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An investigation of the relationships between demand, take-up, supply and rents in the Scottish industrial property market

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AN INVESTIGATION OF THE RELATIONSHIPS BETWEEN DEMAND, TAKE-UP, SUPPLY AND RENTS OF INDUSTRIAL PROPERTY IN CENTRAL SCOTLAND

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Abstract

This paper examines the market's determination of rental values of industrial property in Central Scotland using data provided by Scottish Property Network (SPN). The investigation is in two parts. Firstly, it explores the relationship between availability, take-up and a demand proxy, seeking to establish whether a separate principal component can be drawn from these variables which can reliably measure demand under conditions of changing availability. Secondly, using CB Hillier Parker data, the study seeks an ordinary least squares (OLS) regression model of rent determination with particular emphasis on short term time lags.

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Introduction

The aim of this paper is to explore the market's determination of industrial rents using floorspace availability and take-up data. The data used in this study have been derived from a number of sources. Industrial availability and take-up statistics for the study area (Central Scotland) have been provided by Scottish Property Network (SPN). Set up in 1994, SPN is a partnership between Scottish Enterprise and the University of Paisley, the main objective being to gather and maintain comprehensive information on the stock of business premises in Scotland. The SPN data relevant to this paper are: -

1. **Industrial Stock** - these comprise all industrial units within recognised industrial estates or industrial areas but exclude large single user facilities and 'non standard' premises. Premises identified as 'business units', yards and open storage are also excluded;

2. **Availability** – vacant premises known to be on offer for sale or to let;

3. **Take-up** - floorspace let or sold for occupation.

Rental data have been derived from the CB Hillier Parker Rent Index while Gross Value Added for Scotland, the demand proxy employed in the investigation, was obtained from the Scottish Executive Information Directive.

The remainder of this paper is set out in 4 sections. The first reviews the literature relevant to this study, encompassing work undertaken in both the UK and US markets. Section 2 investigates whether a strong relationship exists between the proxies for satisfied and latent demand with a view to determining the likelihood that a single all encompassing measure for total demand can be identified. A model is then proposed to attempt to explain variations in rental values. Section 3 tests the validity of the model, whilst the final section draws conclusions.

1 The Literature Review

Generally, there are two popular approaches to the modelling of property data for predictive and forecasting purposes. The most widely used approach in the US involves rental adjustment techniques, whereas the preferred approach in the UK is to model using a reduced form single equation model. Notwithstanding this, the choice of model used tends to be determined by the availability of data.

1.1 Rental Adjustment Models

The underlying assumption of the rental adjustment approach to rent determination is that there exists, in every property market, a natural vacancy rate. It is assumed that not all property will be let, and that some will be held back in anticipation of increasing rental values. When the actual vacancy rate deviates from the natural one, rent will move away from its natural equilibrium.

Rosen (1984) adopted a multi-equation model which sought to explain the demand for occupied space, the supply of completed office developments and the change in nominal rent (NR) within the user market with respect to changes in the vacancy rate (VR) and the level of price inflation (IN) inherent within the San Francisco office market.

$$\nwarrow NR_t/NR_{t-1} = \beta_0 + \beta_1(VR^n - VR_t) + \beta_2 IN_t \qquad (1)$$

The natural vacancy rate was estimated by averaging the values of the actual vacancy rates from 1961 through to 1983, and was found to be 7%. The model gave an R^2 value of 0.55 and the coefficients on all the variables were found to be significant and correctly signed.

The following year Hekman (1985) used panel data from 14 US cities to again construct a multi equation model that sought to derive equations for rents and new developments during the period 1979 to 1983. In this case, real rent was used as the dependent variable, having been deflated using the GNP price deflator. The rent equation from this model was:

$$RR_t = \beta_0 + \beta_1 VR_t + \beta_2 GP_t + \beta_3 E_t + \beta_4 U_t \qquad (2)$$

RR is the real rent in period t, VR is the vacancy rate, GP is Gross National Product, E is a measure of employment and U a measure of unemployment. All variables were found to be significant (except for employment) and correctly signed, but the R^2 value of 0.37 was not very impressive. According to Ball *et al* (1998) this could perhaps be due to the inherent assumption within the model that the natural vacancy rate (assumed within the constant β_0) was identical across all 14 cities within the sample.

More recent work has been carried out within the UK office market by Hendershott *et al* (1997), Wheaten *et al* (1997) and Tsolacos *et al* (1998), and Jones & Orr (2000) which construct demand and supply equations in order to model rental figures.

1.2 Single Equation Models

The single equation approach is very much favoured within the UK, and has been used by such authors as Gardiner & Henneberry (1988) and (1991), and Hetherington (1988).

McGough & Tsolacos (1994) make mention of a single equation model developed by Hillier Parker which measured industrial rents (IR) as a function of lagged manufacturing output (M), where a and b are constants, as shown below.

$$IR_t = a + bM_{t-1} \qquad (3)$$

This model was later amended to incorporate different regional influences, by substituting volume of production output (lagged one year) for manufacturing output in the South East, and the level of manufacturing employment (again lagged one year) was substituted for the rest of the regions. It would appear that this equation gave adequate correlation co-efficients as well as a satisfactory R^2 value.

Key *et al* (1994) developed a model for measuring industrial rent that took the following form.

$$RR_t = \beta_0 + \beta_1 RR_{t-n} + \beta_2 D_{t-n} + \beta_3 K_{t-n} + \beta_4 TD_{t-n} + \beta_5 RC_t \qquad (4)$$

D is GDP, K is the total stock of property, TD is a measure of new development, and RC is the real interest rate. This had an R^2 value of 0.9 when modelled at the national level.

More recently, White, Mackay & Gibb (2000) used time series data stemming from 1970 through to 1998 in order to identify and examine peculiarities and features of the Scottish property market relative to the London, South East and UK markets. Two approaches were adopted to measuring property rents in Scotland. Firstly they undertook a standard OLS analysis, using a single equation model incorporating both supply side and demand side variables, as follows.

$$\nwarrow r_t = \alpha + \beta_1 \nwarrow \Phi_{t-i} + \beta_2 \nwarrow r_{t-1} + \beta_3 \nwarrow GDP_t + \beta_4 \nwarrow S_{t-1} + \varepsilon_t \qquad (5)$$

They found that industrial rents in Scotland were a function of manufacturing employment (Φ), the autoregressive element for rents (r) and new construction orders (S), and regional GDP.

Further, while the dependent variable was trend stationary, some of the independent variables were not, and required differencing to become so. They concluded that there may be an issue of whether any long term relationship between the two sides of the equation can be said to exist.

Secondly, they attempted a within sample forecast using an autoregressive moving average (ARMA) model in order to forecast rents for the years 1995 through 1998. The resultant forecasts were then compared with the actual rents for those years. It was found that the most important explanatory variables for industrial rents in Scotland were regional GDP, manufacturing employment and the first lags on construction orders and rents. These findings were similar to those obtained from the OLS model.

2 The Analysis

2.1 The Study Area

The SPN data used for this research were floorspace availability and take-up figures of industrial stock in unit sizes greater than 999 sq.m constructed since 1990[1] in Central Scotland. The time series model used quarterly data from May 1995 through to May 2000. Central Scotland, for the purposes of this study, comprises the Local Enterprise Company [2] areas of Ayrshire, Dunbartonshire, Edinburgh and Lothian, Forth Valley, Glasgow, Lanarkshire and Renfrewshire. The majority of Scottish industrial market activity is focussed within this area. As at May 2000, SPN held information on approximately 11.25 million sq.m of industrial floorspace in Central Scotland. Of this, 828,780 sq.m was constructed post 1990 and are in unit sizes greater than 999 sq.m.

Since May 1995, SPN has recorded an average availability of 74,700 sq.m of post 1990 floorspace within Central Scotland in units greater than 999 sq.m. In terms of take-up for similar space, SPN has recorded an annual average figure of approximately 50,000 sq.m.

In general terms, the Central Scotland industrial market has been heavily influenced by the involvement of the public sector, including the former New Town Development Corporations at Cumbernauld, East Kilbride, Irvine and Livingston and the former enterprise zones at Clydebank and Inverclyde, and currently in Lanarkshire. In recent years, the Scottish Development Agency and its successor, Scottish Enterprise, has taken both a direct and in-direct involvement in industrial floorspace provision where necessary. Significant public sector industrial portfolios have also been sold in recent years. Key industrial areas within Central Scotland include the west side of Edinburgh, Livingston, North Lanarkshire and various locations within Glasgow, most notably Hillington.

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[1] The SPN database monitors the Scottish industrial market using up to 6 age bands. The age band used for this paper (Post 1990) has been chosen to provide the best possible match with the Hillier Parker Rent Index.

[2] Local Enterprise Companies are organisations licensed and funded by Scottish Enterprise to promote economic development and training at a local level. There are 13 such organisations within the Scottish Enterprise area, 7 of which are located within Central Scotland.

2.2 The Relationship between Take-Up and Demand at Varying Levels of Supply

There is no reliable way of measuring occupation demand for property. Only market activity can be measured. In the short term latent demand is converted into take-up only when there is effective supply, as represented by availability of floorspace. Therefore, it is suggested that when the availability of industrial property is plentiful, take-up should be a good indicator of overall demand. Conversely though, when availability is low, only satisfied demand is measured and a substantial element of demand may be frustrated.

The initial concept of this paper was to explore the relationship that exists between take-up and demand at varying levels of supply (represented by the vacancy rate (VR)). The vacancy rate is calculated by taking the level of available floorspace (AV) within the market as a percentage of total stock (TS). Demand is represented by a proxy; in this case Scottish Gross Value Added at constant prices (GVA).

Using principal component analysis, a standard correlation matrix (Figure 1) was constructed to measure the correlation between these two variables at various levels of vacancy rate, in order to determine if a single variable could be used to model overall demand. Unfortunately, the size of the SPN dataset was insufficient to allow for variations in the vacancy rate to be examined. Within this limitation the following correlation matrix was constructed.

<u>Figure 1 – Correlation between Take-Up and Demand</u>

		Take-Up (sqm)	Real Scottish GVA (all Sectors)	Real Scottish GVA (all Sectors) (Lagged 1 Qtr)	Real Scottish GVA (all Sectors) (Lagged 2 Qtr)	Real Scottish GVA (all Sectors) (Lagged 3 Qtr)	Real Scottish GVA (all Sectors) (Lagged 4 Qtr)
Correlation	Take-Up (sqm)	1.000	.392	.423	.389	.395	.406
	Real Scottish GVA (all Sectors)	.392	1.000	.995	.987	.980	.974
	Real Scottish GVA (all Sectors) (Lagged 1 Qtr)	.423	.995	1.000	.995	.989	.985
	Real Scottish GVA (all Sectors) (Lagged 2 Qtr)	.389	.987	.995	1.000	.997	.994
	Real Scottish GVA (all Sectors) (Lagged 3 Qtr)	.395	.980	.989	.997	1.000	.997
	Real Scottish GVA (all Sectors) (Lagged 4 Qtr)	.406	.974	.985	.994	.997	1.000
Sig. (1-tailed)	Take-Up (sqm)		.074	.058	.076	.073	.067
	Real Scottish GVA (all Sectors)	.074		.000	.000	.000	.000
	Real Scottish GVA (all Sectors) (Lagged 1 Qtr)	.058	.000		.000	.000	.000
	Real Scottish GVA (all Sectors) (Lagged 2 Qtr)	.076	.000	.000		.000	.000
	Real Scottish GVA (all Sectors) (Lagged 3 Qtr)	.073	.000	.000	.000		.000
	Real Scottish GVA (all Sectors) (Lagged 4 Qtr)	.067	.000	.000	.000	.000	

a. Determinant = 9.848E-10

Looking at the variances between take-up and the chosen proxy for demand, Scottish Gross Value Added, we can see that there is a reasonable level of correlation between both variables. However, it is not high enough to suggest the existence of a single component explaining both sets of explanatory variables. Thus, there is no reason to argue against their inclusion in the model as separate explanatory variables in their own right.

2.3 *The Model*

The basis for this analysis lies within the confines of the user market for industrial property where rent is seen as the result of an interaction between supply and demand variables. In this model, movements in demand are explained by variables other than rent. Thus, changes in output by firms will result in a change in demand for industrial space, possibly resulting in a shift in rental values. The supply of property will react accordingly until a new equilibrium rent has been achieved.

Therefore, in order to explore the reasons for changing rental values, it is necessary to explore the variables that affect and/or measure supply and demand in the user market. Based on the evidence of the literature review, the following model is proposed for explaining real rental values within the industrial property market in Central Scotland:

$$R_t = \beta_0 + \beta_1 GVA_{t-n} + \beta_2 VR_{t-n} + \beta_3 (TU_{t-n}/TS_{t-n}) + \beta_4 R_{t-n} + \varepsilon \quad (6)$$

where;

R_t	=	Nominal Rent
(TU_{t-n}/TS_{t-n})	=	Take Up as a percentage of Total Stock
VR_{t-n}	=	Vacancy Rate (given by Availability as a percentage of Total Stock
GVA_{t-n}	=	Gross Value Added for Scotland (at constant basic prices)
R_{t-n}	=	Lagged rents
ε	=	The error term

It is assumed that ε is a normally distributed random variable, with an expected value of zero ($E(\varepsilon) = 0$), a variance of $\varepsilon = \sigma^2$, and that the values of the error are independent. This will allow an OLS regression to be undertaken to test the predictive powers of the model.

Thus,

$$E(R_t) = \beta_0 + \beta_1 GVA_{t-n} + \beta_2 VR_t + \beta_3 TU_{t-n} + \beta_4 R_{t-n} \quad (7)$$

Since the parameters β_i are unknown, but can be estimated using the parameters $\hat{}\beta_i$ we end up with the following regression equation.

$$\hat{}R_t = \hat{}\beta_0 + \hat{}\beta_1 GVA_{t-n} + \hat{}\beta_2 VR_t + \hat{}\beta_3 TU_{t-n} + \hat{}\beta_4 R_{t-n} \quad (8)$$

where $\hat{}\beta_i$ is the estimated value of β.

The dependent variable is the nominal rental rate for industrial property within Scotland as a whole. As previously stated, these figures have been taken from the CB Hillier Parker quarterly rent indices for the period May 1995 to May 2000, to coincide with the data on availability and take-up provided by SPN.

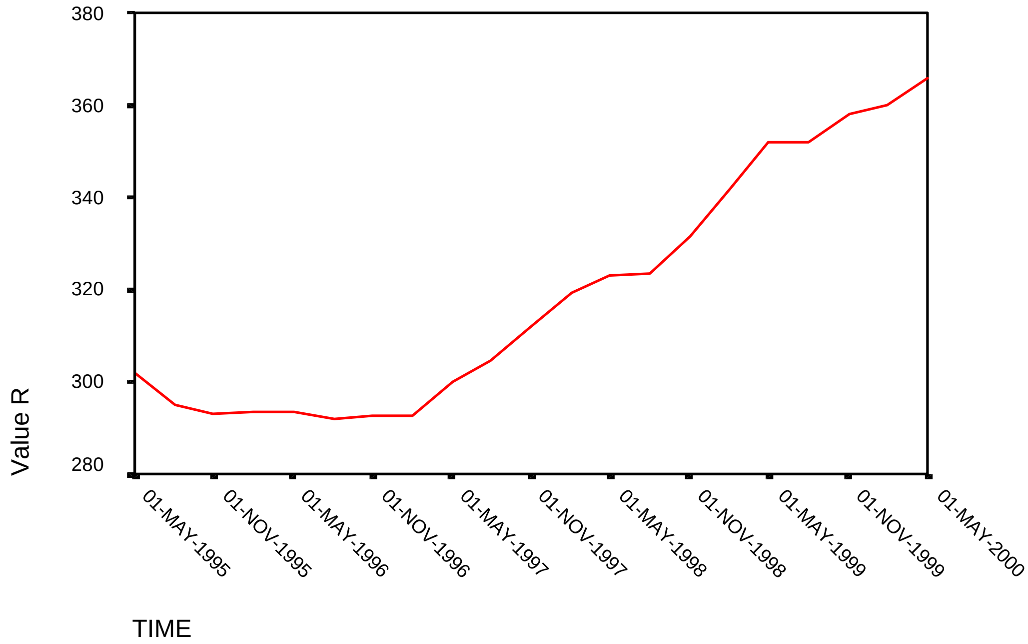
The actual vacancy rate within the model is taken as being the percentage of available floorspace over total stock. Its inclusion is an attempt to capture the impact of movements away from an assumed natural vacancy level, which is implicit within the model. This should go some way in explaining shifts in rental values away from an equilibrium state.

Take-up has been included as a measure of satisfied demand (Jones & Orr, 2000) , with latent demand within the market being measured by GVA.

3 The Empirical Analysis

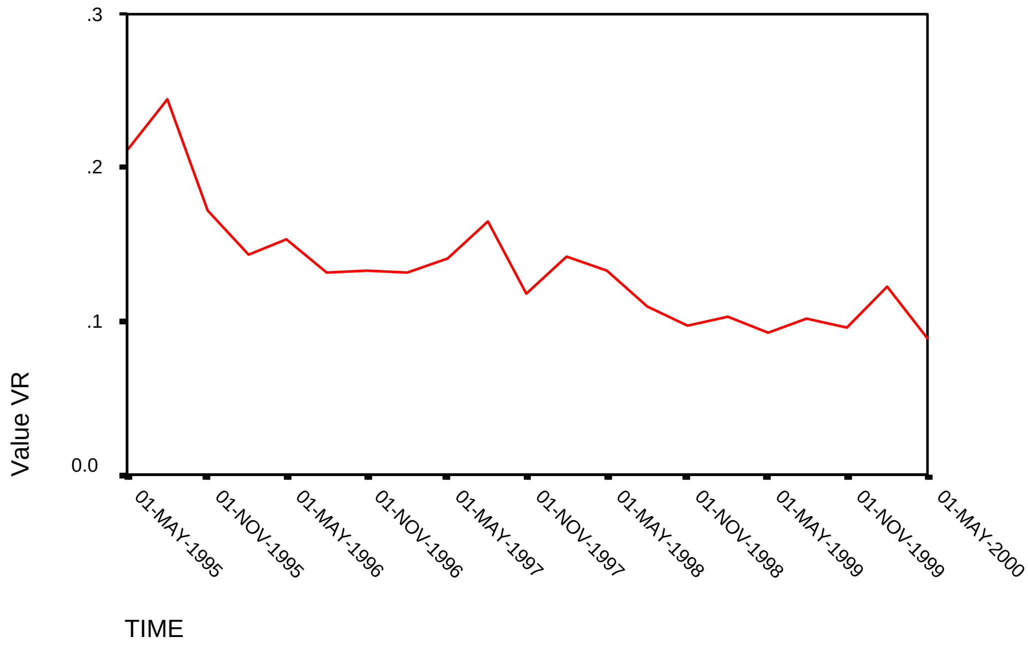
Rental trends over the study period are shown in Figure 2.

Figure 2 – Rental Growth in Central Scotland Industrial Property



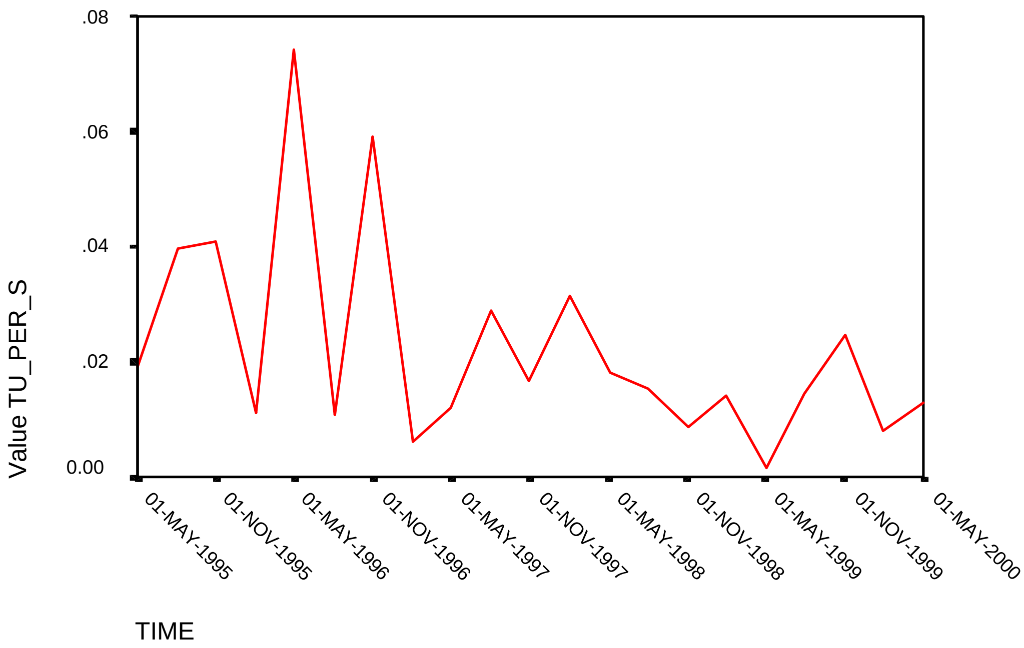
After an initial decline in rental values in the first period of the time series data, rental values levelled out, before rising sharply from February 1997 onwards. This followed closely the movement of GVA over a similar period.

Figure 3 – Vacancy Rates in Central Scotland Industrial Property



Vacancy rates have been in steady decline since August 1995, when they were 24.4%, to a level of 8.4% in May 2000.

Figure 4 – Take-up as a Percentage of Total Stock in Central Scotland Industrial Property



Taking out the observations in May and November 1996, take-up has been fairly steady at around 2% of total stock.

Unit root tests were run on the model as it was suspected that one or more of the variables could be trending over time, thus leading to spurious results in the regression analysis. Unit root tests were conducted (Figure 5) and compared against the critical values (Figure 6) leading to the conclusion from Figure 7 that the data was I(1) except for the dependent variable rent which was found to be I(2). However, the tests were run again leaving out the time observations prior to February 1997. These found that, at the 10% confidence level, rents were also I(1). Therefore it was decided to proceed with the OLS regression. The data applied to the equation were then differenced and logged.

Figure 5 –Augmented Dickey Fuller (ADF) Statistics

ADF Statistics:-

	levels	1st log diff.	2nd log diff.
R	0.59441	-2.372607	-3.534884
VR	-4.022584	-4.090325	-7.085992
AV	-3.221626	-4.044024	-5.434069
GVA	0.033166	-5.465838	-7.036406
TU_PER_S	-1.834902	-6.655593	-10.60609

Figure 6 –ADF Critical Values

Critical Values:-

levels		1st log diff.		2nd log diff.	
1	5	1	5	1	5
-3.8304	-3.0294	-3.8572	-3.04	-3.8877	-3.0521
-3.8304	-3.0294	-3.8572	-3.04	-3.8877	-3.0521
-3.8304	-3.0294	-3.8572	-3.04	-3.8877	-3.0521
-3.8877	-3.0521	-3.9228	-3.0659	-3.9635	-3.0818
-3.8304	-3.0294	-3.8572	-3.04	-3.8877	-3.0521

Figure 7 –Summary of ADF Results

Summary of Results: Rejection of null hypothesis of a unit root

	levels	1st log diff.	2nd log diff.
RRI	-	-	5 %
VR	1 %	1 %	1 %
AV	5 %	1 %	1 %
GVA	-	1 %	1 %
TU_PER_S	-	1 %	1 %

Equation 9 shows the “best” fit estimates of the single equation model outlined in equation 8.

$$R_t = 0.675*GVA_{t-1} - 0.00755*VR_{t-1} + 0.0009218*TU_{t-1} + 0.545*R_{t-1} \quad (9)$$

The model exhibits a reasonable R^2 value of 0.579 and an Adjusted R^2 of 0.459. As expected, the Durbin Watson value of 2.381 was close to 2 as a result of including the lagged dependent variable.

Figure 8 – Single Equation Estimates for Central Scotland Industrial Rents between May 1995 and May 2000

Variable	**Coefficient**	**Std Error**	**t-value**	**t-prob**
GVA_{t-n}	0.675	0.382	1.764	0.100
VR_t	-0.00755	0.021	-0.362	0.723
(TU_{t-n}/TS_{t-n})	0.0009218	0.003	0.367	0.719
R_{t-n}	0.545	0.117	3.085	0.008

Figure 8 shows the results of the OLS regression. Only lagged GVA and lagged rents are significant, at 10% and 1% respectively, and are correctly signed. Vacancy rate and take-up as a percentage of total stock figures are significant only when taken at greater than 70%. They are therefore insignificant in this model. This may not be due to the ineffectiveness of the variables themselves in helping to predict the dependent variable, but in the fact that, as previously stated, the dependent variable is still not trend stationary at I(1). This can be seen from the plot of the first (Figure 9), second (Figure 10) and third (Figure 11) differences of its logged values below, suggesting that the variable may have to be differenced at least 3 times before stationarity is achieved.

Figure 9 – 1st Logged Difference of Rent against Time

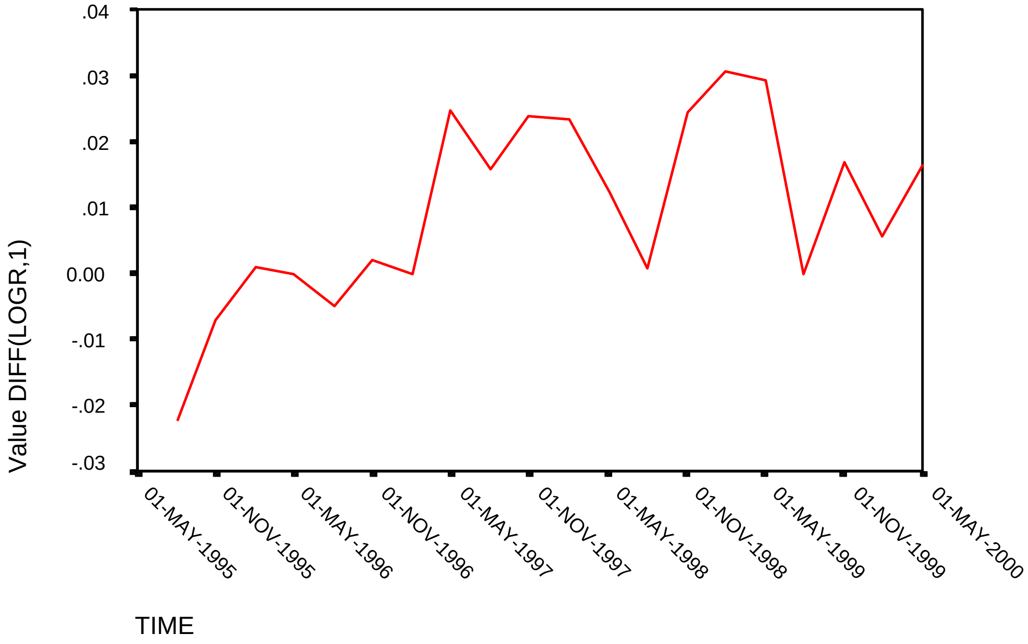


Figure 10 – 2nd Logged Difference of Rent against Time

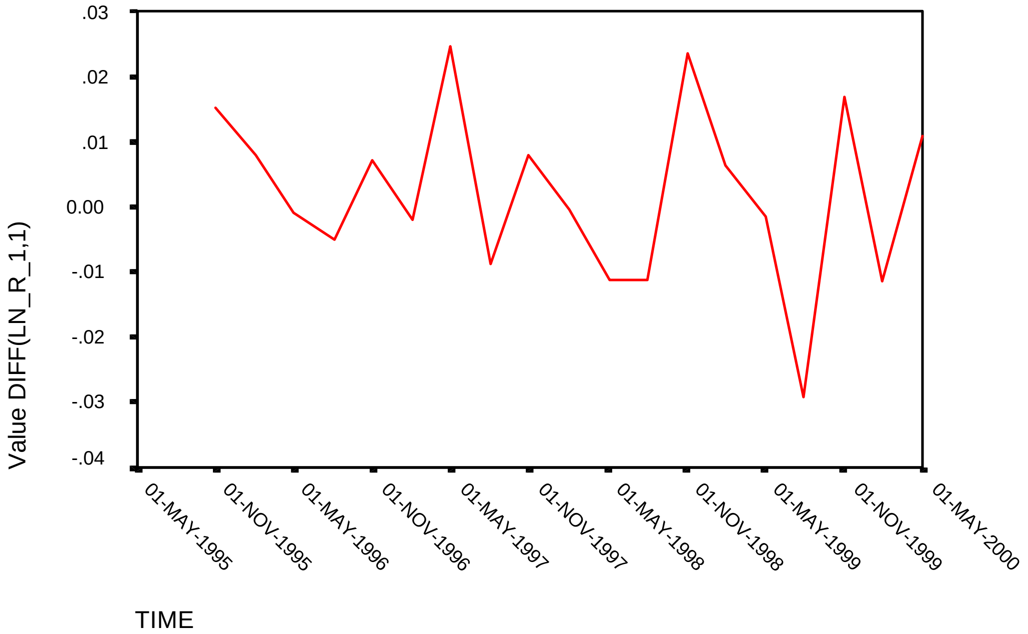
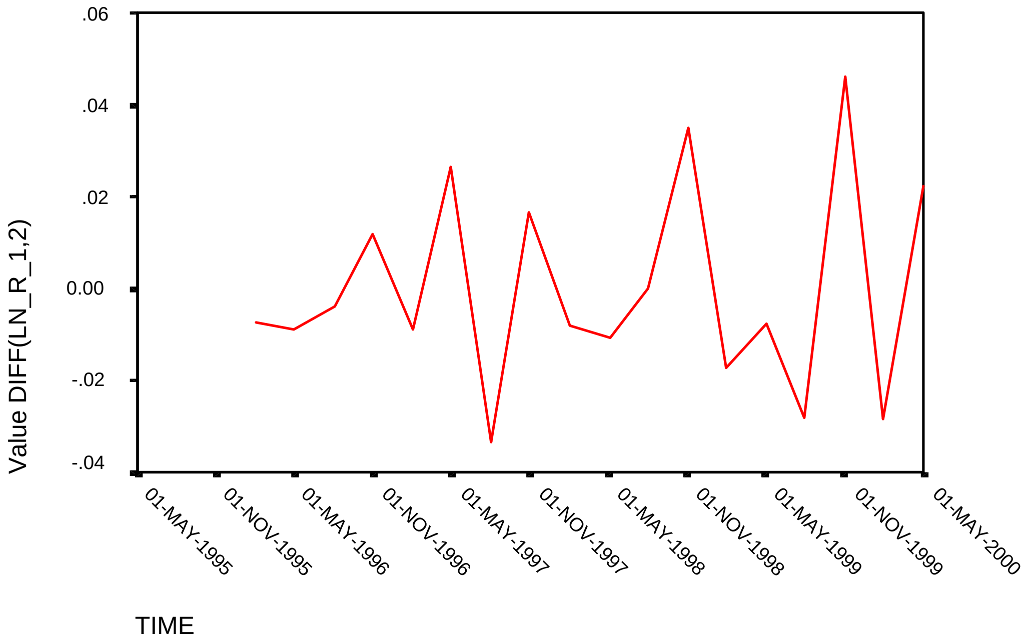
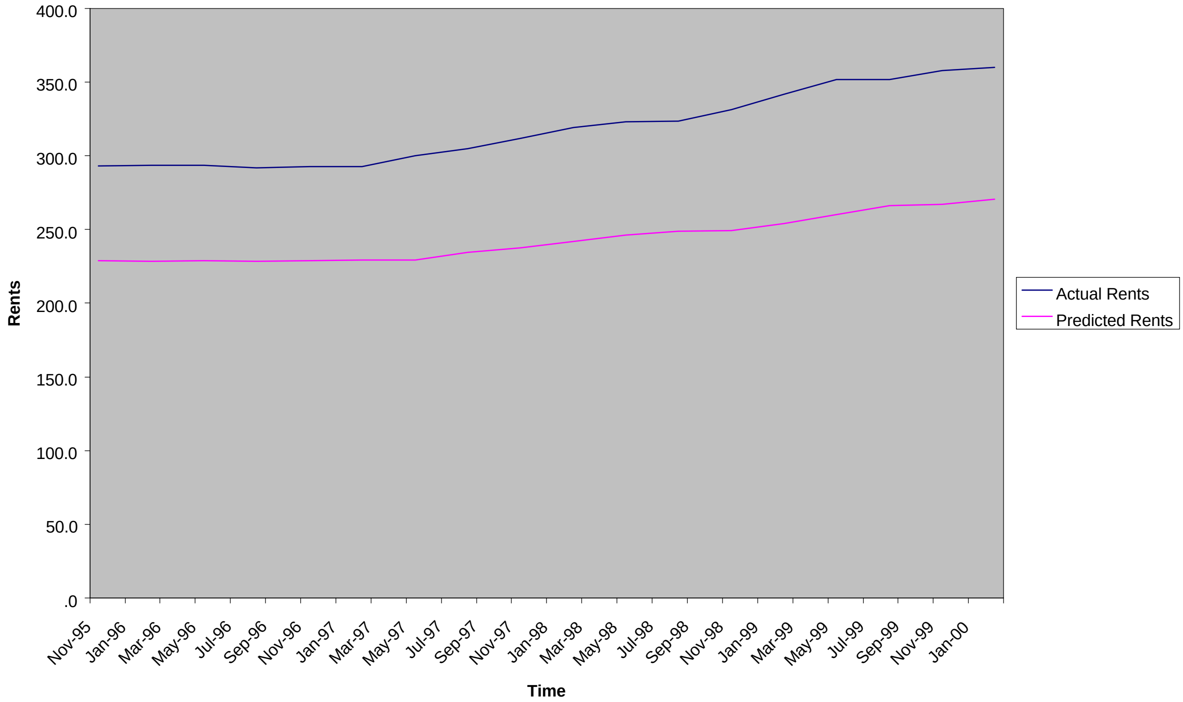


Figure 11 – 3rd Logged Difference of Rent against Time



As would be expected, the predictive power of the model is poor. It trends correctly, but constantly underestimates the actual values, as can be seen in Figure 12.

Figure 12 – Actual Rents and Predicted Values



4.1 Conclusion

It is incontrovertible that take-up and availability are determinants of rental values. However, based on the data and timescale of this study, the model identifies the strength of the economy and the value of rents paid in previous periods, as more significant.

Take-up measures satisfied demand. When the availability of industrial property is plentiful, take-up should be a good indicator of overall demand. Conversely when the availability is low, only satisfied not latent demand will be measured. Over the period of this study, vacancy rates are relatively high and, by definition, only account for the properties which agents have identified as being available for let. It takes no account of under-utilised space or space which has not been put to the market. Thus the effective vacancy rate at any point in time may differ from that recorded.

The results obtained from the regression may be flawed for other reasons. Firstly, it was decided not to deflate the dependent variable. As inflation had already been eliminated from the right hand side of the model, it was felt that there would not be any problem associated with spurious correlation in the results. This will be the subject of further work.

Secondly, it was highlighted that even after second differencing, the explanatory variable was still not trend stationary. Also, each time a variable is differenced it loses some of its explanatory power. The insignificance of the t-statistics on the co-efficients of the explanatory variables relating to take up and vacancy rates mean that to difference any further would only result in a further dilution of the long run relationship between these variables and rents.

4.2 Future Research

Although at present it is impossible to expand the number of time observations within the SPN dataset, it is felt that there are a number of ways of improving the analysis. Firstly, the dependent variable could be deflated using a standard GDP deflator (White, Mackay & Gibb, 2000) in order to see if this has a positive effect on the stationarity issues identified in this analysis. Secondly, a panel data model might be constructed to investigate the various LEC's individually. This would result in a sizeable increase in the number of observations and might enable a more comprehensive investigation of the relationship between take-up and demand at varying levels of availability.

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