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MODELLING OF OFFICE MARKETS IN AUSTRALIA

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Introduction

The cyclical variation in new office construction, vacancies, rents and values are large over time, being dependent on the effects of specific factors, most importantly economic growth (Wheaton, 1987 ; Barras, 1994 ; Liang, 1997 ; MacFarlane, 1998). Demand for office space comes primarily from economic growth generating office employment. As a result, building construction is largely a response to the anticipated growth in the office-occupying service sectors of the economy. An orderly market driven by steady economic growth and a compatible, steady supply of new and refurbished office accommodation will see a relatively constant vacancy rate and rent increases over time (Voith and Crone, 1988 ; Glascock et. al., 1990). However, a sudden surge of new supply or growth significantly higher or lower than that anticipated will upset this fragile equilibrium. It is important to understand the fundamentals of the office market construction cycle and to reduce the possible future impact of enormous variation in office market supply by forecasting future office market demand.

In the Australian office market, a major construction boom developed in the middle and late 1980s in response to relatively high levels of economic growth at the time and further fueled by the ready availability of finance (see JLW, 1990, for a more detailed discussion). This resulted in large quantities of office space coming on line in the early 1990s (Hendershott, 1997). As this coincided with the economy moving into recession, vacancy rates skyrocketed, real effective rents fell rapidly, property values declined sharply and office construction became quite unviable.

The purpose of this study is to examine office market cycles in Australia and to estimate a structural time-series model, based on the models of Wheaton (1987) and Pollakowski et al (1992) with some suitable modifications for Australian economic factors, office market conditions and available data. Forecasts of the office market will be developed through these models. The desired demand for office space, net absorption and the supply of new office space will be estimated. In this research, the CBD office market of the major Australian capital cities (Sydney and Melbourne) will be examined.

Wheaton (1987) used the unsegmented US national office market as the data for analysis, while Pollakowski (1992) used similar models to fit US office market data stratified into 5 groups by office market size.

This paper fits similar models to individual CDB office markets.

Data

Analyses in this paper are based on the time-series data from 1970 to 1997 provided by BIS Shrapnel. It is worth noting that this is annual data whereas that of Wheaton was half-yearly.

The historical data for net absorption, new office completion, vacancy rate and real effective rent for Sydney and Melbourne CBD office markets are shown in Figures 1

to 4. In both cities, the cyclical patterns are somewhat similar. The past trend for vacancy rates in Sydney CBD office market suggests a cycle with a periodicity of roughly 16 years with peaks in 1976 and 1992. Melbourne has a similar cycle also with periodicity of approximately 16 years with peaks in 1977 and 1993 (see Figure 3).

Comparison of Figures 3 and 4, and the extreme values given in Tables 1 and 2 below, indicate that the rent cycle matched inversely to the vacancy cycle and lagged by roughly one year in both Sydney and Melbourne CBD office markets. The vacancy cycles of both cities also show a "bubble" between 1981 and 1987 which is not matched in the rental values.

Table 1: Peaks and Troughs for Vacancy Rates

Location	Trough	Peak	Trough	Peak
Sydney	2.7% (1970)	19.7% (1976)	1.2% (1987)	22.5% (1992)
Melbourne	2.0% (1970)	16.1% (1977)	1.5%(1987)	26.7% (1993)

Table 2: Peaks and Troughs for the Real Effective Prime Rents ($ 89-90)

Location	Peak	Trough	Peak	Trough
Sydney	673 (1971)	314 (1977)	655 (1987)	286 (1993)
Melbourne	439 (1971)	294 (1978)	473 (1987)	115 (1994)

Modelling the Office Markets

Models for the office markets in this paper consist of a demand equation, a supply equation and the use of a rental adjustment equation which effectively removes rents from the analysis. The models are based on the works of Wheaton (1987) and Pollakowski (1992) with some modifications to allow for the Australian context and available data.

We require some notation for the models, so, following Wheaton:

$S(t)$ stock of space at time t
$C(t)$ construction commenced during period t
$E(t)$ office employment in period t
$V(t)$ vacancy rate at time t
$R(t)$ real rental rate for new space at time t
$OS(t)$ occupied space at time t
$A(t)$ net absorption of space during period t

and

$$A(t) \quad = \quad OS(t) - OS(t-1) \qquad (1) \qquad \text{Demand}$$

$$OS(t) \quad = \quad S(t) * (1 - V(t)) \qquad (2) \qquad \text{Vacancy}$$

$$S(t) \quad = \quad S(t-1) + C(t-a1) \qquad (3) \qquad \text{Supply}$$

These equations are straight forward with the parameter a1 representing the time lag between the commencement of construction and space coming onto the rental market.

The space absorbed in any period is a fraction (a2) of the difference between the desired space and the previously occupied space, with the desired space being a function of office employment, rents and employment growth, whence:

$$A(t) \quad = \quad a2 * (DS(t) - OS(t-1))$$

$$= \quad a2 * F1[E(t), R(t), E(t)/E(t-1)] - a2 * OS(t-1) \qquad (4)$$

For supply, since office space under construction takes some time (a1 periods) to appear on the market, construction is seen as a function of rents, vacancy, current supply and employment growth and expectations about these at the time of completion and occupation. This introduces consideration of lags in some of these critical variables. Formally,

$$C(t) \quad = \quad F2[R(t), V(t), S(t), E(t)/E(t-1)] \qquad (5)$$

with this new supply to appear some a1 periods after the commencement of construction.

Recognising the relationship between rents and vacancy, as discussed earlier, Wheaton uses a rent adjustment equation which relates change in rents to the level of vacancy above or below an equilibrium vacancy level, viz.:

$$[R(t) - R(t-1)] / R(t-1) = F_3[V(t) - V^*] \qquad (6)$$

where V^* = average or structural vacancy rate

Equation (6) allows rents to be expressed as a function of vacancy rates and allows the elimination of rents from equations (4) and (5). This is convenient for Wheaton who did not have rental data and which would have varied from city to city (Wheaton analysed the US national office market as one entity). However, it also serves to remove the difficult multicollinearity between rents and vacancy as evident from Figures 3 and 4.

Empirical Results

As the basic model of the office markets, the above equations (4) and (5) are estimated using the time-series data from 1970 to 1997 in Sydney and Melbourne CBDs. Important lags are likely to exist in some of the relationships between dependent and independent variables in the equations , creating considerable difficulty in fitting the model. Examination of the correlations and experimentation with a number of different lagged relationships is required. This is unfortunate but unavoidable given the nature of the models and available data.

The regression results of estimating absorption and construction for Sydney and Melbourne CBD office markets for the period 1970 to 1997 are presented in Tables 3 and 4. While the fits are generally not as satisfactory as those achieved by Wheaton, it is interesting to note that that similar lags between vacancy and absorption (Table 3) and between vacancy and construction and employment growth and construction (Table 4) arose from the Sydney and Melbourne markets as for the US national office market. While the units of measurement were different (resulting in non-comparable parameter values) it is interesting to note that the signs of the estimated parameters are generally as expected and as for Wheaton.

Table 3:   Regression Equations of Net Absorption (Equation 4)

Independent Variables	Dependent Variable (Net Absorption)	
	Sydney	Melbourne
Intercept	-1243 (-4.22) [1]	219.6 (1.00)
E(t) employment	0.77 (0.34)	6.13 (2.69)
V(t-lag) vacancy	592.6 (3.14)	162.6 (1.31)
lag	2	2
OS(t-1)	-0.0724 (-1.19)	-0.1725 (-3.31)
E(t-lag)/E(t-1-lag) employment growth	1345 (3.72)	-311.1 (-1.36)
lag	0	0
N obs	24	26
R2	.77	.38

[1] t Statistics in parentheses

In the net absorption equation, vacancy and employment growth were highly significant in Sydney but lesser so in Melbourne. The negative sign for employment growth in Melbourne is the only sign which is not as expected (the sign of the intercept has no particular significance). The coefficient is not significant, however, and its impact is offset by the presence of the absolute level of employment, E(t), which is significant in the model for Melbourne. The lag on the vacancy rate of 2 years is comparable to that of Wheaton (6 half yearly periods or 3 years). The model fitted here is the "best" fit with a lagged vacancy of 1 or 3 years in the model instead of 2 years having a moderate impact on the R^2 values. The fit for Sydney is comparable to the R^2 of 0.82 achieved by Wheaton.

Table 4:   Regression Equations of Construction (Equation 5)

Independent Variables	Dependent Variable (Net New Supply)	
	Sydney	Melbourne
Intercept	-964.6 (-1.93) [1]	-265.1 (-0.64)
V(t-lag) vacancy	-713.7 (-2.78)	-1364 (-4.53)
lag	2	2
S(t-1)	-0.0214 (-0.67)	0.0472 (1.43)
E(t-lag)/E(t-1-lag)	466.8 (1.16)	1040 (2.23)
employment growth		
lag	1	0
N obs	24	26
R2	.36	.54

[1] t Statistics in parentheses

In the regression analysis of the net office construction, the coefficient of the vacancy rate was significant with expected negative sign in both office markets and vacancy rate was lagged by 2 years. Considering the importance of leasing contracts in the office market, the lagged vacancy rate variables may be viewed as indicators of the role of expectations in the formation of demand and supply decisions. It is worth noting that the lag from commencing construction to completion (denoted by a1 in equation (3)) is also required in conjunction with equation (5). The value was 2 years for both Sydney and Melbourne which was again consistent with Wheaton (18 to 24 months). The fits here are not nearly as good as those achieved by Wheaton (R^2 of 0.91 for the construction equation).

Future Predictions

Using the developed regression models, the net absorption and new office construction can be forecast for the Sydney and Melbourne CBD office markets for the period to 2010 (see Figures 5 to10). The only exogenous data required is a forecast of office employment, E(t), over the period. It is also possible to experiment with a number of different scenarios for office employment over the period and to examine the forecasts for demand, supply and vacancy rates which apply. The forecasts given here use a moderate growth scenario of approximately 30% over the 13 year period for both Sydney and Melbourne.

Since the fitting of the models was only moderately successful, the forecasts need to be viewed warily, but, for Sydney it shows vacancies falling to a low of about 4% in the year 2000 and then increasing out to a high of about 12% over the following decade. This is consistent with other currently available forecasts.

In Melbourne office market, the forecasts show a stronger cyclic behaviour with vacancies predicted to fall to as low as 2% in 2003 followed by a substantial increase to as high as 18% by the year 2010 largely as a result of excess supply.

Conclusion

This paper analyzes demand, supply and rent in the office markets of Sydney and Melbourne CBD using a time-series data from 1970 to 1997. We are thus able to provide some insights into how net absorption, new office completion and rent relate with such independent variables as vacancy rate, occupied space, stock of office space, office employment and employment ratio. In general, the direction of the coefficients on the explanatory variables are as expected.

In Sydney and Melbourne CBD office markets, the vacancy rate suggests a distinct cycle with a periodicity of roughly 16 years

Using the developed models, demand, supply and vacancy rate can be forecast in both cities although further work to improve on the current models is required to have a greater degree of faith in the predictions.

There are a number of areas which could be examined in the search for improved models and forecasting. Some of these are:

1.   generalising the requirement that new supply comes onto the market a fixed number of periods after commencement;

2.   separating net new supply into completions (which are driven factors several periods in the past) less supply removed from the market for refurbishment or redevelopment (which may appear back on the market at a later date (and which is driven by current market conditions);

3.   incorporating rental data more explicitly into the forecasting model.

Each of these, though, have drawbacks in requiring more factors to be estimated from the limited amount of data, or introducing further factors which are highly correlated with those already in the model and which cannot readily be removed.

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Figure 1:   Net Absorption in the Sydney and Melbourne CBD Office Market, 1971-1997
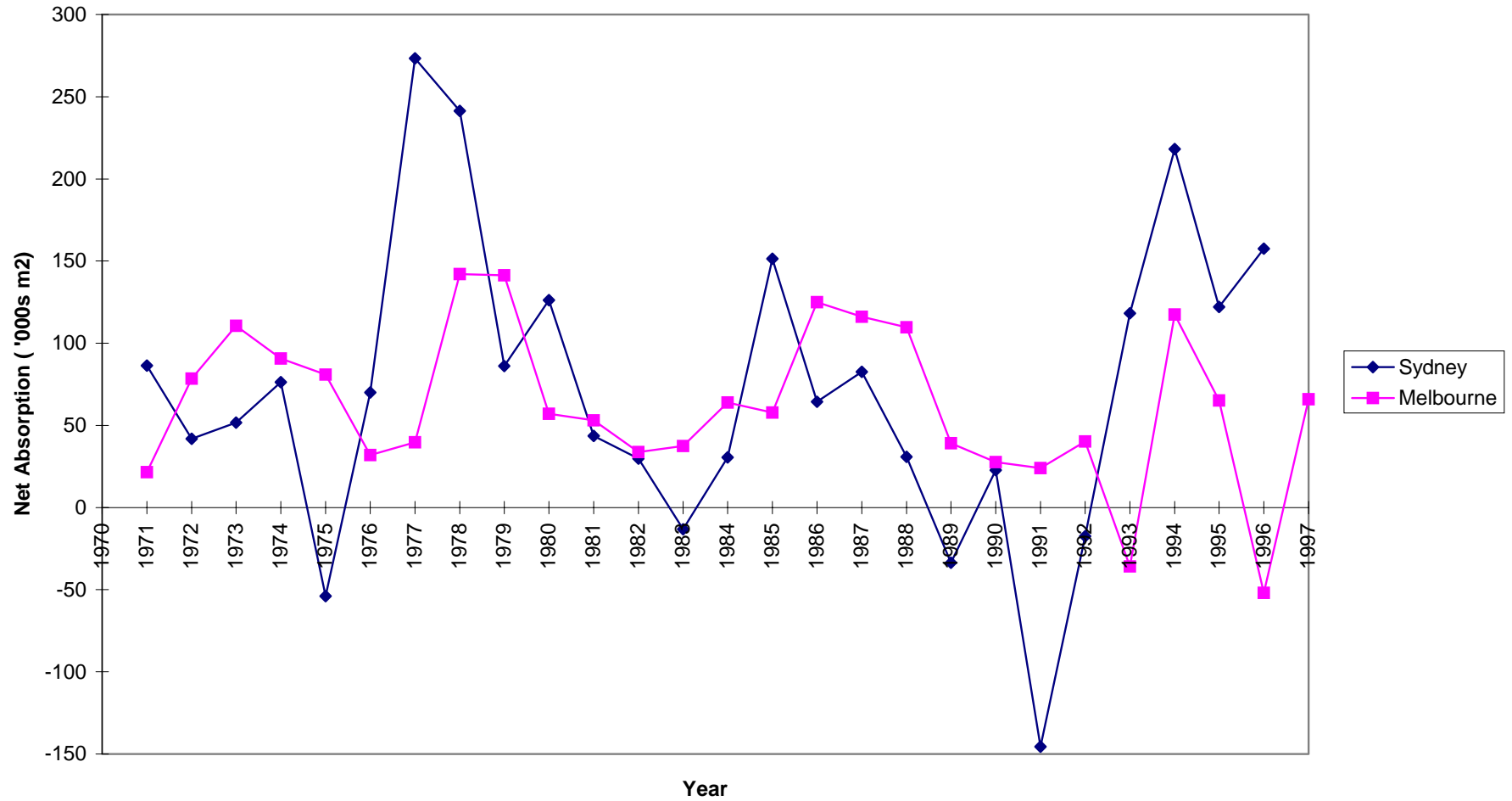
Figure 2:   New Office Completion in the Sydney and Melbourne CBD Office Market, 1971-1997
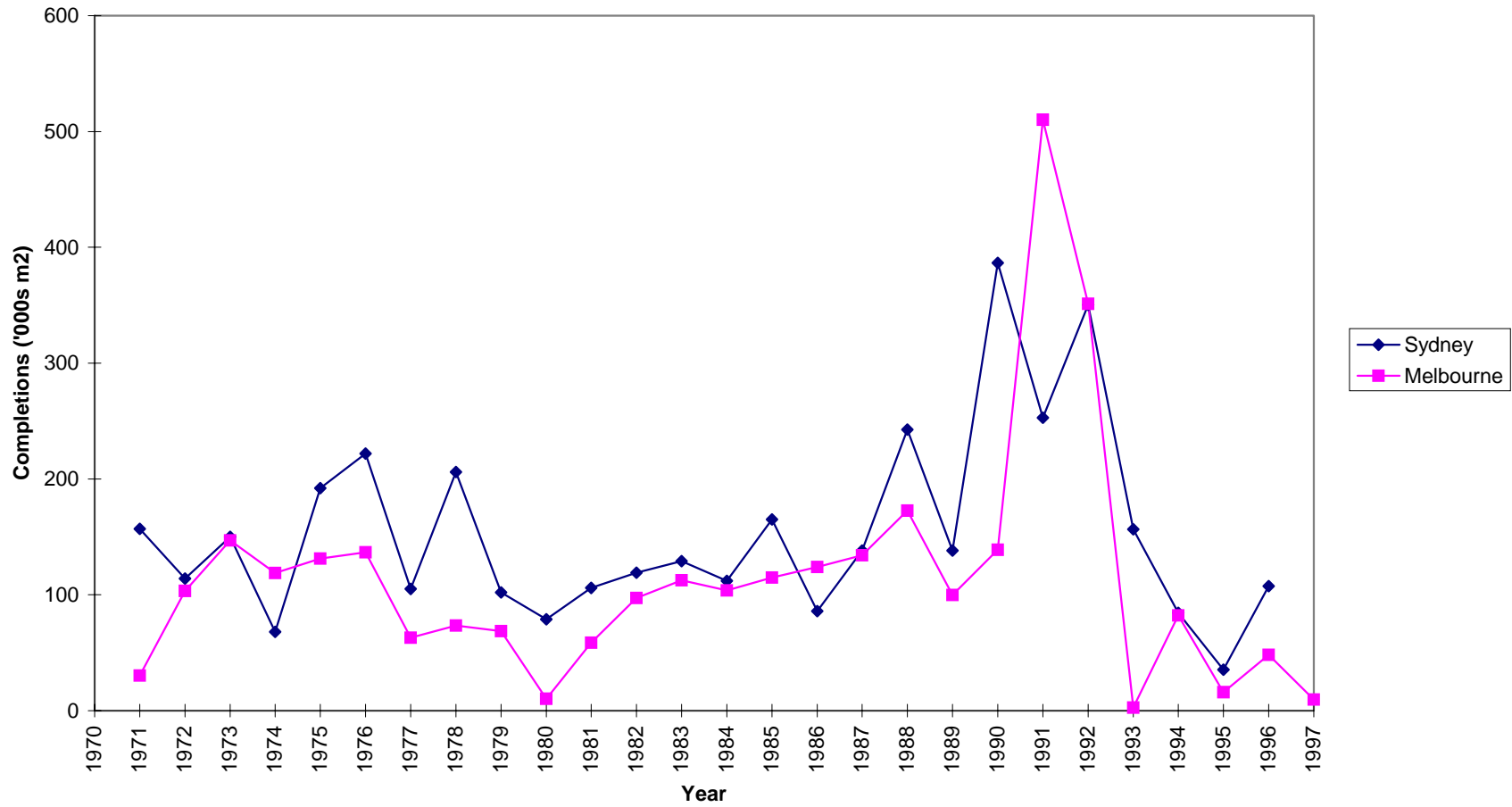
Figure 3:   Vacancy Rates in the Sydney and Melbourne CBD Office Market, 1970-1997
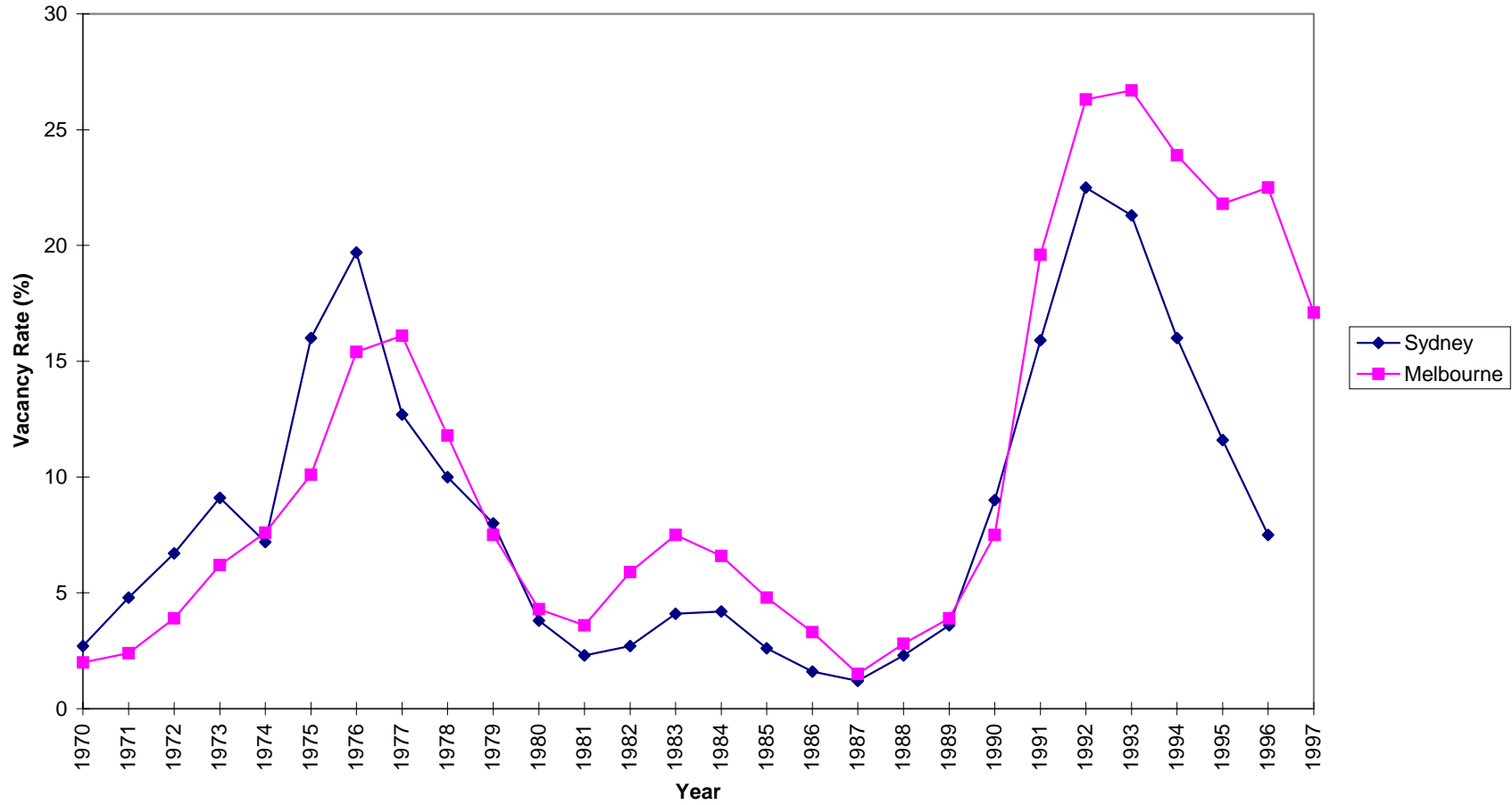
Figure 4:   Real Effective Prime Rent($ 89-90) in the Sydney and Melbourne CBD Office Market, 1970-1997
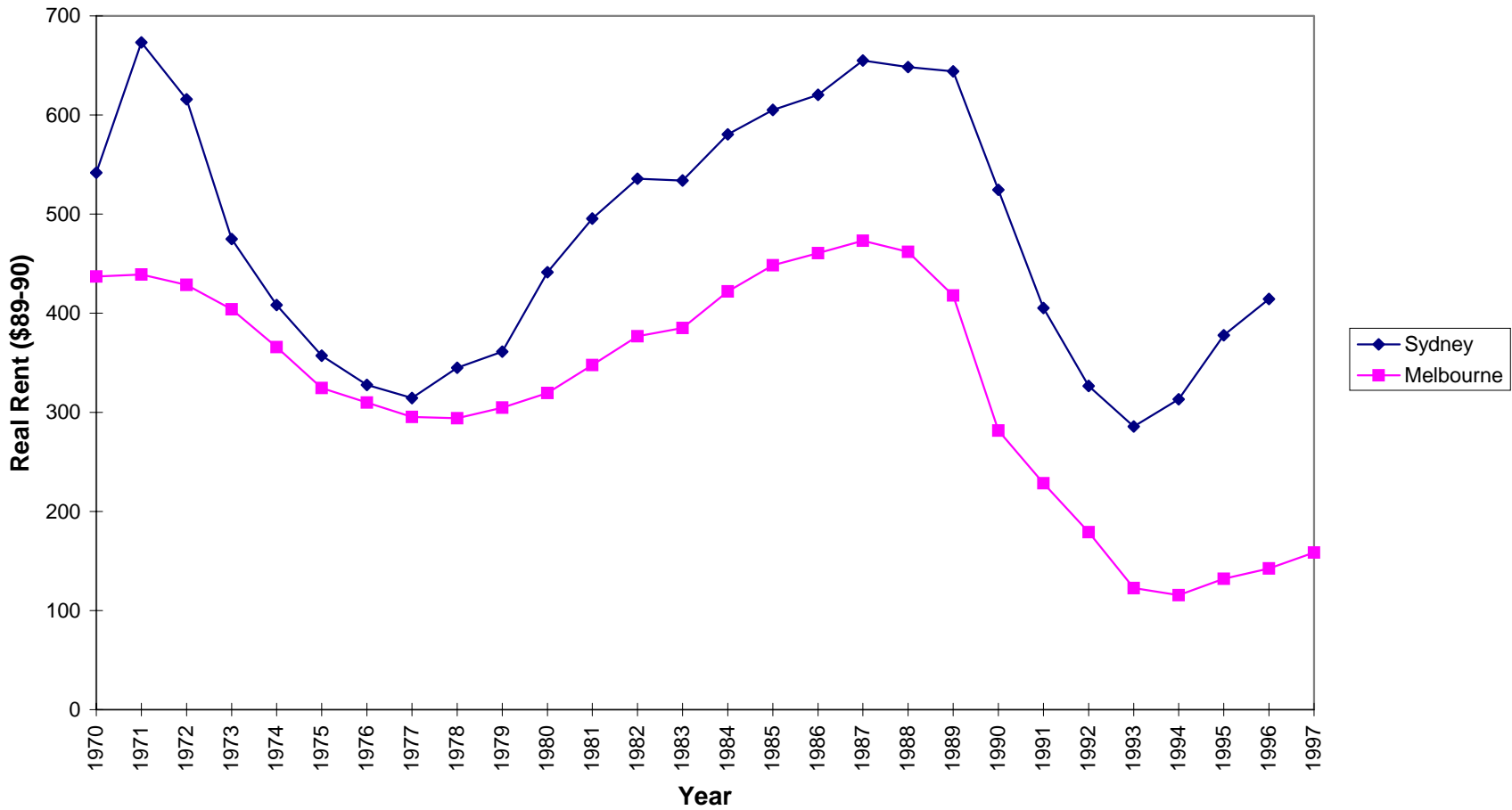
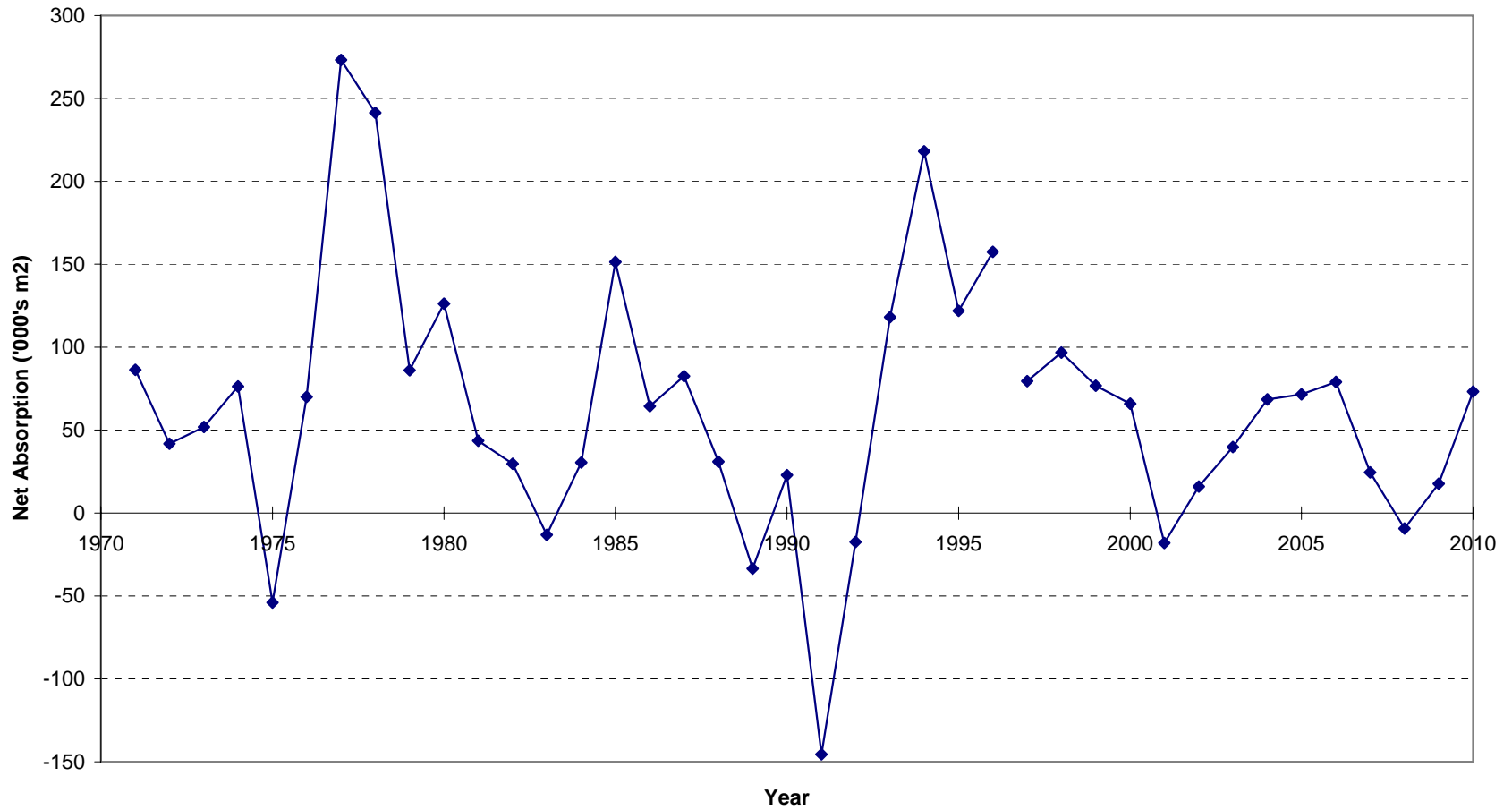**Figure 5: Net Absorption Sydney CDB 1971-96 with Forecasts 1997-2010**

Figure 6: Net New Supply Sydney CDB 1971-96 with Forecasts 1997-2010
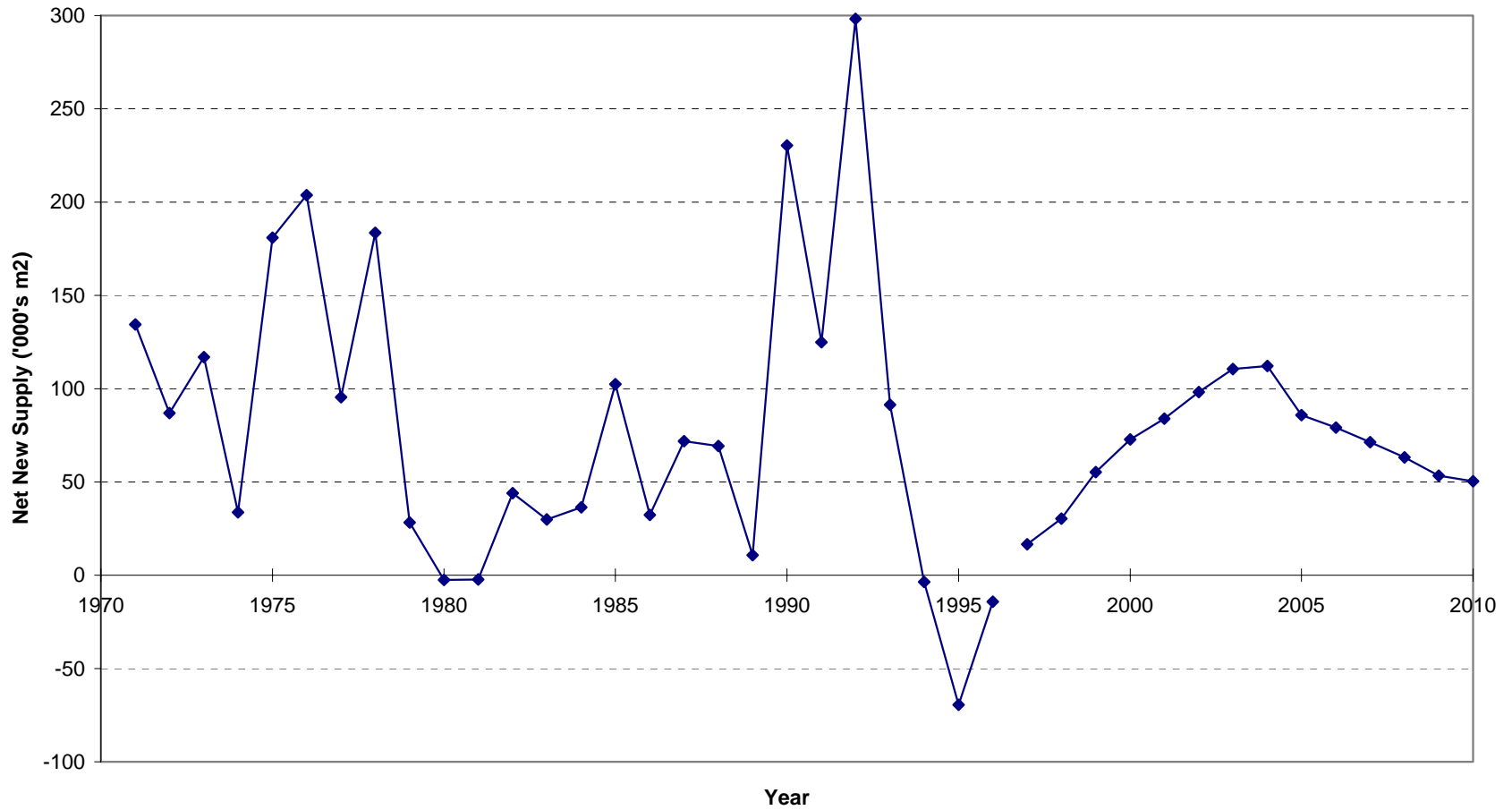
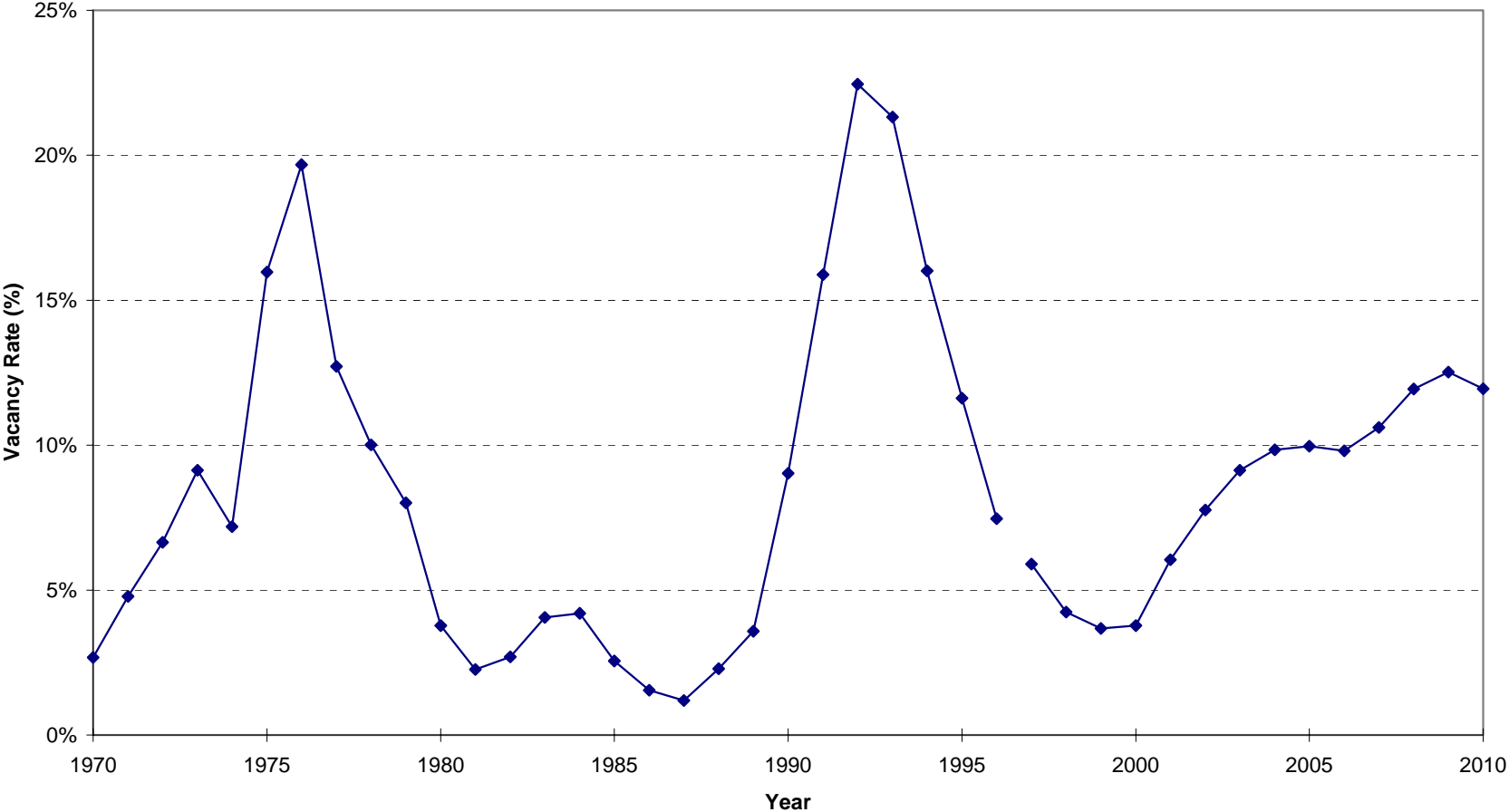**Figure 7: Vacancy Rate Sydney CDB 1970-96 with Forecasts 1997-2010**

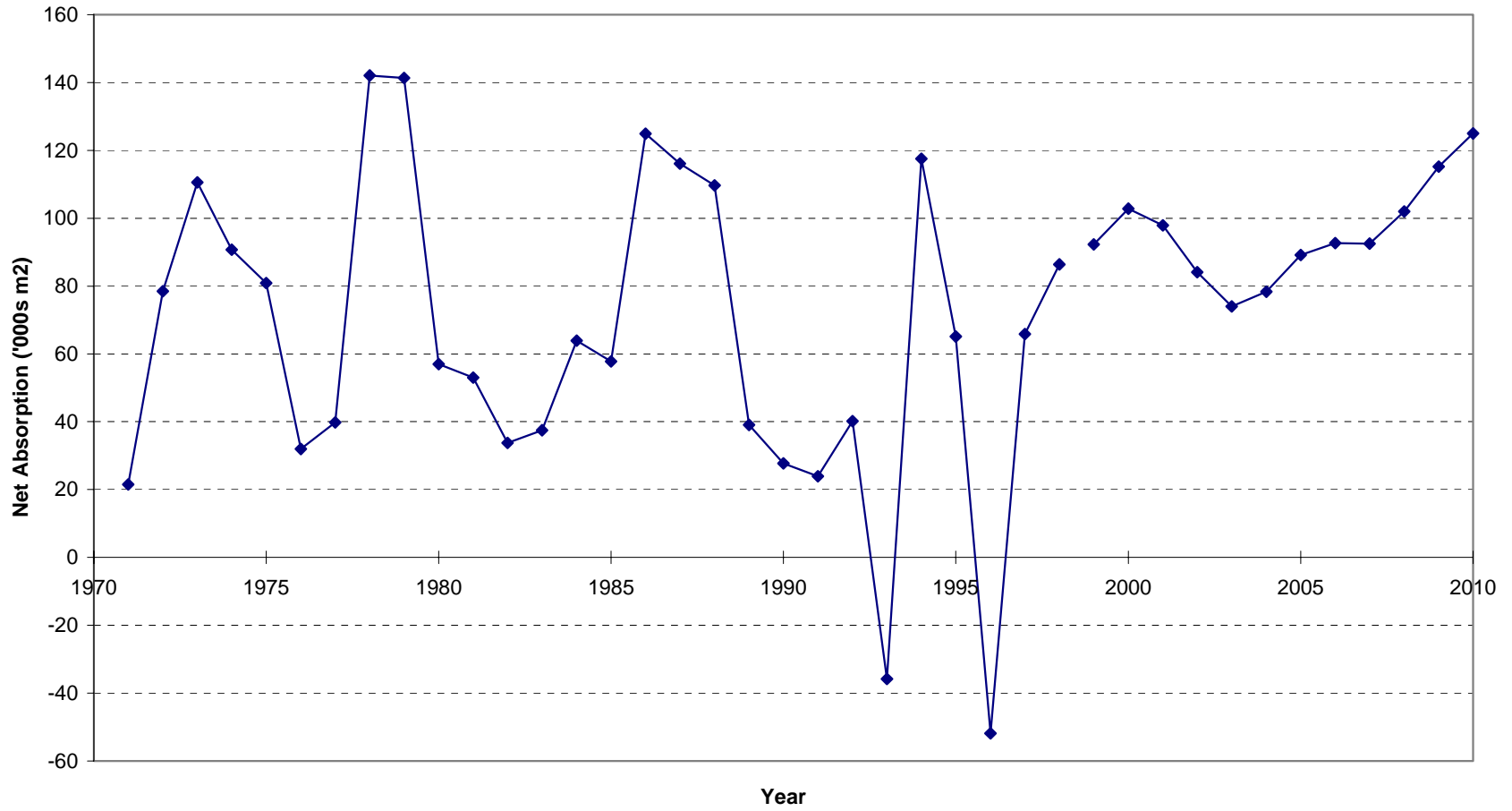**Figure 8: Net Absorption Melbourne CDB 1971-97 with Forecasts 1998-2010**

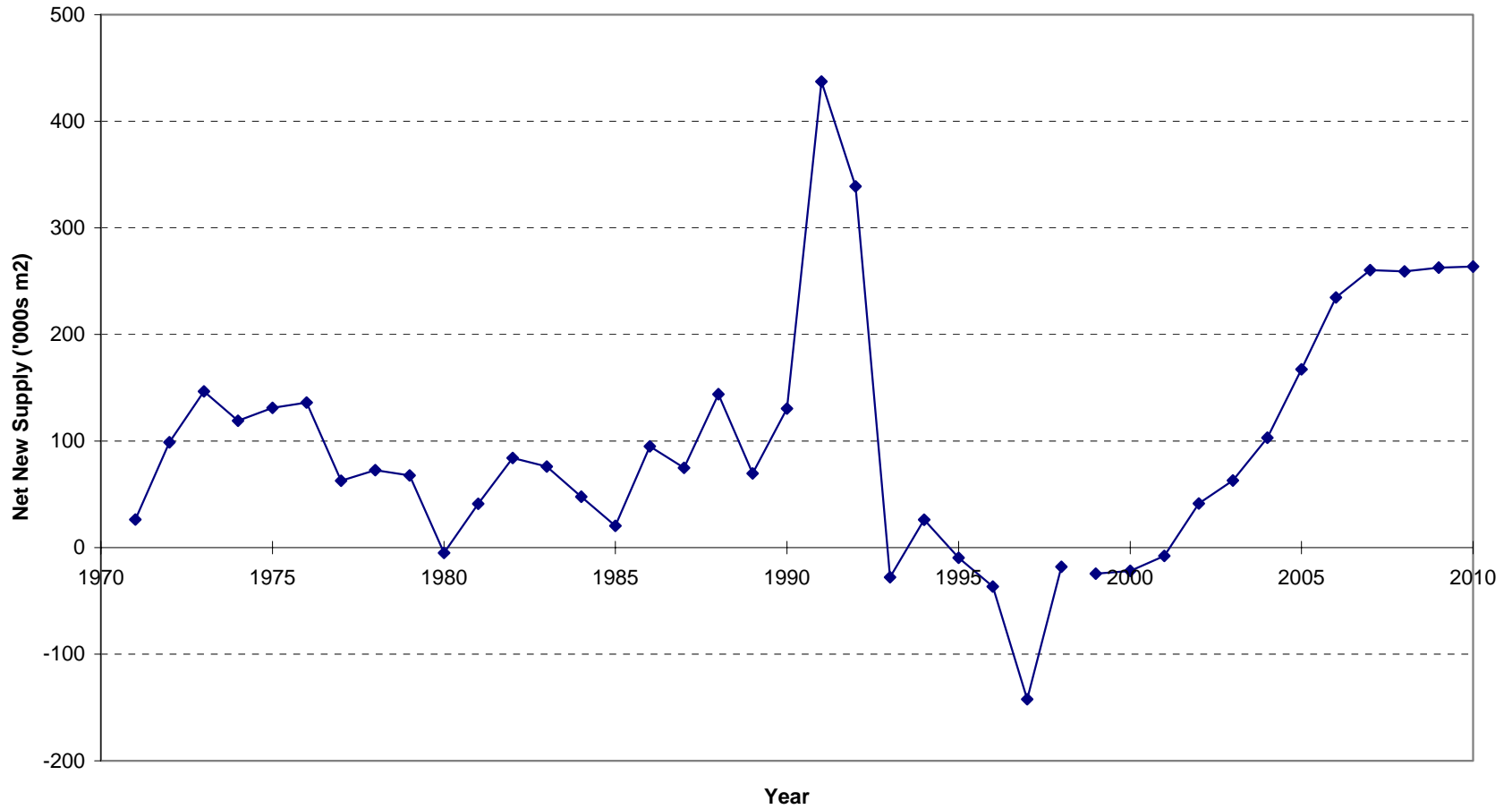**Figure 9: Net New Supply Melbourne CDB 1971-97 with Forecasts 1998-2010**

Figure 10: Vacancy Rate Melbourne CDB 1970-97 with Forecasts 1998-2010