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1. Describing the index

1.1. What is an Index?
An index is a statistical device that summarises a particular underlying quantity (e.g., prices, values or rental returns) for a given segment of the market in a single base figure. This figure is then used as a benchmark for measuring the change in the underlying quantity over time. The base figure is usually assigned an arbitrary value of 100 at a particular base date (all of CoreLogic’s indices have a base date of 31/12/2009) and the values for all subsequent dates is expressed in relation to this base figure.

For example, an index value of 110 two years after the base date means that the underlying quantity has increased by 10% over the intervening two years.

1.2. What does the index value mean?
The index value itself has no intrinsic meaning – it simply serves as a means of benchmarking the changes in the underlying quantity. What’s important to understand is how one index value relates to another index value as at a different point in time. The difference between these values expresses how much the underlying quantity has changed between the two points in time.

1.3. Why are there multiple price indices in the market?
Unlike shares on the ASX, bonds or commodities, there are two key characteristics of the property market that makes it difficult to create an accurate read of growth in the market:

1. Residential property as an asset class is not homogeneous – one property may not be a direct substitute for another property. This means that the agreement to purchase a specific property does not mean a separate property may be offered up for settlement.

Additionally, existing properties are constantly evolving independently with new properties being constructed, changing the composition of the residential property market on a continuous basis.

2. Property markets exhibit much lower liquidity and turnover where only ~6% of all residential properties across Australia are transacted in any given 12 month period.

As a result, multiple methodologies exist to try and combat these inherent pitfalls, creating different readings that can be interpreted differently. Additionally, because there is no centrally managed source of property transactions, the underlying data used by different providers will be different and hence the resulting outputs will also be different.

1.4. What is meant by a ‘market segment’?
The market segment is simply a collection of properties that share a common underlying attribute for which we are attempting to summarise (all the detached dwellings in a particular suburb, or all high rise apartments in a capital city are examples of a market segment).

1.5. What constitutes a house or a unit?
From CoreLogic’s perspective, a house is any property that is on a torrens title, where the title holder claims ownership upon the land which the property resides on. This includes property types such as semi-detached dwellings, terraces and duplexes.

A unit is any property that is on a strata title, where the title holders own a shared claim to common land that multiple properties may reside on. This includes property types such as villas and townhouses.

Both of these only refer to properties which have been deemed by regulatory bodies to be for residential purposes only.
2. Describing the hedonic regression

2.1. What is the Hedonic Index?
A hedonic index is an index that uses the Hedonic Regression methodology for estimating the underlying value of a particular quantity (e.g., prices, rents). The Hedonic Regression assumes that the quantity itself can be broken down into its constituent characteristics to obtain estimates of the contributory value of each individual characteristic. Within the real estate world, this means that the sale value or rental value of a particular property can be attributed to characteristics such as number of bedrooms, number of bathrooms, land size, floor area, location, etc.

By understanding the contributory value of each characteristic, we are able to infer the value of every property in the country and subsequently index the change in property values over time without requiring an actual transaction to be observed.

2.2. Why Hedonic methodology?
The two fundamental aspects of the property market explored in section 1.3 create a number of issues that need to be addressed when trying to identify the growth in a given market:

1. Observing only transacted properties creates a compositional bias – due to the homogeneity of property assets, the distribution of properties transacted do not accurately reflect or represent the entire underlying stock and you risk creating a view of the market that is informed by a small sample of the population due to the low turnover rate in the property market.

For example, when the first home buyer’s policy came out, a significantly larger proportion of properties transacted were made up of properties on the cheaper end of the spectrum resulting in a significant decrease in the average price of transacted properties.

2. Older transactions inform current views of market prices – due to the low turnover rate in the property market, prices from transactions dated many months prior are often used in order to produce enough observations to make sure there is a sufficiently representative sample of transactions being used to infer market prices.

3. Capital works factors significantly into the overall change in the property market – as properties constantly evolve and in particular, new properties are introduced to the market, there is often a premium paid for the generally higher quality of the new stock that does not accurately reflect the organic growth attributed to existing stock.

For example, when large unit developments hit the market all at the same time, the spike in volumes combined with the low turnover rate can result in average prices being skewed towards the new builds, which may exaggerate the perceived growth of property prices.

The Hedonic method has been designed in part to combat each of these issues to create a more robust reading of the property market.

2.2.1. How does the Hedonic method account for compositional bias?
By estimating the values of all properties irrespective of whether they have transacted or not, the hedonic index creates a consistent apples-to-apples comparison when determining change, ensuring that all properties are included in the indexation process.

2.2.2. How does the Hedonic method account for property market illiquidity and delays in property transaction information?
By estimating the values of all properties irrespective of whether they have transacted or not, it fills the gaps for any information that is missing based on the available information. This allows it to create a
contemporary view of the state of the entire population despite only a small sample of observations being available.

2.2.3. How does the Hedonic method account for changes in underlying stock?

By re-valuing all properties across the country based on their constituent characteristics, we are also able to account for any injection of capital (e.g., adding new bedrooms, expanding the land size or building new properties) that may artificially increase the overall value of properties. This is done during the indexation process when we compare the total value of properties in one period to the next, but only include properties that have not changed in characteristics between the two periods (i.e., only properties whose constituent characteristics have remained the same and existed in both periods are included in the comparison).

Effectively we are able to mathematically isolate the change in value associated with the passing of time as opposed to the changes in attributes.

2.3. What are some shortcomings of the hedonic method?

Inferred, not strictly factual – the hedonic method uses an estimate of the underlying quantity for every indexation point using observed transactions. The small number of observed transactions relative to the population of properties means that majority of the indexation is driven by the model’s ability to estimate the contributory value of underlying characteristics of residential properties.

Heavily dependent on data coverage - as the method relies on a model to breakdown the contribution of underlying characteristics to estimate values, significant breadth and depth of data is required to accurately and consistently compute the estimates. The model relies on the abundance of detailed property level information to make up for the absence of sufficient transaction observations.

2.4. How is this connected to Automated Valuation Models (AVMs) produced by CoreLogic?

The AVMs produced by CoreLogic is a completely different analytical solution and should not be confused with the Hedonic Index. Although both solutions leverage the hedonic methodology in some way to impute an estimated value for every property in Australia, they do so with different objectives and as such are optimised differently.

CoreLogic’s AVMs are produced for the sole purpose of gaining insight into an individual property as at a particular point in time, and therefore is optimised for estimating the likely sale value of the given property right now based on all available information. It takes into account more sources and additional algorithmic enhancements for this sole purpose.

CoreLogic’s Indices are produced for the purpose of measuring market movement and therefore is less concerned about being optimised for estimation accuracy and more concerned with optimising for consistency in order to better understand how the portfolio value of properties change over time.

2.5. Where can I find a detailed technical documentation of the model implementation?

All technical documentation, methodology white papers and associated audit statements can be found on our website at https://www.corelogic.com.au/research/rp-data-corelogic-home-value-index-methodology.
3. Changes to CoreLogic’s Hedonic methodology

3.1. What key changes were made to the CoreLogic Hedonic Methodology?

The underlying methodology itself is not a significant departure from the original Rismark International methodology published in 2011. Instead, tweaks and changes were made to the implementation of the methodology due to the availability of improved data and infrastructure.

Certain changes were also made to ensure it adhered to standards issued by the European Statistics Agency which has been legislated for use by the European Commission and endorsed as best practice by the International Monetary Fund and Bank for International Settlements.

The predominant changes are highlighted below with detailed technical implementation specifications included in the technical documentation:

3.1.1. Filtering and treatment of outlier transactions

A two phase dynamic filtering process was adopted in order to better capture a sample of observations that best represented true market transactions. The first phase excluded extreme outliers and any non-arm’s length transactions, and the second phase trim the top and bottom 2.5% of observations based on amount.

3.1.2. Exclusion of off-the-plan transactions

Sales transactions that have settlement periods of longer than 12 months have been excluded from the model. These transactions have a higher chance of being off-the-plan sales where the contract price may not be truly representative of the market value of the underlying stock given that the property did not exist at the point the agreement was entered into.

3.1.3. Increased regression window with linear time weighting

An increased hedonic regression window of twelve months was used in an attempt to improve the accuracy of the indices’ underlying valuations whilst controlling for the timing of the observations by applying a linear weighting factor which put more emphasis on more recent observations.

3.1.4. Treatment of raw data changes

Changes were made to the adjustment of the portfolio population when indexing between two periods to better control for structural changes (changing attributes or new constructions) in the market. This will allow us to avoid volatility introduced by changes in CoreLogic’s underlying data universe as it expands its coverage over time.

3.1.5. Alignment to new ABS standard geographies

All new index outputs will align with the ABS’ 2016 Australian Statistical Geography Standard to ensure comparability between index series published by CoreLogic and those published by ABS and other data providers.

3.2. How does it compare with the previous results published by CoreLogic?

There are three noticeable points of comparison to be aware of between the new series and the old series:

1. Longer time series – the expanded coverage of CoreLogic’s underlying data has allowed us to construct a historical view all the way back to the 1980s with exact length varying by state (not all states started capturing digital records of property transactions at the same time).

2. Similar historical returns with reduced volatility – As can be seen from the tables and charts below, the average monthly return is almost identical across the major capitals with a significant reduction in volatility across the board.
3. Consistent view of historical turning points – the smoother and less volatile readings did not reduce the model’s ability to react to turning points and in most cases reported on turning points earlier than the previous model.
4. Other index construction methodologies

4.1. What other methods of index constructions are traditionally used?

There are typically three other approaches used across the industry for measuring prices, each with its own strengths and weaknesses due to the way in which it tries to get around the heterogeneous and illiquid nature of the property market.

The reason why these methods are often used in place of the hedonic method is due to their simplicity and ease of calculation.

4.1.1. What is the stratified median method?

The stratified median method goes through a process of stratification which creates subsets of properties which are qualitatively similar. Unique prices series are created for each individual subset then aggregated to estimate composition-adjusted price movements in the overall market.

The stratified median price index deployed by CoreLogic creates the subsets based on the median prices of individual suburbs. All properties are then grouped into stratum based on the median price growth of the suburb they reside in. A median price is then calculated for each strata, and the overall index result is calculated as the average across the growth in median prices for each strata.

4.1.2. What is the repeat observations method?

The repeat observations method estimates the performance of the market by analysing the returns on individual properties where there are at least two observed transactions, each at different points in time. These observation pairs are then aggregated together and generalised to estimate the contribution to growth of adjacent time periods.

4.1.3. What is the simple mean / median method?

The simple mean / median method simply looks at all the transactions in a particular time frame (e.g., typically 1 month, 3 months or 12 months) and takes the average (mean) or middle (median) value.

It is the simplest approach to generalise prices for a given market and observing how it changes over time to indicate growth and progression within a market.

4.2. What are the pros and cons of other methods?

These other methods are typically less timely and less robust at assessing more granular segments of the market when compared to the hedonic method. However, they can still provide an additional point of reference due to the unique angles through which they address the heterogeneous and illiquid nature of the property market.

4.2.1. What are the pros and cons of a stratified median method?

The stratified median method tries to overcome the heterogeneous and illiquid nature of the property market by grouping together similar properties into stratum. Each stratum is large enough to have sufficient volumes of observations while being small enough to delineate unique aspects of the property market.

The benefits of a stratified median price index are:

1. It is a direct summary of the prices observed in real settled transactions and does not try to computationally fill in the gaps.

2. It is able to control sufficiently for compositional bias at high levels of geography.

The disadvantages of a stratified median price index are:

1. It is not as timely as it depends on the availability of actual transaction results which can be up to 3 months delayed.

2. The approach cannot be applied consistently at more granular levels of geography.
3. It does not separate growth attributed to the construction of superior quality properties from the organic growth of existing properties.

4.2.2. What are the pros and cons of a repeat observations method?

The repeat observations method tries to overcome the heterogeneous nature of the property market by looking at only properties that have transacted at two points in time to directly observe the growth between two distinct periods.

The benefits of a repeat observations price index are:

1. It provides an accurate indication of price changes in existing stock.
2. It is a direct summary of the prices observed in real settled transactions and does not try to computationally fill in the gaps.
3. It is also more accurate in the absence of sufficient coverage of underlying transactions - the method isn't influenced by the individual price levels of underlying stock.

The disadvantages of a repeat observations price index are:

1. It takes longer to take into account the impact of new stock on the market – there won't be many repeat observations for new stock in the short term.
2. It doesn't control for improvements or renovations done on existing properties.

4.2.3. What are the pros and cons of a simple mean / median method?

The simple mean / median method falls prey to the heterogeneous and illiquid nature of the property market, and it is due to this fallacy that other methods of price measurement have been explored over the years.

The benefits of a simple mean / median method is it is a simple and straightforward way to understand pricing relativity for affordability measures. It is not a great method for obtaining an accurate read on the change in prices over time due to the heterogeneous and illiquid nature of the property market (refer to section 2.2).

4.3. How do the different methods’ results compare to each other?

Generally speaking, the Hedonic index is much less volatile than other series and can be seen to identify the turning points in the market much earlier than the other methodologies. One other point to keep in mind is that all other methodologies do revise over time, so in addition to picking the turning points earlier from a historical perspective, it is also able to identify it earlier in real time due to the data latency.
5. What can I obtain as a subscriber?

5.1. What indices are available?
Our full CoreLogic Research Indices offering includes the following indices:

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<thead>
<tr>
<th>Type</th>
<th>Metric</th>
<th>History</th>
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<tbody>
<tr>
<td>Price Indices</td>
<td>Hedonic Home Value Index</td>
<td>From 1980 onwards</td>
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<tr>
<td></td>
<td>Repeat Sales Price Index</td>
<td></td>
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<tr>
<td></td>
<td>Stratified Median Sales Price Index</td>
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<td></td>
<td>Simple Median Sales Price</td>
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<td></td>
<td>Simple Mean Sales Price</td>
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<td></td>
<td>Simple Median Imputed Home Value</td>
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<td></td>
<td>Hedonic High / Medium / Low Home Value Indices</td>
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<td>Hedonic Decile Strata Home Value Indices</td>
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<tr>
<td>Rental Indices</td>
<td>Hedonic Yields Index</td>
<td>From 2005 onwards</td>
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<td>Hedonic Rents Index</td>
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<td></td>
<td>Simple Median Rents</td>
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<td>Simple Median Imputed Rental Value</td>
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<td></td>
<td>Simple Median Imputed Yield Value</td>
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<tr>
<td>Total Return</td>
<td>Hedonic Accumulation Index</td>
<td>From 2005 onwards</td>
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<tr>
<td>Supporting Measures</td>
<td>Total sales volumes</td>
<td>From 1980 onwards</td>
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<td></td>
<td>Median time on market</td>
<td>From 2005 onwards</td>
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<td></td>
<td>Median vendor discounting</td>
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5.2. How far back does the historical timeseries go?
See 5.1 above.

5.3. What geographies are available?
The Full Research Indices suite covers results for all of the following across Australia:

1. States
2. Combined Capital Cities
3. Combined Rest of State regions
4. Capital Cities and Rest of State regions.

All of these are in line with the Australian Bureau of Statistics’ definitions of the Capital Cities and Rest of State regions as part of the 2016 Australian Statistical Geography Standard (ASGS).

5.4. Why do you use the ABS ASGS boundaries?
We understand the need from all users of our Property Market Indices to compare it with other macro-economic indicators and data sets published by other providers. By keeping in line with the ABS definitions, we allow our users to make direct comparisons with all ABS statistics without having to
worry about the impact of compositional differences due to having different geography definitions.

5.5. What will change for existing subscribers?
All existing subscribers will get the updated index results, which includes:

1. Expanded geographic coverage
2. Change in geographic definition from the previous 2006 ASGC definitions of Capital Cities and Rest of State regions
3. Fully revised and extended historical back series
4. Additional supplementary index measures

5.6. Can I have custom indices?
Yes – these can and will be produced on a bespoke basis. Please consult your account manager or reach out to the CoreLogic sales team to understand process and pricing for the production of bespoke series.
6. Why should I use CoreLogic’s Indices?

CoreLogic Indices is built upon one of the most comprehensive property databases in Australia, with deep coverage across the entire property lifecycle. This breadth and depth of data combined with over 30 years’ experience aggregating and managing property data, allows us to create Australia’s only Hedonic Index suite.

Through CoreLogic’s extensive relationship with the Real Estate Industry, we also have access to one of the most timely datasets.

The original RP Data-Rismark Hedonic Home Value Index was a trusted measure of house price movements by regulators and major industry participants alike, and we continue to stay close to all property market observers to consistently improve upon our data and analytical methods to better support their needs in assessing the property market.

6.1. How can I trust the results being published?

CoreLogic is committed to ensuring a high standard of quality when it comes to our analytical processes, and we put all our models through an extensive governance process that includes both internal and external audits:

1. We have multiple tiers of internal governance to review the model performance by applying rigorous out-of-sample testing before it is assessed against global best practice by our overseas counterparts.

2. We have also commissioned audits from KPMG and Academics from the University of Sydney and Macquarie University to assess whether:
   - The technical methodology adheres to global industry best practice
   - The performance of the model meets benchmarking standards
   - The technical methodology is implemented as documented within CoreLogic’s whitepaper

The technical implementation of the model itself is also aligned to the methodology published by Eurostat (the ABS equivalent of the European Union) legislated for use by the European Commission and endorsed as best practice by the Internal Monetary Fund and Bank for International Settlements.

The whitepapers and reference documents can all be found on our website (https://www.corelogic.com.au/research/rp-data-corelogic-home-value-index-methodology)

6.2. How does it compare with official numbers published by the ABS?

We consistently achieve a 90%+ correlation with ABS’ measure of annual house price growth over the period that ABS has published statistics for. We also consistently achieve a 75%+ correlation with ABS’ measure of quarterly house price growth over the same period.

These high levels of correlation as highlighted in the graphs below means we track the ABS results fairly closely over time and unlike the ABS, which has a 2.5 month delay in publishing results, we are able to publish results on a 1 day delay.
6.3. Why don’t other providers publish a hedonic index?

In order to create a Hedonic Index, there are a number of requirements from a data and processing perspective:

1. It requires timely data – the absence of timely data means the results will be volatile and less accurate when you try to estimate the values of properties at a point in time.

2. Depth of data – because the hedonic approach is underpinned by the ability to assign contributory value to underlying characteristics of the property, a shallow coverage of property characteristics greatly limits the ability to leverage the hedonic methodology.

3. Analytical rigor – the computational complexity of a hedonic approach means that simple differences in data or implementation can require significant theoretical assessments to understand the mathematical implications, the absence of which can result in inaccurate readings of the market.

4. Significant infrastructural requirements – the estimation of values for every property in the country every day is a very computationally intensive process that would require significant investment in the underlying production environments in order to maintain.