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PROPERTY PRICE AND VALUATION MODELLING
(SYDNEY – 1970 TO 2000)

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ABSTRACT

This paper sets out to develop a model of house prices for Sydney and to analyse the risk associated with house prices in individual sectors, represented by Local Government Areas (LGA's). The possibile methods of undertaking such an analysis are discussed and a number of models are reviewed. Initial analysis using ABS published data is undertaken at a city wide level. An analysis of the relationship between price changes, population and income is carried out at an LGA level. An analysis of the relationship between house prices and the Consumer Price Index is undertaken.

Risk is considered to be a function of the way change in a sector relates to change in the market as a whole and is measured using the beta for the LGA with respect to the market. The betas obtained when analysed on a quarterly basis are further from one and suggest that there is not as close a relationship between movements in the market and in LGA's in the short term. When analysed on an annual basis the betas are relatively close to one and suggest short term movements are more haphazard but are smoothed out over time. The increased correlation with the market when analysed on an annual basis as opposed to quarterly basis may indicate that the risks are greatly reduced over the longer term.

INTRODUCTION

General objective

The purpose of this paper is to examine the possibility of developing a usable valuation model which allows prediction of property prices based on social and economic variables after accounting for risk. The method discussed has three elements. Firstly the influences of the wider economy are taken to account within an econometric model at a city wide level. Secondly an adjustment is made to account for risk by adding a beta value determined using the Capital Asset Pricing Model at a local government level. Whilst it is not undertaken in this paper it is intended that the next step would be to build in an hedonic model to allow and adjust for property specific attributes.

It is also possible that by being able to determine a predictable median price for a certain sector or location that the reliance on the need for individual property valuations can be reduced.

The principal criticism of the comparable sales method is that it allows valuation errors to be compounded since short term changes in market conditions, which may not be underpinned by fundamental long term changes, result in changes in valuations. These supporting valuations may then help to perpetuate and exacerbate the effects of a short term change. This systematic compounding causes market fluctuations to be larger than they perhaps should be if valuations were carried out with reference to a broader range of factors other than just recent sales of comparable assets.

When the true economic and social factors which primarily determine values change, or are predicted to change, this should give us an immediate change in property valuations rather than waiting for them to be reflected, often too late, in actual sale prices. As a result it is relevant to look at links with variables such as, income, population changes, interest rates and the CPI such that changes or predicted changes in these variables can be translated into possible changes in property prices. Whilst the difficulties associated with this form of measurement and forecasting are acknowledged the view is taken that attempts should be made to overcome them as far as possible.

In this paper it is assumed that an asset's value is the present value of all future benefits discounted by the sum of the risk free rate and the asset's risk premium rate. The risk premium can be indirectly estimated by determining the historical standard deviation of return in excess of the standard deviation of the (risk free asset) market return. Future benefits consist of all estimated future cash flows derived directly or indirectly from the ownership of the asset. This concept is integral to the need to formulate a valuation method which is based on an estimate of future value adjusted for risk. This future value can only be estimated however by analysing the underlying historical relationships between value and those factors which may influence it. Future

benefits can be better understood and estimated through an understanding of the historical relationships.

The model which this paper sets out to develop is intended to be an estimate of future benefits based on the influence of social and economic variables, adjusted for risk. It suggests that this can then be extended to incorporate the influence of property specific benefits by incorporating a further hedonic model.

LITERATURE & DATA SURVEY

Regression - Background and literature

Many papers have been written within the property industry making use of regression to analyse data, of which one of the earliest examples in Australia is 'The Valuer and Computer Mass Valuation by Use of EDP Methods an Experiment in Victoria'(McGlade A.J. (1971). Perhaps, as a result of the increasing availability of computers and their increasing capability, the considerable quantity of research and analysis taking place in the finance world flowed over into property and, particularly from the late eighties to the present, perhaps the greatest portion of articles published in professional and research journals make at least some use of regression analysis. It is used almost universally where data analysis is undertaken between related variables or information. Many of the papers and theses however use regression to analyse the relationship 'within' the context of the comparable sales method. The models developed are hedonic models, that is, they use sales data to predict the effect on price of different attributes of a property. Examples include 'The Application of Personal Computers to Direct Comparison Valuation' (Fibbens 1993) or 'The Effect of Residential Investment on Nearby Property Values: Evidence from Cleveland Ohio' (Ding, et al, 2000).

Apart from a paper by Oluwoye & Higgins (1999) in which they "examine whether the determinants of aggregate house prices...are linked to financial and economic activity" there appears to be a dearth of research within Australia, attempting to link macro-economic or socio-economic factors to property values.

A paper by Mitchell(1993) would appear to be one of the few detailed studies of the relationships between economic variables and property value. Mitchell identified 'six macro economic factors as influencing residential house prices in New Zealand between March 1970 and June 1991.' Mitchell(1993) identified inflation, real disposable income, real interest rates and consumer confidence as critical economic factors influencing demand for residential property.

The focus of this paper is on residential house prices as these are considered to be relatively stable as far as improvements to land are concerned. Since data on the sale prices of unimproved land is not available in sufficient quantity or adequate quality it is assumed that the

qualitative nature of residential houses will change relatively little over time and as such is the closest we will get to an homogeneous asset.

House price indices have been used and analysed by numerous authors and many argue that to ensure homogeneity of the data the repeat sale method is preferable. Generally this method however is dependent upon large quantities of good data over long periods and this is often not available. As a result Hybrid methods which combine hedonic and repeat sales methods have been developed.(Case and Quigley 1991). Rossini(2000) looks at different techniques to analyse the seasonal effects of residential property markets in Adelaide.

In their paper on 'A Comparison of Residential Rental Indices' Hargraves and Chen(2000) compare methods for measuring changes in residential rental levels in a city in New Zealand. The indices compared were median, hedonic, repeat rent, weighted repeat rent and hybrid. They report that 'technically the hybrid method appeared to be the most appropriate, but ....the method was more costly'.

Costello & Elkins(2000) create a quarterly hedonic price index for ten suburbs across Perth to confirm a low number of statistically significant differences and the existence of a 'price size effect' as a determinant of house price change.

Ratcliff(1972) developed a model designed to enable appraisers to "replicate the buyer calculus". That is, to follow the same thinking process that may be followed by a property's potential buyers. It is hoped that by using regression to help understand the historical relationships, we can improve our ability to predict the thinking process of the market as it estimates future benefits to be derived from a property. In doing this the present value of those future benefits can be estimated more accurately.

Risk and CAPM - Background and Literature

To estimate the present value of future benefits we need to apply a discount rate or required rate of return. This discount rate will be a composite of the risk free rate and a risk premium rate. In analysing risk and the risk premium it is intended to focus on the Capital Asset Pricing Model (CAPM).

"The CAPM defines risk as the co-variability of the security's returns with the market's returns. We can also say that risk is the volatility of the security's returns relative to the volatility of the market portfolios returns". In the CAPM "risk is labeled beta. Beta can replace variance as the measure of risk because we are assuming that investors will hold only diversified portfolios" (Harrington, 1983).

The CAPM is defined as;

$$E(r_i) = r_f + b\,(E(r_m) - r_f)$$

Where: $E(r_i)$ = Expected rate of return on the asset
r_f = Risk free rate
r_m = Market rate of return
β = Beta

Draper and Findlay (1982) comment that "variance (or it's square root, standard deviation) is the most frequently used measure of dispersion(which is, in turn, commonly interpreted as risk). Variance of return is defined as;

$$s^2 = E(R_a - R_m)^2$$

where m = market and a = the individual asset.

An early example using the CAPM in a property context, is 'The value of Houses as a Capital Asset' (Zaima (1980).

Baum (1989) suggests a definition of risk as "the possibility that a return will not be as expected". The proxy for the possibility that return will not be as expected is the historic volatility of returns, measured by the variance or standard deviation of those historic returns.

Blundell(1986) used standard deviation of historic returns. Baum(1989) argues that this seriously underestimates the riskiness of large properties largely citing the poor data quality in comparison to stock market data which is based on actual trading prices.

Ward et al(1998), comment that "The Capital Asset Pricing Model implies that the expected return on any asset depends on only one type of risk attached to holding that asset. ...It can be seen as an economic analysis of market behavior.... The model is expressed in the following terms... the expected return on any asset depends on a) the risk free rate, b) the expected return on the market portfolio (or market index) and c) the systematic risk of the asset. The systematic risk component implies that the only type of risk which has to be paid for by higher returns is a component of total variability of the assets returns. One can only estimate the amount of risk by analysing the relationship between the returns of the asset and the returns of the index".

Baker(2000) defines risk in terms of his model as;

"Risk of LGAi = change in return for LGAi as the market changes/total risk of the return on the market.
The above will incorporate both systematic risk and unsystematic risk. Unsystematic risk will have a distorting effect on the conceptual purity of the calculation." He argues that as the analysis is conducted on an LGA level this will achieve a partial portfolio effect and as a result

reduce the unsystematic risk. By conducting the analysis at the LGA level it may be argued that the variations in return and hence value would be reduced to systematic variations for the relevant LGA.

By looking at the variation in the market and comparing it to the variation in a sector or LGA the difference in the systematic risk for the city and systematic risk in the LGA can be identified.

Baker(2000) points to capital budgeting approaches and in particular the CAPM, as the more appropriate method of analysing investment decisions. He points to the rather simplistic and hollow nature of the popular 'how to' approaches to investment, then looks at the traditional financial approaches which typically use return on investment to measure performance after the event. In presenting his argument in favour of "modern capital budgeting" he states "investment appraisal must adopt an 'ex ante' - forward-looking analysis - as distinct from the backward looking focus of the traditional financial...approaches".

Baker goes on to analyse the history, flaws and benefits of the CAPM then adopts it to residential real estate investment.

The focus of this paper is to make a similar argument with respect to the valuation of property(and by extension all) assets. That is, that the value should be determined by establishing the present value of future benefits.

The Capital Asset Pricing Model is traditionally used to determine the expected return on an asset. As return is an integral part of value and the model takes account of risk, it is considered to be an essential element in analysing property values.

Other Measures of Risk

Risk is generally defined as the variability of future returns. The most common measure of this variability is the standard deviation and it's square the variance.

Other measures include the Semi Variance which Markowitz developed on the assumption that investors were more likely to be concerned with returns below some target value.(Brown & Matysiak 2000). Mean absolute deviation(MAD) is calculated by ignoring the signs of the deviations. Lower Partial Moments recognizes that skew-ness is important when making investment decisions, if an asset has a greater positive skewness of its returns it would be preferred. This method assumes underperformance to be a more important issue than overperformance.

Sharp(1985), Treynor(1965) and Jensen(1969) each developed risk adjusted measures of performance.(Brown & Matysiak 2000). The Sharp ratio is estimated by calculating the ratio of the average risk premium for a portfolio divided by it's total risk. It is used for ranking

performance of diversified portfolios. "The Treynor index also measures desirability but uses systematic risk instead of total risk, and is calculated from the following:

$$T = (r_m - r_f) / b$$

Where r_m is the market rate and r_f is the risk free rate.

The Jensen measure takes the security market line to focus on abnormal performance.

METHODOLOGY

The Data Sources and Analysis

The availability of data on Sydney house price transactions is relatively limited other than through a small number of commercial organizations who provide services to subscribers including Estate Agents, Valuers and Banks. These organizations in turn obtain most of their data from the Valuer General's Department who obtains its data from the Land Titles Office. The information at the Land Titles Office comes from the lodgment of documents associated with the sale of properties generally carried out by Solicitors or Conveyancers. The data is now entered on a computerized database however the process of computerising the records did not commence until the nineteen eighties and it is reasonable to assume that information relating to the period prior to this is limited.

The primary data used in this work was obtained from Residex Pty. Ltd. for six Sydney Local Government Areas (LGA's). As only six LGA's were available they were selected on the basis that they represented a reasonably good geographic and demographic distribution so as to mirror the Sydney market as a whole, as accurately as possible. Transactions went back as far as 1968 however it was not until the 1980s that transactions recorded exceeded more than a hundred or so per LGA per quarter. After 1980 the number of transactions recorded per quarter were more than a thousand and this is more likely to represent the bulk of sales in the particular LGA's. That is, the data for the seventies is not likely to be representative of the market at that time. From an initial database of approximately five hundred thousand, approximately three hundred and sixty thousand were found to be usable, including some back to 1970. The data not used had missing details such as price, suburb or sale date.

The variables included in the data obtained were as follows; street, suburb, sale date, lga, postcode, a grid position/reference, unit number, zoning, vacancy, area, no. of bedrooms, no. of bathrooms, garaging, owner, and sale price. For many of the variables the data was incomplete.

Socio Economic Data, obtained from the ABS was analysed over 5 census periods against median property prices for each of the six LGA's. The LGA's used were Ryde, Warringah, Canterbury, Rockdale, Black town and Campbelltown. As mentioned above, these were

chosen so as to reflect the Sydney market as accurately as possible. The data was sourced from ABS publications and CD's the later of which are readily available at most libraries. The boundaries for Warringah changed after the 1981 Census and as such the population for 1976 and 1981 was estimated.

Initially, average and median sale prices were determined for each LGA for each quarter using the data supplied by Residex.

Betas were determined for each LGA. These were calculated firstly by allowing the risk free rate to be estimated from the data, then using the ten year bond rate and then the ninety day bill rate for the period 1980 to 2000.

The average house price data was considered to be dubious due to possible outliers which were unreasonably effecting the results. Therefore the focus of the analysis switched to median prices.

Median sale prices were determined for each LGA for each year from 1970 to 2000 and betas estimated using the six LGA's as the 'market'. The betas were determined using Excel which requires an adjustment to the calculation of the Covariance as it uses n-1 instead of n.

Repeat sales were analysed to give an index of price changes from 1970 to 2000 on an annual and quarterly basis. Betas were also calculated using these indices.

Aspects of Risk and Variability within a Sector or LGA.

This paper sets out to develop an econometric model of house prices for specific LGA's adjusted for risk using beta from the CAPM. It is important to ensure that the relationship between the LGA and the market is carefully defined so that the riskiness, as measured by the beta, of the LGA or sector is correctly determined.

So why is the variability of prices within a group, sector or LGA important? If within an LGA prices move closely in line with the market then within the context of the CAPM we are saying that it has little unsystematic risk. That is, the capital gains in this LGA will closely parallel the market and as such we can focus on factors which affect the market as a whole rather than sector/LGA specific factors.

If actual sale prices are highly variable within an LGA, for example if there are a few multi million dollar waterfront homes and some run down workers cottages worth say two hundred thousand dollars then it could be argued that regardless of the LGA's beta, there may be a high degree of variability, riskiness in the price of these upper, lower end and 'different' properties. This will certainly be the case and the use of an LGA's model to analyse properties which are quite different from the median property (ie. outliers) may be incorrect. It may be possible for example to identify the upper quartile or lower quartile in an LGA and to analyse this against the

market as a whole. Perhaps in an ideal world the 'components' as used by the Valuer General could be identified and analysed. In this paper the focus has been on the LGA's however any set or subset of the market could be used, provided they have sufficient quantity of data, and generally such subsets are referred to as sectors.

Regardless of how a particular set of properties is defined ,to correctly analyse such properties, they should be selected as a pre-defined group and their beta calculated as a group across the market. For example if we seek to identify the value of a waterfront home at Balmain we should not establish the beta of Balmain but rather the beta of Sydney and Parramatta river waterfront homes as a sector.

It is notable that a single property may variously fall into more than one sector depending on what is being analysed. However when doing the analysis we should ensure that the property doesn't fall into more than one sector for which a beta is being calculated. That is the median house price for Balmain should have a beta calculated against Sydney prices and separately waterfronts in Balmain would be included in a group of Sydney Harbour waterfronts which would have a beta determined by relating that group back to median prices for the rest of Sydney as a whole.

Given the data currently available this sort of analysis is not possible. As a result, we should restrict our assumptions and conclusions regarding the riskiness of an asset within an LGA or sector to assets not too far from the median asset value, say where the model value being estimated for a property is within half a standard deviation of the median value. Alternately it may be considered more appropriate to exclude anything where the model value falls within the upper or lower quartile for that sector. It is not suggested here that whether or not a property can be included or excluded for the purpose of analysis is readily able to be defined and this may be a matter of judgment when the analysis is done.

When attempting to use the model we must ensure that we use it in context and that assets which fall outside the 'norm' for the sector which we are comparing against the market are not analysed using the model for that sector. An asset should be reasonably typical of the sector for the model to be applied to it. The identification of properties in our data which are not typical may be difficult however when assessing the riskiness of an individual property we will usually be aware of the nature and usage of the property. If it is not typical or normal, a separate model should be developed for the sector into which it falls. For example if we have a median value in Rockdale of $280,000 and we wish to determine the 'model' value of a residential three bedroom home that may be worth $260,000 to $300,000 then we can use the beta for Rockdale and the model. If we wish to determine the 'model' value of a property which may be worth around $280,000 but is approved as a child care centre and substantially altered, although still zoned residential, we should not expect to be able to apply the model for Rockdale LGA. We should of course apply a model developed from records of all child care centre sales in the Sydney region. The same principal would apply to a waterfront mansion in the Rockdale

LGA. These properties would need to be individually assessed if there is a lack of comparables to form a sector or component.

Initial Analysis.

Toward the Development of a Model Based on Macro Economic Variables and Adjusted for Risk Using CAPM.

As part of an initial analysis the change in the average house price(AHP) was regressed against data obtained from ABS publications for a ten year period which included the interest rates, average household income and population changes. When the AHP is regressed against interest rates, average household income and population change, an R squared of approximately 63% results. The t and p statistics for the model bring into question the significance of the results. Details are as follows;

YEAR	INT %	AHI%	POP %	AHP%
87/88	11.95	8.5	1.7	11.1
88/89	13.5	6.4	1.8	32.7
89/90	13.4	6.7	1.5	8.5
90/91	11.7	3.4	1.3	0.8
91/92	8.9	1.7	1.2	3.8
92/93	7.7	3.5	1	1.3
93/94	9.63	4.5	1.1	2.9
94/95	9.21	4.7	1.2	3.2
95/96	8.88	3.9	1.3	0.1
96/97	7.05	3.6	1.2	2.1
97/98	5.58	4.1	1.1	6.7
98/99	6.27	2.4	1.3	6.2
AVE	9.48	4.45	1.31	6.62

Where: INT represents interest rates and is the ten year bond rate.
AHI is average household income.
POP is population
AHP is the Average House Price

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.793314
R Square	0.629348
Adjusted R	0.490353
Standard E	6.321675
Observatio	12

ANOVA

	df	*SS*	*MS*	*F*	*Sig F*
Regresn	3	542.848	180.9493	4.527856	0.038923
Residual	8	319.7086	39.96358		
Total	11	862.5567			

	Coefficients	*St Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-32.2088	11.33974	-2.84035	0.0218	-58.3583	-6.05933
INT	-0.46241	1.143549	-0.40436	0.696541	-3.09944	2.174621
AHI %	-0.22221	1.514723	-0.1467	0.886997	-3.71517	3.270747
POP %	33.78218	13.47189	2.507605	0.036507	2.71593	64.84843

The Model predicted is as follows;

$$\Delta AHP = -32.2 - 0.462_{i} - 0.222_{ahi} + 33.782_{p}$$

which will , at best, provide just moderate forecasts of movements in average house prices.

Initial analysis for the calculation of betas.

Data has been analysed by the sixteen Residex Sydney regions. The Sydney wide data has been analysed to obtain the beta of each region.

BETAS BY RESIDEX REGION(PERIOD 1989 TO 1999)

(USING 10YR BOND AS RISK FREE RATE)

REGION	*COVAR*	VAR-SYD	BETA
SYDNEY	0.004803	0.004803	1
INNER S	0.003829	0.004803	0.797087
EAST-S	0.005991	0.004803	1.247255
INNER W	0.005288	0.004803	1.100853
LOWR NS	0.004271	0.004803	0.88922
UPPR NS	0.005046	0.004803	1.050413
NBAY/SPT	0.006393	0.004803	1.330844
M/WAR	0.005858	0.004803	1.219538
NTH WST	0.005561	0.004803	1.157722
WEST	0.004791	0.004803	0.997397
PMATTA	0.004539	0.004803	0.944975

LIVERP/F	0.003797	0.004803	0.790453
C/BANKS	0.004778	0.004803	0.99461
STGEORG	0.005206	0.004803	1.083735
CRON/S	0.004584	0.004803	0.954304
C/TOWN	0.003843	0.004803	0.800005
PENRITH	0.003072	0.004803	0.639603

Using the Capital Asset Pricing Model we can model change, or return, by region as follows;

$$\Delta AH\,\mathrm{Pr} = R_f + b_r * (\Delta AHPm - R_f)$$

Where; $\Delta AH\,\mathrm{P_r}$ is the change in the average house price of the 'Residex' region
R_f is the risk free interest rate, 10 year government bonds.
b_r is the beta for the Residex region
ΔAHP_m is the change in average house price for the whole Sydney market.

By putting both equations together as follows;

$$\Delta AHP_m = -32.2 - 0.462_i - 0.222_{ahi} + 33.782_p + e_1$$

$$\Delta AH\,\mathrm{P_r} = R_f + b\left(\Delta AHP_m - R_f\right) + e_2$$

we get;

$$\Delta AH\,\mathrm{P_r} = R_f + b_r\left(\left(-32.2 - 0.462_i - 0.222_{ahi} + 33.782_p + e_1\right) - R_f\right) + e_2$$

The above combined macro and CAP (Macro/CAPM) model could be used to estimate the change in regional or sector house prices and includes and adjustment for risk. By building on an hedonic model which analyses specific attributes for a sector we may be able to obtain an estimate of an individual property value.

ANALYSIS OF SALES DATA FOR SIX SYDNEY LGAs

Models at a Local Government Area Level

Using ABS data for five census periods, models were developed for six LGAs using firstly population and individual income then income only as the independent variable(s.) The population data was generally very stable for the established areas.

In the areas which were experiencing rapid development and subdivision, particularly Campbelltown and Blacktown the population was growing fairly rapidly however it is easy to assume that subdivision was rapidly increasing the available land suitable for residential homes and this along with other demographic factors made the relationship between residential land values and population changes too dynamic and complex to be readily analyzed. These issues led to the dropping of population as an independent variable.

The correlation between CPI and income was determined. From this it was found that there is a very high correlation existed between the two variables.

CORRELATION BETWEEN INCOME AND CPI(1976 to 1996)

RYDE	90	0.9987
WARRINGAH	91	0.997
CANTERBURY	138	0.9995
ROCKDALE	142	0.9925
BLACKTOWN	214	0.9505
CAMPBELLTOWN	218	0.9874

There may be several reasons for this, the most notable being the link enshrined in industrial relations law and wage negotiations generally, between the inflation rate and incomes. It is also important to note that this link has weakened in recent years and may not be as strong now. Never-the-less the correlation for the established areas were above 99% and only as low as 95% for the newer developing areas. Whilst the relationship was not as strong when the relative changes were analyzed it was felt that the relationships were strong enough to allow inflation to be used as a proxy for income and this is explored later.

The consistency of the regression statistics and the coefficients through all of the areas suggests that when taken as a whole there is a strong relationship between income and median house prices as well as between the CPI and incomes.

STATISTICS FOR LGA MODELS (INCOME AND MHP)

		RYDE	WARGA	CBURY	RDALE	BLACKT	CAMBTN
R SQUARED		0.92527	0.96232	0.91526	0.91345	0.91856	0.94359
ADJUSTED R SQUARED	0.90036	0.95097	0.88702	0.8846	0.89141	0.91538	
ST ERROR		27995.4	22609.1	23547.2	27315.5	13120.9	10462.6
INTERCEPT COEFFICIENT		-31700	-25557	-55810	-30492	-5291.8	-11443
INCOME COEFFICIENT		12.6389	13.5938	16.3118	13.3737	7.28286	6.9013

The results for the absolute values showed high R^2 with the lowest being approximately 91%. This suggests that the model explains almost all of the changes in median prices with regard to income. The t and p statistics suggest in each case a very high level of significance. As a result it may be assumed that the median house price for a particular area is closely linked to the individual income of residents of that area. The coefficients with income for the established areas range from 12 to just over 16 and for the developing areas around 7. The intercepts for the established areas, that is Ryde, Warringah, Rockdale and Canterbury, fall between -$25,000 and -$56,000.

It is apparent that as income rises the marginal propensity to spend on housing increases. For every extra dollar earned in Campbelltown or Blacktown house prices increase by approximately seven dollars however if that dollar is earned in any of the other LGA's it results in an increase in house prices of more than twelve dollars. It may be suggested that where areas have a higher income per person there is a higher propensity to invest in property as income rises. This is consistent with economic theory which suggests that savings increase as income increases. It also reinforces the socio-economic identification of regions. Whilst more may be done to investigate this relationship it is reasonable to suggest that income is a major factor in influencing local house prices.

It is arguable that if the median price in an area moves above the value predicted by the model, prices in that area may be above the sustainable long term value. Perhaps investors should be wary of investing at high levels and lenders should be extra cautious about lending.

It may also be assumed that a high portion of any increase in an individual's income will end up in residential property assets. As consumption choices are generally limited and basic consumption choices are satisfied first spending on residential property will usually be a form of saving. As income increases the marginal propensity to save will increase and hence it is likely that the portion of additional income invested in residential property will increase as income increases. This may also help to explain why the models generally have higher income co-efficients' in areas where absolute income is higher.

When the changes in income and house price are analyzed the relationship is almost non existent however it is reasonable to suggest that given that the data was at five year intervals any lags which overlap the interval dates would result in a low correlation between changes in income

and changes in median house prices. Perhaps if the data were available at a greater frequency the correlation would be higher.

To assess this the median house price was regressed against the consumer price index for the thirty years over which the data extended.

The Relationship between Median House Prices and other Macro Variables, particularly the CPI

There is a very high correlation (r = 0.9598) between the Marginal House Price Index(MHPI) and CPI when analyzed in absolute terms however a very insignificant relationship (r = 0.009138) when changes by quarter are analyzed. This might suggest that whilst they may move in the same direction and fairly consistently over time, the link is not direct and is far from instantaneous.

ANALYSIS OF ABSOLUTE VALUES OF MHP AND CPI

	CPI IND	*ACT MHP*
CPI IND	1	
ACT MHP	0.959814	1

SUMMARY OUTPUT

Regression Statistics

Multiple R	0.959814
R Square	0.921243
Adjusted R Square	0.920587
Standard Error	15926.28
Observations	122

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	3.56E+11	3.56E+11	1403.679	4.53E-68
Residual	120	3.04E+10	2.54E+08		
Total	121	3.86E+11			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-12439	3143.652	-3.95686	0.000129	-18663.2	-6214.79
CPI IND	1459.701	38.96099	37.4657	4.53E-68	1382.561	1536.841

The analysis above suggests that for each one unit increase in the CPI index house prices will increase by approximately $1460. As the CPI basket of goods includes housing it is important to note that the correlation may be driven by the influence of housing prices on the CPI. It is therefore necessary or relevant to be cautious in drawing conclusions about the future direction of house prices based on CPI changes. The inter-relationship between the CPI, income and housing prices is significant however as each effects the other it is appropriate to ask, which changes first?

If this chicken and egg issue may be looked at from a common sense perspective it should follow that changes in income over time are reflected in changes in property values which in turn are reflected in the CPI. If prices increase there may be an increase in both wages and company profits. This will feed back into individual income of which a high proportion may flow into residential property increasing prices further. This relatively common inflationary spiral will generally see residential property as the big long term winner.

It also follows that improved economic growth and company performance will flow into higher incomes to individuals, which will in turn flow into residential property. Residential property is more likely to be the destination of increases in income than commercial property since decisions regarding commercial property flow from business performance and profits re-invested into business are invested only if they reach a required rate of return, if they do not they will flow as profits and income to investors and employees. These individuals will then have increased personal income and again a high proportion of this increased income will be invested in their residential home.

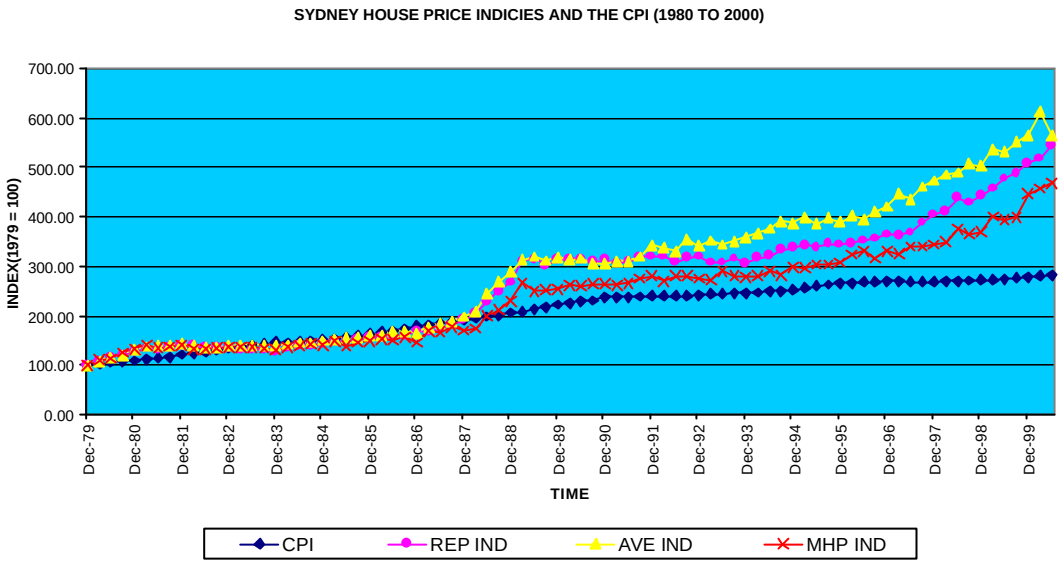
Whilst this may be considered to be an overly simplistic view, and many other factors are at work here, it is an area that warrants further investigation.

The model above indicates that for each additional dollar of income earned by residents of Canterbury the property values of the area have tended to increase by sixteen dollars. It is inconceivable that food or clothing or the cost of cars or holidays could increase by sixteen dollars for each dollar the individual's income increases. This implies a much higher propensity to consume residential property than to consume other goods or services. Competition for property is substantial and this relationship suggests that the residential home is of much more importance to individuals than other consumption options.

Since the marginal utility of most other consumption options will diminish to nil substantially sooner than it will for residential property and since residential property is a transferable asset, it is possible that the majority of the wealth of a society will ultimately be represented by the aggregate value of its residential property.

As discussed above, given the close historical relationship between income and the CPI it is assumed that the CPI can be used as a reasonable proxy for income. When comparing the MHP with the CPI we find an R squared of over ninety percent when the absolute values are regressed. The t and p statistics suggest that the relationship is highly significant. However when the changes in the CPI and MHP are compared we find a very low correlation and an insignificant relationship. It is apparent upon inspection of the data and graphs that the CPI moves along fairly steadily over time however the MHP is significantly more volatile. This seems understandable in that the CPI is a statistical measure compiled from a wide basket of goods which is likely to cause it to be naturally smoother. This basket of goods includes housing which makes up approximately 16 percent of the total. It is also apparent that over the last decade the CPI and MHP have diverged with the MHP increasing at a greater rate then the CPI. It is

notable that there also appears to be a divergence between income and the CPI over the last decade, or at least for the last census. The graph below illustrates these points by showing the MHP index, repeat sales, average sale prices and the CPI.



Analysis of House Price Changes Using a Repeat Sales Index Model

Repeat sales were analyzed to estimate price changes on an annual basis. These changes were relatively close to the results given by the median analysis and indicate a consistency between the repeat sales and median data over the long term. The principal criticism of median data is that it may not be of constant quality.

One of the criticisms of repeat sales analysis is that it is likely to be weighted toward properties which have a higher turnover or churn. Clapp and Giacotto(1992) note that datasets comprising only repeat-sale transactions are likely to be over represented by frequently traded properties.

In NSW property transactions attract a stamp duty of more than 2 percent and this limits the viability of holding properties for a short period even where development or renovation may take place.

For the period 1980 to 2000 it was found that the correlation between the annual repeat sales and median indexes was over 93%. The repeat sales data had a slightly lower mean and slightly lower standard deviation however overall there is no significant difference between the repeat sales and median results when analysed on an annual basis.

When repeat sales data was calculated on a quarterly basis the analysis showed a lower variance and higher co-variances for Sydney and the LGA's when compared to the median data. This gave beta values ranging between 0.75 and 1.13. (See appendix 2). Whilst these values are not as close to one as the yearly values they indicate a closer relationship between the market and quarterly price movements than did the median data. Although the results may be somewhat bias due to the high number of transactions for Blacktown and Campbelltown they suggest that the more central and arguably more affluent suburbs move slower than, or behind, the market as a whole. That is, a $1000 price increase in the market as a whole will result in a $790 increase in Ryde and a $750 increase in Warringah.

It is still apparent that the short term link between market movement and sector movement is not extremely strong however the repeat sales analysis suggests that there is a reasonably strong link.

Of the data used, over half the transactions were for Blacktown and Campbelltown. These suburbs tend to include cheaper housing and more frequently traded properties. This may tend to over represent these types of properties in the market and as such bias the results. This issue is a limitation in the data used and whilst adjustments may be able to be made to the data set to overcome it, ideally an analysis of all Sydney LGA's would be undertaken in order to develop more accurate and representative beta values.

Using CAPM to Estimate the Risk Free Rate for the LGA's

As a means of looking closer at the veracity of the results at the LGA level, the quarterly data has been analysed using the EVIEWS software to estimate the CAPM coefficients. The resulting coefficient(C2) of the model for each of the LGA's, which represents the risk free rate for the area were fairly close. Campbelltown was the lowest at approximately 6 percent per annum with Blacktown at 9 percent and the highest being Rockdale at just over ten percent. From observation the nine to ten percent range seems to fit reasonably well with the ten year bond rate, particularly from the late seventies through to the mid nineties after which it moved down to around the six percent level.

MODEL:

$$r_{lga} = r_f + b(r_{Sydney} - r_f)$$

$$r_{lga} = br_{Sydney} + (1-b)r_f$$

or

$$r_{lga} = C(1)r_{Sydney} + (1-C(1)) * C(2)$$

	C1	C2	Std Err. C1	Std Err. C2
Ryde	0.186597	0.024478	0.102031	0.005711
Warringah	0.191541	0.025190	0.133291	0.007519
Rockdale	0.199038	0.025594	0.134890	0.007689

Canterbury	0.320316	0.023683	0.094783	0.006339
Campbelltown	0.403688	0.015640	0.094320	0.007200
Blacktown	0.554163	0.022459	0.083787	0.008528

The Analysis of Risk

Using data obtained from Residex P/L, the change in median house prices was calculated on a quarterly basis for a twenty year period from 1980 to 2000 and a beta was calculated for each LGA.

This period was chosen because of the relatively low number of transactions recorded for the seventies and due to a concern that the 1970's data lacked integrity. The total data for the six LGA's was used as a proxy for the Sydney market as a whole. The betas for the relevant LGAs range from approximately 0.22 for Ryde and Warringah to 0.58 for Blacktown for the twenty year period. These figures suggest that there are significant factors particular to the individual LGA's , or with the nature of the data ,which influenced the change in median house values. That is, the changes which take place for Sydney as a whole are not closely linked to changes in individual LGA's in the short term. The traditional wisdom in property markets is that price increases begin near to the CBD and radiate out. That is they begin with affluent suburbs such as Woollarah and Randwick and move outward to middle income suburbs such the Inner West, St George and Warringah then Westward to Homebush and so on. It appears from this analysis that the relationship may be far more haphazard than this. However Blacktown and Campbelltown, when analysed on a quarterly basis, are much closer to one than the other LGA's and this suggests that these outer suburbs relate differently to Sydney wide movements than those closer to the CBD.

The low betas are influenced by low correlation of some LGA's and high variation. When the data is analysed on an annual basis however, we get a significantly different picture. Although there is more variation in the thirty year analysis, when the betas are determined for the twenty years from 1980 to 2000 they are all close to one. This indicates that there is not a huge difference in outcomes between LGA's in the longer term. Being higher than one it may be said that Ryde, Warringah and Blacktown have moved at a greater rate than Sydney where Canterbury, Rockdale and Campbelltown have moved behind or at a lesser rate than the market as a whole.

Perhaps this may be explained by slight changes in emphasis by property consumers with respect to the closer metropolitan suburbs. That is, perhaps the preference has moved from suburbs such as Rockdale and Canterbury to the likes of Ryde and Warringah. This may be explained by the improvement in road transport facilities to the North of the City and a greater focus on leisure which may make proximity to beaches and the like relatively more desirable. Warringah in particular is close to Sydneys Northern Beaches which with more space and 'leafier' suburbs could arguably have become more popular over the last two decades.

Blacktown, as with Campbelltown is a newer suburb, and development and land subdivision may have influenced the results here. It is suggested that the highly dynamic nature of these areas over the last twenty years makes drawing any conclusions somewhat problematic.

Whilst the betas obtained using the repeat sales data were closer to one, the bias toward Blacktown and Campbelltown as a result of their constituting over fifty percent of the transactions brings into question the usability of these results.

As discussed above, it is suggested that by applying this beta to the CAPM with Sydney representing the market, we can estimate the return for a particular LGA after accounting for risk.

CONCLUSION

The work done appears to suggest that there is a close relationship between socio-economic variables and property prices.

At the Local Government level it is apparent that income is a key determinant of absolute property prices in the long term. That is, changes in incomes earned by residents within an area will be reflected in changes in property prices.

There appears to be a reasonably close relationship between the changes in the market as a whole and individual sectors as measured by the LGA's in the short term and this relationship becomes much stronger in the longer term.

It is apparent that at present we do not have adequate data to produce a reliable model that can give a statistical estimate of a properties value based on it's future benefits as determined by socio-economic factors and adjusted for risk. The results however are encouraging enough to warrant further work on the matter, particularly in the area of data collection and data base construction and management.

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