STANDARDS FOR STATISTICAL VALUATION METHODS FOR RESIDENTIAL PROPERTIES IN EUROPE

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PART I: GENERAL CONSIDERATIONS AND PRINCIPLES

1 Introduction

1.1 Objectives

These *Standards for Statistical Valuation Methods for Residential Property in Europe* are intended to provide for the first time a coherent set of information and descriptions aimed at increasing the understanding, transparency and clarity on the wide array of existing Statistical Valuation Methods. The document focusses on principles, definitions and minimum requirements for Statistical Valuation Methods[1] applicable across European jurisdictions.

In addition, these standards include guidance with regard to the selection of the appropriate Statistical Valuation Methods, based on the capabilities of the methods themselves in relation to the actual context in which they are intended to be used.

It should also be noted that the Statistical Valuation Methods described in these standards aim to represent the main types of each of the methods; it is; however, recommended that the standards should also apply to variants of these main types, which may incorporate additional elements.

These standards will be monitored, reviewed and updated regularly, based on stakeholder feedback and market needs.

1.2 Scope

These standards provide guidelines for a range of Statistical Valuation Methods used to value residential properties across European jurisdictions. The document comprises an overview of various Statistical Valuation Methods, recommendations on quality control and quality assessment as well as best practice guidelines on the understanding and use of these methods.

Generally, Statistical Valuation Methods can be applied to both residential and commercial properties. The standards presented here, however, explicitly address residential properties only, while Statistical Valuation Methods for non-residential and commercial properties will be left for future consideration.[2]

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[1] Capitalised terms are defined within this document, either in the main parts or in the Glossary found in the Appendix.

[2] Standards for Statistical Valuation Methods should be consistent for residential and for non-residential and commercial properties. From a technical point of view, the reduced availability of data is the paramount constraint that is likely to limit the range of Statistical Valuation Methods available for non-residential and commercial properties. In general, demonstrations of accuracy and suitability in the context of any regulatory framework should determine the application of Statistical Valuation Methods for non-residential properties.

These standards apply to those Statistical Valuation Methods which estimate the value of a given property on the basis of the values of other properties. This constitutes the so-called *sales comparison approach,* or simply *comparison approach*. Other possible approaches exist which estimate property value either on the basis of land value, required labour, material and depreciation (i.e. the *cost approach*), or on the basis of rents, lease or other income that can be generated from the property (i.e. the *income approach*). These approaches require fundamentally different information and assumptions, and for this reason they are not included here.

Finally, these standards do not consider Statistical Valuation Methods assisted by valuers, since the intervention of a valuer, however small, would result in a valuation not being purely statistical any longer.

2 Key Definitions

2.1 Types of Statistical Valuation Methods

All Statistical Valuation Methods for residential properties are mathematical tools for estimating property values based on values of other properties. Different Statistical Valuation Methods vary from each other in the degree of their complexity, both from a mathematical as well as from a technical point of view. A Statistical Valuation Method comprises both the data necessary to initiate a valuation (or a value update) as well as the mathematical routine.

Statistical Valuation Methods comprise the following main types:

- Single Parameter Valuation
- House Price Index
- Hedonic Models (also called *Hedonic AVMs*)
- Comparables Based Automated Valuation Models (also called *Comparables Based AVMs* or simply *AVMs*)

The techniques underlying the various Statistical Valuation Methods can comprise a variety of different analytics approaches, such as linear and non-linear regressions, genetic algorithms, neural networks and fuzzy logic, among others.

Statistical Valuation Methods are entirely objective in the sense that the values are calculated on the basis of measurable characteristics of the property and its location.

2.2 Market Value

The purpose of Statistical Valuation Methods is to estimate a Market Value, sometimes referred to as *Open Market Value*. Depending on the purpose, EU legislation provides several definitions of the term *Market Value*.

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In the valuation of real estate as collateral for a lending institution, *Market Value* is defined as:

> *the estimated amount for which the property should exchange on the date of valuation between a willing buyer and a willing seller in an arm's-length transaction after proper marketing wherein the parties had each acted knowledgeably, prudently and without being under compulsion.*[3]

For VAT purposes *Market Value* is defined as:

> *'open market value' shall mean the full amount that, in order to obtain the goods or services in question at that time, a customer at the same marketing stage at which the supply of goods or services takes place, would have to pay, under conditions of fair competition, to a supplier at arm's length within the territory of the Member State in which the supply is subject to tax.*[4]

For accounting purposes *Market Value* is defined as:

> *The price which a buyer would be prepared to pay for it, having due regard to its condition and location and on the assumption that it could continue to be used.*[5]

If Statistical Valuation Methods are used to estimate values other than the Market Value as defined in the EU legislation above this must be **clearly stated**.

2.3 Intended Use

The adequacy of statistical valuations depends on the reason for the valuation. Different intended uses may require different degrees of detail, accuracy and information on the result and for some intended uses the required amount of detail may or may not be available to feed a Statistical Valuation Method.

Statistical Valuation Methods can be used for two main purposes: to calculate the Market Value of specific residential properties or to monitor the price development of residential property markets generally. However, not all Statistical Valuation Methods are ideally suited for both purposes: some methods may be inappropriate for the calculation of the Market Value of a specific property (e.g. Single Parameter Valuations), some may not be able to value a specific property at all (e.g. House Price Indices when no previous value is available), while others may estimate or update a property without immediate reference to the entire market (e.g. Hedonic Models and Comparables Based AVMs).

The accuracy of the results of a Statistical Valuation Method depends on a number of factors, including the quality and detail of available data and the sophistication of the modelling

[3] Regulation (EU) No 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms.

[4] Articles 135 and 137 of Council Directive of 28 November 2006 on the common system of value added tax.

[5] Article 19(2) of Commission Regulation (EC) No 2909/2000 of 29 December 2000 on the accounting management of the European Communities' non-financial fixed assets.

techniques used. The choice of the appropriate method should carefully consider the required level of accuracy.

2.4 Assumptions

Statistical Valuation Methods need access to and are based on data collected previously and independently from the individual valuation that is carried out. This previously held data may be subject to various degrees of structuring and validation and as a result it may or may not lead to the creation of a property database, from which the provider of the Statistical Valuation Method in question may extract information like previous values, Comparables, hedonic coefficients etc. Quite separate from this historic dataset, all Statistical Valuation Models also require data inputs identifying (and possibly describing) any subject properties to be valued when using the solution. Please note that the historic dataset or property database may not necessarily comprise the subject properties themselves.

The quality and detail of that information in the historic dataset or property database naturally influences the accuracy of the result. High quality data, however, does not necessarily warrant results with high accuracy. Accuracy depends first and foremost on the Statistical Valuation Method and on its sophistication. Only extensive and objective testing can reveal the accuracy of each Statistical Valuation Method.

Market values can be estimated using Statistical Valuation Models both for existing (i.e. 'real') as well as merely hypothetical properties. It is assumed that the property characteristics submitted as input to the Statistical Valuation Method to value a specific property reflect the condition and circumstances for which the valuation is needed.

If data which is significant to estimate the value of a property is missing, or if the statistical process has shown the data to be inconsistent or unreliable, no statistical valuation should be provided or, alternatively, information on reduced expected accuracy should be produced.

Statistical Valuation Methods assume that values of residential properties can be estimated with sufficient accuracy for a given purpose using scientific procedures. The complexity of a Statistical Valuation Method and the amount and detail of data available set the upper limit of its possible accuracy. Statistical Valuation Methods that consider characteristics of properties and location with more precision and detail are typically able to produce results with higher degrees of accuracy.

Statistical Valuation Methods shall state the assumptions that apply to them. In the case of methods regarded in these standards, one fundamental assumption is that the property to be valued and the properties of which the values that are taken as means of comparison are for residential purposes.

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2.5 Mass Appraisals and Portfolio Valuations

The practice of valuing multiple properties as of a given date by a systematic and uniform application of valuation methods and techniques that allow for statistical review and analysis of results is called *Mass Appraisal*.[6] The term Mass Appraisal is typically used in taxation contexts. In the context of financial services such as capital modelling, provisioning, whole loan trading or surveyor management, the valuation of multiple properties is typically called *Portfolio Valuation*.[7]

2.6 Property-Specific Valuations

Property-specific valuations comprise valuations that are performed for specific properties taking into account their individual characteristics. This is fundamentally different from valuations that may be produced for entire sets or categories of properties. This is linked to Granularity: A low degree of Granularity of location, e.g. with municipality or post-code area as the smallest geographic unit, allows no differentiation of individual properties. Likewise, when placing properties into categories by ranges of size or years of construction, no finer differentiation is possible.

Single Parameter Valuations and valuations based on House Price Indices are not property-specific. Hedonic Models do accept individual property characteristics but are based on aggregated data (e.g. parameters for an entire post-code area instead for individual addresses). Comparables Based AVMs do consider specific characteristics both of properties and of locations. They select bespoke sets of appropriate comparables for each individual property being valued from which the value estimate is calculated.

2.7 Granularity

Granularity refers to the size of categories that are considered by a Statistical Valuation Method. Granularity applies to location attributes as well as to categories of Property Characteristics.

In the case of location Granularity can be as precise as a specific property (i.e. a specific single-family house or a specific flat in an apartment block). The degree of Granularity decreases as more and more individual properties are aggregated. For instance, in the case of location, a postcode aggregates over multiple addresses and therefore has a lower degree of Granularity than the address level.

Granularity with regard to Property Characteristics applies to grouping according to certain attributes: For instance, the attribute *year of construction* is sometimes grouped into categories reflecting different architectural or historic periods, or into categories such as *newly built* vs. *existing property*. This poses the additional challenge that attributes do not remain fixed over

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[6] see Glossary in the Appendix.

[7] Idib.

time. Aggregations are possible both for numeric attributes (e.g. year of built, living space, plot size etc.) as well as for categorical attributes (e.g. the grouping together of terraced, semi-detached and detached houses as *houses*).

Granularity is linked to the accuracy of a Statistical Valuation Method in the following way: With all things being equal, a lesser degree of Granularity results into lower accuracy than a greater degree of Granularity.

2.8 Glossary of further Terms and Definitions

A more detailed *Glossary of Terms and Definitions* frequently used in the context of Statistical Valuation Methods can be found in the Appendix to this document; the Glossary is continuously updated and also available online on the website of the European AVM Alliance.

3 Operational Aspects

3.1 Access

Statistical Valuation Methods must be developed and calibrated before they can be applied to yield reliable results. User access can be granted through computer software via web interfaces, system-to-system connections, local installation etc. Less complex Statistical Valuation Methods (e.g. House Price Indices) are sometimes provided as static tables. Providers may also choose not to grant direct access to Statistical Valuation Methods, but to offer instead online or offline services where valuations or value updates are executed on demand.

3.2 Development

The development and calibration of a Statistical Valuation Method requires mathematical skill and expertise, as well as the availability of relevant and sufficient market data. The necessary amount of market data, plus the quality and detail that is required depend on the method, which may call for a high degree of technical knowledge and computation hardware, as well as for sufficiently detailed data.

3.3 Data Quality

Statistical Valuation Methods must be devised, their validity must be tested and the model may need calibration to increase accuracy and reduce statistical noise.

Data preparation should entail thorough validation of the data. The extent and level of complexity of the validation procedure depends on the kind, origin and detail of the data. Statistical validation and cleansing routines should be used alongside screenings of samples to cross-check and improve the data quality.

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3.4 Updates

Statistical Valuation Methods require regular updates; these should be carried out frequently so that the valuation methods can respond promptly to any market developments.

3.5 Quality Assurance

The development of Statistical Valuation Methods, of data preparation, of quality assurance, of update routines and of technical security should be documented and the established processes should be adhered to. Measures must be in place to ensure correct functionality.

3.6 Providers

A provider of Statistical Valuation Methods is a legal entity offering Statistical Valuation Methods to customers. Statistical Valuation Methods can be provided offline through software or data packages, or online through web interfaces. Providers should adhere to the standards included in this document and they should endeavour to maintain the highest levels of quality, data security, and integrity. Providers should always aim to maximise accuracy, and maintain reliability and objectivity of their Statistical Valuation Methods to the benefit of the consumer, a stable economy and the customer.

3.7 Objectivity

Providers of Statistical Valuation Methods should always endeavour to develop objective tools that are unbiased and whose accuracy can be tested. There must under no circumstances be any fitting or manipulation of algorithms or of numerical values to deviate from the result which the Statistical Valuation Method is supposed to produce. This comprises all influences that would cause values to be inflated, deflated or fit for purpose **other than calculating objective Market Values**. Only objective scientific measurements must influence the development. All products that do not aim to calculate Market Values (see section 2.2.) but values for special requirements must **unambiguously** be labelled as such.

3.8 Compliance

Providers should comply with European and national law both within their own jurisdiction and within the jurisdictions of which they hold data and/or for which they provide services. In addition, a member of permanent staff should be officially commissioned with data protection and compliance and should be available for contact.

3.9 Open Doors Policy

Providers of Statistical Valuation Methods should adhere to an Open Doors Policy. Financial regulators, customers and rating agencies should have the possibility to audit services and to ask questions regarding the reliability and accuracy of the services of Statistical Valuation

Methods offered by a provider, as well as the provider's compliance with national and European law.

Providers should answer honestly and to the best of their knowledge. Information that is subject to the protection of personal data, to intellectual property rights, or that are crucial business information may not be shared with all parties or shared with reduced detail, or under a Non-Disclosure Agreement.

3.10 Regulations

The use of Statistical Valuation Methods should comply with national legislation and, where applicable, with the regulatory framework of the European Union. Statistical Valuation Methods should therefore be regularly updated to comply with legislative provisions. When used for credit institutions and in IT-Systems, they should also comply with banking supervisory rules on IT security and outsourcing of services.

4 Technical Aspects – Testing, Quality Assurance and Transparency Standards

4.1 Limitations and Scrutiny Procedures

The results of any Statistical Valuation Methods are of course statistical in nature and are therefore produced subject to a certain degree of uncertainty or error. It is of paramount importance that the frequency and extent of such errors is thoroughly tested and that regular and detailed reports are produced, presenting the performance achieved in any such tests and to be expected from the real-life usage of the Statistical Valuation Method in question.

These tests may be conducted either by the provider or by the user of a Statistical Valuation Method, and in order to be meaningful they should fulfil a number of key requirements. First of all, they should be performed on sufficiently large data samples so as to properly address the statistical nature of the results being produced: It would be extremely dangerous to base the assessment of any Statistical Valuation Method on a small data sample, as this may be affected by stochastic fluctuations and thus misrepresent the true underlying performance of the solution.

Secondly, the samples of properties utilised for testing should be representative of the intended circumstances of usage of the tool. For example, if the intended usage is for the periodic revaluation of a given property portfolio, a randomly selected sample from that very portfolio would be appropriate, not one selected manually, and perhaps focussing on properties with a different mix of geographic locations or property characteristics. It is of course most important that the results not be tested in circumstances more favourable than those to be expected in real-life usage.

Finally, and most importantly, any scrutiny procedures must deploy strictly out-of-sample and Blind Tests. These are closely controlled tests where the Statistical Valuation Method being tested has no access to the Benchmark Value against which it will be compared (see below), neither as part of the inputs being provided, nor within the database that may be used to produce the result. This may require the careful removal of certain pieces of information by the valuation supplier before running the test or the removal of certain test cases altogether by the user after the test itself.

There are at least two main types of Blind Tests that can be deployed to thoroughly assess the performance of a Statistical Valuation Method:

- **Lender Tests** are tests where the Subject Properties being tested are controlled by the user, typically a bank or mortgage lender, and their Benchmark Values are disclosed to the supplier of the Statistical Valuation Method only after the results have been delivered to the user. This aims to verify in a procedural manner that the exercise be truly a Blind Test, hence the typical requirement for the user to utilise only recent cases, whose Benchmark Values or any other indications of value (e.g. Asking Prices, Customer Estimates etc) should not yet be available to the supplier being tested. The main disadvantage of the Lender Tests is the resulting relatively small sample, as well as sometimes the reliability of the Benchmark Values.
- **Bulk Tests** are tests where the subject properties being tested and their Benchmark Values are extracted from the property database held by the service supplier. The latter still has to ensure that these be strictly Blind Tests by not using the Benchmark Value for the purpose of computing the result, but the user has to take this on trust and is not in a position to verify the integrity of the procedure. This is the main disadvantage of the Bulk Tests, their main advantage being the ability to source very large samples and conduct very specific analyses on cases with only the desired or relevant mix of attributes.

4.2 Benchmark Values

Statistical Valuation Methods aim to calculate or update Market Values, sometimes also referred to as Open Market Values. In order to assess how well they are capable of doing so, it is therefore necessary to compare their results to the corresponding 'true' Market Values of the properties being tested. For obvious reasons, the latter are typically referred to as Benchmark Values and they typically consist of either a confirmed sale price or Surveyor Valuation, sometimes also known as appraisal in American English, produced by a professionally qualified individual conducting a full internal inspection of the property. Established market practice in different jurisdictions tends to determine whether sale prices or Surveyor Valuations are typically preferred as Benchmark Values in the testing of any Statistical Valuation Methods.[8]

It is also important to note that Benchmark Values themselves may not be entirely free from error or a margin of uncertainty; hence they may need to be treated accordingly when used for

[8] see Glossary in the Appendix.

testing a Statistical Valuation Method. For example, errors in individual Benchmark Values can arise from transcription problems when extracting the test sample or from the inclusion of sale prices that were not established in a truly open market context, but were altered by special circumstances like a distressed sale or a non–arm's-length relationship between buyer and seller. On the other hand, a certain level of uncertainty, even for Benchmark Values free from errors, is due to the fact that Market Value itself is not an entirely precise concept, because even in ideal open market circumstances the actual price set by different buyers and/or different sellers for the exact same property at the exact same point in time may vary slightly and therefore slightly different valuation results are entirely legitimate.

4.3 Coverage

The primary purpose of any testing should be of course to assess the performance of the Statistical Valuation Method in question. Performance is however a rather generic term used to refer collectively to several aspects, including Coverage, accuracy and the reliability of any Confidence Measures that may be produced as part of the output. The first element of these, i.e. coverage, refers specifically to the ability of a Statistical Valuation Method to produce an acceptable result, quite separately from any considerations of the quality of that result i.e. of its accuracy. Intuitive considerations should make it self-evident that an accurate valuation method is easy to attain, if it were only able to produce a result in very few cases, e.g. only for properties of a given kind in a given location; conversely, a method with high coverage is equally easy to attain if accuracy were of no concern, e.g. by assigning the same value to all properties, hence the two aspects of Coverage and accuracy should never be considered in isolation from each other.

Coverage depends on all of the following:

1. The quality of the data provided as input, which can vary greatly from one property sample to another and is therefore completely independent of course from the performance of the Statistical Valuation Method itself
2. The Input Requirements of the Statistical Valuation Method and its ability to interpret and backfill incomplete and/or invalid data. This can in fact set one method apart from another and it is key to the meaningful assessment of Coverage.
3. **Hit Rate**, defined as the ratio of cases producing a valuation divided by the number of cases where a valuation can be attempted (after points 1. and 2. above have been considered. This is also key to the assessment of Coverage and unlike the Success Rate (see below), Hit Rate can be quoted in general terms, regardless of a given property sample.
4. User-defined Output Rules, determining whether a result is acceptable or has to be rejected. These are typically dependent also on the accuracy of the Statistical Valuation Method.

The overall Coverage of a Statistical Valuation Method is typically quantified by its **Success Rate**, defined as the ratio of cases producing a valid result (after all of points 1. to 4. above have been considered) divided by the total number of cases. As already emphasised, this can only be

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meaningfully measured in the context of a given test sample, where the variability introduced by points 1. and 4. above is removed. On the other hand, Hit Rate is the measure most often quoted independently of a given test sample, but it needs to be considered in conjunction with the other elements, especially the strictness of the Input Requirements.

4.4 Accuracy

Accuracy is a collective term referring to the ability of a Statistical Valuation Method to produce results close to the respective Benchmark Values.

Accuracy of Statistical Valuation Methods incorporates at least two distinct dimensions:

- **Bias**, intended as any overall tendency to systematically overvalue or undervalue properties when compared to the Benchmark Value. This can be quantified by the average Error, although the median Error is typically preferred in order to minimise the effect of any spurious Benchmark Values and thus provide a better representation of the true accuracy of the Statistical Valuation Method.
- **Dispersion**, intended as the relative frequency of all different sizes of Errors. This typically displays the shape of a Bell curve with a tall narrow peak and thin tails if Dispersion is low or a low broad peak and thicker tails if Dispersion is high. It can be quantified by the Standard Deviation or the Average Absolute Error or the percentages of results with an Error within 10%, 15%, 20% etc of the Benchmark Value as described below).

The Error referred to here is the relative difference between the result of the Statistical Valuation Method and the corresponding Benchmark Value (BV), calculated for each individual valuation as shown in Formula 1.

Formula 1: $$Error_{valuation} = \frac{result - BV}{BV}$$

Due to the mutual compensation between overvaluations and undervaluations when calculating the above, the Bias of a Statistical Valuation Method may be small even if few or no cases were actually valued accurately at all, i.e. with an acceptably small Error. For this reason, it is truly most important to assess Dispersion as well, thus capturing the typical distance between the results of a Statistical Valuation Method and the corresponding Benchmark Values, regardless of the direction of the Error.

The most commonly quoted measures of Dispersion for a Statistical Valuation Method are the percentages of value estimates where the Error is within a given margin, e.g. 10%, 15%, 20% etc, from the Benchmark Value, as shown in Formula 2.

Formula 2: $$DispersionPct_{method} = \frac{\{|Error_{valuation}| \leq margin\}}{n_{valuations}}$$

The margin used within the above should be set to a meaningful value, e.g. to no less than 10%, to accommodate the inherent uncertainty typically associated to the very concept of Market Value. This is also the reason why the most often quoted measure of Dispersion is the **percentage of results with an Error within 20% of the Benchmark Value**, because granting a 10% margin to both the result of the Statistical Valuation Method and to the Benchmark Value, the two may differ by up to 20% without necessarily leading to the conclusion that either of them must be inaccurate. Most importantly, to allow fair and objective like-for-like comparisons, the exact same measure of Dispersion must be referred to when comparing the accuracy of different Statistical Valuation Methods.

4.5 Confidence and Reliability

Some Statistical Valuation Methods can provide an estimate of their own accuracy for each individual value estimate they produce. This is provided as an additional output alongside the value estimate itself, and it is usually given on a supplier's proprietary scale.

Please note that the degree to which this confidence indicator actually correlates with the accuracy of the accompanying valuation result when compared with the corresponding Benchmark Value is key to the assessment of the accuracy and usability of a Statistical Valuation Method. It is of paramount importance to verify the truly predictive nature of this Confidence Measure, e.g. that is directly translatable into a Forecast Standard Deviation in line with industry best practice, and therefore that it can be relied upon to accept or reject individual results based on the accuracy requirements and risk management controls set by the user. Naturally, unique or non-standard properties are harder to value than standard properties and this should therefore result in a valuation with low confidence.

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PART II: SPECIFIC CONSIDERATIONS APPLYING TO EACH STATISTICAL VALUATION METHOD

Statistical Valuation Methods differ in the amount and detail of data necessary for their development and the sophistication of the algorithms they deploy, which in turn determine their performance, especially in terms of accuracy. They also differ with regard to their Input Requirements and therefore the operational effort required for using them.

This section provides information on the main types of Statistical Valuation Methods as previously listed. A schematic overview with the key differentiating characteristics of each method can be found in the Appendix.

5 House Price Indices (HPIs)

In a nutshell

A House Price Index (HPI) is a Statistical Valuation Method that consists of a time series capturing the development of values of residential properties in a given geographic area (e.g. postcode, municipality, region etc.). HPIs may or may not consider other property characteristics as well. They can be used to update the value of a property based on a previous value. The result of a valuation produced by applying an HPI is also referred to as an *Indexed Valuation* and it constitutes a mere update of the previous value provided as input, not the attainment of a new and independent valuation.

Description

To obtain a time series, values are needed repeatedly for categories of properties in given areas at regular time intervals. The change of value over time is transformed into a percentage which constitutes the HPI. Based on the data they use and on the methodology they deploy, HPIs can be grouped into several different types including Expert Opinions, Simple Aggregations, Basket of Goods Approach and Repeat Sales Indices.

Expert Opinions: Many HPIs are based on opinions on the development of the property market that are collected through surveys among experts.

Unfortunately, Expert Opinions are highly subjective and tend to focus on discrete figures rather than recognise even small variations; they therefore suffer from a lack of reliability.

Simple Aggregation: In producing this kind of HPIs, the values of individual properties available for a given category, time period and geographic area are aggregated. The aggregation can be attained through means, medians or other statistical measures and the relative changes over time of these aggregated values constitute the HPI.

Simple Aggregations are easy to carry out and require little effort. The disadvantage is that the results are strongly influenced by the volume and typology of cases available for each time period and therefore a change over time may or may not be observed simply because the quantity, quality and distribution of the properties have changed.

Basket of Goods Approach: In a Basket of Goods Approach the HPI is calculated from individual values of the same properties over time. That basket of goods is filled with properties that are valued for each period of time. The valuation of properties can be carried out manually or using Statistical Valuation Methods. The relative change of value of these baskets of goods represents the HPI. The advantage of the Baskets of Goods Approach is that for each period of time the same properties are valued which reduces the problem of to changing components known from Simple Aggregations. However, the quality of each valuation still depends on the quality of valuation of the properties in the basket.

The properties of the basket of goods can be synthetic or real. Synthetic properties are realistic combinations of property characteristics but do not necessarily exist. Real properties are properties that do exist and are chosen to represent a geographic area for the purpose of calculating the House Price Index. Real properties in the basket of goods have the advantage that regional peculiarities can easily be taken into account. The advantage of synthetic properties is that they can be created any number of times for all areas differentiated by the HPI.

Repeat Sales Indices: A type of HPI that uses recorded sale prices of the same properties at two or more points in time. These indices have the benefit of removing any effects from spatial factors and different Property Characteristics.[9] They also have the advantage to not include additional error from the valuation of properties in a basket. As they require very large volumes of sales price data for their production, Repeat Sales Indices are not available for all jurisdictions.

Assumptions

Regardless of the type, every HPI assumes that all properties that fall within the category covered by it (e.g. single-family homes in a certain geographic area) would experience the same price developments. HPIs also assume that the recorded previous value and its valuation date are reliable. In this regard HPIs are highly similar to Single Parameter Valuations, as they place great reliance on a single piece of information.

While HPIs are calculated for whole categories of properties, there may not always be sufficient data available for all geographic areas or all time periods, respectively. In these cases, it is common to revert to including neighbouring categories. Naturally, whenever this is the case, the assumption that all properties covered by the same HPI would experience the same price movement becomes even more far-fetched.

Intended uses

With HPIs an independent estimate of value cannot be calculated. HPIs allow to update a value from a given date or to estimate a value at a previous time if a current value is known. Because of that HPIs are mainly used to monitor portfolios and market trends, e.g. for capital requirement purposes.

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[9] Ibid.

While a previous value is needed to obtain an update of a property value, HPIs are also used by themselves. For instance, when monitoring market trends, the mere rate of change, i.e. percentage of market fluctuation, is looked at.

How to use

Applying HPIs to update values is easy and requires no or little technical support. An HPI for a given Property Type in a given location only requires a Previous Value and the corresponding date to calculate the value for a different date.

Documentation

When providing an HPI the type of HPI (e.g. Basket of Goods Approach, Repeat Sales Index), the source (e.g. listing sites, land registries) and the kind of data (e.g. Surveyor Valuations, sales prices, Asking Prices), that have been used for the calculation should be stated. The documentation should also include a description on how the data were treated and what value is reported (e.g. average, median).

Reporting

Reports of HPI results should contain information on the origin of data (i.e. Expert Opinions, Transaction Data etc.) and type of index (i.e. Simple Aggregation, Basket of Goods Approach, Repeat Sales) and the Granularity for which that value is returned.

Indexed Values should be reported alongside the date and amount of the previous value, the Effective Date of the Indexed Value and the parameters taken into consideration (e.g. property type, geographic area etc.). If categories were extended due to an insufficient quantity of data for a given segment, this should also be reported.

When used as is without updating a value, the report to an HPI should include the dates of the belonging period of time, the parameters taken into consideration (e.g. property type, region, period of time) and the type of HPI, unless made available through documentation. If categories were extended due to insufficient numbers of data for a given geographical region this should also be reported.

How to measure accuracy

Because HPIs do require a previous value to produce a result, testing HPIs is less straightforward than for those Statistical Valuation Methods that are able to produce a value regardless. HPIs can only be tested using properties for which more than one transaction and transaction dates have been recorded within the period of time covered by the HPI.

In a so-called **Match-Pair Analysis** the Benchmark Value is a later value that is compared to an Indexed Value created by applying the HPI to a previous value referring to the same property.[10]

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[10] Ibid.

Accuracy is then measured in the same way as described in section 4.4, e.g. with particular attention to Dispersion and Bias, even in Match-Pair Analyses.

Advantages[11]

When deployed for the purpose of Portfolio Valuations (and naturally subject to the restriction that a previous value be available for each property to be valued), HPIs typically offer some key advantages, including:

- First and foremost they are often relatively cheap or even free. Given the large number of properties involved in many portfolio valuations, coupled with the frequency of the exercise which might be as often as quarterly or even monthly, this is by far the key attraction of using HPIs. Even in those jurisdictions or for those suppliers where HPIs are not completely free, they are typically charged at a small cost and on a flat fee basis, not on a volume basis, making it still very economically attractive for banks.
- Even regardless of cost, in some jurisdictions HPIs are – or have been for a long time – the only available tool that could realistically be deployed for valuing quickly and consistently the large number of properties typically involved by Portfolio Valuations, hence their popularity due to lack of alternatives. In this context, the use of HPI for regularly updating portfolio values is of course much preferable to not applying any updates at all.
- Some users also regard HPIs as providing greater transparency than other Statistical Valuation Methods, e.g. in the eventuality that the resulting property values were subjected to scrutiny by a third party, because their usage entails a trivial multiplication between a previous property value and a factor (or percentage change) that can be disclosed in full. However, this apparent simplicity in the application of HPIs is accompanied by an often overlooked 'black box' approach in their production, i.e. on how the HPI factors themselves are actually produced (see *Limitations*).

Limitations

HPIs do not take into account individual characteristics of properties or addresses. The assumption behind HPIs is that all properties of the same type (e.g. purpose-built flats, second hand single family houses etc.) in the same geographic area (e.g. a given postcode, municipality, region etc.) change value over time at the same rate. The accuracy of HPIs is therefore strongly limited. HPIs come with no confidence information. That is, when applying an HPI to update a property value there is no information on the expected accuracy of that update. The accuracy of an updated value highly depends on the accuracy of the previous value and its date. The accuracy of HPIs decreases with the amount of time passed since the previous value has been observed.

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[11] see EMF/EAA Joint Paper on the use of Automated Valuation Models in Europe, May 2016; http://www.europeanavmalliance.org/publications.html?file=files/eaa/Downloads/EMF%20Paper%20on%20AVMs.pdf

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Since HPIs require a previous value and a previous valuation date, they heavily rely on that information being accurate. Potential errors in either of those would result in serious valuation errors, with no scope for redress by taking any other elements or checks into account.

At last and in contradiction with their perceived simplicity and transparency as previously mentioned, some HPIs, e.g. Expert Opinion HPIs, can be affected by highly subjective elements and even those that are produced solely through quantitative computations may actually deploy methodologies within them that are just as proprietary (and therefore unknown to the user) as those deployed within other Statistical Valuation Methods. The data used to construct an HPI may also not be in the public domain. This makes any checks on the integrity of the calculation process impossible to conduct and, in this light, it becomes understandable why it is not unprecedented for HPI suppliers to occasionally re-state retrospectively entire sections of their HPI history, whenever significant changes to the methodology are introduced and/or any errors are uncovered[12].

6 Single Parameter Valuations

In a nutshell

Single Parameter Valuations estimate the value of a property on the basis of one Property Characteristic. Typically, this is the property type such as *purpose-built flat* or *detached house*, which might be specified further, e.g. *three-bedroom flat in central Vienna*. The concept can be extended to comprise a combination of two or more Property Characteristics, e.g. floor area and property type.

Description

Single Parameter Valuations are typically aggregated values, such as the mean or median value of a number of properties in a given geographic area (e.g. postcode, municipality, region etc.) and for a given time period (e.g. the year 2017). Single Parameter Valuations can be provided as a value per metre square or as the value of an assumed standard property. The standard property might vary for different geographic areas. No previous value is needed.

Assumptions

Single Parameter Valuations assume that one or a couple of parameters sufficiently describe the property to obtain a value with adequate accuracy for the intended use.

Intended uses

Single Parameter Valuations are typically used as a starting point for further analyses or for high level illustration of price levels in given markets. Price developments of residential property

[12] Ibid.

markets can be captured using Single Parameter Valuation by comparing values at different points in time.

How to use

Single Parameter Valuations only require a lookup from a table without further calculation. Only one Property Characteristic and, typically, the geographic area and a valuation date are all that is needed.

Documentation

When providing Single Parameter Valuations the key data source (e.g. listing sites, land registries) and the kind of data (e.g. Asking Prices, Sales Prices, Expert Opinions), should be stated. The documentation should also include a description on how the data were treated and which statistical measure is used to compute the values (e.g. average, median).

Reporting

Reports of Single Parameter Valuations should contain information on the origin of data (i.e. Transaction Data, Asking Price data etc.) and the Granularity for which that value is returned.

Results of Single Parameter Valuations should comprise the value, a statement of the parameters taken into consideration (e.g. Property Type, geographic area) and the technique used (e.g. average, mean).

How to measure accuracy

Accuracy of Single Parameter Valuations can be tested through Bulk Tests. As Single Parameter Valuations are typically used anecdotally but not to actually value properties on an individual or portfolio basis, usually no such tests are usually carried out.

Advantages

Single Parameter Valuations are helpful to describe the general level of property prices in a market at a given time.

Limitations

Only one or a few Property Characteristics, together with geographic area and time period, are taken into consideration. Neither property-specific nor address-specific characteristics are being considered. Valuations are therefore identical for all properties that fall into the same category along these three dimensions, allowing very limited accuracy.

7 Hedonic Models

In a nutshell

Hedonic Models are mathematical equations with pre-calculated parameters that accept multiple Property Characteristics as inputs (e.g. Property Type, floor area, construction year, number of bedrooms) to calculate the estimate of a property value. Hedonic Models are multivariate methods as they typically use multiple parameters for estimating property values. Hedonic Models are sometimes also referred to as Automated Valuation Models (AVM), though they do not necessarily carry out any *automated* process. Hedonic Models are therefore fundamentally different from Comparables Based AVMs (see section 8).

Description

Hedonic Models are analyses of how various Property Characteristics influence the property value in a given time period and for a given geographic area. The general idea is that each characteristic of the property (e.g. size, age etc.) and of its location (e.g. socio-demographic data like unemployment rates, average residents' age, median income etc.) has a quantifiable influence on property value and that each such contribution can be isolated.[13]

The value of a property is estimated through calculating the result of an equation containing Property Characteristics of the property to be valued, possibly based on its generic location.

Parameters are calculated on calibration data sets, which typically comprise both property data and auxiliary information such as socio-economic data.

Different Hedonic Models vary in the complexity of the mathematical equations involved and the number of Property Characteristics taken into consideration. The functional form of the mathematical equation of a Hedonic Model is selected when the model is being developed. The parameters are calculated on a set of property data for which Property Characteristics, value and the characteristics of the geographical area are known.

Assumptions

Hedonic Models assume that the value of a property is a function of its individual characteristics. Hedonic Models also assume that properties can be allocated to geographic groups within which all properties show the same quantifiable relationship between Property Characteristics and value. Hedonic Models focus on a limited number of Property Characteristics that are analysed and quantified and are thought to determine the property value.

Intended uses

Hedonic Models can be used to value properties and take into consideration individual characteristics. Because of that Hedonic Models can value properties e.g. for mortgage applications and be used to monitor values, e.g. for capital requirement purposes.

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[13] see Glossary in the Appendix.

Where market trends are to be monitored Hedonic Models can be an effective tool. However, as they return property values, these must be produced at different points in time and then transformed into a House Price Index in order to fulfil this purpose.

How to use

Typically, Hedonic Models are provided in software applications where the user only needs to input the required Property Characteristics, including property location. Necessary Property Characteristics may also be estimated based on the location of the property so that only the provision of location information is required. The result can be accompanied by a Confidence Measure.

Documentation

The origin, type and detail of any data sets being used should be stated. Because the term *Hedonic Models* is not limited to a certain mathematical model it should also be stated what model is being deployed (e.g. multiple regression). Hedonic Models should be referred to as *Hedonic Models* or as *Hedonic AVMs,* not simply as AVMs. This is to avoid confusion with Comparables Based AVMs that are a different Statistical Valuation Method.

Reporting

Reports should contain information on the origin of the property data (i.e. Sales Prices, Asking Prices etc.) as well as information on non-property-specific data that are used to calculate the value. This should include the Granularity of any data being used.

The result of a Hedonic Model should be presented alongside information on expected Accuracy (e.g. by Confidence Level). With Hedonic Models, all calculations of an estimate are typically based on the same data. Because of this aspect, little additional detail can be added to each single valuation that cannot be covered by generic documentation.

How to measure accuracy

Accuracy of the value estimates can be measured in a straightforward manner through Bulk Tests. Bulk Tests should also demonstrate the reliability of any Confidence Measure provided with each individual valuation.

Advantages

Hedonic Models are typically provided in software applications that are easy to use and do not require any understanding of the actual model. Results are returned within a short timeframe. Hedonic Models do not require location information finer than the smallest geographic area by which the model is segmented. For instance, if the smallest geographic area considered by a Hedonic Model is the municipality, then the complete address does not add any information and therefore does not need to be provided.

Limitations

Hedonic Models typically rely strongly on aggregated information. This is in particularly so in terms of geographical aggregation (e.g. postcode, municipality, region etc. instead of individual addresses). Aggregation reduces the degree of Granularity and therefore the level of attainable accuracy, because the specific details of a given property are lost.

Limits of accuracy should be alleviated if a reliable Confidence Measure is provided with each individual valuation. This is so because reliable Confidence Measures can be used as a filter, keeping only those results that meet a certain accuracy level.

A major reason for developing Hedonic Models is that only small quantities of property data are available or that data records lack crucial details (e.g. the precise address) preventing them from being used within a method that requires precise location. Through using auxiliary data such as socio-economic data, Hedonic Models are able to cover areas where no property data of sufficient quantity and quality is available. While these aspects allow the development of Hedonic Models despite scarce property data, this comes at the cost of a lower achievable accuracy. This is so for two major reasons. One is that because some or all of the auxiliary data are only available for entire areas (e.g. unemployment rates by municipality, purchase power by postcode). Differences on a smaller scale are flattened, limiting accuracy already on theoretical grounds. The other reason is that auxiliary data may tend to contain statistical errors and these are inevitably transmitted to the model and thus into its results.

Hedonic Models assume that all characteristics of property and location that significantly determine the value have been incorporated into the model. As a result, any characteristics that may also have an influence but were not foreseen as relevant and therefore are not included in the model, cannot improve model accuracy.

8 Comparables Based Automated Valuation Models (Comparables Based AVMs)

In a Nutshell

Comparables Based AVMs are intelligent tools that employ sophisticated algorithms to select comparables and calculate value estimates for a specified property at a specified date using mathematical modelling techniques in an automated manner. In order to achieve high accuracy and high coverage Comparables Based AVMs must be based on comprehensive property data bases.[14] While often they are only referred to as *AVM* the specific term of *Comparables Based AVM* emphasises that for each valuation a bespoke set of comparables is selected based on the individual characteristics and location of the property to be valued. As such Comparables Based AVMs differ fundamentally from Hedonic Models (see section 7).

[14] Ibid.

Description

Comparables Based AVMs typically comprise two steps. First, they automatically select appropriate comparables from data bases. These comparables are chosen according to the characteristics of the property to be valued (e.g. property type, floor area, year of construction) and its location (e.g. proximity, comparability of area quality), hence resulting in a different set of comparables for different addresses or different Property Characteristics.

After selecting comparables, the second step consists of using the values of these comparables to estimate the value of the Subject Property itself. Depending on the sophistication of a given Comparables Based AVM, these steps may be iterated and additional data may be taken into consideration.

Assumptions

Comparables Based AVMs assume that the value of a property can best be estimated using the closest matching properties, i.e. comparables. In many circumstances of real life usage, they may also assume that the property being valued be in average condition.

Intended uses

Comparables Based AVMs can be used to value properties where Property Characteristics and detailed information of the address ought to be considered. Comparables Based AVMs are also useful if for regulatory reasons a property value must be calculated on the basis of comparables. Because of that, Comparables Based AVMs can value properties e.g. for mortgage applications and be used to monitor values, e.g. for capital requirement purposes.[15]

Where market trends are to be monitored, Comparables Based AVMs can again be an effective tool. However, as they produce individual property values, their results must first be produced at several subsequent points in time and then transformed into a House-Price Index first for this purpose.

How to use

Comparables Based AVMs can be used to calculate a value for a residential property based on its address (or cadastral reference or other forms of unique property identification) and some of its Property Characteristics. The user provides the required input data (e.g. address, floor area, year of built, condition) and the AVM returns the value and additional information. Depending on the AVM and the purpose of use, Property Characteristics may also be drawn from a database and identification of the property may suffice.

[15] see EMF/EAA Joint Paper on the use of Automated Valuation Models in Europe, May 2016; http://www.europeanavmalliance.org/publications.html?file=files/eaa/Downloads/EMF%20Paper%20on%20AVMs.pdf

Documentation

The origin, type and detail of data available to the AVM should be stated. The fact that comparables are selected should be made explicit to avoid confusion with other methods, in particular with Hedonic Models: In fact, Comparables Based AVMs should typically provide the ability to review a list of (at least some of) the comparables used for each individual valuation.

Reporting

Reports should contain information on the origin of the property data (i.e. Sales Prices, Surveyor Valuations etc.) as well as information on non-property specific data that are used to calculate the value. This includes the Granularity of those data.

Value estimates produced by Comparables Based AVMs should be reported in conjunction with confidence information (i.e. Confidence Levels or Forecast Standard Deviation). Information on the number of comparables selected to calculate the value should also be stated.

How to measure accuracy

The accuracy of the value estimates can be measured through Bulk Tests and Lender Tests as described in section 4. These should also demonstrate the reliability of any Confidence Measures provided for individual valuations.

Advantages[16]

Comparables Based AVMs are cost-effective and easy to use, and typically return a result within a very short time. They also offer a number of other advantages including:

- First and foremost, Comparables Based AVMs operate at a much greater level of Granularity than any other Statistical Valuation Method, by selecting the most appropriate set of comparables upon which to base the valuation of each individual property. As a result, the accuracy of Comparables Based AVMs is typically higher than that of other Statistical Valuation Methods. This is the case because Comparables Based AVM do not or only to a small degree rely on pre-defined geographic areas (e.g. postcodes, municipalities, regions etc) and on data that is bound to such areas. Furthermore, characteristics of the property to be valued and its location can be taken into consideration explicitly as well as implicitly. This is because individual properties are selected as comparables carrying non-explicitly stated properties in their value information.
- Unlike Single Parameter Valuations they do not require any specific Property Characteristic to always be available as input and unlike HPIs they do not require a previous value either, thus being able to value properties even where no previous history is known to the party requiring the valuation. In the specific context of Portfolio Valuations, for example, previous values (and dates) may be missing

[16] Ibid.

whenever there have been data transcription errors, system migrations, merger and acquisition of other banks' portfolios etc. In the context of mortgage origination, if the valuation is being conducted upon request of the buyer or borrower, not the seller, any previous values will also typically be unknown, making the usage of other Statistical Valuation Tools like HPIs a technical impossibility.

- As they do not require or rely solely on a previous value, Comparables Based AVMs do not carry forward forever any bias that might have affected that previous value, e.g. due to fraud, commercial pressure, excessive optimism or other circumstantial reasons. On the contrary, by using fresh comparable evidence every time it is requested to provide a valuation – just like a surveyor would – a Comparables Based AVM is able to reset any such historic issues.
- The accuracy of Comparables Based AVM can be empirically and scientifically measured on Property Data samples that are typically much larger than those feasible for other Statistical Valuation Methods, e.g. HPIs, as the only requirement for such rigorous testing is the availability of a Benchmark Value to compare against (see section 4).
- Comparables Based AVMs include a Confidence Measure as output with each valuation result, thus providing an indication of accuracy at a property-by-property level (again see section 4). This is a critical piece of information for the user of these valuations, as it indicates to what extent they can be relied upon and allows for example the filtering of only a subset of results on which sufficient confidence can be placed.

Limitations

Comparables Based AVMs have a high potential of accurately estimating property values. They were specifically designed to address shortcomings of other statistical valuation methods. Accuracy, however, depends on the quantity and quality of the property data available.

Because Comparables Based AVMs do not require the aggregation of Property Characteristics or of characteristics of the location they draw on the smallest Granularity of all Statistical Valuation Methods. This greatly enhances their accuracy.

Furthermore, their accuracy can be enhanced almost indefinitely, e.g. to meet the specific operational requirements of any given user, by leveraging the fact that they are also capable of producing a Confidence Measure associated with each valuation result. In fact, this can be used as a filter to reject certain results and thus retain only those exceeding the desired level of accuracy.

APPENDIX

9 Schematic Overview of Statistical Valuation Methods

<table>
<tr><th></th><th>Considers individual location characteristics</th><th>Considers individual Property Characteristics</th><th>Can provide Confidence Measure with each individual valuation</th><th>Does not require previous value to estimate value</th><th>Values properties on a truly individual basis</th><th>Suitable for monitoring of market trends</th></tr>
<tr><td>House Price Indices</td><td rowspan="3">no/little reliance on pre-defined areas</td><td rowspan="2">no, properties are grouped into broad categories</td><td rowspan="2">no</td><td>no</td><td rowspan="2">no</td><td>yes</td></tr>
<tr><td>Single Parameter Valuations</td><td rowspan="3">yes</td><td rowspan="3">after conversion to HPI</td></tr>
<tr><td>Hedonic Models</td><td>partly, only characteristics that have been quantified</td><td rowspan="2">Yes</td><td>partly, as heavy reliance on aggregations</td></tr>
<tr><td>Comparables Based AVMs</td><td>yes, explicitly and implicitly</td><td>yes, explicitly and implicitly</td><td>Yes</td></tr>
</table>

10 Glossary of Terms and Definitions

Term	Definition	Remarks
Automated Valuation Model (AVM)	A system that provides an estimate of value of a specified property at a specified date, using mathematical modelling techniques in an automated manner.	- As it only requires a property to be specified, an AVM can function merely based on property address, or cadastral reference or other forms of unique property identification (and possibly a few basic property characteristics), but it does not necessarily require any previous values of the property to be provided as input. An AVM, just like a Surveyor Valuation, can therefore value even properties that have never transacted before or whose history is not known to the user. This feature is one of the key differentiators between AVMs and HPIs. - As it deploys modelling techniques, hence the "M" in the acronym, an AVM is typically a lot more complex and therefore more accurate than just applying a simple factor to a previous value: again, this is one of the key differentiators between AVMs and HPIs. Typically, an AVM consists of sophisticated mathematical formulae requiring the deployment of bespoke technology and it includes elements of a comparable-based valuation approach, similar to Surveyor Valuations. - As it is an automated solution, hence the "A" in the acronym, an AVM operates without any human intervention post-initiation, making it an entirely objective tool, whose results are completely independent of the circumstances of the valuation. Clearly this rules out, for example, any manual selection of Comparables or any other ad-hoc subjective adjustments and it is one of the key differentiators between AVMs and Surveyor Valuations.
AVM Performance	Generic term used to refer collectively to AVM Coverage, AVM Accuracy and the reliability of the Confidence Levels.	Not be confused with AVM System Performance.
AVM Coverage	Collective term referring to the ability of an AVM to produce an acceptable result.	AVM Coverage depends on all of the following 1. The quality of the data provided as input (completely independent of AVM performance) 2. The AVM Input Requirements and the AVM's ability to interpret and backfill incomplete and/or invalid data (key to AVM Coverage) 3. Hit Rate (key to AVM Coverage) 4. User-defined Output Rules (typically dependent on AVM Accuracy)

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		The overall Coverage of an AVM is typically quantified by its Success Rate, but it can really only be meaningfully measured in the context of a given test sample, where the variability introduced by the non-AVM-dependent points 1) and 4) above is removed. Otherwise Hit Rate is the measure most often quoted independently of a given test sample, but it needs to be considered in conjunction with the strictness of the Input Requirements.
AVM Accuracy	Collective term referring to the ability of an AVM to produce results close to the respective Benchmark Values.	AVM Accuracy incorporates the following broadly separate dimensions: - Bias (typically quantified by the Average Error or preferably by the Median Error) - Dispersion (typically quantified by the Standard Deviation, or the Average Absolute Error, or the percentages of AVM results within 5%, 10% etc of the Benchmark Value). Please note some widely used accuracy measures may capture elements of both dimensions, e.g. the percentages of AVM results less than 5%, 10% etc above the Benchmark Value.
Success Rate	The ratio of cases producing a valid AVM result (after all points 1. to 4. to do with Coverage have been considered) divided by the total number of cases.	As 1. is sample-dependent and 4. is user-dependent, it can really only be meaningfully measured in the context of a given test sample, e.g. in a Competitive Test, not quoted in general terms, unlike Hit Rate.
Hit Rate	The ratio of cases producing an AVM result divided by the number of cases where an AVM can be attempted (after points 1. and 2. to do with Coverage have been considered)	Unlike the Success Rate, Hit Rate can be quoted in general terms, regardless of a given test sample.
Benchmark Value (BV)	The property value against which the accuracy of an AVM result is measured	It is intended as the correct Open Market Value, hence it typically consists of either a reliable Surveyor Valuation or Sale Price, which of the two often depending on the established market practice in different jurisdictions.
Error	The relative difference between an AVM and the Benchmark Value expressed as a percentage of the Benchmark Value (not of the AVM): (AVM - BV) / BV	
Bias	Any tendency of an AVM to systematically overvalue or undervalue properties when compared to the Benchmark Value.	AVM Bias can be quantified by the Average Error, but in order to minimise the effect of a few potentially spurious outliers, e.g. due to questionable Benchmark Values, the more robust Median Error is usually preferred.

Dispersion	The relative frequency of all different sizes of Errors.	This typically displays the shape of a Bell curve with a tall narrow peak and thin tails if Dispersion is low, or a low broad peak and thicker tails if Dispersion is high.
Confidence Level	A predictive measure (usually given on an AVM provider's proprietary scale) expressing the estimated accuracy of each AVM result and as such directly translatable into a Forecast Standard Deviation.	Please note the degree to which the Confidence Level actually correlates with the accuracy of the AVM result when compared with the Benchmark Value is key to the assessment of AVM accuracy.
Forecast Standard Deviation (FSD)	The Standard Deviation of the Error distribution predicted for a set of AVM results with a given Confidence Level.	
Bulk Test	An AVM accuracy test where the Subject Properties and their Benchmark Values are extracted from the AVM Property Database.	The AVM provider still ensures that these be Blind Tests by not using the Benchmark Value for the purpose of computing the AVM result, but the user has to take this on trust and has no way of validating the integrity of the test. This is the main disadvantage of the Bulk Tests, their main advantage being the ability to source very large samples and conduct very specific analyses on cases with only certain given characteristics.
Lender Test	An AVM accuracy test where the Subject Properties are controlled by a Lender and their Benchmark Values are disclosed to the AVM supplier only *after* the AVM results have been delivered to the Lender.	This aims to ensure that the exercise be truly a Blind Test, hence the typical requirement for the Lender to use only recent cases, whose Benchmark Values or any other indications of value (e.g. Asking Prices, Customer Estimates etc) should not yet be available to the AVM supplier being tested. The main disadvantage of the Lender Tests is the resulting relatively small sample, as well as sometimes the reliability of the Benchmark Values.

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