FORECASTING RESIDENTIAL RENTS: THE CASE OF AUCKLAND, NEW ZEALAND

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ABSTRACT

A large number of studies have examined the price dynamics of housing markets and the comparative forecasting ability of alternative methodological frameworks. However, there has been relatively little work that focuses on forecasting residential rents. This paper uses two alternative methodological frameworks to forecast residential rents in Auckland, New Zealand from the early 1990's onwards; namely a fundamental variable based Ordinary Least Squares (OLS) model and a univariate Auto Regressive Integrated Moving Average (ARIMA) approach. The results indicate that the simple ARIMA is superior in forecasting residential rents. This suggests that the fundamental variable specification may be useful in estimating turning points in rental movements, but that the simple autoregressive framework is more accurate in predicting rent levels. This is thought to be due to the heterogeneous profile of residential investors and key behavioural issues, such as myopic expectations surrounding returns that surround small-scale non-institutional investors dominating the residential rental market.

Keywords: Forecasting, residential rents, models, New Zealand

INTRODUCTION

A large number of studies have examined the price dynamics of housing markets and the comparative forecasting ability of alternative methodological frameworks. However, there has been relatively little work that focuses on forecasting residential rents. The dynamics of residential rents are a vital component within the housing and investment property mix, due to the fundamental characteristics of housing markets and, in particular, the relative importance that residential investment plays in the accumulation of household wealth and in housing tenure choice. Previous empirical work on residential rents has tended to focus on the relationship between residential rents and house prices (Potepan, 1996; Hargreaves, 2008). Complicating these issues, many housing markets feature home ownership as the dominant tenure choice, with the residential investment market characterized by relatively small scale investors who focus on capital value growth rather than rental return. Because of the dispersed nature of this market, information on residential rents can be difficult to obtain in sufficient quality and with a sufficient number of observations. Further, the existence of a large proportion of owner occupiers within many housing markets makes it difficult to adequately examine residential rental behaviour in isolation.

Potepan (1996) found that key influencing factors driving house prices and rents in the USA were variables such as construction costs, population growth, taxes and amenity level. While this analysis was cross-sectional rather than longitudinal, the results were consistent with theoretical constructs regarding the influence of fundamental variables on residential rents (DiPasquale and Wheaton, 1992). Brown et al. (1997) found similar results in estimating house prices in the UK with the addition of time-varying coefficients. In a similar vein, Hargreaves (2008) illustrated a strong correlation between house prices and residential rental rates in New Zealand, but left open the question about how these relationships may change over time.

An important issue in regard to residential rental markets is one of investor profile. In many metropolitan areas in the USA, rental housing markets are dominated by relatively large institutional investors and purpose built multi-family rental housing developments (NCREIF, 2009). Alternatively, residential investment markets such as those in Ireland, New Zealand, and Australia have relatively little institutional investment in residential rental property (IPD, 2009). Typically in these markets, smaller residential investors directly manage a few properties and deal directly with householders seeking rented accommodation. This acts to make residential investors in these markets a heterogeneous group in comparison to those markets with high levels of institutional investment, particularly in relation to their property management skills and investment decision making criteria. This is further compounded by taxation and policy issues surrounding residential investment property. For example, New Zealand tax law is generally supportive of residential property investment by small scale investors. Capital gains are not generally taxed for non-professional property investors and any losses accruing to the property can be offset against other income (Inland Revenue, 2009). This provides an environment where negative gearing can be effectively used as an investment strategy, such that capital gains dominate the investment return.[1]

The choice of the Auckland market is of interest for several reasons. First, Auckland is the largest metropolitan area in New Zealand with the most diversified economy in the country. As a result, the Auckland residential rental market is the largest in New

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[1] *Negative gearing occurs when investors increase their leverage such that interest expenses rise such that total expenses are greater than revenue. Under New Zealand taxation policies, the loss can be offset against other income such that the investor effectively receives a tax credit. This strategy erodes income returns, such that capital gains dominate.*

Zealand with the most diversified housing stock available for rent. While house price growth was not continuous over the entire period between 1992 and 2008, there is a common perception that between the years 2001 and 2007 there was a significant property price boom, with house prices increasing by 105% in real terms (Quotable Value, 2008). It is also thought that residential property investors represented a significant source of demand during this boom and assisted in driving house prices upwards (DTZ, 2006). In relation to residential rents, Hargreaves (2008) suggested that residential rents are correlated to house prices in New Zealand during the period 1993 to 2005. The author's findings suggest that house prices influence rent setting by investors through targeting a level of return, as expressed by a capitalization rate (the ratio of rent to price). However, it was left unexamined as to whether this relationship extended outside the study period of time or the role of fundamental variables on this relationship.

This paper uses two alternative methodological frameworks to forecast residential rents in Auckland, New Zealand from the early 1990's onwards; namely a fundamental variable based Ordinary Least Squares (OLS) model and a univariate ARIMA approach. This paper is similar in spirit to recent housing supply forecasting work done in Stevenson and Young (2007) and recent forecasting work on house price dynamics such as Crawford and Franatoni (2003) and Guirguis et al. (2005). It is thought that an ARIMA specification will outperform an OLS based forecasting method due to the dispersed and heterogeneous nature of residential investors. The remainder of the paper is set out as follows. The following section details the data used and the modelling approaches adopted. The forecasting performance of the alternative model will be contained in the third section and the final section provides concluding comments.

DATA AND METHODOLOGICAL FRAMEWORK

The data used in this paper is semi-annual and covers the period 1992 through the first half of 2008. Rental rates are obtained from the Department of Building and Housing (DBH, 2008) and represent average rental rates for each semi-annual period. The data was aggregated from the suburban level, meaning that an aggregation of median rates was not possible. As a result, mean rents are utilized. However, the number of properties included within each period ranges between 3,626 and 12,983, providing a good representation of rental market movements and indicating that the use of mean rents should provide meaningful results. This data is collected by the DBH from residential tenancy bonds (deposits) which are held by the residential tenancies bond office and based upon the level of rent that is charged to the tenant. This data excludes public housing in order to avoid problems with below market rental rates.

A forecasting horizon of two years (four periods) was adopted within the analysis. This period was considered appropriate, given the suspected autoregressive nature of

rental rates. Given this suspicion, a short forecasting period (for example six months) would overly favour the ARIMA forecasting model.
The analysis is separated into in-sample testing for the purposes of estimating the models (being 1992H1 to 2003H2), and out-of-sample testing for the purposes of assessing the accuracy of the forecasts (2004H1 to 2008H1) using a recursive window. The use of out-of-sample testing is important for assessing forecast techniques, as the accuracy achieved in-sample does not necessarily testify to its reliability out-of-sample (Brooks, 2003).

ARIMA model

Given that ARIMA models have generated useful results in analysis of house price movements (Crawford and Farantoni, 2003), inclusion of this model specification seems a natural choice. ARIMA models are univariate and rely solely on past reverberations within the data series in question. Therefore the underlying theory is that changes in fundamental influences on the market (as indicated by exogenous variables) are ignored, and rather rental rates are set based on their past behaviour only.

The series is fully described by *p*, the order of autoregressive (AR) component, *q*, the order of moving average (MA) component, and, *d*, the order of integration. The AR component is built upon the assumption that future observations can be approximated and predicted by the behaviour of current and past values. The MA component seeks to incorporate the process by which the effects of past changes continue to reverberate for a number of periods. If y_t is an ARIMA *p,d,q* process, differenced d times in order to achieve stationality, then the series evolves according to the following specification:

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

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. It is required that the series used in the estimation process is stationary. Each recursive window was tested for stationality using the the Dickey-Fuller unit root test[2] and then differencing accordingly. In each time period examined, the rent data had to be differenced once in order to obtain stationarity.

The ARIMA model tested is determined based upon its relative accuracy in-sample. A variety of ARIMA specifications are modelled, all utilizing one level of differencing in order to achieve stationality. The specifications used range from ARIMA (0,1,1) to ARIMA (3,1,3). The assessment of the relative goodness of fit for

[2] *The unit root test is represented as follows:* $\Delta yt = a0 + pYt\text{-}1 + e1$, *therefore the test is that* $p = 0$.

the models in the estimation period is assessed using the Akaike Information Criterion (AIC), which is represented as:

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

where T is the sample size, n is the number of regressors and RSS is the residual sum of squares. The model that emerges with the lowest score on both criteria is the most accurate model. The configuration that consistently achieved strong goodness of fit was the ARIMA (3,1,1); these results are provided in Appendix A. Therefore, the ARIMA (3,1,1) model will be used in the forecasting part of this paper. The importance of this specification is effectively that the rental rates have demonstrated an underlying linear increase and the rate in the current period is influenced by the rates over the previous 3 periods (18 months).

OLS model

The second model used is an OLS specification that is commonly used to model house prices (Rehm and Filippova, 2008). The incorporation of fundamental variables in the OLS specification allows for a comparison with the pure time-series approach represented in the ARIMA. At a high level, the OLS model 'forecasts' by lagging the independent variables by four periods (two years), such that the estimated rental rate will be two years ahead of the most recent independent variables used in its calculation. This avoids issues associated with forecasting the independent variables, and is a common way of structuring models for use in forecasting. The out-of-sample forecasting uses a 'recursive window' (Brooks, 2003: 280), whereby the first data point remains fixed (being 1992H1 to 2003H1), but additional observations are added one at a time to move the forecasted period forward.

The OLS model is specified as:

$$\ln(RENT_{t+4}) = \beta 1 INT_t + \beta 2 \ln(BC_t) + \beta 3 (MIGRAT_t) + \beta 4 \ln(HPI_t) + \alpha + \varepsilon \qquad (4)$$

where RENT is the mean rent for the period, INT is the real fixed mortgage interest rate for the period obtained from the Reserve Bank of New Zealand (RBNZ), BC, is the number of building consents issued for the period from the Auckland Regional Council, MIGRAT is net permanent external migration for the period obtained from Statistics New Zealand[3], HPI is the house price from the Quotable Value House Price Index for the period, α the constant and ε the error. Deflating of data was conducted using the New Zealand Consumer Price Index. An income variable was also available for use, but was removed from the model due to significant correlation with the HPI.

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[3] *Permanent net migration is the difference between permanent arrivals and permanent departures, being those defined as intending to stay in or be away from New Zealand for more than twelve months.*

The majority of the variables are subject to a natural log transformation, which for the model acts to improve goodness of fit and reduce heteroscedasticity. Monetary values are expressed in real terms. It is important to note that vacancy data is not available for the Auckland market and is not included in the models. This is not thought to be a significant problem because market participants do not have access to vacancy data except regarding their individual units. The coefficients for the model are exhibited in Appendix B. Except for HPI and INT, none of the remaining variables obtains coefficients at statistically significant levels. These significant fundamental variables will be addressed in detail within the discussion section of the paper once the forecasting performance of the models has been assessed.

FORECASTING COMPARISON

Forecasted rents on a semi-annual basis are presented in Table 1 for both models. Two issues arise surrounding the forecasting performance of these two models. The first issue is the differing performance between the ARIMA model and the OLS specification. The second issue is the consistent overestimation of rents using the OLS specification during the forecast period, with more accurate forecasts being obtained as the time period is extended. The OLS specification varies considerably in relation to observed rents, with a large adjustment occurring over the first forecasting period and an overestimation of rent in the first forecasted period which carries through, albeit to a lesser extent, throughout the forecasting horizon. This is in contrast to the ARIMA model, which overestimated rent when compared to actual rent in the final period before the forecast horizon, but provided relatively accurate forecasts for the remainder of the time periods observed. Importantly, the forecast accuracy for the ARIMA was maintained throughout the forecast periods while, unexpectedly, the OLS specification performed more accurately as the rolling forecast horizon was extended. This may be due to changes in the dynamics of the New Zealand housing market that were occurring during the period between 2001 and 2007, with credit growth, significant migration to New Zealand and low interest rates leading to a sharp rise in housing market activity (Hargreaves, 2008). However, these changing dynamics may have allowed more small-scale property investors to enter the residential rental market, subsequently increasing the supply of housing available to rent. The resulting overestimation of rents in the OLS model during periods of rapid house price increases and underestimation of rents when house prices were relatively stable indicates that the inclusion of fundamental variables reduced the overall forecasting accuracy when compared to the simple ARIMA. During the entire forecast period, the OLS consistently over-forecast by between 0.2 percent for the first half of 2008 and by 8.5 percent for the first half of 2006. This is compared to the ARIMA which overestimated actual rents by between 0.4 percent in the first half of 2006 and overestimated by 5.2 percent for the end of 2004.

Tables 2 provides relative accuracy measurements for the two models. In the majority of cases, the ARIMA provided the most accurate forecast of rent. While the mean square error was lower for the ARIMA, the error variance was higher. This finding is important as the largest errors within the ARIMA model were smaller than the largest errors found in the OLS specification. However, because the ARIMA results were more balanced around actual rents, both underestimating and overestimating, the OLS specification consistently overestimated rents during the forecast period, reducing the error variance.

Table 1: Out of sample forecast comparison [4]

	Actual	OLS	ARIMA
30-Jun-04	354.03	360.05	362.66
31-Dec-04	351.32	366.27	369.52
30-Jun-05	355.37	373.36	365.03
31-Dec-05	349.03	373.16	332.05
30-Jun-06	353.63	383.75	355.14
31-Dec-06	359.30	369.77	351.89
30-Jun-07	370.43	387.80	373.56
31-Dec-07	380.55	389.70	361.94
30-Jun-08	392.33	393.21	380.76

It would appear based upon these results that rents did not respond adequately to price movements and other changes in fundamental variables. This is further supported by the fact that the ARIMA outperformed in a forecasting context when compared to the OLS model. A key element in this observation may lie in the relatively myopic expectations of residential investors in regard to the information that they deem important regarding their investment, basing their rental growth estimates on historic growth rates, rather than accounting for the wider fundamentals that influence the market. Provided the favourable tax treatment of residential investment in New Zealand, this is not unexpected so long as rents are sufficiently high to cover most of the payments that are required to maintain the property (such as mortgage payments) and capital value growth (through house prices) is high enough to generate the required return. This is revealed in the OLS model where estimated rents relatively ‘undershoot’ when house prices are stable and estimated rents ‘overshoot’ when house prices are rising. By not taking into account house prices, the ARIMA specification provides further evidence that rental growth is not a driving factor for most small-scale residential investors, who instead prefer to focus on the tax-free capital gains available as house prices increase.

[4] *In-sample forecasts are provided in Appendix C.*

Table 2: Forecasting accuracy statistics

	Accuracy measures		Ranking for measure	
	OLS	ARIMA	OLS	ARIMA
Mean Error	14.56	0.39	2	1
Mean absolute error	14.56	12.61	2	1
Mean squared error	285.35	216.74	2	1
Error variance	82.43	243.66	1	2

The presence of myopic expectations among residential investors in relation to capital value growth may help to explain why the ARIMA specification outperforms the OLS model in forecasting accuracy. If house prices are rising and it is possible to achieve excess returns on housing investment, then the predictive nature of housing markets where supply is relatively limited should lead rational investors to increase their residential property holdings (Kim & Shu, 1993; Sheinkman & Xiong, 2003). This increase in the availability of rental housing available, in the short run, should act to stabilise rents when prices are increasing. In the medium to longer term, this would also suggest that rents may rise along with house prices as the costs of servicing a mortgage for the investor increases with prices and the inability of supply to keep up with increasing demand. However, these rational expectations may also play a role in residential investors failing to anticipate any reversal in the upward price trend (Malpezzi & Wachter, 2005). This alternatively suggests that rents will be slow to adjust downward once prices stabilize. In the longer term, as rents remain relatively high in comparison to mortgage costs, more householders may choose to purchase a home rather than rent (Blackley and Follain, 1996).

The OLS results are broadly supportive of Hargreaves (2008) who found a significant correlation between house prices and rents over the period between 1993 and 2005. In that paper, it was suggested that an income capitalization approach could be used for the valuation of residential investment properties and it was further asserted that this capitalization rate could be used to forecast rental market trends. However, the current findings suggest that the nature of this relationship appears to be linked to the myopic expectation of residential investors seeking capital value growth and that the housing tenure choices available to tenants, should rents exceed mortgage repayments on a similar property, represent a serious issue. This presents a variety of problems in relation to any capital market approach to residential investment property valuation, such as capitalisation rates, where owner occupants dominate the existing tenure for current supply. It is often seen that house prices can rise rapidly but are resistant to downward movements (Case & Shiller, 2003; Glaeser & Gyourko, 2005). This could be due to the high proportion of owner occupiers in housing markets where a high proportion of household wealth is tied up in their properties. This may make homeowners unwilling to realize a loss in their property value, instead wishing to ride out any downturn. Within residential investment markets, this may also hold true as investors may tend to anchor on previous prices and be less willing to realize a perceived loss as their myopic expectation of higher prices did not materialize (Seiler, et al., 2008). These observations may explain why the forecast excluding fundamental variables, house prices, in its specification provided more accurate estimation of rents and also suggests that a capital markets approach to residential valuation be studied more closely. Further, the resilience of residential rents to move downward in a fundamental variable specification may reflect the unwillingness of residential investors to accept less rent in the face of less buoyant housing market conditions.

As the OLS model tended to overestimate and then underestimate residential rental movements due to the inclusion house prices in the specification, the relatively accurate prediction of rent levels for the first half of 2008 is of note. House prices fell during this period and transaction activity in the residential investment market slowed considerably. In the OLS model, turning points in house prices were characterised by the model shifting from overestimating rents to underestimating them. This suggests that the fundamental variable specification may be useful in estimating turning points in rental movements, but that the simple autoregressive framework is more accurate in predicting rent levels.

CONCLUSIONS

This paper has compared the forecasting performance of two alternative models. A commonly used OLS model incorporating fundamental variables was compared to a simple ARIMA model. The results highlight several issues in regard to the residential rental market, particularly when the market is dominated by small-scale investors and there is a lack of institutional investment. The forecasting results reveal that the ARIMA approach is preferred over the model incorporating fundamental variables. The rationale behind these findings is related to the myopic expectations of residential investors concerned with capital value growth. Provided these expectations, as house prices increase more investors are drawn to the residential investment market and rents stabilise in the medium term as the availability of rental property increases. As house prices stabilise, investors may be reluctant to realise a perceived loss on their property by selling at a lower than expected price. They may also be less likely to raise rents that would increase their risk of possible vacancy losses at a time when tenants could choose to take advantage of lower prices as an opportunity to own a home. While the OLS model was useful in predicting turning points in the residential rental market, its forecasts were consistently inaccurate. The ARIMA model was more accurate because it purely followed the trends in rents without explicit consideration of house price dynamics. This finding suggests that key behavioural factors may drive residential rent levels and that a capital markets approach to residential investment valuation may require further scrutiny in locations where there is a low level of institutional investment.

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Appendix A: Akaike Information Criterion (AIC) for ARIMA(p,d,q) Models of RENT

Sample Size	**0,1,1**	**0,1,2**	**0,1,3**	**1,1,0**	**1,1,1**	**1,1,2**	**1,1,3**	**2,1,0**	**2,1,1**	**2,1,2**	**2,1,3**	**3,1,0**	**3,1,1**	**3,1,2**	**3,1,3**
24	157.5	154.4	156.1	154.3	154.8	156.0	155.7	153.2	147.3	149.7	151.7	152.5	149.3	157.1	151.6
25	163.2	160.7	161.0	160.0	160.8	162.5	170.9	160.1	159.7	157.6	158.5	160.8	**154.8**	157.9	165.9
26	170.9	172.1	166.3	166.2	167.5	168.8	167.7	166.9	160.2	162.0	161.4	166.2	**160.1**	162.9	181.9
27	176.8	174.2	171.9	172.3	173.7	174.4	173.1	173.0	**166.8**	167.3	169.5	171.7	168.1	168.7	176.1
28	186.4	182.2	183.2	180.6	182.5	182.8	185.2	182.2	175.7	**173.1**	178.2	180.5	175.0	175.4	186.4
29	192.8	188.6	190.2	187.5	189.5	189.6	204.6	189.4	182.8	181.3	186.7	186.5	**179.5**	181.1	179.8
30	198.6	194.1	195.7	193.1	195.1	195.2	196.6	195.0	188.5	188.1	188.7	192.1	**184.8**	186.3	186.3
31	205.3	199.8	201.3	199.4	201.4	200.9	203.0	201.3	193.8	191.1	203.5	197.4	**190.2**	191.2	194.6
32	211.0	205.4	206.8	204.9	206.9	206.3	208.3	206.7	198.8	201.4	210.2	202.7	**195.0**	196.4	196.7
33	217.3	211.1	218.5	210.7	212.6	211.9	214.0	212.5	203.8	200.0	207.5	208.0	**200.0**	201.3	213.4

Appendix B – OLS Coefficients for out-of-sample forecast

Forecasted Period	2004H1	2004H2	2005H1	2005H2	2006H1	2006H2	2007H1	2007H2	2008H1
Data range of dependent variables used in estimating the model[1]	1992H1 2003H1 [2]	–1992H1 2004H1	–1992H1 2004H2	–1992H1 2005H1	–1992H1 2005H2	–1992H1 2006H1	–1992H1 2006H2	–1992H1 2007H1	–1992H1 2007H2
Constant	2.9400***	2.9460***	2.9969***	3.0470***	3.1719***	3.2843***	3.3214***	3.3621***	3.3785***
External Migration	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LN(House Price Index)	0.4296***	0.4265***	0.4352***	0.4208***	0.4060***	0.4077***	0.4058***	0.3886***	0.3804***
LN(Building Consents)	-0.0320	-0.0301	-0.0466	-0.0390	-0.0404	-0.0587	-0.0619	-0.0502	-0.0440

[1] *Independent variables lagged four periods within the OLS regression for purposes of forecasting. For example, the rental forecast for 2004H1 was estimated using a model with Rental rates from 1992H1 to 2003H1 and corresponding independent variables from 1990H1 to 2001H1.*

[2] *It is noted that first forecast (for 2004H1) uses the regression coefficients of the in-sample estimates.*

Appendix C: In-sample estimations of rent

Period	Actual	OLS	ARIMA
30-Jun-92	207.56	256.01	-
31-Dec-92	201.96	228.00	212.60
30-Jun-93	201.60	209.37	198.60
31-Dec-93	210.79	205.68	204.38
30-Jun-94	221.52	208.04	223.58
31-Dec-94	234.10	227.29	236.10
30-Jun-95	253.92	233.29	247.95
31-Dec-95	269.95	244.92	270.57
30-Jun-96	285.88	267.69	283.24
31-Dec-96	292.84	276.45	295.49
30-Jun-97	297.76	295.09	295.49
31-Dec-97	291.79	310.13	296.58
30-Jun-98	287.67	290.58	284.99
31-Dec-98	280.93	297.19	281.45
30-Jun-99	278.52	308.00	276.52
31-Dec-99	282.51	288.47	278.36
30-Jun-00	283.89	291.08	288.58
31-Dec-00	282.71	278.87	290.76
30-Jun-01	292.36	295.70	288.17
31-Dec-01	301.93	304.92	303.45
30-Jun-02	318.98	309.56	314.99
31-Dec-02	340.87	317.79	334.18
30-Jun-03	354.61	338.73	347.73
31-Dec-03	352.01	327.16	357.37

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