Automated Valuation Models (AVMs)
1st edition
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[AVMs]
RICS information paper
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Acknowledgments
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1 Introduction

The valuation of property has long been characterised as both an art and a science: an art because of the need to make value judgments concerning the intangible features that attract certain buyers; a science because it is possible to establish trends and analyse how these are interpreted by buyers and sellers, including the value placed on particular property characteristics.

The use of computer modelling in the science of valuation has merit in a world where there is increased availability and use of data, and where failure to achieve an opinion of value, which takes proper and balanced account of such information and analysis, may result in greater exposure to expensive litigation.

Automated Valuation Models (AVMs) are the application of that science. They use one or more mathematical models – such as regression, adaptive estimation, neural networks or an artificial intelligence program – to estimate the value of a property, a series of properties, or a mass appraisal of millions of properties.

In essence, AVMs are not significantly different from any other tool used by valuation surveyors (valuers), or other professionals and lenders, to undertake their analyses and arrive at supportable estimates of value. AVMs also vary in quality, depending on the data they use and their design.

This paper applies mainly to what is specifically known as Automated Valuation Models and not to other forms of statistical or indexing models which are touched on in section 2.

The technology is not simple and is not always understood. This information paper therefore aims to:

• provide information on what AVMs are and what may contribute to their development, noting the typical data and information that might be used
• provide examples of matters that should be considered by valuers who intend to use AVMs; and
• provide information to valuers on the factors to be taken into account when asked by clients for advice about the use of AVMs.

This information paper is intended for RICS members, but others may find it useful including other professionals, lenders and similar institutions. This paper considers the use of the AVM in the UK and should not be considered to have global application. AVM modelling does occur in other states, but the combination of available market information, differing valuation approaches, together with legal and tax implications would make it too complex to achieve the three principal objectives set out above.

A glossary of terms used in this paper can be found in Appendix 1.
2.1 Introduction

An AVM was defined in 2008 by the RICS AVM Standards Working Group:

‘Automated Valuation Models use one or more mathematical techniques to provide an estimate of value of a specified property at a specified date, accompanied by a measure of confidence in the accuracy of the result, without human intervention post-initiation’.

AVMs are most commonly used to provide estimates of capital or rental value for residential property. They can also be used in other market sectors (such as commercial property or land), but this information paper relates solely to applications in the residential sector.

AVMs can operate independently of any human intervention. They can also, however, be used to assist a qualified valuer in producing an estimate of value. It should be noted that if used as such, the valuation will be subject to review and any necessary refinement in order to ensure that it complies with the RICS Valuation – Professional Standards (the ‘Red Book’), as this will be a valuation and no longer be solely the output of the AVM. This is an important issue for valuers and is expanded on in section 3.2 and sub-section 3.6.2.

AVMs also vary, depending on the modelling techniques used (that is, the technology and methodology used). The detail within the models will not usually be accessible to a valuer, as the models come in the form of software packages from various providers.

There are a number of considerations that providers may take into account in the specification of their AVM. The sections below cover some of the options and types of model that can be used, together with the property information (‘attribute data’) and capital value or rental data required for modelling. It may be useful for valuers to be aware of some of the techniques used in modelling, some of the types of model available and the property data used, so that they can judge whether a particular AVM is applicable for the purpose they, or their client, intend to use it for.

2.2 Types of model

2.2.1 Overview

AVMs differ considerably in their construction, but all use mathematical techniques of varying complexity to provide estimates of property value. A modelling technique for a particular AVM will typically combine property sales data with property characteristics (‘attribute data’), with these forming the variables used in the model.

Models typically comprise one dependent and a number of independent variables. Each independent variable plays a part in explaining the dependent variable. Therefore, if the dependent variable is the estimate of value, the independent variables may be, for example: property type, property age, floor area, and other factors reflecting the physical characteristics or attributes of a property. The model developer will specify the independent variables to be used in the model (i.e. the property attributes). In addition, the model developer will decide which type of model to use – in other words, how the independent variables are related. Some examples are set out below.

2.2.2 Multiple regression analysis [MRA]

MRA, as an AVM methodology, is one of the more sophisticated. It has been used successfully for a relatively long period of time in a number of countries. The modelling process itself, commonly termed ‘calibration’, uses MRA to determine the contribution to value that is attributable to each variable, or property attribute, and so produces a coefficient for each. Two common types of MRA model are described below (for more detail, see Appendix 2).

[1] Additive model

The estimated value is determined by adding the result of multiplying each independent variable, or property attribute, by its coefficient. The constant would represent the basic value (sometimes called the ‘base’ value) for, say, a semi-detached house built at a certain date. Added to this would be each of the property attributes specified in the model, with a basic value multiplied by a coefficient, to take account of such attributes as age, type of development (detached, terraced, etc.), size, number of bedrooms and others.


In a simple multiplicative model, the estimated value is determined by multiplying the independent variables instead of adding them.

In both (1) and (2) above, models are usually calibrated using the MRA process with actual sale prices, on a regular basis, to determine a consistency as to the coefficients and variables in the model.

While MRA is relatively widespread, model developers will commonly use alternative methodologies and mathematical techniques, which are discussed below.
2.2.3 Indexation
Various forms of indexation may be used to adjust actual sale prices within MRA or other models, but these may also be used as models in their own right. Generally, these measure an average change in value over time and factor the value of a property forward from a given benchmark starting date. They can provide very quick value estimates and work best in localities with many similar properties, where the range of value is close to the average value. However, the accuracy of indexed models can be inconsistent and less reliable than fully specified models, according to the Standard on Automated Valuation Models produced by the International Association of Assessing Officers (IAAO) in 2003.

2.2.4 Sales comparison models and automated comparable selection
The valuation of property using sales comparison is a tried and trusted approach among valuers. However, its subjective nature can mean: different valuers will select different comparable sales, make different adjustments to the sale prices (for variations between the comparable and the property to be valued) and draw different conclusions as to value. The automation of this process has the advantage of ensuring a consistent approach to selecting comparable sales. The sales can also be adjusted in a consistent manner to reflect any differences in property attributes from the subject property and the difference in time between each sale and the date of valuation. These differences are generally adjusted through the use of a dissimilarity index. Specified penalty weights are allocated to differences between the comparable property and the subject property (with the greater the difference, the higher the penalty). These penalties are totalled for each property in a modelling sales set, and those with the lowest penalty total (that is, those that are the most similar to the subject property in terms of location, property attributes and sale date) are selected as the best comparable sales.

In models where a mathematical technique (MRA or other methodology) is combined with automated comparable selection, the model coefficients can be used to adjust these comparable properties to match the subject property. The adjusted sales (or surrogates) can then be combined with the model value estimate to produce a final value estimate for the subject property (for example, by adopting rules around averaging the set of values that include the model estimate and best adjusted comparable sales).

Using this methodology, comparable sales may have a significant impact on the final value estimate. Accordingly, there is a further benefit to be gained by ensuring the accuracy of sales information, and the related property attribute details, for the most frequently selected comparables.

Comparable selection may thus be used as part of an MRA model, with other methodology, or on its own as a programme to produce an estimate of value. In each case, there will almost certainly be some form of indexation of comparable properties within the programme to arrive at values at or around the valuation date.

More information can be found on comparable analysis as used by a valuer in the RICS information paper – Comparable evidence in property valuation.

2.2.5 Artificial neural networks (ANNs)
The function of ANNs is to process information: they are a relatively recent adaptation for use in calibrating property valuation models. As the IAAO 2003 Standard notes:

‘The concept is borrowed from the biological sciences and functions of the human brain. The key element is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements that are analogous to neurons and are tied together with weighted connections … ANN comes as close to producing artificial intelligence models as any calibration method … Neural networks can calibrate models that consist of both linear and non-linear terms simultaneously.’

In the ANN, the user inputs each variable with assigned weights (or coefficients). The software then exposes the data, using an algorithm in a ‘hidden layer’, where the weights are adjusted (calibrated) so as to lessen the squared error.

Neural networks are acknowledged by the IAAO Standard to have both strengths and weaknesses. Their major strength is their ability to ‘learn’ as they go: they are ‘trained’ to take in and process new information. The networks are also able to recognise and work with incomplete or complicated data. The standard suggests that the accuracy of these networks is comparable to other calibration methods.

The main weakness of a neural network is the complexity of the process, which is hidden from view: the final output results in a single estimate of value, with the exact formula hidden from the market analyst. A considerable grasp of mathematical concepts, and a sound knowledge of data analysis and structure, is required to use this method properly. The lack of a definable model structure at the output stage makes it harder to explain value and support the final valuation. In addition, there has been only limited research on the use of these networks in real property valuation.

2.3 Property attribute data
The performance of an AVM is dependent on a number of factors, including the completeness of any particular data item, the accuracy of the property attribute data available, and the quality of the modelling techniques used. As far as possible, data should be consistently available for all the properties actually sold and used in the model and for the properties to be valued. Additionally, the data should be recorded in a consistent way and be factual – free from subjectivity. The validation, as far as possible, of property attributes, is thus an important aspect in valuation.
modelling. It is also vital to ensure that the property details for a sale relate to the property at the time of sale.

It is not necessarily the case that the greater the number of data items available, the better the model. It is more a question of establishing which variables, when included in the model, can be combined to best explain value. For instance, the inclusion of floor area rather than number of rooms might produce better results (or vice versa). It might be that certain data items are far more value-significant than others; for example, the number of bathrooms may well influence value more than the type of roof covering, in which case the latter may be excluded from the model. It is accepted in the USA that the number of sales should be at least five times the number of independent variables, particularly when using MRA as a technique.

Data items for modelling might include:

- architectural style
- property type
- age (or year built)
- location (e.g. geographic co-ordinates or allocation of a ‘locality’ identifier)
- floor area
- number of rooms
- number of bedrooms
- number of bathrooms
- plot size
- conservatory
- outbuildings
- parking/garaging
- quality (i.e., specification of the property); or
- condition.

The selection of data items in the UK is limited to those items that are collected electronically from site inspection notes. As computerised site inspection becomes more the norm some of the lesser attributes may be seen to have some significance. The use of actual sale prices in the model is likely to lend itself to greater accuracy in the provision of estimates of value. However, as part of the modelling process, there must be sufficient sales evidence, and this may not always be available to model developers, for a variety of reasons, including property market conditions. Model developers may therefore use adjusted agents’ asking prices; remortgage valuations or market forces.

AVM developers may use other descriptions for neighbourhoods, such as ‘localities’.

Identifying neighbourhoods for modelling purposes is likely to be a key step, and AVM providers will use a variety of methods. Some valuers would argue that there is no substitute for local professional knowledge; however, it is not usually possible for AVM modellers to obtain this, as it would require a whole network of valuers on the ground delineating the information on a map – a resource usually only available to taxation authorities.

However, other methods are available. A starting point may be the use of postcode data (in the UK), supplemented by socio-economic data available from independent providers. The ACORN system, for example, from CACI (there are other suppliers), provides a geodemographic segmentation of the UK’s population into small neighbourhoods or postcodes, or of consumer households into categories, groups and types. It is used by public organisations, retailers and financial organisations to understand lifestyle issues, behaviours and attitudes and to assess the needs of neighbourhoods. Similarly, it is used by some AVM developers to assist in defining neighbourhoods for AVM modelling purposes.

2.5 Sold property data and valuations used in AVM development

As with property attribute data, it is vital that data from sold properties (that is properties that have sold on the open market), or whatever surrogates are used to represent market value, is accurate. There may be actual sales that are not at arm’s length, some forced sales and other non-market sales that need to be edited out of the sales set before calibration (this is sometimes referred to as ‘cleansing’ the sales set). Depending on the data attached to a sale record (for example, the names of the transferor and transferee), it may be possible for the AVM developer to automate a ‘first pass’ editing process (that is a process done by automatic set criteria that takes out, for example, connected party transactions), which may then be followed by manual editing.

Where, after cleansing, the actual number of sold properties to be used in the model is relatively low, some AVM developers may supplement the sales set by the inclusion of agents’ asking prices (suitably adjusted in

2.4 Importance of location

One of the variables often used in modelling is the neighbourhood. A neighbourhood is defined in the Automated Valuation Model (AVM) Standards Working Group Glossary of terms and definitions as:

‘(1) The environment of a subject property that has a direct and immediate effect on value.

(2) An area that is subject to the same, or similar, market forces.

(3) A geographic area of properties sharing important location characteristics defined for purposes of market analysis or modelling (typically with fewer than several thousand properties).

Broadly, in practical terms, a neighbourhood is a continuous area around a subject property from which a valuer would be most happy to select sales comparables.’
most instances to reflect market value), or valuations of typical properties in the market for remortgages, surveys, and so on. The latter might be termed ‘beacon’ valuations. This may bring more subjectivity into the modelling process. There is a risk, for example, in the use of asking prices in a poor market, that AVM outputs or values may be artificially high and the use of such data may well reduce the reliability of the AVM value estimate. Valuers may thus wish to be aware of exactly what the AVM provider has used in their model.

2.6 Market stratification

It is unlikely that one model will work satisfactorily across the entire housing market. Accordingly, model developers will usually look to stratify the market and to apply different models to the different strata. A clear example of this would be a division of the market into houses and apartments or flats, with the ‘houses’ market itself perhaps subdivided into terraced, semi-detached and detached houses, as well as into divisions based on standard properties and those of high quality.

A geographical division of the market is also common. This might be done by segmenting a country by physical features, such as hill ranges or rivers, or by dividing it into its constituent administrative areas.

In making these subdivisions, it is important to ensure that there is a sufficient volume of actual sales (preferably) or of surrogates for effective modelling. Additionally, sold properties should be a representative sample of the total housing stock within each stratum. These ‘market areas’ will often comprise a set of ‘neighbourhoods’ (see definition in section 2.4).

2.7 Model specification

One of the key stages in developing an AVM is the specification of the model. Much will depend on the prime intended use of the AVM and any regulations surrounding that use.

It is likely that an AVM developed for mass appraisal (that is, for the valuation of hundreds, thousands or even millions of properties) at a specific point in time for purposes such as taxation, will have a different specification to an AVM developed for secured lending. Mass appraisal of properties for taxation will usually have a specific single valuation date at some point in the past, often referred to as an ‘antecedent valuation date’, while most other models will have an up-to-date point in time for a valuation.

It may be that for residential purposes, the variables (or property attributes) chosen will be similar for a number of intended uses of an AVM. A determining factor in a particular specification would be a decision around what essentially drives value, taking account of any regulations in force.

The overriding issue is that the variables chosen and the manner in which the model is structured should be established prior to calibration.

2.8 Model calibration

Calibration of a model is the process that, using MRA or the methodology favoured by the AVM developer, produces the coefficients for each of the variables in the model. These coefficients reflect the value of the contribution of each variable to the estimated value.

Applying the coefficients generated by the sales used in the calibration process will provide value estimates that can be compared with the sale prices. Properties for which the value estimate and sale price (or surrogates) are significantly different are termed ‘outliers’. Investigation of these outliers will often reveal errors in property attribute data, sale price inaccuracies or transactions that should have been removed from the sales set (for example, sales not at arm’s length, or forced sales). They might also indicate that ‘beacon’ valuations need to be redrawn or, potentially, that the model needs to be re-specified.

Having identified, and corrected, any matters arising from outlier investigation, the calibration process can be re-run. Further outliers are likely to be generated and, as before, investigated. This process can be undertaken several times, making calibration an iterative process.

It may be that a randomly selected ‘holdout’ set of actual sales is removed from the model calibration process, with this set typically representing between 10 and 15 per cent of the total sales. The results of calibration, for which the remaining 85 to 90 per cent of the sales set is used, are tested against the holdout set, with the latter set used for quality control purposes.

2.9 Measures of model performance and confidence scores

AVM providers will include with the estimate of value some kind of score usually referred to as a ‘confidence score’, indicating the expected accuracy of the value estimate. Different providers may use different names for this ‘score’, but for the purpose of this information paper, reference to ‘score’ will mean ‘confidence score’.

It is expected that all scores will be related to accuracy, but there may be significant differences between AVM providers in the way in which their confidence scores are calculated. It is therefore difficult – and indeed, may be unwise – to try to compare scores between AVM providers.

The underlying meaning of the scores may also vary between providers. Some may produce a percentage estimate of accuracy: for example, ‘there is no less than 90 per cent chance that the estimate is within 10 per cent of the true value’. Others may simply provide numerical or
letter grades or descriptive categorisations. Again, care should be taken in trying to compare what may appear to be similar bases for scores between providers, as the relative scales used may well differ between those providers.

Whatever means are used to provide confidence scores, valuers may wish to be aware of the methodology used in the selected AVM, and to understand the scoring system and output as it relates to that AVM’s estimate of value.
3 Application of AVMs

3.1 Overview

This section looks at what is expected of the valuer when dealing with Automated Valuation Models (AVMs), and considers the regulatory measures governing their usage. It is important to emphasise that a valuer is unlikely to have knowledge of the inner workings of the model. However, the valuer should be able to compare the outcomes of a model against what a reasonably competent valuer would be able to produce.

AVMs are relatively new and the guidance on their application is still developing. However, there are some valid references set out in this section that are intended to provide a benchmark. The application of AVMs is principally in respect of residential property and in connection with residential mortgage lending, but there are other clients who have need for them. A valuer may be asked to give advice on the use of an AVM for a client, or may wish to use one to support the provision of their own valuation.

The RICS information paper Comparable evidence in property valuation (2012) states in section 4.3 that:

‘Output from an AVM can be utilised as part of the evidence in support of a valuation. The valuer may consider such AVM outputs to have lesser or greater weight than other evidence that may be available. The validity of this, however, will depend greatly on the individual valuer’s personal knowledge and experience of AVMs.’

This indicates the expertise required to deal with AVMs and the important role of the valuer in their application. This is supported by Downie and Robson in their paper Integrating automated valuation models (AVMs) with valuation services to meet the needs of UK borrowers, lenders and valuers (2009) that identified:

‘The Directive (Capital Requirements Directive (European Council, 2006)) requires properties to be “valued by an independent valuer at or less than market value” and defines an “independent valuer” as a “person who possesses the necessary qualifications, ability and experience to execute a valuation and who is independent from the credit decision process”. The CML (2007a) in consultation with the FSA clarified this to mean that AVMs “must be overseen and signed off by a valuer”, either internal or external, on the basis of their accuracy overall, not as individual AVM outputs. In practice this requires the independent valuer to understand AVM accuracy for finely disaggregated property types and locations, a point stressed in the interviews by the larger lenders, as requiring considerable resources and AVM expertise. The overview of accuracy leads to detailed policy for AVM use, excluding some property types and locations, approved by each lender’s Credit Risk Committee.’

It is therefore incumbent on valuers who undertake work for such lenders to have the level of knowledge that is expected of them and for the AVM providers to ensure that there is sufficient transparency in their models to meet these needs.

This information paper discusses the free-standing valuation output produced by an AVM, but also touches on the issues around those modified by a valuer (which then becomes the valuer’s own valuation). This is covered in more detail below. Note that this section does not address the selection of an AVM, but assumes that the selection process is complete. The selection of an AVM is covered in section 4.

3.2 Distinguishing independent from modified AVMs

The ‘support role’ for an AVM, where the valuer reviews the process, needs to be distinguished from the modification of an AVM. The Glossary of terms and definitions published by the AVM Standards Working Group in 2009, cautioned in Appendix 1 that:

‘Any modification by a valuer of an AVM output or the comparables selected by an AVM separates the subsequent output from the integrity of the fully automated process which is a defining feature of an AVM.’

Valuers and institutions need to be aware of this distinction. An AVM output may be utilised exactly as it is received from the supplier. In these instances it is essential that appropriate processes and decisions are applied in the selection of an AVM and in the application of the output for the particular purpose at hand. If, by contrast, a valuer modifies an AVM output as part of a valuation procedure, an equivalent level of process and decision making must be applied in order to maintain professional standards and achieve an accurate valuation. In this instance, the valuer has taken responsibility for the valuation and it is highly likely that it will become a valuation subject to the RICS Valuation – Professional Standards (the ‘Red Book’) criteria. In these circumstances the valuation becomes the valuer’s valuation and the valuer has to take responsibility for it and satisfy the criteria set out in the ‘Red Book’.
Before giving advice on the adoption or use of AVMs, or before using or modifying the outputs of an AVM in the course of undertaking valuations, the valuer may wish to consider if they are confident of having the competencies to do so.

### 3.3 The uses of an AVM

An AVM can be used for the purposes of estimating the value of one residential property, or a portfolio of such properties, or for the mass appraisal of thousands or even millions of properties. Some examples of AVM uses are set out in Table 1 below.

It is important to note that the use of AVMs in the ways listed below are independent of interaction with a valuer, other than as required by a regulatory body in determining the process (as discussed in section 3.5).

<table>
<thead>
<tr>
<th>Table 1: Examples of AVMs in use</th>
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<tbody>
<tr>
<td><strong>1)</strong> By lenders for the loan origination process or subsequent revaluation for credit decision purposes.</td>
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<td><strong>2)</strong> In-arrears assessment and planning.</td>
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<td><strong>3)</strong> In an audit of valuations.</td>
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<td><strong>4)</strong> For mass appraisal, such as for local taxation purposes.</td>
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<td><strong>5)</strong> For the provision of valuation estimates for individual capital tax purposes.</td>
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<td><strong>6)</strong> For the identification of fraudulent activity.</td>
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<td><strong>7)</strong> For the provision of valuation estimates for large-scale asset valuations, for example, a portfolio of local–authority–owned residential properties, or the sale of a mortgage book in respect of ‘securitisation’.</td>
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<tr>
<td><strong>8)</strong> For estimating compensation payments to owners of residential property due to the effect of the use of new public works, for example, road schemes or airport expansion, and so on.</td>
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<tr>
<td><strong>9)</strong> For cost/benefit analyses for potential public expenditure.</td>
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<tr>
<td><strong>10)</strong> For lending [capital adequacy purposes].</td>
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3.4 Assessing the appropriate use of an AVM

When assessing the appropriate use of an AVM, it is advisable to determine whether the AVM is a suitable methodology for the type of property selected. There is not necessarily a clear answer to this, as it depends on the level of confidence required. Unusual properties and limited comparable evidence will reduce the confidence score of an AVM and may make the output unusable, whereas a suitably experienced human valuer may be expected to reach a valuation decision in almost any circumstances. The key difference is that a human valuer can make subtle adjustments to allow for variations in unique features of a property, especially where volumes of evidence are relatively small. Many of these decisions consist of opinion based on past experience, and may not be factually supported.

It is also advisable to ascertain (among other matters set out in section 4) the prime intended use behind the development of the AVM being considered. There may be legal statutory requirements and bases for valuations that specify certain criteria (such as the exclusion of the condition of a property) and these may not have been taken into account in the development of certain AVMs, which reflect sales prices or valuations that account for condition. Some other examples are as follows:

- Valuations for compensation arising from the use of new public works are for diminution in the value of a property (where no land has been compulsorily acquired) due to use of the works (for example, from noise, dust, fumes, artificial light, and so on), and not their physical presence. It is likely that nearby sale prices incorporated in an AVM would reflect the physical presence of the works as well as their use.
- Valuations for tax purposes will be at a fixed date in the past. Although AVMs can be set to function at a date in the past, confidence could be substantially reduced, if this is a considerable time ago, due to a lack of information at the prescribed date.
- Valuations for local tax or other similar purposes will generally be undertaken by, or on behalf of the public body responsible and an AVM will usually take account of statutory regulations. For council tax for example, the assumption must be that the property is in a reasonable state of repair (whether it is or not) and that no further development value attaches to the property (for example, any additional value attaching to a building plot currently used as a garden, but suitable for further residential development, must be valued as a garden and included in the overall value of the property – that is, giving its ‘current use value’). Independently developed AVMs used for other purposes may not reflect this requirement and may thus be impractical for this purpose.

Similar principles apply in both the public and private sectors in the development and use of AVMs. Valuations or AVM estimates developed for public purposes such as local taxes, compensation or national taxes, largely with historic valuation dates, will be able to take advantage of sales evidence windows around specific antecedent valuation dates where sufficient evidence applies.

3.5 Advantages and disadvantages in using AVMs

An AVM bases its decisions on facts that are produced through a small set of attributes (discussed in section 2.3). Where there is a reasonable volume of property that is broadly similar, and the differences can be highlighted by differing attributes (such as two bedrooms as opposed to three, or a smaller physical size compared with a bigger one) the AVM should be able to work successfully with a high degree of confidence.

Where a property is unique and there are a limited number of similar examples, such as may be found with an architect-designed property in a rural area, or one with an exceptional view, then it is less likely that a high confidence factor will be achieved. Depending on the intended use of the AVM, a high confidence factor may not be critical. It is also possible that an AVM will have other compensations with regard to how it calculates an estimate: for example, if a property has previously been sold, then an indexation factor may be included that can provide a reasonable estimate of current value.
### Table 2: The key points in the application and appropriate use of an AVM

<table>
<thead>
<tr>
<th>Key points</th>
<th>Favourable</th>
<th>Questionable, if high degree of confidence required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data sources</td>
<td>A level of confidence needs to be established to meet the needs of the client. A lender, for example, will have certain confidence levels that must be achieved for their purposes. It is important to select a model that uses a combination of data sources to produce a balance of market activity. It is also essential to be aware of volumes, as this can affect confidence values. See Volume (immediately below) for more information.</td>
<td>An AVM can be used to identify the highest likely level of value. This can be achieved by an emphasis on the use of asking prices in the algorithm, especially in times when market prices are falling. An asking price is the optimum price that is likely to be obtained other than in times when 'gazumping' is commonplace and when such emphasis could be misleading. This practice is known as 'value shopping'.</td>
</tr>
<tr>
<td>Volume</td>
<td>There needs to be a good level of transactions in order to achieve a reasonable level of confidence. Urban areas generally achieve this, while rural areas may not.</td>
<td>Specific types of property, such as semi-detached bungalows in inner-city areas, may be scarce and therefore give a lower confidence score, as may properties in rural areas.</td>
</tr>
<tr>
<td>Similar/definable attributes</td>
<td>Where properties may differ in size, but the attributes are defined, a model can better cope with variations of fact and be a better example than a rural area where there are numerous variables ranging from size of plot to variations in design. Similar terraced houses in an urban area are likely to provide good confidence scores.</td>
<td>A unique property where the number of rooms does not fairly reflect the design and internal or external features may adversely affect the confidence score. A thatched cottage would be a good example.</td>
</tr>
<tr>
<td>Condition</td>
<td>Condition or state of repair does not usually or consistently feature as a measurable or differentiated attribute, and if it is not a requirement, then an AVM may be an appropriate valuation methodology to use. While sale prices and valuations do reflect condition, such issues cannot easily be distinguished in an AVM.</td>
<td>Where accuracy or the tolerance on value is restricted, unknowns such as the condition of a property may be the determining factor in the decision to obtain a human inspection.</td>
</tr>
<tr>
<td>A small geographic spread</td>
<td>Urban properties or similar properties within a community or neighbourhood limit variations due to locational features. A model may use postcode as a key locational attribute; this will statistically reflect a significant number of locational attributes based on price or value.</td>
<td>Lack of density in the sample is a key issue, where again, rural areas may not be suitable.</td>
</tr>
<tr>
<td>A stable market situation</td>
<td>It is vital to have a market that has not been subject to significant abnormality. The volume of transactions during a certain year may have been lower than in a previous year, but this is acceptable if they were relatively stable. If, however, there is a year with exceptionally low transaction volumes, and with a number of repossession sales that could be considered as creating distortions, this may pose a problem. Some models, however, may have volumes of data high enough for this to be taken into account.</td>
<td>Significant volatility in market prices or in volumes of transactions, such as may have been seen in an area of recent flooding, may distort the AVM output.</td>
</tr>
</tbody>
</table>
## Table 2: The key points in the application and appropriate use of an AVM continued

<table>
<thead>
<tr>
<th>Key points</th>
<th>Favourable</th>
<th>Questionable, if high degree of confidence required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accurate input of information</td>
<td>It is important that the sample being considered comprises accurate and complete information.</td>
<td>Where some attributes, such as postcode, number of bedrooms, or type of property are missing, the model may not work at all, or at least, will be impaired.</td>
</tr>
<tr>
<td>Fraud</td>
<td>An AVM may be capable of detecting fraudulent activity where a sample size is large. Various techniques within the modelling may assist with this, but the user needs to be aware of what these are.</td>
<td>Some areas selected, or part of the sample, may have been influenced by fraudulent activity, which will distort the sample and make the use of the AVM inappropriate.</td>
</tr>
<tr>
<td>Cost</td>
<td>Where a low-cost option is required to sample for monitoring purposes then an AVM may be the most appropriate choice, as long as it complies with the regulatory criteria. It may be a preliminary exercise, to be followed up by an independent human valuer.</td>
<td>An AVM should not be considered a cheap option where there is doubt over some of the features mentioned above.</td>
</tr>
<tr>
<td>Thresholds</td>
<td>Where the positive points comply, as mentioned above, then the level of accuracy should be sufficient to meet any imposed thresholds.</td>
<td>Lenders, particularly, may have capital adequacy thresholds or other constraints. Where tolerances are tight, an AVM may not have sufficient refinement at the margin.</td>
</tr>
<tr>
<td>New build</td>
<td>New build property is generally thought of as extremely homogenous; however, early phases may lack sufficient evidence to feed a model. Where there are later phases with similar sales established over recent years, an AVM can work very successfully.</td>
<td>With new property in older established areas, it is not generally possible to reflect the new construction standards relative to the older property.</td>
</tr>
</tbody>
</table>

Although some of these features may be described as being negative with regard to AVM use, it is important to check with the supplier in each case. There may be some specific components within a model that contradict expectations.

### 3.6 Regulatory controls

#### 3.6.1 Introduction

The primary reference source for standards and regulation as they apply to RICS valuers is the current version of the RICS Valuation – Professional Standards (the ‘Red Book’). However, valuers should also be aware of any other references that influence the activities of their clients. For those in the financial services sector, the principal source of regulation in the UK comes through the Financial Conduct Authority (FCA).

#### 3.6.2 Red Book references

The first reference to an AVM in the 2012 version of the Red Book is in VS2.4, Restricted information, where it refers to a client desiring a restricted service and mentions, among others, ‘providing a valuation based on an automated valuation model (AVM)’. There is then a note advising the valuer to ensure that the client is aware of the relevant restrictions and giving consideration to whether a restricted service is possible.

AVMs are further referred to in section 6, Valuations without internal inspection, of UK appendix 11 of the Red Book, which provides that:

‘where an opinion is provided on this basis, it must be confirmed in writing, and the manner of valuation and the restrictions under which it is given must be clearly stated (see VS 2.4, Restricted information).’

The section then goes on to say that this form of valuation should not be disclosed to any third parties. The important issue for valuers to be aware of is if they alter an AVM output then their valuation will be subject to the ‘Red Book’ criteria and they take the responsibility for the valuation.

#### 3.6.3 Financial Conduct Authority (FCA) references

The FCA provides general guidance in its Prudential sourcebook for Banks, Building Societies and Investment Firms (known as BIPRU). Rule 3.4.66 sets out the method for monitoring property values, noting that it allows ‘statistical methods to be used to monitor the value of the property and to identify property that needs revaluation’.

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However, it goes on to say that ‘the property must be reviewed by an independent valuer when information indicates that the value of the property may have declined materially relative to general market prices’.

AVMs may, therefore, provide a good sampling tool, but are not considered a solution in all circumstances. Allowances may be made in respect of risk and where a lender’s exposure is secured on a number of properties, where the assessment can be taken on the level of exposure rather than on individual cases.

The Prudential Regulatory Authority (PRA) differentiates the criteria for building societies, who have their own sourcebook (known by the acronym BSOCS – Building Societies Sourcebook). Building societies are required to put arrangements in place for obtaining reliable security valuations, including the use of AVMs. The following guidance is given:

‘If a society proposes to use an automatic valuation model (AVM), either as part of its loan origination process or subsequent revaluation for credit decision purposes, it should do so within the terms of clear and well-considered policies. In doing so it should note that, in the calculation of the credit risk capital component, in relation to risk weights assigned to exposures secured by mortgages on residential property, BIPRU 3.4.77 R requires that the “property shall be valued by an independent valuer at or less than market value” and that an independent valuer is defined in BIPRU 3.4.66 R as a “person who possesses the necessary qualifications, ability and experience to execute a valuation and who is independent from the credit decision process.” This means that, for those purposes, the use of AVM output must always fall within a process leading to a valuation that can be ascribed to an independent valuer.’

BSOCS 2.2.8 Guidance 01/04/2013

Thus even if an AVM is used, it cannot be used independently of the normal valuation process. In effect, the PRA says, a human valuer needs to be involved.

In BSOCS 2.2.9 Building societies are further instructed to consider the limitations of AVMs before making a decision as to whether such a model is appropriate, particularly when the valuation plays an important role in the calculation of capital requirements.

The societies are advised that a reasonable approach to AVMs would be to consider that:

‘(1) all AVMs have estimation errors;
(2) there are strengths and weaknesses of various AVMs. For example, many AVMs could be well suited to urban areas with many similar properties, but most will find it difficult accurately to value a property with little in common to those close by, for example in rural areas;
(3) AVMs should not be used to value non-domestic properties;

In BSOCS 2.2.10 it is stated ‘The higher the LTV [loan-to-value ratio], the greater the risk that an over-valuation of the property could result in the CRD (capital adequacy) risk weighting being mis-stated…”

BSOCS 2.2.11 states ‘If a society chooses to use AVMs, its lending policy should set out clearly when it intends to do so. For example, it may set a maximum LTV or loan amount. A society should also have procedures for reviewing its use of AVMs based on experience and market developments.’

BSOCS 2.2.9-2.2.11 Guidance 01/04/2013

In many cases, those lenders without internal advisors will need to look outside for support. This is not a task that should be viewed lightly by any valuer providing such support, as the lender will be held accountable for the advice it takes.

Section 2.2.12 of the BSOCS guidance sets down the basis on which monitoring can be undertaken with the use of an AVM:

‘Statistical methods, such as house price indices or AVMs, can also be used to monitor the value of a property, identify property that needs revaluation and amend valuations assigned to a property. The detailed rules concerning monitoring of property values for the purposes of calculating the credit risk capital component are contained in BIPRU 3.4.66R to BIPRU 3.4.71G. If AVMs are used in this way, the principles of AVM use are the same as for loan origination and societies should consider the appropriateness of AVMs to obtain a prudent value.’
4 AVM selection and use

4.1 Establishing best practice for AVM selection

The Financial Conduct Authority (FCA) is alone in having set down criteria to establish best practice in the use of an Automated Valuation Model (AVM) in the UK. However, this does not preclude others who have need of such models in following a prudential approach. The following information is targeted towards residential lending, as this is governed by strict regulations. A valuer may be required to be part of the initial selection process for an AVM, especially for smaller organisations that may not have their own in-house valuation support function. However, it is more likely that a valuer will simply be presented with figures already produced by an AVM and be requested to advise on whether there are any issues with the figures produced relative to the property being considered. It would, in such circumstances, be appropriate for the valuer to understand some of the detail of the AVM and the process used to select the particular model.

When choosing an AVM or multiple AVMs, it is appropriate for the valuer, or their client, to ensure that the organisation has the relevant in-house or external expertise. Lenders have the added responsibility to ensure that persons who validate an AVM (either initially, or on an ongoing basis), are independent of the loan production and collection processes.

A framework for applying due diligence to an AVM is set out below. This list is not exhaustive, but gives an indication of the areas that may be covered:

- In conjunction with the client, establish acceptable minimum performance criteria for a model, prior to and independent of the validation process. This will include such matters as:
  - the level of confidence produced by the model that is required to satisfy underwriting requirements
  - how assumptions (such as condition of the property) are reflected by the model
  - parameters for loan-to-value ratios
  - whether the figures input to the AVM have been adjusted in any way, and if so, how; and
  - what controls have been put in place to limit the impact of that manipulation, and how the variance in output is measured.

- Establish how model developers conduct performance testing and ascertain the testing frequency and criteria for retesting.

- Establish what system is in place for:
  - calibrating/baselining the model
  - how this compares to the current level of house prices; and
  - note which figures or indices are used.

- Evaluate the underlying data used in the model(s), including the data sources and types, frequency of updates, calibration, quality control performed on the data, cleansing and exclusions.

- Assess modelling techniques and the inherent strengths and weaknesses of different model types (such as hedonic, index, and comparable (see section 2.2) and how they interact).

- Address standards for the use of multiple AVMs, if applicable, for valuing the same property or to support a particular lending activity.

- Establish:
  - an appropriate sample size for the organisation utilising the AVM, based on its portfolio of property to be assessed
  - the expectations for that sample size
  - whether any standards apply to the performance measures to be used, and if so, whether they meet those standards in the geographic level tested (such as in a postcode sector).

- Assess how a model or models perform for different property types (such as flats, or homes in urban or rural areas) and in some cases there may be regional variations to consider. An AVM can only use the data that is collected, and this is usually limited to core issues such as number of bedrooms, kitchen, garage provision, and so on. Matters such as benefits of a view, which are not currently collected on a standard database, can only be ascertained by inference, as a model is unlikely to be this specific. Nevertheless, the information on pricing may include such a benefit, and it is thus important to establish whether such matters are reflected in the confidence factor.

- Establish whether sales alone are modelled, or whether asking prices (‘beacon valuations’) are included in the sales set. Understand the source of the sales data, and:
  - what measures are in place to determine that sufficient sales have been used to ensure that the models are stable
  - what work has been done to check sales prices, editing of any sales prices that may appear excessive, and the property attributes used in the model.
• the sales window (for example, is the model relying on recent sales?); and
• how neighbourhoods have been defined (was it by someone with knowledge of the local market, or through the use of other data)?

4.2 Using the AVM

Once the selection process has been completed, it may be appropriate to undertake ongoing monitoring and validation to ensure that the model continues to perform as expected. It is important to build such measures into a programme, if desired, and determine appropriate means of sampling. Indeed, this is essential for matters such as a lender’s mortgage portfolio, where the Financial Conduct Authority (FCA) requires the periodic checking of property values (in rule 3.4.66 of the Prudential sourcebook for Banks, Building Societies and Investment Firms – known as BIPRU), and where an AVM could be the most efficient means of sampling a mortgage book, provided the model performs to the same level of accuracy over the longer term. In another example, if a model is used for tax purposes, for example a local tax based on the value of individual homes then it could be challenged by an aggrieved taxpayer, with such matters forming the basis of an appeal. The risk here is the integrity of the AVM outcomes themselves. From time to time providers will adjust their models for genuine reasons; obviously, this would be a good time to undertake a performance test. Validating performance is covered in section 4.3.

Using exclusions, such as those listed immediately above, by default gives clear areas where AVMs can be used successfully. These are probably far greater than the exclusions and too numerous to list here.

In general terms, for an AVM to be reliable and consistent, the volume of comparable transactions needs to be reasonably high. How high should be part of the testing programme against recognised valuations and agreed levels of accuracy to be recorded, and models will differ in this respect (see sections 2.3 and 2.5). The AVM supplier will be able to provide benchmark levels; variations from these need to be considered within the context of the purpose of the AVM use.
4.3 Validating AVM results

4.3.1 Overview
A client’s need to validate AVM results may vary depending on regulatory controls that govern that sector, however, a prudential organisation would normally want to establish procedures for ongoing monitoring and model validation, including multiple AVMs, to ensure that results remain credible. It is likely that a client would wish this process to be recorded and be proportional to the risk and complexity of the transactions. It would be advisable for validation to be carried out independently of the credit decision process (where a lender is involved) and the production of the model, and by someone who is qualified to assess the findings. These processes will enable the client to monitor the effectiveness of the AVM(s) adopted and their usefulness for the purpose, as well as provide a tool for auditing.

Each AVM supplier will undertake their own testing, and make frequent adjustments to calibration, dependent on changing circumstances in the market place. Fairly often, this will occur if the supplier notices variations developing with surveyors’ valuations. The frequency of such changes should ideally be known and be supported by testing following such changes. In many respects, this process is a refinement to that of the initial selection of the model, as those criteria first established will be rechecked to see that performance is as originally indicated. Some of the checks can be suspended, as they will not have changed, but the bulleted points in 4.2 and suggestions immediately above remain a good basis for validation.

4.3.2 Comparing AVM and surveyor valuations
Limited evidence is available of the outcomes of such testing, but one such test in May 2007 (see below) used existing valuations as a benchmark, on the basis that a few studies had indicated that surveyor values could be biased depending on the circumstances of a valuation (for example, for a loan purpose, or with market pressure), whereas automated values were intrinsically ignorant of such factors. However, the testers’ view was that, at that time, surveyor values were, and continue to be, commonly accepted values, and that market participants have become accustomed to basing their lending decisions on them. Consequently, they naturally lend themselves as the best basis for comparison.

The following test, based on the published study Criteria for Automated Valuation Models in the UK (Fitch) gives surveyors an understanding of the level of skills required to carry out such a comparative exercise and of some of the performance measures. It should be noted that this study was undertaken in 2007; lessons will undoubtedly have been learnt from the experience in the market place since that time. For this reason, only selected parts of the study have been included here, which may form benchmarks for any review of the models.

‘This analysis has been based on the following performance measure:

\[
\text{Percentage error based on automated value} = \frac{\text{AVM Value} - \text{Surveyor Value}}{\text{Surveyor Value}} 
\]

The performance error definition determines the likely range of surveyor values given the automated value. This definition is necessary to determine adjustments once a surveyor value is no longer available. For example, on receipt of a pool of loans with AVM values, surveyor values will not be available, so the percentage adjustment that has been made will be based on the AVM value that was received. Consequently, when determining the adjustments, the differential between the AVM and the surveyor value should be taken as a percentage of the AVM value’

Fitch described how the percentage errors were actually analysed, i.e. by AVM provider, country region, type of property and value bracket and reported levels of accuracy. As far as the results are concerned Fitch found that:

- ‘Low surveyor values are typically overvalued by AVMs as a consequence of the sampling method. The variance between the two valuations will cause properties that happened to be valued particularly low by surveyors to be (on average) valued higher by AVMs. An illustrative example would be an ex-local authority right-to-buy flat in Notting Hill, which may be valued quite low by a surveyor who has performed both the internal and external assessment, but which may be valued higher by an AVM that has based its valuation on comparable properties in the vicinity. It is anticipated here that the inference is for there to be not many Right to Buy flats in Notting Hill so the figure would be skewed.
- High surveyor valuations are more often undervalued than overvalued by AVMs. Typically, in these cases, the surveyor can exploit certain positive information about the specific property (i.e. a special view from the veranda or a swimming pool) which the AVM might ignore. Conversely, if the automated values are taken as a base, high automated values often overvalue surveyor values. This will typically be because the surveyor has considered specific negative information about the property which the AVM ignores, such as roof rot or dampness.
- As expected, there is more variation in less populated and less homogeneous segments of the pool, such as flats and bungalows, and properties located in areas with less historical information.’

Importantly, Fitch found that because the complexity of situations that could result in variations is considerable in number then a valuer would have to consider each case on its own merits. In turn, they recognised that with the complexity of the statistical analysis involved,
someone with this particular expertise would need to be involved in the review. They also concluded that where an organisation uses more than one AVM then each one should be validated.

As stated earlier in this section under 4.1 and 4.2, Fitch suggested:

'To assess the effectiveness of its AVM practices, an organisation should verify whether loans or tax assessments in which an AVM was used to establish value met the institution’s performance expectations relative to similar situations that used a different valuation process.'

Fitch’s findings indicate that AVM users should conduct periodic audits to compare the results of an AVM with actual sales or valuation data prior to the information being available to the model. If more than one AVM is used, each AVM should be validated.

The findings of this study also indicate that to assess the effectiveness of its AVM practices, lenders should regularly verify whether loans in which an AVM was used to establish value met their performance expectations relative to similar loans that used a different valuation process. The results of this validation and audit process should be documented and the findings used to analyse and periodically update policies and procedures for AVM use.

AVMs are now a common tool available to valuers and are used by some lending institutions and by a large number of public bodies across the world for property related taxation purposes.

Their main advantage over valuations provided by valuers on an individual basis is their consistency and cost effectiveness. However, as previous sections indicate, a certain degree of skill, knowledge and awareness is required by valuers in their use and in any advice they may be asked to provide to clients.

The purpose of this information paper was to provide a basic understanding and overview of what AVMs are; what may go into their production and development (that is the data used and methodology adopted), and issues that valuers may need to consider before using AVMs on behalf of clients or when asked by clients for advice about the use of AVMs.

For those requiring more information, a good starting point is the source provided by the bibliography in Appendix 3.
Appendix 1: Glossary of terms

This glossary is divided into two sections: the terms and expressions in the first section are primarily related to AVM use and interpretation, with some of these being unique to AVMs. The second section comprises terms and expressions that are frequently encountered in the context of AVM use and analysis but which also have a wider use, mostly either within the residential property sector or in the field of statistics.

Acknowledgements

The IAAO Standard on AVMs (2003), and the glossary it includes, has proved an invaluable resource during the preparation of this glossary, which is gratefully acknowledged.

The following served on the AVM Standards Working Group and have contributed to and reviewed this glossary:

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Ian Cook, FRICS  Dr. Atanasios Mitropoulos  Graeme Winser, MRICS.
### Part 1: Glossary of AVM terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>adjusted hit rate</td>
<td>See effective hit rate [preferred terminology].</td>
</tr>
<tr>
<td>appraiser-assisted AVM</td>
<td>See desktop valuation [preferred terminology].</td>
</tr>
<tr>
<td>automated valuation model (AVM)</td>
<td>A model that uses one or more mathematical techniques to provide an estimate of value of a specified property at a specified date, accompanied by a measure of confidence in the accuracy of the result, without human intervention post-initiation.</td>
</tr>
<tr>
<td>AVM-assisted appraisal</td>
<td>See desktop valuation [preferred terminology].</td>
</tr>
<tr>
<td>AVM-assisted valuation</td>
<td>See desktop valuation [preferred terminology]. Note: Any modification or manipulation by a valuer of an AVM output or of the comparables selected by an AVM separates the subsequent output from the integrity of the fully automated process which is a defining feature of an AVM. Therefore, ‘AVM-assisted valuations’, ‘valuer-assisted AVMs’ and similar expressions fall within the definition of a desktop valuation. For clarity it is recommended that these expressions should be avoided.</td>
</tr>
<tr>
<td>AVM cascade</td>
<td>There is no agreed definition for this term in the UK.</td>
</tr>
<tr>
<td>AVM comparable</td>
<td>A property used in the AVM process to assist in establishing value. See comparable.</td>
</tr>
<tr>
<td>AVM valuation</td>
<td>An estimate of property value as calculated by an AVM.</td>
</tr>
<tr>
<td>bias</td>
<td>The propensity of an AVM to systematically over- or under-estimate a sample in comparison with the reference value, usually expressed in percentage terms.</td>
</tr>
<tr>
<td>cascade</td>
<td>There is no agreed definition for this term in the UK.</td>
</tr>
<tr>
<td>comparable</td>
<td>A property used during the valuation process as evidence in support of a valuation of a different property. The description of the comparable in a valuer’s justification of value will depend on the nature and complexity of the valuation being undertaken but will typically include its address, some financial information such as sale price or rent agreed at a particular date and some indication of the similarities with, or differences from, the property being valued.</td>
</tr>
<tr>
<td>comparable evidence</td>
<td>A set of comparables in support of a valuation.</td>
</tr>
<tr>
<td>coefficient of dispersion [COD]</td>
<td>A measure of performance of an AVM. In mathematical terms, COD is a normalised measure of the dispersion of a probability distribution; it is a measure used to quantify whether a set of observed occurrences are clustered or dispersed compared to a standard statistical model. Note: In statistics texts, ‘COD’ stands for ‘coefficient of determination’ – a name given to the R-squared value. This is different from the coefficient of dispersion described here.</td>
</tr>
<tr>
<td>coefficient of variation [CDV]</td>
<td>A measure of performance of an AVM. A statistical measure of the dispersion of data points in a data series around the mean: calculated by dividing the standard deviation by the mean of the distribution. The measure is dimensionless and hence scale invariant.</td>
</tr>
<tr>
<td>confidence interval</td>
<td>For a given confidence level, the range within which one can conclude that a measure of the population lies.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<tr>
<td>-------------------------</td>
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</tbody>
</table>
| confidence level        | [1] A statistically derived figure [usually given on an AVM provider’s proprietary scale] that gives a measure of confidence in the accuracy of the AVM estimate. The degree to which the confidence level correlates with the accuracy of the AVM estimate of valuation when compared with the reference value is an important measure of the performance of the AVM.  
[2] The probability that a confidence interval will include the population measure; commonly 90, 95, or 99 per cent. A 95 per cent confidence interval would mean, for example, that one can be 95 per cent confident that the population measure (such as the median or mean appraisal ratio) falls in the indicated range. |
| confidence measure      | See confidence level.                                                                                                                                                                                                                                                                                                                   |
| confidence score        | See confidence level.                                                                                                                                                                                                                                                                                                                   |
| data cleansing          | The process of refining data associated with potential AVM comparables with the aim of improving the AVM’s accuracy.                                                                                                                                                                                                                       |
| data edit               | The process of examining recorded data to ensure that each element of data is reasonable and is consistent with others recorded for the same property. It also refers to the exclusion of non-open market sales from the sales set which is to be used in model calibration. Data editing, which may be done manually or by computer, is essentially a mechanical process, distinct from verifying the correctness of the recorded information by inspecting the property. See also hard edit and soft edit. |
| desktop valuation       | An estimate of value of a property completed by a chartered surveyor without undertaking a physical inspection of the subject property, based on local knowledge, personal experience, internet sourced sales data and comparable evidence, which may or may not incorporate data from property databases, including AVM estimates of value. |
| effective hit rate      | The number of successfully returned AVM results which also meet additional user-defined criteria, divided by the total number of requests submitted by the user, usually expressed as a percentage.  
Note: Effective hit rate is not measured by dividing the number of successfully returned AVM results which also meet additional user-defined criteria by the number of successfully returned AVM results. This produces an artificially high result. Contrast with hit rate. |
<p>| forecast standard deviation | With respect to difference between the AVM valuation and the reference value, the forecast standard deviation is the predicted forecast confidence interval at a confidence level of 68% [i.e. ± one standard deviation].                                                                                       |
| hard edit               | A data error sufficiently serious to trigger rejection of an item from use in the modelling process. Contrast with soft edit.                                                                                                                                                                                                                     |
| hit rate                | The number of AVM results returned where there is a valuation estimate and a confidence level divided by the total number of requests submitted, usually expressed as a percentage. Contrast with effective hit rate.                                                                                                                                                    |
| holdout set             | A set of data which is excluded during the AVM development and therefore provides an independent test sample for the purpose of assessing model performance. Also known as a test set.                                                                                                                                                     |
| locality                | See neighbourhood.                                                                                                                                                                                                                                                                                                                     |
| locality group          | See neighbourhood group.                                                                                                                                                                                                                                                                                                               |</p>
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>index</td>
<td>A numerical scale, or a number on it, that expresses the price, value, or level of something in relation to a base number. Within an AVM this would be associated with property-related price information.</td>
</tr>
<tr>
<td>neighbourhood or locality</td>
<td>(1) The environment of a subject property that has a direct and immediate effect on value.</td>
</tr>
<tr>
<td></td>
<td>(2) An area that is subject to the same, or similar, market forces.</td>
</tr>
<tr>
<td></td>
<td>(3) A geographic area of properties sharing important location characteristics defined for purposes of market analysis or modelling (typically with fewer than several thousand properties). Broadly, in practical terms, a <strong>neighbourhood</strong> is a contiguous area around a subject property from which a valuer would be most happy to select sales comparables.</td>
</tr>
<tr>
<td>neighbourhood group or locality group</td>
<td>A group of <strong>neighbourhoods/localities</strong> [not necessarily contiguous] which can be modelled together, i.e. where they are subject to similar market forces. In practical terms, if the subject property is within one neighbourhood, the other neighbourhoods in the neighbourhood group are where a valuer would seek comparable sales if insufficient sales are available within the immediate neighbourhood.</td>
</tr>
<tr>
<td>portfolio valuation</td>
<td>In relation to an AVM, the process of undertaking multiple valuations in a batch process.</td>
</tr>
<tr>
<td>ratio study</td>
<td>A study of the relationship between appraised or assessed values and market values (sale prices).</td>
</tr>
<tr>
<td>reference value</td>
<td>The value against which the AVM estimate of value is being measured.</td>
</tr>
<tr>
<td></td>
<td>NB. Lenders typically use as the basis for mortgage lending a valuation carried out by a chartered surveyor under the mortgage valuation specification for residential property agreed with the Council of Mortgage Lenders, set out in the RICS Valuation Standards [the ‘Red Book’]. These valuations are often used as Reference Values. Alternatives, such as sale price, may also be used, depending on the circumstances.</td>
</tr>
<tr>
<td>response rate</td>
<td>See hit rate [preferred terminology].</td>
</tr>
<tr>
<td>soft edit</td>
<td>A data edit signalling an atypical entry and triggering a warning message. Data subject to a soft edit may still be used in the modelling process. Contrast with <strong>hard edit</strong>.</td>
</tr>
<tr>
<td>test set</td>
<td>See <strong>holdout set</strong>.</td>
</tr>
<tr>
<td>true value</td>
<td>This is a term used in case law to indicate the correct Market Value i.e. the one that should have been used for the original valuation. The expression <strong>reference value</strong> should always be used in the context of AVM performance [see <strong>reference value</strong>].</td>
</tr>
<tr>
<td>valuer-assisted AVM</td>
<td>See <strong>desktop valuation</strong> [preferred terminology]. Note: Any modification or manipulation by a valuer of an AVM output or of the comparables selected by an AVM separates the subsequent output from the integrity of the fully automated process which is a defining feature of an AVM. Hence, ‘Valuer-Assisted AVMs’, ‘AVM-Assisted Valuations’ and similar expressions fall within the definition of a <strong>desktop valuation</strong>. For clarity it is recommended that these expressions should be avoided.</td>
</tr>
</tbody>
</table>
## Part 2: Glossary of additional terms not specific to AVMs

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>additive model</td>
<td>A model in which the dependent variable [e.g. property value] is estimated by multiplying each independent variable [e.g. property attribute] by its coefficient and adding the results to a constant.</td>
</tr>
<tr>
<td>appraisal</td>
<td>(1) The act of estimating the money value of property. (2) The monetary value of property as estimated by an appraiser [valuer].</td>
</tr>
<tr>
<td>attribute [property attribute]</td>
<td>A property characteristic; e.g. type, size, number of rooms, etc.</td>
</tr>
<tr>
<td>blended model</td>
<td>A blended model is one where more than one modelling technique is used in deriving the estimate of value. Typically, the technique involves running a hedonic model and a repeat sales index. The results are then compared and evaluated. Based on each result, the blended model reports a final estimate of value.</td>
</tr>
<tr>
<td>bypass</td>
<td>A property sale subject to a data edit which means it is not used in the calibration process [i.e. it is flagged as not useful and ‘bypassed’]; e.g. a sale not at arm’s length.</td>
</tr>
<tr>
<td>calibration</td>
<td>See model calibration.</td>
</tr>
<tr>
<td>class [property class]</td>
<td>A classification of property used by VOA – typically a stratum used for modelling. Each ‘class’ is modelled separately; e.g. ‘house’, and ‘flat’. See also property type and property style.</td>
</tr>
<tr>
<td>computer-assisted mass appraisal [CAMA]</td>
<td>(1) A generic term for a system, incorporating an AVM, used by government authorised organisations to perform mass evaluations of entire property classes within defined geographic areas at a particular date for public administration purposes. (2) In property taxation systems, as well as an AVM, a CAMA system often integrates the administrative functions associated with maintenance and appeal processes.</td>
</tr>
<tr>
<td>coefficient</td>
<td>In a mathematical expression or model, a number or letter preceding and multiplying a variable. For example, in the expression $5x$, 5 is the coefficient of the variable $x$. See also regression coefficient.</td>
</tr>
<tr>
<td>dependent variable</td>
<td>A variable, such as open market value, which is predicted by the values of other variables, such as floor area, number of rooms, number of bathrooms, etc. Such a variable is said to depend on other independent variables.</td>
</tr>
<tr>
<td>difference</td>
<td>See error.</td>
</tr>
<tr>
<td>dispersion</td>
<td>The degree to which data are distributed, either tightly or loosely, around a measure of central tendency. Measures of dispersion include the average deviation, coefficient of dispersion, coefficient of variation, range, variance and standard deviation.</td>
</tr>
<tr>
<td>error</td>
<td>The difference between the actual value of a variable and the predicted or expected value. Errors may be positive or negative, although in common speech taking the absolute value of the errors is sometimes implied. In multiple regression analysis, the term ‘error’ is a loose synonym for residual.</td>
</tr>
<tr>
<td>geographic information system [GIS]</td>
<td>(1) A database management system used to store, retrieve, manipulate, analyse and display spatial information. (2) One type of computerised mapping system capable of integrating spatial data [land information] and attribute data among different layers on a base map.</td>
</tr>
<tr>
<td>Term</td>
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<tr>
<td>hedonic model</td>
<td>Hedonic pricing attempts to take observations of the overall value attributable to a property and to deduct how the individual components of that property influence that value. Calibration of the attribute components is performed statistically by regressing the overall price onto the characteristics.</td>
</tr>
<tr>
<td>independent variable</td>
<td>A variable whose value is not determined by other variables. Contrast with dependent variable.</td>
</tr>
<tr>
<td>intercept</td>
<td>Graphically, the point at which a line, such as a regression line, intersects the axis on which the dependent variable (e.g. property value) is represented; the value of the predicted variable when the value of all other values in the model is zero; the constant in the MRA equation.</td>
</tr>
<tr>
<td>iteration</td>
<td>One repetition or cycle in a series of repetitions or cycles. The results of each iteration are used to refine the next one.</td>
</tr>
<tr>
<td>iterative process</td>
<td>A cyclical process whereby the results of one iteration [or pass] are used to refine the next.</td>
</tr>
<tr>
<td>mass appraisal</td>
<td>The process of valuing a group of properties as of a given date using common data, standardised methods, and statistical testing (US usage).</td>
</tr>
<tr>
<td>model specification</td>
<td>The formal development of a model based on data analysis and appraisal theory. During model specification, one determines the variables to test or use in a mass appraisal model (e.g. floor area, number of rooms, etc).</td>
</tr>
<tr>
<td>multiple regression, multiple regression analysis [MRA]</td>
<td>A statistical technique, similar to correlation, used to analyse data in order to predict the value of one variable [the dependent variable], such as market value, from the known values of other variables [called independent variables], such as floor area, number of rooms, etc. If only one independent variable is used, the procedure is called simple regression analysis and differs from correlation analysis only in that correlation analysis measures the strength of a relationship, whereas regression predicts the value of one variable from the value of the other. When two or more variables are used, the procedure is called multiple regression analysis.</td>
</tr>
<tr>
<td>outliers</td>
<td>Extreme values in a distribution.</td>
</tr>
<tr>
<td>property style</td>
<td>Sub-categorisation of properties used by many valuers and AVM providers, e.g. detached, semi-detached, terrace, purpose built, converted. See also property type.</td>
</tr>
<tr>
<td>property type</td>
<td>Categorisation of properties used by many valuers and AVM providers, e.g. house, bungalow, flat. See also property style.</td>
</tr>
<tr>
<td>r-squared [coefficient of determination]</td>
<td>In regression analysis, a measure of the strength of the relationship between the independent variables and the dependent variable. The measure ranges from 0 to 1 - the higher the number, the stronger the relationship [0 would indicate no relationship].</td>
</tr>
<tr>
<td>regression coefficient</td>
<td>The value or number calculated by the regression algorithm for each variable in the model. Multiplying the coefficients against the variables with which they are associated yields the predicted value of the dependent variable. For example, in the equation, Value = £30,000 + (£15,000 x number of rooms), £15,000 is a regression coefficient. See also coefficient.</td>
</tr>
<tr>
<td>regression line</td>
<td>The line on a graph that represents the linear relationship between an independent variable and a dependent variable. a regression line has a constant, represented by the point at which the line intersects the vertical axis, and slope, quantified by a regression coefficient. For example, in the above definition of regression coefficient, the regression line would have a constant of £30,000 and slope [regression coefficient] of £15,000. Regression lines can be meaningfully displayed only when there are one or possibly two independent variables.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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</tr>
<tr>
<td>residual</td>
<td>The difference between an observed value and a predicted value for a dependent variable. See also error.</td>
</tr>
<tr>
<td>standard deviation</td>
<td>A statistical term which is the measure of dispersion.</td>
</tr>
<tr>
<td>scatterplot or scatter diagram</td>
<td>A graphic means of depicting the relationship or correlation between two variables by plotting one variable on the horizontal axis and one variable on the vertical axis. In ratio studies it is often informative to determine how ratios are related to other variables. A variable of interest is plotted on the horizontal axis, and ratios are plotted on the vertical axis.</td>
</tr>
<tr>
<td>stepwise regression analysis</td>
<td>A kind of multiple regression analysis in which the independent variables enter the model, and leave it if appropriate, one by one according to their ability to improve the equation’s power to predict the value of the dependent variable.</td>
</tr>
<tr>
<td>stratify</td>
<td>To divide, for purposes of analysis, a sample of observations into two or more subsets according to some criterion or set of criteria. See also class.</td>
</tr>
<tr>
<td>stratum, strata (pl)</td>
<td>A class or subset that results from stratification.</td>
</tr>
<tr>
<td>transformation</td>
<td>The process of changing the values and definitions of one or more variables so as to make them more useful for further analyses. If market value changes with plot size, for example, a valuable transformation would be to change frontage and depth to plot size, and if market value does not change proportionally with size, a valuable transformation might be to use the square root or logarithm of plot size.</td>
</tr>
<tr>
<td>usable hit rate</td>
<td>See effective hit rate.</td>
</tr>
<tr>
<td>variable</td>
<td>An item of observation that can assume various values, for example, square feet, sales prices, or sales ratios. Variables are commonly described using measures of central tendency and dispersion.</td>
</tr>
<tr>
<td>variance</td>
<td>A measure of spread about the mean, the square of the standard deviation.</td>
</tr>
</tbody>
</table>
Appendix 2: AVM Models – Illustrations

[i] Additive model

The estimated value is determined by multiplying each independent variable (derived from property attribute) by its coefficient and adding the results to a constant: i.e.

\[
\text{Est. value} = \beta_0 + \beta_1 y_1 + \beta_2 y_2 + \ldots + \beta_n y_n
\]

where

- \( \beta_0 \) = constant
- \( \beta_{1-n} \) = coefficients
- \( y_{1-n} \) = property attributes

An example of an additive model might be:

Est. value = £145,000 (base value) + (£350 (base price) x flr area in m²) + (£82,000 (base value) x property type index) – (£500 (base value) x age in years)

Assuming the variable ‘property type’ is represented by an index as follows:

- Terrace 0.8
- End terrace 0.95
- Semi-detached 1.0
- Detached 1.25

The value estimate for a 10-year-old detached house of 120m² would be:

\[
£145,000 + (£350 \times 120) + (£82,000 \times 1.25) – (£500 \times 10) = £284,500
\]

The figures and indices used above are simplistic and for illustrative purposes only.
(ii) Multiplicative model

In a simple multiplicative model, the estimated value is determined by each variable being raised to a power (the powers being in place of the coefficients in the additive model) and then multiplying the results: i.e.

\[
\text{Est. value} = \beta_0 \times y_1^{\beta_1} \times y_2^{\beta_2} \times \ldots \times y_n^{\beta_n}
\]

where

- \(\beta_0\) = constant
- \(\beta_{1-n}\) = powers
- \(y_{1-n}\) = property attributes

The multiplicative model can also be written as

\[
\ln(\text{Est. val.}) = \ln(\beta_0) + \beta_1\ln(y_1) + \beta_2\ln(y_2) + \ldots + \beta_n\ln(y_n)
\]

where

- \(\ln\) = natural log

(iii) Models combining methodology and comparable selection

Models sometimes referred to as ‘hybrids’, use a combination of the additive and multiplicative models and may also use comparable selection in the process.

Automating comparable selection in the model has the advantage of ensuring a consistent approach to selecting comparable sales. The sales can also be adjusted in a consistent manner to reflect any differences in property attributes from the subject property and the difference in time between each sale and the date of valuation.

The coefficients of the multiple regression analysis (MRA) can be used to adjust these comparable properties to ‘match’ the subject property. The adjusted sales can then be combined with the MRA value estimate to produce a final value estimate for the subject property (for example, by adopting rules around averaging the set of values which include the MRA estimate and ‘best’ adjusted comparable sales).
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