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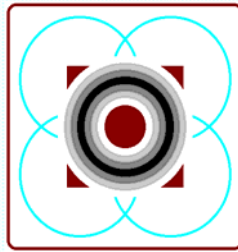# to
Australian Property Institute

Concerning

Residential sales analysis
1988 to 2006

Prepared by:
Dennis Barton
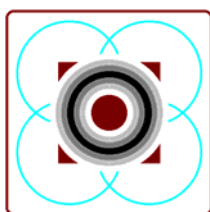
Barton Consultancy

Providing solutions as actuaries, economists, mediators and statisticians.
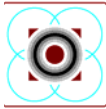
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1   EXECUTIVE SUMMARY

1.1   The Key Question

1.   What effect does heritage listing have on property values? The question arises because while heritage registered properties have intrinsic public value, they are mainly privately owned. There has been concern expressed that private property values may be diminished as a consequence of heritage listing.

2.   The question of the *effect* of listing cannot be answered as it is not possible to conduct "blind" trials involving the listing of randomly chosen otherwise identical properties. All that can be asked is *"Can the fact that a property is heritage listed **explain** the differences in values and value growth between it and otherwise similar non listed properties?"* If this fact can explain the differences, one cannot say whether: -

    a.   listing caused the differences or

    b.   the factors leading to the differences caused the listing.

3.   In other words, while the *fact that* a property is listed may be identified as coinciding with price or price growth trends, it cannot be said that the listing has *caused* the price or value growth.

4.   The Australian Property Institute (WA Division) has sought to answer this question with Western Australian evidence. The Institute has commissioned an empirical study of the sale-price performance of heritage listed residential properties in three suburbs over an 18 year period from 1988-2006. The suburbs are Mt Lawley, Subiaco and Shenton Park.

5.   While the project sponsors and the Institute had contemplated analysis of the effect of listing of commercial properties, it was concluded that there was insufficient evidence to capture all of the non heritage factors that influence the value of such properties. Therefore, the study was confined to detached residential properties only.

6.   Similarly, the Town of Vincent and City of Perth were to have been included in the study, but this was not done due to the unexpectedly low number of relevant house sales.

1.2   Data and Methodology

7.   Sales data for all of the detached house-sales over that period were obtained from Landgate and listing information was obtained from the Heritage Council. In summary: -

    a.   4,027 sales were analysed;

    b.   1,652 of the sales analysed were repeat sales comprising -

        i.   225 listed at the time of sale and
        ii.   1,427 not listed at the time of sale;

8.   Excluded from the analysis were a small number of properties for which the information supplied was obviously erroneous. Also excluded were properties that changed owners within one year. These were excluded because the Institute considered that such sales are likely to have involved significant renovations, rendering "like with like" comparisons difficult.

9.   The project methodology was developed in the light of comparable studies carried out in the eastern states and overseas.

10.   The methodology differed from that of other studies as it was able to relate prices and price growth to the Landgate ValueWatch index and growth in that index. In summary, it involved: -

a.   a regression analysis to ascertain the relative influence on price of heritage listing and a range of factors such as number of bathrooms, number of bedrooms, land area, zoning and so on. The regression seeks to 'disentangle' the influence of heritage listing from other factors and

b.   an analysis which compared the average annual growth rates (relative the ValueWatch index) for the suburbs in question of heritage listed houses that were resold in the study period with non listed houses resold in the period.

1.3   Key Findings

11.   The key findings of the study are: -

a.   taking all the sales in the three suburbs collectively, there is no statistically significant evidence that heritage listing explains differences the price of residential property, or explains differences in the rate of appreciation;

b.   the average annual growth in values of resold properties has been compared with the ValueWatch benchmark. The average annual growth of heritage listed properties in the three suburbs collectively was 2.6% faster per annum than the relevant ValueWatch measure whereas the average annual growth of non listed properties was 2.3% faster than the ValueWatch measure. This finding is, however, not statistically significant.

c.   only in the suburb of Mt Lawley is there evidence that heritage listing is a statistically significantly explainer of price. In Mt Lawley, heritage listed property prices were found to be approximately $35,000 greater than the price of a similar non listed property.

12.   The reason that the findings have been mostly 'not statistically significant' is that the observed differences were so small that they could reasonably have occurred as a result of random fluctuations within a statistical distribution which is common to both listed and unlisted properties. It is only if the differences are so large as to be highly unlikely under a common distribution, that one can say they are statistically significant.

2 INTRODUCTION AND SUMMARY

2.1 Instructions

1. This report is prepared after a meeting between representatives of Institute and the Heritage Council and me in my office on 14 March 2007.

2.2 Summary of Results

2. With the exception of some outliers, obvious errors and sales in quick succession, I have analysed all supplied detached residential sales in Mount Lawley, Shenton Park and Subiaco ("the Subject Suburbs") between 1 July 1988 and 30 June 2006 ("the Subject Period").

3. The statistical analyses that I have performed comprise: -

a. a "t" test for statistically significant differences in average growth in excess of the LandGate index "ValueWatch" and

b. a determination of estimates of sale price and average annual growth in excess of ValueWatch using the statistical process known as "Multiple linear least squares regression".

4. Over the Subject Suburbs collectively, excess growth averaged 2.6% in properties that were listed at sale compared with 2.3% for non listed properties. However, the "t" test indicates this is *not statistically significantly evidence of faster* excess annual *growth of listed properties*. *No individual suburb* experienced *statistically significantly* different excess annual *growth* for listed properties.

5. The "t" test is ignorant of factors other than listing that might influence price or excess growth. The linear regression allows one to separate the contribution of each factor.

6. Over the Subject Suburbs collectively, the formulae that best estimate sale price and excess growth are set out below. Only variables which are statistically significant at the 5% level have been shown in the formulae.

Sale price $			Excess growth per annum			
Constant	(83,880)		**Constant**	1.0000%		
Plus	1.424	times	Sale ValueWatch		times	
			Plus	0.00001777%		Sale price
Less	177.5	times	Sale age	**Less**	(0.007250%)	times	Land area
Plus	14,460	times	Car shelters	**Less**	(0.00001862%)	times	Sale ValueWatch
Plus	26,490	times	Pool	**Plus**	0.03961%	times	Sale age

Sale price $				Excess growth per annum			
Plus	52,770	times	Study	Plus	1.083%	times	Dining
Plus	9,876	times	Family				
Plus	87,500	times	Baths				
Plus	23,580	times	Beds				
Less	625.4	times	Zoning				
Plus	185.6	times	Land area				
Less	104,200	times	Kitchen				
Plus	36,070	times	Meals				
Plus	15,840	times	Dining				

7.   After *allowing for more significant descriptors* of price and growth, there is *no statistically significant evidence that heritage listing influences either price or growth.* This is reflected in the fact that listing does not appear in the table above. In fact, whether a property is listed at the time of sale *ranks 17th in statistical significance out of 20* variables examined as potential *influencers of price*. It should be noted that this variable, while not statistically significant, it is very close to being significant, and would be if fewer decimal places were used in my calculations.

8.   The *ranking* of *listing at sale* is higher (*12th of 21*) as an influence on excess growth.

9.   Whether a property was listed at earlier purchase ranks 7th in significance as an influence on excess growth.

10.   *As written above none of these influences is statistically significant.*

11.   Considering individual suburbs, it is *only in Mount Lawley* that listing is a *statistically significant influence on price*. In this suburb, listing is the tenth most significant influence and it is positive, in the sense that listing at sale is associated with higher prices.

12.   In *no individual suburb* is listing at sale a *significant influence on excess annual growth*.

13.   I have extended the regression analysis to allow for all variables for which data was supplied excluding whether the property was listed at sale and then examined the impact of including that fact. Essentially, this analysis is examining the question of whether the fact that a property is listed at sale is a significant influence on price or excess growth after all other factors have been taken to account.

14.   For *the Subject Suburbs collectively*, listing is *not a statistically significant final influence of price*. This is also individually true of *Shenton Park* and *Subiaco* and *not* true of *Mount Lawley* where listing is a significant final positive influence.

15. In *none of the individual suburbs* was listing a *statistically significant final influence on excess annual growth*. *Nor* is a listing statistically significant final influence on excess annual growth in the *Subject Suburbs collectively*.

16. The following table summarises the observed influences of listing. It describes influences as "positive" if they are to the advantage of the selling owner. It describes an influence as "significant" if one can be 95% confident that it is an influence.

	All	**Mount Lawley**	**Shenton Park**	**Subiaco**
Listed growth compared with unlisted growth in the absence of other influences	Insignificantly positive	Insignificantly negative	Insignificantly positive	Insignificantly positive
Listing at sale as an influence on price after allowing for more significant influences	Insignificantly positive	**Significantly positive**	Insignificantly positive	Insignificantly positive
Listing at sale as the final influence on price	Insignificantly positive	**Significantly positive**	Insignificantly positive	Insignificantly positive
Listing at sale as an influence on excess annual growth after allowing for more significant influences	Insignificantly negative	Insignificantly negative	Insignificantly positive	Insignificantly positive
Listing at sale as the final influence on excess annual growth	Insignificantly negative	Insignificantly negative	Insignificantly positive	Insignificantly positive

2.3   Comments

17. It is the essence of statistical analysis that it can justify neither absolute statements nor statements about causality. It can only determine the likelihood of a particular set of observations under particular hypotheses. Nor can it deal with individual properties; it can only make "global" observations.

18. In aggregate, for the Subject Suburbs collectively and in each suburb, there is no evidence that listing is detrimental to either value or value growth. However, *what is true in aggregate is not necessarily true in individual cases*. This is clearly demonstrated by the following chart, which shows the distribution of annual growth in excess of ValueWatch of listed and unlisted properties and the average such growth for each group. Many properties, both listed and unlisted, experience below average growth.
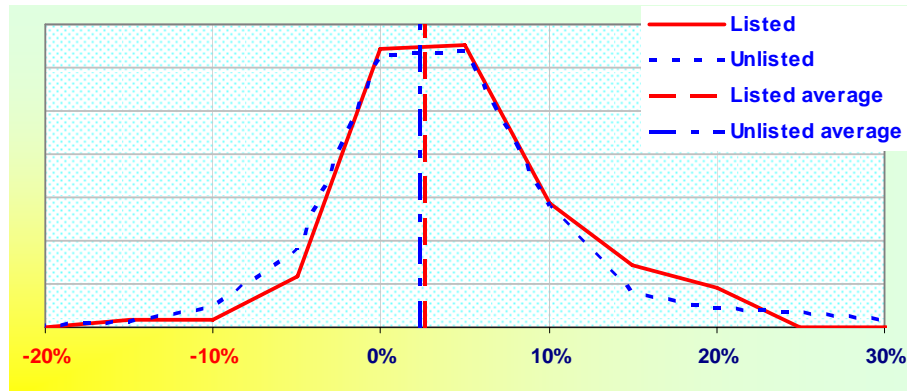
3   BACKGROUND

3.1   Previous Reports

19.   I have previously report to the Institute on similar matters being: -

a.   a report 04067C.doc, dated 5 July 2006, which examined the annual growth, in excess of the ValueWatch index, of heritage listed properties in the City of Stirling. This report found that-

    iii.   the excess growth of all listed properties was statistically significantly less than zero (ie detrimental),

    iv.   restricting the analysis to transactions that first occurred after heritage listing indicated greater detriment and

    v.   examining individual suburbs revealed statistically significant negative growth compared with the ValueWatch index in the suburbs of Menora and Mount Lawley;

b.   a letter 04067E.doc, dated 7 November 2006, which examined the relationship of Subiaco prices and growth in excess of ValueWatch index to a small number of variables. This letter noted that-

    i.   heritage properties had statistically significantly higher prices than non heritage properties,

    ii.   there was no statistically significant relationship between the excess growth of properties and their heritage listing status,

    iii.   there were statistically significant relationships between price and sale date and price and land area and

    iv.   there was some, but not statistically significant, evidence that listed properties experienced greater growth than non listed properties and

c.   a report 04067F.doc dated 24 January 2007. This report applied the methodology of a United States of America study "Economic Impacts of Historical

Preservation" to all Mount Lawley residential sales between July 1988 and July 2004. This report found that –

i.   there was statistically significant evidence to support the contention that heritage listed properties had higher prices than non listed properties but

ii. there was no statistically significant evidence that listing, in isolation, explained the difference between excess annual growth of properties.

20.   In discussion of the January report, I was asked to extend the analysis to include the suburbs of Shenton Park and Subiaco and to include more recent Mount Lawley information.

21.   The July report differed from the third report and this report to the extent that it included allowances for known renovations. Unless renovations are materially different for listed properties, ignoring renovation expenses will not invalidate the analysis performed for the January report or this report.

3.2   History & Legislation

22.   In my July report, I described the relevant history and legislation.

4   INFORMATION SUPPLIED AND USED

4.1   Previously Supplied

23.   I used the previously supplied (and described in my earlier reports) information concerning: -

a.   the ValueWatch index published by the LandGate (formerly Department of Land Information);

b.   spreadsheets containing information about all Mount Lawley residential sales. This information comprised –

   i.   Land identification,
   ii.   Land area,
   iii.   Sale price,
   iv.   Sale date,
   v.   R code,
   vi.   Available lots if redeveloped,
   vii.   Year in which built,
   viii. Number of pools,
   ix.   Number of bedrooms,
   x.   Number of bathrooms,
   xi.   Number of dining rooms,
   xii.   Number of kitchens,
   xiii. Number of family rooms,
   xiv.   Number of games rooms,

        xv.   Number of meals areas,

        xvi.   Number of lounges,

        xvii.   Number of studies and

        xviii. Number of garages and

    c.   heritage listings of Mount Lawley properties.

4.2   Additional Information

24. I was supplied with: -

    a.   more recent Mount Lawley information in the form described above;

    b.   similar information for the two other Subject Suburbs;

    c.   updated ValueWatch information for Mount Lawley and

    a.   ValueWatch information for the two other suburbs.

4.3   Modifications and Exclusions

25. The supplied data were modified in some cases where information was not displayed but had been displayed in respect of the same property in another sale transaction. In these cases, the data from the other transaction was adopted. The fields for which this applied included: -

    a.   land area;

    b.   R codes and

    c.   available lots if developed.

26. In some cases, where the year of construction was unknown, it could be inferred from later sales. If this was not so, I adopted a built year of 1950.

27. In other cases where information was not displayed, the records were excluded from the analysis.

28. Further transactions were excluded from analysis of resales. These were transactions that: -

    a.   involved a sale price of less than $10,000;

    b.   were within a year of the original sale and

    c.   some transactions with abnormally large growth in excess of the ValueWatch index.

29. To simplify calculations,: -

    a.   sale and purchase dates were transformed into the number of years including part years from January 1980 and called "Relative years" and

    b.   years built were transformed by subtracting 1900 and called "Relative year built".

4.4   Summary

30. The following table summarises the supplied data and associated ValueWatch information in respect of the Subject Suburbs collectively.

	Transactions	Resales	Listed transactions	Unlisted transactions	Listed resales	Unlisted resales
Number	4,027	1,652	362	3,665	225	1,427
Listed at sale	9.0%	13.6%	100.0%	0.0%	100.0%	0.0%
Listed at purchase	2.7%	6.7%	30.4%	0.0%	48.9%	0.0%
Land area (average m2)	498	476	567	492	544	465
Zoning (average R)	28.7	26.6	25.8	29.0	25.3	26.8
Development potential (average lots)	1.2	1.1	1.2	1.1	1.2	1.1
Sale ValueWatch (average $'000)	322	367	393	315	411	360
Bed rooms (average)	2.6	2.7	2.8	2.6	2.8	2.7
Bath rooms (average)	1.3	1.3	1.2	1.3	1.3	1.3
Lounges (average)	1.0	1.0	1.0	1.0	1.0	1.0
Dining rooms (average)	0.5	0.6	0.6	0.5	0.6	0.6
Kitchens (average)	1.0	1.0	1.0	1.0	1.0	1.0
Meals areas (average)	0.1	0.1	0.2	0.1	0.2	0.1
Family rooms (average)	0.3	0.3	0.3	0.3	0.3	0.3
Games rooms (average)	0.0	0.0	0.0	0.0	0.0	0.0
Studies (average)	0.1	0.2	0.1	0.1	0.1	0.2
Pools (average)	0.1	0.1	0.1	0.1	0.1	0.1
Car shelters (average)	0.8	0.8	0.8	0.8	0.8	0.8
Relative built year (average relative 1900)	42.0	39.3	33.0	42.9	32.1	40.4
Relative sale year (average relative 1980)	18.1	20.0	20.9	17.8	21.4	19.8
Sale age (average years)	56	60	67	54	69	59
Sale price$'000	399	459	505	389	533	448
VW Excess annual growth (average% pa)	NA	2.3%	NA	NA	2.6%	2.3%
Standard deviation VW Excess annual growth (% pa)	NA	10.1%	NA	NA	8.9%	10.3%

31. Similar summaries for individual suburbs follow.

4.4.1   Mount Lawley

	Transactions	Resales	Listed transactions	Unlisted transactions	Listed resales	Unlisted resales
Number	835	241	134	701	85	156
Listed at sale	16.0%	35.3%	100.0%	0.0%	100.0%	0.0%
Listed at purchase	5.5%	19.1%	34.3%	0.0%	54.1%	0.0%
Land area (average m2)	751	732	809	739	768	712
Zoning (average R)	26.8	24.2	22.2	27.7	21.3	25.8
Development potential (average lots)	1.5	1.4	1.5	1.5	1.3	1.5
Sale ValueWatch (average $'000)	338	374	378	330	408	356
Bed rooms (average)	2.8	2.9	3.0	2.8	3.0	2.8
Bath rooms (average)	1.2	1.3	1.3	1.2	1.4	1.2
Lounges (average)	1.0	1.0	1.0	1.0	1.0	1.0
Dining rooms (average)	0.6	0.6	0.6	0.6	0.7	0.6
Kitchens (average)	1.0	1.0	1.0	1.0	1.0	1.0
Meals areas (average)	0.1	0.1	0.2	0.1	0.2	0.1
Family rooms (average)	0.3	0.3	0.4	0.3	0.4	0.3
Games rooms (average)	0.0	0.0	0.0	0.0	0.0	0.0
Studies (average)	0.1	0.1	0.1	0.1	0.1	0.1
Pools (average)	0.2	0.2	0.2	0.2	0.3	0.2
Car shelters (average)	1.0	1.0	1.0	0.9	1.1	0.9
Relative built year (average relative 1900)	43.5	43.3	45.2	43.2	44.9	42.4
Relative sale year (average relative 1980)	18.3	19.7	20.1	18.0	20.9	19.1
Sale age (average years)	54	56	54	54	56	56
Sale price$'000	432	479	546	410	577	426
VW Excess annual growth (average% pa)	NA	0.5%	NA	NA	0.4%	0.5%
Standard deviation VW Excess annual growth (% pa)	NA	9.6%	NA	NA	8.4%	10.2%

4.4.2   Shenton Park

	Transactions	Resales	Listed transactions	Unlisted transactions	Listed resales	Unlisted resales
Number	1,357	608	79	1,278	49	559
Listed at sale	5.8%	8.1%	100.0%	0.0%	100.0%	0.0%
Listed at purchase	1.5%	3.3%	25.3%	0.0%	40.8%	0.0%
Land area (average m2)	460	450	454	461	427	452
Zoning (average R)	24.8	23.0	21.3	25.0	20.5	23.2
Development potential (average lots)	1.0	1.0	1.0	1.0	1.0	1.0
Sale ValueWatch (average $'000)	289	335	367	284	366	332
Bed rooms (average)	2.5	2.6	2.6	2.5	2.6	2.6
Bath rooms (average)	1.2	1.3	1.1	1.2	1.1	1.3
Lounges (average)	1.0	1.0	1.0	1.0	1.0	1.0
Dining rooms (average)	0.5	0.5	0.5	0.5	0.5	0.5
Kitchens (average)	1.0	1.0	1.0	1.0	1.0	1.0
Meals areas (average)	0.1	0.1	0.1	0.1	0.2	0.1
Family rooms (average)	0.3	0.3	0.3	0.3	0.3	0.3
Games rooms (average)	0.0	0.0	0.0	0.0	0.0	0.0
Studies (average)	0.1	0.2	0.1	0.1	0.1	0.2
Pools (average)	0.1	0.1	0.0	0.1	0.0	0.1
Car shelters (average)	0.7	0.7	0.6	0.7	0.5	0.8
Relative built year (average relative 1900)	43.7	41.6	29.6	44.6	28.2	42.8
Relative sale year (average relative 1980)	18.0	20.1	21.7	17.7	21.8	20.0
Sale age (average years)	54	58	72	53	73	57
Sale price$'000	365	436	464	359	460	434
VW Excess annual growth (average% pa)	NA	2.0%	NA	NA	3.4%	1.9%
Standard deviation VW Excess annual growth (% pa)	NA	9.8%	NA	NA	5.3%	10.1%

4.4.3   Subiaco

	Transactions	Resales	Listed transactions	Unlisted transactions	Listed resales	Unlisted resales
Number	1,835	803	149	1,686	91	712
Listed at sale	8.1%	11.3%	100.0%	0.0%	100.0%	0.0%
Listed at purchase	2.4%	5.5%	29.5%	0.0%	48.4%	0.0%
Land area (average m2)	412	418	409	412	397	421
Zoning (average R)	32.6	30.2	31.5	32.7	31.6	30.0
Development potential (average lots)	1.1	1.1	1.1	1.1	1.1	1.1
Sale ValueWatch (average $'000)	339	389	419	332	439	382
Bed rooms (average)	2.6	2.7	2.6	2.6	2.7	2.7
Bath rooms (average)	1.3	1.3	1.2	1.3	1.2	1.3
Lounges (average)	1.0	1.0	1.0	1.0	1.0	1.0
Dining rooms (average)	0.5	0.6	0.5	0.5	0.5	0.6
Kitchens (average)	1.0	1.0	1.0	1.0	1.0	1.0
Meals areas (average)	0.1	0.1	0.2	0.1	0.2	0.1
Family rooms (average)	0.3	0.3	0.3	0.3	0.3	0.4
Games rooms (average)	0.0	0.0	0.0	0.0	0.0	0.0
Studies (average)	0.2	0.2	0.1	0.2	0.1	0.2
Pools (average)	0.0	0.0	0.0	0.0	0.0	0.0
Car shelters (average)	0.8	0.8	0.8	0.8	0.8	0.8
Relative built year (average relative 1900)	40.2	36.3	23.8	41.6	22.2	38.1
Relative sale year (average relative 1980)	18.0	20.0	21.1	17.7	21.8	19.8
Sale age (average years)	57	63	77	56	79	61
Sale price$'000	409	471	489	402	530	464
VW Excess annual growth (average% pa)	NA	3.1%	NA	NA	4.3%	3.0%
Standard deviation VW Excess annual growth (% pa)	NA	10.4%	NA	NA	10.4%	10.4%

5   METHODOLOGY

5.1   General

32.   This section describes the methodology I have used. The description is abstract in the sense that it seeks to describe the concepts used, rather than the specific results of this investigation.

33. The description of the methodology serves two sometimes conflicting purposes: -

   a. to explain the methodology to the general reader and

   b. to document my processes so they can be confirmed or repeated by another actuary.

5.2   Use of ValueWatch Index

34. It is generally recognised that property values experience compound, rather than linear, growth. This means that the growth is better expressed as a percentage per annum, rather than a dollar amount per year. All other variables that might influence property values are more likely to be linear in their operation.

35. To remove the compounding effect of price changes, I have introduced a further variable, the ValueWatch index at the time of sale. This is broadly a measure of the market at that time. By using this variable, the influence of other variables can be examined without the complications of compound growth.

36. I have calculated the ValueWatch index at the any time by linear ("straight line") interpolation between the index values at dates immediately before and after the sale date.

5.3   Growth in Excess of ValueWatch Index

37. For each property that has been the subject of multiple sales, I have determined the growth in excess of the ValueWatch index by: -

   a. determining a "price factor", being the resale price as a proportion of the sale price;

   b. calculating the ValueWatch index at the date of sale and resale;

   c. determining a "ValueWatch factor", being the resale date ValueWatch index as a proportion of the sale date ValueWatch index;

   d. determining "excess growth" by dividing the price factor by the ValueWatch factor;

   e. converting the excess growth to an annual growth rate by raising it to the power of the reciprocal of the inter sale period and

   f. converting the factor to an excess annual rate of growth by subtracting 1 therefrom.

38. An example of this calculation is set out in the following table.

	Sale	**Resale**	**Factor**
Date	14 Jul 97	11 Dec 99	2.41 years
Amount $	320,000	450,000	140.6%
ValueWatch $	280,761	381,304	135.8%
Excess growth	140.6% / 135.8%		103.5%
Excess growth annual factor	103.5% ^ [1 / 2.41]		101.5%
Excess growth per annum	101.5% - 1		1.5%

5.4   Tests of Differences in Average Annual Excess Growth

39.   To test whether properties that are heritage listed have different average annual growth in excess of the ValueWatch index, I have: -

   a.   adopted a Null Hypothesis that the two have the same distribution of excess annual growth rates. In sense, distribution is defined by the mid point ("Mean") and dispersion ("Variance");

   b.   confirmed, using the "F" statistical distribution, that there is no statistically significant evidence to reject the hypothesis that the Variances of the two groups are the same;

   c.   calculated a particular statistic "t" from the observations;

   d.   examined the statistical distribution of the "t" statistic to determine whether the observed statistic could have occurred by chance if the Null Hypothesis were true and

   e.   used this probability to decide whether to reject the Null Hypothesis.

40.   The "t" statistic is calculated as

$$(\overline{Y}_1 - \overline{Y}_2) / \{ s_p \sqrt{((1 / n_1) + (1 / n_2))}\}$$

and it follows the "t" distribution with $n_1 + n_2 - 2$ "degrees of freedom".

Where

   $\overline{Y}_1$ = the average excess growth of listed properties;

   $\overline{Y}_2$ = the average excess growth of unlisted properties;

   $s_p = \sqrt{[((n_1 - 1)s_1 + (n_2 - 1)s_2)] / [n_1 + n_2 - 2]}$;

s_1 is the standard deviation of excess growth of listed properties and

s_2 is the standard deviation of excess growth of unlisted properties.

5.5   Regression Calculations

5.5.1   General

41.   I have calculated the parameters that best describe the relationship between price and excess annual growth and other variables using "least squares multiple linear regression" processes. These processes determine the parameters in a way that minimises the total "difference" between observed and estimated results. The "difference" used is actually the square of actual differences. This is necessary to properly deal with the fact that differences can be positive or negative.

42.   The above process estimates a relationship that is "linear" and takes the form: -
   a.   in the single regression case

$$y = a + bx \quad \text{and}$$

   b.   in the multiple regression case

$$y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + \ldots + b_nx_n.$$

or

$$y = a + \sum b_ix_i$$

43.   In the above example, "y" is the variable that is the intended subject of prediction and is dependent on the other variables. For this reason, it is called the "dependent variable".

5.5.2   Significance of Results

44.   In the single variable regressions, one can test the significance of regression results by: -
   a.   measuring the extent of departure of all dependent variables from the global average thereof. This is calculated as the sum of the squares of differences of individual dependent variables from the global average and can be called the "Global Sum of Squares";

   b.   measuring the extent of departure from the global average that can be attributable to the regression formula. This is calculated as the sum of the squares of the difference between individual dependent variables and those predicted by the formula and can be called the "Regression Sum of Squares" and

   c.   determining the "Residual Sum of Squares" as the difference between the Global and Regression Sums of Squares.

45.   One can then proceed from the Null Hypothesis that there is no relationship between individual variables and the dependent variables. If this is so, one would expect the Regression Sum of Squares to be small relative to the Residual Sum of Squares. Using a statistical function known as the "F" distribution, it is possible to determine the probability of the observed or larger Regression Sum of Squares occurring if there is in fact no relationship. If this is low it indicates a strong relationship.

46.   To simplify the description, one can say that the confidence that can be ascribed to the existence of a relationship is the complement of the probability determined in the previous paragraph. For example if the "F" distribution indicates that there is a 5% probability of the Regression Sum of Squares being as large or larger than observed, one can be 95% confident that there is a relationship.

47.   The methodology used with multiple regressions is similar, but the issue of the order of introduction of variables needs to be addressed. To do this, I have: -

   a.   performed a single variable regression on the variable to which is attached the greatest confidence;

   b.   determined the difference between actual results and those that would have been expected using the single variable formula;

   c.   examined the relationship of all remaining variables to this difference;

   d.   selected the variable that best explains this relationship;

   e.   performed a regression using this variable and the single variable initially used and

   f.   repeated the process increasing the number of variables in the regression until

   g.   either-

      i.   there is no further variable or
      ii.   in some cases, additional variables no longer produce statistically significant results.

6   RESULTS

6.1   Excess Annual Growth

48.   Over the Subject Suburbs collectively, average annual growth of properties that have been resold is 2.3% per annum faster than the ValueWatch index. For listed properties, the average is 2.6%. Using the "t" statistical test, I have determined that the difference is not statistically significant. This means there is *no statistically significant evidence that listing in isolation is associated with faster growth*.

49.   In the *individual suburbs,* there was *no statistically significant evidence to link listing with excess annual growth.* The particular excess annual growth rates were: -

a.   Mount Lawley-
    i.   listed properties   0.4% per annum and
    ii.   all properties   0.5% per annum;

b.   Shenton Park-
    iii.   listed properties   3.8% per annum and
    iv.   all properties   1.9% per annum and

c.   Subiaco-
    i.   listed properties   4.3% per annum and
    ii.   all properties   3.0% per annum.

6.2   Sale Price Regression

6.2.1   General

50.   For the Subject Suburbs collectively, the single variable that best relates to sale price is the ValueWatch index at the time of sale. The relationship, which explains 63.8% of departures from the average sale price, is

Price = 1.39 times ValueWatch index less $48,000.

51.   The following chart shows actual prices as dots on the vertical access and ValueWatch index value at the time of sale on the horizontal axis. It also shows the regression line.

◆ Sale ValueWatch
✕ Regression Sale ValueWatch horizontal Sale_Price vertical
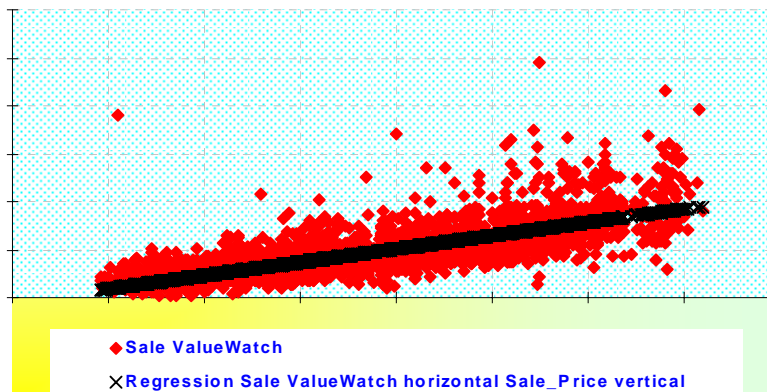
52.   The strength of the relationship is clear from the chart. It is also clear from the chart that the relationship is not perfect.

53.   One can assign confidence to the relationship by examining the probability of the observed "F" statistic occurring if there were no relationship. This probability is practically

zero, giving a great deal of confidence to the rejection of the Null Hypothesis that there is no relationship between price and ValueWatch index at sale.

54.   After allowing for the impact of the ValueWatch index, the variable that next best relates to sale price is the age of the property at sale. Introducing this variable into the equation changes the weight applied to ValueWatch imperceptibly and changes the constant from -$48,000 to +$43,000 generating an estimate of price of

> *Price = 1.39 times ValueWatch index less $1,600 times the age of the*
> *property at sale plus $43,000.*

55.   The calculation is now three dimensional and not capable of charting, but the relationship now explains 66.6% of the difference between sale prices and the average sale price.

56.   One's confidence in the validity of adding the additional variable is tested using the "F" statistic. Once again the probability of observed results on the assumption that there is no relationship between the age of properties and their sale price adjusted for ValueWatch is practically zero. This indicates virtually 100% confidence that the age of a property is an influence on its value.

6.2.2   Best Fit

57.   I have continued the process of adding the next best indicator and arrived at the complete description of the sale price set out in the following table. The chart that follows the table shows: -

   a.   the proportion of the difference between actual sale prices and the average sale price that is explained by the addition of each variable to the formula;

   b.   the confidence one can attach to the formula as a descriptor of the sale price ***up to and including*** each variable and

   c.   the confidence one can attach to ***adding*** each of the variables.

58.   The last three columns of the table show: -

   a.   the incremental determination – this is the increase in the proportion of the difference between   actual and average sale prices that is explained by the introduction of the variable. For example as described above, the addition of the age at sale increases the proportion explained from 63.8% to 66.6% - a difference of 2.8% (2.79% in the table);

   b.   the incremental confidence – this is the confidence with which one can assert that the particular variable influences the value after allowing for all previous variables and

   c.   significant formula – this is the formula that applies if one only considers significant variables as discussed in paragraph 59 below.

	$		Variable	Incremental determination	Incremental confidence	"Significant" formula $
Constant	(43,780)					(83,880)
Plus	1.426	times	Sale ValueWatch	63.77%	100.00%	1.424
Less	788.2	times	Sale age	2.79%	100.00%	177.5
Plus	14,480	times	Car shelters	1.08%	100.00%	14,460
Plus	25,160	times	Pool	1.09%	100.00%	26,490
Plus	53,500	times	Study	1.78%	100.00%	52,770
Plus	10,490	times	Family	0.84%	100.00%	9,876
Plus	87,190	times	Baths	2.12%	100.00%	87,500
Plus	22,980	times	Beds	0.71%	100.00%	23,580
Less	624.3	times	Zoning	0.51%	100.00%	625.4
Plus	183.5	times	Land area	1.63%	100.00%	185.6
Less	123,500	times	Kitchen	0.21%	100.00%	104,200
Plus	34,930	times	Meals	0.15%	100.00%	36,070
Plus	15,430	times	Dining	0.07%	99.94%	15,840
Less	17,550	times	Development potential	0.08%	99.99%	17,860
Plus	30,230	times	Games	0.04%	98.89%	30,710
Less	6,464	times	Relative sale year	0.19%	100.00%	6,882
Plus	**12,780**	**times**	**Listed at sale**	**0.02%**	**94.99%**	
Plus	31,040	times	Lounge	0.01%	88.45%	
Plus	2,348	times	Listed at purchase	0.00%	13.12%	
Less	581.8	times	Relative built year	0.00%	6.93%	
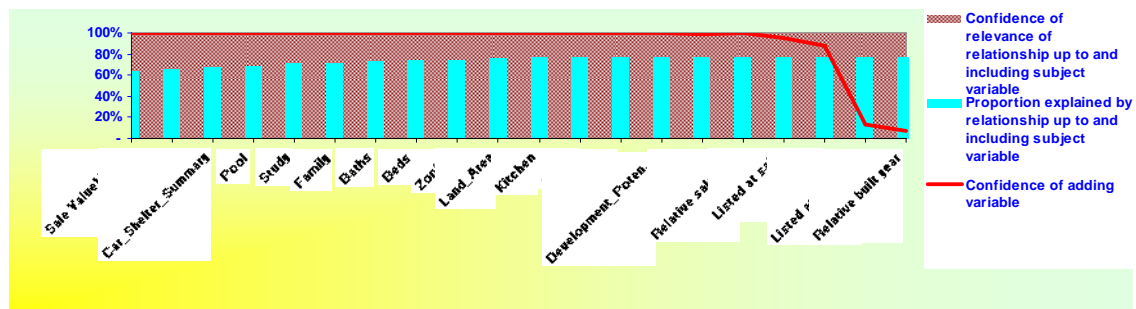
59.   As shown in the "incremental confidence" column of the table and in the chart, the confidence that listing at sale and later variables influence the sale price is less than 95% (although just so). Conventionally, such variables are excluded from the descriptive equation. The reason for this is that the variables are not statistically significant descriptors of sale price.

60.   If the insignificant variables are removed, the formula that describes the sale price changes, as indicated in the "Significant formula" column of the table, from

> *$43,780 + 1.426 times ValueWatch at sale +... -6,464 times relative built year + $12,780 if listed at sale + ……   to*
>
> *$83,880 + 1.424 times ValueWatch at sale +... -6,882 times relative built year.*

6.2.3   Listing as Final Variable

61.   I have been asked to comment on the effect of introducing the matter of whether the property is listed at sale as the final variable after all other variables have been considered. As indicated by the low level of incremental confidence associated with listing at sale (the **bold** line in the table following paragraph 58 above), whether the property is listed is not a significant descriptor of sale price after one considers all variables that are *significant or better descriptors*.

62.   If listing is considered after *all* other variables are considered, it leads to a higher calculated price. However, the "F" test indicates a 11.5% probability of the observed or a larger "F" value occurring under the Null Hypothesis that listing has no effect on sale price. *This is not statistically significant evidence that listed properties have a higher sale price that unlisted properties after allowing for all other influences*.

6.2.4   Individual Suburbs

63.   Before setting out individual suburban formulae, I report on the significance of adding listing as the final variable after allowance for all other variables. In all cases, the influence leads to a higher calculated price. The "F" test probabilities are: -

  a.   Mount Lawley   4.5% providing statistically significant evidence to reject the hypothesis that listing is irrelevant in favour of a hypothesis that listing increases the sale price of a property;

  b.   Shenton Park   10.4% giving no significant grounds for rejecting the hypothesis that listing is irrelevant and

  c.   Subiaco   83.3% giving no significant grounds for rejecting the hypothesis that listing is irrelevant.

64.   The following tables reproduce the table following paragraph 58 above for each suburb.

6.2.4.1 Mount Lawley

	$		Variable	Incremental determination	Incremental confidence	"Significant" formula $
Constant	(625,147)					(231,673)
Plus	1.513	times	Sale ValueWatch	55.92%	100.00%	1.049
Plus	90,800	times	Meals	3.95%	100.00%	97,740
Plus	27,540	times	Beds	4.68%	100.00%	31,620
Plus	323.9	times	Land area	9.22%	100.00%	317.6
Plus	66,400	times	Baths	1.40%	100.00%	77,910
Less	1,211	times	Zoning	0.57%	100.00%	1,563
Plus	30,610	times	Pool	0.29%	99.84%	36,370
Less	11,650	times	Kitchen	0.21%	99.34%	99,750
Plus	39,420	times	Study	0.17%	98.62%	42,460
Plus	**35,280**	**times**	**Listed at sale**	**0.14%**	**97.41%**	**30,790**
Plus	69,730	times	Lounge	0.10%	93.85%	
Plus	6,004	times	Sale age	0.06%	84.70%	
Plus	22,220	times	Family	0.04%	78.59%	
Plus	25,970	times	Listed at purchase	0.04%	78.32%	
Less	21,860	times	Relative sale year	0.43%	99.99%	
Less	5,989	times	Development potential	0.01%	45.04%	
Less	1,239	times	Car shelters	0.00%	14.49%	
Plus	4,993	times	Games	0.00%	13.40%	
Less	1,479	times	Dining	0.00%	10.23%	
Plus	6,264	times	Relative built year	0.00%	28.15%	

65.   For this suburb, listing at sale is the last *statistically significant descriptor* of sale price.

6.2.4.2 Shenton Park

	$		Variable	Incremental determination	Incremental confidence	"Significant" formula $
Constant	341,000					(63,851)
Plus	1.848	times	Sale ValueWatch	61.43%	100.00%	1.424
Less	5,234	times	Sale age	2.37%	100.00%	177.5
Plus	56,280	times	Pool	2.05%	100.00%	14,460
Plus	44,960	times	Study	2.42%	100.00%	26,490
Plus	88,540	times	Baths	3.46%	100.00%	52,770
Plus	232.6	times	Land area	2.86%	100.00%	9,876
Plus	20,410	times	Car shelters	0.34%	100.00%	87,500
Less	10,260	times	Kitchen	0.21%	99.93%	23,580
Plus	16,740	times	Beds	0.41%	100.00%	625.4
Plus	16,890	times	Dining	0.10%	98.30%	185.6
Less	9,011	times	Relative sale year	0.62%	100.00%	104,200
Less	1,497	times	Zoning	0.16%	99.76%	36,070
Plus	13,280	times	Meals	0.05%	91.28%	15,840
Plus	**24,260**	**times**	**Listed at sale**	**0.04%**	**87.64%**	**17,860**
Plus	27,840	times	Games	0.03%	80.72%	30,710
Plus	13,250	times	Family	0.05%	90.34%	6,882
Plus	17,570	times	Development potential	0.02%	69.34%	
Less	18,150	times	Listed at purchase	0.01%	47.30%	
Less	15,720	times	Lounge	0.00%	38.88%	
Less	5,197	times	Relative built year	0.00%	38.23%	

66.   For this suburb, listing at sale is ***not a statistically significant descriptor*** of sale price.

6.2.4.3 Subiaco

			Variable	Incremental determination	Incremental confidence	"Significant" formula
Constant	(370,129)					(156,049)
Plus	2.083	times	Sale ValueWatch	70.10%	100.00%	1.424
Plus	3,125	times	Sale age	3.43%	100.00%	177.5
Plus	51,880	times	Study	2.00%	100.00%	14,460
Plus	89,840	times	Baths	3.09%	100.00%	26,490
Plus	206.8	times	Land area	1.39%	100.00%	52,770
Plus	25,690	times	Beds	0.52%	100.00%	9,876
Plus	19,910	times	Car shelters	0.25%	100.00%	87,500
Plus	38,090	times	Pool	0.09%	99.56%	23,580
Plus	45,450	times	Games	0.09%	99.66%	625.4
Plus	21,200	times	Dining	0.09%	99.72%	185.6
Plus	22,710	times	Meals	0.09%	99.70%	104,200
Less	27,430	times	Relative sale year	1.38%	100.00%	36,070
Less	9,989	times	Development potential	0.06%	98.64%	15,840
Plus	11,330	times	Family	0.03%	92.87%	17,860
Less	48,680	times	Kitchen	0.02%	81.02%	30,710
Less	217.4	times	Zoning	0.01%	73.66%	6,882
Plus	5,344	times	Listed at purchase	0.00%	34.34%	
Plus	11,190	times	Lounge	0.00%	26.96%	
Plus	**2,320**	**times**	**Listed at sale**	**0.00%**	**17.36%**	
Plus	3,294	times	Relative built year	0.00%	29.82%	

67. For this suburb, listing at sale is *not a statistically significant descriptor* of sale price.

6.3   Excess Annual Growth Regression

6.3.1   General

68. For the Subject Suburbs collectively, the single variable that best relates to excess annual growth above the ValueWatch index is the sale price. More expensive properties tended to have faster excess annual growth. This could be interpreted as more recently sold properties having higher excess annual growth. This is somewhat confirmed by the positive correlation between excess annual growth and the year of sale.

69.   After allowing for sale price, the next most significant descriptor of average annual growth is the land area, which is negatively correlated to excess growth.

6.3.2   Best Fit

70.   I have followed the same processes as described in connection with the sale price regression. The tables which follow are similar to those of the previous section. The chart following the first table is similar to that of the previous section and indicates much reduced contributions of the variables to explaining the difference between actual and average excess growth.

6.3.2.1 Subject Suburbs Collectively

			Variable	Incremental determination	Incremental confidence	"Significant" formula
Constant	(19.10%)					1.0000%
Plus	0.00001844%	Times	Sale price	5.11%	100.00%	0.00001777%
Less	0.006010%	Times	Land area	0.68%	99.94%	0.007250%
Less	0.00002480%	Times	Sale ValueWatch	1.76%	100.00%	0.00001862%
Plus	0.3020%	Times	Sale age	0.71%	99.96%	0.03960%
Plus	1.311%	Times	Dining	0.25%	96.61%	1.083%
Less	1.586%	Times	Pool	0.14%	88.77%	0.0%
Plus	2.580%	Times	Listed at purchase	0.14%	89.09%	0.0%
Less	1.120%	Times	Study	0.13%	86.81%	0.0%
Less	0.6608%	Times	Development potential	0.08%	77.39%	0.0%
Plus	0.3654%	Times	Car shelters	0.07%	74.24%	0.0%
Less	0.4591%	Times	Beds	0.08%	76.80%	0.0%
Less	**1.301%**	**Times**	**Listed at sale**	**0.09%**	**80.91%**	**0.0%**
Plus	0.5078%	Times	Meals	0.03%	51.61%	0.0%
Less	0.09798%	Times	Relative sale year	0.06%	71.46%	0.0%
Less	0.5482%	Times	Lounge	0.00%	14.40%	0.0%
Plus	0.2316%	Times	Games	0.00%	11.25%	0.0%
Plus	0.1033%	Times	Family	0.00%	12.09%	0.0%
Less	0.001084%	Times	Zoning	0.00%	4.69%	0.0%
Plus	0.007355%	Times	Baths	0.00%	1.51%	0.0%
Plus	0.006790%	Times	Kitchen	0.00%	0.79%	0.0%
Plus	0.2626%	Times	Relative built year	0.01%	24.86%	0.0%
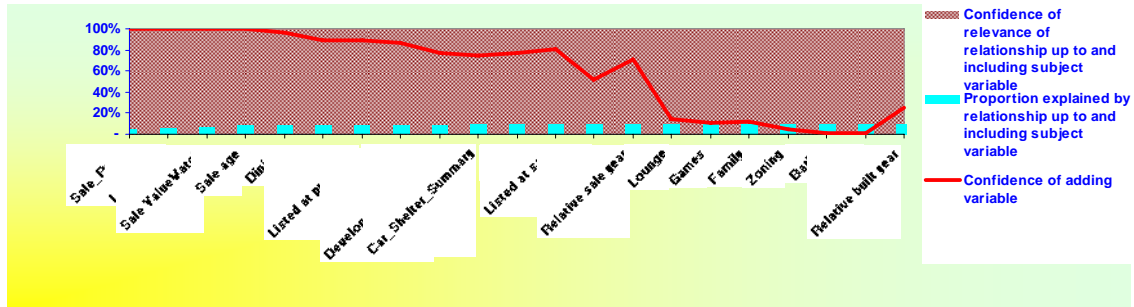
71. For the Subject Suburbs collectively, there are five statistically significant descriptors of excess annual growth and listing at the time of sale is not one of them. Therefore, there i*s* ***no statistically significant evidence that listing at sale influences a property's growth rate***.

6.3.2.2 Mount Lawley

			Variable	Incremental determination	Incremental confidence	"Significant" formula
Constant	(303.3%)					9.000%
Less	1.726%	Times	Development potential	2.01%	97.23%	1.946%
Plus	0.00001471%	Times	Sale price	1.68%	95.76%	0.000009491%
Less	4.604%	Times	Relative sale year	2.58%	98.87%	0.4981%
Less	3.135%	Times	Pool	1.08%	90.14%	0.0%
Less	0.004576%	Times	Land area	1.39%	93.99%	0.0%
Plus	2.248%	Times	Dining	0.54%	75.99%	0.0%
Less	1.630%	Times	Beds	1.05%	90.05%	0.0%
Less	2.534%	Times	Meals	0.61%	79.21%	0.0%
Plus	3.909%	times	Listed at purchase	0.46%	72.62%	0.0%
Less	**2.470%**	**times**	**Listed at sale**	**0.88%**	**86.93%**	**0.0%**
Plus	1.994%	times	Family	0.62%	79.76%	0.0%
Plus	3.650%	times	Games	0.25%	58.27%	0.0%
Plus	0.04448%	times	Zoning	0.19%	51.81%	0.0%
Less	3.420%	times	Lounge	0.06%	29.93%	0.0%
Plus	0.4772%	times	Baths	0.02%	18.23%	0.0%
Plus	0.2370%	times	Car shelters	0.01%	13.68%	0.0%
Plus	4.036%	times	Relative built year	0.00%	7.30%	0.0%
Plus	4.036%	times	Sale age	1.22%	92.36%	0.0%
Less	0.000004276%	times	Sale ValueWatch	0.02%	17.38%	0.0%
Less	0.5266%	times	Kitchen	0.00%	3.79%	0.0%
Plus	0.01438%	times	Study	0.00%	0.57%	0.0%

72.   For this suburb, *listing at sale is not statistically significant,* the only statistically significant descriptors of excess annual growth are: -

a.   development potential;

b.   sale price and

c.   sale year.

6.3.2.3 Shenton Park

			Variable	Incremental determination	Incremental confidence	"Significant" formula
Constant	(19.10%					1.000%
Plus	0.00001482%	times	Sale price	8.71%	100.00%	0.00001090%
Less	0.1050%	times	Zoning	0.82%	98.06%	0.1399%
Plus	6.952%	times	Development potential	0.59%	95.28%	6.593%
Less	1.178%	times	Beds	0.35%	87.47%	0.0%
Plus	6.966%	times	Kitchen	0.32%	85.54%	0.0%
Plus	1.045%	times	Family	0.16%	69.90%	0.0%
Plus	**0.5907%**	**times**	**Listed at sale**	**0.07%**	**50.01%**	**0.0%**
Less	0.8629%	times	Baths	0.07%	50.62%	0.0%
Plus	0.8375%	times	Pool	0.04%	40.35%	0.0%
Less	0.00002132%	times	Sale ValueWatch	0.08%	53.32%	0.0%
Plus	0.1658%	times	Relative sale year	0.42%	90.76%	0.0%
Less	0.2343%	times	Car shelters	0.04%	37.66%	0.0%
Less	0.4899%	times	Study	0.03%	34.50%	0.0%
Less	0.001118%	times	Land area	0.01%	23.68%	0.0%
Plus	0.3015%	times	Sale age	0.00%	13.90%	0.0%
Plus	0.1065%	times	Dining	0.00%	12.15%	0.0%
Less	0.09909%	times	Meals	0.00%	8.70%	0.0%
Plus	0.3452%	times	Lounge	0.00%	7.98%	0.0%
Less	0.2319%	times	Games	0.00%	5.82%	0.0%
Less	0.09345%	times	Listed at purchase	0.00%	2.96%	0.0%
Plus	0.2982%	times	Relative built year	0.01%	17.36%	0.0%

73. For this suburb, *listing at sale is not statistically significant,* the only statistically significant descriptors of excess annual growth are: -

a. sale price;

b. zoning and

c. development potential.

6.3.2.4 Subiaco

			Variable	Incremental determination	Incremental confidence	"Significant" formula
Constant	72.00%					5.000%
Plus	0.00002464%	times	Sale price	4.49%	100.00%	0.00002506%
Less	0.00004683%	times	Sale ValueWatch	4.06%	100.00%	0.00003314%
Less	0.7497%	times	Sale age	0.82%	99.27%	(0.04397%)
Less	0.006344%	times	Land area	0.69%	98.64%	0.008545%
Plus	3.843%	times	Listed at purchase	0.42%	94.73%	0.0%
Plus	1.771%	times	Dining	0.36%	92.77%	0.0%
Less	1.747%	times	Study	0.48%	96.10%	0.0%
Less	1.613%	times	Family	0.17%	78.65%	0.0%
Plus	1.417%	times	Meals	0.22%	84.17%	0.0%
Plus	0.5293%	times	Car shelters	0.17%	78.65%	0.0%
Less	5.697%	times	Kitchen	0.13%	72.79%	0.0%
Less	1.165%	times	Development potential	0.10%	65.72%	0.0%
Plus	0.8357%	times	Baths	0.10%	66.64%	0.0%
Less	1.120%	times	Pool	0.04%	44.06%	0.0%
Less	**1.340%**	**times**	**Listed at sale**	**0.06%**	**53.05%**	**0.0%**
Less	2.650%	times	Lounge	0.02%	29.24%	0.0%
Plus	1.196%	times	Relative sale year	0.12%	70.98%	0.0%
Plus	0.009847%	times	Zoning	0.02%	29.29%	0.0%
Less	0.6276%	times	Games	0.01%	17.37%	0.0%
Less	0.04098%	times	Beds	0.00%	5.64%	0.0%
Less	0.8010%	times	Relative built year	0.05%	49.73%	0.0%

74.   For this suburb, ***listing at sale is not statistically significant,*** the only statistically significant descriptors of excess annual growth are: -

   a.   sale price;

   b.   sale ValueWatch;

   c.   age at sale and

   d.   land area.

6.3.3   Listing as Final Variable

75.   The impact of listing as the final variable on the growth in excess of ValueWatch is ***not statistically significant*** as the impacts and the associated "F" test probabilities are: -

  a.   the Subject Suburbs collectively negative, but with an "F" test probability of 18.3%, giving no significant grounds for rejecting the hypothesis that listing is irrelevant;

  b.   Mount Lawley   negative, but with an "F" test probability of 15.9%, giving no significant grounds for rejecting the hypothesis that listing is irrelevant;

  c.   Shenton Park   positive, but with an "F" test probability of 74.9%, giving no significant grounds for rejecting the hypothesis that listing is irrelevant and

  d.   Subiaco   positive but with an "F" test probability of 38.2%, giving no significant grounds for rejecting the hypothesis that listing is irrelevant.

7   CONCLUSION

76.   I thank the Institute for the opportunity of helping with this project.

77.   Should the Institute or (with the Institute's permission) any other organisation which to discuss it, I would be pleased to do so.

Dennis E Barton
Director