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Countercyclical Capital Regime: A Proposed Design and Empirical Evaluation*

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Abstract

Motivated by the Great Recession in 2008, countercyclical capital regimes are now being considered by financial regulators. Here we offer both a specific design of a countercyclical capital regime and present an empirical examination of how it might have worked had it been applicable to Fannie Mae's book of fixed-rate 30-year loans acquired during the period 2002 through 2010, which constituted the bulk of their credit exposure during that period. Our design for a countercyclical capital regime is relatively straightforward and could be easily implemented by regulators or financial institutions as part of their economic capital models. Our empirical results show that had this regime been imposed on Fannie Mae in 2002, their capital requirements would have increased dramatically in the early years of the house price bubble, 2003-2005, and then decreased during the decline of the bubble as should happen with a countercyclical capital regime. Also, we find that the stress test embedded in our approach would have been sufficiently stressful to have required enough capital at acquisition to fully capitalize the mortgages against lifetime losses. Had the countercyclical requirements been in place, Fannie Mae would have been incapable of, or severely deterred from, obtaining the required additional capital to allow for the acquisition of those loans that in actual fact resulted in substantial losses equal to several times their historic capital levels. Such higher capital requirements, had they been met, would had to have been accompanied by higher prices or guarantee fees as well in order to generate sufficient returns on that capital. If applied broadly to the mortgage market, the countercyclical capital regime could have significantly reduced the quantity demanded for housing, and thereby mitigated the amplitude of the house price bubble.

Countercyclical Capital Regime:
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Background.

The experience of the Great Recession has prompted new proposals on how to design and implement a countercyclical capital regime.[1] However, with the exception of a few theoretical exercises and the limited real world experience with dynamic loss provisioning programs, empirical examinations of how a countercyclical capital program might actually work are absent. Here we offer both a specific design of a countercyclical capital regime and present an empirical examination of how it might have worked had it been applicable to Fannie Mae's book of fixed-rate 30-year loans acquired during the period 2003 through 2010, which constituted the bulk of their credit exposure during that period. We find that this countercyclical regime would have resulted in a rapidly escalating capital requirement well prior to the bursting of the housing price bubble. Fannie Mae, in all likelihood, would have had difficulty raising enough capital to keep pace with that capital requirement, and consequently would have been discouraged, if not prevented, from acquiring loans which have since resulted in losses of over $100 billion, more than sufficient to have exhausted Fannie Mae's actual capital at the time by three times over. The higher capital requirements would have also required Fannie Mae to raise prices or guarantee fees significantly in order to generate sufficient returns on that capital. Had the countercyclical regime been applied broadly, the likely outcome of such higher prices, combined with a higher capital requirement, would have been to lessen the demand for loans by borrowers and mortgage credit risk takers like Fannie Mae sufficiently to have mitigated the housing price bubble. Alternatively, in the event that Fannie Mae, or any firm, had been able to meet the capital requirement required under

[1] Overviews are provided by Galati and Moessner (2011), Repullo and Saurina (2011), and Elliot (2011), among others.

our proposed regime, they likely would have maintained a positive level of capital throughout the crises.

Crowe et. al. (2011) state that the two main objectives of any countercyclical capital regime are preventing real estate booms and, should a boom occur in any event, increasing resilience of the financial system to the subsequent real estate bust. The proposal described in the Basel Committee on Banking Supervision (BCBS) Consultative Document (2010), which provides for a countercyclical capital add-on to the capital conservation buffer in keeping with the Basel III guidance, is less ambitious in stating "The potential moderating effect on the build-up phase of the credit cycle should be viewed as a positive side benefit, rather than the primary aim of the proposal."

Countercyclical regimes can extend to more than just capital requirements. Adjustments to underwriting standards, provisioning rules, or prices in terms of mortgage rates, guarantee-fees (compensation for taking credit risk) or equivalents also might achieve the same outcome as a countercyclical capital regime. However, countercyclical capital requirements need to be in place in any event to properly gauge these other adjustments. In this regard, countercyclical capital requirements can be viewed as the driving force inspiring adjustments to underwriting standards in order to reduce the capital requirement, or adjustments to mortgage rates or guarantee-fees in order to raise capital.

Among concerns raised in the literature with recent proposals, including the Basel III design, are that some would rely on the discretion of the supervisory authorities to implement the countercyclical adjustments to capital requirements, underwriting limits, or provisioning rules. As suggested by Crowe et al., Kowalik (2011), and Repullo and Saurina (2011), implementation of discretion based approaches can be subject to circumvention, delay, and inconsistency because they rely on supervisory judgment. Further, such judgment may be influenced by pressures sure to be imposed on supervisory authorities by the business and political communities. Of course rules can be changed, but a rules-based approach stands a better chance of being applied consistently and in a timely manner, and will be more insulated from the pressures of affected parties.

Another concern with alternative approaches is with the reference measure used to gauge the countercyclical capital adjustment. Wezel (2010) reviews the provisioning regimes of several countries and concludes that their reliance on historical data to adjust provisioning amounts could lead to over or under provisioning depending on how the reference historical cycle compares to the next actual cycle. The BCBS Consultative Document follows the recommendation of Drehmann et al. (2010) to use the credit/GDP gap (difference from trend). Repullo and Saurina are critical of the selection of the credit/GDP gap as the reference point, and conclude instead that credit growth (deviations from long-run average) would be a much better reference point. Drehmann et al. also looked at property prices as a potential reference point and found that it performs well in identifying the build-up phase for capital but would not do well in the release phase (releasing capital too early).

The design of our regime is focused on addressing the capital requirements applicable to holders of credit risk associated with mortgage assets. Mortgage assets are of primary importance in the design of any countercyclical capital regime because, as Crowe et. al. describe, banking distress episodes typically are associated with property price bubbles. Our design may well be adapted to other types or categories of assets, but any countercyclical regime applied to the U.S. should be made to work for mortgage assets given their magnitude and associated credit risk in the U.S. economy.

Outcome-Related Design Goals for a Countercyclical Capital Regime

The idea of a countercyclical capital regime is to avoid situations where additional capital is required but uneconomical to obtain. We decompose this idea into outcome related design goals of full capitalization, deterring risk exposure, and allowing capital to absorb losses as intended.

Fully capitalize at acquisition: The idea of a countercyclical capital regime is to require a firm to raise sufficient capital during the upswing of a price bubble so that it need not raise capital during the downswing, when to do so would be expensive or otherwise impractical. This clearly implies that assets should be fully capitalized at time of acquisition.

Capital requirements must significantly increase during credit expansion: Full capitalization at acquisition aligns with a rising capital requirement during the upswing of the asset price bubble. The rising capital requirement, if modeled appropriately, will increase at a rate faster than the pace at which the asset prices (housing prices) are rising above long-run trend. At some point during the upswing, the increase in the capital requirement should be high enough to deter the firm from acquiring additional mortgage assets, and thereby limit its risk of future losses to a manageable level. Correspondingly, price increases that would accompany any such increase in capital requirements would deter borrowers from obtaining the loans in the first place. If all firms are subject to the same countercyclical capital requirement, then as the upswing progresses, all firms will become deterred from acquiring additional mortgage assets. The combined effect of the price increases and higher capital requirements will be to dampen quantity demanded--thus curbing the upswing and ultimately reducing the amplitude of such housing price cycles. As a result, the capital requirements for a given firm may never actually become excessive, as the firm would be prevented or deterred from acquiring the riskier assets to begin with. Simultaneously, as the housing price cycle is dampened in response to the countercyclical capital regime, the risk to the financial system is also abated. If a sufficient portion of all institutions are subject to the same countercyclical capital regime it is possible that the system would correct itself and prevent price bubbles from occurring.

Capital requirements must be allowed to fall as appropriate: The idea of fully capitalizing a loan at acquisition is based on being able to model the expected lifetime losses of that loan. As the loan ages and assuming it remains current, those expected lifetime losses will decline, ceteris paribus. Therefore, the associated capital requirement should also decline. Letting the capital requirement decline as dictated by the loan-level loss estimation obviates the need to invent a capital release trigger as contemplated by the Basel III proposal.

Implementation Design Goals

A countercyclical capital regime has a better chance of acceptance if it is straightforward in design, risk-based to achieve credibility, and applied with certainty. We designed our approach to be responsive to these implementation design goals.

<u>A simple and transparent stress scenario</u>: The grand potential of a countercyclical capital regime, to mitigate asset price cycles, can be achieved only if it is applied broadly to encompass the vast majority of the market volume. Clearly, a general or broad applicability is best achieved with a simple design of the stress scenario. A simple stress scenario should be based on the movement of a single key economic measure, or reference measure, relative to its long-term trend. For mortgage assets, severe credit losses track directly to decreasing housing prices, therefore the housing price index (HPI) is the preferred reference measure. Any stress test or countercyclical shock based on an HPI would be transparent to all market participants.

<u>Requirement must reflect risk of the assets</u>: In order to fully capitalize the assets at acquisition, the capital requirement must reflect the specific risk characteristics of the assets as they interact with a reasonable, yet worst-case, financial stress. The key risk-related characteristics of a mortgage asset, such as loan-to-value (LTV) ratio, Fair Isaac (FICO) credit score, etc., are known at the time of acquisition. The worst-case financial stress, or HPI shock, will not be known with certainty, but can be reasonably approximated by reliance on fundamental economic relationships. Consequently, the interaction of the risk-related characteristics and the HPI shock scenario can be modeled at the time of acquisition. This will result in an estimate of potential lifetime losses that approximates the amount necessary to fully capitalize the asset.

Rules-based implementation: In our view, a countercyclical capital regime that fully capitalizes assets at acquisition should be rules-based or non-discretionary. Using discretion, even if anchored by a reference measure, could lead to inadequate adjustments in capital requirements because of the much greater likelihood for any combination of delay, political or industry influence, or simple incompetence in assessing the reference measure and other available data. We note that between 2005 and well in to 2008, public comments of financial institution regulators generally suggested that national measures of housing prices would not fall appreciably, if at all, and that they did not expect significant spillovers from the troubled subprime sector to the rest of the economy.

Our design relies on having the capital requirement at acquisition adjust automatically via the applied HPI shock. Further, we intend that the HPI shock will be reapplied to a given cohort of loans on a going forward basis such that the eventual release of capital (reduction in the requirement) can be appropriately gauged (in a rules based approach) to a comparable stress level as applied to the aging cohort of loans.

Countercyclical Shock Design

The shock to the HPI that we impose is based on the premise that housing prices will revert to trend at some point, but travel beforehand to a defined level below trend. The amount above trend in any time period roughly gauges the severity of the shock that should be applied to acquisitions at that point in time. In that regard, the shock path is not dependent on recent or past cycles per se, as in the dynamic loan-loss provisioning approaches' design. In fact, our shock design is roughly similar to the reference measure suggested in the BCBS Consultative Document for determining whether to implement the countercyclical buffer add-on. Recall that Drehmann et al. found that property prices performed very well as conditioning variables for the accumulation of capital phase.

HPI Trend: After examining the HPI data for the United States (the weighted average of all 50 states plus Washington D.C.) we conclude that December 2001 is a reasonable cutoff for estimating trends to date because house prices from 2002 forward form an incomplete cycle where real HPI has risen above and then fallen below trend, but as yet has not recovered fully back to trend. Including data from an incomplete cycle would of course bias the estimated trend. We use the national cycle to determine a data cutoff date for the state-level trend determinations in order to avoid having to determine a cutoff date on a state-by-state basis. This simplification should not significantly affect the results because the most recent housing boom has been more national in nature such that most states have experienced similar starting dates for their most recent price cycle. For each state, we estimate a long-run exponential trend using data from January 1975 through December 2001. The specific weighted regression model used is:

$$\frac{RealHPI_i}{w_i} = \alpha(1+\beta)^{\frac{MonthNumber_i}{w_i}} + \frac{\varepsilon_i}{w_i}$$

where α is the initial level of real HPI,[2] β is the constant monthly growth rate, the exponent *MonthNumber* is 1 in January 1975 and increases by 1 for each month, and ε is the error term. Each observation of real HPI is weighted by w_i , its standard deviation of each monthly (i) estimate of HPI.[3] We do this to avoid undue influence from volatile HPI estimates. For those few states for which the monthly growth rate is negative (Texas, Louisiana, Alaska) we set the growth rate to zero and determine the long-run trend level by taking an average of the HPI from 1975 to 2001. A negative trend is not plausible, particularly extended out 30 to 40 years as it would be in the HPI shock scenario.

The resulting exponential trend is but one option for calculating a trend. We also looked at a simple linear trend, which made little difference, and two more complicated procedures: the Hodrick-Prescott (HP) filter[4] and a cross-sectional model for long-run

[2] To convert nominal HPI into real HPI, we deflate the nominal HPI series using the CPI for all items less shelter (series id CUUR0000SA0L2). This series can be downloaded from the BLS website: http://data.bls.gov/cgi-bin/srgate.

[3] A typical consequence of the weighting is that the more recent years are likely to be weighted more heavily because there are more observations (transaction pairs) in those years, which translates into a lower standard deviation.

[4] Hodrick and Prescott (1997).

HPI proposed by Klyuev (2008).[5] Repullo and Saurina (2011) propose using a HP-filter to construct a trend in the credit-to-GDP ratio for the purposes of creating a discretionary counter-cyclical capital buffer. The HP filter splits a time series into cyclical and trend components, but is not suitable for our purposes because it does not produce a means to forecast the trend into the future which our approach requires. Similarly, the Klyuev model is not ideal for projection into the future because it requires predicting the future level of each underlying price driver. Further, resulting trends from both the HP Filter and the Klyuev model exhibit muted cycles, which we find to be conceptually inconsistent with the idea of a trend. When applying the HP filter to a real HPI series, the only way to remove cyclicality from the trend is to set the smoothing parameter close to infinity, which, as Hodrick and Prescott (1997) point out, then transforms the HP filter to a linear time trend.[6]

Shock Trough: For each state, we examine the 1975-2001 real HPI data to identify that level of real HPI which is the furthest below trend as a proportion of trend. This trend proportion is then used to determine the trough of the HPI shock to be applied to the current HPI level. We impose criteria to overcome situations of historical data spikes owing to insufficient observations. Specifically, we require that the trough determination only be based on downturns that were at least four years in length, and all one-month data spikes were smoothed in line with surrounding observations.

To ensure that the HPI shock would in fact be a downward shock, should HPI currently be at the trough or lower as we determined, we impose a constraint that the shock must reduce real HPI by at least five percent below its current level. Given that the recent downturn is both very severe and outside our data window for trough determination, we evaluate the reasonableness of our approach by examining the frequency and extent to which recent HPI levels may have breached our measure of the trough. We find that in recent years, and given the high severity of the current actual HPI

[5] Klyuev (July 2008). The model replicated is the reduced form of the "Long-Run" model described in the paper's "Asset price approach" section.
[6] Hodrick and Prescott (1997), Page 3

shock, real HPI has breached our measure of trough for only five states. Thus, we conclude that our method for determining the shock trough is reasonable.

Shock Path: We observe in the historical data that a real HPI decline or shock of any magnitude will not move HPI from peak to trough instantaneously. Instead HPI moves to trough over time with a specified pattern. Of the 50 states plus Washington, D.C., we found that, for the cycles that reduced real HPI to the furthest below trend historically, the pattern of the downturn was U-shaped for 28 states, V-shaped for 21, and W-shaped for two.[7] For all states, the average duration of the peak to trough and back to trend cycle was 9.9 years, and the average and median durations for the U-shaped states was 10.3 and 9.9 years.

Based on these results, we select a U-shaped real HPI shock path of 10 years duration. The shock begins in month one after the current period and is paced to take three years to reach the trough, then to remain at the level of the trough for four years during which it grows at the long-run trend growth rate, and finally to increase over three more years at a rate necessary to raise the level of HPI back to the level of the long-term trend. We refer to this shock path as a 3-4-3 pattern. Beyond these first 10 years of the shock cycle, HPI is assumed to grow at the long-term trend growth rate for the remaining maturity of the assets. Beginning the shock at the point or time of acquisition should result in the most conservative, or maximum, capital amount necessary to cover losses over the life of the asset, consistent with our design goal of fully capitalizing the assets at acquisition.

Depiction of the Shock Path: Figure 1 depicts the shock to real HPI at two different points in time, 2003 and 2005, as applied to California. For each point in time, real HPI is shocked to fall from its current level to the trough and back to trend following the 3-4-3 pattern. The shock severity (measured as peak to trough), and therefore the corresponding capital requirement, will clearly be greater as applied to loans acquired in

[7] By V-shaped, we mean that prices fall and then immediately begin a recovery back to trend. By U-shaped we mean that prices fall, hover around the trough close to a year at least, and then recover. By W-shaped we mean that prices fall, rise, and fall again prior to a recovery back to trend, and then recover.

2005 compared to 2003 acquisitions.   For the 2003 loans, when evaluated in 2005 they will in effect be subject to about the same shock severity as they were initially in 2003. This is because the increase in the shock severity between 2003 and 2005 will be effectively offset by the appreciation (growth in HPI) since 2003.

Figure 1.

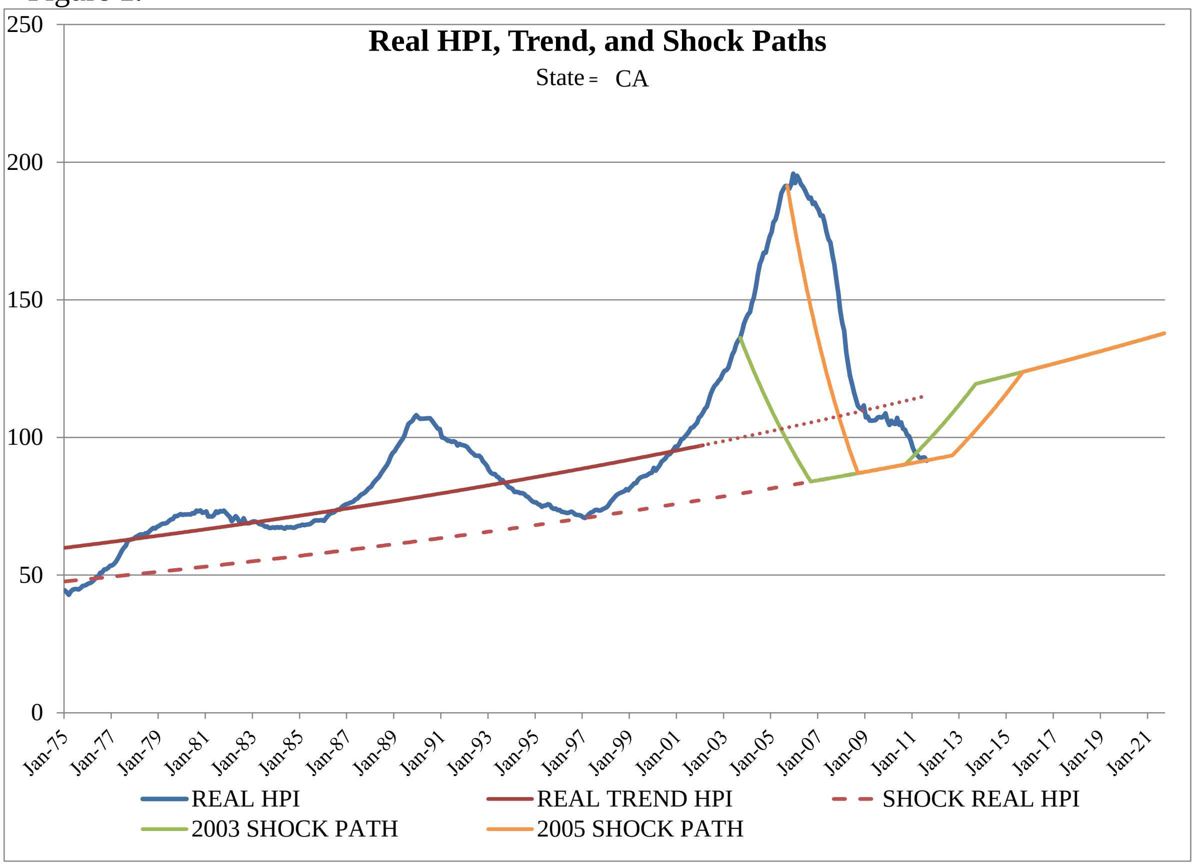

Table 1 shows how the shock severity varies across time, increasing during the upswing in the cycle from 2001 through 2005/2006 and then decreasing during the downswing as we move from 2005/2006 through 2010. It also illustrates how the shock severity can vary appreciably across states in a given year, which will result in different capital requirements for similar loans in different states at any point in time.

Table 1: HPI Shocks Peak to Trough in Percent of Nominal HPI by State
(Shocks constrained to be a minimum 5% down from current level of HPI in real terms)

	Year in Which Stress Scenario is Implemented								
State	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
US	-22.2	-25.5	-30.0	-32.4	-33.8	-31.2	-20.1	-18.2	-13.9
FL	-24.8	-32.1	-41.9	-50.8	-53.2	-48.9	-27.3	-20.5	-12.3
CA	-29.3	-36.8	-47.5	-53.4	-51.5	-43.2	-15.5	-10.7	-5.1
NY	-25.8	-31.0	-34.4	-35.6	-35.3	-33.6	-27.2	-24.2	-21.5
MS	-13.2	-14.7	-16.1	-17.9	-23.1	-22.7	-14.7	-14.7	-12.2
OH	-19.0	-19.8	-20.4	-17.7	-17.3	-12.7	-2.7	-3.6	-2.6

Converting the HPI Shock from Real to Nominal: The HPI shock is initially determined in real terms because the trend and lowest below trend measures would otherwise be biased by volatility in past inflation rates. Of course, a borrower's decisions about prepayment and default, and losses associated with default, will be a function of movements in nominal house prices. Hence, our real HPI shock, which is forward looking, must be converted into a nominal HPI shock that embeds an assumption about future inflation.

Rather than attempting to develop a predictive model of inflation, we look to the actual inflation experience of the current recession to provide a pattern for the rate path of inflation to coincide with our HPI scenario. As shown in Table 2, we smooth out the assumed inflation rate resulting in a set of rates that understate the actual inflation experience by a modest amount. If in fact actual inflation for the next HPI shock were higher than we assume, we would possibly overestimate capital requirements, but likely by an immaterial amount.

Table 2: Inflation Assumption

Actual Inflation		**Assumed Inflation**	
Dec 2007- Dec 2008	0.1	Year 1	0
Dec 2008- Dec 2009	2.7	Year 2	1.0
Dec 2009- Dec 2010	1.5	Year 3	1.5
Dec 2010- Dec 2011	3.0	Year 4-7	2.0
Avg. last 20 years	2.5	Year 8-40	2.5

Interest Rate Scenario: Consistent with other such models, the behavioral model we use to estimate mortgage prepayments and default rates includes interest rates as a factor. Since we impose a single path HPI shock, we sought to derive a corresponding single path for each of the interest rates in the behavioral model. As there is no consistent correlation between past interest rates and HPI, we again look to the experience of the current recession to impose an assumption on the movement of interest rates consistent with that experience.

During the current recession, the year over year (annual) HPI first turned negative on a national level in August of 2007. Over the next 16 months, the Federal Reserve dropped the target Federal Funds rate from 5.25 percent to 0.125 percent, where it has remained for some time now. Based on a detailed review of this policy response, we construct the interest rate shock in the following manner. For a level of HPI in any given month, our imposed HPI shock will ultimately result in an annual (cumulative 12-month) reduction in HPI one or more months later. In keeping with the Federal Reserve's actions, when the annual reduction first occurs, we initiate a reduction in our projections of both the 2- and 10-year swap rates (two of the rates used in our model) paced at 14 bps and 9 bps per month, respectively, until they reach the 2008-2010 average for those rates, which is consistent with the rate of descent and trough levels observed in those rates during the 2007-10 historical period in response to the Federal Reserve's actions to reduce the Federal Funds rate. Once at the trough levels, the projected rates are kept constant until year seven (the start of the recovery in the 3-4-3 scenario) and then increased at half the pace of the prior descent rate until the rates reach levels consistent with the historical period of November 1994 through December of 2000, during which rates were stable and Federal Reserve policy actions minimal. The Freddie Mac Primary Mortgage Market Survey (PMMS) commitment rate for 30-year mortgages is also used in our model and is simulated in each HPI shock as a function of the projected 2- and 10-year swap rates.[8]

Table 3 shows that for the one time-period where our projected rates should closely align with actual rates, namely if the HPI shock had been initiated in October of 2007, the two sets of rates are reasonably close, especially considering that the behavioral model is not that sensitive to modest changes in rates. As shown in the table, the design of the interest rate simulation will result in the three rates used in our model dropping from wherever they are in the current period to a defined minimum level, and then recovering slowly back to a stable level. Thus, the severity of the interest rate shock depends on where rates are at the beginning of the HPI shock.

Table 3: Comparison of Actual to Simulated Interest Rates

Target Federal Funds Rate Post-Crisis and Consequent Interest Rates (in percent)				
	Target Federal Funds Rate	2-year Swap	10-year Swap	PMMS
Aug-2007	5.25	4.97	5.39	6.57
Dec-2008	0.125	1.75	2.70	5.33
Dec 2008 to Sep 2010 Avg.	0.125	2.09	2.40	4.95
Oct-2011	0.125	0.64	2.31	4.07
Interest Rate Scenario Implemented October 2007				
		2-year Swap	10-year Swap	PMMS
Oct- 2007		4.86	5.32	6.51
Jul-2011		2.09	2.40	4.27
May 2011 to Sep 2014 Avg.		2.09	2.40	4.27

Empirical Testing Methodology

The recent financial crisis provides a rich data environment with which to examine how well our proposed countercyclical capital regime would have performed if it had been

[8] Specifically, we regressed the PMMS on a constant and the 2- and 10-year swap rates over the period Jan. 2000 through Sep. 2010. The resulting coefficients were then used to generate PMMS rates for each HPI shock scenario by substituting in the corresponding projected 2- and 10-year swap rates.

implemented prior to the crisis. Specifically, we estimate the amount of capital sufficient to cover lifetime losses that our proposed countercyclical regime would have required by cohort (year of acquisition) for an actual loan portfolio in the years 2003, 2005-8, and 2010. Using these estimates, we assess whether the countercyclical capital regime would have required more capital than the firm could have acquired, or would have found economical to acquire, in order to support those assets.

We apply our countercyclical HPI shock to internally developed default and severity models to estimate the lifetime losses for each cohort of loan acquisitions. The estimated losses constitute the countercyclical credit-risk capital requirement. A firm could then meet that requirement through some combination of capital, loss reserve, and expected guarantee fee revenue.

Data Set: The assets included in our simulation are the fixed-rate 30-year single family loans acquired or securitized by Fannie Mae during this period. These loans accounted for about 70 percent of all single-family loans acquired or securitized by Fannie Mae during this period. Because of computing limitations, we proceeded with 2-million loan samples for each calendar year. The populations ranged from around 10-17 million loans across the years. The SURVEY SELECT stratified sampling procedure available in SAS was the method used to select the samples. In order to test the sampling procedure, we compared loss estimates for two samples with the population results for 2010. We found the two samples compared very favorably to each other and further produced nearly identical results to those of the population, differing by less than one percent overall, and particularly for all large states and each cohort year.

Prepayment, Default, and Severity Models: The behavioral models forecasting prepayment and default supporting the loss estimates are an augmented version of the Dunsky-Ho model. The model differs from Dunsky-Ho (2007) with the inclusion of a series of mark-to-market LTV and credit score interaction variables. Common to the mortgage termination literature, the models are specified as a multinomial logit where the borrower chooses each month to either “make their mortgage payment”, “prepay the loan" or "default", where "default" is defined as a first time 90+ day delinquency. The estimation data set was constructed from a population of 80 million mortgage loans via a stratified sampling algorithm using the survey select procedure in SAS.

The loss given default model is a subcomponent of the US Treasury Home Affordable Modification Program NPV model with minor augmentations. The loss given default model forecasts the loss severity of a loan, given that it has defaulted. Unpaid principal balances that are expected to complete the foreclosure process post as a "charge-off" according to foreclosure time lines as affected by each state's foreclosure laws. The charge-off amount equals the expected foreclosed loan balances plus expected Real Estate Owned (REO) selling expenses less REO proceeds (expected REO sales price plus expected mortgage insurance (MI) if applicable). In addition, three months of lost interest and foreclosure costs are subtracted from expected REO proceeds. While the home is classified as REO, we post monthly taxes, insurance, condo/HOA fees, utilities, property maintenance, and house value changes to the REO operating expenses cash flow account (also known as foreclosed property expenses, or REO carrying costs). The REO asset is deemed liquidated according to the state-level 12-month average of REO liquidation times. On the liquidation date, credit enhancements (pool insurance, MI, repurchases and "make wholes") and final disposition price are added to the REO Operating Expense cash flow item.

Empirical Results

<u>Capital Estimates</u>: The results of our baseline capital requirement estimates, using the model coefficients estimated with data through 2010, are presented in Table 4. The results appear reasonable given that the capital requirements shown for loans originated in the benchmark, or more normal, years of 2003 and 2010 are consistent with historical losses on mortgage assets acquired in non-price bubble years.

The capital requirements shown in Table 4 represent the lifetime losses resulting from the countercyclical shock path that are allocated monthly in the simulation and discounted back to the simulation start-year. Because Fannie Mae often reinvested in its own MBS, an approximation of the Fannie Mae current coupon rate was used for discounting.[9] Note also that the estimated losses do not incorporate any credit from guarantee-fee revenue although such revenues may be counted as available capital to meet these capital requirements. Further, the estimates are based on the assumption that mortgage insurance claims will be received in full. This is a reasonable assumption in other than stress years. If this assumption was relaxed as applied in the loss given default model, the resulting capital requirements would be even higher than the already elevated rates listed in Table 4 for the stressful years and beyond.

Table 4: Estimated Capital Charges for FRM-30 Loans

Capital Charges as Percent of UPB	**Simulation Start-Year (as of September 30)**							
Origination Year	**2003**	**2004[a]**	**2005**	**2006**	**2007**	**2008**	**2009[a]**	**2010**
2001	1.45		1.19	1.11	1.02	0.80		1.35
2002	3.34		2.11	2.06	1.78	1.34		2.52
2003	3.51		1.94	1.80	1.49	1.12		1.91
2004			5.11	4.92	4.23	3.34		5.32
2005			9.97	9.83	8.78	7.54		11.19
2006				15.84	14.69	13.51		20.82
2007					16.88	14.68		22.11
2008						8.79		12.27
2009								2.19
2010								2.62

[a] There are no estimates for Start-Years 2004 and 2009 only because we elected to reduce our computational burden.

Overall, these results satisfy our expectations based on the design of the HPI shock. The year of acquisition for a cohort of loans is when the origination year and the simulation start-year are the same. Consistent with our design goal that the loans should

[9] Because we use forecasts of the 2- and 10-year swap rates in the model, the discount rate was set to be a constant spread of the Fannie Mae current coupon rate to those rates. Specifically, the discount rate for period i of the HPI shock scenario is: .05x(2-yr swap rate (i)) + .95x(10-yr swap rate(i)) + FNM current coupon (time zero) – [.05x(2-yr swap rate (time zero)) + .95x(10-yr swap rate(time zero))], where the part after the second + sign represents a constant spread of the Fannie Mae current coupon rate in time zero over the weighted average of the 2- and 10-years swap rates, which is applied to the simulated 2- and 10-year swap rates in each period of the simulation.

be fully capitalized at acquisition, the estimated capital requirements are highest for each cohort in the year of acquisition (along the results diagonal). For a given cohort of loans, the capital requirement in dollar amount falls each year after acquisition. This is observed with the decline in the percentage requirement each year, except for between 2008 and 2010, where the percentage requirement increases significantly, but importantly the total amount of capital required for each cohort continues to fall each year moving forward. This apparent anomaly in the percentage requirement is the consequence of a significant fall-off in the outstanding unpaid principal balance (UPB) for all cohorts because of rapid prepayments between 2008 and 2010 such that the loans remaining in each cohort by 2010 are dominated by those subject to the higher percentage capital requirement.[10] The decline in the capital requirement for new acquisitions post 2007 is also consistent with our design goal of allowing requirements to fall in the downside of the cycle.

Disaggregated Results: Table 4 shows capital charges specific to the book of business that Fannie Mae actually acquired or securitized in those years. A breakdown of the results reveals that the charges, as is true of the HPI shock, will vary significantly across states. For example, for 2007, the capital charges for loans from Florida average 28 percent, while only about 14 to 15 percent for loans from California and Mississippi. Even though California and Florida experience a similar drop in HPI in 2007, both over 40 percent, the California charge is significantly less because foreclosures are processed with much shorter timelines, and hence cost less, in California. A further breakdown of capital charges for California loans acquired in 2007 and across the risk factors of LTV and FICO shows that the estimated charges for lower risk loans would have been about five percent. These results suggest that even at the height of the crisis, some loans from every state might still have been subject to reasonable or more modest capital charges.

Model Sensitivity to Estimation Period: The prepayment and default model was re-estimated using historical data through 2005 in addition to the version used to generate

[10] To a modest extent as well, the HPI shock is actually more severe in 2010 for five states because our constraint that the minimum HPI shock must be at least 5 percent down (in real terms) is invoked for the first time with the 2010 estimates as those five states are finally at or near their lowest HPI below trend.

the results in Table 4 based on historical data through 2010. This allows us to see how the resulting countercyclical capital requirements might have changed over time as new information became available, in essence a test of one component of model risk. We find that the default rates estimated from the 2005 and 2010 version models for the 2005 and earlier cohorts are quite similar.

Unfortunately, we were unable to create a 2005 version of the loss given default model, so with the same 2010 version of that model applied to both versions of the default model we estimate similar capital requirements for both versions of the default model for each of the cohorts from 2005 and earlier. Since loss given default is driven in the model largely by the mark-to-market LTV ratio, and the time in foreclosure, it is likely that a 2005 version of the severity model would not have differed much from the 2010 version. If that is the case, the results of this exercise at least do not refute the prospect that this countercyclical regime may produce reasonably consistent results across time. Nonetheless, going forward, we will have the option to include the 2005-2010 history in the default model so this comparison only reveals the extent to which we may have underestimated the capital requirements had the countercyclical regime been in place but hampered by the lack of the recent experience on just how severe a stress period could be.

<u>Results Sensitivity to Inclusion of a Conservative Buffer:</u> The countercyclical HPI shock is based on the worst HPI level below trend observed in the 26 years prior to 2002 for a given state. We examine the consequence of adding a conservative buffer to the worst HPI level to allow for the probability that the worst HPI level below trend may yet occur in the future, as in fact it has occurred for five states in the current crisis. Further, we consider that the method to estimate the credit losses clearly involves some significant model risk, so incorporating an extra capital charge in the form of the conservative buffer would be prudent. These motivations for the buffer do not, however, provide any indication on how large the buffer should be. Consequently, we test a conservative buffer that lowers the worst level of HPI for every state by an additional five percent of trend in real terms.

Adding a five percent buffer increases the estimated capital requirements by from 15 to 40 percent depending on the year and cohort. As we expected, the model estimates are very sensitive to a marginal increase in the shock, because the first 20 percent or so of the shock is largely covered by equity or mortgage insurance resulting in little loss. So, for example, to increase an HPI shock from 25 percent to 30 percent is tantamount to doubling the shock intensity, as though the shock were increased from 5 to 10 percent after accounting for credit enhancements.

In our view, adding the five percent buffer universally results in too large of an increase in the capital requirements. We note that even without the buffer, we already incorporate conservative assumptions in that we are applying the HPI shock to all states simultaneously, and we include a constraint that the minimum HPI shock must be at least five percent in real terms. Besides, any newly achieved worst HPI levels will get incorporated into the countercyclical regime over time.

Sensitivity to Alternative Shock Patterns: As discussed above, we examine the historical data to arrive at a timing pattern of the HPI shock with respect to years from peak to trough, time at the trough, and time of recovery back to trend. We settled on a 3-4-3 pattern as the most likely. We also examined a 3-0-3 (V-shaped) pattern on the 2005 data to gauge the sensitivity of the results to imposing a shorter duration of the HPI shock, while keeping the depth of the shock the same. We found that the 3-0-3 pattern reduced the capital requirements for the 2005 and earlier cohorts by about one-third. Clearly duration of the HPI shock matters. While we believe that our approach to arrive at a timing pattern is reasonable, we also recognize that this is one aspect of the design that would benefit from further research.

Conclusion

The concept of countercyclical capital requirements is gaining acceptance in the literature and among regulators and practitioners as an improvement over prior and current capital regimes. Here we offer a methodology on structuring a countercyclical capital requirement to achieve the goal of determining, at the time of acquisition, an amount of capital sufficient to survive a plausible but worst case stress period, in essence to fully capitalize the asset at acquisition. The capital charge would be asset specific and rules based, in contrast to the current Basel III proposal.

We test this methodology on the actual book of loans acquired by Fannie Mae during the period 2003-2010 and find that the capital charges would have complied with our goals for a countercyclical capital regime. Specifically, our estimates show that the capital requirements with this regime increase dramatically in the early years of an HPI bubble, fall in the decline of the bubble, and constitute full capitalization at acquisition. Had the countercyclical requirements been in place, Fannie Mae would have been unable, or at least deterred, from obtaining sufficient additional capital to acquire those loans which ultimately resulted in losses of more than three times their capital levels. Had Fannie Mae been able to raise some of such additional capital, they would have had to also raise prices to maintain an adequate return on that capital. In this respect, the countercyclical capital regime would likely have resulted in lessening the quantity demanded for mortgage loans in the market and thereby mitigated the amplitude of the HPI bubble.

In general, we believe this design for a countercyclical capital regime could be implemented by regulators or financial institutions as part of their economic capital models. Any firm that would adopt this approach would be well positioned to survive the next major HPI cycle even if the approach is not implemented by most other firms in the industry.

Of course, no methodology is immune to improvement. Going forward, we intend to examine the robustness of our approach as applied to different prepayment default and severity models. Improvements might also be made in the design of objective methods to find the lowest level of HPI below trend, and in the time path of the HPI shock. Further, it is worth exploring whether a more granular application of the HPI shock, perhaps at the MSA level rather than state level, would be beneficial. It remains to be shown, however, whether improvements in these features of the design would have much of an effect on the resulting capital requirements.

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