



Automated Valuation Models Past, Present, and Future

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Abstract

The lending market has been largely reactive in bringing on new technology in the past. A good example of this is the automated valuation model, brought to market for lending use in the mid '90s and not yet been fully accepted for use despite being a solid solution to many of the competitive market issues that lenders face. This paper reviews the history of AVM market development and the direction the products are taking in order to meet client needs for the future. It seeks to examine ways that are only now being explored that may have brought about market acceptance more quickly if considered earlier in the process.

Introduction

The Low Tech Lending Environment

The mortgage lending industry in the US has been traditionally slow to move towards technology changes. Unlike its sister business, retail banking, where there has been quick adoption of statistical modeling for credit card fraud detection, automated banking solutions, and Internet access, mortgage lending has maintained a more traditional approach to business.

Acceptance and implementation of FICO credit scores was one of the first major technology moves in lending. While lenders were not dedicating resources to statistical modeling for predicting risk, Fair Isaac was able to make a success of their product through adoption at Fannie Mae and Freddie Mac. There was little use of credit scores in the industry until the GSE's gave it their blessing. Once that occurred, FICO scores quickly became an industry standard. There was no implementation process to interrupt operations, which made adoption easier. Although it had

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to find its place into the workflow and credit policy decisions had to be made around its use, it was much easier than implementing a large IT project with big budgetary concerns.

Within most banking institutions, the mortgage group has been the “cash cow” of the organization with high compensation for volume creating a heavily sales driven culture. The mortgage group typically sees a much larger flow of cash to support the lending efforts, including pricey presidents’ club awards, sales rallies, and lucrative contests for bringing in fundable loan applications. Successful sales campaigns within most institutions create an atmosphere of maintaining the status quo – if it’s not broken, don’t fix it. Loan agents, who carry considerable weight especially if they are high producers, preferred to keep things within their control, and frequently had direct contact with underwriters and appraisers who handled their loans. Appraiser pressure (which is still an issue but more frequently on the wholesale lending side rather than retail lending) is one of the ways that the successful loan agent can control the origination process to insure that funding happens quickly and with the highest loan to value ratio that can be obtained.

Technology adoption in the US mortgage market has typically followed the cycles of interest rate high’s and low’s. When interest rates are dropping, everything focuses on pipeline management and closing the loans. There is no time for researching new technology and certainly no time for implementation. The last thing that anyone is willing to do is put in new processes that would slow things down, require training, and frustrate employees and borrowers with systems that are not implemented correctly or are unfamiliar to operations.

During the fast paced cycle of low interest rates, there is little focus on efficiencies and costs. The primary focus is to close the loans before the rate changes or the customer defects to a competing lender. Things are often done in a less cost conscious but more expedient manner.

As interest rates rise, the emphasis switches to operational efficiencies and cost cutting measures. As volume decreases, the business units have more time to focus on how things are being done and how they could be improved in preparation for the next interest rate turn. However, with a slowdown in production, there is also more emphasis on budget and frequently (particularly if this coincides with the end of the fiscal year) there is little money left for technology projects.

This has been a frustrating cycle for technology vendors who continually were faced with a situation that when there was money there was no time and when there was time there was no budget. There never seemed to be the right time for technology improvements, which really translated to the fact that it was not given a high level of priority. This was also illustrated by the position that the IT people held within the lending organization. They were typically staffed more to implement and maintain the network and pc systems within the organization rather than to develop strategies for newly emerging technologies and system improvements.

Market Needs Drive the Change

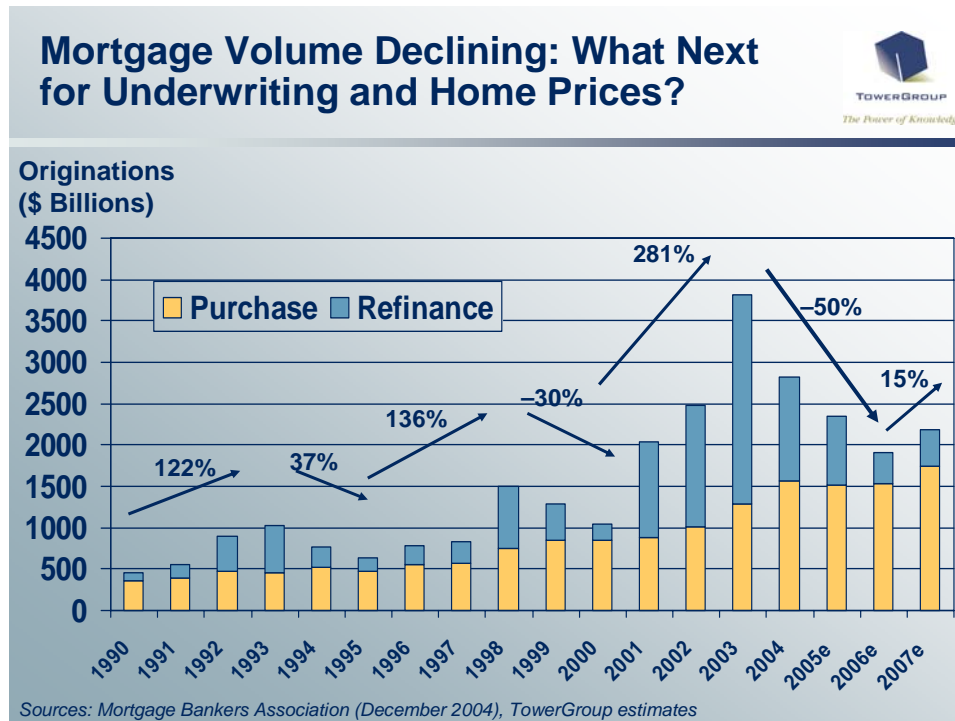
With the advent of Internet immediacy and a hugely competitive lending environment, borrowers came to expect the lending process to be faster and less expensive than before. Pressure to close and fund a loan, whether for purchase of a home, refinance, or tapping into home equity, created a situation that called for more automated systems to speed up the process and allow lenders to lower fees through savings obtained within this new systems environment. The first step was to automate the underwriting process.

Initially, there was push back with regard to these automated systems. People in operations feared the elimination of the underwriter, and the technology was seen as a replacement for large operations with elimination of most of the positions. In reality, while AU systems did allow for some level of downsizing, the underwriting position has not been eliminated, but more focused on the complicated deals and more intricate portions of the underwriting process.

As underwriting systems developed and produced data, loan origination systems were also developed to manage the information and disseminate it to different parts of the organization. The rules based underwriting systems allowed fundamental decisions to be made automatically and eventually incorporated the decisions and data flow into the loan origination system giving workflow access to different departments and allowing automated ordering of vendor services such as credit and title products to increase efficiencies. Electronic workflow began at the loan originator's desk and the information was collected and moved into the production centers for underwriting, tracking and ordering of the required vendor products. Things moved more quickly, information was more readily available to all those who handled the loan process and as a result the borrower was able to be kept better informed and hooked in to the process.

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In the early 1990's lending volume increased substantially, going from just under \$500 billion in loans to an increase of over 120% in 1992 and continuing to increase through 1993. The market began its decline in second quarter of 1994 and continued through the year into Q1 of 1995. It was during this market downturn that both automated underwriting and automated valuation models were introduced. While the last half of 1995 began to see positive movement in the market, it was not at the rate that had been experienced during the high levels two and three years previously. It had become obvious during the sharp jumps in volume in 1992 and 1993 that there had to be a better way to deal with the volume. The relative downswing of the market during 1994 and 1995 gave everyone a breather and allowed time to examine operational efficiencies and cost savings in preparation for the decrease in interest rates and the real estate market that would come back at some point.



Fannie and Freddie Approval Drives Acceptance

Early in the AUS adoption process, Fannie Mae and Freddie Mac developed their own proprietary systems that they made available to their clients. Selling the loan to the GSE's became easier as the loan review and approval for their acceptance came at the beginning of the process. As a result, the automated underwriting systems quickly became a standard within the industry with acceptance of the technology increasing over time from 5% use in 1995 (early

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adopters) jumping to 40% in 1997 and jumping again to over 60% adoption in 1999 and an additional 10% in 2000. Corresponding to the second jump of 60% was another drop in the market from 1998 through 2000 which gave the technology followers time to get caught up to the higher tech competitors. .

With the increasing dependence on automated systems, the IT people were brought out of their insulated computer rooms and high level technology positions were created at top levels of the organizations. Process flow and information dissemination became a technology initiative rather than an operational issue as more sophisticated products came on to the market to address the needs of the industry.

All was going well with lending automation. Everyone calmed down and went back to work once the underwriters realized their jobs were not being eliminated, and the loan agents realized that the automated underwriting systems were not going to result in more strict guidelines with fewer of their loans being closed. While technology was helping the underwriters to do their job more quickly, it didn't necessarily mean that the rules of the game had changed all that much.

The appraisal process was left to its traditional pattern, with only the ordering of the appraisal being automated. The loan agent was still in control of the process and the appraiser relationship, and even possibly the ordering and tracking of the appraisal being done.

While this was a satisfactory situation for the loan agent, the appraisal process did not meet the expectations of the market in terms of turn around time to fund the loan. In addition, the information regarding the property was being stored in PDF format, so there was no ability to integrate the data with the other elements of the loan that were now being driven through the loan origination system. As the data elements of the loan became available electronically, it now was becoming feasible to use this information to better determine risk with regard to risk based pricing, prepayment, and default. FICO scores were being used in the risk analysis, but there was no property score to include rounding out the determination of risk.

Automated Valuation Models

In the secondary market environment, kept separate from the mortgage origination space due to its need to handle loans on a portfolio basis rather than on a per loan basis, members of the academic community developed a statistical method to determine property values on a portfolio

level. The accuracy of the valuations obtained was measured on a portfolio basis as well, rather than on an individual loan bases. The product was designed to become more accurate the larger the sample size, to handle the needs of the portfolio oriented secondary market. It was then and continues to be used heavily used in the Wall Street investment community including the rating agencies.

This product, known as the Case-Shiller Indexes (CSI) was developed by the research principals, Karl E. Case, Ph.D. and Robert J. Schiller, Ph.D. who pioneered the repeat sales technique upon which most modern home price indexes are based. Their research began in the 1980's as they worked towards developing an accurate method of quantifying residential property price changes.

The CSI product has come to be considered to be the grandfather of today's AVM products with the price index concept still in use and considered a viable alternative to the other statistical methods that have developed over time.

While Wall Street was using this valuation technology for analysis and prediction of their portfolio performance, little was being done to address the valuation technology needs of the lending community particularly on an individual loan level.

Introduction of automated valuations for the lending market began its process in 1995. These models were statistically driven experiments that were geared to determining values on an individual property basis rather than the price index models that were being used for portfolio valuation. The theory was that, while indices gave good overall portfolio values, there were inherent inaccuracies on an individual property basis. Developing a property value simply by moving the initial sales price through the index over time was flawed when considering that there may have been improvements to the home, changes in condition, or increases in size that would not be reflected in that value increase calculation. It also became less accurate when used on an individual property basis when the home had not sold for many years so that the index applied to the initial sales price had many shifts over that longer time period.

These new valuation models were designed to pay particular attention to the attributes of the individual property and recent sales in the immediate neighborhood. The challenges in these "hedonic" models became twofold: identification of the neighborhood and identification of the data points that actually had an effect on the property value.

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The model development in its initial experimental stages took into account as much information about the property as it could find. The most information rich property data was found on the URAR report – the standard Fannie Mae appraisal report that was used for lending purposes. As models were tested and developed it was determined that there were a handful of data points that when used together became important influencers in the prediction of the property value. Included in this list were: square footage, age, number of bedrooms, number of bathrooms, and total room count. Different modeling techniques used additional or fewer attributes, but these became common in most models. The issue then became the ability to obtain enough data to be an adequate sample size to build the models.

Neighborhood identification was also seen as a means to gain accuracy in predicting property value. Debates and testing formed around the differences in doing radial searches for comparable properties as opposed to using other means of neighborhood identification such as census tract, zip code levels, and similarity in sales trends.

Two models emerged initially in the development of automated valuations for lending. Value Point was developed by TRW (later becoming First American Real Estate Services). This model was a combination of appraiser emulation with statistical regression modeling to form a product that worked well with a fairly detailed database of information. It was a complementary product to the public record database business that TRW had been in for years, licensing real estate related public records information to the lending community for various purposes including appraisal comparable searching, identification of leads for new loans, and tracking the competition. TRW already had the target customer base with their existing products and also had ownership of the data that was needed to build the automated valuation models.

The other company that was successfully building valuation models at the same time was a much different organization – HNC Software, Inc. The core business for HNC was statistical modeling and their success was evident with their flagship product, Falcon, used to detect fraudulent credit card transactions. It was determined that the neural network technology that detected elaborate patterns in the database when analyzing credit card transactions could also be applied to detecting patterns in home sales, identifying a neighborhood accurately, and determining the pattern relationships with property characteristics. As a result “AREAS” was built with sophisticated neural network pattern recognition technology and was able to successfully compete with the TRW model development results.

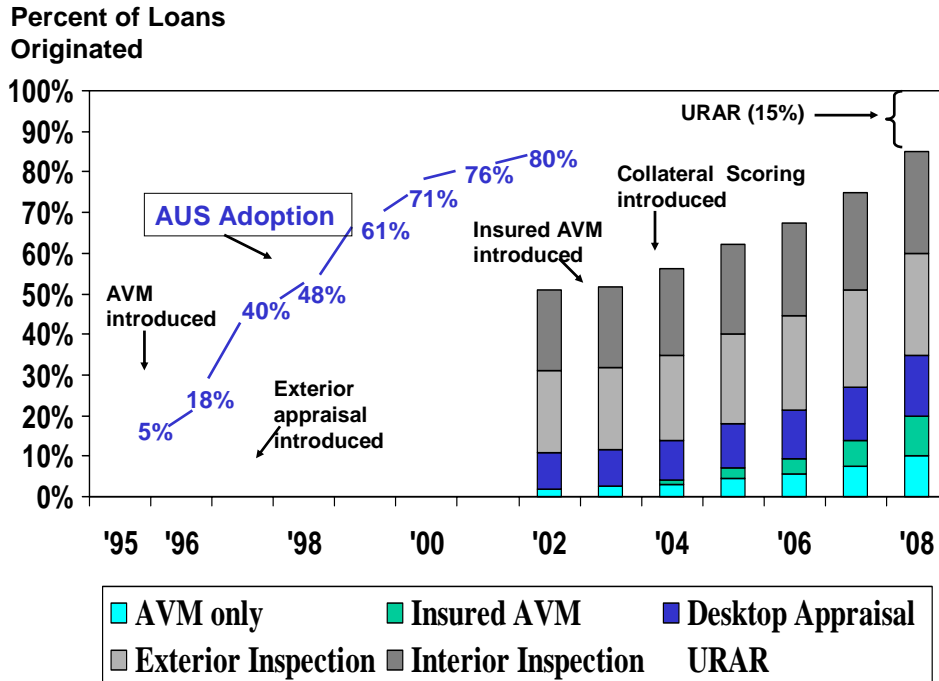
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Initially both models (and subsequent model development as well) were developed on a public record database of housing transactions in California. This data had typically been more robust and better organized than in other parts of the country. The models were built using a fair amount of property characteristics and a healthy dose of sales information. They were brought to market with geographical coverage in California and promises of expansion into other states happening quickly.

While the development of the automated valuation models was happening in parallel with the automated underwriting system development, AVM's immediately had the additional hurdle of believability to take into stride. Both products faced operational issues such as assumed displacement of staff, implementation into the workflow, and training and installation curves. But it didn't take a complicated process for operations to understand that automating underwriting and increasing the flow of data to the different parts of the organization would serve the business well. AU systems were rules based, with the information used to build the rules coming from the lenders' own credit policy and underwriting guidelines. Algorithms were developed with the participation of the operations group and rules were input by people who were most familiar with their use in the process. None of it appeared to be black box technology.

AVM's, on the other hand, had the uphill battle of convincing everyone that they actually worked.

AUS and AVM Related Product Introduction



Sources: TowerGroup, OFHEO, MorTech

AVM Market Adoption – A Slow Process

The use of automated valuations was a difficult sell during market introduction. The target market was a lending community not used to statistical products being part of an operations solution. The automated underwriting systems were a direct translation of manual into automated processes. The initial AVM products were considered to be “black box” technology with no ability to look into the box to see what was going on. The standard appraisal form was easy to understand and there were systems in place for underwriting and appraisal review for accuracy. The statistical models had no allowance for such review techniques and accuracy was measured in statistical terms by the models themselves using “confidence scores”. Despite presentations, explanations, and training, the client had little comfort in the accuracy of the valuation predictions.

Additionally, if the credit risk groups were to accept AVM use in the origination process, who else would need to buy in to the process?

- The Loan Agent – the Loan Agent had much to lose with the use of an AVM instead of an appraisal. There was no appraiser to establish a relationship and work with to get the value that was needed for the loan – whether legitimately or through appraiser

- intimidation. The value produced by an AVM came in at a single point rather than a range and there was no room for negotiation.
- The GSE's – As the development of AVM's and proof of their accuracy took hold, Fannie Mae and Freddie Mac began their own internal development of models. However, they were not interested in endorsing other models and so the process that the FICO score enjoyed with GSE blessing moving use quickly into the market was not available to the AVM's.
 - Wall Street – Without Fannie and Freddie endorsement, Wall Street was unlikely to approve the valuations in portfolios being purchased on the secondary market. Ironically, this is the same group that had been using the index models for quite awhile. But their comfort in the initial valuation being done by a full appraisal was at the base of analysis of the loans being purchased.

While loan volume began to increase in 1996 to an all time high in 1998, automated underwriting became a standard to address the inability to handle the number of loans coming in. This should also have been an opportunity for AVM adoption but, held back largely by secondary market acceptance, there was no great surge in use of the statistical products. Instead, the appraisal industry addressed the turn time issues with the GSE's accepting a shortened standard in appraisal products, allowing for high quality loans to be funded using “drive by” appraisals with no interior inspection or appointment with the borrower needed. This shortened the time between order and receipt of the valuation considerably and met the needs of the market. AVM's were unable to solve the market issues that they faced and lost the market advantage that they may have had at that point in time.

Analytics Tools become More Prevalent

With the growing availability of data within the lending institutions and some community gathering of information such as the cooperative database that has been developed by Loan Performance, lending institutions grew to become more sophisticated about the risks being taken on in their portfolios, the pricing issues that resulted, and how they could become smarter about purchasing and selling portfolios. As interest rates rapidly increased, “serial refinancing” became more common and the borrowers became more sophisticated in their mortgage practices. The values of portfolios sold were greatly influenced by interest rate fluctuations that resulted in high levels of prepayment within those portfolios. Prepayment and default models became much more detailed and valuable for secondary market participants.

Statistical modeling was finding its way into the loan process and the previous “black box” concept was not as threatening. Many lending institutions began to bring statisticians on staff and involved them in the discussions with the AVM product vendors. More products became available on the market and continual model improvement began to produce increases in accuracy and ability to deal with the less robust property data outside California. Freddie Mac made their AVM (Home Value Estimator) available to the market. Things opened up a bit for AVM use – but the GSE’s and the secondary market were still not willing to accept automated valuations in place of appraisals for the first mortgages (Freddie Mac would allow use of their HVE product but not other commercial products.)

As statistical methodology became more relied upon, automated valuations were better understood. Lenders were unable to use them for secondary market transactions, but found that they worked well enough to be used for internal purposes, either in a quality control environment as an appraisal review tool, or for funding on high quality loans that were kept within the institution such as home equity lending.

Additional Products Fill in the Comfort Gaps

To add additional comfort to the valuation, lenders began to include complementary products such as AVM’s with photos of the property (to determine condition), or an interior or exterior inspection by an appraiser, real estate agent, or property inspector. This led to the development of additional products such as the insured AVM that guarantees the lender security if there is a loss due to the AVM producing an inaccurate value. Insured valuation products have come into the market with the intention to help AVM product acceptance in a more round about way.

Development of “collateral score” products that related to AVM usage has also come into being. The various products available attempt to place a score (likened to a FICO score for the property) on the risk of the property based on the type of valuation used or the quality of the value produced, whether by an AVM, full appraisal, or one of the in between products.

The most recent product grouping that appears to be gaining in acceptance is the “appraiser assisted” AVM. This is a product that takes several forms varying from an AVM being run with an appraiser reviewing it to validate the predicted value, to an appraiser inputting the appropriate comparables and running the statistical analysis on the hand picked data. There are arguments against all types of these products. In particular, the appraisers object to “signing off” on a

statistical valuation that was determined without their involvement. With the latter, the statisticians objects to the appraiser hand picking the sales data as they feel that this will insert the very bias that the AVM in its truly automated form serves to provide. However, this type of combination product –statistical modeling blended with some form of human interaction – is seen as a bridge to a faster and less expensive method of valuing property for lending purposes and addresses the competitive market issues that the lender faces today.

Freddie Mac is currently reviewing the use of appraiser assisted AVM products and is in the process of setting up guidelines for this combined product's use. These guidelines will be specific as to the product, the appraiser experience and training, as well as the loans that will be able to be included in the program. Appraisers must be trained in the understanding and use of automated valuations. The loans acceptable for use with these products will initially be low risk with regard to FICO score and loan to value. Many in the industry see this as the first real step to secondary market acceptance of AVM products and will eventually lead to full AVM acceptance without appraiser involvement. This is not Freddie Mac's stated objective but the industry is hopeful that further acceptance for AVM's is the direction that it will go.

Automated Valuations – Today's Issues

As the lending market pushes forward with technology, the use of AVM's increases. Increased use of statistical modeling to measure and predict for successful business strategy has become the way business is being done. These statistical valuation products have continued to improve, each in its own way, with better modeling and data handling resulting in higher hit rates and improved accuracy.

Automated valuation products have now come into their adulthood stage, bringing with it responsibilities that will be required in order for market share to increase. These responsibilities come in the form of a broader view of client needs which translates to industry standards.

Lenders are comfortable with the technology and are pushing at the secondary market for increased acceptance and replacement of the traditional valuation products. The competitive market demands a level of cost and time savings that is best accomplished by using these products more frequently and in additional ways than is currently accepted. When used in the quality assurance capacity, as a back up for other valuation techniques, or as a prequalification tool, the lender is taking on minimal risk. However, increasing use in the first mortgage market

and then passing those loans on to the investment community takes on another level of risk that must be carefully considered.

With increased use comes increased attention. That includes attention from the regulatory agencies that measure the safety and soundness of lending practices. As more creative valuation practices come into use, there are expectations that lenders and AVM vendors take on responsible measures similar to what is expected in other areas of the lending institutions. The regulators and businesses, such as the mortgage insurance companies, that take on the burden of problem loans are requiring documented policies with regard to AVM accuracy testing, guidelines around product use, measurement of risk, and industry standards.

The AVM industry has not paid much attention to standards, with each vendor developing its own proprietary methodology for determining value and measuring accuracy. They fear that standards will dull the competitive edge and while everyone is a friendly competitor in the industry, no one wants to level the playing field. However, the lenders and the regulatory agencies are forcing the issues. Regulators are interested in setting requirement for product testing and rules governing and documenting use. Lenders have to answer questions and document files to prove they are not taking on additional risk through elimination of more traditional products in favor of statistical methodology.

One of the industry groups that has been formed to address these issues and work on setting standards is the Joint Industry Task Force on AVM Standards. Membership is all inclusive intending to bring in anyone interested in participating in the standards formation. Lending institutions, GSE's, mortgage insurance organizations, professional organizations such as the Appraisal Institute, and the AVM vendors themselves have all been invited to participate and expand participation to others who would be relevant to the discussion. Subcommittees have been formed to work on terminology, testing, confidence scores and standards, all in an effort to build structure around the concept without inhibiting the creativity and improvement of the individual products. It is believed that working towards this common goal will create a new level of product acceptance and comfort that will allow for increased product usage.

Conclusions – What We Can All Learn from the Process

Standards and Faster Product Adoption

Testing - In retrospect, the process of individual lender acceptance and use of the automated valuation process was seen as a competitive step by the vendors. The goal was for each vendor to track who was doing testing for product selection and to make sure that their product was part of the test.

The lenders were hesitant to have the vendors participate in the testing process as they wanted to insure that the tests performed would be unbiased. Each of the lenders tested differently and on a relatively small sample size, using the internal data that was available to them through their production systems. Some tested against sales prices, but did not necessarily make certain that the sales prices were so recent that they were not yet incorporated in the public record databases that the vendors were using (so the “answer” could be found in the data). This gave the vendors with public record data ownership (as opposed to licensing it from another organization) an advantage as they would have the most recent information – even if it was only a few days difference. Some lenders tested against appraised value, automatically building a bias into the test with the assumption that the appraised values were the “right answer”. Some lenders had people performing the test that did not understand the nuances of the statistics and could not properly analyze the results.

Confidence scores – Each vendor developed a proprietary way to provide an indication of risk level for the value produced in a specific report. While this technique is certainly valuable in a statistical product, because there was no relationship between the various vendor scores, it was difficult for the lender customer to understand. Including this score in the testing process was difficult and did not provide a comparison between products. The assumption by the lenders became simply that the confidence scores didn’t work. They could not relate them to the accuracy of the value and did not understand that there was not necessarily a relationship between the accuracy and a low score, but rather was a red flag regarding the underlying data issues. Without this fundamental understanding, the lenders were lead to assume that the sometime disconnect was a flaw in the score.

General standards of use - The vendors have correctly stayed out of the credit policy decisions of their individual clients. Their job is to build the best possible model. It is the lenders’ job to determine the individual policy around its use for each individual organization. However, as a

group, it can be best determined based on product idiosyncrasies, where some of the lines should be drawn and what documentation for the decisions can best be supplied for historical review and regulatory approval. The danger in not doing so is that those responsible for the risk measurement will make decisions that could work against the operational and cost efficiencies that are hoped to be gained by product use. When left to the most conservative group to make the decision, the resulting decision will tend to be the most conservative as well.

Drivers for technology change - Market driven changes in technology are not always the most efficient way of doing things. Lenders in the US have been driven by market demands in a reactive mode. Two of the important automation changes have been forced by large spikes in volume that the lending community has been unable to handle in any efficient manner. They have been forced to muddle through the crisis at hand and only after the painful process have they realized that the products that have been available all along would have saved money and resources as well as closing more loans less painfully. There has been little proactive work done as the status quo has been comfortable in the past. This cycle is now moving to the servicing side of the house as the loans that have been brought in during an elongated lending frenzy now have to be monitored for delinquency and fraud in an efficient manner. It is up to the servicing groups to keep the portfolio profitable. Yet, little has been spent in development of products and services for this group as the emphasis has been in origination. The results will unfold in the next few years as the portfolios age.

Conclusions

Standard setting at the onset of market introduction and use of automated valuation models was not even a consideration at the time, but could have gone a long way to move the products toward easier industry acceptance. This is a responsibility that should be shared by a variety of members in the lending community, similar to what the Joint Industry Task Force is working to accomplish now. Any of the individually affected groups attempting to build standards without input from the others would miss important input that is vital to the process. It would serve lending communities in other countries well to consider the process and bring on some formal structure early in the process.

In addition, as models are brought to market, it would be well advised to keep a broader view of the market needs, not just for the initial lender client, but what will also work for the secondary market and regulatory agencies. The products developed in the US were driven by lender needs

and neither the vendor nor the lender considered the larger picture extensively. Right from the beginning, better communication in the broader circle would have helped the process along as well.

Since so much of the banking/lending community is global, it would not be difficult to take advantage of sister organizations in the US who have climbed the learning curve already. However, it is imperative to understand that, while the process of implementation and use may be similar, the underlying data, statistical analysis and product development may be very different based on each culture's housing market, data availability, and purchasing patterns. What makes a model work well in one country may be very different in other places. Development in the US has become very standardized and considered by those in the US vendor market to be the "way it is done". While there are lessons here for the development market outside the US, there is also an exciting creative atmosphere in the UK and other countries for similar products but with a fresh eye to the data and modeling techniques.

References

Estimating Selling Prices of Homes

Arthur, Frank, Janssen, Christian. Appraisal Institute of Canada. A I M, Appraisal Institute Magazine Winnipeg: Dec 1980. Vol. 24, Iss. 4, p. 28

A Semiparametric Method for Valuing Residential Locations: Application to Automated Valuation

John M Clapp. Journal of Real Estate Finance and Economics Boston: Nov 2003. Vol. 27, Iss. 3, p. 303-320

Standard on Automated Valuation Models (AVMs)

Anonymous. Assessment Journal Chicago :Fall 2003. Vol. 10 Iss. 4, p. 109-154 (46 pp.)

Real time valuation

Jeffrey D Fisher. Journal of Property Investment & Finance Bradford: 2002. Vol. 20, Iss. 3, p. 213 (9 pp.)

The Tale of AVMs

Charlyne McWilliams, Mortgage Banking Magazine, February 2004, p. 80-84

Evaluating Real Estate Valuation Systems

Robert J. Shiller, Ph.D. and Allan N. Weiss, Ph.D, American Statistical Association, Business and economics statistics section, 1996.