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# An exploratory analysis of land and house price data over time

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## Abstract

This paper presents an exploratory analysis of vacant land and house price transaction data for a 25 year period in order to provide context for later research on the land pricing strategies of the housing development industry. Residential developers are important agents of change within the urban landscape and yet little academic work has been conducted in Australia on their decision making. Adelaide, the state capital of South Australia has been selected as a case study as transaction data for both house and vacant land was available. The city is also recognized by the development industry in Australia as one of the best managed in terms of land supply. This paper primarily aims to report on the data cleaning and manipulation processes required before analysis of the house and land price trends could begin. The steps taken to assimilate and clean over 1 million sales are explained before the results of the preliminary time series analysis are presented. The results report on over 121,833 vacant land transactions for a 30 year time period from 1981 to 2010 across 4 sectors of metropolitan Adelaide and some 404,549 detached dwelling transactions between 1985 and 2010. Land prices are discussed according to median site price and on a median $ per square metre basis for each sector. Next indexed land and house prices for various time periods are reported. Finally a Site Adjusted Price Index for vacant land and an equivalent Quality Adjusted Housing Price Index are compared for the 25 year time period from 1985 to 2010.

## Key Words

Land pricing, data cleaning, time series analysis

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## Introduction

This paper presents an exploratory analysis of vacant land and house price transaction data for a 25 year period in order to provide the context for later research on the land pricing strategies of the housing development industry. Adelaide, the state capital of South Australia has been selected as a case study as transaction data for both house and vacant land was available. The city is also recognized by the development industry in Australia as one of the best managed in terms of land supply. This paper primarily aims to report on the data cleaning and manipulation methods used before analysis of the house and land price trends could begin. The steps taken to assimilate and clean over 1 million sales are explained and the results of the preliminary time series analysis are presented.

## Background

Although residential developers are important agents of change within the urban landscape little academic work has been conducted in Australia on their pricing strategies or on the relationship between land and house prices under different market conditions. The recently convened Australian Housing Supply Council (2009) has recognized the need for better information about the housing development industry identifying the need for greater insights into the pricing, staging and land acquiring strategies of the industry. This has also been echoed by the Housing Industry Association (HIA) (2008) who has called for greater research into the residential development industry in Australia and into the relationship between land and house prices. The Australian Property Council (2008) has called for a greater understanding of the underlying demand for and supply of land while the HIA (2009) have identified the understanding of housing delivery bottlenecks a priority.

The metropolitan area of Adelaide has been selected as a case study as it is recognized by the development industry as one of the best managed capital cities in terms of vacant land supply (HIA, 2009) within Australia. Adelaide has a long history of government land management stretching back to the South Australian Land Commission in the early 1970s, to the Urban Land Trust in the 1980s and finally the incumbent Land Management Corporation. The Dunstan era introduced land banking to South Australia (SA) in 1973 with the Land Commission's priority, by means of staged land release, to ensure low and stable land prices and so provide land to those members of the community who did not have large financial resources. The Land Commission was then replaced by the Urban Land Trust in 1981 by means of new legislation. The Trust's brief was not so magnanimous though it still looked to provide an adequate supply of broadacre land across Adelaide and so facilitated in the development of Golden Grove, the largest residential development of its kind at the time in Australia. In 1996 with a change of government new legislation was again introduced and the Land Management Corporation (LMC) was brought into being. It must, by law, seek to maximize returns to government in terms of broadacre land release and infill development and, to this end, the volume and pricing of both broadacre and infill government owned land to the development industry has been closely monitored by the LMC.

Planning regimes and environmental attitudes have also changed quite substantially over the period of the study. Up to the 1970s land in metropolitan areas such as Adelaide was relatively plentiful and therefore cheap and the typical housing form was the single storey detached dwelling built on a large allotment of some 1000 square metres with substantial setbacks to side and street boundaries. These sites provided considerable areas of private open space and resulted in net urban housing densities as low as 17 dwellings per hectare (Planning SA, 2006). However through the 1980s and 1990s attitudes changed and the state government in SA no longer considered this low density form of housing development to be viable. Over the last decade urban containment strategies have been introduced in SA to protect agricultural land, improve the efficiency of land use and to reduce the costs associated with the delivery of government services (Quirk, 2008). These strategies have included the establishment of urban growth boundaries, the introduction of public transport corridors and the facilitation through planning codes of higher forms of dwelling density. Most state governments across Australia have drawn up strategic plans which facilitate higher density residential development much of which is to be introduced into already established urban areas and to this

end the 30 Year Plan for Greater Adelaide (State Government of SA, 2010) has recently been adopted. The housing form that is to be encouraged across metropolitan Adelaide, 70% of which is to be within existing suburbs, is described as medium density; attached dwellings, typically but not exclusively units, flats or apartment of up to 3 storeys (ABS, 2006) on allotment sizes of less than 300 square metres (State Government of SA, 2010).

## Literature

A key rationale for the reporting of land prices and their relationship, if any, with house prices, lies within the context of housing affordability. And despite financial downturns housing affordability continues to be a critical issue in Australia. Home ownership is considered an important element in the sustainability of urban communities, in the securing of financial futures for would be retirees and in the growth of the national economy. One factor considered critical to the determination of housing affordability is land costs in that cheaper land should result in a more affordable housing market. In the more recent government literature (Housing Supply Council, 2009) and invariably in the industry material (Moran, 2008; Day, 2009; UDIA, 2009; APC, 2007) rising house prices across Australia are understood to be fundamentally a result of rising land prices which in turn are the product of land supply. Put simply land prices drive house prices and any constraint on the supply of land will force house prices up across the market. This is despite the general recognition that the rate at which new houses can be built (the flow of housing) is very small relative to the existing stock of dwellings (approximately 2 percent) and that as a result house prices across the wider economy could rise or fall irrespective of what is happening to the supply of new homes (Ellis, 2006). The focus on land supply as being the main impediment to housing affordability reflects the interpretation adopted by the wide ranging Barker Review (2004) in the UK that land supply restrictions had contributed to land and property value increases well in excess of inflation.

However this cause and effect runs contrary to the theoretical understanding of the relationship between land and house prices and to the methodology of land appraisal. The theory and practice of land pricing assumes that land values are a function of house price and not vice versa (Appraisal Institute, 1992). Developers look to the already existing housing market to establish a likely selling price for their product. Since the supply of houses for sale in an area is usually dominated by established properties (up to 90 percent) developers are considered to be 'price takers' (Oxley, 2004). From this approach it can be seem that the price paid for the land is a function of the expected selling price of the development which has been largely derived from the existing market. As such land prices are fundamentally a product of house prices. This basic premise has been supported in empirical work carried out by Ball (1983), Lambert (1990), Bramley and Watkins (1996), Dipasquale and Wheaton (1996), Gillen and Fisher (2002), Leishman et al (2000) and Adams et al (2009). While the calculations involved in determining the present value of a staged development, the multiple inputs, the variety of financial constraints and the high sensitivity of the result to small changes in some variables all require considerable financial sophistication, still the basic premise remains that land prices are considered a residual after the deduction of development costs and desired profits from predicted revenues (Leishman et al, 2009).

As a first step in understanding the relationship between land and house prices, and to establish some context for later research into developer land pricing strategies, this paper presents an exploratory analysis of vacant land and house prices for a complete 25 year period. Primarily it explains the methodology used to clean over 1 million sales before the results of a preliminary time series analysis are presented.

## Methodology

This paper reports on vacant land and detached housing transaction data for the Adelaide Metropolitan Area principally for a 25 year period from 1985 to 2010 but also, where the data is available, for a 30 year period, from 1981 to 2010. The property transaction data for 1981 to 1992 was obtained from the Valuer General SA and the data from 1993 to November 2010 from the State Government SA and RP Data. The methodology

includes a discussion of the alternative ways in which the data could be cleaned and the advantages and disadvantages of each approach. Then the actual steps adopted for the cleaning are listed. Finally the equations used in the hedonic models to adjust land and house prices are described.

## Data cleaning

One of the basic starting points when working with property transaction data and creating a time series is that the data needs to be “cleaned” to remove observations that might not reflect the true market position. Typically this process will simply be reported as "removing non-market transactions”. However in practice the method used to collect the data and the level of information available will have a significant impact on how data is cleaned. The requirements for cleaning will therefore vary by jurisdiction and by land-use. The major problem concern with cleaning is the typical Type I and Type II error problem in statistics. Insufficient cleaning may result in a biased time series by including sales transactions which do not properly reflect the position of the market. Over cleaning will dramatically reduce the sample size and may systematically remove properties and so skew the results.

The establishment of median house prices and a hedonic house price index within Adelaide is well researched and the authors have significant experience in the creation of such time series data. However vacant land creates a different problem. Significantly more vacant urban land is sold only once as a vacant site (after which it is developed) and greater percentages are sold in multiple transactions and under circumstances which might be considered non-market. For this study a number of cleaning options were available and as a preliminary step a number of these for both the housing and vacant land market were trialed. As such the cleaning steps involved one or more of the following.

1. Sales tagged as "OTHER LAND" or "nonmarket transactions" are removed. The first tag refers to sales involving more than one parcel of land or more than land; for example the sale of several parcels of land under one contract price. The second tag refers to transactions where the government authority deems the sale to be nonmarket; for example they involve related parties.
2. Sales in development zones which are most probably designated for commercial-industrial activities are removed as they may reflect non-residential prices.
3. Restrictions are placed upon land and building sizes. In practice this is an essential process when using a hedonic price index as both of these variables are important “adjusters” in the model and must be included. As building areas were not recorded prior to 1985 data from 1981 to 1984 is dropped when using this restriction.
4. Restrictions are made by comparing the sale price to the assessed capital value (AS ratio). A number of different ratio ranges have been trialed in this study. The most broad of these remove sales only if the AS ratio is less than .3 (that is sale price is 3/10ths of the capital value) or greater than three (that is sale price is 3 times the capital value). Narrower ratio ranges were also trialed in the cleaning process.
5. A further restriction that can be used for vacant land is to remove sales where the assessed capital value does not equal the assessed site value. Technically for unimproved vacant land these should be identical.

TABLE 1

| Step | "Cleaning" steps | # House Sales | % of Total | # Land Sales | % of Total |
|---|---|---|---|---|---|
| 1 | All Sales of that Land Use | 581955 | 100% | 169412 | 100% |
| 2 | Remove "OTHER LAND" and VG non-markets | 527342 | 91% | 141760 | 84% |
| 3 | Remove "OTHER LAND", VG non-markets and COM IND | 521166 | 90% | 135953 | 80% |
| 4 | Remove "OTHER LAND", VG non-markets, COM IND and restrict land size. | N/A | N/A | 121833 | 72% |
| 5 | Remove "OTHER LAND", VG non-markets, COM IND, restrict land sizes and CV=SV. | N/A | N/A | 72398 | 43% |
| 6 | Remove "OTHER LAND", VG non-markets, COM IND, AS Ratio <.3 AS Ratio >3 | 502098 | 86% | 61014 | 36% |
| 7 | Remove "OTHER LAND", VG non-markets, COM IND, AS Ratio <.5 AS Ratio >2.5 | 495856 | 85% | 49755 | 29% |
| 8 | Remove "OTHER LAND", VG non-markets, COM IND, AS Ratio <.6 AS Ratio >2 | 482578 | 83% | 42943 | 25% |
| 9 | Remove "OTHER LAND",VG non-markets, COM IND, AS Ratio <.6 AS Ratio >2 ,restrict land and building sizes. | 404549 | 78% * | N/A | N/A |

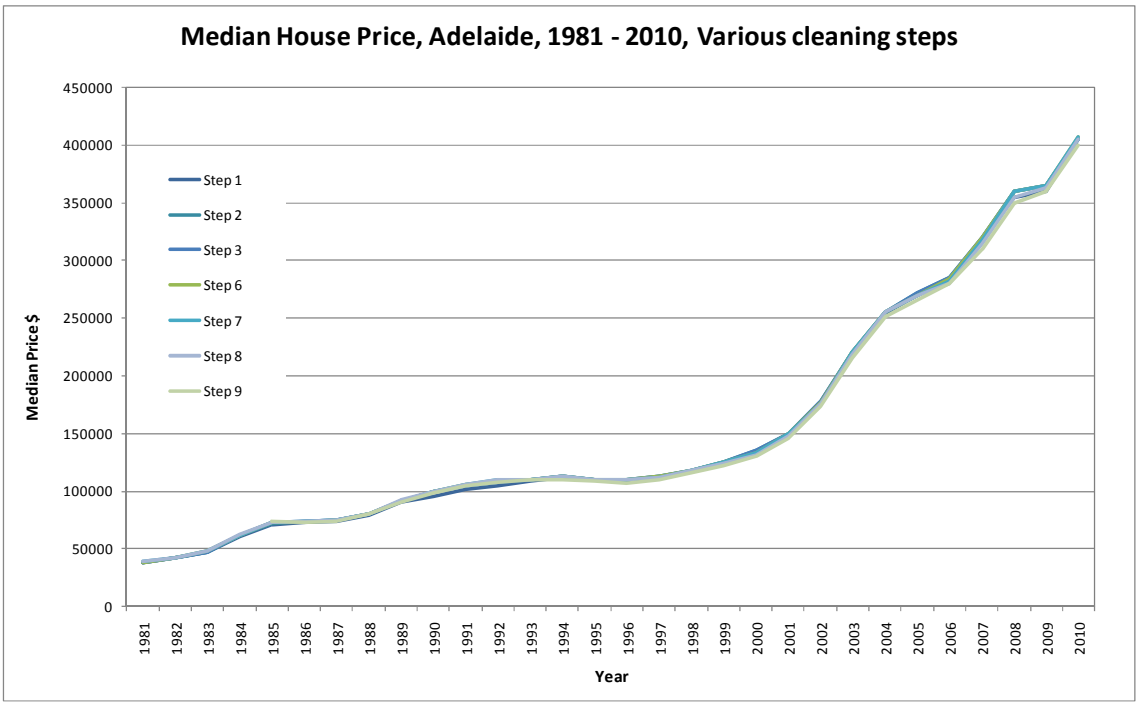
* This percentage is of the houses sold from 1985 onwards when building size data was available.

Table 1 shows the volumes of transactions for various different cleaning steps. For housing the minimal cleaning is probably at Step 3, that is the removal of clearly nonmarket transactions and probable commercial industrial zone properties. This results in around 10% of houses and 20% of vacant land sites being removed. Further cleaning effects for housing leads to a further reduction of 12% (78% of the original sales) at the most extreme point where properties outside of a narrow AS ratio band and restricted land and building sizes.

Within land sales however additional cleaning has a dramatic effect upon the sample size and the use of assessed value indicators (either CV equals SV or any of the AS ratio ranges) results in sample sizes dropping below 50% and down to as low as 25%. This size of reduction in the sample leads to an a-priori rejection of using AS ratio cleaning for vacant land transactions although it is probably very useful for housing.

The significant issue is how cleaning the data affects the time series. To give some indication of the effect of cleaning on the time series the mean and median price is calculated for both housing and vacant land using each cleaning process and the results are compared on a visual basis. Figure 1 shows the time series of median house prices across Metropolitan Adelaide between 1981 in 2010 using various cleaning steps.

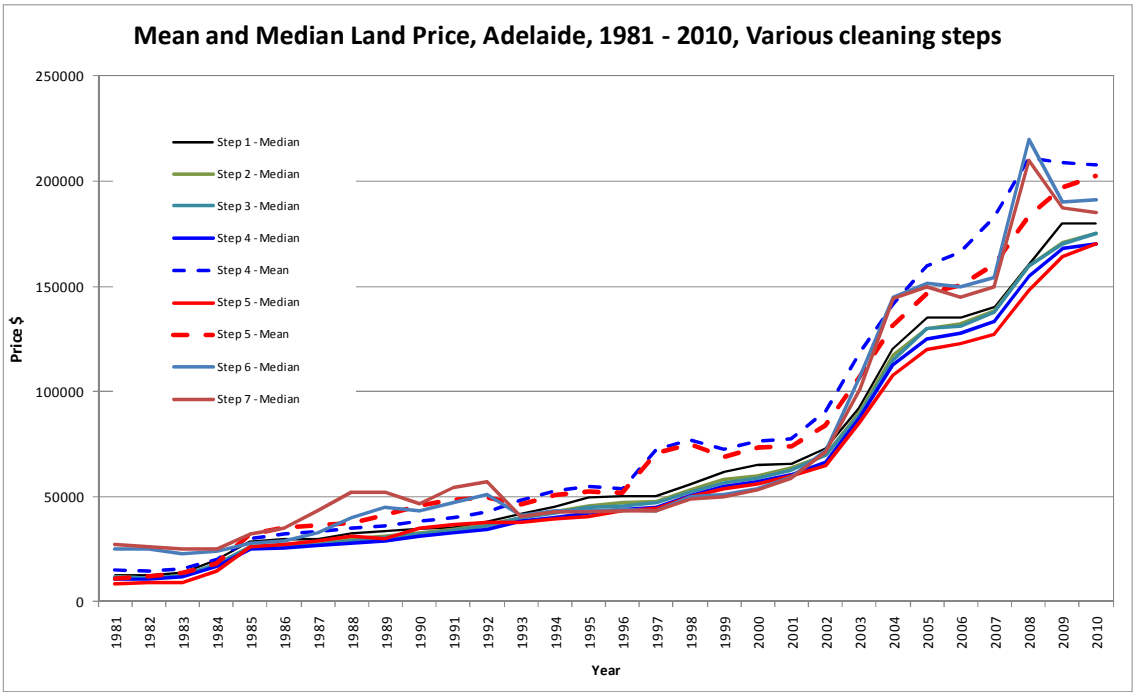
FIGURE 1




Source Author analysis based on data from SA VG, SA State Government & RPData

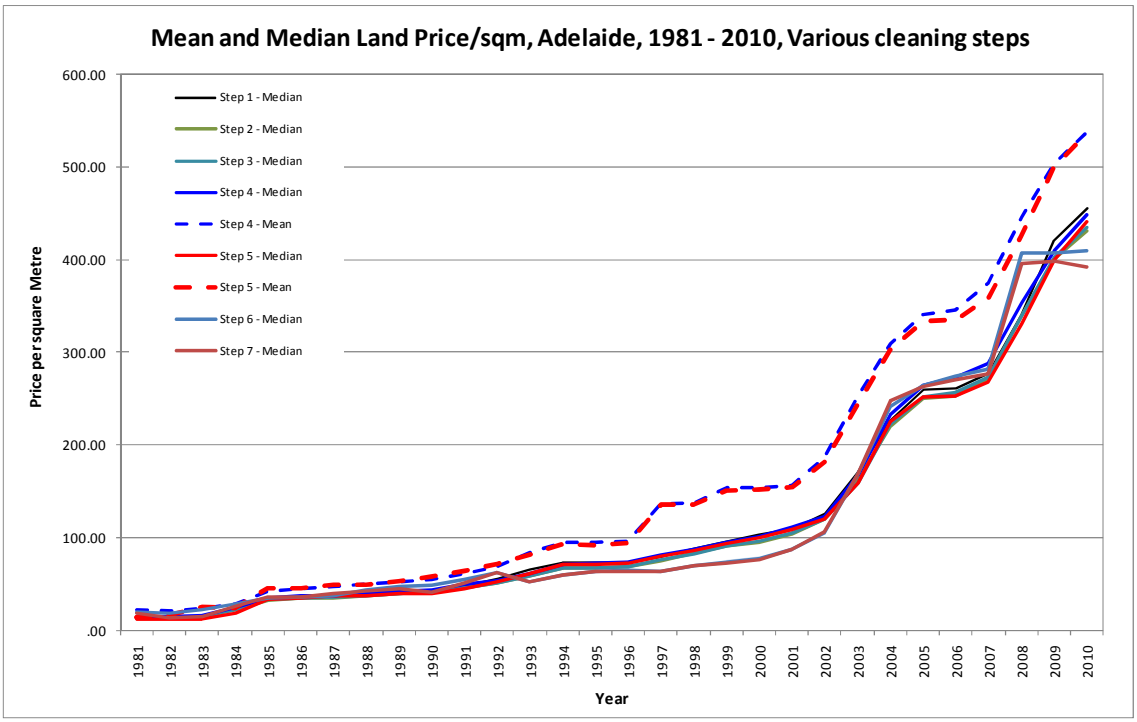
What is immediately noticeable on a visual inspection is that regardless of what cleaning step is used the time series follows almost exactly the same pattern and that the overall results vary very little. Having said this one difference is that the 2010 average price for housing in Adelaide varies between $405,000 and $407,000 for the cleaning methods used in Steps 1 to 8 but is only $400,000 when Step 9 is introduced that is the restricting of land and building sizes. Figure 2 shows the mean and median land price for metropolitan Adelaide over the same period for each cleaning process. Figure 3 shows this same time series where price is calculated on a per square metre basis.

FIGURE 2




Source Author analysis based on SA VG, SA State Government & RPData

FIGURE 3




Source Author analysis of SA VG, SA State Government & RPData

Both Figure 2 and Figure 3 show that there is a significant difference in the time series depending upon the cleaning method used and that particular methods, such as using AS ratio cleaning (steps six and seven), result in very different outcomes from the other methods and that the results are "lumpy".

These "lumps" seem to relate to periods when large numbers of sales are deleted from particular locations suggesting some bias in site value assessment of vacant allotments which in turn suggests that AS ratio cleaning is inappropriate for vacant land. It is also clear that the mean and median prices showed a somewhat different pattern and that and the price per square metre using most of the cleaning methods produces a more consistent result than using land prices.

On this basis this study adopted the following cleaning processes.

- In each instance "other land", nonmarket transactions and probable commercial-industrial zoned properties were removed.
- In the case of land transaction, size restrictions were then imposed and only land transactions when the land was between 50 m² and 1500 m² were included.
- For housing the same land area restriction was imposed and only properties with a building area between 30 m² and 500 m² were included.
- In addition housing where the sale price was greater than twice the capital assessed value or less than .6 of the assessed value were removed.
- This results in 78% of all sales involving a detached or semi-detached house being included in the analysis and 72% of land transactions.

## Hedonic models used in the Indexes for Land and House Price

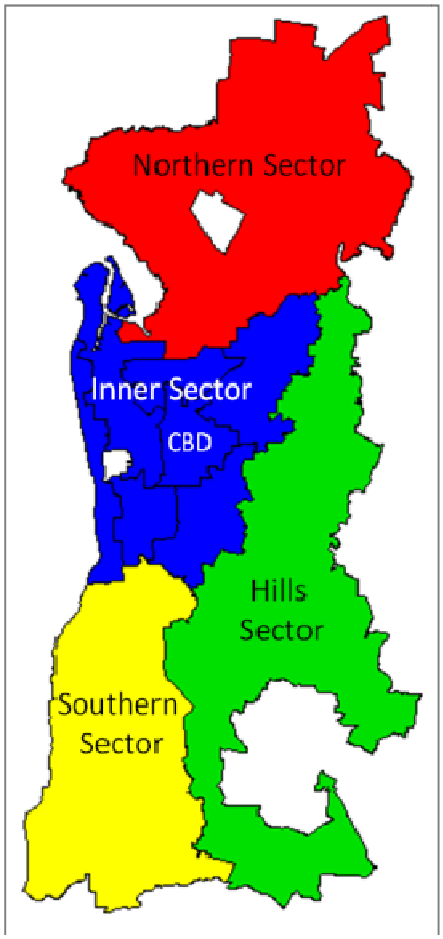
The hedonic models developed for this study used an OLS process. For both houses and land the models were specified as

$$\ln Y = \ln \beta_0 + \ln \beta_1 d_1 .... \ln \beta_n d_3 + \ln \theta_1 X_1 ..... \ln \theta_3 X_n$$

Where $Y$ = a vector of property transaction prices
$\beta_0$ = a constant
$d_{1...}$ $d_n$ = dummy variable for year 1 to year n
$\beta_1 ... \beta_n$ = price index for year 1 to year n
$X_1$..X.n= an array of physical attributes
$\theta_1 ... \theta_n$ = price index for physical attribute 1 to attribute n

For vacant land sales the only physical attribute available was the site area in square metres and this was used together with the site area squared to allow for diminishing marginal returns to produce a Site Adjusted Land Price Index. For housing the building area (and building area squared) and building age were also included to produce a Quality Adjusted House Price Index. After cleaning the time series data was analyzed both at metro level and also broken down by sector, Northern, Southern, Inner and Hills (Figure 4). These sectors reflect contiguous postcodes with similar socioeconomic makeup as well as taking account of natural boundaries such as the Hills Face Zone of the Adelaide Hills.

FIGURE 4




Source Author 2010

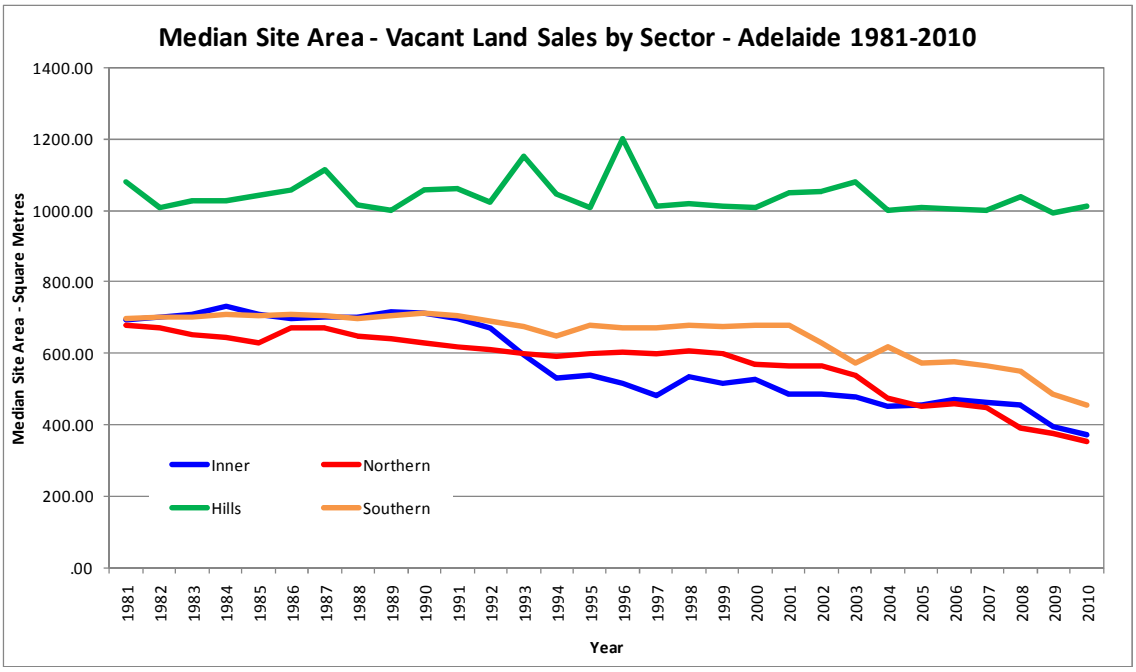
## Results

The results report on over 121,833 vacant land transactions for a 30 year time period from 1981 to 2010 across 4 sectors of metropolitan Adelaide and some 404,549 detached dwelling transactions between 1985 (when building size data was available) and 2010. The median site area of the land sales for each sector is covered first. Then land prices are discussed according to median site price and on a median $ per square metre basis for each sector. Next land prices indexed to the Year 2000, are reported as median site price and on a median $/sqm basis. Then vacant land transactions from 1985 to 2010 are adjusted using the

hedonic model described above to produce a Site Adjusted Price Index with the base year set at 2000 and the metro area included. An equivalent Quality Adjusted Housing Price Index is also presented. Finally the two hedonic indexes are shown for the 25 year time period from 1985 to 2010 with a base year of 1985.

Figure 5 shows that over the period of this study block sizes have been steadily decreasing across most of metropolitan Adelaide. The change in block size has been most dramatic in the Northern sector where average block size began to fall below 600 square meters as early as the mid 1990s, when the largest single residential development in Australia at the time, Golden Grove, began to offer affordable house and land packages. Since then size in this sector has continued to fall and now averages less than 400 square meters as other replica, though smaller, housing developments have taken place. Block sizes in the Inner sector has dropped quite dramatically from around 700 square meters in 1991 to about 500 within 5 years, reflecting the planning drive for urban consolidation. Block sizes in the Inner sector are now are comparable to those in the Northern sector. In the Southern sector block sizes have remained around 700 square meters for much longer than in the Northern or Inner sectors and only in the last 5 years have begun to shrink though they still remain on average well above 400 square meters. Largely as a result of planning codes which limit the size of subdivision, block sizes in the Hills sector have consistently hovered around 1000 square meters for most of the time period and this is still the case in 2010. As such block sizes in the Hills sector are now at least double the size of those in all other sectors.

FIGURE 5

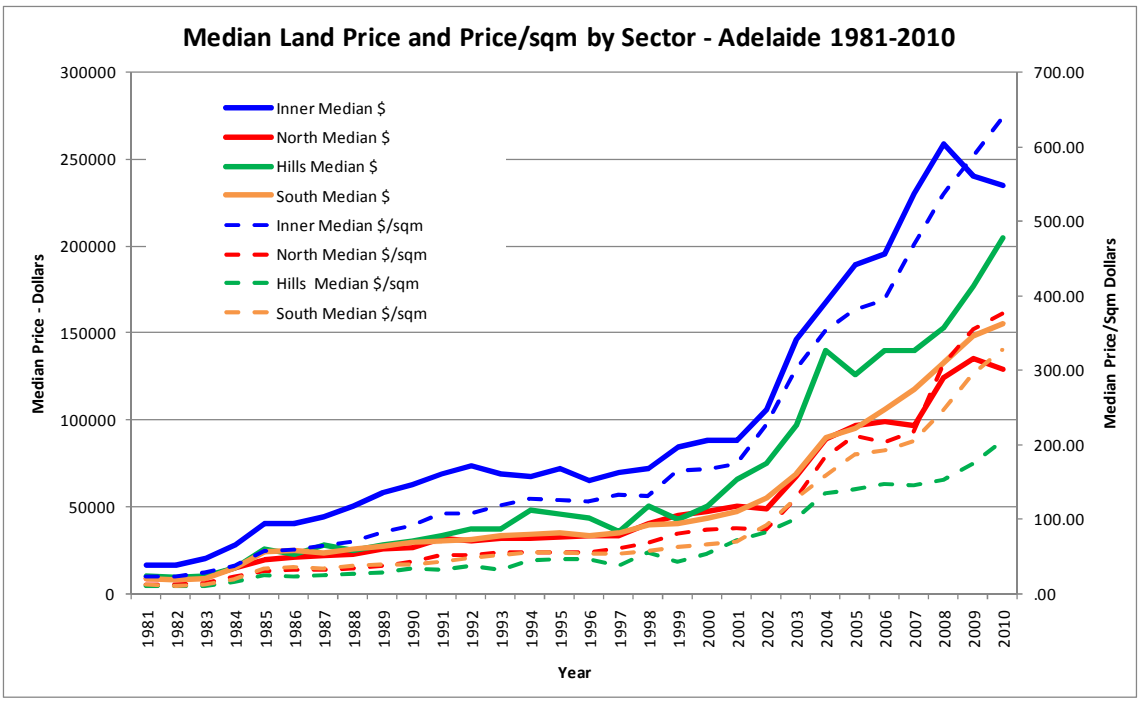



Source Author analysis of SA VG, SA State Government & RPData

Figure 6 shows that some 20 years between 1981 and 2000 land prices across metropolitan Adelaide remained relatively low and stable and, with the exception of the Inner sector, were within a fairly narrow price band across all sectors of the city. This period follows the establishment of the South Australian Land Commission in 1973 and coincides with the introduction of the Urban Land Trust in 1981. On the back of the substantial land banking which occurred in the 1970s, the 1980s was a period of major land release to the north and south of metropolitan Adelaide. On the other hand land in the Inner sector has consistently been more expensive both in terms of overall block price and on a $ per square metre basis. However with urban consolidation priorities, inner sector blocks have shrunk in size to below 400 square meters overall. As a result site values appear to have actually fallen while in fact a premium is now being paid for these Inner sector sites on a $/sq metre basis. Although site prices overall for the Hills region have increased substantially in the last 5 years on a current $ per square metre basis they have been, and remain, the

lowest for Adelaide. Median site prices in the Northern Sector and Southern have been on a par for most of the period though as sites in the Northern Sector continue to get smaller, prices on a current $ per square metre have overtaken those in the Southern Sector.

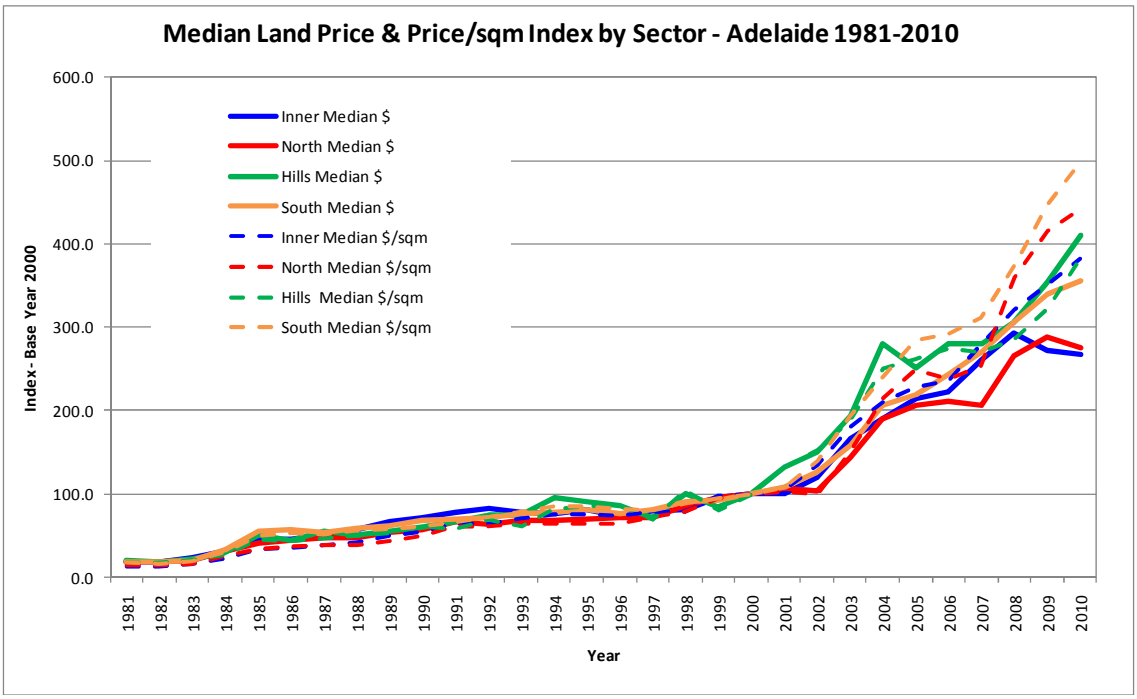
FIGURE 6




Source Author analysis of SA VG, SA State Government & RPData

Figure 7 shows that land prices on a $ per sq metre basis have increased most recently in the Southern and in the Northern relative to the other two sectors. In both the change has occurred in the 2007/2008 period which coincides with a period of government incentive to first home buyers who typically buy in these cheaper areas, especially to the north. Land and house prices in the first home market were largely boosted by the subsidy and may be represented in the pick in land prices for these sectors. Overall site prices have increased most in the Hills Sector relative to the rest of the metro area while the increasingly smaller sites in the Inner Sector have dropped relative to the other sectors.

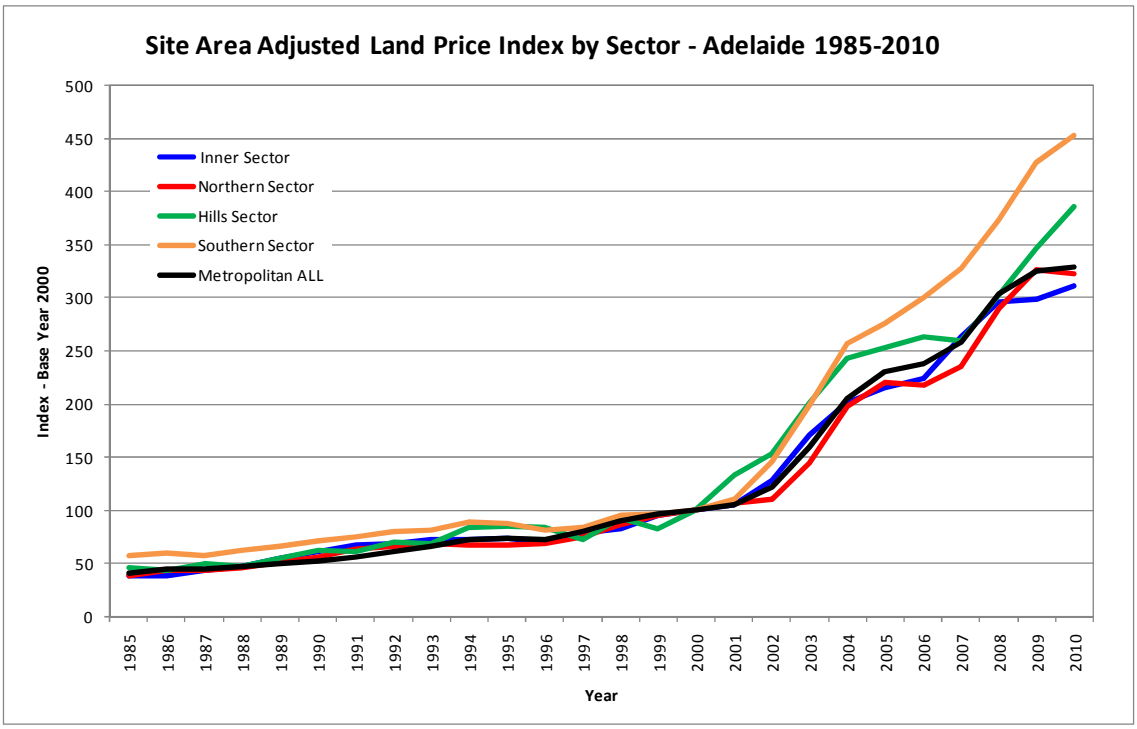
FIGURE 7




Source Author analysis of SA VG, SA State Government & RPData

Figure 8 shows that when sites are adjusted for size the relative increase in prices to the south is even more apparent. The Southern sector may have cheaper blocks relative to the Hills on a site basis and be cheaper than the Northern on a current $ per sq metre basis but since 2000 vacant land prices in this sector have increased at the highest rate. On the other hand the Northern and Inner sectors overall have followed each other more closely. As the prices are site adjusted it is not because the lots are small (blocks in the Northern and Inner sectors are smaller). One explanation for the price growth may be that the land released in the south, with ocean and hills views, is of higher quality than the flat plains to the north or the re-sized infill sites close to the inner city. Demand for land in this sector means that on average the prices in the Southern Sector have increased more than in the other areas especially in the last 5 years or so. Site prices in the Hills have also shown an increase and again lifestyle, quality of location and faster commuter travel may be prompting this surge in the rate of land price increase.

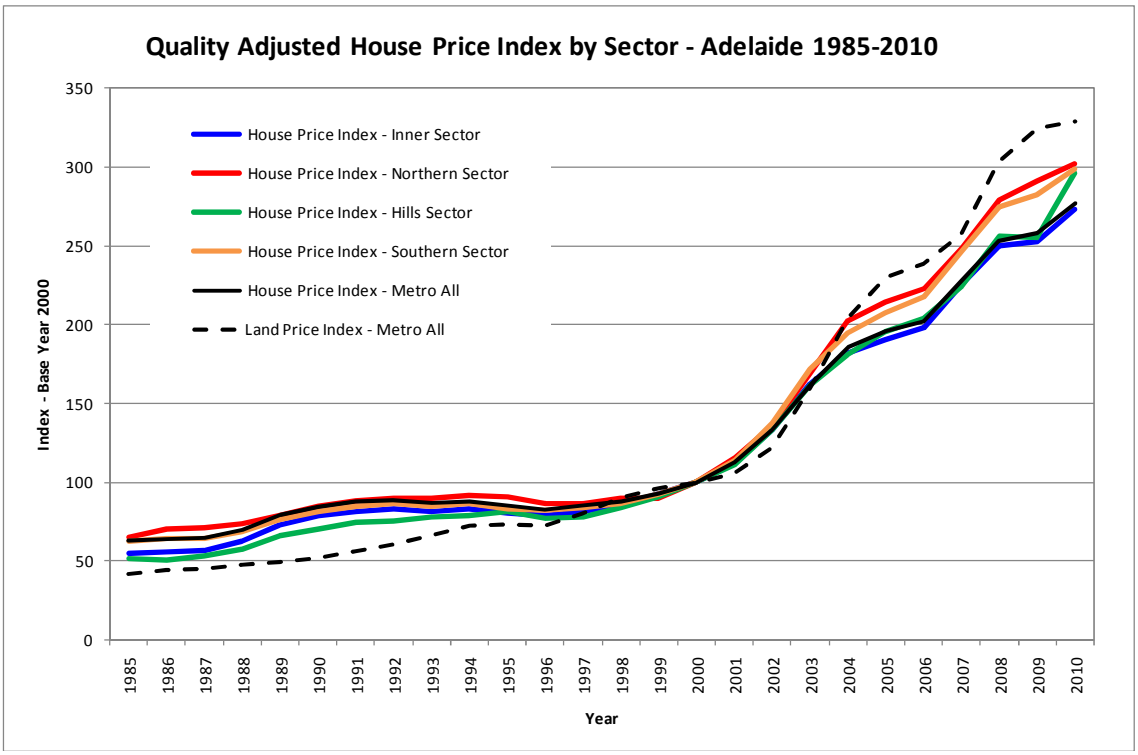
FIGURE 8




Source Author analysis of SA VG, SA State Government & RPData

On a quality adjusted basis Figure 9 shows that since 2000 detached house prices have had the greatest rate of increase in the Northern and Southern sectors, traditional areas of first home and family purchase. In the last 2 years house prices in the Hills have also shown a marked increase in their rate of growth. The rate of increase in the Northern sector has closely matched the overall metro rate for Adelaide. In the period before 2000 vacant land prices increases were low relative to detached house prices but as of 2000 and especially from 2002/2003 began to jump well ahead of metro house price increases to eventually outpace detached house price increases in all sectors.

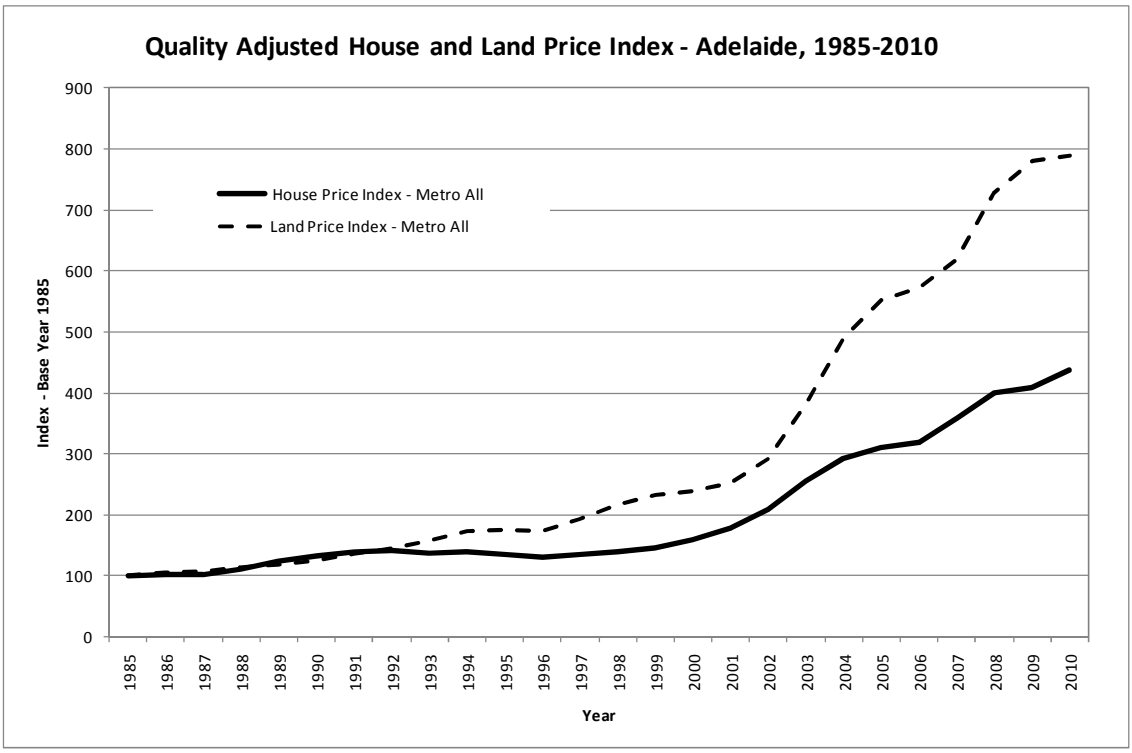
FIGURE 9




Source Author analysis of SA VG, SA State Government & RPData

This increasing gap in the rate of growth between vacant land and detached house prices across metropolitan Adelaide is well illustrated by Figure 10. Using 1985 as the base year it shows relative price increases for vacant land and for detached dwellings for metropolitan Adelaide over a 25 year period. There can be no doubt about the rising cost of vacant land relative to detached dwellings on improved sites. The period of the Urban Land Trust from 1981 to 1996 would appear to be one of modest house price growth and a moderate rise in the rate of land price increase. However as of 1996, which just happens to coincide with the introduction of the profit seeking Land Management Corporation, land price increase picks up before escalating as of 2001/2002 to surge again in 2007/ 2008. Both these periods coincide with government subsidies to first home buyers. However as only some 20% of first home buyers purchase, or build, new homes the explanation, if there is one, probably lies elsewhere.

FIGURE 10




Source Author analysis of SA VG, SA State Government & RPData

## Conclusion

The next stage of this research will be to undertake some causality modeling of land and house prices using the indexes presented in Figure 10 and to explore event analysis. Also to enquire of residential developers their view of the world. This paper presents, in particular, a most rigorous and detailed selection and cleaning of a massive data set with a view to offering an analysis of vacant land prices which will afford close scrutiny by both academics and the development industry. We wish to be as well placed as possible in order to engage with the industry in terms of their land pricing strategies and this research has gone some way towards meeting that objective. The paper places land price change in the context of house price change both over time and across sectors. What it does not do is offer much by way of explanation. That is our next goal.

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