A Comparison of the Forecasting Ability of ARIMA Models

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Abstract

This study compares the relative performance of ARIMA models in the forecasting of UK rents across the office, retail and industrial sectors. The performance of each model is assessed both in the estimation phase and out-of-sample. The ranked performance of each of the models is then compared to examine whether the best fitting model also tends to provide the most accurate forecast of future rental movements. The results show that while there is little evidence of a strong positive relationship between estimation and forecast performance, there is also a lack of evidence of a consistent negative relationship. In addition, in the majority of cases all ARIMA variations correctly predict general market movements.

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1: Introduction

The analysis and forecasting of rental values and the associated academic literature has largely centred around the alternative methodological approaches that can be adopted in the modelling of property rents. The majority of the literature, especially in the United States, has concentrated on equilibrium models, with a strong theoretical base. Models such as Wheaton, (1987), Wheaton & Torto (1988) and Hendershott et al. (1999) have been generally based on the rent adjustment literature and have concentrated extensively on the impact of vacancy rates on rental values. There has also been a large literature that has examined the issue of forecasting from a less structured view-point with the modelling of demand and supply in reduced form models. The majority of these studies have used Ordinary Least Squares (OLS) models, although a growing number have utilised Vector Autorgressive techniques (e.g. McGough & Tsolacos, 1994, Brooks & Tsolacos, 2000 and Stevenson & McGrath, 2000)[1].

The majority of rental forecasting papers have concentrated of the estimation of the model concerned and even in cases where forecasting ability is assessed it has generally been concerned with the testing of the final specification adopted. However, papers such as Chaplin (1998, 1999) provide evidence that in the majority of cases, the best fitting model actually fails to provide the best forecast of rental movements. Both of these papers examined reduced form models based on OLS estimation. This paper aims to examine this issue from the perspective of ARIMA models. A number of studies have used such an approach in rental value forecasting and have found that particularly for short-term forecasts ARIMA models do provide good forecasting ability. McGough & Tsolacos (1995b) examine the UK office market, while Tse (1997) examines the real estate market in Hong Kong. The approach has also been used in papers that have compared alternative forecasting approaches. Brooks & Tsolacos (2000) compare AIRMA models with a number of OLS and VAR based models in the context of British retail property, while Stevenson & McGrath (2000) compare a number of alternative approaches using London office market rental data.

This paper uses UK rental data over rolling windows to assess the relative accuracy of ARIMA based forecasts. In the spirit of the Chaplin papers, forecasts are based on a variety of alternative specifications with the empirical analysis concentrating on the accuracy of the 'best' specified model in sample relative to other alternative models. Although ARIMA models may be classified as atheoretical they are appealing in the application in real estate markets due to the cyclical nature of the asset. While rental value indices do not suffer from the same level of problems with regard to smoothing as overall total return indices, as they are based on estimated current rental values, they is still an element of smoothing in rental data. As with all indices temporal aggregation will play a role due to the fact that real estate indices tend to be produced on a quarterly or similar periodic basis[2]. In addition, factors such as cross-autocorrelation can also play a role in rental series (Brown & Matysiak, 2000). The presence of smoothing due to these factors and the general need for comparable transaction data, means that rental series will have a smoothed element, meaning that a modelling approach such as an ARIMA is well suited to pick up short-term trends in the data. The remainder of the paper is laid out as follows. The following section describes the approach adopted in the ARIMA modelling. Section three presents the estimation procedure used, while Section four compares the performance of these models and their ability to forecast ahead four quarters. The final section provides concluding comments.

2: Data Requirements and Methodological Framework

The rental series' examined in this study comprise of the Jones LangLaSalle indices for the UK Office, Retail and Industrial sectors over the period 1978-2001. ARIMA models for each sector are estimated over rolling periods with the forecasting performance then assessed over the following four quarters. There has been some debate as to the minimum number of observations required to generate an ARIMA model, with both McGough & Tsolacos (1995) and Tse (1997) recommending at least 50 observations. For the purposes of this study due to the use of quarterly data 13 years of data is used in the estimation period, thereby providing 52 observations. The first time period used is 1978-1990, with the forecasts made for 1991. This procedure

is rolled forward each four quarters, with the last estimation period being 1988-2000 and forecasts made for 2001.

An ARIMA model is a univariate model that seeks to depict a single variable as an Autoregressive Integrated Moving Average process. Herein, the series is fully described by *p*, the order of the AR component, *q*, the order of the MA component and *d*, the order of integration. The AR component is built upon the assumption that future realisations can be approximated and predicted by the behaviour of current and past values. The MA component, on the other hand, seeks to depict the processes where the effects of past environmental innovations continue to reverberate for a number of periods. If y_t is an ARIMA *p,d,q* process, then the series evolves according to the following specification:

$$y_t = \beta_1 y_{t-1} + \beta_2 y_{t-2} + \ldots + \beta_p y_{t-p} + \theta_0 + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \ldots + \theta_q \varepsilon_{t-q} \qquad (1).$$

Where θ_0 is a constant, ε is the error term, *q* is the number of lagged terms of ε and *p* is the number of lagged terms of y_t. The ARIMA model can be described as atheoretical, as it ignores all potential underlying theories, except those that hypothesise repeating patterns in the variable under study.

It is required that the series used in the estimation process is stationary, i.e. that its stochastic properties are invariant to time transition. Failure to observe this condition will introduce multicollinearity problems. Therefore, in each period we initially test for stationarity using the Dickey-Fuller unit root test, which can be represented as follows:

$$\Delta y_t = a_0 + pY_{t-1} + \varepsilon_t \qquad (2).$$

The series is differenced in order to provide a stationary series. The forecasts are based on alternative AR and MA terms ranging from ARMA (1,0) to ARMA (2,2). The assessment of the relative goodness of fit of the models in the estimation period is

examined using the Akaike Information Criterion (AIC) and the Schwartz Bayesian Criterion (SBC). The two selection rules are calculated as:

$$AIC = T\ln(RSS) + 2n \quad (3)$$

$$SBC = T\ln(RSS) + n\ln(T) \quad (4)$$

Where T is the sample size, n is the number of regressors and RSS is the residual sum of squares. The most accurate model is that which emerges with the smallest figure on both criteria. It should be noted that while the AIC is used in this study, as in previous studies such as McGough & Tsolacos (1995) and Tse (1997), this critera may select an overparameterized model (Mills, 1990).

3: Forecasting Evaluation

As stated in the previous section the first step in the estimation of each ARIMA model is to assess the stationarity of each series. Unit root tests were estimated in each time period for each of the three markets with the appropriate degree of differencing then adopted in the estimation and the assessment of the best fitting model in-sample. The range of differencing required in each time period varies considerably, especially when one considers that in each case only four out of 52 observations are altered in each case. The degree of differencing required to ensure each time series stationary is reported in Table A1 in the appendix[3]. Based on these results the eight alternative ARIMA models are estimated for each time period. Tables 1 through 3 report the AIC and SBC results for each model and in each time period. Based on these findings the model with the minimum figure is deemed to be provide the most accurate estimate in-sample, with the results ranked accordingly. These rankings are contained in Tables 4 through 6 for the office, retail and industrial markets respectively.

For each sector there is considerable variation in the ranking of each form of model, with little consistency as to which model provides the best estimate. For each of the sectors four of the eight models are deemed to be the best fit in sample in at least one of the time periods. The main consistent factor is that the ARMA (2,2) provides the most number of number 1 rankings across the three sectors, especially in the case of

retail property. In this case it is the best estimate in seven of the eleven time periods according to the AIC criteria and in eight time periods according to the SBC criteria. The two alternative criteria are relatively consistent, especially in the case of the best fitting model. In only two cases is a different model ranked 1. These are both for the 1983-1995 period and for the retail and industrial sectors. In the retail case the ARMA (1,0) is ranked 1 according to the AIC, while the ARMA (2,2) is ranked 1 according to the SBC. In the industrial case the reverse is true, with the AIC selecting the ARMA (2,2) and the SBC the ARMA (1,0).

4: Comparative Forecasting Accuracy

This section of the paper assess the performance of the models out-of-sample through the use of them to forecast rental movements over the four quarters immediately following the estimation period. The accuracy of each forecast is measured using three alternative measures of forecast accuracy, namely; the Mean Absolute Error, the Mean Squared Error and the Error Variance. Tables 7 through 9 provide equivalent rankings to those reported previously with respect to in-sample estimation. These results rank the accuracy of the forecast generated from the models. The aim of this analysis is to assess whether the ranking obtained in the estimation process is similar to that obtained in the forecasting stage of the analysis. As with the estimation rankings, it is clear that there is a large degree of variation in the ranking obtained, with no single model consistently providing the best forecast[4].

In the case of the office market all eight models rank first in terms of forecast accuracy at least once over the different time periods for the mean absolute error and mean squared error, while for the error variance only the ARMA (0,1) variation does not rank first at least once. Similarly, for the retail and industrial sectors six of the models rank first in at least one time period, with the exception of the error variance measure for the industrial sector when the figure is five. However, while the variation in rankings is of interest it is not the primary point of concern as variation was also noted in the estimation rankings. The main issue is therefore whether a relationship exists between the estimation and forecast rankings. Thereby illustrating whether a high accuracy ranking in the estimation phase is likely to lead to a similar ranking

out-of-sample. In order to examine this issue we initially examine the forecast rank obtained by the best fitting model in sample. Tables 10 and 11 report the rankings according to all forecast accuracy measures for the best fitting model. As noted previously on only two occasions does the first ranked model in the estimation phase differ depending on whether the AIC or SBC criteria is used to assess best fit. The specific cases where the findings differ are both for the 1983-1995 estimation period, which is used to estimate rental movements in 1996 and for the retail and industrial sectors. The office results are identical across both estimation measures.

The results show that in the majority of cases the ranking obtained doesn't appear to signify anything about the subsequent ranking out-of-sample. The office market results show that in only one period does the best fitting model also provide the most accurate forecast over the following four quarters. This was the ARMA (2,2) model for the estimation period 1984-1996 with the forecast for 1997. In a number of cases the best fitting model provides the poorest forecast, indicating that there is little relationship between the estimation and forecast accuracy of the ARIMA models. The results for the retail and industrial sectors are more encouraging, and in the industrial case only when the error variance is used to assess forecast accuracy. Even in the case of retail rents when the best fitting model provides the best forecast on four occasions, this still leaves seven periods when it does not. In addition, while the figure is reduced, the best fitting retail model does also lead to a large number of periods when it is one of the worst performing models in a forecasting context. It should however be noted that while the best performing model in-sample does often tend to provide one of the worst forecasted, the differences in the AIC and SBC statistics used to provide an estimate of the best fitting model is often small, with minor changes leading to major changes in the rankings.

In order to examine this issue in more depth a number of alternative tests are conducted. Initially, we examine whether the best fitting forecast correctly assess the direction of the markets movements and secondly, we estimate the rank correlations in each time period between the estimation and forecast ranks. This will allow us to assess what exact form of relationship exists and whether that relationship is significant at statistically significant levels. Table 12 reports whether the alternative

ARIMA models correctly predicted the general market movement over the four quarters in the forecasting period. It is noticeable that despite the general poor performance of the best fitting model in the majority of the periods most of the alternative models correctly predicted the direction of the market. For each of the three sectors in only one year do none of the models correctly predict the actual movement of the market. For the office and retail markets this is for the forecast in 1995, when the rental values increased and all of the models predicted market declines. This year was a market turning point. As can be seen from Table 12 all three sectors saw falls in rental values in the early nineties, with market turning points in 1994/1995. For the industrial sector the year in which none of the models predicted correctly was 2000, when the market actually increased. However, in the majority of cases the models did well in correctly predicting market movements, with a number of periods in which all models predicted market direction correctly.

Tables 13 and 14 report the Spearman Rank Correlations between the in sample and forecasting rank performance of the eight ARIMA models. It can be seen that in the majority of cases the correlation coefficients are not significant at conventional levels, and in particular, there are limited numbers of significant negative coefficients, which would support the hypothesis that the estimation ranks do not accuracy portray and forecast ranks. However, there are a number of cases of significant positive coefficients, for example in 1991 for the office market, 1996 for the retail sector and 2001 for industrial property. The lack of consistent results supports the previous results. As previously stated a large degree of the inconsistency in the ranking results may results from the fact that if one examines both the AIC and SBC in-sample criteria and the actual forecasting performance, slight changes in results can lead to major shifts in the ranking obtained. The results are weaker than those found by Chaplin (1998, 1999) in his analysis of reduced form OLS models, where stronger evidence was noted of the poor performance out-of-sample of the best fitting models. This may be due to the fact that the ARIMA forecasts do not tend to differ substantially from each other and therefore, the difference, both in and out of sample, between the best and worst performing variations may not be that great. In the Chaplin papers the use of different economic series as explanatory variables would in

all likelihood lead to greater variation in the accuracy of the alternatives ex-ante and ex-post.

5: Concluding Comments

This paper has compared the performance of alternative ARIMA models on an out-of-sample basis. The results show that the best fitting model in-sample frequently fails to provide the best forecast of rental values. These findings correspond with the findings of Chaplin (1998, 1999) with regard to OLS based models. However, while the rankings based on best fit may provide little indication of forecasting ranking this does not necessarily mean that the actual forecasts are substantially different from the actual rental values in the JLL indices. As the ARIMA models tended to be fairly consistent in terms of both the estimation and forecasting phases of the analysis the rankings could be altered with relatively little change in the model. The results do broadly support the use of ARIMA models in the analysis and forecasting of rental values, with all variations correctly predicting the direction of market movements in the majority of cases. Due to the nature of the models it is not surprising that they tend to mis-estimate market direction at key turning points in the market.

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Tables

Table 1: Office Market AIC & SBC Results

	ARMA (1,0)	ARMA (0,1)	ARMA (2,0)	ARMA (0,2)	ARMA (1,1)	ARMA (2,1)	ARMA (1,2)	ARMA (2,2)
Panel A: AIC Results								
1978-1990, 1991	-7.2124	-7.5927	-7.3102	-7.7312	-7.6709	-7.68	-7.7168	-7.6534
1979-1991, 1992	-7.8741	-7.8985	-7.8442	-7.8374	-7.8374	-7.7827	-7.8178	-7.6911
1980-1992, 1993	-6.6039	-3.7177	-6.6143	-4.7881	-7.2952	-7.407	-7.4001	-7.458
1981-1993, 1994	-6.582	-3.9524	-6.6631	-4.9918	-7.2346	-7.3395	-7.3883	-7.5487
1982-1994, 1995	-7.8977	-7.9065	-7.8821	-7.8759	-7.8572	-7.9663	-7.8715	-7.7912
1983-1995, 1996	-7.893	-7.8968	-7.8693	-7.8686	-7.8475	-7.9761	-7.8618	-7.7897
1984-1996, 1997	-7.9203	-7.9277	-7.9024	-7.8977	-7.8767	-8.0171	-7.8877	-7.8691
1985-1997, 1998	-7.2176	-7.7376	-7.6376	-7.84	-7.7573	-7.7565	-7.8498	-7.8057
1986-1998, 1999	-6.5314	-4.5272	-6.6195	-5.4622	-6.9536	-7.1008	-7.3091	-7.4414
1987-1999, 2000	-6.5535	-4.6991	-6.7207	-5.6244	-6.9627	-7.1636	-7.2425	-7.4415
1988-2000, 2001	-7.7296	-7.6553	-7.6694	-7.7366	-7.669	-7.6112	-7.6736	-7.6582
Panel B: SBC Results								
1978-1990, 1991	-7.1352	-7.5154	-7.1944	-7.6153	-7.5551	-7.5255	-7.5623	-7.4606
1979-1991, 1992	-7.7976	-7.822	-7.7294	-7.7227	-7.7227	-7.6297	-7.6648	-7.4999
1980-1992, 1993	-6.5289	-3.6426	-6.5017	-4.6755	-7.1826	-7.2569	-7.25	-7.2703
1981-1993, 1994	-6.507	-3.8773	-6.5506	-4.8792	-7.122	-7.1894	-7.2382	-7.3611
1982-1994, 1995	-7.8212	-7.83	-7.7673	-7.7611	-7.7424	-7.8133	-7.7185	-7.6000
1983-1995, 1996	-7.8165	-7.8203	-7.7546	-7.7539	-7.7328	-7.8232	-7.7089	-7.5985
1984-1996, 1997	-7.8438	-7.8512	-7.7876	-7.783	-7.762	-7.8641	-7.7348	-7.6779
1985-1997, 1998	-7.1404	-7.6604	-7.5218	-7.7242	-7.6415	-7.6021	-7.6954	-7.6127
1986-1998, 1999	-6.4563	-4.4522	-6.5069	-5.3496	-6.8411	-6.9507	-7.159	-7.2538
1987-1999, 2000	-6.4784	-4.6241	-6.6081	-5.5119	-6.8501	-7.0135	-7.0924	-7.2539
1988-2000, 2001	-7.6531	-7.5789	-7.5547	-7.6219	-7.5543	-7.4582	-7.5206	-7.467

Table 1 reports the AIC and SBC criteria for the eight alternative ARIMA models in the estimation phase for the office sector. The models with the lowest statistic for each criteria is deemed to be the most accurate in-sample. The estimates are run using 52 quarterly observations, with forecasts produced for the following four quarters.

Table 2: Retail Market AIC & SBC Results

	ARMA (1,0)	ARMA (0,1)	ARMA (2,0)	ARMA (0,2)	ARMA (1,1)	ARMA (2,1)	ARMA (1,2)	ARMA (2,2)
Panel A: AIC Results								
1978-1990, 1991	-7.6881	-7.5559	-7.6276	-7.5641	-7.6282	-7.5775	-7.5869	-7.508
1979-1991, 1992	-7.0753	-7.1725	-7.132	-7.4815	-7.6212	-6.9509	-7.5256	-7.5107
1980-1992, 1993	-7.8186	-7.7329	-7.7574	-7.7157	-7.7582	-7.7078	-7.7337	-7.6905
1981-1993, 1994	-8.6724	-8.6865	-8.6358	-8.6291	-8.6058	-8.5746	-8.5649	-8.5284
1982-1994, 1995	-8.6991	-8.7132	-8.6733	-8.6621	-8.6039	-8.615	-8.645	-8.554
1983-1995, 1996	-8.1047	-8.6313	-8.3318	-8.6382	-8.6048	-8.6787	-8.635	-8.1709
1984-1996, 1997	-8.7047	-8.7149	-8.6679	-8.659	-8.6563	-8.6116	-8.6104	-8.534
1985-1997, 1998	-8.6987	-8.7088	-8.6568	-8.6488	-8.5981	-8.6051	-8.6026	-8.5919
1986-1998, 1999	-7.9769	-8.335	-8.1455	-8.4096	-8.4108	-8.0155	-8.453	-7.7109
1987-1999, 2000	-7.228	-5.0957	-6.7313	-6.2244	-7.8629	-7.6042	-8.3316	-8.1239
1988-2000, 2001	-8.7895	-8.1482	-8.9603	-8.5856	-8.839	-8.9182	-8.9502	-8.8621
Panel B: SBC Results								
1978-1990, 1991	-7.6116	-7.4794	-7.5129	-7.4493	-7.5135	-7.4246	-7.4339	-7.3168
1979-1991, 1992	-6.9981	-7.0953	-7.0162	-7.3657	-7.5054	-6.7965	-7.3712	-7.3177
1980-1992, 1993	-7.7421	-7.6565	-7.6427	-7.601	-7.6435	-7.5548	-7.5808	-7.4975
1981-1993, 1994	-8.5959	-8.61	-8.5211	-8.5144	-8.491	-8.4217	-8.4119	-8.3372
1982-1994, 1995	-8.6227	-8.6367	-8.5586	-8.5474	-8.4892	-8.4621	-8.4921	-8.3628
1983-1995, 1996	-8.0275	-8.5541	-8.216	-8.5223	-8.489	-8.5243	-8.4806	-7.9779
1984-1996, 1997	-8.6282	-8.6384	-8.5531	-8.5443	-8.5415	-8.4587	-8.4574	-8.3428
1985-1997, 1998	-8.6222	-8.6324	-8.5421	-8.534	-8.4834	-8.4522	-8.4496	-8.4007
1986-1998, 1999	-7.8996	-8.2577	-8.0296	-8.2938	-8.295	-7.8611	-8.2985	-7.5179
1987-1999, 2000	-7.153	-5.0207	-6.6188	-6.1119	-7.7503	-7.4541	-8.1815	-7.9362
1988-2000, 2001	-8.7138	-8.0724	-8.8466	-8.472	-8.7253	-8.7667	-8.7987	-8.6727

Table 2 reports the AIC and SBC criteria for the eight alternative ARIMA models in the estimation phase for the retail sector. The models with the lowest statistic for each criteria is deemed to be the most accurate in-sample. The estimates are run using 52 quarterly observations, with forecasts produced for the following four quarters.

Table 3: Industrial Market AIC & SBC Results

	ARMA (1,0)	ARMA (0,1)	ARMA (2,0)	ARMA (0,2)	ARMA (1,1)	ARMA (2,1)	ARMA (1,2)	ARMA (2,2)
Panel A: AIC Results								
1978-1990, 1991	-6.5782	-3.812	-6.9215	-4.8099	-6.9244	-7.1961	-7.135	-6.7405
1979-1991, 1992	-7.0208	-7.4718	-7.2091	-7.6036	-7.5365	-7.5736	-7.5792	-6.7594
1980-1992, 1993	-7.9823	-7.9629	-7.9218	-7.9218	-7.9218	-7.8596	-7.8597	-7.7973
1981-1993, 1994	-7.5563	-7.8809	-7.6827	-7.9514	-7.9883	-7.9147	-7.9122	-7.8544
1982-1994, 1995	-7.5579	-7.86	-7.6691	-7.9356	-7.9655	-7.9125	-7.9937	-7.9516
1983-1995, 1996	-7.5494	-7.877	-7.6691	-8.05	-7.973	-7.9979	-7.9873	7.9434
1984-1996, 1997	-8.0947	-8.0666	-8.0355	-8.0294	-8.0357	-7.9742	-7.9745	-7.9143
1985-1997, 1998	-7.6342	-7.9303	-7.7359	-7.9866	-8.025	-7.5109	-7.9565	-7.8103
1986-1998, 1999	-8.1508	-8.1185	-8.0927	-8.0902	-8.0924	-8.0319	-8.0317	-8.0162
1987-1999, 2000	-7.004	-5.1557	-6.8292	-6.2046	-7.5179	-7.4437	-7.7929	-7.7476
1988-2000, 2001	-7.8406	-8.1347	-7.998	-8.2515	-8.1612	-8.1962	-8.2173	-8.1088
Panel B: SBC Results								
1978-1990, 1991	-6.5031	-3.737	-6.8089	-4.6973	-6.8118	-7.046	-6.9849	-6.5529
1979-1991, 1992	-6.9436	-7.3946	-7.0933	-7.4878	-7.4207	-7.4192	-7.4247	-6.5664
1980-1992, 1993	-7.9058	-7.8865	-7.8071	-7.8071	-7.8071	-7.7066	-7.7067	-7.6061
1981-1993, 1994	-7.4791	-7.8036	-7.5668	-7.8356	-7.8725	-7.7603	-7.7578	-7.6614
1982-1994, 1995	-7.4807	-7.7827	-7.5533	-7.8198	-7.8497	-7.758	-7.8392	-7.7585
1983-1995, 1996	-7.4722	-7.7998	-7.5533	-7.9342	-7.8572	-7.8435	-7.8328	-7.7504
1984-1996, 1997	-8.0182	-7.9901	-7.9208	-7.9147	-7.921	-7.8212	-7.8216	-7.7231
1985-1997, 1998	-7.5569	-7.853	-7.6201	-7.8707	-7.9092	-7.3565	-7.8021	-7.6173
1986-1998, 1999	-8.0744	-8.042	-7.978	-7.9755	-7.9777	-7.8789	-7.8788	-7.825
1987-1999, 2000	-6.9289	-5.0807	-6.7167	-6.092	-7.4054	-7.2936	-7.6426	-7.56
1988-2000, 2001	-7.7634	-8.0574	-7.8821	-8.1357	-8.0453	-8.0418	-8.0629	-7.9158

Table 3 reports the AIC and SBC criteria for the eight alternative ARIMA models in the estimation phase for the industrial sector. The models with the lowest statistic for each criteria is deemed to be the most accurate in-sample. The estimates are run using 52 quarterly observations, with forecasts produced for the following four quarters.

Table 4: Ranking of Office Market Estimates

	ARMA (1,0)	ARMA (0,1)	ARMA (2,0)	ARMA (0,2)	ARMA (1,1)	ARMA (2,1)	ARMA (1,2)	ARMA (2,2)
Panel A: AIC Results								
1978-1990, 1991	1	3	2	8	5	6	7	4
1979-1991, 1992	7	8	6	4	4	2	3	1
1980-1992, 1993	3	1	4	2	5	7	6	8
1981-1993, 1994	3	1	4	2	5	6	7	8
1982-1994, 1995	6	7	5	4	2	8	3	1
1983-1995, 1996	6	7	5	4	2	8	3	1
1984-1996, 1997	6	7	5	4	2	8	3	1
1985-1997, 1998	1	3	2	7	5	4	8	6
1986-1998, 1999	3	1	4	2	5	6	7	8
1987-1999, 2000	3	1	4	2	5	6	7	8
1988-2000, 2001	7	2	5	8	4	1	6	3
Panel B: SBC Results								
1978-1990, 1991	1	4	2	8	6	5	7	3
1979-1991, 1992	7	8	6	4	4	2	3	1
1980-1992, 1993	4	1	3	2	5	7	6	8
1981-1993, 1994	3	1	4	2	5	6	7	8
1982-1994, 1995	7	8	5	4	3	6	2	1
1983-1995, 1996	6	7	5	4	3	8	2	1
1984-1996, 1997	6	7	5	4	3	8	2	1
1985-1997, 1998	1	6	2	8	5	3	7	4
1986-1998, 1999	3	1	4	2	5	6	7	8
1987-1999, 2000	3	1	4	2	5	6	7	8
1988-2000, 2001	8	6	5	7	4	1	3	2

Table 4 ranks each of the ARIMA models for the office sector according to the AIC and SBC criteria. The model with the lowest statistic for each criteria is deemed to be the most accurate in-sample. The estimates are run using 52 quarterly observations, with forecasts produced for the following four quarters.

Table 5: Ranking of Retail Market Estimates

	ARMA (1,0)	ARMA (0,1)	ARMA (2,0)	ARMA (0,2)	ARMA (1,1)	ARMA (2,1)	ARMA (1,2)	ARMA (2,2)
Panel A: AIC Results								
1978-1990, 1991	8	2	6	3	7	4	5	1
1979-1991, 1992	2	4	3	5	8	1	7	6
1980-1992, 1993	8	4	6	3	7	2	5	1
1981-1993, 1994	7	8	6	5	4	3	2	1
1982-1994, 1995	7	8	6	5	2	3	4	1
1983-1995, 1996	1	5	3	7	4	8	6	2
1984-1996, 1997	7	8	6	5	4	3	2	1
1985-1997, 1998	7	8	6	5	2	4	3	1
1986-1998, 1999	2	5	4	6	7	3	8	1
1987-1999, 2000	4	1	3	2	6	5	8	7
1988-2000, 2001	3	1	8	2	4	6	7	5
Panel B: SBC Results								
1978-1990, 1991	8	5	6	4	7	2	3	1
1979-1991, 1992	2	4	3	6	8	1	7	5
1980-1992, 1993	8	7	5	4	6	2	3	1
1981-1993, 1994	7	8	6	5	4	3	2	1
1982-1994, 1995	7	8	6	5	3	2	4	1
1983-1995, 1996	2	8	3	6	5	7	4	1
1984-1996, 1997	7	8	6	5	4	3	2	1
1985-1997, 1998	7	8	6	5	4	3	2	1
1986-1998, 1999	3	5	4	6	7	2	8	1
1987-1999, 2000	4	1	3	2	6	5	8	7
1988-2000, 2001	4	1	8	2	5	6	7	3

Table 5 ranks each of the ARIMA models for the retail sector according to the AIC and SBC criteria. The model with the lowest statistic for each criteria is deemed to be the most accurate in-sample. The estimates are run using 52 quarterly observations, with forecasts produced for the following four quarters.

Table 6: Ranking of Industrial Market Estimates

	ARMA (1,0)	ARMA (0,1)	ARMA (2,0)	ARMA (0,2)	ARMA (1,1)	ARMA (2,1)	ARMA (1,2)	ARMA (2,2)
Panel A: AIC Results								
1978-1990, 1991	3	1	5	2	6	8	7	4
1979-1991, 1992	2	4	3	8	5	6	7	1
1980-1992, 1993	8	7	4	4	4	2	3	1
1981-1993, 1994	1	4	2	7	8	6	5	3
1982-1994, 1995	1	3	2	5	7	4	8	6
1983-1995, 1996	2	4	3	8	5	7	6	1
1984-1996, 1997	8	7	5	4	6	2	3	1
1985-1997, 1998	2	5	3	7	8	1	6	4
1986-1998, 1999	8	7	6	4	5	3	2	1
1987-1999, 2000	4	1	3	2	6	5	8	7
1988-2000, 2001	1	4	2	8	5	6	7	3
Panel B: SBC Results								
1978-1990, 1991	3	1	5	2	6	8	7	4
1979-1991, 1992	2	4	3	8	6	5	7	1
1980-1992, 1993	8	7	4	4	4	2	3	1
1981-1993, 1994	1	6	2	7	8	5	4	3
1982-1994, 1995	1	5	2	6	8	3	7	4
1983-1995, 1996	1	4	2	8	7	6	5	3
1984-1996, 1997	8	7	5	4	6	2	3	1
1985-1997, 1998	2	6	4	7	8	1	5	3
1986-1998, 1999	8	7	6	4	5	3	2	1
1987-1999, 2000	4	1	3	2	6	5	8	7
1988-2000, 2001	1	6	2	8	5	4	7	3

Table 6 ranks each of the ARIMA models for the industrial sector according to the AIC and SBC criteria. The model with the lowest statistic for each criteria is deemed to be the most accurate in-sample. The estimates are run using 52 quarterly observations, with forecasts produced for the following four quarters.

Table 7: Ranking of Office Market Forecasts

	ARMA (1,0)	ARMA (0,1)	ARMA (2,0)	ARMA (0,2)	ARMA (1,1)	ARMA (2,1)	ARMA (1,2)	ARMA (2,2)
Panel A: Mean Absolute Error								
1978-1990, 1991	2	3	1	5	4	7	8	6
1979-1991, 1992	7	3	6	1	2	5	4	8
1980-1992, 1993	5	2	8	1	4	7	6	3
1981-1993, 1994	1	8	3	7	6	5	4	2
1982-1994, 1995	2	6	7	4	5	3	1	8
1983-1995, 1996	3	2	5	6	4	1	8	7
1984-1996, 1997	6	3	4	7	5	2	8	1
1985-1997, 1998	5	6	4	7	1	2	8	3
1986-1998, 1999	6	8	4	7	2	1	5	3
1987-1999, 2000	6	8	4	7	5	3	2	1
1988-2000, 2001	2	1	4	8	3	5	7	6
Panel B: Mean Squared Error								
1978-1990, 1991	2	3	1	6	4	7	8	5
1979-1991, 1992	7	3	6	1	2	5	4	8
1980-1992, 1993	5	2	8	1	4	7	6	3
1981-1993, 1994	1	8	2	7	6	5	4	3
1982-1994, 1995	2	6	7	4	5	3	1	8
1983-1995, 1996	3	2	5	6	4	1	8	7
1984-1996, 1997	6	3	4	7	5	2	8	1
1985-1997, 1998	5	6	4	7	1	2	8	3
1986-1998, 1999	6	8	4	7	2	1	5	3
1987-1999, 2000	6	8	4	7	5	3	2	1
1988-2000, 2001	2	1	4	8	3	5	7	6
Panel C: Error Variance								
1978-1990, 1991	2	3	1	6	4	7	8	5
1979-1991, 1992	7	4	6	2	3	5	1	8
1980-1992, 1993	3	2	8	1	4	7	5	6
1981-1993, 1994	2	8	3	7	1	4	5	6
1982-1994, 1995	3	7	8	4	5	2	1	6
1983-1995, 1996	3	2	5	7	4	1	8	6
1984-1996, 1997	3	2	5	7	6	4	8	1
1985-1997, 1998	5	6	4	7	1	3	8	2
1986-1998, 1999	5	8	3	7	6	2	4	1
1987-1999, 2000	5	8	3	7	6	2	4	1
1988-2000, 2001	1	2	4	8	3	5	7	6

Table 7 reports the rankings obtained for the office sector. The forecasting accuracy of each of the alternative ARIMA models is assessed using three alternative measures: Mean Absolute Error, Mean Squared Error and the Error Variance.

Table 8: Ranking of Retail Market Forecasts

	ARMA (1,0)	ARMA (0,1)	ARMA (2,0)	ARMA (0,2)	ARMA (1,1)	ARMA (2,1)	ARMA (1,2)	ARMA (2,2)
Panel A: Mean Absolute Error								
1978-1990, 1991	3	8	4	6	5	2	7	1
1979-1991, 1992	5	8	3	7	4	6	1	2
1980-1992, 1993	7	1	6	2	4	5	3	8
1981-1993, 1994	2	4	6	7	8	5	3	1
1982-1994, 1995	5	4	2	3	6	7	8	1
1983-1995, 1996	4	2	1	6	3	7	8	5
1984-1996, 1997	7	5	2	3	4	1	8	6
1985-1997, 1998	4	2	3	1	6	8	5	7
1986-1998, 1999	5	1	4	2	3	7	8	6
1987-1999, 2000	6	8	3	7	4	1	5	2
1988-2000, 2001	8	1	3	2	6	5	7	4
Panel B: Mean Squared Error								
1978-1990, 1991	3	7	4	6	5	2	8	1
1979-1991, 1992	5	8	3	7	4	6	1	2
1980-1992, 1993	7	1	5	2	4	6	3	8
1981-1993, 1994	2	4	6	7	8	5	3	1
1982-1994, 1995	5	4	2	3	6	7	8	1
1983-1995, 1996	4	2	1	6	3	7	8	5
1984-1996, 1997	7	4	2	5	3	1	8	6
1985-1997, 1998	5	2	3	1	6	8	4	7
1986-1998, 1999	5	1	4	2	3	7	8	6
1987-1999, 2000	6	8	3	7	4	1	5	2
1988-2000, 2001	8	1	3	2	6	5	7	4
Panel C: Error Variance								
1978-1990, 1991	3	7	4	5	6	2	8	1
1979-1991, 1992	5	8	1	7	4	6	2	3
1980-1992, 1993	5	1	4	2	6	7	3	8
1981-1993, 1994	1	3	6	7	8	5	2	4
1982-1994, 1995	5	3	2	4	6	7	8	1
1983-1995, 1996	4	2	1	6	3	7	8	5
1984-1996, 1997	2	3	6	7	4	5	8	1
1985-1997, 1998	5	2	3	1	6	8	4	7
1986-1998, 1999	5	1	4	2	3	7	8	6
1987-1999, 2000	4	7	3	8	5	1	6	2
1988-2000, 2001	8	1	3	4	2	6	7	5

Table 8 reports the rankings obtained for the retail sector. The forecasting accuracy of each of the alternative ARIMA models is assessed using three alternative measures: Mean Absolute Error, Mean Squared Error and the Error Variance.

Table 9: Ranking of Industrial Market Forecasts

	ARMA (1,0)	ARMA (0,1)	ARMA (2,0)	ARMA (0,2)	ARMA (1,1)	ARMA (2,1)	ARMA (1,2)	ARMA (2,2)
Panel A: Mean Absolute Error								
1978-1990, 1991	4	8	6	7	2	5	1	3
1979-1991, 1992	7	1	6	5	3	4	8	2
1980-1992, 1993	6	1	4	7	3	8	2	5
1981-1993, 1994	6	3	8	7	1	5	2	4
1982-1994, 1995	6	1	5	3	2	4	7	8
1983-1995, 1996	4	1	3	6	2	5	8	7
1984-1996, 1997	1	7	5	3	6	2	4	8
1985-1997, 1998	5	2	7	1	4	6	3	8
1986-1998, 1999	5	7	2	6	1	3	4	8
1987-1999, 2000	6	8	4	7	5	2	3	1
1988-2000, 2001	3	5	2	7	1	6	8	4
Panel B: Mean Squared Error								
1978-1990, 1991	4	8	6	7	2	5	1	3
1979-1991, 1992	7	1	6	5	3	4	8	2
1980-1992, 1993	6	1	4	8	3	7	2	5
1981-1993, 1994	3	2	8	7	1	6	4	5
1982-1994, 1995	6	1	5	3	2	4	7	8
1983-1995, 1996	4	1	3	6	2	5	8	7
1984-1996, 1997	1	7	4	2	6	3	5	8
1985-1997, 1998	5	3	7	1	4	6	2	8
1986-1998, 1999	5	7	3	6	1	2	4	8
1987-1999, 2000	6	8	4	7	5	2	3	1
1988-2000, 2001	3	5	2	7	1	6	8	4
Panel C: Error Variance								
1978-1990, 1991	3	7	6	8	2	5	4	1
1979-1991, 1992	7	2	5	6	3	4	8	1
1980-1992, 1993	4	1	5	8	6	7	2	3
1981-1993, 1994	1	2	8	7	3	6	4	5
1982-1994, 1995	6	1	5	3	2	4	7	8
1983-1995, 1996	4	1	3	6	2	5	8	7
1984-1996, 1997	7	8	4	2	3	5	6	1
1985-1997, 1998	5	3	7	1	4	6	2	8
1986-1998, 1999	3	1	5	2	6	7	4	8
1987-1999, 2000	4	8	3	7	6	2	5	1
1988-2000, 2001	3	5	2	7	1	6	8	4

Table 9 reports the rankings obtained for the industrial sector. The forecasting accuracy of each of the alternative ARIMA models is assessed using three alternative measures: Mean Absolute Error, Mean Squared Error and the Error Variance.

Table 10: Performance of Best Estimate by AIC

	Model	Mean Absolute Error	Mean Squared Error	Error Variance
Panel A: Office Market				
1978-1990, 1991	1,0	2	2	2
1979-1991, 1992	2,2	8	8	8
1980-1992, 1993	0,1	2	2	2
1981-1993, 1994	0,1	8	8	8
1982-1994, 1995	2,2	8	8	6
1983-1995, 1996	2,2	7	7	6
1984-1996, 1997	2,2	1	1	1
1985-1997, 1998	1,0	5	5	5
1986-1998, 1999	0,1	8	8	8
1987-1999, 2000	0,1	8	8	8
1988-2000, 2001	2,1	5	5	5
Panel B: Retail Market				
1978-1990, 1991	2,2	1	1	1
1979-1991, 1992	2,1	6	6	6
1980-1992, 1993	2,2	8	8	8
1981-1993, 1994	2,2	1	1	4
1982-1994, 1995	2,2	1	1	1
1983-1995, 1996	1,0	4	4	4
1984-1996, 1997	2,2	6	6	1
1985-1997, 1998	2,2	7	7	7
1986-1998, 1999	2,2	6	6	6
1987-1999, 2000	0,1	8	8	7
1988-2000, 2001	0,1	1	1	1
Panel C: Industrial Market				
1978-1990, 1991	0,1	8	8	7
1979-1991, 1992	2,2	2	2	1
1980-1992, 1993	2,2	5	5	3
1981-1993, 1994	1,0	6	3	4
1982-1994, 1995	1,0	6	6	1
1983-1995, 1996	2,2	7	7	7
1984-1996, 1997	2,2	8	8	1
1985-1997, 1998	2,1	6	6	6
1986-1998, 1999	2,2	8	8	8
1987-1999, 2000	0,1	8	8	8
1988-2000, 2001	1,0	3	3	3

Table 10 reports the forecast rank obtained by the appropriate best-fitting model in the estimation phase according the AIC criteria.

Table 11: Performance of Best Estimate by SBC

	Model	Mean Absolute Error	Mean Squared Error	Error Variance
Panel A: Office Market				
1978-1990, 1991	1,0	2	2	2
1979-1991, 1992	2,2	8	8	8
1980-1992, 1993	0,1	2	2	2
1981-1993, 1994	0,1	8	8	8
1982-1994, 1995	2,2	8	8	6
1983-1995, 1996	2,2	7	7	6
1984-1996, 1997	2,2	1	1	1
1985-1997, 1998	1,0	5	5	5
1986-1998, 1999	0,1	8	8	8
1987-1999, 2000	0,1	8	8	8
1988-2000, 2001	2,1	5	5	5
Panel B: Retail Market				
1978-1990, 1991	2,2	1	1	1
1979-1991, 1992	2,1	6	6	6
1980-1992, 1993	2,2	8	8	8
1981-1993, 1994	2,2	1	1	4
1982-1994, 1995	2,2	1	1	1
1983-1995, 1996	2,2	5	5	5
1984-1996, 1997	2,2	6	6	1
1985-1997, 1998	2,2	7	7	7
1986-1998, 1999	2,2	6	6	6
1987-1999, 2000	0,1	8	8	7
1988-2000, 2001	0,1	1	1	1
Panel C: Industrial Market				
1978-1990, 1991	0,1	8	8	7
1979-1991, 1992	2,2	2	2	1
1980-1992, 1993	2,2	5	5	3
1981-1993, 1994	1,0	6	3	4
1982-1994, 1995	1,0	6	6	1
1983-1995, 1996	1.0	4	4	4
1984-1996, 1997	2,2	8	8	1
1985-1997, 1998	2,1	6	6	6
1986-1998, 1999	2,2	8	8	8
1987-1999, 2000	0,1	8	8	8
1988-2000, 2001	1,0	3	3	3

Table 11 reports the forecast rank obtained by the appropriate best-fitting model in the estimation phase according the SBC criteria.

Table 12: Assessment of Market Direction

	Actual Movement	ARMA (1,0)	ARMA (0,1)	ARMA (2,0)	ARMA (0,2)	ARMA (1,1)	ARMA (2,1)	ARMA (1,2)	ARMA (2,2)	No. Correct
Panel A: Office Market										
1978-1990, 1991	Down	Correct	Correct	Correct	Correct	Correct	Correct	Incorrect	Correct	7
1979-1991, 1992	Down	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	8
1980-1992, 1993	Down	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	8
1981-1993, 1994	Down	Correct	Correct	Correct	Incorrect	Incorrect	Incorrect	Incorrect	Correct	4
1982-1994, 1995	Up	Incorrect	Incorrect	Incorrect	Incorrect	Incorrect	Incorrect	Incorrect	Incorrect	0
1983-1995, 1996	Up	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	8
1984-1996, 1997	Up	Correct	Correct	Correct	Correct	Correct	Correct	Incorrect	Correct	7
1985-1997, 1998	Up	Correct	Incorrect	Correct	Incorrect	Correct	Correct	Incorrect	Correct	5
1986-1998, 1999	Up	Incorrect	Incorrect	Incorrect	Incorrect	Correct	Correct	Incorrect	Incorrect	2
1987-1999, 2000	Up	Incorrect	Incorrect	Incorrect	Incorrect	Incorrect	Incorrect	Incorrect	Correct	1
1988-2000, 2001	Up	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	8
Panel B: Retail Market										
1978-1990, 1991	Down	Correct	Incorrect	Correct	Incorrect	Correct	Correct	Correct	Correct	6
1979-1991, 1992	Down	Incorrect	Correct	Correct	Correct	Correct	Incorrect	Correct	Correct	6
1980-1992, 1993	Down	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	8
1981-1993, 1994	Down	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	8
1982-1994, 1995	Down	Incorrect	Incorrect	Incorrect	Incorrect	Incorrect	Incorrect	Incorrect	Incorrect	0
1983-1995, 1996	Up	Correct	Incorrect	Incorrect	Correct	Incorrect	Correct	Correct	Incorrect	4
1984-1996, 1997	Up	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	8
1985-1997, 1998	Up	Correct	Correct	Correct	Correct	Correct	Incorrect	Correct	Correct	7
1986-1998, 1999	Up	Incorrect	Correct	Incorrect	Correct	Correct	Incorrect	Correct	Incorrect	4
1987-1999, 2000	Up	Incorrect	Incorrect	Incorrect	Incorrect	Incorrect	Correct	Incorrect	Incorrect	1
1988-2000, 2001	Up	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	8

Panel C: Industrial Market										
1978-1990, 1991	Down	Correct	Correct	Incorrect	Correct	Correct	Incorrect	Correct	Correct	6
1979-1991, 1992	Down	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	8
1980-1992, 1993	Down	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	8
1981-1993, 1994	Down	Correct	Correct	Incorrect	Correct	Correct	Correct	Correct	Correct	7
1982-1994, 1995	Down	Incorrect	Correct	Incorrect	Correct	Correct	Correct	Correct	Correct	6
1983-1995, 1996	Up	Correct	Correct	Correct	Correct	Correct	Incorrect	Incorrect	Incorrect	5
1984-1996, 1997	Up	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	8
1985-1997, 1998	Up	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Incorrect	7
1986-1998, 1999	Up	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	8
1987-1999, 2000	Up	Incorrect	Incorrect	Incorrect	Incorrect	Incorrect	Incorrect	Incorrect	Incorrect	0
1988-2000, 2001	Up	Correct	Incorrect	Correct	Correct	Correct	Incorrect	Incorrect	Incorrect	4

Table 12 details whether each of the alternative ARIMA models correctly predicted the direction of rental movements in the four quarters of the forecasting period.

Table 13: Rank Correlations: AIC in-sample Criteria

	Mean Absolute Error	Mean Squared Error	Error Variance
Panel A: Office Market			
1978-1990, 1991	0.7857**	0.8810**	0.8810**
1979-1991, 1992	-0.1548	-0.1548	0.0119
1980-1992, 1993	0.4286	0.4286	0.7143**
1981-1993, 1994	-0.5000	-0.4048	-0.2381
1982-1994, 1995	-0.2857	-0.2857	-0.0952
1983-1995, 1996	-0.8095***	-0.8095***	-0.7381**
1984-1996, 1997	-0.1429	-0.1429	-0.1905
1985-1997, 1998	0.3095	0.3095	0.2619
1986-1998, 1999	-0.7381**	-0.7381**	-0.8333***
1987-1999, 2000	-0.9762***	-0.9762***	-0.8333***
1988-2000, 2001	0.3571	0.3571	0.2381
Panel B: Retail Market			
1978-1990, 1991	-0.0238	0.0476	0.1429
1979-1991, 1992	-0.4524	-0.4524	-0.2857
1980-1992, 1993	0.0238	-0.0714	-0.2143
1981-1993, 1994	0.2143	0.2143	-0.1190
1982-1994, 1995	-0.0476	-0.0476	-0.1190
1983-1995, 1996	0.5476*	0.5476*	0.5476*
1984-1996, 1997	-0.1190	-0.1667	-0.1190
1985-1997, 1998	-0.6905**	-0.5952*	-0.5952*
1986-1998, 1999	-0.1667	-0.1667	-0.1667
1987-1999, 2000	-0.5714*	-0.5714*	-0.4048
1988-2000, 2001	0.3333	0.3333	0.3095
Panel A: Industrial Market			
1978-1990, 1991	-0.6429**	-0.6429**	-0.3810
1979-1991, 1992	0.2619	0.2619	0.4524
1980-1992, 1993	-0.2262	-0.1786	-0.2262
1981-1993, 1994	-0.4524	-0.1667	0.1667
1982-1994, 1995	0.1429	0.1429	0.1429
1983-1995, 1996	0.1667	0.1667	0.1667
1984-1996, 1997	-0.1905	-0.2857	0.5952*
1985-1997, 1998	-0.6190*	-0.6429**	-0.6429**
1986-1998, 1999	-0.1667	-0.0952	-0.6190*
1987-1999, 2000	-0.7857**	-0.7857**	-0.5238*
1988-2000, 2001	0.7143**	0.7143**	0.7143**

Table 13 provides details of the Spearman rank correlations between the rank obtained using the AIC criteria in-sample and the relevant ranks obtained in the forecasting period according to each of the three measures used to assess forecasting accuracy.

Table 14: Rank Correlations: SBC in-sample Criteria

	Mean Absolute Error	Mean Squared Error	Error Variance
Panel A: Office Market			
1978-1990, 1991	0.6429**	0.7619**	0.7619**
1979-1991, 1992	-0.1548	-0.1548	0.0119
1980-1992, 1993	0.3571	0.3571	0.5952*
1981-1993, 1994	-0.5000	-0.4048	-0.2381
1982-1994, 1995	-0.1429	-0.1429	0.1429
1983-1995, 1996	-0.9048***	-0.9048***	-0.8333***
1984-1996, 1997	-0.2143	-0.2143	-0.2381
1985-1997, 1998	0.5238*	0.5238*	0.5000
1986-1998, 1999	-0.7381**	-0.7381**	-0.8333***
1987-1999, 2000	-0.9762***	-0.9762***	-0.8333***
1988-2000, 2001	-0.3333	-0.3333	-0.3810
Panel B: Retail Market			
1978-1990, 1991	0.2619	0.2143	0.2857
1979-1991, 1992	-0.3333	-0.3333	-0.1905
1980-1992, 1993	-0.2381	-0.3095	-0.4762
1981-1993, 1994	0.2143	0.2143	-0.1190
1982-1994, 1995	-0.0714	-0.0714	-0.1429
1983-1995, 1996	0.0476	0.0476	0.0476
1984-1996, 1997	-0.1190	-0.1667	-0.1190
1985-1997, 1998	-0.7143**	-0.5952*	-0.5952*
1986-1998, 1999	-0.2143	-0.2143	-0.2143
1987-1999, 2000	-0.5714*	-0.5714*	-0.4048
1988-2000, 2001	0.4762	0.4762	0.3095
Panel A: Industrial Market			
1978-1990, 1991	-0.6429**	-0.6429**	-0.3810
1979-1991, 1992	0.2381	0.2381	0.4286
1980-1992, 1993	-0.2262	-0.1786	-0.2262
1981-1993, 1994	-0.4762	-0.3095	0.0238
1982-1994, 1995	-0.3333	-0.3333	-0.3333
1983-1995, 1996	0.1190	0.1190	0.1190
1984-1996, 1997	-0.1905	-0.2857	0.5952*
1985-1997, 1998	-0.6667***	-0.6429**	-0.6429**
1986-1998, 1999	-0.1667	-0.0952	-0.6190*
1987-1999, 2000	-0.7857**	-0.7857**	-0.5238*
1988-2000, 2001	0.6667***	0.6667**	0.6667**

Table 14 provides details of the Spearman rank correlations between the rank obtained using the SBC criteria in-sample and the relevant ranks obtained in the forecasting period according to each of the three measures used to assess forecasting accuracy.

Appendix

Table A1: Degree of Differencing Required to Ensure Stationarity

	Office Market	Retail Market	Industrial Market
1978-1990, 1991	3	2	0
1979-1991, 1992	2	3	3
1980-1992, 1993	0	2	2
1981-1993, 1994	0	2	3
1982-1994, 1995	2	2	3
1983-1995, 1996	2	3	3
1984-1996, 1997	2	2	2
1985-1997, 1998	3	2	3
1986-1998, 1999	0	3	2
1987-1999, 2000	0	0	0
1988-2000, 2001	2	1	3

Endnotes:

[1] There are numerous examples of studies to have examined rental values using reduced form OLS based models. These papers have examined a wide variety of both countries, localised markets and property sectors. Examples include D'Arcy et al. (1997, 1999), Gardiner & Henneberry (1988, 1991), Giussani et al. (1993), Jackson (2001), McGough & Tsolacos (1995a, 1999), Mitchell & MacNamara (1997) and Tsolacos et al. (1998).

[2] See Geltner (1993) for a full discussion on temporal aggregation.

[3] The full unit root tests are available from the author on request.

[4] The full forecast results are available from the author. These results highlight that on occasions forecasts from the models were substantially different from the actual movements of the indices.