.25	0.27	0.26
Adjusted R^2	0.41	0.66	0.32	0.58	0.45	0.39	0.51

Table 4 Principal Variables in Individual TTWA Regressions

Market Wide	TTWA 1	TTWA 2	TTWA 3	TTWA 4	TTWA 5	TTWA 6
Size	Nearest Central Access Point	Age 1970-79	Size	Size	Nearest Motorway Junction	Size
Age 1990 on	Size	Age 1980-89	Age 1980-89	Nearest Motorway Junction	Size	Age 1990 on
Nearest Motorway Junction	Age 1980-89	Age 1990 on	Age 1990 on	Age 1990 on	Nearest Central Access Point	Nearest Central Access Point
Age 1980-89	Age 1970-79	Nearest Central Access Point	Warehousing	Age 1980-89	YEAR98	Age 1980-89
Age 1970-79	Age 1990 on	Nearest Motorway Junction	Hi-tech Space	Age 1970-79	YEAR95	Hi-tech Space

1 = South and East Ayrshire; 2 = North Ayrshire; 3 = East and West Dunbartonshire
4 = Glasgow, East Kilbride and Cumbernauld; 5 = Renfrewshire and Inverclyde: 6 = Lanarkshire except East Kilbride and Cumbernauld

Table 5 Results of Hedonic Regression Models for each Size Band

	Market Wide Model	Sizeband 1	Sizeband 2	Sizeband 3	Sizeband 4	Size Band 5
(Constant)	5.00**	5.44**	5.03**	3.96**	3.59**	5.02**
Size	-0.14**	-0.14**	-0.15**	-0.06	-0.04	-0.13
Nearest Motorway Junction	-0.05**	-0.07**	-0.06**	-0.06**	-0.03	0.02
Nearest Principal Town	0.02**	0.00	0.02	0.09**	0.09**	0.06
Nearest Central Access Point	-0.04**	-0.05**	-0.04**	-0.04**	-0.08**	-0.17**
Age 1960-69	-0.04**	0.04	-0.02	-0.07**	0.02	-0.24
Age 1970-79	0.11**	0.03	0.16**	0.13**	0.30**	0.41**
Age 1980-89	0.14**	0.07**	0.17**	0.16**	0.37**	0.45**
Age 1990 - on	0.24**	0.11**	0.36**	0.29**	0.61**	0.75**
YEAR94	-0.08	-0.06**	-0.11			
YEAR95	-0.03	-0.04	-0.06	0.04	0.14	-0.04
YEAR96	-0.06	-0.08	-0.09	0.00	0.04	-0.12
YEAR97	-0.06	-0.06	-0.08	0.00	-0.03	0.04
YEAR98	-0.06	-0.08**	-0.04	0.01	0.04	0.05
YEAR99	0.00		-0.05	0.03	0.23**	-0.13
YEAR00	0.00	0.01	-0.04	0.02	0.16	-0.07
TTWA1	-0.12**	-0.07**	0.00	-0.32**	-0.27**	-0.26
TTWA2	-0.05**	-0.13**	0.04	0.22**	0.01	0.50**
TTWA3	-0.05**	-0.01	-0.07	-0.01	-0.05	-0.29
TTWA5	-0.05**	-0.13**	0.06	0.05	0.17**	-0.35
TTWA6	-0.06**	-0.04	-0.03	-0.07	-0.14**	-0.10
Workshop/Studio	-0.03	-0.06	-0.10			
Warehousing	0.02	0.01	0.04	0.03	-0.11**	-0.07
Managed Work Space	0.33**	0.39**			-0.01	
Hi-tech Space	0.16**	0.10	0.19**	0.18**	-0.22	-0.14
No. of Obs.	3180	1626	765	418	301	70
Standard Error	0.28	0.25	0.24	0.26	0.31	0.25
Adjusted R^2	0.42	0.32	0.30	0.34	0.36	0.73

Table 6 Principal Variables in Individual Size Band Regressions

Market Wide Model	Sizeband 1	Sizeband 2	Sizeband 3	Sizeband 4	Size Band 5
Size	Size	Age 1990 on	Age 1990 on	Age 1990 on	Age 1990 on
Age 1990 on	Nearest Motorway Junction	AGE4	Nearest Motorway Junction	Age 1980-89	Age 1980-89
Age 1980-89	Age 1990 on	Nearest Motorway Junction	Age 1980-89	Age 1970-79	Age 1970-79
Nearest Motorway Junction	Managed Workspace	Age 1970-79	Nearest Principal Town	YEAR99	TTWA2
Age 1970-79	TTWA5	YEAR94	TTWA1	Nearest Principal Town	Nearest Central Access Point

Table 7 Results of Hedonic Regression Models by Use Type

	Market Wide Model	Manufacturing	Warehousing
(Constant)	5.02**	5.17**	5.01**
Size	-0.14**	-0.13**	-0.15**
Nearest Motorway Junction	-0.05**	-0.05**	-0.05**
Nearest Principal Town	0.02**	0.02**	0.02
Nearest Central Access Point	-0.05**	-0.07**	-0.03**
Age 1960-69	-0.04	-0.06**	-0.02
Age 1970-79	0.11**	0.07**	0.14**
Age 1980-89	0.14**	0.11**	0.18**
Age 1990 - on	0.26**	0.18**	0.31**
YEAR94	-0.08	-0.05**	-0.09
YEAR95	-0.05	-0.02	-0.02
YEAR96	-0.07	-0.05**	-0.07
YEAR97	-0.07	-0.02	-0.10
YEAR98	-0.07	-0.03	-0.07
YEAR99	-0.01		0.00
YEAR00	-0.01	0.01	-0.02
TTWA1	-0.13**	-0.16**	-0.11**
TTWA2	-0.06**	-0.01	-0.12**
TTWA3	-0.03	0.04	-0.12**
TTWA5	-0.05**	-0.05**	-0.04
TTWA6	-0.07**	-0.03	-0.08**
No. of Obs.	3180	1638	1366
Standard Error	0.28	0.28	0.27
Adjusted R2	0.40	0.39	0.41

Table 8 Principal Variables in Individual Use Type Regressions

Market Wide Model	Manufacturing	Warehousing
Size	Size	Size
Age 1990-on	Age 1990-on	Age 1990-on
Age 1980-89	Nearest Motorway Junction	Age 1980-89
Nearest Motorway Junction	Age 1980-89	Nearest Motorway Junction
Age 1970-79	Nearest Central Access Point	Age 1970-79

- * Significant at the 5 per cent level
- ** Significant at the 1 per cent level

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Appendix

Industrial Subtype Categories

Manufacturing
Part of a complex of factories, either an industrial estate or area. The property is not of specialised design and could be used by other manufacturers with the minimum of alteration work. In some instances, the property may alternatively be used as a warehouse without the need for further planning consent.

Studio/Workshop
Part of a multi-storey, multi-occupied building where suites can be used for either office or industrial use, but the complex is not managed. Most occupiers tend to be small companies or start-up situations.

Warehouse/Storage
Part of a complex of warehouses where planning consent would probably be required to change the use to manufacturing use.

Managed workspace
Studio/workshop space with shared security and office facilities - including telephone answering. Occupiers tend to be small companies or start-up situations.

High Tech Units
Includes all high tech units (i.e having a high proportion of office space (20% plus) associated with manufacturing or storage) either situated on a specially developed park of similar units or an industrial estate or possibly surrounded by non-business uses. Will generally be a large unit (500sq m plus) of high quality, and have been built since 1985. The surrounding park will have a high proportion of landscaping and a high provision of car parking spaces