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2022 CCAR SCENARIOS: AD&CO'S ANALYTICS AND DATA FILES

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Summary

On February 10, the Federal Reserve Board (Fed) released two scenarios—Base and Severely Adverse—for the 2022 Comprehensive Capital Analysis and Review (CCAR). These scenarios describe three-year trajectories based on key economic indicators—of the 28 variables, the ones used by AD&Co's mortgage models are home price (CoreLogic national HPI); interest rates (3-month, 5-year, and 10-year Treasury, prime index, and mortgage primary rate); and national unemployment.

The information provided by the Fed is not sufficient to project credit losses and bank capital levels without some transformation (including interpolation and extrapolation) of its assumptions. In order to assess lifetime losses or changes in market values, a much longer projection of the variables is required. Furthermore, most adjustable-rate mortgages are not indexed to the three Treasury rates provided, and the forecast of the national HPI is not an accurate indicator of diverse geographical stresses.

Therefore, after each annual release, Andrew Davidson & Co., Inc. (AD&Co) prepares a set of data files that convert the Fed's scenarios into a form more suitable for modeling; our internal valuation model restores a full set of economic variables. The process is described in the Appendix, and some useful information can also be found in our annual articles published from 2013 through 2021.[1] The current article focuses on the 2022 version and compares results from the 2022 CCAR stresses to our standard credit-scenario grid.

Clients who license one of AD&Co's valuation/risk systems (RiskProfiler, LoanKinetics, or Kinetics) can replicate these projections. Those who license the LoanDynamics Model (LDM) can use our extended scenario files through their vendor systems' interface.

2022 CCAR Scenarios and Changes from 2021 and 2020

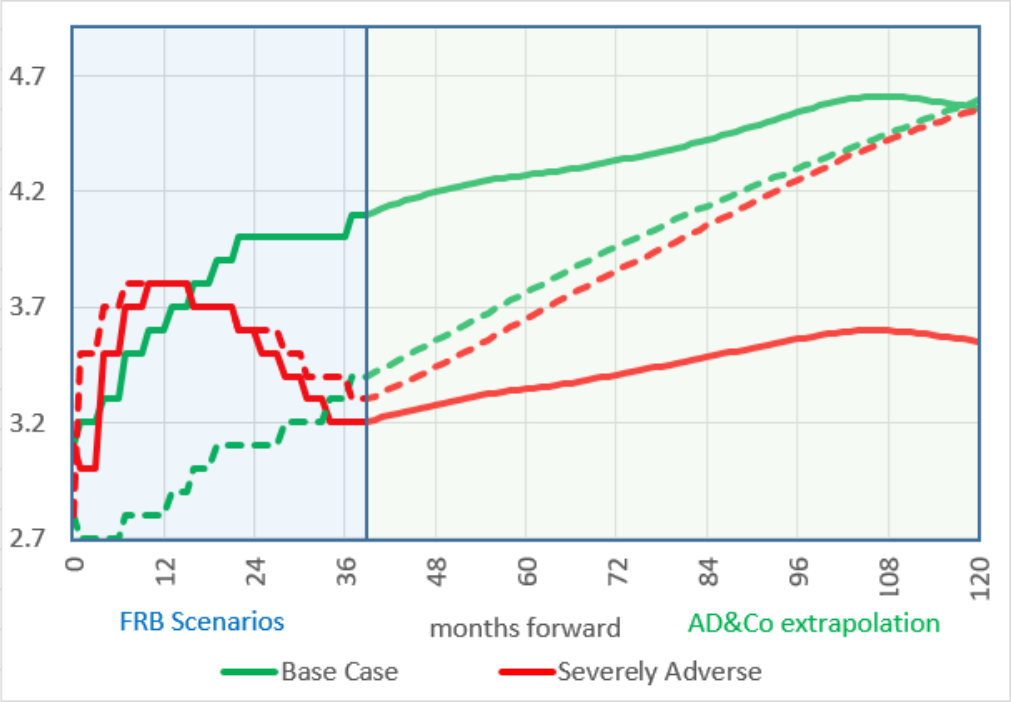
The Fed produces economic scenarios that we transform and use in our models. The 13-quarter series is interpolated (to obtain other variables), extrapolated (to reach a 30-year horizon), and, in some cases, transformed. These operations are explained in the Appendix; immediately below are results and comments.

[1] See, for example, J. Gao, A. Levin, and D. Swanson, "CCAR 2020: AD&Co's Analytics and Data Files," *The Pipeline* 175 (March 2021).

Interest rate scenarios are provided for three tenors of the Treasury curve (3-month, 5-year, and 10-year), mortgage primary rate (from the Freddie Mac originator survey), and prime index. At every forward point in time, we fill in the missing points on the Treasury curve and reconstruct the Libor-Swap curve and the SOFR-swap curve (see Appendix). At the end of the Fed's forecast, we then utilize this restored interest rate market and project each tenor using its forward rate trajectory.

Additionally, both secondary and primary mortgage rates are subject to their own modeling steps, which are linked to market benchmarks (Libor-Swap curve, in AD&Co's case). The resulting scenarios and their comparison to 2021 numbers for primary mortgage rate are shown in Figure 1.

Figure 1. Primary Mortgage Rate Scenarios: 2021 (dashed line) vs 2022 (solid)

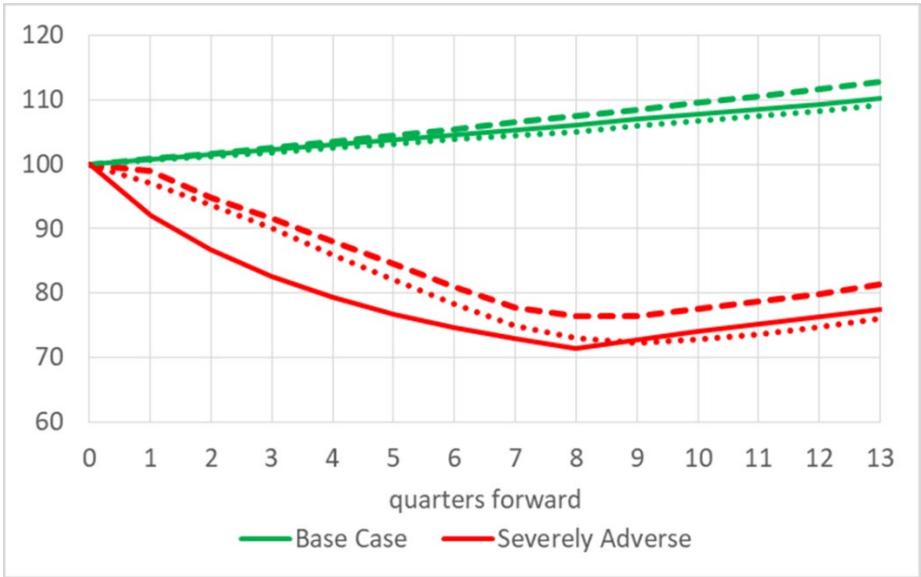


During 2021, mortgage rates rose somewhat; therefore, the solid and dashed lines start from different points. The Severely Adverse scenario features a quick increase in mortgage rates (as well as other spreads of credit products), followed by their fall. By the end of the Fed's 13-quarter outlook, the derived forward curves look different between the two versions, with the 2022 edition being a flatter one. Therefore, the AD&Co–interpolated mortgage rates are projected to be lower than they were projected for 2021 CCAR. This mere fact will mitigate credit risk and offset stronger stresses in home price index (HPI) and unemployment, as demonstrated further below.

HPI scenarios are provided for the CoreLogic (CL) national index only. Relative to the 2021 edition, the Severely Adverse scenario became *more* severe, manifesting counter-cyclicality after a very strong 2021 appreciation. This difference will increase expected losses for all affected assets. The Base Case scenario points to a modest appreciation (as for all prior years) and is seriously below both other forecasts and historical realization[2] (see Figure 2).

[2] The latest Pulsenomics survey of 100+ experts has HPA median for one year at 6.3% vs 3.1% for CCAR and a two-year HPA of 11.1% vs 6.2% for CCAR. The actual CoreLogic US HPA was 18.5% in 2021 alone.

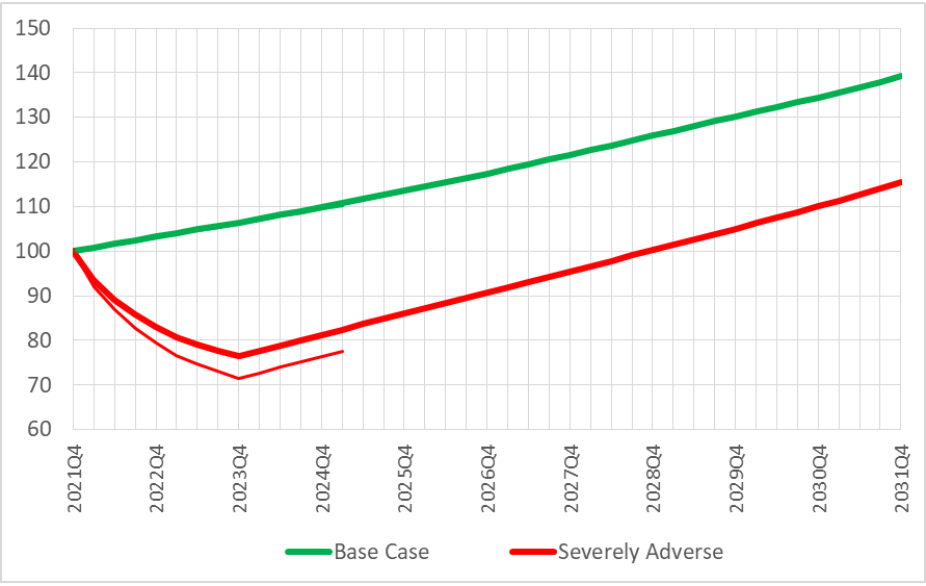
Figure 2. 2022 (solid), 2021 (dashed line), and 2020 (dotted line) CoreLogic HPI Scenarios



AD&Co transforms the provided scenarios in three ways (explained in the Appendix); the first two transformations are illustrated in Figure 3:

1. We convert CoreLogic's scale into the Federal Housing Finance Agency (FHFA) scale used in our credit model. In simple terms, stresses are expected to be 20% weaker, net of a common national affordability driver.
2. We extend HPI for the full 30-year period of modeling.
3. Stresses are localized so that HPIs in high-volatility areas (CA, FL, AZ, and NV) will be stressed more deeply.

Figure 3. Converted and Extended 2022 CCAR US HPI Projections

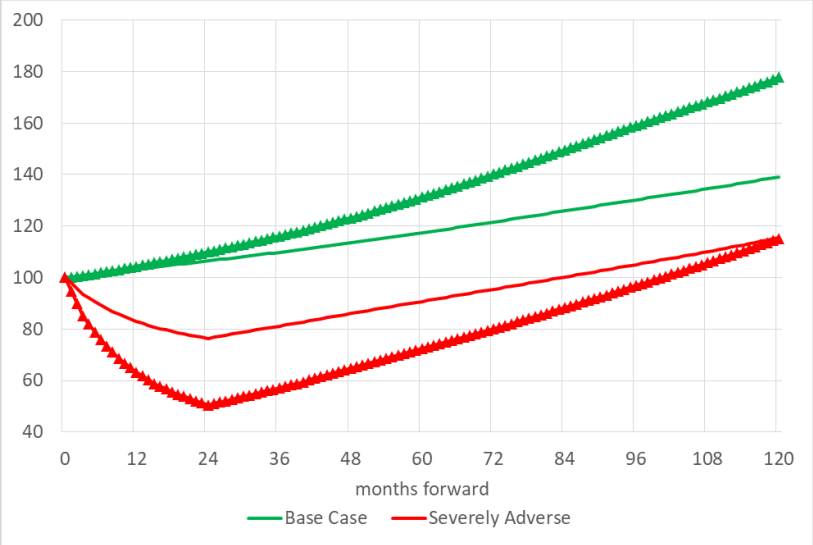


Thin lines = CoreLogic raw series; Thick lines = AD&Co-constructed FHFA equivalent

To illustrate localization (item 3 in the list above), Figure 4 compares 2022 HPI scenarios in California to those in the US as a whole, using the FHFA scale. Note that home prices in California are projected to decline much

more than the national index in the Severely Adverse Case. As for the Base Case, California's HPA is projected by our model to be similar to the US HPA in the near term but more positive in the long term..

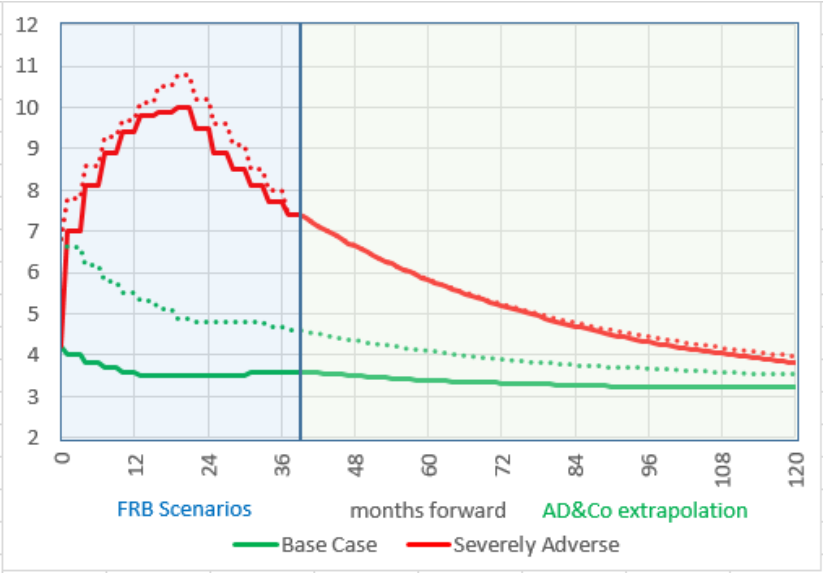
Figure 4. Geographical Comparison of HPI Scenarios: US (solid) vs CA (triangles)



Interestingly, the Fed's 2022 description of the Severely Adverse scenario specifies that "declines in aggregate U.S. house prices should be assumed to be concentrated in regions that have experienced rapid price gains over the past two years."[3] While our modeling view doesn't necessary contain an explicit prediction of counter-cyclical movements, California HPI has indeed outpaced other regions in recent years.

Unemployment scenarios are provided at the national level. US unemployment starts from a much lower level in 2022 than it did in 2021, but flies up by a larger amount to reach a slightly lower peak level (from 4.2% to 10.0% in 2022 versus from 6.8% to 10.8% in 2021). With the inception of the new unemployment model, our long-term unemployment rate is similar to the 3.5% rate that the US had pre-pandemic (see Figure 5).

Figure 5. US Unemployment Rate Scenarios: 2021 (dotted line) vs 2022 (solid)



[3] *2022 Stress Test Scenarios*, Board of Governors of the Federal Reserve System, February 2022.

We will now examine the use of unemployment scenarios in two versions of our borrower behavior model.

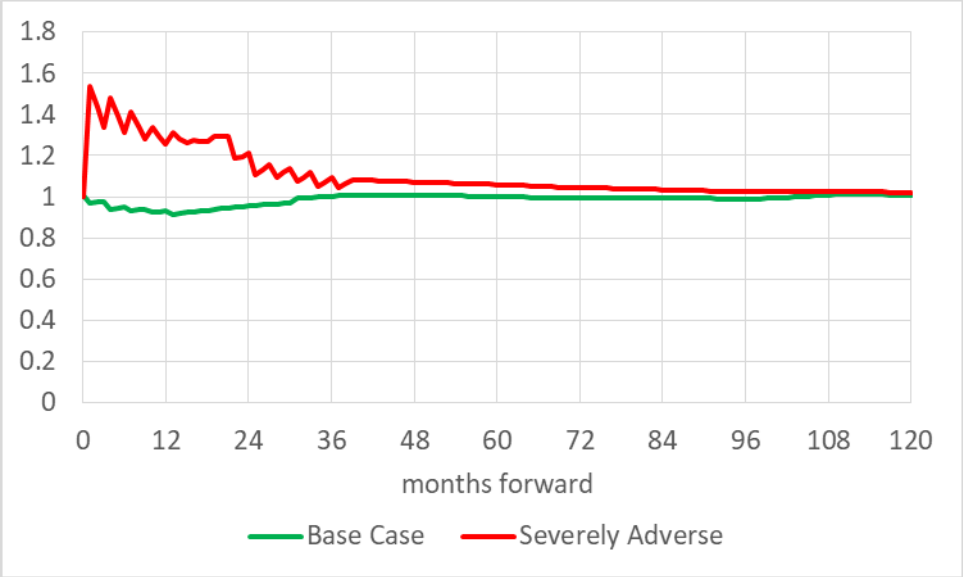
LDM 3.0 (ALDM+)

Version 3.0 *explicitly* takes unemployment projection for agency loans.[4] That is, no tunings are required if the LDM vendor system allows for passing unemployment projections. Extrapolated values for the Fed's unemployment scenarios, shown above in Figure 5, are distributed by AD&Co in a file. AD&Co's own financial engineering models (RiskValDynamics, formerly known as OAS Subroutine) and applications (RiskProfiler, LoanKinetics, and the Kinetics platform) are fully equipped to accept unemployment scenarios.

LDM 3.0 (NA LDM) and Prior Versions of LDM

For most clients using the non-agency model or a prior version of the agency model, Current-to-Delinquent (CtoD) tunings concurrently utilize information coming from projected home prices, interest rates, and unemployment. As with other modeling steps mentioned in this article, more details can be found in the Appendix. In short, should unemployment develop in line with the historical pattern explained by home prices and interest rates (per the new AD&Co unemployment model), the CtoD dial will be 1.0, meaning that we would not accelerate or decelerate the formation of new delinquencies. If unemployment exceeds the historical pattern, CtoD will be tuned above 1.0. Figure 6 demonstrates recommended tunings, which are stored in data files for LDM users.

Figure 6. CtoD Dials for the 2022 CCAR Scenarios



The green line in Figure 6 suggests that the Fed's Base Case unemployment scenario is close to historical pattern and requires virtually no CtoD correction. The red line depicts a somewhat accelerated mode of unemployment development for the Severely Adverse scenario—relative to the historical pattern (e.g., the previous financial crisis). While the pattern of CtoD increase/decrease may seem notable, the associated increase in cumulative defaults and losses is actually rather moderate.

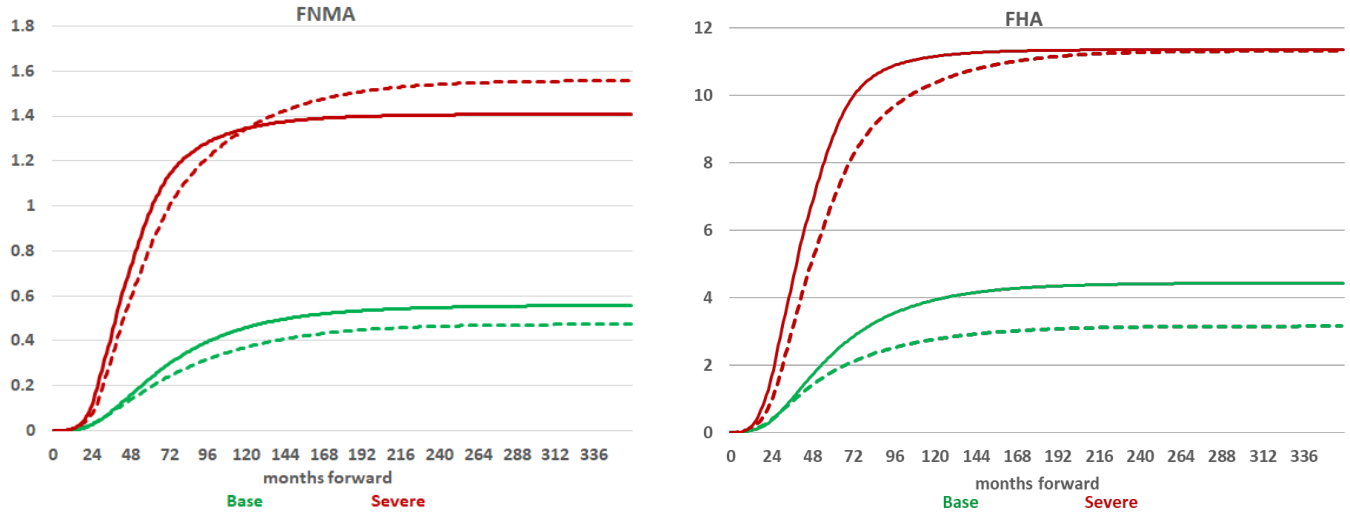
2021 vs 2022: Comparison of Model Results

[4] See D. Swanson, "New Feature in LDM 3.0," *The Pipeline* 175 (March 2021).

Using LDM 3.0 we calculate projected cumulative defaults over time under both the CCAR 2021 and CCAR 2022 Base Case and Severely Adverse scenarios for two newly originated loans[5] (Figure 7).

The severe lifetime defaults are lower for the 2022 version (FNMA loan) or similar (FHA loan), but more front-loaded. This is a function of the sharper decline in home prices, coupled with the faster recovery and, when gauging just the CCAR-defined span, the 2022 edition is slightly more severe.

Figure 7. Cumulative Default Rates Projections, % (solid = 2022, dash = 2021)

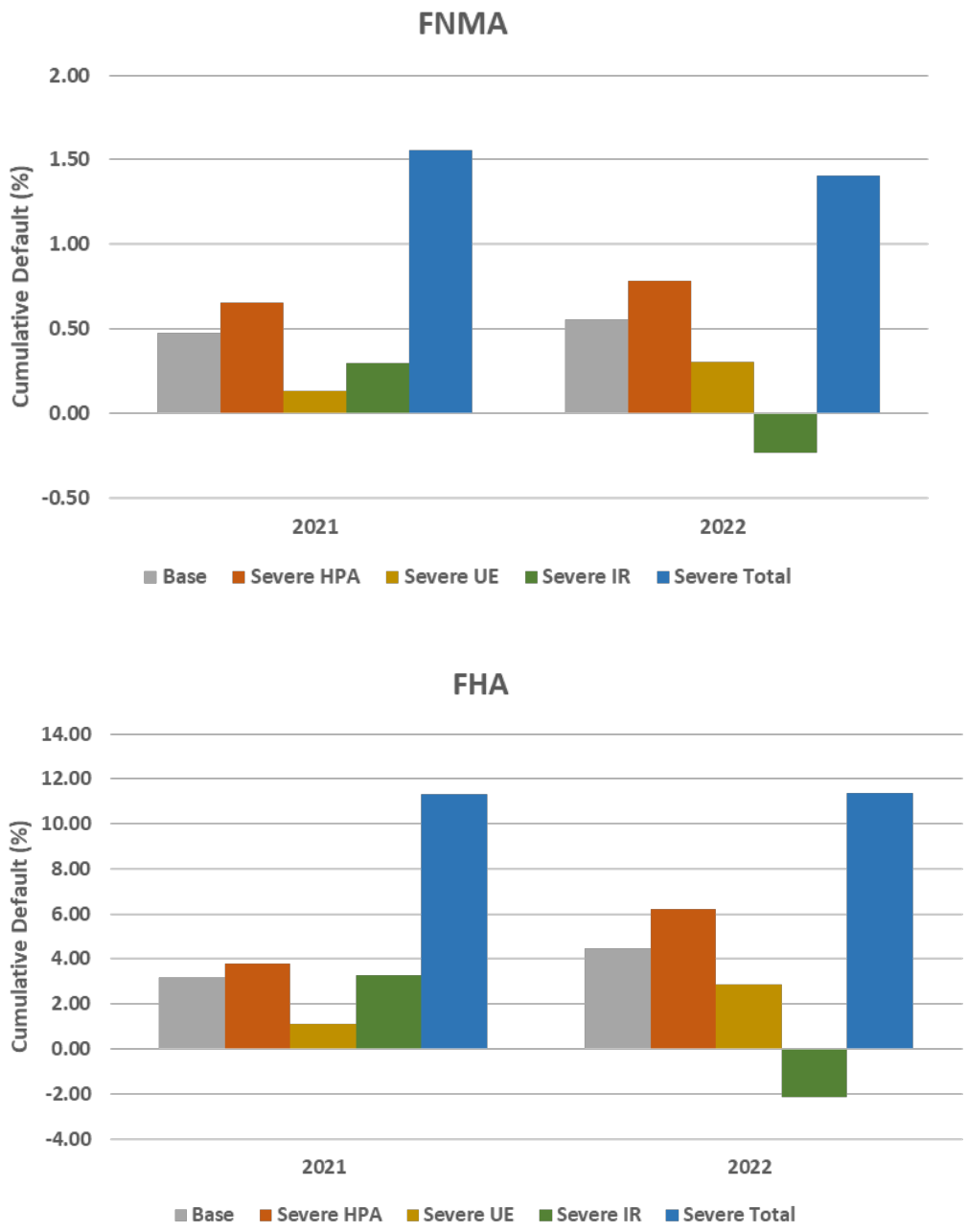


Despite the apparent counter-cyclical approach to stress testing, a flatter yield curve and a lower mortgage rate extension implied by the Severely Adverse scenario offset the stresses. This is clearly seen in Figure 8, where we demonstrate the contribution of each macroeconomic driver, applied sequentially (that is, start from the Base Case, then add Severely Adverse HPI, then Severely Adverse unemployment, and finally, the Severely Adverse interest rates). We used par-rate prevailing-quality new loans for this demonstration.

HPI provides a large initial impact, with unemployment adding to that in both years (more so in 2022 than in 2021, which makes sense as the unemployment change was larger in 2022). However, the rate effect was an additional stress factor in 2021, while it became a stress-reducing factor in 2022. In addition, despite a deeper HPI decline, the recovery appears to be stronger, with a visible jump in HPA—from negative to positive—after the two years of decline. The total severe stress is shown to be on par (FHA) or slightly below (FNMA) the 2021 edition.

[5] FNMA: Age=0, Rate=Par, FICO=750, LTV=75, Bal=300K, Geo=US
FHA: Age=0, Rate=Par, FICO=680, LTV=95, Bal=200K, Geo=US

Figure 8. Attribution of Macroeconomic Drivers



Let us keep in mind that all the effects are contingent on loan characteristics. The risk-offsetting role of lower interest rates will be weaker for a lower-quality loan (e.g., FHA loan) or a discount-rate loan (e.g., originated in 2020). For those loans, we should expect a stronger effect of the increased 2022 macroeconomic stresses relative to the 2021 stresses.

2022 CCAR vs AD&Co's Standard-Scenario Grid

One of most interesting questions we are asked regarding the CCAR scenarios is their "location" within the AD&Co standard-scenario grid, which is used for many analyses. The description of the scenario-grid method for credit analysis can be found in a number of our earlier publications. We limit exposition here to a very brief overview.

We construct 20 deterministic scenarios (numbered from 0 to 19) sorted in order of stresses. Each scenario features changes in interest rates, home prices, and LDM scales. Therefore, to account for possible model errors, we combine market stresses with model stresses. Scenario 7 is our typical base case (median scenario), where rates follow their respective forward curves, HPIs follow the AD&Co model, and LDM's outputs are used without alterations. Scenario 19 is the extreme stress case, projecting a long and deep FHFA national home price decline, when high interest rates make it difficult to refinance. Furthermore, we assume that, in stresses, the model understates defaults and losses and overstates prepayments. Thus, it is a compounded combination of stresses.

Each scenario is assigned a theoretical probability that follows what we call "3-group Vasicek" distribution. This is an adaptation of the O. Vasicek theory of loan defaults, in which defaults are bounded between minimal and maximal levels computed from the scenario grid. In Figure 9, those are 0.03% and 5.29%, respectively. The median default rate, 0.37%, is another important parameter. Finally, the correlation parameter entering Vasicek's formula is set at 25% (this level is calibrated to a Monte Carlo–generated distributional tail). The theoretical Cumulative Distribution Function (CDF) and scenario weights are shown in the last two columns.

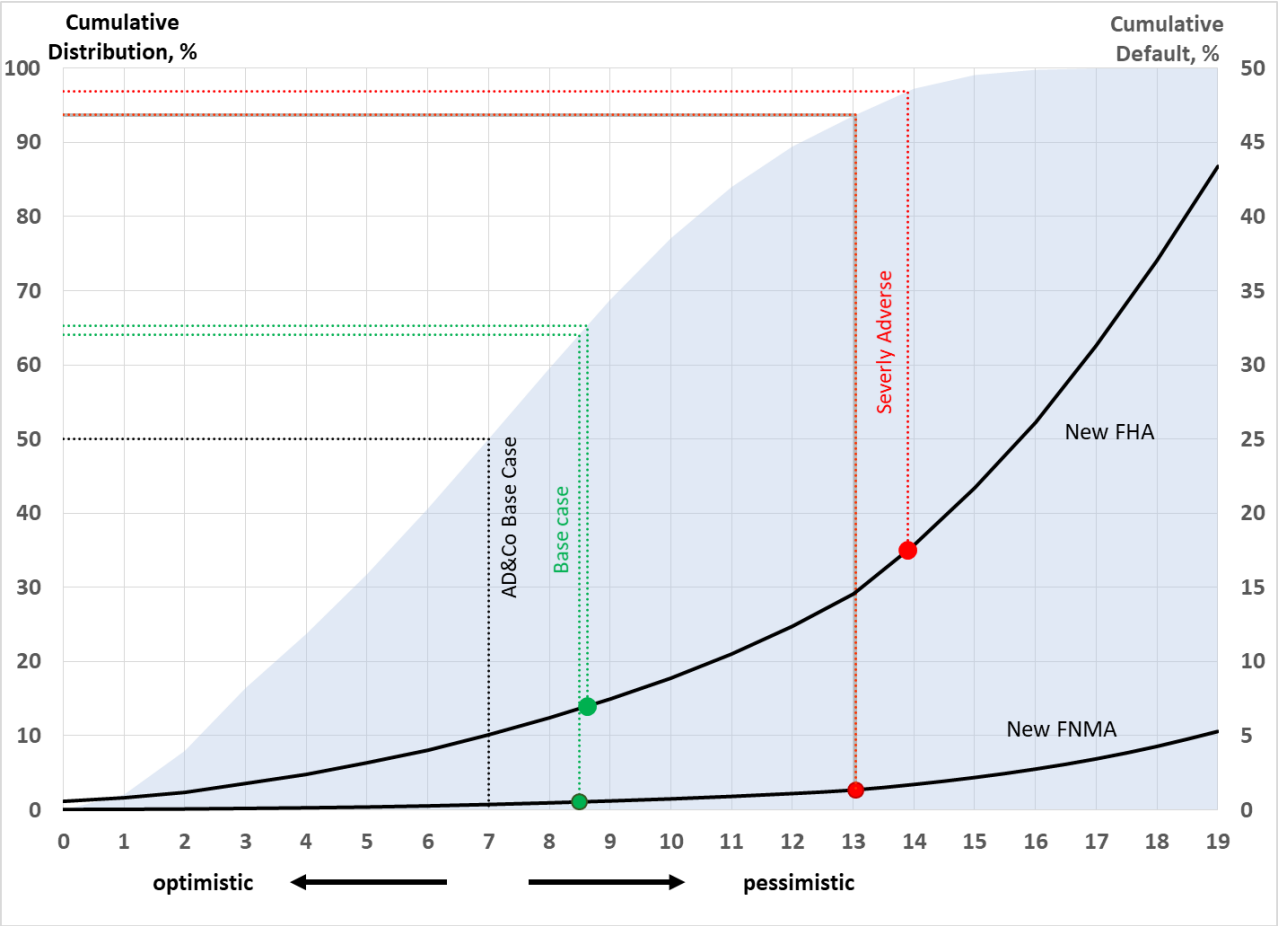
Figure 9. Standard AD&Co Economic and Model Stresses (New FNMA Loan)

		HPA			Model Scales			Cumulative		Probability	
Scenario type	Scenario	2-yr	Trough	IR Shock	Default	Severity	Prepay	Loss	Default	CDF	Weight
Best	0	41.31		-125	0.75	0.875	1.25	0.00	0.03	0.00	0.26
	1	37.09		-100	0.8	0.9	1.2	0.01	0.04	0.52	1.44
	2	33.00		-75	0.85	0.925	1.15	0.01	0.07	2.87	4.14
	3	29.04		-50	0.9	0.95	1.1	0.02	0.10	8.80	6.43
Improving	4	25.58		-37.5	0.925	0.9625	1.075	0.03	0.14	15.73	8.34
	5	22.20		-25	0.95	0.975	1.05	0.04	0.20	25.49	10.83
	6	18.92		-12.5	0.975	0.9875	1.025	0.06	0.28	37.40	12.26
Base	7	15.73		0	1	1	1	0.08	0.37	50.00	12.20
	8	12.62		12.5	1.025	1.0125	0.975	0.12	0.48	61.80	10.94
	9	9.59		25	1.05	1.025	0.95	0.15	0.61	71.89	9.18
Moderate Stress	10	6.65		37.5	1.075	1.0375	0.925	0.20	0.75	80.15	7.42
	11	3.78		50	1.1	1.05	0.9	0.26	0.91	86.73	5.79
	12	0.99		62.5	1.125	1.0625	0.875	0.33	1.11	91.73	4.33
	13	-1.73	-2.79	75	1.15	1.075	0.85	0.42	1.34	95.40	3.27
Stress	14	-4.67	-8.22	100	1.2	1.1	0.8	0.60	1.72	98.27	2.06
	15	-7.53	-13.84	125	1.25	1.125	0.75	0.84	2.19	99.51	0.82
	16	-10.31	-19.36	150	1.3	1.15	0.7	1.17	2.76	99.91	0.24
	17	-13.01	-24.69	175	1.35	1.175	0.65	1.61	3.45	99.99	0.04
	18	-15.64	-29.80	200	1.4	1.2	0.6	2.19	4.29	100.00	0.00
Extreme Stress	19	-18.20	-34.68	225	1.45	1.225	0.55	2.94	5.29	100.00	4.E-05

Figure 10 compares AD&Co's projected default rates from the scenarios in Figure 9 to those using the 2022 CCAR scenarios. In order to make this analysis more challenging and objective, we considered loans of vastly different credit quality: a recently originated FNMA loan of typically high quality and a high-risk new FHA loan (with 95 LTV and 680 FICO).

The CCAR 2022 Base Case scenario lies neatly between scenarios 8 and 9 for both loans; the Severely Adverse scenario generally maps between scenario 13 (low-risk loans) and scenario 14 (high-risk loans). Note that for every CCAR scenario, its probability assignment only modestly depends on loan type. This is an interesting fact that should not be taken for granted since the Vasicek CDF is a function of default rate that varies vastly across loan types.

Figure 10. 2022 CCAR Scenarios (dotted lines) on the AD&Co Scenario Grid



Looking at the probability assessment (the left y-axis), we see that the Severely Adverse scenario is given a CDF ranging from (approximately) 0.937 (1:16 odds of occurring for the low-risk loan) to 0.969 (1:32 odds for the high-risk loan). This assessment does not contradict common intuition. Despite some discrepancies in the odds, the power of the 3-group Vasicek distribution in matching an empirically designed borrower behavior model is quite remarkable. Table 1 maps CCAR scenarios for the last several years onto our scenario grid.

Table 1. Historical CCAR Scenario Map on the AD&Co 20-Scenario Grid

Year of Stress Testing	Base Case	Adverse	Severely Adverse
2017	8	11	12–13
2018	8–9	10–11	15
2019	8	10±	13±
2020	8	N/A	13–14
2021	9	N/A	13–14
2022	**8–9**	**N/A**	**13–14**

While the Base Case scenario remains mostly unchanged through the years of stress testing, the same cannot be said about the Severely Adverse scenario. According to the aforementioned Fed's 2022 CCAR document, the year-over-year change "reflects the Scenario Design Framework, which calls for a more pronounced economic downturn when current conditions are stronger." This is in contrast to the design of AD&Co's 20-scenario grid that keeps "scenario distances" from its Base Case (#7).

What Are Our Clients Getting?

The information set facilitating CCAR analysis depends on whether our clients use one of our financial engineering (FE) tools (RiskValDynamics, aka "OAS Subroutine," assessed directly or via RiskProfiler or LoanKinetics applications) or exclusively use LoanDynamics Model (LDM) via a third-party vendor.

AD&Co's FE Tools are capable of reading interest rates, home prices, and unemployment scenarios (stored in files) directly and employing them in a CCAR analysis. For example, the CtoD dialing vectors used in older versions of LDM (and depicted in Figure A.2 of Appendix of this article) will be computed during run time; the HPI stresses will be localized by the HPI model (a part of RiskValDynamics); and interest rates will be interpolated and extended using forward rates computed by our interest rate model (another part of RiskValDynamics).

Advanced CCAR Analytics is incorporated in AD&Co's FE Tools and enables valuation of mortgage assets at future points, using one of the CCAR scenarios. This valuation method utilizes market information known at those points, without foresight. Our 2017 article explains this important function that is mandatory for mark-to-market assets such as Mortgage Servicing Rights.[6]

For users of **LDM** through **Third-Party Vendors**, the aforementioned home price and interest rate files are available to plug into third-party vendor systems. Depending on the vendor, the format of the files may need to be transformed. Custom tuning files, which employ the appropriate CtoD tuning depending on the scenario in question, are also available for older versions of LDM.

Finally, we have created a version of the **LDM Spreadsheet** with the CCAR scenarios for interest rates, home prices, and tunings (pre-loaded for each scenario).

For more information, please contact alex@ad-co.com, daniel@ad-co.com or support@ad-co.com.

[6] A. Levin and L. Wu, "CCAR 2017: Forward Valuation without Foresight ("Advanced CCAR")," *The Pipeline* 150 (June 2017).

APPENDIX

We describe herein the interpolation/extrapolation processes that are necessary, given the limitations of the CCAR scenario data, to run fixed income analysis.

Interest Rates

As a first step, the interest rates are interpolated and extended forward. The CCAR scenarios only describe the 3-month, 5-year, and 10-year Treasury rate, the Prime rate, and the primary mortgage rate, for a three-year horizon. Modeling and valuation require much more—rates for all maturity tenors and for up to 30 years in the future. For example, both OTTI (other-than-temporary impairment) and mark-to-market require us to project cash flows of an MBS (mortgage-backed security) at the end of the CCAR horizon, which would assume knowledge of the entire market at that point.

We first fill in missing rates for the three-year horizon specified by the Fed. Although we only know the three Treasury-point trajectories, we can compare them with the starting points and interpolate the entire curve reasonably well. For example, a move in the one-year point would be the weighted average of moves in the 3-month and 5-year tenors from respected forwards, with weights being commensurate with the distances to those tenors. This will let us predict all yield-curve points for the next three years. Once we have the yield curve three years in the future, we can construct forward rates at the end of the CCAR horizon and extend the projection using the no-arbitrage assumptions.

Libor and SOFR rates are projected similarly; using the established distance from any point of the Treasury curve from today's forward rate, we place the matching Libor, SOFR or swap tenor off its known forward curve.

Mortgage rates are projected according to our model. In order to project primary mortgage rates, we first "invert" our primary/secondary spread (PSS) model to derive the current coupon yields (CCY) from the primary rates. At the end of the three-year horizon, we compare CCYs thus obtained to the 2-year point and the 10-year point. This allows us to establish the regression's intercept (Alpha) for our widely used empirical CCY model. Once this is done, CCY can be projected in the distant future using that Alpha and the two benchmark rates. Primary rates are then computed using this extrapolated CCY and the PSS from its model.

Home Prices

Our home price model is essentially utilized to extend the scenarios, but it is also used to convert the CoreLogic HPI forecast into an equivalent FHFA HPI forecast and to "localize" national stresses.

HPI Conversion

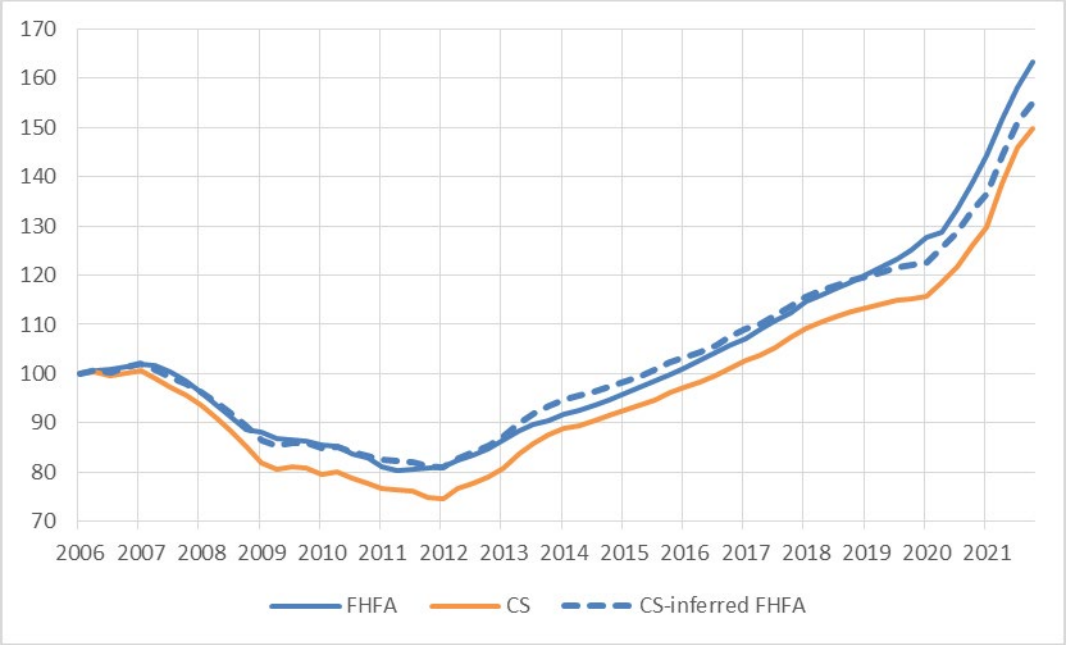
Our key tool in generating borrower behavior response to economic stresses is the LoanDynamics Model (LDM). It was built using publicly available FHFA home price indices. Those indices declined less during the 2008–09 crises than the CoreLogic (CL) HPI or the Case-Shiller (CS) HPI. Therefore, in order to pass economic stresses to LDM, we first need to convert HPI projections stated in the CoreLogic form into the approximately similar FHFA form. Note that historically CL HPI was a different and a slightly more volatile index than CS HPI. After CoreLogic acquired the rights to Case Shiller HPI from Fiserv in 2013, it began producing what they termed "CoreLogic Case-Shiller HPI" and the two indices became identical. We think that the CS index's volatility is more relevant for the future projections than the CL ones (before the acquisition), hence assume the CS property for the HPA conversion.

The conversion is performed using a simple variation of our Geographical Localizer (a regression):

$$HPA_{FHFA}(t) - F(t) = \beta[HPA_{CS}(t) - F(t)]$$

where $F(t)$ is the common HPA factor and Beta is the regression's coefficient, estimated at 0.833. Understanding the common factor $F(t)$ is the key to appreciating this conversation. As stated, the FHFA indices have historically been less volatile than the Case-Shiller/CoreLogic indices. However, this difference should be controlled for the common factors that measure borrower economics—primarily, interest rates, size of down payment, and income. If a stress is solely attributed to that common factor, there will be no difference between the two HPI projections. Our 2017 article contains a historical "in sample" data series that supports the conversion.[7] Four years later, we confirm that the conversion still does a good job out of sample (Figure A1).

Figure A1. Case-Shiller vs FHFA HPI since 2006



Geographical Localization of Stresses

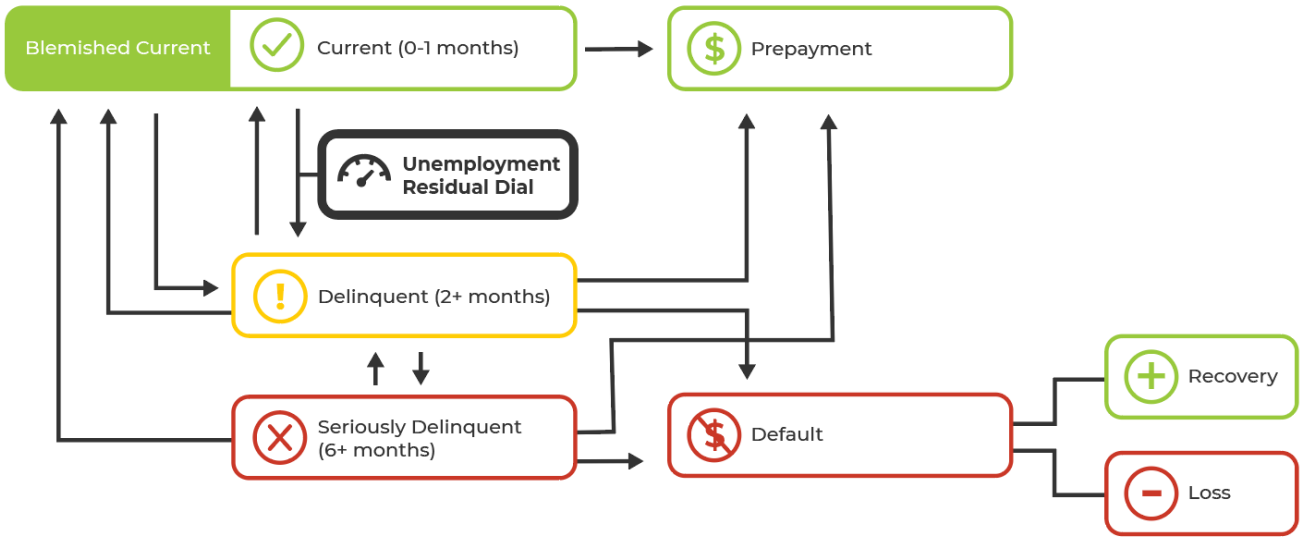
A uniform propagation of national HPI stress to states and MSAs (metropolitan statistical areas) would understate losses. A simple explanation for this is that any loan cohort contains a large portfolio of default options. Due to the nonlinear nature of an option exercise, the averaged HPI volatility does not point to the averaged option value, but rather to a lower one. Therefore, we "localize" HPI stresses by following the coefficients in our Geographical Localizer. For example, if region X is N times more volatile (net of the common factor) than the national index, its decline will be N times the national decline (again, net of the common factor). In addition, home prices in California are projected to decline much more than the national index in the Adverse and Severely Adverse Cases despite being possibly more optimistic in the Base Case.

[7] A. Levin and L. Wu, "CCAR 2017: Stress Scenarios, Analytical Extensions and Loss Projections," *The Pipeline* 146 (February 2017).

The Role of Unemployment

Unemployment is not an explicit factor in the Non-Agency LDM or any LDM prior to version 3.0, but it is utilized in our CCAR process. In doing so, we avoid double-counting the stresses by first subtracting an unemployment component statistically explained by home prices (and, lately, interest rates). Therefore, only the differential unemployment, termed "unemployment residual," affects the new delinquency (Current-to-Delinquent, or CtoD) transition with LDM. Figure A2 below, reproduced from our prior publications, illustrates where the unemployment residual term is factored into the well-known LDM structure.

Figure A2. LoanDynamics Model with Unemployment Interference (v2.2 and prior)



These dials are already implemented in AD&Co's Financial Engineering OAS subroutine (and the products using it). They are sent as files to LDM vendors for implementation.

Starting with version 3.0, unemployment factor enters LDM's CtoD transition explicitly (ALDM+ only).