

ANALYSIS

Prepared by

Tony Hughes
Tony.Hughes@moodys.com
Managing Director

Contact Us

Email
help@economy.com

U.S./Canada
+1.866.275.3266

EMEA
+44.20.7772.5454 (London)
+420.224.222.929 (Prague)

Asia/Pacific
+852.3551.3077

All Others
+1.610.235.5299

Web
www.economy.com
www.moodysanalytics.com

Market Share-Based Credit Analysis

Introduction

When credit scoring or conducting portfolio analysis, credit modelers typically rely on a handful of proven methodological approaches. When scoring loan applications, for instance, lenders typically use externally sourced models such as the FICO score or Moody's Analytics RiskCalc; conversely, they will build internal models using broadly similar approaches. Those looking to develop a stress test or to forecast losses may employ the same basic model or one based on more aggregate portfolio-level information such as roll rates or rating transition models. Such methods are used broadly across the industry and will be well known to anyone game enough to still be reading this article.

In this paper, we provide a useful counterpoint to traditional credit performance analyses by taking a market share-based approach. We find that peer-relative measures of credit performance have well established trending and cyclical characteristics that make them highly forecastable using econometric techniques. This allows for the generation of compelling stress scenarios for bank-specific credit losses and associated series. Here we explain the rationale behind our approach and demonstrate its utility to credit analysts and business managers.

Market Share-Based Credit Analysis

BY TONY HUGHES

When credit scoring or conducting portfolio analysis, credit modelers typically rely on a handful of proven methodological approaches. When scoring loan applications, for instance, lenders typically use externally sourced models such as the FICO score or Moody's Analytics RiskCalc; conversely, they will build internal models using broadly similar approaches. Those looking to develop a stress test or to forecast losses may employ the same basic model or one based on more aggregate portfolio-level information such as roll rates or rating transition models. Such methods are used broadly across the industry and will be well known to anyone game enough to still be reading this article.

In this paper, we provide a useful counterpoint to traditional credit performance analyses by taking a market share-based approach. We find that peer-relative measures of credit performance have well established trending and cyclical characteristics that make them highly forecastable using econometric techniques. This allows for the generation of compelling stress scenarios for bank-specific credit losses and associated series. Here we explain the rationale behind our approach and demonstrate its utility to credit analysts and business managers.

Most credit analysis starts with a microeconomic behavioral model. In a loan-level context, if one can discern the relevant characteristics of a given borrower and how these interact with the external economic environment, one can predict the probability of future default with a high degree of accuracy. At the vintage, cohort or portfolio level, modeling proceeds by applying the same basic behavioral structure, albeit to more highly aggregated portfolio data.

Our approach, in contrast, considers the behavior of banks when trying to secure their desired slice of the aggregate credit pie. The nature and size of the pie are, from the perspective of the banks, taken to be exogenously determined by a separate macroeconomic model of national credit behavior.

The nature of the bank's desired slice will be determined by its strategic vision for the portfolio and the appetite for risk established by the bank's board and managers. Banks are not automatically endowed with their desired slice; rather, they have to fight to secure it in the face of competition from other banks vying to achieve similar ends.

Therefore, our method reduces the problem of credit modeling from a complex microeconomic examination of borrower behavior to a straightforward zero-sum game played by banks to secure the portfolio they deem to provide the best value for their shareholders.

In this form of analysis we are effectively assuming that no individual bank can take action that changes the trajectory of aggregate lending volume, the aggregate amount of credit risk in the system, the aggregate rate of default in any lending product, or the associated aggregate recovery rate. In other words, we are making an assumption of perfect competition in the market for lending products. It may be possible to believe that the biggest handful of banks in the U.S. has the power to shape aggregate outcomes through their actions, but it will be very difficult to identify this phenomenon in historical data. For the vast majority of U.S. banks, meanwhile, the assumption

will hold, for all intents and purposes, with watertight certainty.

Culture

At the national level, the underlying "credit culture" of the country evolves only slowly over time and in a manner that is closely related to the business cycle. The representative borrower will have a certain demand for credit, and the representative bank will have a certain appetite and ability to supply it. The total amount of credit risk in each product will wax and wane as the economy stumbles along, and these risks will be realized in a manner that is also determined by the performance of the wider economy.

For example, one can surmise that the total amount of mortgage credit risk in the system during the mid-2000s was growing rapidly. This may have been driven by technological change—the advent of originate-to-securitize or of deep subprime mortgages—by shifts in government policy or by a collective delusion that house prices would never fall across the board. It is equally true that terrible economic conditions in 2008-2009, combined with or perhaps caused by the high level of risk in the system at the outset of the recession, led mortgage default rates to explode. It was not the fault of any specific borrower or lender; it was instead a

situation in which exuberant aggregate demand for mortgages was met by an equally exuberant willingness to supply.

Considering the industry in this way dramatically eases our ability to model and forecast credit outcomes at the bank level. In traditional microeconomic frameworks, actions taken by the bank may have a profound impact on the estimated model used to assess credit performance. Let us imagine that a particular bank, relying primarily on internally built models, has always concentrated on the prime end of the credit card spectrum. Management, in its wisdom, decides to make a big push into deep subprime. It is not difficult to imagine that the bank's model, trained on prime loans, will fail to accurately project performance of the subprime part of the portfolio, from which a disproportionate amount of credit loss is likely to stem.

We exaggerate for effect here, though the principle also applies at the margin—small changes in the nature of the portfolio may damage the effectiveness of a model built with internal data only. Similarly, making a big push on collections may “bend the needle” on defaults in a way that is invisible to a probability of default model trained with a baseline level of collections activity. In the context of the macro environment, meanwhile, these actions have no impact. If aggregate collections activity or underwriting policy is related to the business cycle, macro variables will do a good job of proxying for the changing behavior of the representative bank.

Such management actions can, of course, affect the nature and size of the individual bank's slice. At this level, the relevant question concerns how the actions of the bank compare with those of peer institutions. A bank making a big push on collections, for instance, will likely enjoy higher recoveries than one taking an apathetic stance. We often speak to bank managers who tell us that a particular lending book is thriving; we then discover that the bank's performance in originating loans is poorer than that of its close rivals. Similarly, bank risk analysts are often surprised to learn that improvements in credit quality they have recently experienced in their own bank

are matched or even surpassed by comparable peer institutions.

We find that the “risk culture” of individual banks is highly persistent. In modeling an institution's behavior relative to its peers there is typically clear evidence of established trends and cycles in the behavior of the bank. Managers “pull the levers” of a given portfolio, but they are doing this in the context of a prevailing corporate culture that strongly influences their behavior. A bank may be unintentionally suffering declining market share, for example, which can be very difficult to arrest, even for talented replacement managers. Likewise, a particular bank may behave in a manner that is highly pro- or countercyclical. We do occasionally witness profound structural breaks in bank credit behavior, some examples of which will be provided later, though these are far rarer than most analysts would imagine. In most circumstances, projecting peer-relative bank-level trends and cycles provides a compelling, accurate forecast of likely future credit performance for any bank.

If nothing else, having a projection based on such a profoundly distinct modeling paradigm provides a useful benchmark against which internal projections can be compared. Such an approach also allows internal bank-level forecasts to be directly compared with selected peer institutions in an apples-to-apples manner.

In the next section we will briefly develop a mathematical framework that shows the utility of our approach and highlights the importance of the assumption of perfect competition. We will then launch into an empirical analysis of credit risk based on call report data.

Mathematical model

For bank i , define the default rate for a given lending portfolio as:

$$PD_{it} = \frac{d_{it}}{y_{it}}$$

where d_{it} is the total gross credit loss experienced by the bank at time t and y_{it} is the total volume of outstanding loans. The equivalent calculation in the aggregate,

which corresponds to the default rate for the representative bank is:

$$PD_t^* = \frac{d_t^*}{y_t^*}$$

We can then calculate the relative default rate for bank i which can be expressed as:

$$\frac{PD_{it}}{PD_t^*} = \frac{d_{it}}{y_{it}} \div \frac{d_t^*}{y_t^*}$$

or conversely:

$$\frac{PD_{it}}{PD_t^*} = \frac{d_{it}}{d_t^*} \div \frac{y_{it}}{y_t^*} = MS_i^d \div MS_i^y \quad (1)$$

which is the ratio of the market share of defaults and the market share of all loans outstanding.

It is our view that a consideration of these market share measures holds the key to constructing highly accurate and informative projections of credit behavior as well as the construction of related stress scenarios.

Let us dig further into the market share of defaults in isolation. Assume that there is a dynamic macroeconomic component, $f(x)$ that is common to all banks and an idiosyncratic component, $g_i(z_i)$ that is particular to each bank. We define $g_i(z_i)$ as a relative concept such that $g_i(z_i) > 1$ for banks with a riskier portfolio than the representative institution. The $g_i(z_i)$ component may move higher for a bank that is in the process of scaling up its operation or that is increasing its risk appetite relative to its peers. Meanwhile, $f(x)$ may move higher if the economy is deteriorating or if the overall industry is taking on more risk, as it was for mortgages back in the mid-2000s.

Assuming the components are multiplicative, we find:

$$\frac{d_{it}}{d_t^*} = MS_{0i}^d \frac{f(x_t)g_i(z_{it})}{f(x_t)} = MS_{0i}^d \times g_i(z_{it}) \quad (2)$$

where MS_{0i}^d is a fixed effect that represents the baseline market share of defaults for bank i .

In the context of a traditional micro model, only the numerator in (2) is consid-

ered. The key observation here is that x_t and z_{it} may contain common cyclical or trend elements that are difficult to statistically isolate since the two components are likely to interact. For example, a bank may respond to a deteriorating macroeconomic environment by attempting to reduce its exposure to riskier loans. The resultant collinearity between management action and external effect makes it difficult to disentangle the corresponding contributions to credit loss in a traditional model. A robust stress test should apply only to the external effect, leaving bank managers able to assess a range of potential responses.

The denominator in (2) lacks an idiosyncratic term, thanks to our assumption of perfect competition in the market for lending products. This algebra suggests that the market share of defaults can reasonably be expressed as a function only of bank-specific idiosyncratic elements measured relative to the representative bank—we have effectively removed the common macro effects from the equation. We could pursue a similar exposition in the context of the market share of all loans, in the market share of impaired loans—those that are delinquent by 30 days or more, say—or in the market share of recoveries.

Important to note: When modeling the cyclical elements in market share using macro variables, it is not possible to determine, a priori, the sign that each variable should take. We can therefore let the data decide whether a given bank is more beholden to the business cycle or successfully bucks against it. One should not understate the importance of this observation. When modeling internal data against macro drivers, modelers and validation teams spend an inordinate amount of angst in deciding whether the estimated signs are “correct” or not, a task made perilously difficult when a bank seeks to behave in a countercyclical manner. We expend this angst only at the macro level, where the data yield cleaner signals of cyclical behavior and where interpretation of signs is not affected by interaction between the economy and the internal behavior of any specific bank.

The vector z_{it} may contain trending or cyclical components that can be modeled

using a combination of macroeconomic data and deterministic trend and seasonal components. In terms of constructing our forecasts and stress scenarios, we concentrate on these elements, leaving more idiosyncratic behavior in the residual where its behavior can be explained by bank employees with first-hand knowledge of past actions taken by the bank. In forming projections, we assume that historical correlation to the business cycle will continue through the forecast horizon.

Risk appetite

Objectively measuring someone's appetite for food is a difficult exercise. We can ask someone how hungry he is or we can guess his appetite based on his observed actions in the kitchen. Appetite is the person's *desired* rate of consumption, which may or may not be comparable to the observed rate at which she is eating. If I observe someone gorging on food, I can reasonably infer that he was recently very hungry. If someone is not eating, it may be that the fridge is empty, she is on a strict diet, or that she is simply not very hungry.

In banking, the definition of appetite as it pertains to risk is fundamentally identical. The Institute of Risk Management, for example, defines risk appetite as “the amount and type of risk that an organization is willing to take in order to meet their strategic objectives.” The organization may want to take on more risk than it currently holds but is constrained by competitive pressures or by a lack of demand.

Conversely, regulators may be forcing it to maintain a strict diet.

In terms of an *objective* measure of risk appetite—one that can be compared across banks or across time—we propose the Relative Realized Risk Ratio. Mathematically, the RRRR is identical in form to (1), though there are a number of variations that can be considered with the available data. In the call reports, we have access to gross and net charge-offs by product and also data on the stock of impaired loans (those that are 30 or 90 days past due) held by the bank at any given time.

The RRRR is a very simple concept but a powerful one. We would be surprised if

banks did not routinely consider how their observed default rates compare with industry averages or to selected peers. Our contribution is to make the alternative market share-based decompositions explicit and to highlight the fact that these decompositions clear the way for effective forecasts and stress scenarios to be developed.

One practical problem when using gross or net charge-offs as the basis for the calculation of the RRRR is that banks sometimes report negative numbers, perhaps due to loan curing or various accounting rules regarding the timing of defaults. The default data are flows; we find that stock variables typically behave more cleanly in the current context. When using underlying data on flows, we recommend that smoothing techniques be used to lessen the probability of observing negative outcomes.

Empirical findings

In this paper we will mainly rely on the stock of impaired loans (those more than 30 days past due) as the basis for the calculation of RRRR. We use smoothing techniques for clarity, though the underlying series are generally well-behaved.

Table 1 below shows the 16 largest super-regional banks in the U.S. ranked according to their RRRR for all loan and lease products combined. Rather than using the overall industry as the benchmark, here we use behavior of the peer group as the point of comparison. This choice has little bearing on the qualitative nature of our findings, though this group is, generally speaking, observed to be more risk-averse than the broader population of banks. To smooth the underlying series, we use an eight-quarter trailing moving average so the data reflect behavior over the two-year window ended in the stated quarter. We can compare the behavior of a recent period with behavior during the dark days of the Great Recession as well as the period immediately prior to the onset of that event.

Over the past two years, M&T Bank has had the highest ratio of impaired loans to total loans. At various other times in history, however, it has been among the group of banks with the lowest measured appetite for risk. Indeed, through the recession we find

Table 1: Realized Relative Risk Ratios for All Loans and Leases

Bank	2017Q2		2009Q4		2005Q4	
	RRRR	Rank	RRRR	Rank	RRRR	Rank
M&T Bank	2.45	1	0.7	13	1.18	4
SunTrust	1.7	2	1.32	1	1.17	5
BB&T	1.28	3	1.19	4	0.8	12
Regions	1.08	4	1.24	3	1.29	3
BMO Harris	1.07	5	1.09	6	1.06	7
Huntington	1.03	6	1.17	5	1.53	1
Fifth Third	0.95	7	1.3	2	1.05	8
Key Corp.	0.74	8	1.02	9	1.14	6
Compass	0.65	9	1.09	7	0.91	11
Citizens	0.56	10	0.6	14	0.62	14
Santander	0.53	11	1.04	8	1.04	9
Northern Trust	0.49	12	0.93	10	1.36	2
Zions	0.48	13	0.93	11	0.68	13
Bancwest	0.41	14	0.77	12	0.93	10
Comerica	0.4	15	0.57	15	0.39	16
MUFG Americas	0.27	16	0.46	16	0.4	15

Sources: FDIC, Moody's Analytics

that M&T's RRRR was below all banks save for Citizens, Comerica and Union Bank. There is evidence, therefore, that M&T seeks to run a countercyclical lending policy—consolidating the portfolio when the economic outlook is uncertain while looking to cash in when times are good. We see this type of behavior quite a bit across the banking industry.

Most banks, though, are more consistent in their behavior over time. Union Bank, for example, has enjoyed an invariably low rate of impaired loans over the entire period of the data and currently has the lowest observed risk appetite for all banks. SunTrust and Regions are consistently observed to be above average in their tolerance for risk. Huntington and Northern Trust, meanwhile, have historically been very aggressive at various points but are now exhibiting a far higher level of risk aversion.

The fact that M&T Bank heads this particular league table is not, of itself, a judgment on the soundness of its business. It merely points out that this bank has recently experienced the highest rate of loss realizations relative to portfolio size among the cohort. If the bank's earnings are rising in line with the higher level of risk that is present in the portfolio, and if the bank is adequately capitalized to cover a potentially higher rate of losses, the strategy of increasing risk tolerance

should be of little concern. Society, after all, needs banks to take some risks to help fuel growth in a dynamic economic environment.

Chart 1 shows the evolution of the underlying market share components (those in equation (2)) for Comerica. This bank clearly takes a conservative stance and has consistently enjoyed a lower rate of loan impairment than one might expect, given its overall prominence in the market. We show the history of the series going back to 2002 and depict baseline and severely adverse projections under the 2018 Comprehensive Capital Analysis and Review scenarios.

Comerica's share of the peer group has been in slow decline throughout the period in question. Its share of all loans and leases has trended down from 5.3% to around 3.9% in the most recent period. The share of impaired loans has fallen approximately proportionally. The other key feature of the series is that they are both highly cyclical. Bear in mind that these are mar-

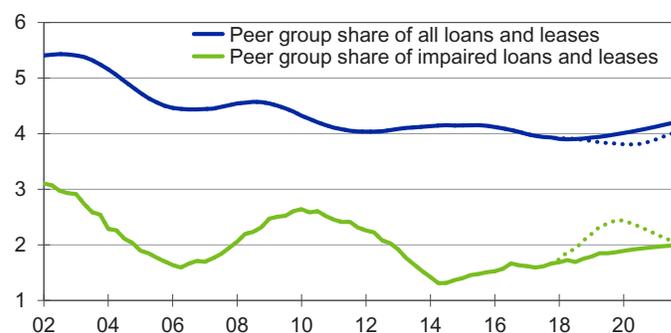
ket shares viewed in isolation—we have no a priori expectations for whether these series will exhibit pro- or countercyclical tendencies (though bank insiders should be able to readily form such expectations).

It turns out, though, that Comerica's share of impairments is highly countercyclical in the sense that the prevalence of bad loans tends to rise during periods of recession and fall commensurately with improving economic conditions. During the 2002-2006 economic expansion, Comerica's share of bad loans declined from 3% to 1.6% and then increased to 2.7% during the Great Recession. As the economy improved in 2012 and 2013, the bank's share of impairments fell once more. Over the past few years, the share has ticked higher but currently lies slightly below the long-term trend level. Under baseline future conditions, we therefore expect this share to inch slightly higher. Because Comerica typically endures a rising share of recession-induced impairments, our severely adverse projection shows a more rapid ascent, nudging toward 2.5% during the darkest days. Managers could take action to buck these cycles, though past behavior suggests that they will face an uphill battle to contain impairments during a period of renewed stress.

The cyclical behavior of overall market share is less obvious but nonetheless apparent. Though market share for Comerica rose slightly in 2007 and 2008, our models identify a slight procyclicality. As a result, severely adverse projections for Comerica's peer group prominence are slightly below those seen for the baseline scenario.

Chart 1: Comerica Conservative

2018 CCAR baseline (solid), severely adverse (dotted), 8-qtr MA, %



Sources: FDIC Statistics on Depository Institutions, Moody's Analytics

Chart 2: Huntington Hunts Safety

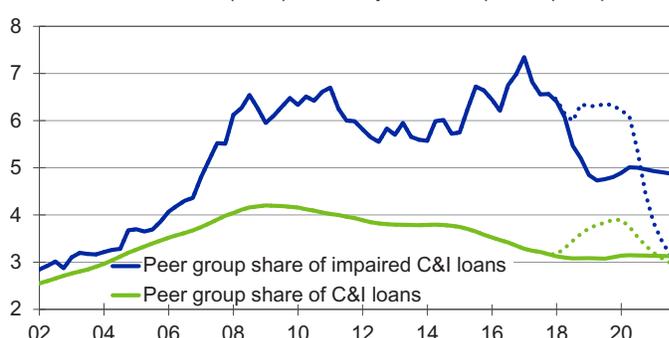
2018 CCAR baseline (solid), severely adverse (dotted), 8-qtr MA, %



Sources: FDIC Statistics on Depository Institutions, Moody's Analytics

Chart 3: Yawning C&I Gap at Zions

2018 CCAR baseline (solid), severely adverse (dotted), 8-qtr MA, %



Sources: FDIC Statistics on Depository Institutions, Moody's Analytics

While Comerica's share of impaired loans tends to rise in recessions, it must be remembered that the share for the representative bank is time-invariant by definition. This implies that we must be able to find other peer group members with the polar opposite relationship to the business cycle.

The example we will use here is Huntington, which is depicted in Chart 2. This bank also provides an example of a possible structural break in behavior, though this observation is debatable. Prior to the Great Recession, Huntington maintained a portfolio that experienced above-par levels of impaired loans—its RRRR was well above unity. During and since the recession, however, the bank has succeeded in improving the credit quality of its portfolio and is now projected to enjoy lower rates of impaired loans than expected, given its overall market prominence. It may be that this improvement in performance is trend-based, or it may suggest a more specific cultural shift in the mid-2000s to gear the bank toward safer lending practices.

In terms of cyclical, meanwhile, we can observe that Huntington's share of impaired loans tends to be highly procyclical. During times of economic expansion, the bank's scale of its impaired loan portfolio often rises relative to those of its peers, and its performance in recessions tends to be better than average. This connection to the business cycle leads us to project a more sanguine performance under severely adverse conditions than we would for the representative peer group member.

Commercial and industrial loans

Using the call report data, we can easily extend this analysis to specific products. Turning first to commercial and industrial loans (see Table 2), we find that BMO Harris has had the highest appetite for risk, as measured by realizations of impaired loans, over the past two years. This result is something of an anomaly, given that the bank experienced low losses during the recession and is normally situated in the middle of the risk group. In C&I lending it is more likely that a midsize institution may be impacted by a large default or two, which will increase the institution's perceived risk appetite.

Zions, which also has a high RRRR for C&I loans, is perhaps a more interesting case study (see Chart 3). Leading up to the recession, the bank was able to capture an increasing share of the peer group C&I portfolio, and the share of impaired loans was rising at a similar rate. Zions' impairments, though, are somewhat countercyclical, which means that bad loans tend to rise at a faster clip, in recession, than the representative institution. After the recession, while overall market share leveled off and then fell slightly, the bank's share of impaired loans ratcheted higher. A yawning gap has opened between the two curves over the past three years.

Table 2: Realized Relative Risk Ratios for C&I Loans

Bank	2017Q2		2009Q4		2005Q4	
	RRRR	Rank	RRRR	Rank	RRRR	Rank
BMO Harris	4.45	1	0.79	11	1.15	6
Zions	2.13	2	1.48	4	1.08	8
Key Corp.	1.29	3	1.57	2	0.73	13
M&T Bank	1.26	4	0.51	14	0.92	11
Comerica	1.23	5	0.38	16	0.35	16
BB&T	0.86	6	1.04	10	0.94	10
Huntington	0.84	7	1.48	3	1.64	2
Northern Trust	0.79	8	3.19	1	3.21	1
Bancwest	0.75	9	1.08	9	1.54	3
Compass	0.65	10	1.17	7	0.77	12
Regions	0.62	11	1.09	8	1.34	4
Santander	0.57	12	1.17	6	0.94	9
Citizens	0.51	13	0.65	13	0.47	15
SunTrust	0.5	14	0.65	12	1.34	5
Fifth Third	0.29	15	1.18	5	1.12	7
MUFG Americas	0.28	16	0.38	15	0.51	14

Sources: FDIC, Moody's Analytics

Chart 4: Northern Trust Shifted C&I Course

2018 CCAR baseline (solid), severely adverse (dotted), 8-qtr MA, %



Sources: FDIC Statistics on Depository Institutions, Moody's Analytics

As stated previously, this type of trend is of little consequence, provided the bank remains well capitalized and earnings from the portfolio are rising in line with its underlying risk.

The trend toward poorer quality C&I loans, though, demands deeper consideration. In large part, the trend may be due to Zions' exposure to oil and gas producers in the middle of the U.S. that have been hit hard by declining energy prices since the recession. If this is true, we should see the bank gradually return toward the par state as these markets stabilize. Our technique, which merely extrapolates the established historical relationship to the business cycle, suggests that such a correction will now occur, at least partially. Our tool further suggests that Zions' portfolio is more recession-prone than average and is likely to suffer high losses if a recession now ensues. We also find that Zions tends to adjust quickly on the back end of recessions—the prevalence of impaired loans falls rapidly during 2020 and 2021.

The other bank that stands out in this league table is Northern Trust. Prior to and during the recession it ran a risky C&I portfolio and at one point during 2009 held an RRRR of 4.1. It has since decided to take a more conservative stance to commercial lending and since the recession has been among the safer banks in the cohort (see Chart 4). This is a clear example of an institution implementing a sharp structural break, shifting a risk-seeking posture in favor of a more conservative underwriting policy almost overnight. Comerica and M&T, in

contrast, adopted relatively riskier postures after the recession. Note, too, that Northern Trust's share behavior has not generally been very cyclical in nature. As a result, projections for the portfolio's performance show only minor variations when a stress scenario is

employed. Though the structural break occurred during the recession, our technique does not replicate the sharp drop in impaired loans in a renewed stress event.

Readers should note that when such share forecasts are combined with underlying macro forecasts, the Northern Trust C&I book experiences a significant deterioration relative to baseline. It is only when viewed relative to the representative institution that its performance is unaffected by stress.

Mortgage

Although Zions currently has the riskiest C&I posture, as measured by the RRRR, the bank currently enjoys the safest mortgage

portfolio in the peer group. We commented on a yawning gap in Zions' C&I portfolio—interestingly, a similar gap is opening in its mortgage book, albeit in the direction of increased safety.

In general, the league table (see Table 3) for mortgages is quite similar to that for the overall lending book. Some institutions shuffle higher, while others, including Zions, move down the list in terms of riskiness. M&T is found to have had the most liberal lending policy of late, while Union Bank has, apart from Zions, the safest portfolio of all banks considered. Bear in mind that these numbers are for all loans backed by residential property, including HELOCs, first and second mortgages.

As before, we can identify a few interesting case studies in this product. One question to consider is the effect of acquisitions on the analysis. We may posit that banks that acquired failed rivals during the Great Recession would witness unusual behavior in the years since. Banks primarily failed because of poor underwriting practices in mortgages. The technique used here subsumes all historical data on the failed banks into the legacy data for the new parent at all historical time points.

In this peer group, two acquisitions stand out, both of which occurred within

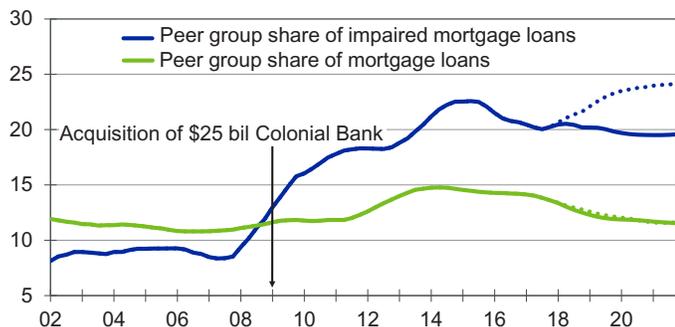
Table 3: Realized Relative Risk Ratios for All Mortgages

Bank	2017Q2		2009Q4		2005Q4	
	RRRR	Rank	RRRR	Rank	RRRR	Rank
M&T Bank	2.6	1	0.88	9	1.64	2
BB&T	1.63	2	1.47	2	0.93	8
Fifth Third	1.52	3	1.42	3	1.2	6
Regions	1.25	4	1.37	4	1.37	3
Huntington	1	5	1.55	1	1.83	1
BMO Harris	0.93	6	1	7	0.8	11
SunTrust	0.89	7	1.36	5	0.71	12
Santander	0.78	8	1.28	6	1.25	5
Key Corp.	0.54	9	0.54	12	1.32	4
Compass	0.53	10	0.96	8	1.04	7
Comerica	0.49	11	0.78	10	0.85	9
Citizens	0.37	12	0.44	13	0.44	14
Bancwest	0.27	13	0.55	11	0.83	10
Northern Trust	0.23	14	0.41	15	0.39	15
MUFG Americas	0.2	15	0.34	16	0.23	16
Zions	0.13	16	0.41	14	0.53	13

Sources: FDIC, Moody's Analytics

Chart 5: BB&T Slip Caused by Merger?

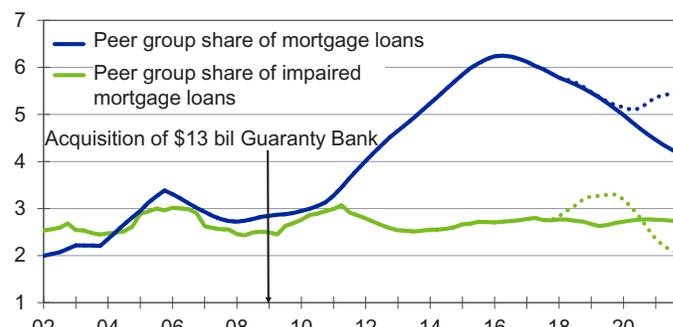
2018 CCAR baseline (solid), severely adverse (dotted), 8-qtr MA, %



Sources: FDIC Statistics on Depository Institutions, Moody's Analytics

Chart 6: Compass Unaffected by Merger

2018 CCAR baseline (solid), severely adverse (dotted), 8-qtr MA, %



Sources: FDIC Statistics on Depository Institutions, Moody's Analytics

one week of each other in August 2009. In this month, BB&T acquired the \$25 billion Colonial Bank of Alabama, the subject of a major fraud case that has sent at least two people to jail. Days later, BBVA Compass acquired the \$13 billion Guaranty Bank of Texas, which was forced to sell after taking a large write-down of its holdings of mortgage-backed securities.

Chart 5 depicts the behavior of BB&T and Colonial's collective mortgage holdings through this period. Quite clearly, impairments in the book were rising several quarters before the acquisition was implemented. The important question here is whether BB&T's legacy book was experiencing problems prior to the August merger. If the evident problems resided solely on Colonial's books, BB&T managers could reasonably argue that its underlying culture does not make the bank recession-prone. Exploring the data for the two separate banks prior to

the acquisition, however, reveals that the rise in the share of impaired loans was due to a deterioration in the legacy book of BB&T. This suggests that the forecast indicating declining performance under the severely adverse scenario is sound. Colonial primarily failed because of fraud, not necessarily as a consequence of poor lending in the mortgage sphere.

In a similar example, Chart 6 shows BBVA Compass' mortgage portfolio around the time of its merger with Guaranty Bank of Texas. In this case, at least in terms of on-balance sheet assets, the acquisition had no bearing on subsequent behavior of the book. Impairments for the merged bank remained very low, despite the fact that overall market share rose rapidly in the post-recession period.

The interesting thing about M&T's mortgage book (see Chart 7) is the high countercyclicality of its overall market share.

and the subsequent rise that is often seen in impairments. We note that M&T's measured level of risk in mortgage products is currently high but is predicted to fall back to levels closer to par under both alternative scenarios considered.

Conclusion

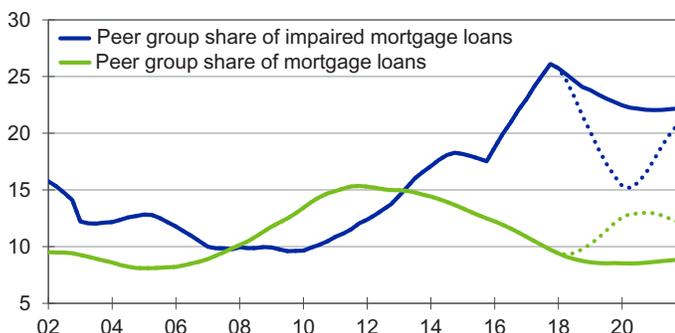
The analysis presented in this report contains no account-level behavioral analysis or credit scoring. We do not try to forecast the performance of portfolios by modeling data on the makeup of the underlying loans. We have demonstrated instead that peer-relative measures of credit performance have well-established trending and cyclical characteristics that make them highly forecastable using econometric techniques. The existence of cycles further allows us to generate compelling stress scenarios for bank-specific data.

The results described here could easily be combined with industry-level projections to produce forecasts that can be directly compared with internal stress-test results.

That trends and cycles are so prevalent in bank-level data is highly suggestive of the persistence of the institutional management culture. If bank behavior were truly idiosyncratic, with skilled managers making fleet-footed decisions on a whim and senior officials continually opting to change tack in the face of market pressures, we would fail to identify such cyclicity in the peer-relative call report data. The reality is that each bank has well-established patterns of behavior, driven by internal culture, that survive even

Chart 7: M&T Performs Better in Recession

2018 CCAR baseline (solid), severely adverse (dotted), 8-qtr MA, %



Sources: FDIC Statistics on Depository Institutions, Moody's Analytics

During periods of recession, the tail end of the 2001 event, as well as the Great Recession, M&T tends to raise its mortgage market share. Its prominence in the market then declines as the economic expansion matures. There tends to be a lag between aggressive originations activity

in the face of acquisitions or other big shifts in the makeup of management.

We did identify a few cases in which significant directional shifts were implemented; the techniques used here allowed such breaks to be exposed and pinpointed. The forecasts developed were not fooled by these sudden movements, recognizing them as structural breaks and not conflating them with cyclical behavior in the broader economy. This was true even when the breaks occurred during recessions. The models instead focused on cyclical and trend behavior in the bank-level data and projected accordingly.

The uses of these projections are many and varied. Because the forecasts are built using a modeling paradigm that is com-

pletely at odds with standard approaches, the numbers provide an ideal benchmark for internal models. That we can produce these forecasts for any U.S. bank, relying only on public information, means that any institution can use our forecasts to compare themselves with any nominated peer using a consistent methodology. Small banks, or any institution trying to contain the cost of stress-testing, could use the data to produce an accurate stress test of the entire set of financial statements in a highly cost-effective manner. Banks looking for acquisition targets could apply our models to accurately assess the recession sensitivity of various targets.

The forecasts are also likely to be hard to beat for accuracy. As mentioned at the

outset, the underlying structure here—a competitive game among banks to produce portfolios that are consistent with the investment requirements of shareholders—is far simpler than the behavioral framework typically employed by micro credit modelers. In forecasting, such parsimonious models are often extremely accurate, providing a difficult challenge for more complex formulations.

We have previously demonstrated the application of Moody's Analytics Bank Call Report Forecasts in the context of deposit modeling and pre-provision net revenue forecasting. The results described here give ample demonstration of the power of the technique in credit modeling as well.

About the Author

Tony Hughes is a managing director of research at Moody's Analytics. He serves as head of a small group of high-caliber modelers, charged with identifying new business opportunities for the company. Prior to this appointment, he led the Consumer Credit Analytics team for eight years from its inception in 2007. His first role after joining the company in 2003 was as lead economist and head of the Sydney office of the company Moody's Economy.com.

Dr. Hughes helped develop a number of Moody's Analytics products. He proposed the methodology behind CreditCycle and CreditForecast 4.0, developed the pilot version of the Stressed EDF module for CreditEdge, and initiated the construction of the Portfolio Analyzer (ABS) product that provides forecasts and stress scenarios of collateral performance for structured securities worldwide. More recently, he championed and oversaw the development of AutoCycle, a tool that provides forecasts and stress scenarios for used-car prices at the make/model/year level. He has a current development project related to quantifying counterparty network risks that can be applied to the assessment of systemic risk in the financial system.

In the credit field, Dr. Hughes' research has covered all forms of retail lending, large corporate loans, commercial real estate, peer-to-peer, structured finance and the full range of pre-provision net revenue elements. He has conducted innovative research in deposit modeling and in the construction of macroeconomic scenarios for use in stress-testing.

Dr. Hughes has managed a wide variety of large projects for major banks and other lending institutions. In addition, he has published widely, in industry publications such as American Banker, Nikkei, GARP, and the Journal of Structured Finance as well as several papers in peer reviewed academic journals. He obtained his PhD in econometrics from Monash University in Australia in 1997.

About Moody's Analytics

Moody's Analytics provides financial intelligence and analytical tools supporting our clients' growth, efficiency and risk management objectives. The combination of our unparalleled expertise in risk, expansive information resources, and innovative application of technology helps today's business leaders confidently navigate an evolving marketplace. We are recognized for our industry-leading solutions, comprising research, data, software and professional services, assembled to deliver a seamless customer experience. Thousands of organizations worldwide have made us their trusted partner because of our uncompromising commitment to quality, client service, and integrity.

Concise and timely economic research by Moody's Analytics supports firms and policymakers in strategic planning, product and sales forecasting, credit risk and sensitivity management, and investment research. Our economic research publications provide in-depth analysis of the global economy, including the U.S. and all of its state and metropolitan areas, all European countries and their subnational areas, Asia, and the Americas. We track and forecast economic growth and cover specialized topics such as labor markets, housing, consumer spending and credit, output and income, mortgage activity, demographics, central bank behavior, and prices. We also provide real-time monitoring of macroeconomic indicators and analysis on timely topics such as monetary policy and sovereign risk. Our clients include multinational corporations, governments at all levels, central banks, financial regulators, retailers, mutual funds, financial institutions, utilities, residential and commercial real estate firms, insurance companies, and professional investors.

Moody's Analytics added the economic forecasting firm Economy.com to its portfolio in 2005. This unit is based in West Chester PA, a suburb of Philadelphia, with offices in London, Prague and Sydney. More information is available at www.economy.com.

Moody's Analytics is a subsidiary of Moody's Corporation (NYSE: MCO). Further information is available at www.moodyanalytics.com.

DISCLAIMER: Moody's Analytics, a unit of Moody's Corporation, provides economic analysis, credit risk data and insight, as well as risk management solutions. Research authored by Moody's Analytics does not reflect the opinions of Moody's Investors Service, the credit rating agency. To avoid confusion, please use the full company name "Moody's Analytics", when citing views from Moody's Analytics.

About Moody's Corporation

Moody's Analytics is a subsidiary of Moody's Corporation (NYSE: MCO). MCO reported revenue of \$4.2 billion in 2017, employs approximately 11,900 people worldwide and maintains a presence in 41 countries. Further information about Moody's Analytics is available at www.moodyanalytics.com.

© 2018 Moody's Corporation, Moody's Investors Service, Inc., Moody's Analytics, Inc. and/or their licensors and affiliates (collectively, "MOODY'S"). All rights reserved.

CREDIT RATINGS ISSUED BY MOODY'S INVESTORS SERVICE, INC. AND ITS RATINGS AFFILIATES ("MIS") ARE MOODY'S CURRENT OPINIONS OF THE RELATIVE FUTURE CREDIT RISK OF ENTITIES, CREDIT COMMITMENTS, OR DEBT OR DEBT-LIKE SECURITIES, AND MOODY'S PUBLICATIONS MAY INCLUDE MOODY'S CURRENT OPINIONS OF THE RELATIVE FUTURE CREDIT RISK OF ENTITIES, CREDIT COMMITMENTS, OR DEBT OR DEBT-LIKE SECURITIES. MOODY'S DEFINES CREDIT RISK AS THE RISK THAT AN ENTITY MAY NOT MEET ITS CONTRACTUAL, FINANCIAL OBLIGATIONS AS THEY COME DUE AND ANY ESTIMATED FINANCIAL LOSS IN THE EVENT OF DEFAULT. CREDIT RATINGS DO NOT ADDRESS ANY OTHER RISK, INCLUDING BUT NOT LIMITED TO: LIQUIDITY RISK, MARKET VALUE RISK, OR PRICE VOLATILITY. CREDIT RATINGS AND MOODY'S OPINIONS INCLUDED IN MOODY'S PUBLICATIONS ARE NOT STATEMENTS OF CURRENT OR HISTORICAL FACT. MOODY'S PUBLICATIONS MAY ALSO INCLUDE QUANTITATIVE MODEL-BASED ESTIMATES OF CREDIT RISK AND RELATED OPINIONS OR COMMENTARY PUBLISHED BY MOODY'S ANALYTICS, INC. CREDIT RATINGS AND MOODY'S PUBLICATIONS DO NOT CONSTITUTE OR PROVIDE INVESTMENT OR FINANCIAL ADVICE, AND CREDIT RATINGS AND MOODY'S PUBLICATIONS ARE NOT AND DO NOT PROVIDE RECOMMENDATIONS TO PURCHASE, SELL, OR HOLD PARTICULAR SECURITIES. NEITHER CREDIT RATINGS NOR MOODY'S PUBLICATIONS COMMENT ON THE SUITABILITY OF AN INVESTMENT FOR ANY PARTICULAR INVESTOR. MOODY'S ISSUES ITS CREDIT RATINGS AND PUBLISHES MOODY'S PUBLICATIONS WITH THE EXPECTATION AND UNDERSTANDING THAT EACH INVESTOR WILL, WITH DUE CARE, MAKE ITS OWN STUDY AND EVALUATION OF EACH SECURITY THAT IS UNDER CONSIDERATION FOR PURCHASE, HOLDING, OR SALE.

MOODY'S CREDIT RATINGS AND MOODY'S PUBLICATIONS ARE NOT INTENDED FOR USE BY RETAIL INVESTORS AND IT WOULD BE RECKLESS AND INAPPROPRIATE FOR RETAIL INVESTORS TO USE MOODY'S CREDIT RATINGS OR MOODY'S PUBLICATIONS WHEN MAKING AN INVESTMENT DECISION. IF IN DOUBT YOU SHOULD CONTACT YOUR FINANCIAL OR OTHER PROFESSIONAL ADVISER.

ALL INFORMATION CONTAINED HEREIN IS PROTECTED BY LAW, INCLUDING BUT NOT LIMITED TO, COPYRIGHT LAW, AND NONE OF SUCH INFORMATION MAY BE COPIED OR OTHERWISE REPRODUCED, REPACKAGED, FURTHER TRANSMITTED, TRANSFERRED, DISSEMINATED, REDISTRIBUTED OR RESOLD, OR STORED FOR SUBSEQUENT USE FOR ANY SUCH PURPOSE, IN WHOLE OR IN PART, IN ANY FORM OR MANNER OR BY ANY MEANS WHATSOEVER, BY ANY PERSON WITHOUT MOODY'S PRIOR WRITTEN CONSENT.

All information contained herein is obtained by MOODY'S from sources believed by it to be accurate and reliable. Because of the possibility of human or mechanical error as well as other factors, however, all information contained herein is provided "AS IS" without warranty of any kind. MOODY'S adopts all necessary measures so that the information it uses in assigning a credit rating is of sufficient quality and from sources MOODY'S considers to be reliable including, when appropriate, independent third-party sources. However, MOODY'S is not an auditor and cannot in every instance independently verify or validate information received in the rating process or in preparing the Moody's publications.

To the extent permitted by law, MOODY'S and its directors, officers, employees, agents, representatives, licensors and suppliers disclaim liability to any person or entity for any indirect, special, consequential, or incidental losses or damages whatsoever arising from or in connection with the information contained herein or the use of or inability to use any such information, even if MOODY'S or any of its directors, officers, employees, agents, representatives, licensors or suppliers is advised in advance of the possibility of such losses or damages, including but not limited to: (a) any loss of present or prospective profits or (b) any loss or damage arising where the relevant financial instrument is not the subject of a particular credit rating assigned by MOODY'S.

To the extent permitted by law, MOODY'S and its directors, officers, employees, agents, representatives, licensors and suppliers disclaim liability for any direct or compensatory losses or damages caused to any person or entity, including but not limited to by any negligence (but excluding fraud, willful misconduct or any other type of liability that, for the avoidance of doubt, by law cannot be excluded) on the part of, or any contingency within or beyond the control of, MOODY'S or any of its directors, officers, employees, agents, representatives, licensors or suppliers, arising from or in connection with the information contained herein or the use of or inability to use any such information.

NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE ACCURACY, TIMELINESS, COMPLETENESS, MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE OF ANY SUCH RATING OR OTHER OPINION OR INFORMATION IS GIVEN OR MADE BY MOODY'S IN ANY FORM OR MANNER WHATSOEVER.

Moody's Investors Service, Inc., a wholly-owned credit rating agency subsidiary of Moody's Corporation ("MCO"), hereby discloses that most issuers of debt securities (including corporate and municipal bonds, debentures, notes and commercial paper) and preferred stock rated by Moody's Investors Service, Inc. have, prior to assignment of any rating, agreed to pay to Moody's Investors Service, Inc. for appraisal and rating services rendered by it fees ranging from \$1,500 to approximately \$2,500,000. MCO and MIS also maintain policies and procedures to address the independence of MIS's ratings and rating processes. Information regarding certain affiliations that may exist between directors of MCO and rated entities, and between entities who hold ratings from MIS and have also publicly reported to the SEC an ownership interest in MCO of more than 5%, is posted annually at www.moody's.com under the heading "Investor Relations — Corporate Governance — Director and Shareholder Affiliation Policy."

Additional terms for Australia only: Any publication into Australia of this document is pursuant to the Australian Financial Services License of MOODY'S affiliate, Moody's Investors Service Pty Limited ABN 61 003 399 657AFSL 336969 and/or Moody's Analytics Australia Pty Ltd ABN 94 105 136 972 AFSL 383569 (as applicable). This document is intended to be provided only to "wholesale clients" within the meaning of section 761G of the Corporations Act 2001. By continuing to access this document from within Australia, you represent to MOODY'S that you are, or are accessing the document as a representative of, a "wholesale client" and that neither you nor the entity you represent will directly or indirectly disseminate this document or its contents to "retail clients" within the meaning of section 761G of the Corporations Act 2001. MOODY'S credit rating is an opinion as to the creditworthiness of a debt obligation of the issuer, not on the equity securities of the issuer or any form of security that is available to retail investors. It would be reckless and inappropriate for retail investors to use MOODY'S credit ratings or publications when making an investment decision. If in doubt you should contact your financial or other professional adviser.

Additional terms for Japan only: Moody's Japan K.K. ("MJKK") is a wholly-owned credit rating agency subsidiary of Moody's Group Japan G.K., which is wholly-owned by Moody's Overseas Holdings Inc., a wholly-owned subsidiary of MCO. Moody's SF Japan K.K. ("MSFJ") is a wholly-owned credit rating agency subsidiary of MJKK. MSFJ is not a Nationally Recognized Statistical Rating Organization ("NRSRO"). Therefore, credit ratings assigned by MSFJ are Non-NRSRO Credit Ratings. Non-NRSRO Credit Ratings are assigned by an entity that is not a NRSRO and, consequently, the rated obligation will not qualify for certain types of treatment under U.S. laws. MJKK and MSFJ are credit rating agencies registered with the Japan Financial Services Agency and their registration numbers are FSA Commissioner (Ratings) No. 2 and 3 respectively.

MJKK or MSFJ (as applicable) hereby disclose that most issuers of debt securities (including corporate and municipal bonds, debentures, notes and commercial paper) and preferred stock rated by MJKK or MSFJ (as applicable) have, prior to assignment of any rating, agreed to pay to MJKK or MSFJ (as applicable) for appraisal and rating services rendered by it fees ranging from JPY200,000 to approximately JPY350,000,000.

MJKK and MSFJ also maintain policies and procedures to address Japanese regulatory requirements.