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## Developing a weekly residential price index using the Sales Price Appraisal Ratio

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**Keywords:** House Price Index, SPAR index, Hedonic Indices

**Abstract:** In July 2004 the Reserve Bank of Australia published an influential paper discussing issues relating to the longitudinal measurement of housing prices. In that paper it was suggested that residential house price indices were fraught with problems including timeliness, sample selection bias and a failure to deal with changes in quality. This paper reports research that uses a Sales Price Appraisal Ratio (SPAR) technique to develop an index that could be timelier than traditional indices that are released at quarterly intervals. The research compares the results of a monthly SPAR index to other indices based on mean, median and tri-mean prices as well as a hedonic index. The SPAR index is then calculated at a weekly level and compared to the traditional indices calculated at the same level. The research shows that the SPAR index produces very similar results to the hedonic index with less variable results than the mean, median and tri-mean index. The results suggest that the SPAR index would be suitable as a monthly index across a broad region or it would make a usable weekly index across a broad region, and a monthly index at a submarket level. The research also illustrates that a SPAR index may provide a suitable methodology for producing price indices for other land-use types where indices have been traditionally impossible to produce.

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## Introduction

In July 2004 the Reserve Bank of Australia released a bulletin that discussed a variety of issues regarding the measurement of housing prices and was widely publicised in the popular press (for example Wood, 2005). The Bank states that it is difficult to measure housing prices (in practice they are discussing this in the context of a suitable house price index over time) naming three principle problems to obtaining an accurate and timely reading.

- (a) Timeliness, caused by the time lag between contract and settlement dates; the lack of data at point of contract and the lags that occur in compilation after settlements.
- (b) Compositional Changes resulting from the variable sample of properties that sell during each period. This variation together with the heterogeneous nature of real estate makes it difficult to use simple measures such as medians because of sample selection bias. (Note: while the median is based on all probable market transactions it is still a sample statistic as it is interpreted as inferring movements across all properties in a market segment)
- (c) Quality Improvement changes are caused by a gradual improvement in housing quality (especially building area) over time. This is a problem that has been well researched with early work in Australia being carried out by Rossini (1995) demonstrating the problem.

In suggesting there are no reliable measures of housing prices the bank then reviews the various mainstream measures. In a similar paper, Abelson et al (2004) also reviews these measures with some conflicting results. These are in summary

1. Real Estate Institute of Australia (REIA) – which the bank states has released quarterly median prices since the late 1970's. They go on to say that for most capitals the median is based on lands titles data. This is in fact only true in recent years and previously the REIA used a sample of data based on returns from agents in their organization. This data was found to be heavily biased in the early 1980's and presumably this bias remains in the early figures. Neither author chooses to acknowledge the research that demonstrates this bias.
2. Commonwealth Bank of Australia (CBA) – uses data from their loans. This creates a timelier index as the data is probably available two weeks before settlement in most cases. However the data is heavily biased, representing dwellings involving only properties involving a loan and from only one lender.
3. Australian Bureau of Statistics (ABS) – produces quarterly indices for capital cities dating back to 1986. They are robust in terms of data collection and lack of bias but they are not timely and the attempt to control for compositional change through stratification is very limited.
4. Residex index – This index should overcome some of the compositional changes by the use of repeat sales. The indexes are produced only for Brisbane, Melbourne and Sydney but do go back to 1978. Very little is known about the calculation of this index but it will certainly suffer from the typical repeat sales problems which will be exacerbated by the poor quantity of data in each location (discussed later).
5. Australia Property Monitors (APM) – estimate median prices for all seven Australian capitals based on settlement prices however the index is subject to minor changes as the index is reviewed as more data is included (this is not really a problem in our opinion).
6. Land Titles Offices – in all states they are the original collector of transaction data and some distribute summaries. Abelson state that “only NSW LTO regularly publishes summary statistics on housing prices”. This may be strictly true as in

other states the data is assembled and reported by other agencies. For example in South Australia the Office of the Valuer General has released quarterly summaries with various stratifications since the 1970's! These are currently available "free of charge" on a government web site. Abelson's statement that (other than NSW) "none publishes summary price statistics on a regular and timely basis" would appear to be very misleading, unless quarterly is not considered to be timely.

## Index Construction

Abelson (2004) provides a comprehensive set of median prices and indexes across Australia. Many of these seem to be created through various "judgmental" adjustments. Certainly the figures for Adelaide from 1970 to 1980 do not match those calculated by the author from the set of all transactions over this period (as recorded by the LTO). This calls into question the validity of some of the results. Notwithstanding the vagaries of different calculations across the data, the underlying concern is the continued use of median prices. Since the 1960's academics have been producing papers showing the problems with simple median indices. Notable landmarks in the development of indices are papers by Bailey et al (1963) and Case and Shiller (1989) but in practice there has been a gradual improvement in index theory mainly from the US. At the PRRS conference in Melbourne, 2005, a paper by Bourassa et al (2005) summarised this development (see also Bourassa et al, 2004) and outlined the problems of severe biases that exist in median indexes. They outlined the three main groups of index models, namely the hedonic; repeat sales and hybrid models as well as highlighting some of the problems with them. They then suggested a more simple method, the Sale Price Appraisal Ratio, SPAR index, that had the same advantages as the other three but with an easier calculation.

Many of these index methods overcome the problems of compositional changes and quality improvement but do not deal with the issue of timeliness. Research on these types of indices in Australia has been around since the 1990's. In 1995, Rossini et al discussed the use of a variety of measures across time and demonstrated the problems in using median prices using data from Port Pirie in South Australia. They used a simple method to adjust median process for measurable quality changes in a market that showed dramatic changes to house quality due to a Government sponsored lead decontamination project. In follow up papers (Rossini, 1996a and 1996b) showed similar problems of interpretation of the median price index in other Adelaide suburbs. At the same time Costello (1997) was using more conventional repeat sales methods on data from Perth in Western Australia. Both Costello and Rossini have continued research in these two cities and have included research on the seasonal effects of property prices (Rossini et al, 2000 and Costello, 2001). Notably neither found any significant seasonal effect of residential property prices but the RBA (2004) suggest that they seasonally adjust their indices although closer examination suggest that they simply smooth the data (possibly with a moving average calculation typically used in estimating season indexes). It's not unreasonable to suggest that Perth (Western Australia) and Adelaide (South Australia) have the best property data in Australia. Both states have long term arrangements (over 20 years) for LTO data to be combined with other valuation data to form richer datasets than most eastern states (such as New South Wales, Victoria and Queensland). The repeat sale method used by Costello relies heavily on finding repeat sales where quality has remained constant. This requires the analyst to have access to property indicators that can be used to establish the constant quality. It's difficult to see how this level of analysis can be achieved in the data poor eastern states markets. Rossini utilizes a hedonic approach and has released quarterly indexes for Metropolitan Adelaide (also stratified by location and dwelling size) for several years. These

have been used for other research (e.g. Rossini et al 2001 and 2002) and compared to the published ABS index. These indices will be used as the benchmark in this research.

The hedonic, repeat sales and hybrid methods require rich data sets and complex econometric estimation. The SPAR index suggested by Bourassa et al is quite simple while producing similar results. According to Bourassa, the SPAR index has been used in New Zealand since 1961 (until 1982 it was value weighted). The calculation requires arms length transaction prices and a single point appraisal (such as a rating assessment). This has similarities to repeat sales except that one value is the actual price and the second an appraised value. Bourassa explains that the advantages in having the appraised value at one date means that the complex econometric estimation is not required. The index also requires less data although a similar issue can occur if the sale and appraised value are not based on a constant quality as in the repeat sales index.

The use of the SPAR index may make the index timelier. Timeliness is a function both of the time difference between contract and settlement date as well as the period of the index. Klan (2005) reports that the ABS is considering using information from banks and lending institutions in an attempt to shorten the gap between contract and settlement dates. The ABS hopes to release the index by as little as four or five weeks after the end of the quarter compared with their current practice of releasing it after eight weeks. But this may still mean that there is a four month gap between a price movement and its reporting. The simpler SPAR index may offer a more timely solution if produced at more regular intervals. In South Australia the typical gap between contract and settlement is about 3-4 weeks. A monthly index based on settlement data would be significantly timelier than a quarterly index based on contract dates. However a shorter term index tends to be more "lumpy". This trade-off between "timeliness" and "lumpiness" is best considered through empirical testing. A second issue with a shorter term index is that it is likely to require revisions as more data becomes available. This is an issue with the APM index and the level of adjustment may be an issue. This also needs to be tested empirically. A third issue to be considered is the use of the SPAR index for non-residential properties. The development of an index for some land uses is almost impossible. Rural properties present probably the biggest challenge with small numbers of transactions involved a very heterogeneous product. The SPAR index may offer a useful approach to non-residential index construction.

## Methodology

This paper does not seek to discuss the theoretical issues in the development of a SPAR index. The work of Bourassa et al (2005) is certainly more than sufficient on this issue. Readers interested in the construction of a SPAR or other indices are directed to this material. The research behind this paper seeks to test the practical usefulness of a SPAR index in South Australian property markets. Results from this analysis may then suggest the usefulness of the approach in other locations. The following procedure is adopted:

1. Produce the **quarterly** SPAR index for houses across Adelaide and compare this to the existing hedonic index and as well as mean, median and tri-mean indices.
2. Produce the **monthly** mean, median, tri-mean, hedonic and SPAR index for houses across Adelaide. The monthly hedonic and SPAR indices are compared to the quarterly index to test for consistency.
3. Produce the **weekly** mean, median, tri-mean, and SPAR index for houses across Adelaide. The hedonic index is ignored at this point due to the time requirements of construction at a weekly level.

4. For one time period produce the SPAR index for houses across Adelaide on a rolling basis and examine how the index changes as more data is added. This is calculated based on the data as it arrives from the LTO and is hoped to simulate other time periods. The analysis will compare the weekly index at the end of the week when sales are recorded then the same value is compared for the following 5 weeks as more data from the LTO are added. This will simulate how much the index may change between an initial index and a finalised index when data is completed (probably at the end of the year)
5. Produce the **quarterly** mean, median, tri-mean, and SPAR index for viable primary production land uses across South Australia.

## **Data**

Data for this project is supplied through UPmarket Software Services who are one of several data resellers in South Australia. Each of these resellers purchases data from the South Australian Government. Transaction and legal details are from the LTO and this is merged with valuation data prior to resale. For this project the data used was from 1994 to 2004. While earlier data is available, a single point Capital Value is a part of the data set for this period so it is selected for ease of use. The CV is dated January 1- 2004 although in practice the Valuer General would have compiled this during 2003. The SPAR index is generally calculated with the assessment at the end of the period. However Bourassa et al (2005) suggests that other researchers have used data where the assessment is at other periods. To test the viability of a timelier index it is necessary to have the index created with a fixed point in the past (for new indices) but there are advantages of having it as near to the end of the series as possible. Properties constructed after the assessment date will not have a suitable previous assessment. Fixing the assessment period at the beginning of the series will exclude all properties constructed after that (in this case 1994). By using data with the fixed assessment date as near as possible to the end of the period, more sales can be used. Only recently constructed properties are ignored and these are likely to provide bias in any case. The date of sale is the settlement date as contract dates are not collected.

For all residential indices the data are arms length transactions, and further filtered for obvious errors. Sales are within metropolitan Adelaide and listed as detached houses.

For the indices of primary production properties, the whole of South Australia is used and all properties listed with a viable primary production land use are included. This will include a large number of small properties that may be considered to be hobby farms.

## **Output**

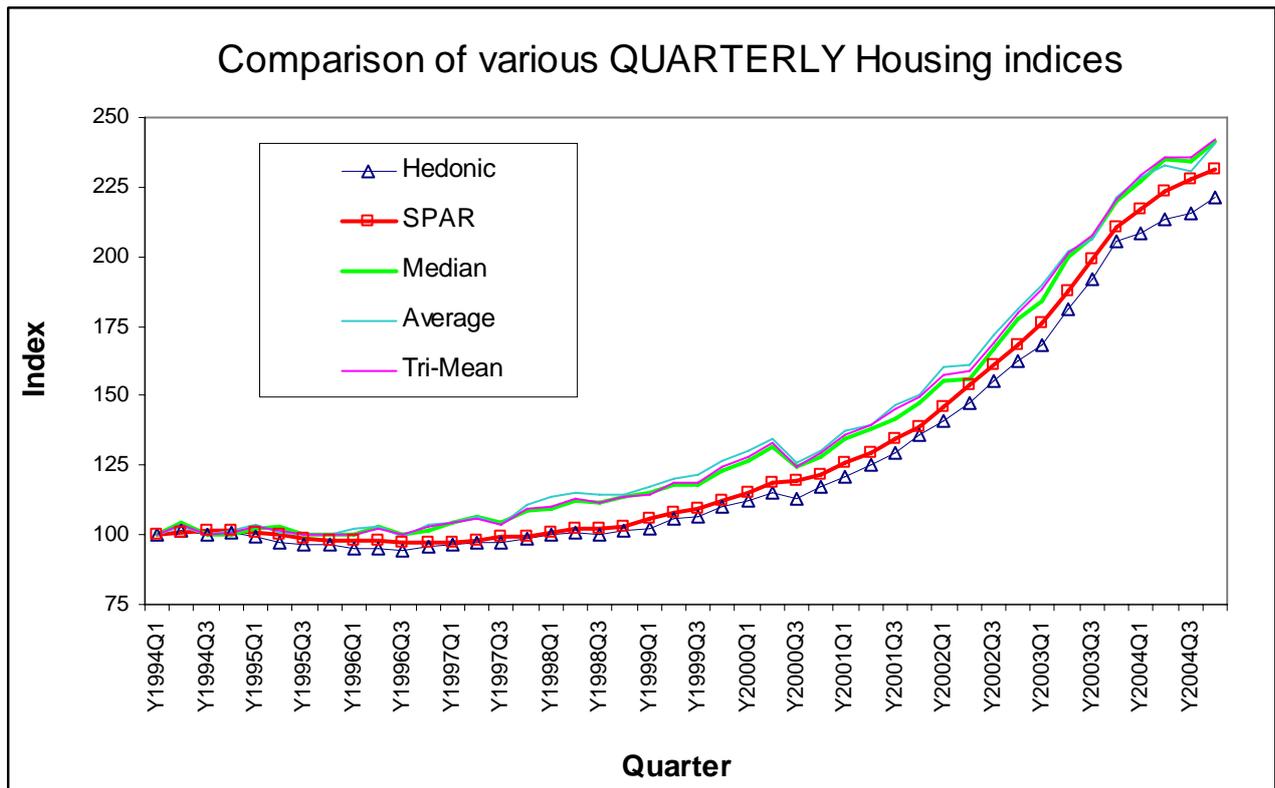
For this preliminary investigation only charts are displayed as a visual tool for comparison and statistics of index differences are calculated. When comparing indices for “lumpiness” the coefficient of variation (COV) of the differences is a useful tool. The COV is the ratio of the standard deviation to the arithmetic mean. As the index becomes “lumpy” it varies significantly from period to period and the COV of differences increases sharply. Actual indices will be made available at a latter stage in the same manner as is currently available for hedonic price indices.

## Results

### Quarterly Housing Index

The quarterly housing index is a useful starting point for comparison. The hedonic index for Adelaide is well established and quarterly median figures are widely used throughout Australia. The results for the hedonic, median, mean and tri-mean and SPAR indices are shown in Figure 1.

**Figure 1 - Chart showing quarterly hedonic, SPAR, median, average and tri-mean housing indices for Adelaide over 11 years**



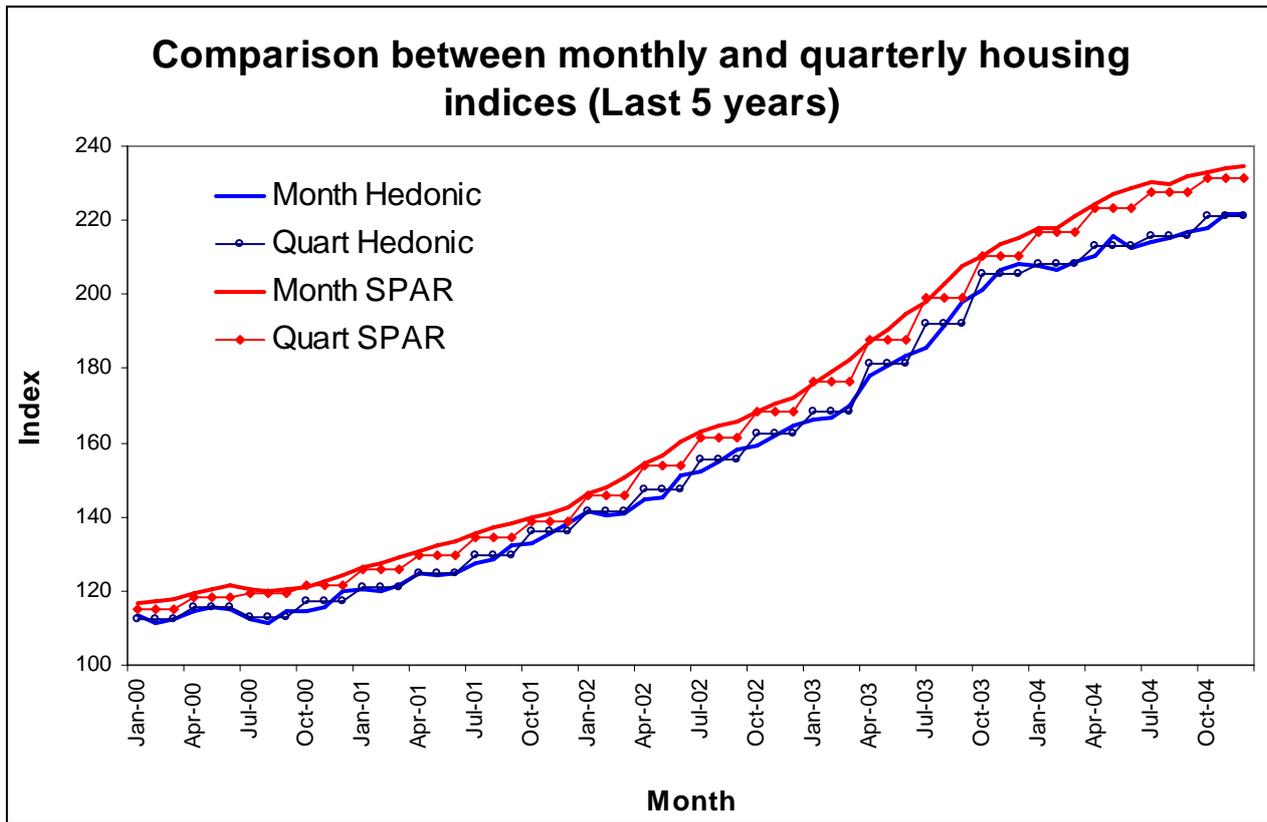
The indexes based on mean, median and tri-mean are all very similar. This is primarily due to efficient data filtering. When only reasonably probable arms length transactions are used, many of the advantages of the median and tri-mean are lost. Each of these measures shows the expected deviation from the more reliable hedonic index. The gradual positive drift is a result of the quality improvement over time. In essence the “typical” property has improved and this is not held constant in the simple indices. The SPAR and hedonic index deal with this issue much better and give a more correct view of the long term change. The SPAR index tends to track the hedonic index very closely until the end of 2003. This equates to the period of the assessment and this variation is likely to be caused by a small measure of sales chasing in the assessments. This needs to be investigated further and will be the focus of future research to determine the effect of this on the SPAR index. The median, average and tri-mean index also show problems of compositional change. Most of the “lumpiness” in the three simple indices are due to this issue which is not evident in the hedonic and SPAR index. A particular point of interest is at the end of Quarter 2, 2000 when the GST was introduced in Australia. The three simple indices show a marked drop in value, the hedonic has a minor decline and the SPAR is almost unaffected. Examination of the data at this period shows that sales leading up

to the introduction on GST were slightly better than average. For example the mean building area of sales was about 2% above the long term average for that period. After the introduction of the GST there was a predominance of smaller, cheaper houses sold. In Quarter 3, 2001, period immediately after the introduction of the GST, in the mean building area was around 3% below the long term average. This difference in the composition of the sales is the reason for the decrease in mean and median prices although this may be incorrectly assessed as a price decrease associated with the introduction of the GST. These are the types of compositional changes that plague the simple indices particularly on a short term basis.

**Monthly Housing Index**

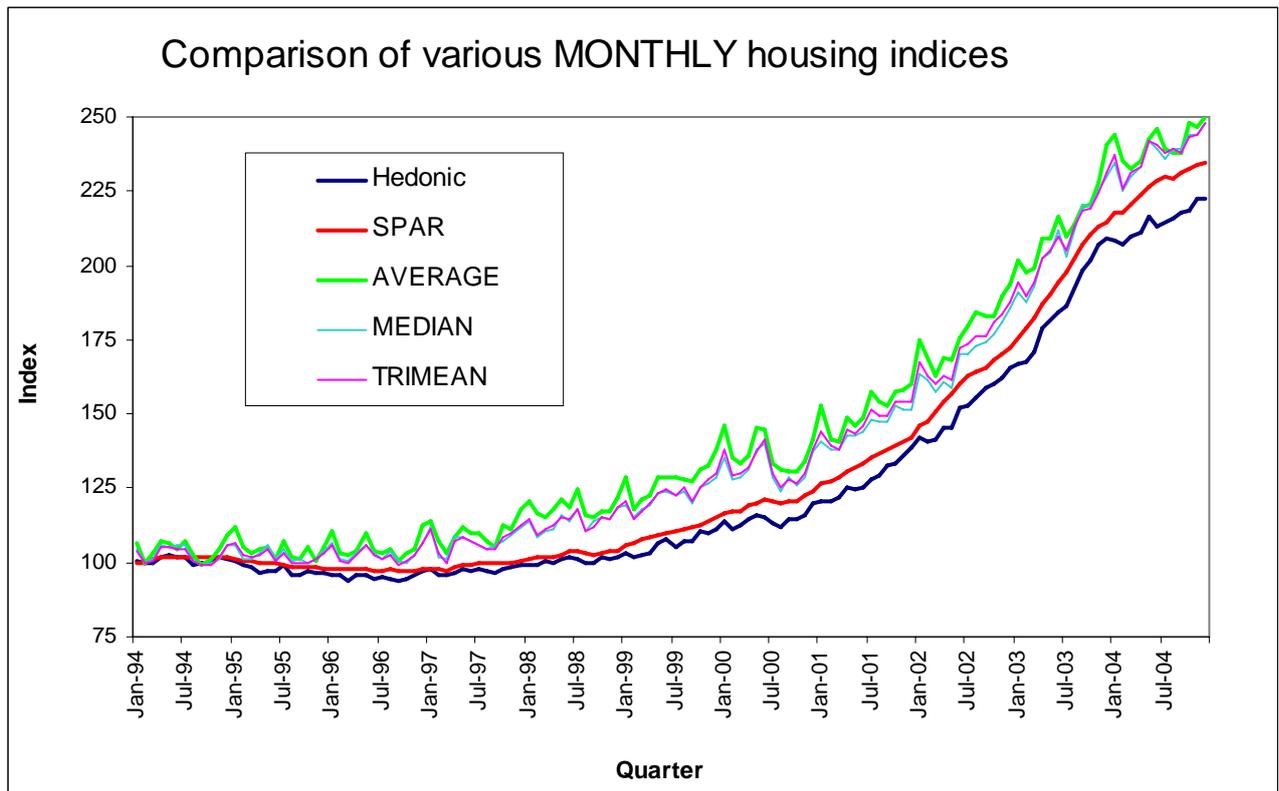
The Indices are recalculated at a monthly level. Figure 2 shows the comparison between the quarterly and monthly SPAR and Hedonic indices. In each case the monthly index is consistent with the quarterly index. The SPAR index is particularly good showing steady progressions between the quarterly figures. This chart suggests that a monthly SPAR index is certainly an option for the whole metropolitan area.

**Figure 2 - Chart showing the comparison monthly hedonic and SPAR indices for housing in Adelaide over 5 years.**

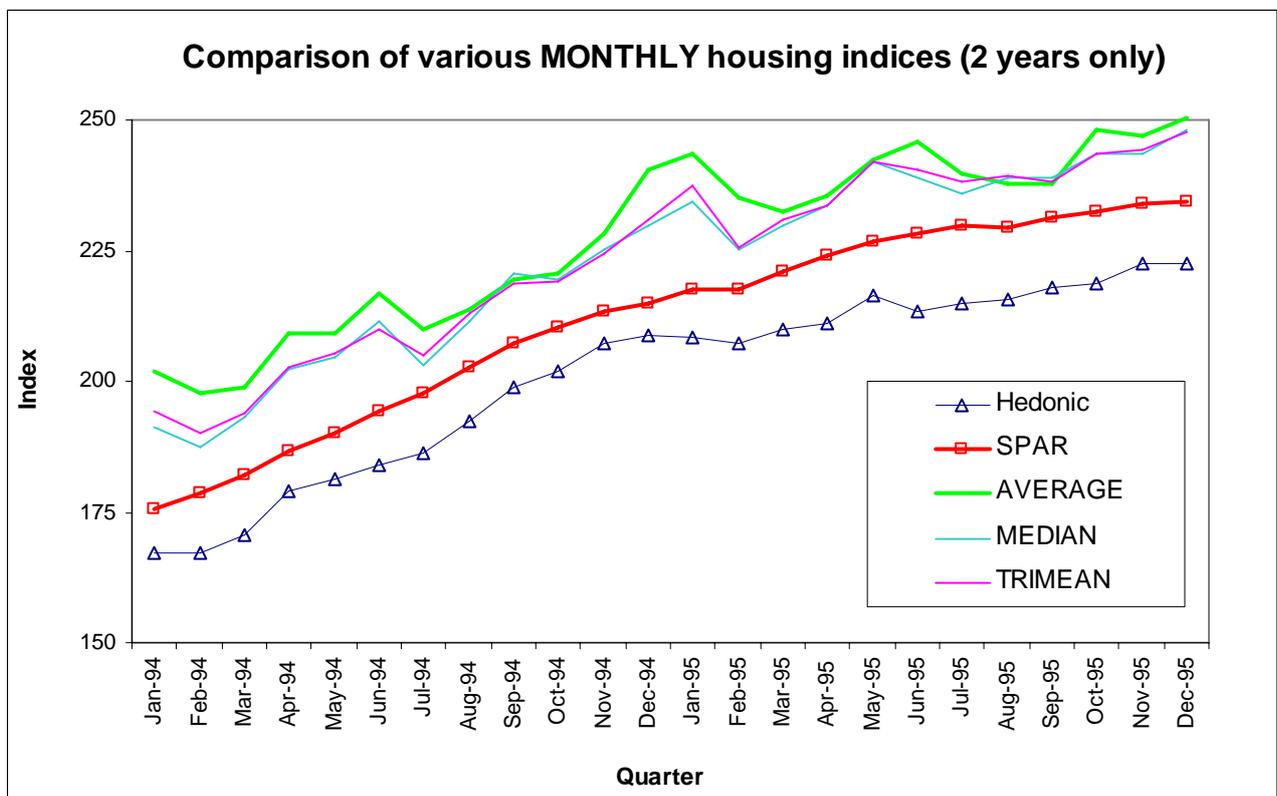


The monthly indices for all methods are shown in Figure 3 and Figure 4.

**Figure 3 - Chart showing monthly hedonic, SPAR, median, average and tri-mean housing indices for Adelaide over 11 years**



**Figure 4 - Chart showing monthly hedonic, SPAR, median, average and tri-mean housing indices for Adelaide over 2 years.**



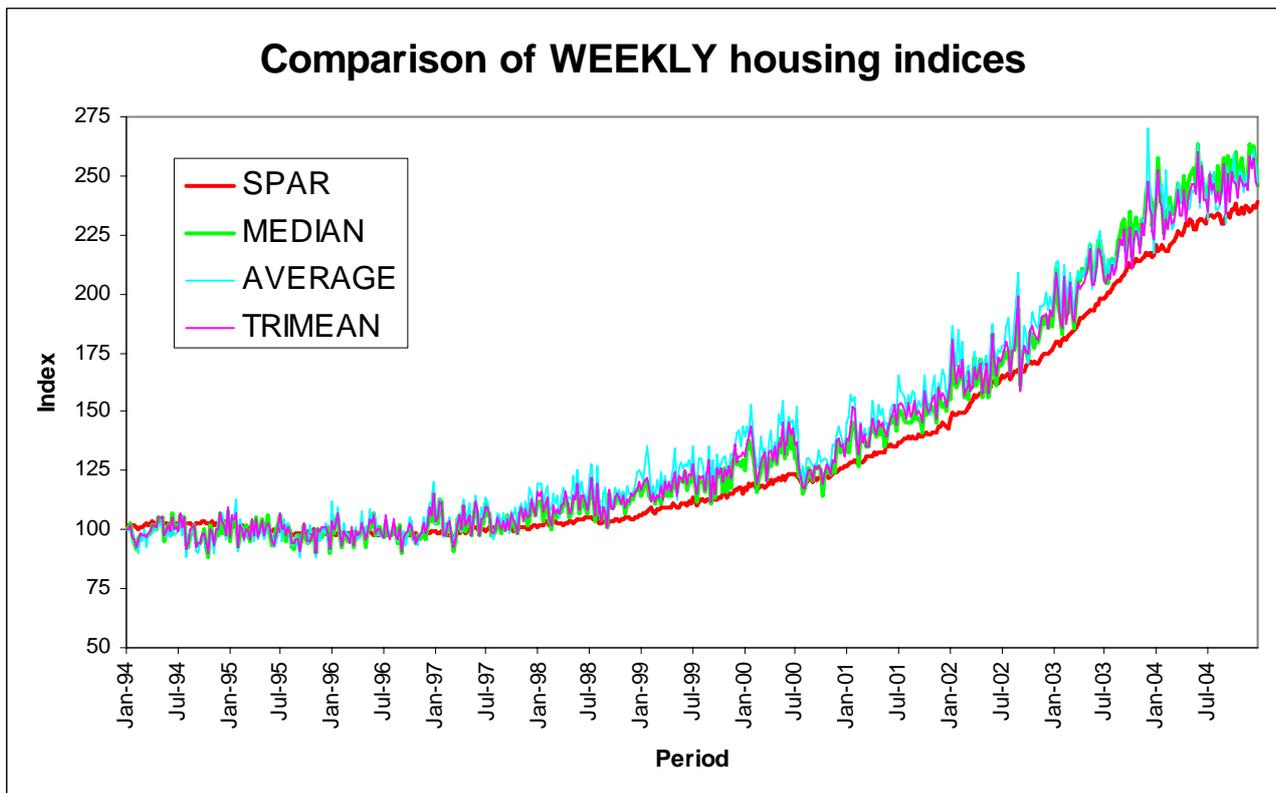
The monthly figures indicate the usefulness of the SPAR index when calculated over a shorter time scale. The hedonic index become “lumpier” as the number of coefficients in the econometric model increases and the statistical significance decreases. The compositional changes seem to affect the hedonic model at a monthly level but the effect is still significantly less than for the simple indices. The median and tri-mean track each other closely and the average is still similar. Each suffers major “glitches” as the composition of the transactions varies. The number of arms length house transactions sales in Adelaide varies each month but are almost always between 1250 and 2250. This is sufficient to provide quite a smooth index using the SPAR but can easily be biased for the more simple methods. Dividing this into smaller strata on say a house size or location basis may lead to considerable variability. The “lumpiness” of some of these indices is highlighted in Table 1. The COV of the differences for the SPAR index is smaller than the hedonic index and very much lower than for the three simple indices. The SPAR is measurably less lumpy.

<b>Table 1 - Monthly Index Differences</b>					
	Hedonic	SPAR	Median	Average	Tri-mean
Average	0.932	1.027	1.096	1.095	1.100
St Dev	1.964	1.312	5.065	4.184	4.158
COV	2.106	1.277	4.623	3.821	3.780

### **Weekly Housing Index**

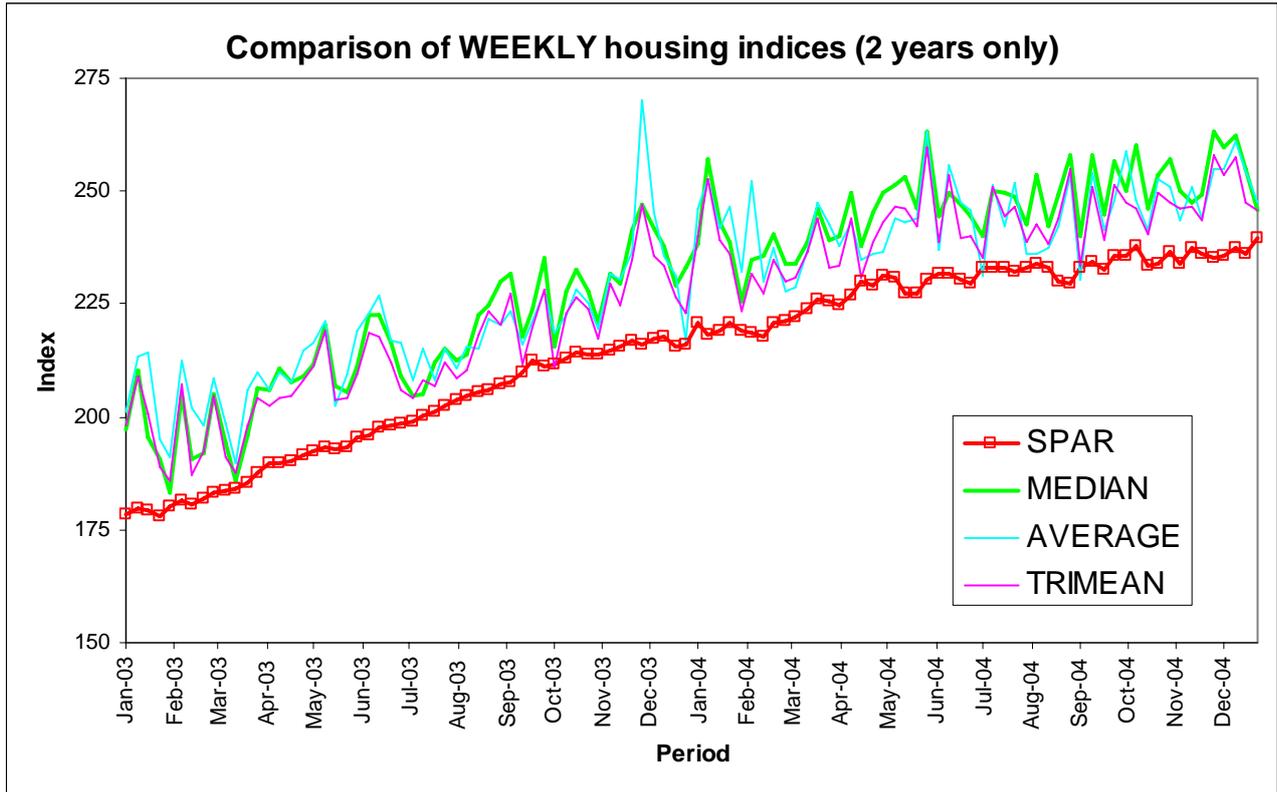
The SPAR, median, average and tri-mean index were then calculated at weekly level. Figure 5 shows the index for 11 years while Figure 6 shows the results for a shorter period of time to highlight the stability of the SPAR index compared to the other indices.

**Figure 5 - Chart showing weekly SPAR, median, average and tri-mean housing indices for Adelaide over 11 years**



The chart showing the weekly indices over 11 years shows the same general trends as the monthly and quarterly indices. The median, average and tri-mean show creep due to the changes in overall quality while this is largely corrected in the SPAR. The variation due to compositional changes are also a problem both on a week to week basis and on a longer basis (note the problem in mid 2002 when the GST was introduced appears now as a series of higher then lower values).

**Figure 6 - Chart showing weekly SPAR, median, average and tri-mean housing indices for Adelaide over 2 years**



The three simple indices are noticeably “lumpy” and this is highlighted in Table 3. The COV of differences for the SPAR index is many times smaller than for the three simple indices.

	SPAR	Median	Average	Tri-mean
Average	0.243	0.258	0.255	0.255
St Dev	1.067	8.329	6.700	6.728
COV	4.386	32.318	26.316	26.425

	Quarterly	Monthly	Weekly
Average	3.060	1.027	0.243
St Dev	3.501	1.312	1.067
COV	1.144	1.277	4.386

However the COV for the SPAR index is also much larger for the weekly index than for the quarterly or monthly index. This is shown in Table 2.

### **Changes to the index as more data is collected.**

One of the major issues with an index over a short period will be the change to the index with the addition of subsequent data. This is allegedly an issue with the CBA index. Regardless of how data is collected, new data will appear after the index is released. If contract dates are used then data would need to be removed if the sale fails to eventuate. When settlement dates are used, new data appears due to errors in the original documentation. Whatever the problems, the effect will be greater for a short period index. The effect of new data may not necessarily make major changes to the index, depending upon the type of index. To simulate the effect of new data a period was selected 5 weeks before the end of the data period. The index was then constructed on a weekly basis using all data up to that particular week. This is based on the record date (this is the date the transaction is added to the database). To produce an index each week, the settlement date is used as the transaction date but in subsequent weeks, additional transactions with that date will appear. Most of these will appear in the following week probably due to short-term data processing issues. For example a property that is settled on a Friday afternoon will probably be added on Monday morning. In this instance 75% of the transactions occurring in that week appeared in the data base by the end of the week. By the end of the following week 96% of transactions were in the data base. The effect of the additional data makes very small changes to the values used in the index. This is shown in Table 4.

**Table 4 - The effect of changes to the data base following the weekly index.**

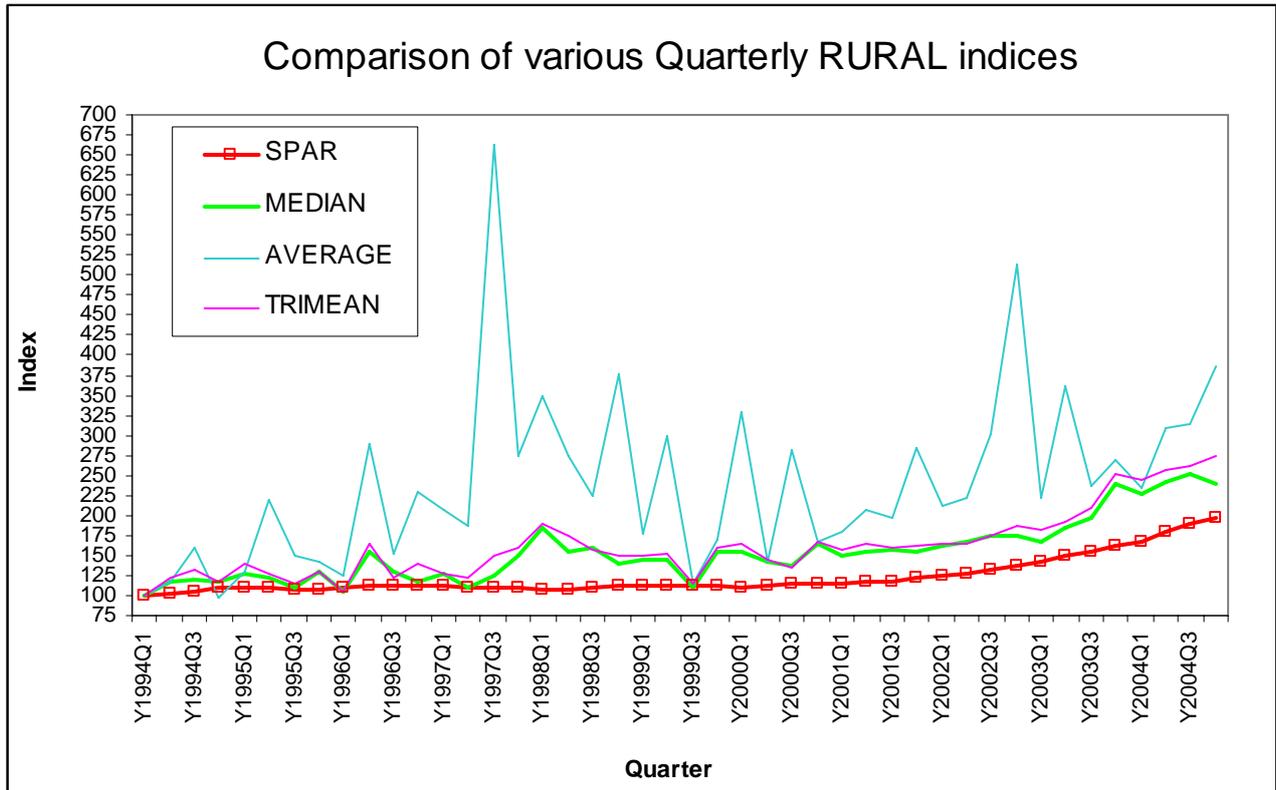
<b>Changes to base values (before indexing)</b>						<b>Percentage changes (before indexing)</b>				
	SPAR	Average	Median	Tri-Mean	Count	SPAR	Average	Median	Tri-Mean	
1 Week	1.1331	303709	270000	274594	1181					
2 Week	1.1335	307187	272250	276938	1499	0.04%	1.15%	0.83%	0.85%	
3 Week	1.1346	306749	271500	276500	1538	0.14%	1.00%	0.56%	0.69%	
4 Week	1.1349	306961	271750	276625	1549	0.16%	1.07%	0.65%	0.74%	
5 Week	1.1353	306977	272000	276750	1554	0.19%	1.08%	0.74%	0.79%	

The SPAR changes from 1.1331 to 1.1353 or just .19% after the initial week. While these changes are small it will still result in past index values being changed over a short period. However it is difficult to see how this can be overcome and may mean that a likely outcome is to release a preliminary index each week with it being finalised each month or quarter. The data does suggest that over 99% of the data will be available after one month.

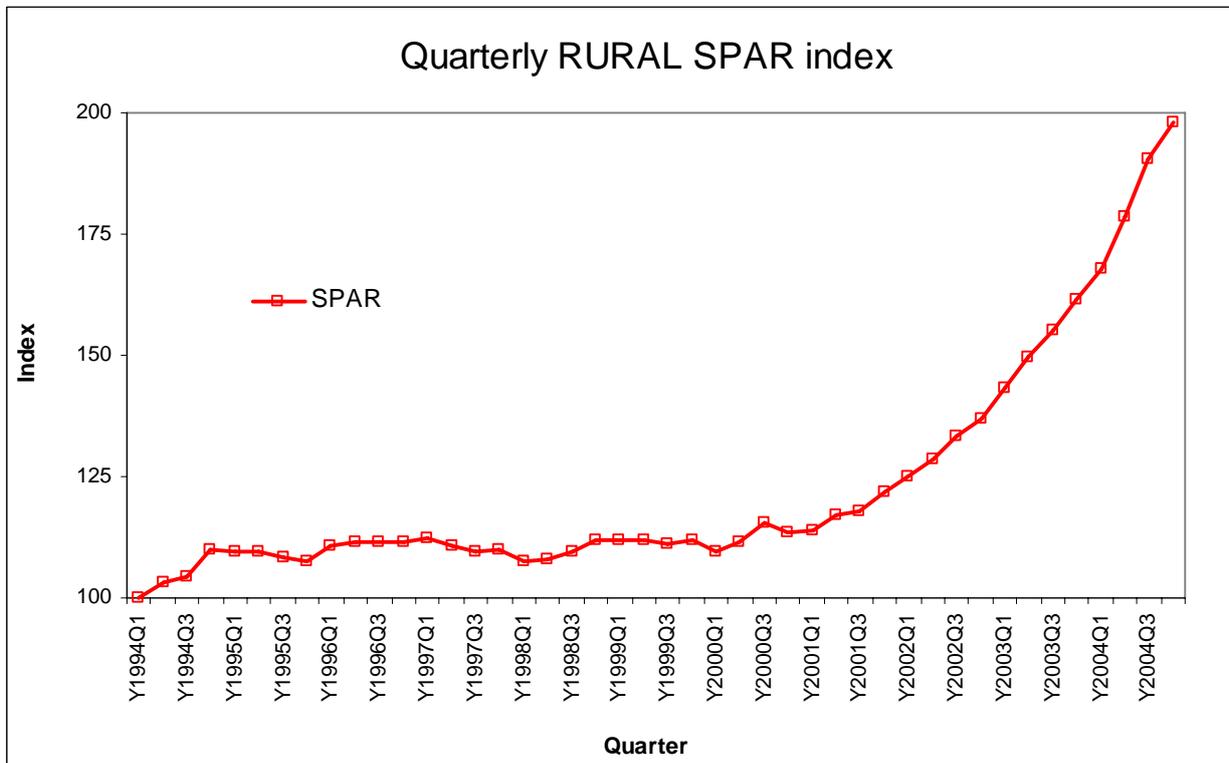
### **A Rural SPAR index**

While much has been made of residential indices, there is less recent discussion about indices for other property types. Several of these exist for commercial and industrial property. The Property Council of Australia has released such indices for many years and these are widely accepted. Most of these rely on using a fixed sample of properties with frequent revaluations. But they may also incorporate sales data. The use of the SPAR index is a possible way to incorporate a larger number of properties into such an index. Perhaps the concern would be the accuracy of the assessments especially where the definition of value for the assessments varies greatly from the typical notion of market value. For this paper a simple example was developed using primary production land. The index is produced using the median, average, tri-mean and SPAR and these are shown in Figure 7.

**Figure 7 - Chart showing quarterly SPAR, median, average and tri-mean indices for viable primary production properties in South Australia over 11 years.**



**Figure 8 – Chart showing quarterly SPAR index for viable primary production properties in South Australia over 11 years**



The index is particularly lumpy for the average and considerably lumpy for the median and tri-mean while the SPAR index is very smooth. The creation of a rural index presents particular problems. Large rural acreages are normally quoted on a per hectare basis and analysed on this basis. But the rates vary dramatically in different locations and land uses. More intensive productive land is difficult to compare with the larger extensive land uses and both may have different characteristics to small viable farm-lets on the urban-rural fringe. Compositional change is likely to be dramatic across different time periods. The SPAR index appears to offer a simple solution and results in a relatively smooth index that retains some of the movements that are expected in rural markets. This pattern is more apparent in the chart in Figure 8. It is not clear if this pattern is expected and more research is required into the use of the SPAR for this land use.

## Discussion

This paper has presented the empirical testing of the SPAR index in a number of different situations using data from South Australia. A number of issues arise as a result.

1. The quarterly SPAR index for metropolitan Adelaide produces an index that is comparable to the hedonic index and far superior to a simple index based on the mean, median or tri-mean of prices. In particular it appears to deal with the issues of compositional change and quality improvement. Both of these issues are considered to be a problem in the indices available in Australia. There is a concern relating to the SPAR index at the end of the series where the sales occur around the time of the assessment. During this period any "sales chasing" which occurs in the assessment process can cause problems and this appears to be evident in the data. The extent of this problem requires further research.
2. The issue of timeliness may be dealt with by reducing the period of the index rather than by a costly and difficult process of obtaining data faster. A change to a monthly index would result in a timelier index than a quarterly index based on "faster" data but this depends on the "lumpiness" of the index.
3. The SPAR index calculated on a monthly basis is very suitable as an indicator when applied to the Adelaide Metropolitan area for all housing. While the index based on mean, median or tri-mean become very lumpy the SPAR index remains quite smooth and provides results that are consistent with the hedonic approach but it is noticeably smoother than the hedonic index. This is highlighted by the low COV for the differences.
4. The weekly SPAR index starts to develop lumps. At the weekly level all other indices have become seriously lumpy and are completely unacceptable. The lumpiness in the weekly SPAR index would probably be a problem as well, as the index would have slight upward and downward movements that are probably not reflected in the market place. Although the change to the index after the original release may be small, any changes together with the natural lumpiness of the index suggest that it may be unsuitable. A compromise may be a fortnightly index. In any case the index would need to be "fixed" periodically. A suggestion would be to use the very stable quarterly index as the main index and then to release a provisional weekly index that is fixed at the end of each quarter. The weekly SPAR index would almost certainly be a problem if the data were stratified by location and dwelling type.
5. The SPAR index offers significant opportunities for use in non residential uses particularly where a simple mean or median estimate is not useful. Rural land uses are a particular area that is worthy of consideration. Further research is needed to establish suitable time periods and land-use and spatial stratification.

## Conclusion

This paper aimed to establish if a SPAR index could answer some of the criticism of housing market indices that were suggested by the Reserve Bank of Australia. The research shows that a SPAR index for housing in Adelaide would produce an index that is far superior to a simple median, mean or tri-mean index as it allows for compositional changes and quality improvement. While these advantages are also seen in the hedonic index, the SPAR index produces consistent results with considerably less effort. The SPAR index may also answer the need for a timelier index. At a broad spatial level it could be used for a weekly index although it would suffer from a small degree of lumpiness. There would also be some problems with the need to adjust the index after release. A more suitable outcome would be a monthly index which proves to be very smooth and would probably not need any major revision after release. The paper also demonstrates that the SPAR index is suitable for other land uses and may be particularly useful for producing indexes for property markets that have been traditionally difficult (or impossible) to plot over time.

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