



Home Price Index Methodology

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Methodology

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PropTrack Home Price Index Methodology

Home Price Index information

Concept

The PropTrack Home Price Index (HPI) model measures monthly changes in residential dwelling values across Australia. It provides an up to date and accurate assessment of housing market performance and trends.

The PropTrack HPI model utilises a unique hybrid methodology that combines repeat sales and hedonic regression methodologies to control for the effect of observed property characteristics on prices. Both methodologies are frequently and independently used to measure home price movements in Australia and overseas (Eurostat 2013).

The PropTrack HPI hybrid methodology repeat sales regression component matches transactions of identical properties over time. This is based on the premise that the change in value of a specific dwelling over time should only reflect changes in market prices, assuming no significant alteration or renovation was undertaken between sale dates.

The PropTrack HPI hybrid methodology extends the repeat sales regression by allowing transactions for non-identical, but closely located dwellings of the same type (house or unit) to be paired together. This extends the repeat sales regression by acknowledging that dwellings within close proximity share similar characteristics generally.

PropTrack aligns to the Australian Statistical Geography Standard as defined by the Australian Bureau of Statistics (ABS 2016). Statistical Area levels 1 to 4 are defined within this standard and are referred to in the methodology paper.

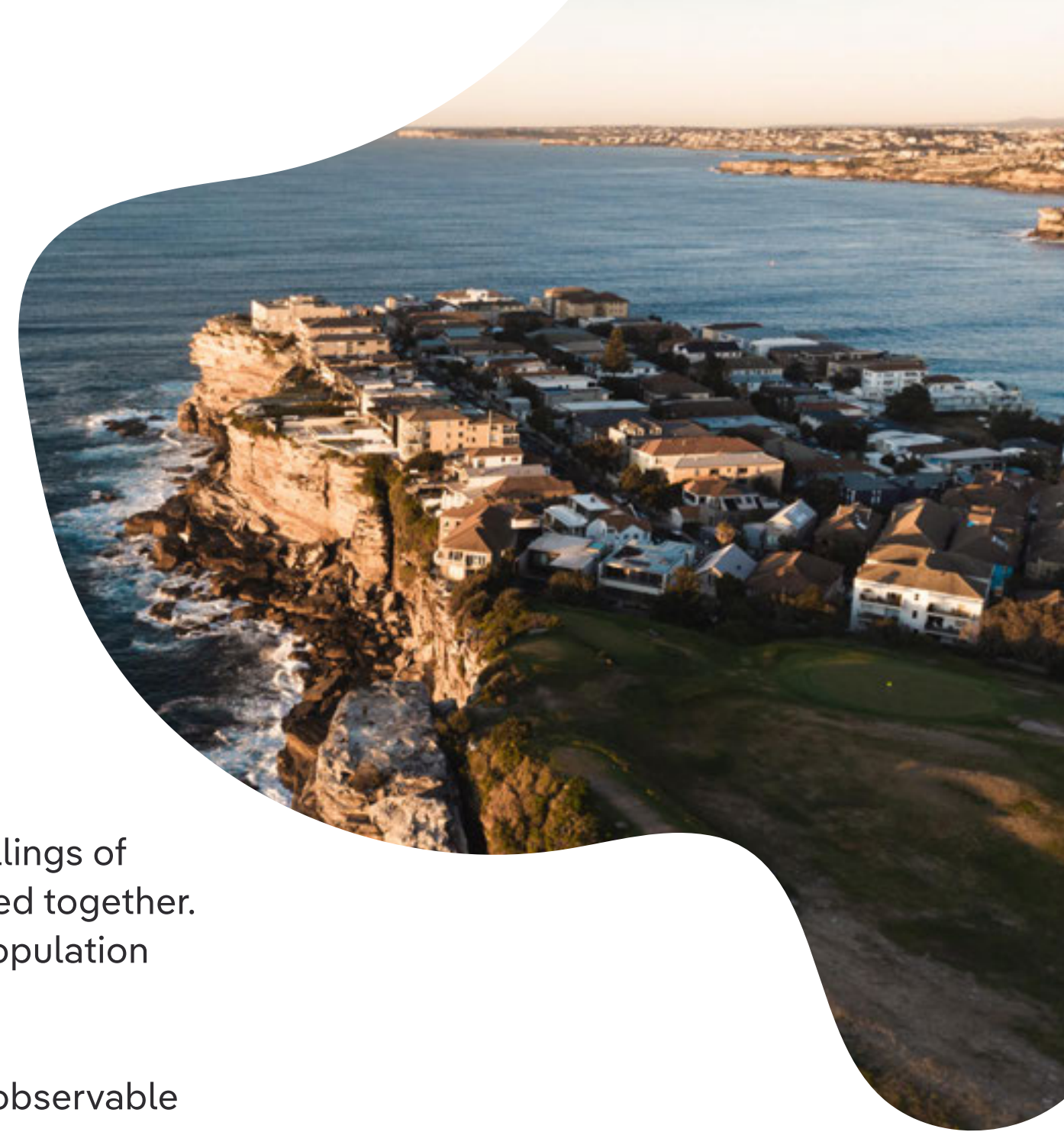
Within each Statistical Area Level 4 (SA4), sale transactions of dwellings of the same type within the same Statistical Area Level 1 (SA1) are paired together. There are over 57,000 spatial SA1 regions across Australia, with a population generally between 200 and 800 people.

Hedonic regression is used to separate the value of dwellings into observable attributes to account for differences in sold dwellings over time.

The hedonic regression component of the PropTrack HPI hybrid methodology controls for observed differences between the dwellings that are paired together. Specifically, the PropTrack HPI hedonic regression component is used to control for differences in the number of bedrooms in dwellings that are paired together, which also proxies for differences in dwelling size.

The hybrid methodology has the benefit of augmenting the repeat sales methodology so that dwelling price growth can be more robustly estimated in regions where there may not be sufficient volumes of repeated sales transactions.

The PropTrack HPI is a revisionary index, where updates to the full history are recalculated each month. This is an important feature because it compensates for the delay in the receipt of comprehensive official records of sales transactions after settlement occurs. The revisionary nature of the PropTrack HPI mitigates significant revisions when new data are received.



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Index representation

The PropTrack HPI series are presented in nominal terms, with no adjustment for general price inflation. The indices can therefore be interpreted as the average change in the prices paid for homes across Australia, excluding observed compositional changes, in current dollar terms.

Temporal coverage

The PropTrack HPI is recalculated at the end of every calendar month.

The PropTrack HPI series is indexed to on 31 January 2010, with indices set to 100 for that date.

All PropTrack HPI indices commence as early as January 1990, where data availability allows.

Geographic coverage

The PropTrack HPI is calculated for every spatial SA4 across Australia (excluding SA4s in Other Territories) – a total of 88 regions. It is calculated for each dwelling type (houses and units), and an all dwellings aggregation is additionally provided.

In some cases there is insufficient sales evidence to enable the production of unit indices. This occurs includes in regional areas of South Australia and the Northern Territory.

The PropTrack HPI is aggregated to Greater Capital City Statistical Areas (ABS 2016), which cover the capital city and rest of state regions within each state and territory.

Each month, aggregate indices for Capital Cities (which includes all eight capital cities), Regional Areas (which includes all rest of state regions) and a National index are produced.

Revisions

The PropTrack HPI is a revisionary index. The entire history of the indices are recalculated each month. The revisionary nature of the index guarantees that as soon as sales transactions are observed, they are incorporated into the index to provide the most complete and accurate assessment of the change in dwelling values over time.

This is an important and distinguishing feature of the PropTrack HPI because it compensates for the delay in receiving the official records of sales transactions, after they settle, from State and Territory Valuer General offices.

Calculations of the Index for the most recent month are based primarily on agent advised sale information. Once sales transactions are provided by the Valuer Generals, the official prices replace the agent advised prices. The revisionary Index therefore avoids significant revisions when new data are incorporated.



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Seasonal adjustment

The PropTrack HPI is not seasonally adjusted. The HPI provides an up to date, compositionally adjusted, measure of home price movements, which includes seasonal patterns.

A seasonally adjusted version of the HPI may be released at a future date.

Assumptions & limitations

There are a number of assumptions and limitations considered as part of the construction of the PropTrack HPI. They are summarised as follows:

- Data errors in dwelling transaction databases will cause inaccurate estimates of dwelling price growth. Appropriate outlier detection and price filtering operations mitigate the effect of erroneous records.
- PropTrack does not have attribute information for every dwelling, especially if no prior sales or listing event has been observed. Transactions of these properties are excluded (see 'Eligibility rules' section). While coverage for the attributes used in the HPI is very high, PropTrack is continuously improving data coverage and quality, which result in accurate dwelling price movements through the revisionary process.
- The HPI is unable to account for unobserved characteristics of sold dwellings, such as the condition or quality of the dwellings. The PropTrack HPI assumes that there is no systematic over representation of these unobserved characteristics so there are no biases across regions, on average.
- There are inconsistencies in representing an address for a dwelling and differences exist among data providers. Address matching solutions are used to both identify the location of dwelling transactions and match transactions from different sources. There is a risk that this may be imprecise and subject to error. Mismatched or mislocated records may result in duplicated transactions or the creation of erroneous records. PropTrack has sophisticated data processing rules designed to identify duplicated transactions, which are incrementally refined over time. Address matching also undergoes continuous improvement activities to reduce errors. These improvements flow through into the HPI in real time through the revisionary process, which reduces the risk of restating indices by a significant margin.



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Data preparation

Data sources

The PropTrack HPI uses sales data from many sources. The primary data sources are State and Territory Valuer Generals (VG). VG data has comprehensive coverage of all property sales but is not available in a timely manner.

Due to the delay in the availability of VG data, the PropTrack HPI is supplemented with recent sales price data provided by agents to realestate.com.au. This covers a significant share of sales across the country which gives an up-to-date view on the market and allows timely calculation of the HPI.

Eligibility rules

Dwelling Type

The PropTrack HPI covers residential dwellings and is calculated for houses and units.

Dwellings are categorised as 'houses' if they have a Torrens title, with Strata and other titled dwellings categorised as 'units'.

Transactions of other dwelling types, such as land, acreage, serviced apartments, retirement villages and rural properties are excluded from the calculation of the PropTrack HPI.

Price

Only the transactions that include price information are included in the construction of the HPI.

Bedrooms

Only the sale transactions for dwellings with attribute information about the number of bedrooms in the home are included in the construction of the HPI.



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Outlier detection and price filtering

Outlier detection and price filtering is conducted dynamically every time the HPI is calculated. This process is intended to remove both erroneous transaction records as well as very low or high valued transactions that may lead to less precise or accurate estimates of typical dwelling price changes.

Such transactions may represent sales between family members, multiple properties sold at once, or typographical errors. There are not representative of the normal (and arm's length) market.

Statistical methods are employed to filter sales transactions, by dwelling type, time of sale and geographic region groupings.

Outlier and price filtering is conducted in two stages:

1. All sales with a value >\$100,000,000 (one hundred million dollars) are removed.
2. Transactions with Z-score above 1.75 or below -1.75 are removed.
Z-scores are calculated for each transaction, based on the distribution of sales in each SA4, property type and 12 month period (using a fixed width period, with the last period ending in the latest month).

Z-scores are calculated as:

$$Z_i = \frac{x_i - \mu}{\sigma}$$

Where:

- Z_i = Z score of transaction i
- x_i = Price of transaction i
- μ = Mean price of transactions in the SA4, property type, 12 month period
- σ = Standard deviation of transaction prices in the SA4, property type, 12 month period

If normally distributed, this will remove 8% of transactions in each grouping.



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Purpose

Measuring price movements can be challenging because the size and quality of dwellings that transact over time and are not representative of the broader stock of dwellings.

The PropTrack HPI hybrid methodology is designed to estimate the change in typical dwelling values using the small sample of dwellings that transact in a given period.

Overview

Hybrid methodology

The PropTrack HPI hybrid methodology extends the repeat sales methodology by allowing transactions for non-identical, but closely located, properties of the same type (house or unit) to be matched together. Sales of properties of the same type, in the same ABS Statistical Area Level 1 (SA1) are matched together.

Hedonic regression is used to account for differences in the number of bedrooms in properties matched together, which is highly correlated with dwelling size.

Calculation steps

The broad steps to estimate the PropTrack HPI are as follows:

- Collect historical transaction data, aggregate across sources
- Exclude data which do not meet the eligibility rules either due to insufficient data, or the outlier and filtering rules
- For each SA4 region, pair transactions to all previous sales within their SA1 region, for the same dwelling type
- For each of these paired transaction, calculate the price difference, time of each sale and difference in the count of bedrooms
- Estimate of the PropTrack HPI hybrid model
- Aggregate to larger geographical aggregations and combined all dwellings measures



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Calculation

Estimation equation

The PropTrack HPI is calculated for each SA4 region, separately for houses and units, using the following equation for all matched pairs of transactions:

$$\ln(P_{m,g,t}) - \ln(P_{n,g,s}) = \sum_{i=s+1}^t \eta_i \lambda_i + \beta(X_m - X_n) + \epsilon_{m,t} - \epsilon_{n,s}$$

$\eta_i = \ln\left(\frac{I_i}{I_{i-1}}\right)$ with I_i being the estimated index at month i ,
the variable of interest

$$\lambda_i = \begin{cases} 1, & s < i \leq t \\ 0, & \text{otherwise} \end{cases}$$

Where:

- $P_{m,g,t}$ is the price of property m sold in month t ; in SA1 location g ; of property type h
- $t \geq s$
- m may be equal to n (when the pair is a repeated sale)
- X_m is the count of bedrooms in property m
- The errors $(\epsilon_{m,t} - \epsilon_{n,s})$ have expected value 0, by construction

This equation is derived from the canonical hedonic regression equation:

$$\ln(P_{m,g,t}) = \sum_{i=1}^I \alpha_i X_i + \sum_{j=1}^J \beta_j T_j + \sum_{g=1}^G \delta_g G_g + \epsilon_{m,t}$$

Where X_i are attributes; T_j are time dummies equal to 1 if $j=t$; G_g and H_h are dummy variables that equal 1 if the SA1 location is in region g and property type is h , respectively.

When transactions are paired on location (SA1) and property type, the latter terms cancel, leaving the differences in attributes (bedroom counts in our formulation) and the vector of time dummies.

Matched pair restrictions

There are two limits placed on matched pairs of transactions:

- A limit of 200 months between matched transactions (t and s)
- Repeated sales (where m and n are equal) must be at least 9 months apart

Estimation

The estimation equation is estimated using a ridge regression which reduces the impact of imprecisely estimated parameters. This is an issue in periods with a small number of sales, and prevents them from having an outsized impact on the index.



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Index construction

Setting the first value of the index to unity (i.e. $I_s = 1$), and using the estimated coefficients from the above estimation equation gives the index for each month period with a simple transformation:

$$\ln(I_t) - \ln(I_s) = \sum_{i=s+1}^t \ln\left(\frac{I_i}{I_{i-1}}\right)$$

$$I_t = \exp\left(\sum_{i=s+1}^t \eta_i\right)$$

Gives the index at month t

Aggregation

The indices are estimated for each SA4 region separately for houses and units. These indices are aggregated up to both 'all dwellings' indices, as well as indices at the Greater Capital City Statistical Area (GCCSA) level (which includes capital city and rest of state regions), Capital Cities, Regional and National indices.

The most recent estimate of dwelling values are used for these aggregations. Dwelling values are drawn from the PropTrack Automatic Valuation Models.

$$I'_t = \frac{\sum_{k=1}^K (I_{t,k} \cdot \omega_k)}{\sum_{k=1}^K \omega_k}$$

Where:

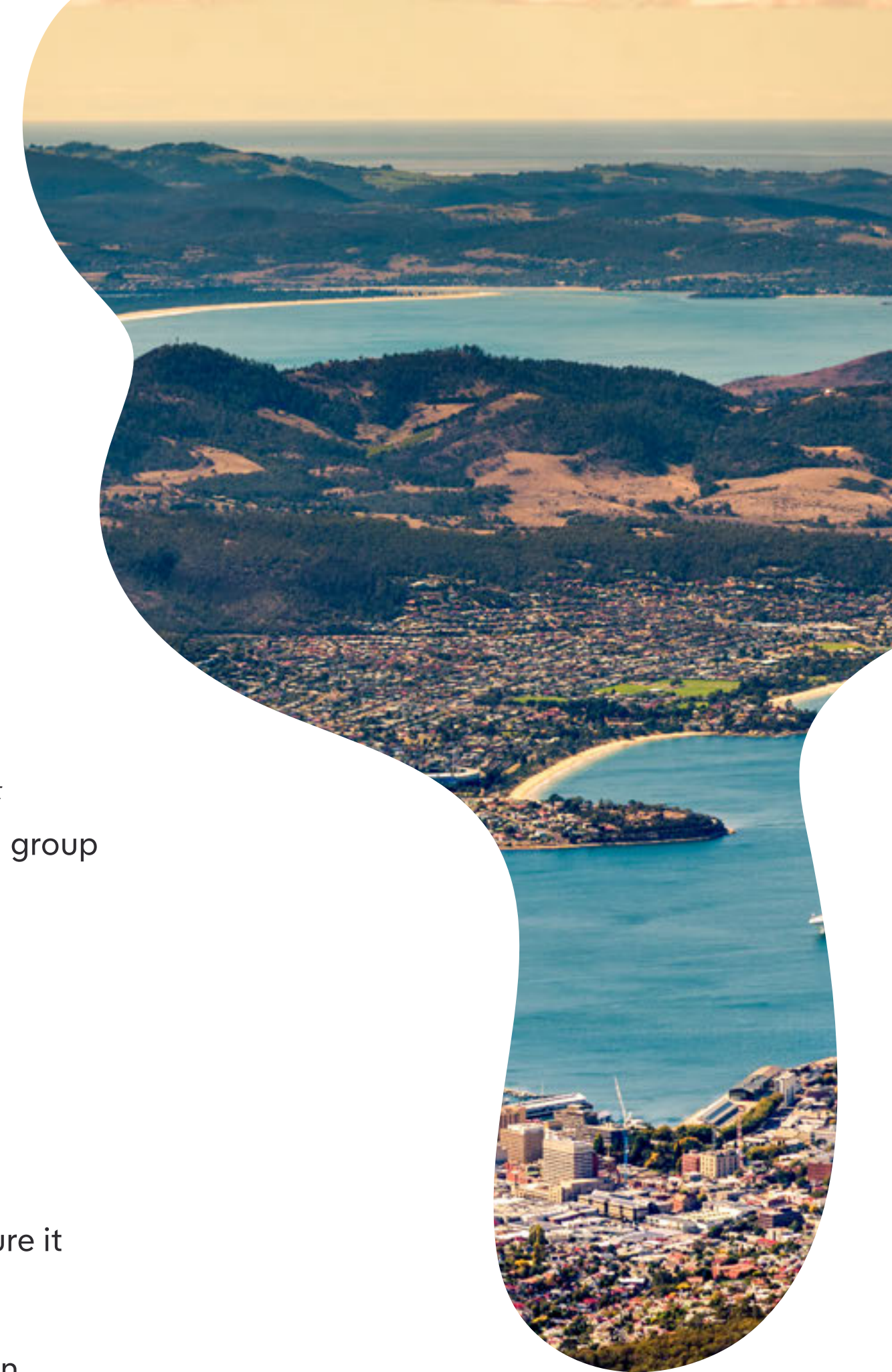
- I'_t = the aggregated index (larger region or all dwellings) in month t
- k = each group in the aggregation, with $I_{t,k}$ the index level of each group
- $\omega_k = \frac{\text{Total AVM value}_k}{\sum_{k=1}^K \text{Total AVM value}_k}$ the dwelling value weight of the group

Index validation

The PropTrack HPI has been validated internally and externally to ensure it tracks trends in the Australian property market well.

The theoretical modelling approach of the HPI has been validated in an external review (Deloitte 2019).

The implementation of the HPI methodology by PropTrack has been validated internally by the use of benchmarking, using predicted sale price errors and comparisons with other publicly available home price indices.



PropTrack Home Price Index Construction



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Eurostat (2013), "Handbook on Residential Property Price Indices (RPPIs)," Eurostat Methodologies & Working Papers, Luxembourg.

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Home Price Index Whitepaper

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About PropTrack

Since we began life as a start-up in 2008, our focus has been on transforming property data and digitising the valuations market. Our mission is to provide data that enables new property experiences and solutions, streamlines banking and lending operations with automated solutions and the best property insights.

Since our acquisition by REA Group, we have invested heavily in new expertise, innovative technologies and unlocked unique behavioural data generated by the millions of Australians that use REA Group platforms every month.

Join the PropTrack customers and partners who are already creating new innovative experiences with PropTrack data.

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