Property Valuation Methods and Data in the United States

by Charles A. Calhoun

INTRODUCTION

Residential property valuation is a subject that permeates social, political, and economic life in the United States. Property valuation serves as an endless topic of discussion among neighbors, but also provides the impetus for major property tax reforms and other public policy measures. Some say that the two most common shared experiences of American daily life are the duration of your commute to work and how much your house has appreciated in the past year. That discussion is increasingly well informed, as the availability of broad-based house price indexes (HPIs) and automated valuation models (AVMs) has evolved rapidly in recent years.[1] This paper aims to provide a survey of the basic statistical methods, historical developments, and recent innovations in house price indexes and property valuation models in the United States, and to give a preliminary assessment of the requirements and prospects for applying similar approaches in other countries.

Charles A. Calhoun is an economic and statistical consultant based in Washington, D.C. He previously served in senior research positions at Fannie Mae, The Urban Institute, and the Office of Federal Housing Enterprise Oversight (OFHEO), and has been involved in the development of several major house price indexes and property valuation models in the United States. His current research includes a project to develop loan performance models and house price indexes for the Government Housing Bank of Thailand. This paper was written with financial support from Countrywide Credit Industries. The opinions expressed are those of the author.

A common thread throughout the discussion is the need for more and better data, and the innovative solutions that have emerged to exploit information from a variety of sources, including government surveys, tax assessments, real estate listings, appraisals, mortgage originations, and actual sales transactions. Data gaps and statistical uncertainties persist, and to a certain extent are unavoidable given the relative infrequency and idiosyncratic nature of real property transactions. However, one can also see a steady trend toward more complete geographic coverage, and information that is more readily accessible to homeowners, lenders, brokers, investors, and government regulators, with definite advantages for the efficient operation of the housing finance system.

Applications of HPIs and AVMs

Applications of HPIs and AVMs are almost as varied as the methods and data underlying them. House price indexes are used to track the national, regional, and local performance of residential real estate. Periodic HPI publications represent the most readily available source of information on the economic performance of the most important financial asset for a majority of U.S. households. At their most basic level, HPIs represent an attempt to estimate the rates of appreciation or depreciation in housing values over time periods when a relative minority of properties are actually traded. Thus, in one important sense, HPIs attempt to create data where none existed. HPIs are an important data input into a wide range of academic, financial, and regulatory models concerned with the financial performance of housing and mortgage markets. As discussed in greater detail below, HPIs also comprise an essential component of many large-scale commercial AVMs in the United States.

The United States may be unique in terms of the number of applications of HPIs to housing policy and financial regulation at the national level. For example, a house price index is used to determine increases in the conforming loan limits for eligibility for purchase or securitization of residential mortgages by the Federal National Mortgage Association (also known as Fannie Mae) or the Federal Home Loan Mortgage Corporation (also known as Freddie Mac).[2] The Office of Federal Housing Enterprise Oversight

(OFHEO), the financial safety and soundness regulator for Fannie Mae and Freddie Mac, has proposed a risk-based capital model under specific statutory requirements for the use of HPIs when projecting the financial performance of the enterprises under conditions of economic stress. Loan limits for first-time homebuyers under the Federal Housing Administration (FHA) single-family program are currently tied to loan limits for Fannie Mae and Freddie Mac.[3] Efforts are currently underway to develop local house price indexes from multiple data sources with potential application to setting FHA loan eligibility requirements.

AVM models are an increasingly important tool for use by mortgage lenders and servicers in the United States. A recent study by Pricewaterhouse Coopers indicates that AVMs are used on between 5% and 25% of purchase and refinance loans as a supplemental estimate of value.[4] Although they are rarely used as the only estimate of value for purchase or refinance loans, AVMs are used on 35% to 55% of home equity loans as the only estimate of value.

Ross and Nattagh (1996) describe four primary applications for which AVM models or systems are likely to be adopted, including: mortgage quality control or appraisal review, loss mitigation analysis, portfolio valuation, and appraisal process redesign. Mortgage quality control entails validation or verification of appraisals conducted to determine the market values of collateral properties securing purchase money or refinance loans. Conventional quality control methods typically entail manual review of a random sample of completed appraisals. Application of an AVM to this process offers the advantages of increased speed and reduced subjectivity, limiting the need for manual review to cases identified by the AVM as exceptional.

In loss-mitigation analysis, AVMs can be applied to estimate the current loan-to-value ratio on nonperforming loans to assist the lender or guarantor in determining optimal foreclosure strategies. Lenders may be more eager to provide alternatives to foreclosure and to avoid booking an accounting loss when the proceeds from a foreclosure sale are not likely to cover the outstanding mortgage principal. In this case, better information may benefit both borrowers and lenders.[5]

Portfolio valuation is a natural application of AVM technology, providing an efficient means of marking-to-market a large number of property values, and is most closely aligned with the underlying statistical methods.[6] And, as this application illustrates, AVMs can be applied to both case-by-case valuations and batch processing of thousands of properties.

The fourth application mentioned by Ross and Nattagh, appraisal process redesign, foresees the simultaneous application of an AVM model in conjunction with the efforts of professional appraisers. The automation features of the AVM can reduce the need for manual data collection and manipulation by the appraiser, while simultaneously providing an independent estimate of value. The role of the appraiser would be to evaluate the findings from the AVM in light of his/her own physical inspection of the property, verification of comparables, and knowledge of local market conditions.

The next section provides a brief introduction to the statistical methods underlying the various house price indexes and large-scale automated property valuation systems currently in use in the United States. This is followed by a broad outline of historical developments in the production of residential house price indexes and property valuation models. Discussion of the various data sources occurs throughout the paper, as data availability tends to drive the selection of methods.

Our goal is to give the reader a sense for how analysts, agencies, and firms in the United States have been able to overcome various methodological hurdles and data deficiencies to reach the point where automated valuation systems now represent a viable alternative to manual valuations by professional appraisers. At the same time, we wish to emphasize that no ideal method or data source currently exists, and all of the major asset valuation models currently in use in the United States depend on the application of more than one methodological approach and data source. An important conclusion of the paper is that a similarly eclectic approach is likely to be required when attempting to apply knowledge gained from the U.S. experience to property valuation in other countries.

INDEX AND VALUATION METHODS

A number of statistical methods have been applied to index estimation and property valuation in the United States. Selection of a particular methodology has depended largely on the available data, and as data quantity and quality have improved so have the estimates. This section briefly reviews the methods that have had or gained widespread acceptance in recent years, including: sales comparisons, mean or median transaction prices, hedonic estimation, repeat-sales estimation, hybrid repeat-sales/hedonic methods, rules-based artificial intelligence or expert systems, and artificial neural networks. As discussed in the introduction, the selection of particular methods or combinations of methods depends on the intended applications, which may range from appraising collateral properties securing mortgage loans and valuing real estate portfolios, to production of house price indexes for a variety of financial and regulatory applications.

Sales Comparisons

The traditional method of valuing residential properties has been through the use of pro-

fessional appraisers. Appraisers follow established state and national guidelines in producing estimates of the current market value of a property, relying primarily on comparison with houses recently sold or listed for sale and knowledge of neighborhood trends.[7] Appraisers observe the values of comparable properties, and make numerical adjustments to the prices of the comparables to align them with the features of the subject property and arrive at an estimate of value.

This approach is still the most widely used technique to obtain appraisal values on collateral properties securing residential mortgages and as the basis for periodic real estate assessments by local tax authorities. Professional appraisers in the United States operate under established guidelines, such as the Uniform Standards of Professional Appraisal Practice, or USPAP.[8] The USPAP standards generally refer to minimum standards that must be attained. Appraisers are also subject to various underwriting guidelines that may exceed the requirements of USPAP, such as those imposed by secondary market institutions like Fannie Mae and Freddie Mac, private mortgage insurance companies like PMI Mortgage Insurance Co. and Mortgage Guaranty Insurance Corp., or by government agencies like the Department of Housing and Urban Development or the Federal Home Loan Bank Board.[9]

The primary criticism of the comparative sales approach is that it is subjective, both in terms of selecting comparable sales and with regard to the types of adjustments that are made to determine value. In practice, the number of comparables is usually limited to three or four properties, and separate adjustments are made for specific property characteristics.

Mean or Median Transaction Prices

As with many economic and financial indicators, year-to-year changes in mean or median values continue to be of interest to market participants. This type of index is simple to compute and provides easy to understand summaries of sales activity within relatively localized areas such as ZIP codes. One widely recognized shortcoming is the failure to control for differences in the composition of the sample and the relative quality of the properties transacting from period to period. This makes it difficult to separate out differences in prices that occur because of actual appreciation in housing values from differences in the characteristics of the properties that are being sold. This has lead to a search for "constant quality" house price indexes based on hedonic and repeat-sales methods.

Hedonic Methods

The hedonic method of property valuation recognizes that housing is a composite good, and defines value as a mathematical function of its characteristics.[10] Hedonic methods employ multiple regression techniques to estimate the contribution to total value of specific property characteristics, such as: number of bedrooms, number of bathrooms, number of fireplaces, parking facilities, living area, and lot size. The main strength of hedonic methods is that they control for the characteristics of properties, thereby allowing the analyst to distinguish the impact of changing sample composition from actual property appreciation.

Hedonic methods can be applied to estimate the value of new or existing homes, and observations on value may be actual sales prices, listing prices, appraisal values, or even owners' estimates of housing values. Given an estimated equation expressing property value as a function of housing characteristics, one simply enters the values of the subject property characteristics to predict the total value. Constant-quality house price indexes can be generated, either by including the valuation date (e.g., month, quarter, or year) in the multiple regression, or estimating separate regressions for each time period. A standard bundle of characteristics can be used in the equation(s) to project changes in the value of an "average" house over time.

The main difficulty with the hedonic method is the requirement for detailed information on property characteristics. Even when data on property characteristics are available, these may not be ideal measures of the attributes of houses over which consumer preferences are defined. Also, the available hedonic characteristics tend to be limited to the features of individual houses, and may not provide adequate measures of important differences in neighborhoods and other environmental factors or externalities affecting the market value of a property.

Repeat-Sales Methods

Repeat-sales methods use the observed sales prices of the same properties at different points in time to create a sample of price differentials that can be used to estimate the appreciation rates of houses. If one can assume that the properties in the repeat-sales sample have not undergone significant physical improvements or deterioration between the observed sales, then using price differentials for the same properties automatically controls for the impact of quality on the estimated index of appreciation. Multiple regression methods are used to account for the fact that not all the properties in the sample are sold or re-sold at the same dates, but the only data required are the transaction prices and dates.

Bailey, Muth, and Nourse (1963) first proposed the application of multiple regression methods to the estimation of repeat-sales indexes. Case and Shiller (1987, 1989) extended their approach by accounting for differences in the sampling distributions of price changes observed over different

lengths of time between repeat sales. They proposed a weighted-repeat-sales (WRS) model based on a generalized least squares regression to account for this source of heteroscedasticity in the errors.[11]

Hybrid Methods

Various attempts have been made to improve on both the hedonic and repeat-sales methods of house price index construction. For example, Case, Pollakowski, and Wachter (1991) investigate a hybrid of the hedonic and repeat-sales methods, utilizing repeat transactions when available, but otherwise using hedonic information to control for differences in quality and to confirm that no significant physical changes have occurred for properties with repeat observations. Various other hybrid methods have been proposed that introduce a spatial dimension, such as the distance-weighted repeat-sales (DWRS) method advanced by Goetzmann and Spiegel (1995, 1997). The spatial dimension in this case does not necessarily refer to location per se; rather it corresponds to the correlation among appreciation rates for individual properties that may be closer or farther apart in either geographic space or "characteristic" space. Distance-based methods have been found to improve the accuracy of indexes for smaller areas such as neighborhoods.[12]

AUTOMATED PROPERTY VALUATION METHODS

Computer Assisted Assessments and Appraisals

With the advent of computer technology and computerized databases, regional authorities in the United States were the first to implement computer assisted valuation methods.[13] Some of the earlier applications of computers to the assessment or appraisal of real property are referred to in the literature under such names as Computer Assisted Mass Assessments (CAMA), Computer Assisted Review Appraisals (CARA), and Computer Assisted Real Estate Appraisal System (CAREAS).[14] These systems are essentially automated versions of traditional valuation methods such as the comparative sales approach. While some systems focused mainly on the automation of standard forms and record keeping, others provide early examples of the application of multivariate regression models to the task of valuation.

Rules-Based Artificial Intelligence

Rules-based artificial intelligence (AI) methods, also called expert systems, attempt to apply or emulate, via computer programs, established principles and guidelines, such as those contained in standard texts on practices and standards for real estate appraisal, or comprising professional standards, such as the Uniform Standards of Professional Appraisal Practice, or USPAP.[15] One advantage that rules-based methods have over "black box" approaches such as multiple regression models or artificial neural networks (discussed below) is that it may be easier to explain why a particular result was obtained. On the other hand, rules-based systems depend critically on the efficient selection of the sample of comparable properties to be used as the basis for estimating the value of the subject property. This is another potential source of error since the existence of recent sales is itself a statistical process subject to its own sources of variation and bias.[16]

Valuations based on expert systems can be used to supplement or replace human appraisals. In this case, the perceived accuracy of the results may also depend on the extent to which human appraisals are actually consistent with the theory or quantifiable standards underlying the system.[17] While there is consensus that appraisal standards and practices have improved over the past 10 years, there remains a general perception that valuations based on arms-length sales transactions provide more accurate and meaningful representations of market value.[18] Current directions point to rules-based expert systems calibrated using actual sales transactions, and this should lead to more accurate and robust estimates of market value.

Artificial Neural Networks

Artificial neural networks attempt to emulate the process by which the human brain converts external stimuli (inputs) into specific responses (outputs) via neurons and synapses. In this sense an artificial neural network is a type of AI model that replicates the learning process that occurs in the brain. In the case of an artificial neural network, mathematical functions called "nodes" are used to represent the neurons and are connected to each other in processing layers corresponding to the input layer, hidden layer or layers, and the output layer.

Worzla, Lenk, and Silva (1995) provide a summary of the neural network approach to real estate valuation and a comparison with multiple regression models.[19] When applied to property valuation, the inputs are the explanatory or independent variables, such as location and property characteristics, and the output is the dependent variable, in this case the property value. The hidden layers are generally nonlinear mathematical functions that assign weights to the inputs as they pass through the nodes of the hidden layer to the output layer. The ultimate goal of the neural network is to determine the weights that will result in a response like that which really exists between the independent variables and the output or dependent variable. Typically, one subset of data is used to "train" the model through repeated iterations until some objective function is satisfied, and then the model is tested for accuracy on another subset of

data by letting it predict outputs based on a new set of inputs.

HISTORICAL DEVELOPMENTS

This section of the paper provides a brief history of the evolution of HPIs and AVMs in the United States. Once again, the development and application of alternative methods largely reflects data content and availability.

Commerce Constant Quality Index

Since the 1960s, the U.S. Department of Commerce has issued constant-quality house prices indexes for new homes sold and listed for sale. The Commerce Constant Quality Index (CCQI) is a hedonic house price index based on data from the Housing Sales Survey conducted by the Bureau of the Census.[20] The sample used to estimate the CCQI comprises approximately 13,000 new houses sold or listed for sale each year. Information on the physical characteristics and sales prices of new one-family houses are obtained through interviews with a nationally representative sample of builders and owners. A national price index is derived from five separate price models: four for detached houses in each of the Census regions, and one model for attached houses. Each model is "designed to measure changes over time in the sales price of new one-family houses which are the same with respect to many important physical characteristics." House characteristics included in all five models are: floor area, geographic division within the region, inside or outside a metropolitan statistical area (MSA), number of fireplaces, number of bathrooms, type of parking facility, and type of foundation. The national index is a weighted average of the five indexes for detached and attached houses, and the weights are defined using various combinations of housing characteristics. The price index is computed from actual transaction prices, which include the value of the developed lot. However, land costs are not explicitly accounted for in the hedonic estimation and weighting procedures.

Other Research on Hedonic Indexes

A number of academic researchers have developed hedonic house price indexes, primarily from periodic surveys like the American Housing Survey (AHS).[21] The AHS includes data on both new and existing properties, and provides information on the physical attributes of properties and neighborhoods and the demographics of occupants. A unique aspect of AHS data is that for many years the only source of information on housing values was owner's valuations. Kiel and Zabel (1999) provide a summary of research on the accuracy of owners' estimates of housing value for a number of data sources, including the AHS.[22] These studies generally find that owners tend to overestimate their property values when compared with appraisals, estimates from hedonic regressions, or actual sales prices. Kiel and Zabel develop a more complete model that includes some earlier models as special cases and find that owners do overestimate their property values by about 5% on average, but that the differences are not related to particular occupant, house, or neighborhood characteristics. This implies that owners' valuations remain fairly reliable for measuring changes in housing prices over time.

NAR Existing House Price Series

The first large-scale effort to provide purchase price indexes of existing houses was undertaken by the National Association of Realtors (NAR), utilizing multiple listing service (MLS) data from local member offices.[23] The NAR continues to publish monthly and annual house prices series showing the mean and median prices of houses listed for sale.

Case-Shiller Repeat-Sales Indexes

Renewed interest in constant quality indexes for existing homes was stimulated in the late 1980s by the work of Case and Shiller (1987, 1989). Case and Shiller began by utilizing multiple listing service (MLS) data obtained from local real estate organizations in four U.S. cities (Atlanta, Chicago, Dallas, and Oakland) to estimate repeat-sales house price indexes. Case and Shiller subsequently expanded their original research into a national data collection effort and established a commercial business marketing house price indexes and an online property valuation service.

Agency Repeat-Transactions Indexes

Government-sponsored enterprises (GSEs) Fannie Mae and Freddie Mac have developed repeat-transactions indexes utilizing the sales prices or appraisal values of residential properties securing loans sold into the secondary mortgage market in the United States. The GSEs now publish an index series based on their combined data under the name Conventional Mortgage Home Price Index (CMHPI).[24]

OFHEO, the financial safety and soundness regulator for Fannie Mae and Freddie Mac, produces and publishes an official government house price index series based on data submitted each quarter by the GSEs and employing essentially the same statistical methodology for repeat transactions. The OFHEO HPI was developed to meet certain regulatory requirements for the use of house price indexes in projecting the financial performance of the GSEs under stressful economic scenarios.[25] Since 1995, OFHEO has published quarterly index series for the nation, the nine Census divisions, and the 50 states and the District of Columbia. OFHEO has recently undertaken to release quarterly indexes for 329 metropolitan areas. A key aspect of the OFHEO HPI is its unrestricted

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.