An Analysis of the Limitations of Utilizing the Development Method for Projecting Mortgage Credit Losses and Recommended Enhancements

Michael Schmitz, FCAS, and Kyle Mrotek, FCAS

Abstract: The rise and fall of subprime mortgage securitizations contributed in part to the ensuing credit crisis and financial crisis of 2008. Some participants in the subprime-mortgage-backed securities market relied at least in part on analyses grounded in the loss development factor (LDF) method, and many did not conduct their own credit analyses, relying instead on the work of others such as securities brokers and rating agencies. In some cases, the parties providing these analyses may have lacked the independence, or at least the appearance of it, that would have likely better served the market.

A new appreciation for the value of independent analysis is clearly a silver lining and an important lesson to be taken from the crisis. Actuaries are well positioned to lend assistance to the endeavor.

Mortgages are long-duration assets and, similarly, mortgage credit losses are relatively long-tailed. As casualty actuaries are aware, the LDF method has inherent limitations associated with immature development. The authors in this paper will cite examples of parties relying on the LDF or similar methods for projecting subprime mortgage credit losses, highlight the limitations of relying exclusively on such methods for projecting subprime mortgage credit performance, and conclude by offering general enhancements for an improved approach that considers the underwriting characteristics of the underlying loans as well as economic factors.

Keywords. Mortgage, credit risk, cash flow modeling, credit crisis, cash flow modeling, independence

1. INTRODUCTION

The rise and fall of subprime mortgage securitizations contributed in part to the ensuing credit crisis and financial crisis of 2008. Some participants in the subprime-mortgage-backed securities market did not conduct their own credit analyses, relying instead on the work of others such as securities brokers and rating agencies. In some cases, the parties providing these analyses may have lacked the independence, at least in appearance, which would have likely served the market better.

A new appreciation for the value of independent analysis is clearly a silver lining and an important lesson to be taken from the crisis. Actuaries are well positioned to lend assistance to the endeavor. In fact, actuaries might be interested to learn that several market participants have relied at least in part on analyses grounded in the loss development factor (LDF) method.

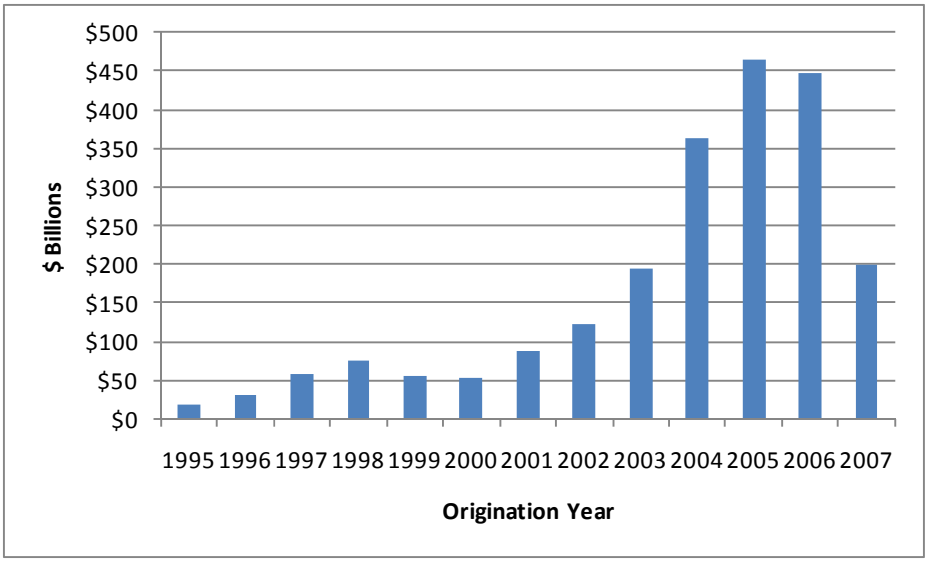
Mortgages are long-duration assets and, similarly, mortgage credit losses are relatively long-tailed. As casualty actuaries are aware, the LDF method has inherent limitations associated with immature development. The authors in this paper will cite examples of parties relying at least in part on the LDF or similar methods for projecting subprime mortgage credit losses, highlight the limitations of

relying exclusively on such methods for projecting subprime mortgage credit performance, and conclude by offering general enhancements for an improved approach that considers the underwriting characteristics of the underlying loans, as well as economic factors.

2. Mortgage-Backed Securities: Whose Analysis and for What Purpose?

Despite the tremendous growth of funds flowing into mortgage-backed securities (MBS) during the period 2004-2006, it's arguable that there was altogether too little independent analysis conducted in critical parts of this market space. Figure 1 illustrates the growth in subprime MBS gross issuance by origination year.

Figure 1: Subprime MBS Gross Issuance by Origination Year



Source: Subprime Mortgage Credit Derivatives, Goodman, et al., (Frank J. Fabozzi series).

Many investors searching for extra yield in the low-interest-rate environment of the time viewed MBS as a safe way to add alpha, or extra return to their portfolios. After all, the securities were rated AAA and backed by collateral that seemed solidly dependable: ever-rising home values and the ability of borrowers to pay their mortgages or refinance into subprime mortgages via cashing out on the additional equity that rising prices offered.

Subprime MBS market participants often relied on the security ratings provided by credit rating agencies, even though credit rating agencies do not necessarily intend their ratings to be used for

buy/hold/sell decisions. Instead, they provide opinions on "the risk to the debtholder of not receiving timely payment of principal and interest on this specific debt security."[1]

Despite this description of the intent of the rating, investors have tended to rely on them, perhaps to no fault of the credit rating agencies. For example, the ratings of MBS tend to affect insurance company investment decisions just as it did for many investors. "Credit opinions have long served as a fundamental barometer for NAIC policy formulations tied to invested assets," notes a National Association of Insurance Commissioners (NAIC) staff report.[2]

> The NAIC first accepted credit ratings as evidence that a security was "amply secured," which permitted the insurer to use amortized accounting. Credit opinions were then used to drive decisions about the value of securities. With the adoption of the Mandatory Securities Valuation Reserve (the precursor to the current Asset Valuation and Interest Maintenance Reserves), credit opinions were used to set reserving levels. Today, credit opinions serve as switches in a number of regulatory activities… Insurers need not file any NRSRO-rated securities with the SVO and instead self assign an NAIC designation to the security in accordance with a prescribed equivalency formula.

The MBS holdings of NAIC insurance companies are not trivial. According to the American Council of Life Insurers (ACLI), life and health insurers held $145 billion of non-agency MBS at year-end 2008,[3] plus $384 billion of agency MBS, for a total of $529 billion. As a note, non-agency mortgage-related securities outstanding at year-end 2009, not just for the life/health insurance industry, but in total, amounted to $2.4 trillion according to the Securities Industry and Financial Markets Association (SIFMA).

Another issue investors should consider is that some third parties providing analysis of MBS may lack the independence that might better serve the role (or at least the appearance of a potential lack of independence). For example, the potential for conflicts of interest can exist when relying on broker-dealer quotes for valuation estimates. First, the investor is asking the broker-dealer to analyze or value an asset that the broker-dealer is in the business of transacting with investors. Furthermore, the quotes provided by broker-dealers are not necessarily consistent with intrinsic values, but rather, might represent the quotes at which the broker-dealer is willing to buy or sell. This input results in a valuation akin to a market valuation (never mind that the market for price discovery is not always deep or transparent). There is considerable benefit to be gained from an intrinsic valuation of the MBS securities (along with a risk assessment of the securities). Furthermore, an intrinsic valuation can have accounting implications as discussed below.

For financial reporting purposes, an intrinsic valuation may be useful in order to separate impairment items that are fundamental, such as credit from items that are temporary but impacting market prices such as liquidity. FASB Staff Position (FSP) 115-2 "requires the recognition of an OTTI [other than temporary impairment] charge if the present value of cash flows of a debt security expected to be collected is less than the amortized cost basis of the debt security. The intent is to help companies avoid taking unnecessary write-downs to securities unless there is a true credit loss. The FSP also requires the OTTI to be split into credit and non-credit portions, where the credit portion is reflected on the income statement. As the market values of many securities are well below their present value of estimated cash flows even after consideration of projected defaults, the non-credit portion of the loss can be reflected as Other Comprehensive Impairment (OCI) in the shareholder equity section of the balance sheet and not on the income statement."[4] Pure market valuations alone do not provide this decomposition.

As reported by the *Wall Street Journal*, even third parties not participating in trade at the surface may have institutional relationships with traders.[5] The ACLI requested that the NAIC consider modifying its approach to developing NAIC ratings for residential mortgage-backed securities (RMBS).[6] In October 2009, the NAIC issued a request for proposal to generate responses from interested and qualified parties to work with the NAIC to help establish ratings for 18,000 RMBSs estimated to be owned by U.S. insurers at year-end 2009. The results of the analysis were to be used for statutory financial reporting at year-end and to determine RBC requirements.[7] One of the qualifications necessary for a firm to be considered for the engagement was that it have "safeguards in place to avoid conflict of interest, both in fact and appearance."

The NAIC ultimately selected PIMCO Advisory, a unit of PIMCO, "a leading global investment management firm ... manag[ing] investments for an array of clients, including retirement and other assets that reach more than 8 million people in the U.S. and millions more around the world," including bond fund PIMCO Mortgage-Backed Securities Fund (PTRIX), and also a unit of Allianz, with more than €8 billion of corporate (i.e., non-agency) residential or corporate MBS (R/CMBS) as of year-end 2009,[8] not to mention life, health, and property/casualty insurance companies with premiums for year 2009 of €10 billion in the United States alone,[9] much of which is under the domain of the NAIC.

2.1 Type of Analysis

The increased importance of independent risk analysis and intrinsic values of MBS holdings highlights the importance of sound credit risk analysis. The critical factors to driving credit losses are the underwriting characteristics of the underlying mortgage loans and the economic conditions to which those loans are exposed. The mortgage credit loss estimation process generally involves the following three main components:

- Loss frequency or default rate
- Loss severity (the magnitude of credit losses on defaulting loans)
- Loss emergence pattern (the timing of loss incidence for a block of loans underwritten in a particular vintage)

Note that the last factor suggests the deployment of development types of projections may be useful. However, practitioners must consider the limitations of such methods and also the impact of the underwriting quality and economic factors referenced above.

The estimation of each of the three components above is interrelated and some applied methods are briefly described. Frequencies, or default rates, are sometimes measured separately from severities, and sometimes the two are combined into loss rates (losses as a percentage of original loan balance in a given vintage). Most of the approaches referred to below for default rates can be utilized for loss rates as well.

Default frequencies can be measured as the percentage of loans originated in a cohort that ultimately gives rise to a mortgage credit loss. This can be expressed on a count basis or on a dollar-weighted average basis and the frequencies are generally referred to as default rates.

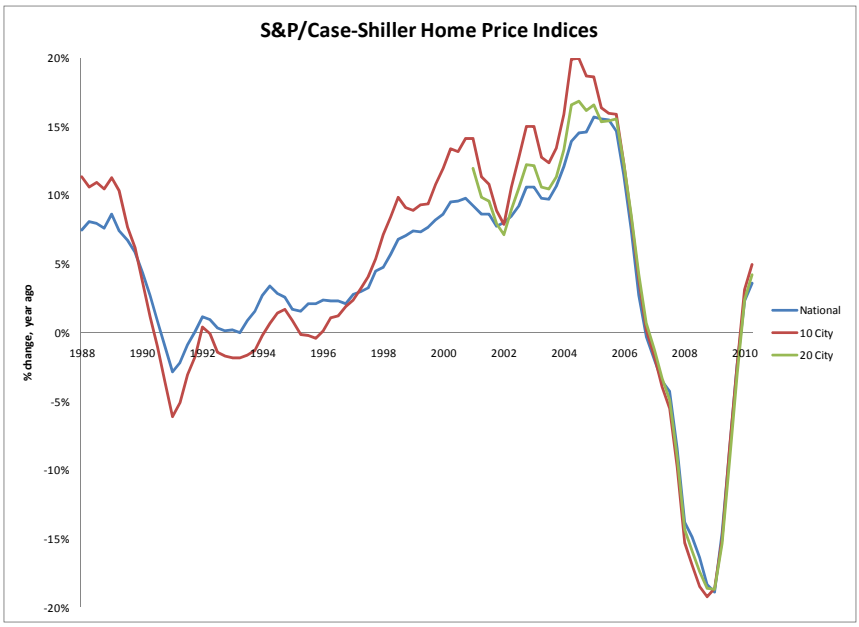
Practitioners take various approaches to this estimation process, but generally start with a review of historical data in order to project future losses after adjustments for development, trends in the book of business, changes in risk profile, etc. A particular practitioner's or company's data may be supplemented by relevant external data such as industry experience and other relevant sources.

Some practitioners have also developed proprietary underwriting models that estimate default rates and severities based on underwriting characteristics of loans. These models are in turn calibrated by analyzing historical data and can be factored into the loss estimation process. Econometric models have also been employed for analyzing historical default rates as a function of certain economic variables. Such an approach is particularly useful for reviewing past performance

because of the strong influence of economic factors on mortgage credit losses, and for sensitivity testing of forecasts to various scenarios of economic conditions.

Mortgage credit loss analysis should rely on reviewing the long-term historical experience, especially in determining tail risk, in order to capture the economically cyclical nature of mortgage performance stemming from the underlying correlation of individual mortgages as a result of economic impacts. This long-term perspective is a critical consideration for mortgage credit loss analysis and may have been overlooked by many participants that calibrated their models to the relatively benign experience during the late 1990s and early 2000s, which was characterized by steadily increasing home prices, as shown in Figure 2.

Figure 2: S&P/Case-Shiller Home Price Indices



The default loss estimation process can generally involve analyzing losses on an origination or loan underwriting vintage basis. This involves grouping all loans into the period in which the loan was originated or underwritten. Data is grouped to balance the homogeneity of risks with the credibility of their loss experience. New loan products and risk categories with limited histories are frequently analyzed based on the relative performance over their limited loss histories. Then, the more credible longer-term experience of risks with more exposure throughout robust loss cycles can be used to augment the risk evaluated.

It takes many years before the actual ultimate default frequencies for an origination cohort are known with relative confidence because of the long-term nature of mortgage credit risk (loans can remain outstanding for up to 30 years or more after a loan is underwritten). Peak default incidence tends to occur three to seven years after origination, and it is therefore necessary to project the ultimate default rates for more recent cohorts based on patterns of loss emergence exhibited by older and more mature loan vintages.

Loss development techniques can be employed for this purpose. As mentioned above, data is generally grouped into segments in an attempt to balance homogeneous risk characteristics and credibility (the predictive value of a segment of data). As a group of loans ages, their collective sum of default losses (either paid or "incurred," where "incurred" includes a provision for losses on loans that have become delinquent but have not been foreclosed upon or liquidated). Equivalently, their collective incurred or paid loss rates or claim rates similarly change. This change in value over time can be modeled as loss development.

Quite familiar to casualty actuaries, the loss development factor (LDF) method is a traditional actuarial approach that relies on the historical changes in losses from one evaluation point to another to project the current valuation of loss to an ultimate loss basis. Development patterns that have been exhibited by more mature (older) cohorts and historical industry experience are used to estimate the expected development of the less mature (more recent) cohorts. Thus, development methods can be useful methods, though practitioners should consider the underwriting characteristics and economic conditions mentioned above, as well as changes in persistency of loans when using development methods.

2.2 Limitations of Development Methods as They Relate to Mortgage Credit Losses

The chief limitation of development methods as they related to forecasting mortgage credit losses stems from the need to consider the impact of the underwriting quality of the loans and the economic conditions to which the loans are exposed, as discussed below.

RMBSs are certainly long-duration assets, with payments to an investor of an RMBS stretching over 30 years or even longer. While average durations of subprime MBS with high pre-payment rates tended to be quite a bit shorter before the crisis (e.g., durations of three to six years), pre-payment rates have dropped considerably since the crisis while falling home prices have eroded equity and

lenders have tightened credit. This has caused an exposure extension that also should be considered in the analysis as discussed below.

One mortgage product feature that gained in popularity is the 40-year term mortgage. The 40-year term mortgage was more or less rolled out in the 1980s when mortgage rates were double digits.[10] By extending the term of the mortgage, monthly payments are reduced, and therefore, borrowers can *afford* more house. Of course, this stretching out of the payback period results in the borrower having less equity in the property, as principal balance is paid down more slowly.

In May 2006, 40-year mortgages represented 5% of new mortgages in the United States and 25% of new mortgages in California, where house prices were even more out of reach for many borrowers. Just as house prices in the United States were reaching a peak in mid-2006, mortgages with 50-year terms were starting to gain traction.[11] Figure 2 illustrates that home prices were increasing, even if at a decreasing rate, through mid-2006.

Similarly, mortgage credit losses are also relatively long-tailed. Depending on the type of residential mortgages, the midpoint for mortgage credit losses in a pool can range from three to seven years, but the full development of credit losses can theoretically extend out almost as long as the mortgage term, up to 30 years (although losses that far out are generally negligible).

As casualty actuaries are aware, the LDF method has inherent limitations associated with immature development. The difficulty that development methods encountered with respect to forecasting mortgage collateral loss was its key assumption, which does not always hold in the case of mortgage collateral. "The distinguishing characteristic of the development method is that ultimate claims [collateral loss] for each accident year [vintage] are produced from recorded values assuming that future claims' development is similar to prior years' development," writes Friedland.[12]

Development methods can be unreliable when the loss experience is susceptible to calendar-year effects, which affect triangle diagonals. Friedland elaborates about when the development method works and when it does not:

> The development technique is based on the premise that we can predict future claims activity for an accident year (or policy year, report year, etc.) based on historical claims activity to date for that accident year. The primary assumption of this technique is that the reporting and payment of future claims will be similar to the patterns observed in the past. When used with reported claims, there is an implicit assumption that there have been no significant changes in the adequacy of case outstanding during the experience period; when used with paid claims, there is an implicit assumption that there have been no significant changes during the

> experience period in the speed of claims closure and payment. Thus, the development method is appropriate for insurers in a relatively stable environment. When there are no major organizational changes for the insurer, and when there are no major external environmental changes, the development technique is an appropriate method to use in combination with other techniques for estimating unpaid claims.
>
> However, if there are any changes to the insurer's operation (e.g., new claims processing systems; revisions to tabular formulae for case outstanding; or changes in claims management philosophy, policyholder deductibles, or the insurer's reinsurance limits), the assumption that the past will be predictive of the future may not hold true. Environmental changes can also invalidate the primary assumption of the development technique. For example, when a major tort reform occurs (such as a cap on claim settlements or a restriction in the statute of limitations), actuaries may no longer be able to assume that historical claim development experience will be predictive of future claims experience. In such situations, the actuary should consider alternative techniques for estimating unpaid claims, or at the very least, adjust the selected claim development factors.[13]

The inherent risk profile of loans changed markedly, leading up to the mortgage credit crisis stemming from the severe decline in the underwriting quality of the loans. Coupled with that, environmental changes occurred with respect to the performance of mortgages as home prices reached an unusually high peak in mid-2006 and then started a steep descent.

The underwriting quality of loans packaged into non-agency MBS declined as referenced above. The change occurred similarly across product types from prime to Alt-A to subprime. Figure 3 highlights the decay in underwriting for subprime adjustable-rate mortgages (ARMs) for select collateral characteristics by origination year (OY).

Figure 3: Select Collateral Characteristics for Subprime ARM

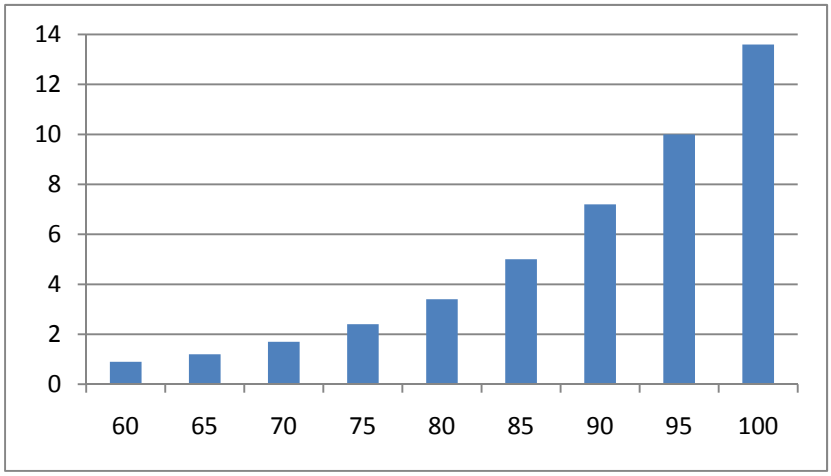
Collateral Characteristics Subprime ARMs							
OY	CLTV	% IO	% 40 Yr	% Piggyback	% CLTV > 80%	% CLTV > 90%	% Full Doc
2001	81	0	0	4	45	25	71
2002	81	1	0	4	47	27	66
2003	84	6	0	11	56	38	63
2004	85	21	0	20	61	45	59
2005	87	33	8	29	64	51	55
2006	88	20	31	34	69	56	53
2007	85	19	28	20	64	49	57

Source: Subprime Mortgage Credit Derivatives, Goodman, et al., (Frank J. Fabozzi series).

Interest-only (IO) loans began the 2000 decade with negligible representation and then exceeded 19% for four years from 2004 to 2007. Similarly, 40-year terms and loans with piggybacks also

experienced growth from virtually nothing to sizeable representation. Further, the proportion of loans with full documentation declined from more than two-thirds to about one-half. The increase in combined loan to value ratio (CLTV) from 81% to its peak at 88% can be exaggerated by speaking to its complement: borrower equity decreased from 19% to 12%. What's more, the increase in the proportion of loans with CLTV exceeding 80% went from about one-half to two-thirds, while the proportion of loans with CLTV exceeding 90% increased from one-quarter to one-half. This increase has a substantial impact on underwriting quality because frequency of default and CLTV are not linearly related—but rather, default frequency increases at a degree higher than one. Figure 4 illustrates the higher magnitude relationship between median foreclosure frequency and LTV for borrowers with a FICO credit score of 620 and otherwise generally vanilla underwriting characteristics.

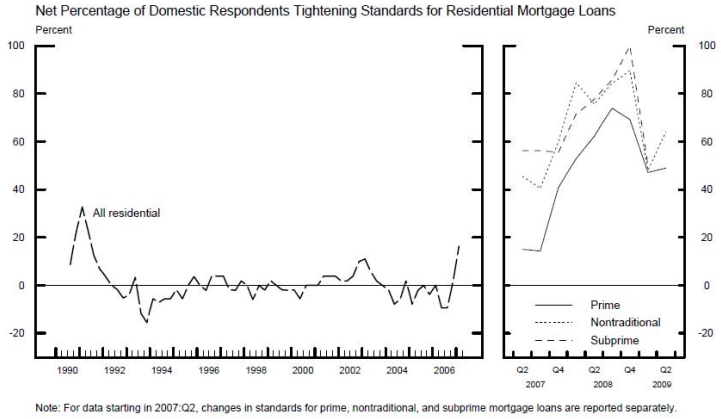
Figure 4: Relationship Between Foreclosure Frequency and LTV



Source: Fitch IBCA Residential Mortgage-Backed Securities Criteria

The rising tide of home price appreciation that obscured mortgage credit risk during the housing boom quickly reversed course into home price depreciation, which magnified credit risk markedly. And, while home prices experienced an unprecedented decline, the availability of credit to weak borrowers only diminished further, which reinforced the price declines in a credit-risk-amplifying feedback loop. Figure 5 illustrates the tightening of standards for residential mortgage loans based on the Federal Reserve's survey of bank lending practices.

Figure 5: Net Percentage of Domestic Respondents Tightening Standards for Residential Mortgage Loans



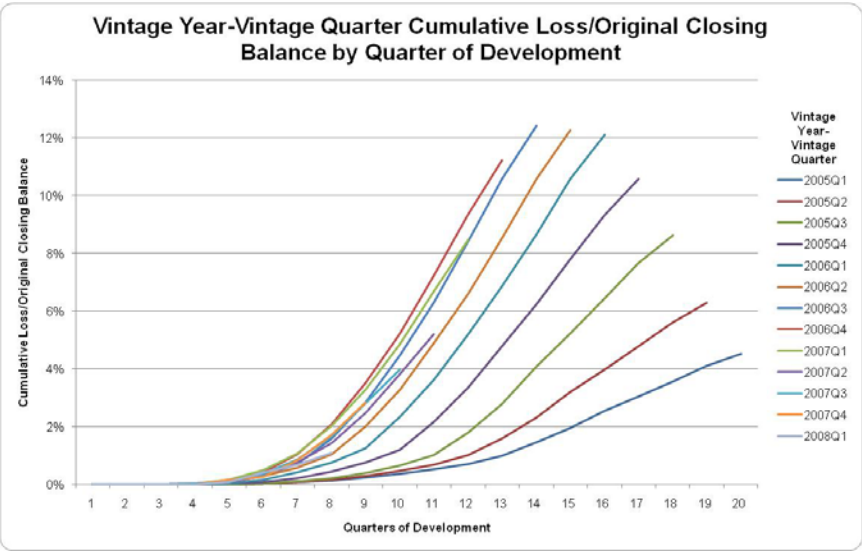
Source: Federal Reserve

We compiled vintage quarter cumulative loss rates using LoanPerformance's mortgage securities database to demonstrate the calendar-year effect. The database represents a significant portion of mortgage collateral underlying non-agency RMBS, including,

- Loan-level data on 97 percent of active non-agency securitized mortgages (over $1.4 trillion)
- More than 98 percent of the jumbo mortgage pools
- More than 93 percent of the asset-backed securities (ABS) market
- More than 12,000 active private-issue securities
- History back to 1991[14]

Figure 6 illustrates that each subsequent vintage quarter demonstrates a more accelerated development than the previous vintage from VY2005-Q1 to VY2006-Q4. The calendar-year effect of the credit crisis impacted each vintage adversely, and this is shown by ever steeper loss development curves.

Figure 6: Cumulative Loss Rate Development by Vintage Quarter



Source: Milliman, LoanPerformance mortgage securities data

2.3 Practitioner Use of Development-Type Projections

Many practitioners, including the authors, have deployed development-type methods, so it is critical to understand the limitations of such methods as discussed above.

For example, Moody's Investors Service (Moody's) "provides credit ratings and research covering debt instruments and securities."[15] In addition, Moody's RMBS Group is a "source of credit ratings and research for Jumbo MBS and Mortgage-Related ABS including home equity and manufactured housing. Asset classes include: prime mortgages, subprime mortgages, home equity loans, net interest margins, manufactured housing, and residential mortgage servicers."[16]

As of April 2010, Moody's had nearly 7,200 outstanding deals rated, corresponding to $5.5 trillion of original loan balance for RMBS asset classes worldwide. For U.S. deals, the numbers were almost 6,000 deals, corresponding to $3.4 trillion. Figure 7 summarizes the deal counts for Moody's by region and RMBS asset class and shows original loan balance on outstanding deals rated by region.

Figure 7: Summary of Moody's RMBS Ratings Coverage by Collateral and Geography

RMBS						
	US	**EMEA**	**Asia-Pacific**	**Non-US Amer**	**Global**	
HOME EQ/US	768				768	
SUBPRIME/US	2,007				2,007	
ALT-A/US	1,853				1,853	
PRIME/US	911				911	
EMEA		594			594	
ASIA PACIFIC			316		316	
AMERICAS				68	68	
OTHER	446	158	59	4	667	
RMBS TOTALS	5,985	752	375	72	7,184	deals
	$3,436	$1,704	$360	$12	$5,511	US $bill, orig balance

Source: Moody's Investor Service, Structured Finance Quick Look, 12 April 2010.

An integral part of providing credit ratings of RMBS is the ability to forecast mortgage collateral credit losses. Collateral credit losses directly affect RMBS investor cash flow obligations, the ability of the RMBS to make timely payments of principal and interest, and therefore, RMBS credit ratings.

As of September 2008, Moody's approach to projecting mortgage collateral credit loss appears to have included loss development-based techniques, among other methods.[17]

Moody's loss-curve-based loss projection for each pool (i.e., cohort of loans) consisted of three components:

(1) The pool's realized cumulative losses to date.

(2) The projected losses for the next 18 months associated with loans that are currently delinquent (the "pipeline" losses).

(3) The projected "future losses" on loans that are not currently delinquent, plus the projected losses beyond the next 18 months associated with loans that are currently delinquent.

Moody's approach to projecting ultimate loss rested more or less on an approach akin to the incurred loss development technique[18] with slight tweaks but still readily identifiable as analogous to an incurred loss development technique. Item (1) above is the same as cumulative paid losses where the paid loss data is organized as a cumulative paid loss triangle with vintage quarters in one column to the left and cumulative paid loss development since vintage reading from left to right. Figure 8 presents a vintage cumulative paid loss development triangle but without specific numbers, which is due to limitations of distribution.

Figure 8: Illustrative Vintage Cumulative Paid Loss Development Triangle

Cumulative Paid Losses										
	Development Since Vintage									
Vintage	1	2	3	4	5	6	7	8	9	10
1	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
2	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	
3	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		
4	XXX	XXX	XXX	XXX	XXX	XXX	XXX			
5	XXX	XXX	XXX	XXX	XXX	XXX				
6	XXX	XXX	XXX	XXX	XXX					
7	XXX	XXX	XXX	XXX						
8	XXX	XXX	XXX							
9	XXX	XXX								
10	XXX									

Item (2) is comparable to case reserves. In fact, mortgage guaranty insurers establish reserves for delinquent loans—however, not only for the next 18 months of payments on delinquent loans. Delinquency is considered to be the occurrence for purposes of accruing a loss reserve.[19]

The sum of Items (1) and (2) is essentially cumulative incurred losses. In order to derive a loss curve that is essentially the incurred loss curve, the paid loss curve is chosen and accelerated 18 months. Loss curve refers to "the expected percentage of a pool's ultimate losses that will be realized at a given point in the life of the pool."[20]

In other words, loss curve is the reciprocal of cumulative loss development factors. It is not clear how Moody's derived their paid loss curve, but one can be derived from the cumulative loss development factors.[21] The paid loss curve is accelerated 18 months and is meant to represent the incurred loss curve with the assumption that the amounts derived in Item (2) above will be paid within 18 months of the evaluation.

Given the challenges involved with analyzing mortgage guaranty insurance loss data and the importance of path dependence,[22] Moody's does offer a solution for easing data handling, but this segregation of case reserves between those associated with defaults in the next 18 months and those beyond would not be consistent with mortgage insurance accounting.

In order to project ultimate losses on loans that are not currently delinquent, plus the projected losses beyond the next 18 months associated with loans that are currently delinquent, the sum of Items (1) and (2) (i.e., essentially cumulative incurred losses) is divided by the corresponding incurred loss curve. Item (3) is then calculated as the difference of the quotient minus the sum of Items (1) and (2).

The remaining difference between Moody's approach and the loss development technique of actuaries was one of terminology. Actuaries refer to the approach as the "loss development

technique," whereas structured finance practitioners refer to it as the "loss curve-based loss projection." Actuaries rely on cumulative loss development factors and take the product of cumulative loss times cumulative loss development factors to calculate ultimate loss, while structured finance practitioners take the quotient of cumulative loss divided by the loss curve to calculate lifetime cumulative loss. The loss curve is comparable to the reciprocal of a cumulative loss development factor.

It is worth noting that Moody's has introduced a loss methodology relying on not only a loss development technique, but also on underwriting characteristics and economic projections. Moody's loss methodology can be broken down into five steps (the paper cites four steps, but there appear to be five listed).[23] The loss methodology for first lien subprime RMBS is summarized in the following steps:

Step 1: Delinquency projection to near-term distress period.

Step 2: Calculating the rate of new delinquencies.

Step 3: Calculating future delinquencies after near-term distress period.

Step 4: Calculating losses from delinquencies.

Step 5: Modification adjustment.

Step 1 is a mix of both development and collateral-based projection methods, the latter being a regression model based on key loan-level credit characteristics and economic forecasts. However, Steps 2 and 3 rely fundamentally on the development technique. Step 2 notes,

> To forecast future defaults after the near-term distress period, we first calculate the rate of new delinquencies that occurs during the near-term distress period… The rate of new delinquencies is the annual change in serious delinquencies during the near-term distress period divided by the balance of loans that are contractually current or 30 days delinquent at the beginning of the near-term distress period.

Step 3 continues, "Project additional annual delinquencies for seven years after the near-term distress period, by decelerating the rate of new delinquencies calculated in Step 2 to reflect the expected incremental improvement in future economic and housing conditions." The component of Step 2 is derived using both development and collateral-based projection methods, the components of Step 3 are derived by changes in the component of Step 2, basically a development approach. Step 4 leverages frequency projections from Steps 1 through 3 and severity estimates to calculate loss amounts, while Step 5 acknowledges major mortgage industry reform aiming to curb mortgage

credit losses; programs such as Home Affordable Modification Program (HAMP), principal write-down, foreclosure moratorium, etc.

There are other examples of practitioners referring to the loss development methods in connection with mortgage credit risk analysis. In *Subprime Mortgage Credit Derivatives*,[24] the authors advocate a pseudo-incurred loss development method similar to Moody's described above. They recognize econometric/statistical models for forecasting mortgage collateral credit loss, but focus their description of a methodology fully on the pseudo-incurred loss development method, termed an "autopilot model" because it is "more straightforward; it is completely transparent, with no hidden assumptions," replicable, and driven by loss performance.

The autopilot model is summarized in five steps:

Step 1: Convert 60-, 90+-days delinquent and bankruptcy loans to pipeline default.

Step 2: Calculate the default pipeline as percent of the current balance.

Step 3: Calculate the total default as a percent of the original balance.

Step 4: Project the cumulative default from default timing curve and total default.

Step 5: Project the cumulative loss.

The autopilot model is similar to Moody's loss curve projection model except for some subtle difference and terminology. The case reserve portion for Fabozzi and his team represents projected lifetime losses (not just for the next 18 months) for loans that are currently delinquent. The loss curve is accelerated an amount of time consistent with the average transition time from delinquent to default. Nevertheless, this approach is a development method. However, Fabozzi's team appears to advocate reviewing indications of assumptions by homogeneous key economic assumptions, particularly home price appreciation (more on that below).

There are also examples of investors holding non-agency RMBS that appear to be utilizing loss development techniques for valuing mortgage collateral underlying RMBS. According to their Sept. 30, 2009, SEC 10Q, Old National Bancorp (ONB) owns non-agency RMBS with a market value of $184 million. There is not enough text to draw conclusions with certainty about the robustness of their loss methodology, but the excerpt below leads us to believe that ONB relies on a loss development technique with assumptions based on limited risk segmentation of loan-to-value (LTV), property location, and loan status (i.e., healthy vs. seriousness of delinquency):

> …a detailed analysis of deal-specific data was obtained from remittance reports provided by the trustee and data from the servicer. The collateral was broken down into several distinct buckets based on loan performance characteristics in order to apply different assumptions to each bucket. The most significant drivers affecting loan performance were examined including original loan-to-value ('LTV'), underlying property location and the loan status. The loans in the current status bucket were further divided based on their original LTV: a high-LTV and a low-LTV group to which different default curves and severity percentages were applied. The high-LTV group was further bifurcated into loans originated in high-risk states and all other states and a higher default-curve and severity percentages were applied to loans originated in the high-risk states. Different default curves and severity rates were applied to the remaining non-current collateral buckets.

The authors have also utilized loss development techniques for analyzing mortgage credit risk, as well as other methods. In doing so, we have gained an appreciation for techniques that can augment such analyses in light of the limitations discussed above.

2.4 Some Suggestions for Practitioners in Coping with the Development Method Limitations

The loss development technique is a method that's easy to use and should be considered when performing mortgage credit loss analysis, but generally should not be relied upon solely. Other approaches that should be considered include econometric models, Bornhuetter-Ferguson (B-F),[25] Berquist-Sherman,[26] and Barnett-Zehnwirth.[27]

For example, we suggest that one approach for estimating future mortgage credit losses in light of the considerations we have outlined is to include not only the development techniques, but also B-F methods and econometric models with suitable adjustments. The keys to the B-F method are a priori estimation of loss and loss emergence patterns. The loss pattern can be derived from the loss development factors of appropriate mortgage pools with any adjustments that the practitioner deems appropriate in light of economic conditions. The a priori is based on the ultimate loss estimates derived from the proposed econometric technique coupled with a loan-level assessment of the underwriting characteristics of the subject loan pool.

B-F techniques can be particularly valuable to provide a more stable estimate of ultimate loss rates in situations where loss development is volatile, substantial, and/or immature, and yet, provide a forecast that is responsive to economic conditions by grounding the a priori indication to economic conditions and forecasts. The B-F approach is particularly useful for mortgage credit loss projections because of the long-term nature of the risk and its ability to blend the unfolding loss

development experience with a forecast of future loss development that is responsive to the underwriting characteristics of the loans remaining in the collateral pool along with economic risks to which those loans are exposed.

For example, the practitioner has the ability to adjust the forecasted losses for changes in persistency rate of the cohort of loans and changes in the nature of the risks as the run-off of terminated loans changes the risk profile of the block of loans remaining in the collateral pool. Specifically, the analyst can adjust the a priori ultimate claim or loss rate utilized to project future loss emergence in order to better reflect the faster-/slower-than-expected terminations of loans and changes in book risk profile for recent years, as well as biases that can exist in the loans that remain compared to those that terminate. This suggests two important adjustments:

(1) The exposure duration for mortgages can vary significantly depending on termination rates. During periods of robust growth in credit availability and increasing home prices, subprime mortgages pre-paid at rapid rates. This had the effect of accelerating the loss emergence curve (LDF pattern) and decreasing the ultimate level of losses due to shorter exposure to default losses. After the crisis, the voluntary pre-payment rate (i.e., excluding defaults) on subprime mortgages has plummeted and this has lead to a longer exposure to loss and a greater exposure to loss. This might suggest a corresponding adjustment to the length and shape of the emergence curve, as well as the a priori default rate or loss rate.

(2) The B-F is concerned with forecasting future default losses indicative of the underwriting characteristics of loans that remain in the collateral pool, as well as the economic environment to which those loans will be exposed. This highlights the importance of re-selecting an a priori rate that reflects the underwriting characteristics of the remaining pool and the forecasted future economic environment. Importantly, there tends to be a negative bias in the quality of loans that remain after loans voluntarily terminate from refinancing activity. When changes in the nature of these voluntary pre-payments occur, this can cause significant distortions that should be considered.

Thus, the econometric types of approaches to establishing the a priori default rate or loss rate should consider loan-level collateral characteristics, aggregate portfolio persistency, and forecasts of key economic variables.

There are a host of loan-level collateral characteristics available to the actuary for calibrating a regression model. The underwriting characteristics can be categorized as those relating to the

borrower, loan, and property. Fabozzi et al. identify characteristics to consider for collateral-based modeling: borrower FICO, LTV, documentation type, loan purpose, and loan size. Dihora, Mrotek, and Schmitz identify the variables borrower FICO, LTV, presence of interest-only or negative amortization option, loan purpose, property type, occupancy, documentation, loan size, and amortization.[28] Moody's updated loss methodology incorporating collateral-based projection relies on the following characteristics: loan type (fixed/adjustable), purpose, occupancy status, property type, vintage, origination FICO score, loan amortization (interest-only or principal-and-interest), loan origination, and updated LTV ratios. FitchRatings variables are credit score, credit sector, LTV, documentation type, property type, product type, loan term, prepayment penalty, occupancy, debt-to-income ratio (DTI), loan balance, and loan purpose.[29]

Needless to say, there are many other publications available addressing loan-level characteristics to consider for mortgage credit loss modeling. Oftentimes, the analyst is limited to using characteristics represented in the data set. Havlicek/Mrotek reviewed the LoanPerformance mortgage securities data set, for example, where all underwriting fields deemed to be well populated were found to be statistically significant.[30] These fields were LTV, FICO, interest rate delta, loan product, property type, loan purpose, foreclosure type in state, loan term, documentation type, lien position, presence of negative amortization feature, occupancy, prepay penalty, and loan size.

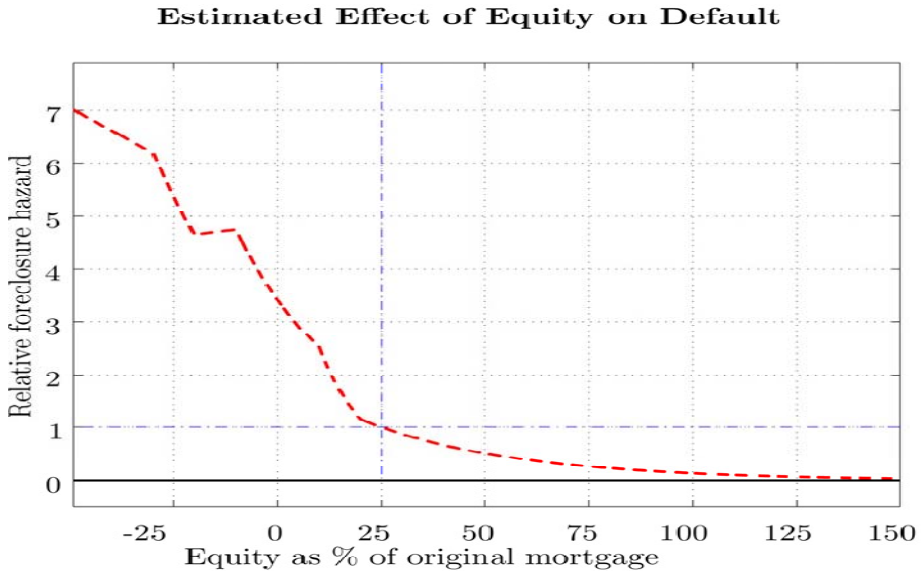
In addition to underwriting attributes, it is critical to include forecasts of key economic variables. Three economic variables often mentioned when modeling mortgage credit losses are home price appreciation, unemployment, and interest rates.

Home price appreciation is the most critical of the economic forecasts. Laurie Goodman, co-author of "Negative Equity Trumps Unemployment in Predicting Defaults," in testimony to Congress about her paper said, "The evidence is irrefutable. Negative equity is the most important predictor of default."[31]

Figure 9 charts the relative foreclosure hazard (y-axis) as a function of equity as a proportion of the original mortgage (x-axis). The independent variable in this chart is more or less the aggregate result of combining original LTV, home price appreciation (HPA) from origination through evaluation, and principal payments. Original LTV is addressed in the underwriting attributes and relative principal payments in the peak loss years tend to be small, which indicates that HPA is a major driver. When a borrower has 25% or more equity in their property, the relative foreclosure hazard is relatively inelastic. Basically, there tends to be enough equity to insulate the lender from

loss because the borrower's equity acts as a buffer against first loss. But as equity declines from 25% to negative equity, relative foreclosure hazard increases markedly.

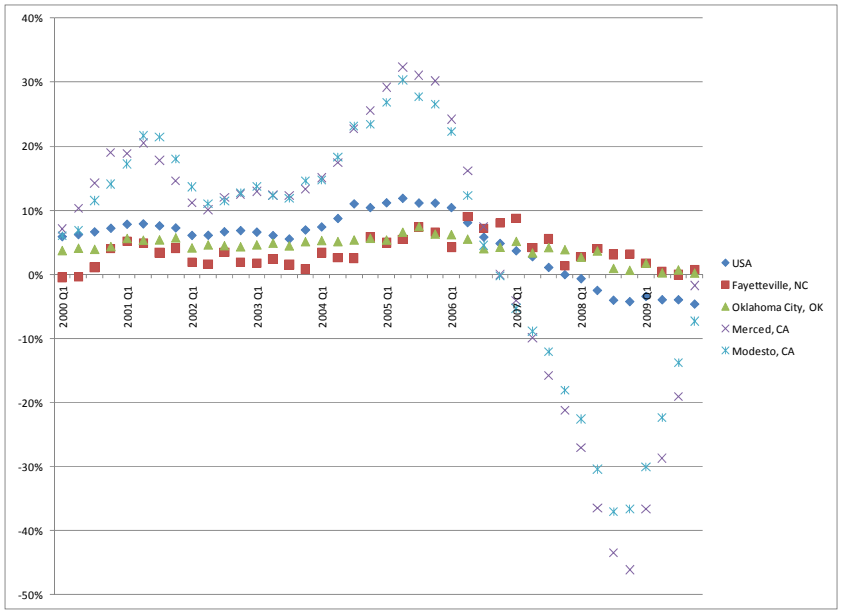
Figure 9: Estimated Effect of Equity on Default



Source: Foote et al., "Negative Equity and Foreclosure: Theory and Evidence."[32]

When considering home prices forecasts, it is important to rely on those at the most granular level available. Home prices vary significantly by region. There are nearly 400 metropolitan statistical areas in the United States.[33] For properties not in metropolitan areas, the home prices of the state can act as a substitute. Figure 10 illustrates the Federal Housing Finance Agency (FHFA) variations in home prices by four different metropolitan areas against the aggregate of the United States. It highlights the variation between geographical regions, particularly that while some regions are experiencing modest increases of a few points per year, others can experience double-digit changes, either positively or negatively. This difference in underlying economics can lead to materially different mortgage credit performance. Note that these changes in home price are for the 12 months leading up to the evaluation date. For example, the 32% annual home price appreciation for Merced, Calif., as of 2005-Q2 was for the 12 months July 2004 through June 2005.

Figure 10: FHFA Changes in Home Price Indices by Selected Metropolitan Area and U.S.



Source: Milliman, FHFA All-Transactions Indexes through 2009-Q4

Forecasts of home prices by metropolitan area, state, or just the United States, can be purchased from economists or internally developed and incorporated into mortgage credit loss projections. The forecasts from economists tend to be released quarterly and the future periods are also quarterly. Two providers of this data include Moody's Economy.com and Global Insight. Several trade groups publish forecasts of home prices, but the level of granularity is much more limited, typically only covering large geographies and limited time periods. The Mortgage Bankers Association, National Association of Realtors, and *Wall Street Journal* surveys of economists are free sources.

Unemployment is another variable to consider. Moody's identifies change in unemployment rates over a six-month period as an input into their modeling.[34] For obvious reasons, common sense suggests unemployment might be a predictor of mortgage credit losses. Borrowers without jobs and income, all things being equal, will have more difficulty making mortgage payments and therefore heading down the path to default. However, whereas home price appreciation tends to have a macro impact on house prices and therefore borrower equity, unemployment tends to be more binary. Borrowers are either employed or unemployed (admittedly, this can be a definition with gray areas such as underemployment).

Several studies indicate that unemployment is not a statistically significant predictor of mortgage credit losses. The Mortgage Insurance (MMI) actuarial report of the Federal Housing Administration (FHA) for fiscal year 2007[35] cites a weak link between unemployment and mortgage credit losses:

> As described in the FY 2006 Review, we previously undertook to develop a measure of changes in metropolitan area unemployment rates. Data on metropolitan area unemployment rates were obtained from the Bureau of Labor Statistics and converted into times series from which we computed a dynamic measure for the percentage change in the unemployment rate over the preceding year. The unemployment rate variables did not perform well in any of the preliminary models that were estimated, and have not been included in the final model specifications. No consistent pattern was observed between mortgage claims and increases in local area unemployment rates, in contrast to the strong relationship between loan performance and borrower equity. This outcome is consistent with prior experience using this variable in loan-level models in which borrower behavior is more strongly linked to changes in the borrower's equity position or changes in the value of the mortgage instrument due to changes in interest rates. Changes in these variables have a direct impact on property and mortgage values, whereas the local area unemployment measure has a much weaker connection to individual borrowers.

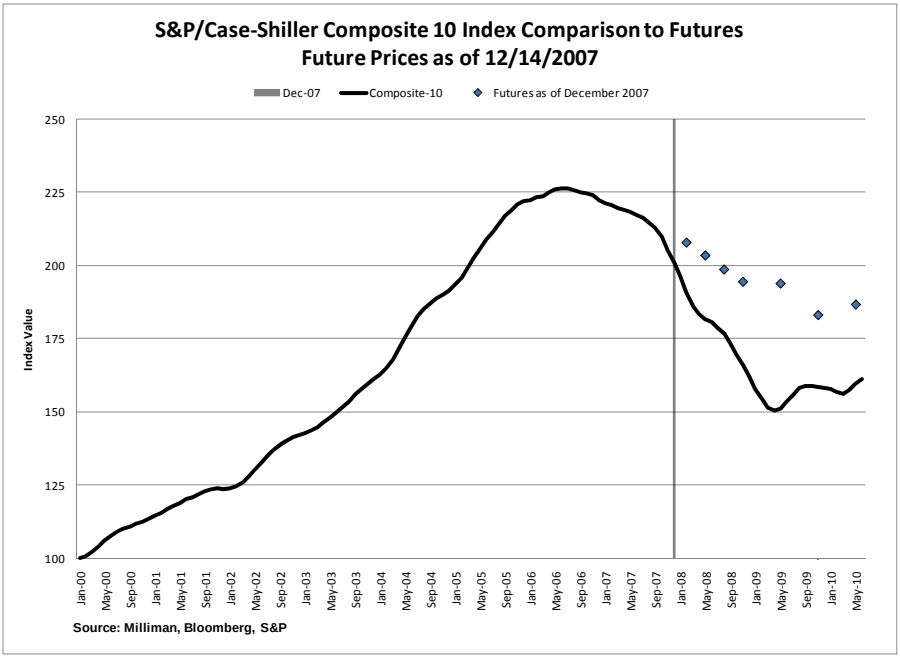
Laurie Goodman, in her testimony to Congress, also speaks of unemployment's role in predicting mortgage defaults, saying, "If a borrower has positive equity, unemployment plays a negligible role. We found that all borrowers with positive equity performed similarly no matter the local level of unemployment."[36]

Therefore, HPA tends to receive more attention when forecasting mortgage credit losses. The implications of the relationship between foreclosure and negative equity illustrated in Figure 9 suggest the highlighted importance of reflecting home price appreciation or depreciation in calibrating mortgage credit risk models. When home price appreciation is strongly positive, as it was leading up to the peak in 2006, borrowers from the early 2000s with even small down payments (i.e., high loan-to-value (LTV) ratios) quickly found themselves with significant positive equity, which permitted them to refinance or at least took them down into the relatively inelastic portion of the graph above where relative foreclosure hazard is low. On the other hand, when home prices began to drop in late 2006, many borrowers with higher LTV ratios who took out loans near the top of the market found that their equity evaporated quickly and then turned markedly negative, and this had a dramatic effect on default risk as borrowers slid up the graph on Figure 9 toward the higher hazard multiples.

Econometric modeling should thus pay keen consideration to home price changes for forecasting mortgage credit losses. The original LTV ratio establishes an estimate of starting equity position. Beyond that point in time, it can be valuable to incorporate an estimate of the change in home price since loan inception. This can be accomplished using the changes in home price indices from loan inception to current evaluation date and then augment this with a forecast of future price changes over the default loss forecast horizon. Ideally, this should be done at the loan level, using as granular an estimate of home price changes since inception as possible.

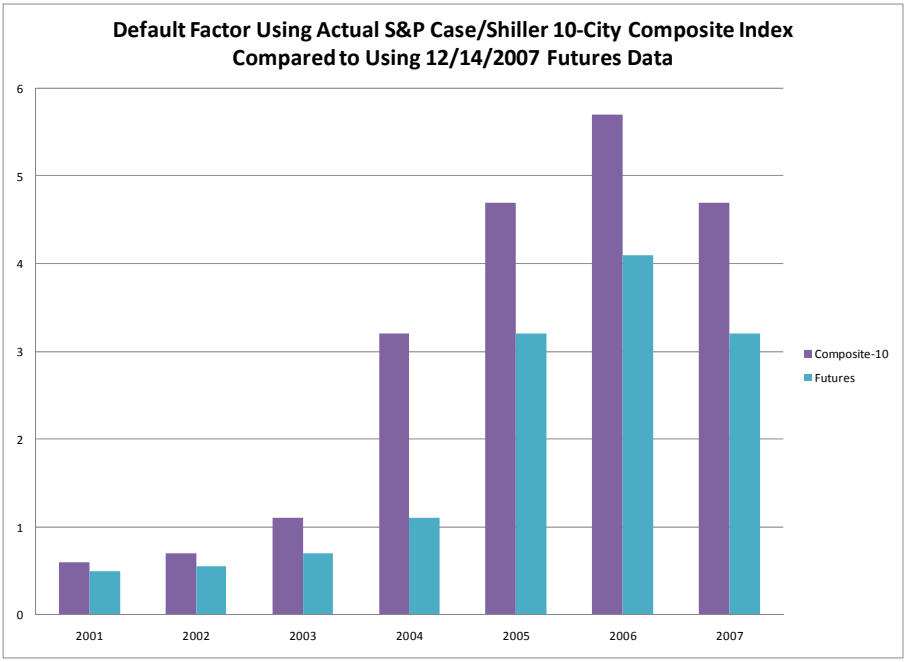
However, a simple illustration of this relationship is instructive based on the implied average equity position derived from using the starting LTV ratio for the composite average subprime vintages, as illustrated in Figure 3. We take these average LTV ratios by vintage as the starting equity position and then adjust for price changes implied by the S&P Case-Shiller 10-city composite index since loan origination (i.e., ignoring amortization and assuming uniform loan originations during the vintage year). Figure 11 shows the home price path for the 10-city composite index. The actual change in the 10-city index is shown along with the futures values implicit forecast valued at December 2007. It is interesting to look at these contrasting paths, since the futures values can serve as one barometer of forecasted price changes that might have been used by a practitioner at the end of 2007, while the actual index path can show the resulting forecast with perfect knowledge of home price changes for the index.

Figure 11: S&P/Case Shiller Composite 10 City Index, CME Futures and Actual



As seen in Figure 11, the home price depreciation from peak to trough was considerably more severe than that suggested by the futures values as of December 2007. Specifically, the peak to trough drop in the actual index from the graph is approximately 34%, while the December 2007 futures values suggested an approximate 19% peak to trough decline. This suggests that the default rates projected using the actual home price changes will certainly be higher. We estimate the equity position at the bottom of the market implied for the average combined LTV from Figure 3 adjusted for the change in home prices since inception. Based on these average equity position proxies, Figure 12 compares relative default rate multipliers using the relative foreclosure hazard relativities from Figure 9 (the base of 1.0 for this graph is identical to that from Figure 9, which represents 25% equity, or an LTV of 75%).

Figure 12: Default Factor Using Actual Index Versus Futures



Clearly, there is a high degree difference in mortgage credit risk propensity by vintage due to economic factors alone at the bottom of the house market, as suggested by this exercise. Furthermore, the deeper actual index declines to trough relative to those suggested by the futures values at December 2007 lead to a significantly higher default rate multiplier. This illustration simply represents the relative default propensity at the trough, though the practitioner may be interested in the relative propensity over the forecast horizon when calibrating the a priori default or loss rate for the B-F method. Despite the over-simplicity of this illustration, it is indicative of the strong impact that home price changes can have on default propensity, and thus, the importance of consideration in this type of analysis.

3. Conclusion

The increased attention on independent mortgage credit risk analysis represents an opportunity for actuaries knowledgeable in this area. As actuaries, we often consider loss development techniques to be a valuable tool and some practitioners rely at least in part on these methods for projecting mortgage credit losses. When doing so, it is critically important to consider the characteristics of mortgage loans and the economic conditions to which the loans are exposed. As

casualty actuaries are aware, the LDF method has inherent limitations associated with immature development. Methods relied on for projecting mortgage credit losses should properly consider loan-level underwriting characteristics related to the borrower, property, and loan, and to key economic variables. As one example, B-F methods can be adapted to reflect these considerations.

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[Note: One subtle difference between Moody's provision for pipeline losses and insurance case reserves is that Moody's pipeline losses are for defaults in the next 18 months, associated with currently delinquent loans, whereas insurance case reserves are losses associated with currently delinquent loans that remain delinquent continuously until default. Put differently, losses on defaults in the next 18 months associated with currently delinquent loans that will become healthy (i.e., not delinquent), then go delinquent again later on and eventually default within 18 months should not be reflected in case reserves on currently delinquent loans (in mortgage insurance). But this amount

would be accounted for in Moody's pipeline losses.]
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Acknowledgment

The authors acknowledge the members of the CAS's Committee on Valuation, Finance, and Investments for their editorial comments and coordinating the Call Paper Program. Additionally, the authors acknowledge Jonathan Glowacki, Paul Keuler, Debbie James, and Virginia Davis for their contributions to research, analysis, and document preparation.

Biographies of the Authors

Michael Schmitz is a Principal and Consulting Actuary in the Milwaukee office of Milliman and has been with the firm since 1993. Mike manages a practice dedicated to financial risks such as mortgage guaranty, financial guaranty, and credit enhancement products. He is a Fellow of the CAS, Member of the American Academy of Actuaries, and President and co-founder of the CAS's Credit Risk Special Interest Section.

Kyle Mrotek is a Principal and Consulting Actuary in the Milwaukee office of Milliman. Kyle provides actuarial consulting services to insurers, financial institutions, investors, and government agencies on issues relating to both credit risk and traditional property/casualty exposures. He is a Fellow of the CAS and a Member of the American Academy of Actuaries.