Industrial Market

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***Abstract.* This study estimates models of industrial rents at the national level in Great Britain. James Lan Wooten and CB Hillier Parker rent indices are used to model changes in real rents. These changes are positively related to changes in real GDP and inversely affected by absorption, as measured by King Sturge & Co. Additionally, changes in rents convey information not captured by GDP and absorption. The lagged effects of the variables differ for each index, attributable to the construction methodologies followed. Dynamic forecasts for both models show a small overprediction in 1996 and 1997. Ex ante forecasts suggest that both will show positive real growth throughout 1998 and 1999.**

Introduction

Industrial rent determination remains a relatively under-researched area in property market analysis. The lack of interest and published empirical work can partially be attributed to the importance of the owner-occupied sector in the industrial market and the lower weight that industrial property has in institutional portfolios. Insight on industrial rent determination is provided by a number of studies that have identified location and building characteristics as the main influences on industrial property values and rents. Work by Hillier Parker (1987) has shown that industrial property values are sensitive to proximity to large cities and motorways and are affected by depreciation arising from factors including inefficient layout, high energy/ maintenance costs and inadequate parking (see also Salway, 1986). Baum (1991) found that accessibility, building quality, state of repair and level of deterioration are important parameters influencing industrial rental values. Ambrose (1990) concluded that certain property-specific factors (which do not include the age of the building and the ceiling height) explain the differences in asking prices in the warehouse property market. On the other hand, this study did not establish a similar significant relationship between physical characteristics and asking warehouse rents.

Other research highlights the importance of both physical and locational characteristics and market conditions. The study of Fehribach, Rutherford and Eakin (1993) provided empirical support to the importance of physical factors in explaining the sales price of industrial property. It also concluded that local market conditions,

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proxied by the industrial capitalization rate and the prime interest rate, are significant in the explanation of industrial sales prices. Lockwood and Rutherford (1996) found that the values of industrial buildings reflect primarily local economic factors, the physical characteristics and location of the property. Similar results were obtained by Buttimer, Rutherford and Witten (1997) who posited that real rents are positively related to non-agricultural employment, the proxy for general market conditions. According to this study, real rents are also effected by physical characteristics including the number of high-grade doors, age of the building, the ceiling height, office space content and location.

Work on industrial rents has also focused on the impact of economic and market conditions on industrial property values and rents. An early study by Hoag (1980) argued that industrial property values are positively influenced by broad market changes. Hillier Parker (1985, 1986) concluded that the volume of manufacturing output, level of manufacturing employment and volume of industrial production are the main variables that affect industrial rents in the British regions but their significance varies across the regions. The empirical results in the study of Atteberry and Rutherford (1993) indicated that the monetary base, a proxy for economic conditions, causes variation in industrial property prices. Industrial building construction, a variable that was used to capture the investors' perceptions of future industrial capacity, also appeared significant in explaining the variation in industrial property sale prices. Another notable finding of this study is the significant relationship between past and current industrial prices. McGough and Tsolacos (1995) also suggested that movements in industrial rents can be modeled autoregressively and forecast in the short-run on the basis of their recent past values. The results of the RICS study (RICS, 1994) further supported these findings. A positive influence of industrial rents one year ago and a negative influence of industrial rents two years ago on current industrial rents in Great Britain was established. In addition, the volume of manufacturing output one year ago and the current *GDP* growth rate exert a positive influence on the current level of industrial rents, whereas the change in construction starts (a supply side variable) two years ago was a negative influence.

The principal objective of this study is to generate further empirical evidence on the determinant factors of industrial rent changes through time. Industrial rents are examined at the national level and the data are from British sources. This aggregate study of industrial rents is motivated by the dearth of relevant research at this level of analysis and the need for a better understanding of the broad movements of industrial rents. Although rents in localized industrial markets will reflect location, building characteristics and other similar attributes, it is expected that changing macroeconomic circumstances and trends in the industrial property market as a whole will influence (to varying degrees) the direction of rent movements across sub-markets. The statistical analysis of industrial rents in this study is carried out utilizing two different series, the Jones Lang Wootton Industrial Rent Index and the CB Hillier Parker Rent Index. Since these two indices are constructed differently, another aim of this study is to examine whether models of industrial rents are sensitive to the particular series of rents employed. The study uses quarterly data for the period 1977: 2 through 1997:4.

A second purpose of this study is to obtain forecasts of industrial rents from the estimated models. Initially, the forecasting adequacy of the models is examined by producing forecasts of rental values for both indices for 1996 and 1997 and comparing them to the realized quarterly values of rents. Subsequently, quarterly forecasts of the Jones Lang Wootton and CB Hillier Parker rent indices are made for 1998 and 1999.

The remainder of the study is organized in five sections. The next section discusses theoretical issues on industrial rent determination and the data utilized. In the following two sections, the rent models are estimated and the ex post and ex ante forecasts presented. The last section provides a summary and some concluding remarks.

Theoretical Framework and Data

Short-run movements of industrial rents are assumed to respond mainly to demand and supply forces in the market. There are several factors that affect demand for industrial space at the national and more localized levels. At the aggregate level, an increasing demand can be attributed to factors including the expansion of existing industries, the establishment of new firms, changing methods of production and productivity. In this study, changes in the requirements for industrial space are assumed to be concomitant with the increasing or shrinking operations of the industrial sector. In good times, the demand for industrial space will increase with the expansion of industrial production and in less prosperous times demand will fall as industrial activities are curtailed. The theoretical framework of industrial rent determination proposed in this study contains two macroeconomic series in order to capture the changing trends in industrial sector activity and the resulting changes in industrial space requirements. The first series is the gross domestic product, a measure of conditions in the broad economy. It is expected that industrial activity will be positively related to the fluctuations of the general economy. The second series is manufacturing employment, which represents a more direct measure of industrial activity. Trends in manufacturing employment also allow for the effects of productivity in the industrial sector. In the last fifteen years, the industrial sector in Great Britain has experienced a significant productivity growth, which is higher than that recorded for the economy as a whole.[1] Industrial output can increase without a corresponding increase in employment and possibly in floorspace. This 'floorspace productivity' (output/floorspace), which can be considered as a determinant of industrial space requirements, may be captured by 'employment productivity' (output/employment).

The other major parameter in the determination of rents is the supply of industrial space. The supply of industrial space for any period consists of new properties coming on the market and pre-existing buildings that are vacated and put on the market for lease or sale. A rise in industrial space requirements can be partly or totally met by the existing supply of buildings. This would likely restrict rental growth when demand for industrial space tends to rise. The part of the demand satisfied by the supply of buildings is assumed to be reflected in the absorption rate of industrial floorspace. A high absorption rate over a period of time indicates that a significant proportion of the demand for industrial space is accommodated and that rental growth is likely to remain subdued (rents may not increase as much as they would have otherwise risen). An inverse relationship can, therefore, be argued between the absorption rate and the growth rate of industrial rents. The greater the proportion of demand satisfied by the existing supply, the greater the negative influence of the supply side on rental growth. Therefore, in this study, a negative relationship between the absorption rate and industrial rents is expected, which conforms the hypothesis tested and the sign obtained in the study of industrial building production in the U.K. by Giussani and Tsolacos (1994).

In addition to the market demand and supply related series, which are considered in explaining the movements of industrial rents, the final specification also makes use of the results in the studies of Atteberry and Rutherford (1993), RICS (1994) and McGough and Tsolacos (1995). These authors found strong evidence that industrial rents can be reasonably modeled autoregressively. This means that recent past information on industrial rents can be used to explain rents in the current period and make short-term predictions. This finding is important to the construction of industrial rent equations, since past values of rents can be included assuming that they convey information that is not contained by other explanatory variables. Therefore, the model of industrial rents in the present study incorporates past values of rental changes.

The general mathematical form of the industrial rent model is given by Equation (1):

$$\Delta_1 RENT_t = \alpha_0 + \Sigma\alpha_{1i}\Delta_1 GDP_{t-i} + \Sigma\alpha_{2i}\Delta_1 EMP_{t-i} - \Sigma\alpha_{3i}\Delta_1 VAC_{t-i} + \Sigma\alpha_{4j}\Delta_1 RENT_{t-j} + \varepsilon_t \quad (1)$$

for $i = 0, 1 \ldots I$ and $j = 0, 1, \ldots J$.

In Equation (1), Δ_1 signifies the first difference operator. *RENT* is an index of national industrial rents adjusted for inflation using the *GDP* implicit price deflator series. In this study two indices are used; the Jones Lang Wootton (JLWRE) Index and the CB Hillier Parker (CBHPRE) Index. *GDP* is the volume of the gross domestic product. *EMP* is manufacturing employment. *VAC* is the King Sturge & Co series of the level of industrial floorspace vacancy. $\Delta_1 VAC$ represents the absorption rate. $t - i$ and $t - j$ denote lags and I and J maximum lag lengths. The maximum lag lengths and the most significant lags are expected to be different for each explanatory variable. The most significant lags and maximum lag lengths for these variables cannot be determined, a priori, and will be estimated by the data. The term ε_t is the stochastic error, which satisfies the usual statistical properties.

The JLWRE reflects achievable rents of actual properties under management at rent review. The CBHPRE is constructed from estimates of open market rental value for hypothetical new buildings of circa 15,000 sq. ft. of standard construction with an average eaves height of 18 feet, good access, good loading space, adequate parking and usual mains services. A difference between these two indices is the weighting given to properties in the sample across different regions. The CBHPRE Index has a fixed spatial weighting. For example, rent points in the South East region are represented with 51% weight throughout the series. These weights are variable in the JLWRE. Industrial property in the South East region represented 71.2% of the index by value in 1983 for example, but only 64% at the end of 1997. Data for *GDP* and manufacturing employment are supplied by the Office for National Statistics. The industrial floorspace availability series is compiled by King Sturge & Co. Industrial floorspace availability is drawn from internal trading databases of vacant stock being the total of all leasable space above 5,000 sq. ft. available at the data point. Buildings that are functionally obsolete and suitable only for redevelopment are excluded from the data.

The study uses quarterly data and the sample period is dictated by the availability of data for industrial rents. The starting date for both indices is the 1977:2. However, since first differences are used, the sample period starts in the 1977:3. The end date is the 1997:4. Further degrees of freedom are likely to be lost if lags of the term $\Delta_1 RENT_{t-j}$ appear significant in the estimations of Equation (1) when the two indices are used.

Results

The relationship between the JLWRE and CBHPRE indices of industrial rents is given in Exhibit 1. Exhibit 1 illustrates their relationship by presenting cross correlations between the current values of the JLWRE Index and the contemporaneous, past and led values of the CBHPRE Index. Both indices are adjusted for inflation. The cross-correlations are estimated both in levels and absolute first differences.

A number of observations can be made from the inspection of the results in Exhibit 1. As expected, the two indices show a positive relationship and therefore they display similar cyclical co-movements. Overall, the contemporaneous values of the JLWRE Index are correlated more strongly, in both levels and first differences, with lagged values of the CBHPRE Index than led values (the exception to this pattern is the values at $t - 1$ and $t + 1$ when first differences are used). This is an indication that

Exhibit 1
Cross-Correlations between the CBHPRE and JLWRE Indices

$t-3$	$t-2$	$t-1$	t	$t+1$	$t+2$	$t+3$
Panel A: Levels						
0.61	0.64	0.65	0.64	0.61	0.56	0.49
Panel B: First Differences						
0.59	0.64	0.55	0.60	0.60	0.55	0.51

Note: The cross-correlation coefficients are the product of correlations between the contemporaneous values of the JLWRE Index (that is at time *t*) and the contemporaneous (*t*), lagged ($t - 1$, $t - 2$ and $t - 3$) and led ($t + 1$, $t + 2$ and $t + 3$) values of the CBHPRE Index the CBHPRE Index leads the JLWRE Index. When first differences are considered, the highest correlation coefficient is obtained when the CBHPRE Index is lagged two quarters. This suggests that changes in the CBHPRE Index lead changes of the same magnitude in the JLWRE Index by about six months. This is attributable to their different construction. The CBHPRE Index is based on estimates by those active in the market. The large majority of business transacted in the market is for existing stock. Because the index is also based upon the estimated value of new (*i.e.*, never previously occupied) property, inevitably it includes an element of expectation. Conversely, the JLWRE Index is constructed from property already held in a portfolio by specialists in rent review. That this lags the CBHPRE Index therefore is to be expected.

Finally, the size of the correlation coefficients suggests that the relationship between the two indices is not very strong (the highest value is 0.65 in levels). Therefore, the results of the cross-correlations presented in Exhibit 2 establish certain differences between the two series and this may have implications for the specification of the industrial rent model in each case.

Summary statistics (mean, standard deviation and coefficient of variation) for the two indices of real industrial rents, the *GDP* series (in real terms), industrial employment and the level of vacancy are shown in Exhibit 2. The calculated values of the mean and standard deviation are higher for the CBHPRE Index than for the JLWRE. The coefficient of variation suggests that the CBHPRE series is more volatile than the JLWRE series. The fluctuation of the standard deviation around the mean of the data is 39% for the former series and 30% for the latter. The economic series vary the least (smaller coefficient of variation). The vacancy series shows variation, which is broadly similar to that of JLWRE. When the above statistics are estimated for the first differences of the variables, these conclusions do not alter. However, when first differences are considered, the $\Delta_1 CBHPRE$ series is significantly more volatile than the $\Delta_1 JLWRE$ series.

The regression form of Equation (1) initially included seven lags of each of the independent variables. It was assumed that a period of two years in the past provides a sufficiently long time horizon for rent movements to reflect the effects of these variables. In estimating Equation (1), a general to specific approach was followed in the computations. This process involved the exclusion of the contemporaneous and lagged values of the explanatory variables, which did not take the a priori sign or

Exhibit 2
Summary Statistics—1997:2–1997:4

	JLWRE	*CBHPRE*	*GDP*	*EMP*	*VAC*
Mean	221	254	91.6	4811.1	11.5
Std. Dev.	65.6	98.4	12.1	847.1	3.6
Coefficient of Variation	30	39	13	18	31

were statistically insignificant, and the specification with the lowest value of the Akaike information criterion was chosen (Akaike, 1973). The application of these criteria, when the JLWRE Index is used, resulted in the rent model, which is shown in Exhibit 3. This model incorporates $\Delta_1 GDP$ lagged five and six quarters, $\Delta_1 VAC$ lagged seven quarters (longer lags were not significant) and $\Delta_1 JLWRE$ lagged two quarters. The lagged terms of $\Delta_1 GDP$ and $\Delta_1 VAC$ take the expected sign (the sign of $\Delta_1 JLWRE(-2)$ cannot be defined a priori and is determined by the data) and all variables are significant at the 5% level. The findings do not establish any statistically significant relationship between $\Delta_1 JLWRE$ and the lags of $\Delta_1 EMP$ when the fifth and six lags of $\Delta_1 GDP$ are present in the estimates. The information contained by this variable about changes in the demand for industrial space is captured by the $\Delta_1 GDP$ series. The model explains 47% of the changes in industrial rents. This is moderate explanatory power, but it is not unsatisfactory, given the volatility of the $\Delta_1 JLWRE$ series from quarter to quarter that makes the task of modeling the series difficult. The Breusch-Godfrey test (Breusch, 1978; and Godfrey, 1978), is carried out to test for the presence of more general forms of serial correlation, but it did not indicate autocorrelation up to fourth order in the residuals. Similarly, heteroskedasticity problems were not detected by the application of White's (1980) test. Moreover, ADF regressions showed that the residuals are not a random walk at the 5% level (thus, there is no evidence of a unit root in the residuals). Based on the above diagnostics, the residuals do not appear to capture influences that persistently affect changes in industrial rents but are omitted from Equation (2). Finally, the cumulative sum of squared residuals test did not indicate any structural breaks.

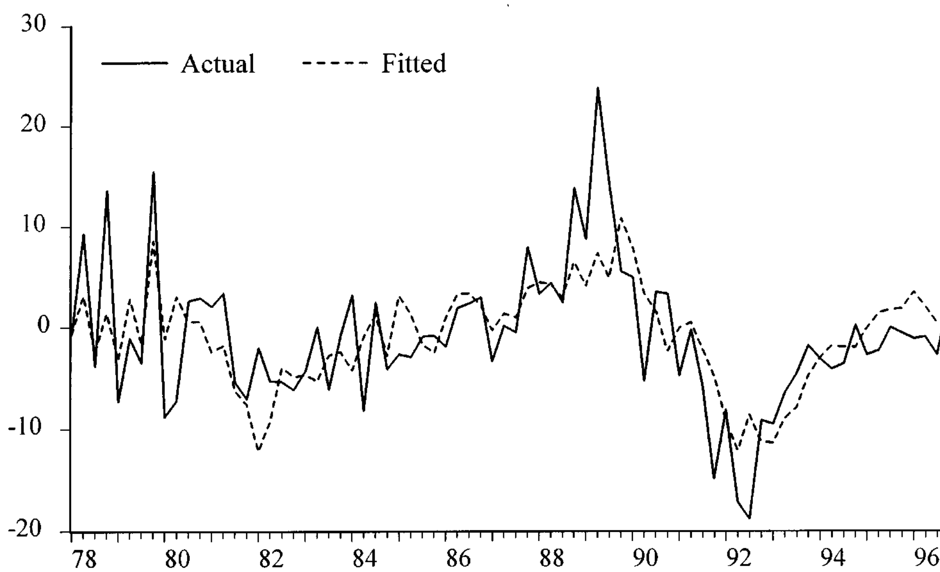
The actual and fitted values generated by Equation (2) are shown in Exhibit 4. The fitted values are the predicted values from the regression computed by applying the estimated coefficients to the independent variables. The model replicates the changing directions in rent growth, but it does not capture the actual peaks and troughs of these changes. This is particularly evident in the late 1980s, when the substantial increases in the growth rate of rents are not explained by the model. In this period, other factors

Exhibit 3
Empirical Estimation of the Industrial Rent Model Using the JLWRE Index

Variable	Coefficient	*t*-ratio	Probability
Constant	−2.15	2.8	0.00
$\Delta_1 GDP(-5)$	2.08	2.7	0.01
$\Delta_1 GDP(-6)$	1.89	2.2	0.03
$\Delta_1 VAC(-7)$	−2.07	2.3	0.03
$\Delta_1 JLWRE(-2)$	0.35	3.9	0.00

Note: The dependent variable is $\Delta_1 JLWRE_t$; the adjusted R^2 is .47; *F*-Statistic is 18.25; the Breusch-Godfrey serial correlation test (testing for up to 4th order autocorrelation) = 3.88, (critical value at 5% is $\chi^2(4) = 9.49$); the White test for heteroskedasticity = 20.14, (critical value at 5% is $\chi^2(14) = 23.68$). The sample period is 1978:1–1997:4. The number of observations is 80. The numbers in parentheses indicate lags.

Exhibit 4
Actual and Fitted Values of Changes in JLW Real Industrial Rents Based on Equation (2)

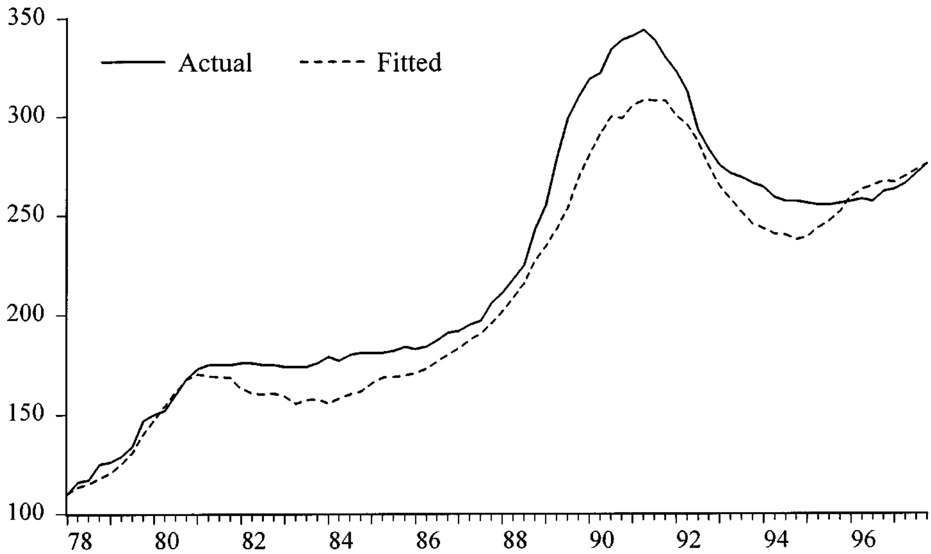


could have played a role, such as expectations about sustainable rates of high growth fueled by an excess optimism. The fitted values, however, in Exhibit 4 seem to track satisfactorily the negative rates of rent growth in the early 1990s and the recovery in this rate of decrease that followed.

Subsequently, Equation (2) is used to produce the fitted JLW series in nominal terms and compare it with the actual series produced by JLW. From the fitted changes in real rents, the fitted real rent series is produced and the latter is converted into the fitted JLW nominal rents using the *GDP* deflator index. Exhibit 5 plots both the actual and fitted nominal series. A first observation is that the fitted series replicates adequately the trend of the actual series. A second observation is that the fitted series under predicts the actual series for most of the sample period.

Exhibit 6 reports the output of estimating Equation (1), which is the general form of the industrial rent model, using the CBHPRE Index. Similar to the results obtained when the JLWRE Index is used, $\Delta_1 GDP$ and $\Delta_1 VAC$ appear to be significant variables in explaining $\Delta_1 CBHPRE$. The lags of the variables that capture most of these effects are two and five quarters, respectively. Changes in manufacturing employment did not add any explanatory power. Changes in rents lagged one quarter also appeared significant. The fact that changes in the CBHPRE Index are explained by more recent lags of $\Delta_1 GDP$ and $\Delta_1 VAC$, compared to the JLWRE Index, could be attributable to the fact that the latter index lags the former. Equation (3) explains 66% of the actual changes in CBHPRE real rents. The diagnostic tests carried out for Equation (2) are

Exhibit 5
Actual and Fitted Values of the JLW Nominal Industrial Rent Index (1977:2 = 100)



also applied to Equation (3) but the results combined do not suggest any misspecification problems. A sign of instability was only suggested by the cumulative sum of squares test in 1991–1992. The test line breaks the upper limit and remains above the limit for four quarters. Then it reverts back within the critical lines. This means that a structural break tended to occur in the early 1990s but the model absorbed it after a few quarters.

Exhibit 6
Empirical Estimation of the Industrial Rent Model Using the CB Hillier CBHPRE Index

Variable	Coefficient	*t*-ratio	Probability
Constant	−0.58	1.0	0.30
$\Delta_1 GDP(-2)$	1.50	2.2	0.03
$\Delta_1 VAC(-5)$	−1.54	2.1	0.04
$\Delta_1 CBHPRE(-1)$	0.68	8.8	0.00

Note: The dependent variable is $\Delta_1 CBHPRE_t$; the adjusted R^2 is .66; the *F*-Statistic is 52.7; the Breusch-Godfrey serial correlation test (testing for up to 4th order autocorrelation) = 2.54, (critical value at 5%: $\chi^2(4) = 9.49$); the White test for heteroskedasticity = 14.88, (critical value at 5%: $\chi^2(9) = 16.90$). The sample period is 1997:4–1997:4. The number of observations is 81. The numbers in parentheses indicate lags.

The actual and fitted values are given in Exhibit 7. The CBHPRE rent model replicates the changing trends of the actual series satisfactorily and it seems to track the spikes of the series more adequately than the JLWRE model, including the substantial increase in the change of rent at the end of 1988. In Exhibit 8, the actual and fitted nominal values are plotted. Equation (3) fits the actual rent index well, but it tends to under perform it in the period mid-1980s to mid-1990s. Finally, it was found that the lagged rent variable in the CBHPRE model has a relatively greater power in explaining rent changes of that index in the current period than the rent variable in the JLWRE model. A reason for this could be the different methodologies followed in the construction of these indices.

Forecasts

Ex Post Forecasts

The ex post forecasting performance of Equation (2), the JLW industrial rent equation, and Equation (3), the CB Hillier Parker industrial rent equation, is examined by producing in sample quarterly forecasts for 1996 and 1997 and comparing them with the realized (actual) values of the JLWRE and the CBHPRE industrial rent indices. In producing the forecasts, the estimated lags and coefficients of the explanatory variables are held constant. The lag structure of Equations (2) and (3) imposes restrictions on the length of the forecast period when the past (and current) values of the independent variables are used. The term $\Delta_1 GDP(-5)$ in Equation (2) allows forecasts of rents for five quarters. For longer predictions, future values of $\Delta_1 GDP$

Exhibit 7
Actual and Fitted Values of Changes in CB Hillier Parker Real Industrial Rents Based on Equation (3)

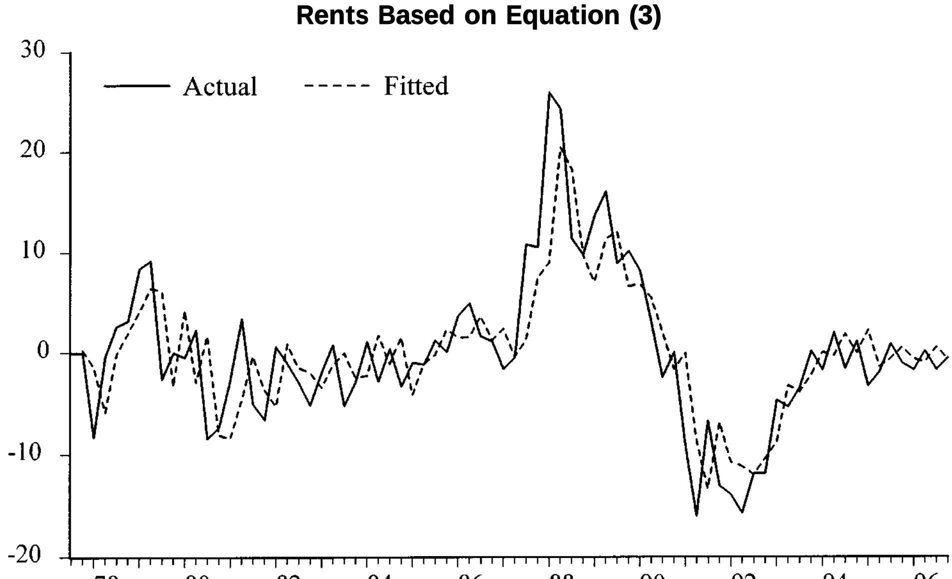
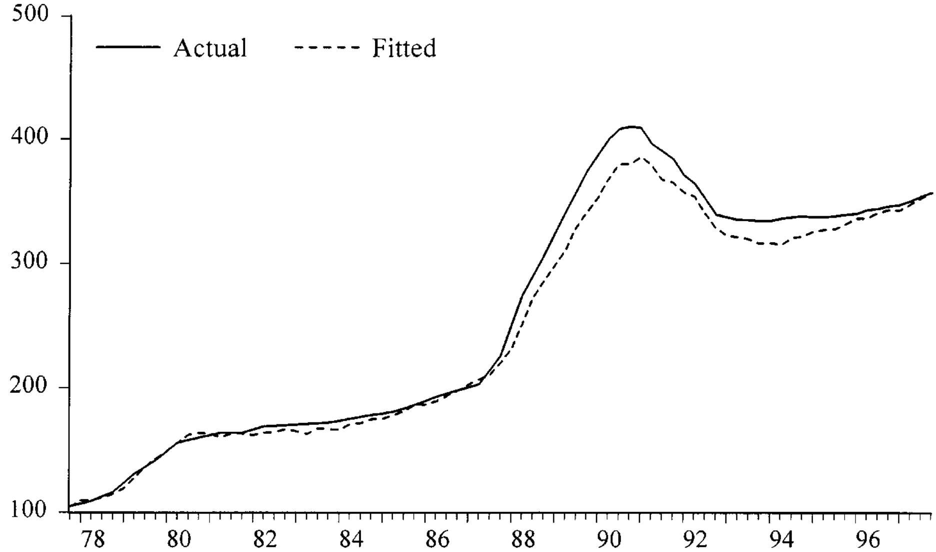


Exhibit 8
Actual and Fitted Values of the CB Hillier Parker Nominal Industrial Rent Index (1997:2 = 100)



need to be used and projections of this variable be made. For example, in the quarterly forecasts to 1997:4 the values of $\Delta_1 GDP$ for 1996:1, 1996:2 and 1996:3 are required. Similarly, the value of $\Delta_1 VAC$ for the 1996:1 value is required. Turning to Equation (3), $\Delta_1 GDP$ values are needed up to 1997:2 and values of $\Delta_1 VAC$ up to 1996:3. For the estimation of the ex post forecasts obtained from both equations, the actual values of $\Delta_1 GDP$ and $\Delta_1 VAC$ are used for the quarters required. The values, however, for the

Exhibit 9
Ex Post Forecasts of the JLWRE and CBHPRE Indices

	JLWRE Index Actual	JLWRE Index Forecast	% Error	CBHPRE Index Actual	CBHPRE Index Forecast	% Error
1996:1	257	263	2.5	340	343	0.8
1996:2	258	267	3.5	343	346	0.8
1996:3	257	271	5.5	344	350	1.6
1996:4	262	275	4.8	346	354	2.4
1997:1	263	276	4.9	347	355	2.3
1997:2	266	278	4.7	350	360	2.9
1997:3	271	282	3.9	354	367	3.6
1997:4	276	285	3.2	357	373	4.6

Note: Actual values are 1977:2 = 100.

terms $\Delta_1 JLWRE(-2)$ and $\Delta_1 CBHPRE(-1)$ are those that the respective models forecast for each quarter of 1996 and 1997 and not the realized (actual) changes of the JLWRE and CBHPRE.

Initially the changes in real industrial rents are forecast. The forecast performance of both equations is evaluated by comparing the values of the standard error of the regressions with the values of the root mean square error (RMSE) for the forecast period. The values of the RMSE for the JLWRE and CBHPRE equations are 2.64 and 1.88, respectively. These values are lower than the standard error of the estimation period equation (4.95 for the JLWRE equation and 4.31 for the CBHPRE equation). Therefore, this is a strong indication of acceptable forecasting performance. From the forecast values of changes in real rents, the quarterly values of the level of real rents for both indices are predicted. The forecast nominal series are then obtained by using the *GDP* deflator.

The forecasts that Equations (2) and (3) produce for 1996 and 1997 are satisfactory. The forecast errors are not large, but both models appear to over predict (positive errors). Overall the CBHPRE model produces smaller forecast errors. However, the forecasts obtained from this model are subject to larger errors as the forecast period is lengthened. A reason for this could be the greater influence of the lagged rent term in the CBHPRE equation. Part of the forecast errors is due to the lagged rent variable. Since past forecasts of this variable are used in order to predict its value for the next period, the error made in the previous forecasts is transferred to the next periods. Forecasts from the CBHPRE model are more prone to this type of error because the rent variable plays a relatively more significant part in the determination of current rents than in the case of the JLWRE equation. In the JLWRE equation, the exogenous variable *GDP* has more power and, therefore, the correction mechanism is stronger than in the CBHPRE equation.

Ex Ante Forecasts

The models of industrial rents are now used to make quarterly predictions for 1998 and 1999. As noted earlier, due to the lag structure of the models projections of $\Delta_1 GDP$ and $\Delta_1 VAC$ are required. For the predictions of real industrial rents based on the JLWRE model (Equation (2)), values of $\Delta_1 GDP$ up to 1998:3 and the value of $\Delta_1 VAC$ for 1998:1 need to be projected. For the CBHPRE model (Equation (3)), values of $\Delta_1 GDP$ are needed up to 1999:2 and values of $\Delta_1 VAC$ up to 1998:3. Moreover, the values of the unobservable rents (up to 1999:2 for the $\Delta_1 JLWRE$ and up to 1999:3 for $\Delta_1 CBHPRE$), which are also required, are the forecast values obtained from the models. Finally, in order to produce the nominal series for both indices, projections of the inflation rate (and therefore the implied *GDP* deflator series) will be needed for the forecast period.

Quarterly predictions of *GDP* were obtained from Cambridge Econometrics, an independent organization in the U.K. that models the macroeconomy and produces macroeconomic forecasts. An annual *GDP* increase of 2.2% in 1998 was expected with the economy slowing down after the second quarter (smaller growth rates).

The average *GDP* growth rate for the first two quarters of 1999 is 1.9%. Forecasts of the absorption rate are generated by a double exponential smoothing model, which is applied to the industrial floorspace availability series. Exponential smoothing involves the use of a moving average model, which is exponentially weighted. By using a double-smoothing procedure, less weight is given to more remote data points. The application of double exponential smoothing suggests that the level of floorspace availability will fall further in the first three quarters of 1998. In 1997:4, the vacancy level stood at 11.68mn sq. ft. A fall to 11.21mn sq. ft. is expected in 1998:1, and a further reduction to 10.71mn sq. ft. and to 10.21mn sq. ft. in the following two quarters. Projections of inflation were also obtained from Cambridge Econometrics. An annual rate of 3.6% was expected for 1998 and 2.9% for 1999.

The procedure of computing forecasts of rents to the end of 1999 is similar to that followed for the ex post forecasts. From the forecast changes in real rents, forecasts of real rents in levels are produced. Subsequently, the nominal values of both rent indices are obtained from the forecast real values and the quarterly predictions of the *GDP* implicit deflator for 1998 and 1999. The latter was estimated by the forecasts of the inflation rate supplied by Cambridge Econometrics. These inflation forecasts were 3.6% in 1998 and 2.9% in 1999. Exhibits 10 and 11 present the forecasts. In Exhibit 10, the forecast percentage changes in real rents are presented. Both indices are expected to show a positive growth rate throughout the forecast period. According to the estimates for the JLWRE Index, the growth rate of real rents will decline after 1998:3. Therefore, after this quarter real rents will increase, but at a slower rate. According to the estimates for the CBHPRE Index, the forecast growth of real rents will decline until 1Q99. This trend will reverse in 1999:2. Since this index leads changes in the JLWRE Index by two quarters, it can be argued that the decline in its growth rate in 1999 is likely to be reversed in the first two quarters of 2000.

Exhibit 11 presents the forecasts for the nominal values of the indices. An increase is expected in the nominal values for both indices, as became clear from Exhibit 10

Exhibit 10
Ex Ante Forecasts of Changes in the JLWRE and CBHPRE Real Industrial Rent Series

	JLWRE Real % Changes	CBHPRE Real % Changes
1998:1	1.5	0.5
1998:2	1.6	0.5
1998:3	1.7	0.5
1998:4	1.1	0.3
1999:1	1.2	0.2
1999:2	0.6	0.3
1999:3	0.6	0.4
1999:4	0.5	0.5

Exhibit 11
Ex Ante Forecasts of the JLWRE and CBHPRE Nominal Industrial Rent Indices—1997:2 = 100

	JLWRE Nominal	CBHPRE Nominal
1997:1	(263)	(347)
1997:2	(266)	(350)
1997:3	(271)	(354)
1997:4	(276)	(357)
1998:1	285	365
1998:2	291	369
1998:3	298	373
1998:4	303	376
1999:1	311	382
1999:2	314	385
1999:3	317	388
1999:4	320	391

(positive growth rates). The JLWRE Index is expected to reach the value of 320 and the CBHPRE Index the value of 391 (for both indices 1997:2 = 100). The increase for the JLWRE and CBHPRE Indices are 15.9% and 9.5%, respectively, over the two year period. This growth is larger than the projected increase in inflation (6.5% over both years) and suggests that industrial properties can offer a return above the rate of inflation for 1998 and 1999. There are, however, two issues that invite a comment. First, the ex post forecasts suggested that both models tend to over predict in 1996 and 1997. Assuming that an element of over prediction is also present in the forecasts for 1998 and 1999, the above growth rates in rents may need to be adjusted downwards by the average forecast error in 1996 and 1997 (that is 4.5% for the JLWRE forecasts and 2.9% for the CBHPRE forecasts). Second, the projected inflation of 3.6% in 1998 is well above the government's target of 2.5%. A potential consequence, if this inflation rate materializes, is that the recently independent Bank of England will raise interest rates in 1998, and more likely in the first half of the year. Lower inflation will result in smaller predicted values of nominal rents. However, more importantly, the higher interest rates will slowdown economic activity and further affect the industrial sector (in particular, manufacturing exports) through a stronger pound. This means that the positive *GDP* growth and absorption rates assumed in the estimates may emerge as less strong, resulting in a slower growth of real rents than that projected. Both suggest that there may be forces underway that will dampen the forecast growth in industrial rents.

Conclusion

The lack of empirical work on industrial rent determination at the aggregate level and the need to understand more fully the relationship between industrial rents and both macroeconomic and industrial property market variables provide the motivation for this study. This study examines industrial rents at the national level in Great Britain using quarterly data. For the empirical investigation, two indices of industrial rents are used: the Jones Lang Wootton Industrial Rent Index and the CB Hillier Parker Rent Index. These indices do not correlate very strongly and the CB Hillier Parker Rent Index precedes the Jones Lang Wootton Industrial Rent Index by about six months. This is the result of the different methods used in their construction, but it has implications for the specifications explaining rent movements.

The estimation of rent equations revealed that changes in real *GDP* have an important influence on changes in real industrial rents through their effect on the demand for industrial space. Changes in *GDP* show a greater statistical significance in determining industrial rents than manufacturing employment, which is considered a more direct macroeconomic variable of industrial sector activity. Industrial rents measured by the JLWRE Index are influenced most significantly by changes in *GDP* in the past five and six quarters, whereas CBHPRE rents by *GDP* changes lagged two quarters. Changes in the availability of floorspace (absorption rate) appeared most important when lagged seven quarters in the estimation of the JLWRE equation and five quarters in the CBHPRE equation. Overall, this variable has a statistically significant effect (at the 5% level) on rent changes, suggesting that absorption of the existing available space restricts rental growth. Another major influence, in both cases, originates in past changes in actual (realized) industrial rents. This conforms with the findings of Atteberry and Rutherford (1993), RICS (1994) and McGough and Tsolacos (1995) that undertook statistical analysis to test specifically for this type of influence.

Forecasts of nominal industrial rents based on these models for 1996 and 1997 produced acceptable errors, but the model appears to over predict by comparison with actual values. Ex ante quarterly forecasts of the JLWRE and CBHPRE Indices for 1998 and 1999 suggest that industrial rents, measured by either index, will show a positive growth, which will be above the rate of inflation for both years. The forecasts of rental growth based on the JLWRE Index are more optimistic. The increase in real rents over the eight quarter period 1998:1 to 1999:4 is predicted to be 9.2%, if the model for the JLW index is used. However, this increase, according to the CBHPRE Parker model, will only be 3.2%. In nominal terms, the respective increases are 15.9% and 9.5%. It was pointed out in the analysis that the assumed inflation rate (3.6% in 1998 and 2.9% in 1999) used in forecasting the nominal values of the two rent indices was above the government's target (2.5%). This can be interpreted as an indication of the possibility that the Bank of England will take tougher measures, mainly through further interest rate increases, to restrict inflation growth. The resulting slowdown in economic activity may limit the growth of industrial rents forecast by both models. Moreover, it should be remembered that the forecasts obtained from well specified econometric models with time invariant coefficients indicate the most likely path for the variables of interest. Analysts can use the rent specifications developed in this study and the forecasts as the best estimate of the movements in rents for 1998 and 1999. However, some variation around this central path should be expected.

Empirical work to examine the dynamics of industrial rent movements at the aggregate level can advance in several ways. Demand and supply influences on rents can be examined in different geographical contexts for the production of comparative results. It would be useful for both academics and practicing professionals to illustrate whether common forces and variables are responsible for short-run rent movements in different countries and markers. Moreover, analysts may consider other variables in the determination of rents, such as the output/floorspace ratio but, in the absence of relevant statistics, they will have to generate estimates (see Thompson, 1997). In addition, alternative estimation methodologies can be deployed to study industrial rent determination and provide forecasts. Finally, another research avenue is to examine quantitatively industrial rents in localized markets where the relative significance of an aggregate model and the contribution of variables describing the characteristics of the local economy and industrial market can be assessed.

Notes

[1] For example, over the period 1980 to 1998, productivity in the whole economy increased by an average annual rate of 2.8% whereas in the manufacturing industries by 4.9%. Productivity is defined as output per person employed (in the whole economy and manufacturing industries, respectively). The data, in the form of an index, are provided by the Office for National Statistics. Index numbers of output per person employed are calculated by dividing an index of output (*GDP* for the whole economy and manufacturing output in the industrial sector) by an index of the numbers employed. These numbers include employees in employment and self-employed persons but they do not take into account part-time workers.

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