



HAL
open science

Risk Asymmetry in Contingent Capital: An evaluation of trigger thresholds and the role of supervisory discretion

Stuart Macdonnell

► **To cite this version:**

Stuart Macdonnell. Risk Asymmetry in Contingent Capital: An evaluation of trigger thresholds and the role of supervisory discretion. Business administration. HESAM Université, 2021. English. NNT: 2021HESAC033 . tel-03652148

HAL Id: tel-03652148

<https://theses.hal.science/tel-03652148>

Submitted on 26 Apr 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

DEPARTEMENT ÉCONOMIE, FINANCE, ASSURANCE, BANQUE
le Laboratoire d'Excellence en Régulation Financière

THÈSE

présentée par : **Stuart MACDONNELL**

soutenue le : **18 novembre 2021**

pour obtenir le grade de : **Docteur d'HESAM Université**

préparée au : **Conservatoire national des arts et métiers**

Discipline : **Sciences de gestion et du management**

Spécialité : **Expertise et ingénierie financière**

ASYMETRIE DES RISQUES DANS LES FONDS PROPRES CONDITIONNELS

**Une évaluation des seuils de déclenchement et du rôle
du pouvoir discrétionnaire des autorités de surveillance**

THÈSE dirigée par :

M. COLLOMB Alexis, Professeur du Cnam - Finance de marché

Jury

M. le Professeur Jean-Paul LAURENT (Université Paris 1 Panthéon – Sorbonne)
Président·e, Rapporteur·e

Mme. la Professeure Olga KOLOKOLOVA (Alliance Manchester Business School)
Rapporteur·e

Mme. la Professeure Iryna VERYZHENKO (Conservatoire national des arts et métiers)
Examineur·rice

M. Preston S. KEAT (Head of Political and Country Risk, UBS)
Invité·e

Mme. Dilyara SALAKHOVA (Senior Financial Stability Expert, European Central Bank)
Invité·e

Affidavit

Je soussigné, Stuart MacDonnell, déclare par la présente que le travail présenté dans ce manuscrit est mon propre travail, réalisé sous la direction scientifique de Alexis Collomb (directeur), dans le respect des principes d'honnêteté, d'intégrité et de responsabilité inhérents à la mission de recherche. Les travaux de recherche et la rédaction de ce manuscrit ont été réalisés dans le respect de la charte nationale de déontologie des métiers de la recherche. Ce travail n'a pas été précédemment soumis en France ou à l'étranger dans une version identique ou similaire à un organisme examinateur.

Fait à Paris, le 18 novembre 2021

Signature

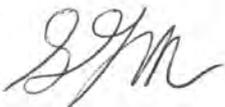


Affidavit

I, undersigned, Stuart MacDonnell, hereby declare that the work presented in this manuscript is my own work, carried out under the scientific direction of Alexis Collomb (thesis director), in accordance with the principles of honesty, integrity and responsibility inherent to the research mission. The research work and the writing of this manuscript have been carried out in compliance with the French charter for Research Integrity. This work has not been submitted previously either in France or abroad in the same or in a similar version to any other examination body.

Paris, 18 November 2021

Signature



Résumé

Nous étudions un nouveau type de capital conditionnel, les Fonds Propres Additionnels (AT1, de l'anglais « Additional Tier 1 »), conçus dans le but d'éviter les renflouements financés par les contribuables en cas de futures crises financières. Les AT1 sont conçus avec des déclencheurs automatiques pour conversion du principal, annulation du coupon et prolongation de l'échéance. Notre enquête est motivée par l'effondrement de Popular Español en juin 2017, ses AT1 n'étant pas parvenus à réduire les coupons ni à passer en capital tant que la banque était encore solvable. Nos objectifs sont triples : (1) évaluer si les ratios CET1/RWA utilisés comme seuils de déclenchement sont fixés trop bas pour que les AT1 agissent comme des fonds propres « en continuité » ; (2) déterminer l'importance de l'omission des coupons et des barrières de réinitialisation dans la formation des prix ; (3) évaluer si la portée du pouvoir discrétionnaire de surveillance compromet les mécanismes de déclenchement automatique. Nos travaux empiriques suggèrent que les investisseurs n'évaluent pas les caractéristiques de conception qui déterminent le potentiel de perte ou le taux de récupération de la valeur principale, telles que le niveau de déclenchement, le prix de conversion ou la clause de réécriture. Nos résultats indiquent que le « point de non-viabilité » est supérieur au niveau de déclenchement de l'adéquation des fonds propres, de sorte que le facteur-clé qui détermine la probabilité d'un événement imprévu est le pouvoir collectif des banques centrales d'invoquer le « PONV » (de l'anglais « Point Of Non-Viability »). Nous recommandons que le déclencheur d'adéquation des fonds propres soit basé sur une formule : les exigences du Pilier 1 plus la « composante minimale de fonds propres de base de catégorie 1 de l'exigence du Pilier 2 ». Notre proposition relèverait le seuil de déclenchement automatique d'environ 300 points de base à des ratios CET1/RWA d'environ 9,2 %, afin de permettre aux investisseurs d'évaluer plus précisément le risque de perte en principal.

Mots clefs

Stabilité financière, fonds propres conditionnels, modèles d'évaluation, discrétionnaire de surveillance, point de non-viabilité

Abstract

We investigate a new type of contingent capital, Additional Tier 1 (AT1), which is engineered with the aim of avoiding taxpayer-funded bailouts in the event of future financial crises. AT1s are designed with automatic triggers for principal conversion, coupon cancellation and maturity extension. Our investigation is motivated by the collapse of Popular Español in June 2017, given that its AT1s failed to cut coupons or convert to equity while the bank was still solvent. Our objectives are threefold: (1) to assess whether CET1/RWA ratios used as trigger levels are set too low for AT1s to act as ‘going concern’ capital; (2) to determine the prominence of coupon omission and reset barriers in price formation; (3) to evaluate if the scope for supervisory discretion is undermining the automatic triggering mechanics. Our empirical work suggests that investors do not price the design features that determine the loss potential or recovery rate of the principal value, such as the triggering level, conversion rate or write-back clause. Our findings indicate that the “point of non-viability” is above the level of the capital adequacy trigger, such that the key factor shaping the probability of a contingency event is the central banks’ collective power to invoke “PONV”. We recommend the capital adequacy trigger be based on a formula: Pillar 1 plus the minimum CET1 component of Pillar 2. Our proposal would raise the automatic triggering threshold c300 basis points to CET1/RWA ratios of c9.2%, to enable investors to assess the risk of principal loss more accurately.

Key words

Financial stability, contingent capital, valuation models, supervisory discretion, point of non-viability

| | |
|--|-----|
| RESEARCH AGENDA – EVALUATION OF THE ARCHITECTURE OF AT1s | 7 |
| I. Central Objectives | 8 |
| A. The Research Problem | 8 |
| B. Research Questions..... | 19 |
| C. Main Findings | 20 |
| D. Contributions..... | 27 |
| E. Thesis outline..... | 30 |
| INCEPTION – A SOLUTION TO STAVE OFF FUTURE CRISES | 32 |
| II. Additional Tier 1: Origins, Risk Profile & Market Growth..... | 33 |
| A. Genesis – Basel Accords, Mark III..... | 33 |
| B. Asymmetrical Risk Profile..... | 35 |
| C. Growth into a Distinct Asset Class | 46 |
| III. Incentives & Risk Shifting | 49 |
| 1. Supervisory-bank nexus..... | 49 |
| 2. National governments | 53 |
| 3. National supervisory authorities | 57 |
| 4. Bank management..... | 60 |
| 5. Investors: Shareholders vs CoCo holders..... | 63 |
| EMPIRICAL ANALYSIS OF THE ASSUMPTIONS OF VALUATION MODELS | 70 |
| IV. Literature Review: CoCo Valuation Techniques | 71 |
| A. Modelling the Capital Adequacy Trigger | 71 |
| B. Efforts to Incorporate Coupon Cancellation & Extension | 89 |
| V. Empirical Programme – Overview | 95 |
| A. Universe of CoCos..... | 95 |
| B. Continuous (dependent) variables | 98 |
| VI. Paired T-Tests..... | 105 |

| | | |
|-------|---|------------|
| 1. | CET1 trigger | 105 |
| 2. | Loss Mechanism | 108 |
| 3. | Recovery Rates | 112 |
| 4. | Trigger Levels | 120 |
| VII. | Multiple Regression Analysis | 126 |
| A. | Methodology | 126 |
| B. | Main Regression Variables | 128 |
| C. | Findings from Cross-Sectional Regressions | 136 |
| VIII. | Time Series of Market-Implied Proxies | 141 |
| A. | Lack of correlation between share prices & CET1 ratios | 145 |
| B. | Neglect of conversion prices & writeback clauses | 150 |
| | AUTOMATICITY, INTERVENTION AND FORBEARANCE | 153 |
| IX. | Evaluating the Assumption of Automatic Triggers | 154 |
| A. | Modelling as if supervisory discretion didn't exist | 154 |
| B. | SREP-MDA ratio is not incorporated as an input | 156 |
| C. | The economics of extension risk are not incorporated | 161 |
| X. | Principal Risk – ‘Going’ vs ‘Gone Concern’ Capital | 166 |
| A. | Automaticity for AT1 Principal – Capital Adequacy Barrier | 166 |
| B. | PONV Power: Early Intervention | 177 |
| C. | Bail-in Capital: The Tendency for Forbearance | 181 |
| XI. | Coupon Risk – The MDA Threshold, A Moving Target | 194 |
| A. | Automaticity for AT1 Coupons – MDA & ADI Barriers | 194 |
| B. | The MDA Trigger – A Game of Moveable Goalposts | 200 |
| C. | ADIs – Another Dimension of Coupon Risk | 220 |
| XII. | Extension Risk – Reset Rates & Future Credit Profiles | 225 |
| A. | Automaticity for Maturity – Implied Coupon at First Call | 225 |

| | | |
|-------|---|------------|
| B. | Key Determinants in the Decision to Call or Skip..... | 231 |
| C. | Structural Dimension: The Spectre of a Perpetual Vintage | 238 |
| | CASE STUDY OF FIRST AT1 CoCo CONVERSION..... | 243 |
| XIII. | Banco Popular Español – Patient Zero | 244 |
| | CONCLUSION – A PROPOSAL FOR RAISING THRESHOLDS | 257 |
| XIV. | Concluding Thoughts - A New Basis for Calculating Triggers..... | 258 |
| 1. | Valuation approaches must continue to evolve..... | 258 |
| 2. | Coupon risk mechanics should be incorporated into models | 259 |
| 3. | Maturity extension is the most salient risk | 260 |
| 4. | The role of the supervisor remains decisive..... | 261 |
| 5. | Lack of market discipline is a symptom of design flaws | 262 |
| 6. | A formula for raising the capital adequacy threshold | 265 |
| | Bibliography..... | 272 |
| | RÉSUMÉ | 285 |
| | RÉSUMÉ EN ANGLAIS | 286 |

RESEARCH AGENDA – EVALUATION OF THE ARCHITECTURE OF AT1s

This chapter sets out the research problems, motivations and questions for our dissertation.

We focus on AT1 CoCos, a new type of contingent capital engineered to recapitalise banks proactively, that can be held as Tier 1 regulatory capital.

Our overarching goals are to assess (1) whether the trigger level for conversion is set too low, in relation to the location of the point of non-viability and (2) whether the scope for discretion is undermining the automatic pre-arranged consequences of breaching a barrier.

Although AT1s are being promoted more strongly than ever, their going-concern character is being eroded. Along with the introduction of total loss-absorbing capital requirements, the European Central Bank looks set to rely on its ability to declare a non-viability event as the primary trigger and forgo automatic barriers. Making the case for higher conversion-triggering thresholds and stricter enforcement of coupon restriction rules, as opposed to a reliance on discretionary power and soft-stopper guidance, forms the focal point of our thesis.

In our view, for AT1s to fulfil their vital role in preventing future financial meltdowns they must retain their ability to recapitalise an institution while it remains solvent. We believe that contractual triggers should be allowed to function freely, as this would restore market discipline in the pricing of risks embedded in AT1s and thereby encourage bank management to follow prudent policies.

I. Central Objectives

A. The Research Problem

AT1s were designed as going concern, but are being subsumed into gone concern

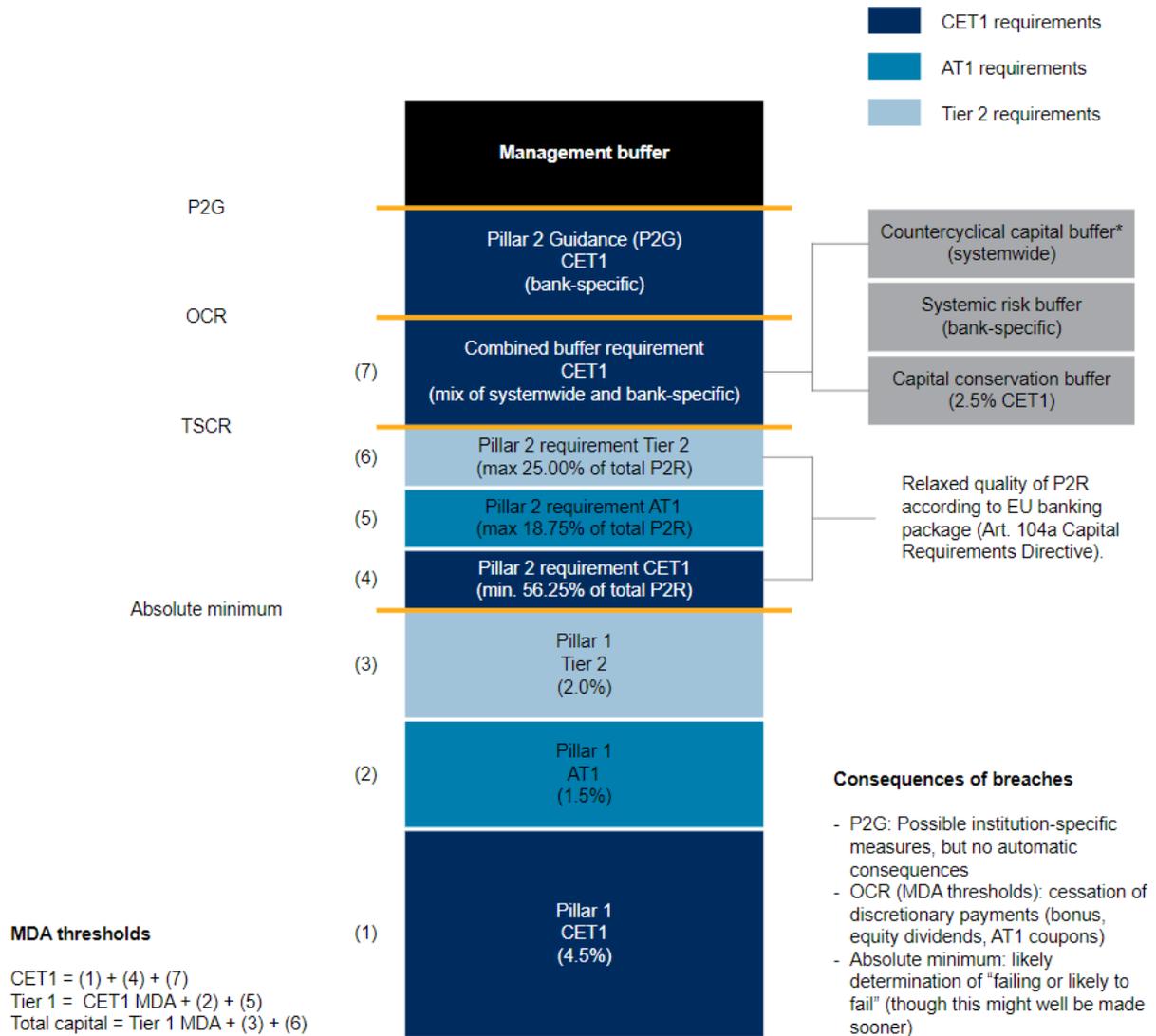
In the systemic crisis of 2007/8, a credit contraction cascaded from financial markets into the real economy. Taxpayers' money was used to resuscitate failed institutions. Subsequently, governments worldwide set for central banks the task of coming up with a solution to prevent a repeat of the 'too big to fail' phenomenon. The argument that contingent capital offered a way out of the dilemma of bank funding amid financial distress gradually gained pace. The proposal to inject contingency into the capital structure of banks was not entirely new. There were a handful of earlier examples of structured notes with contingent triggers. The deal brokered by Royal Bank of Canada (RBC) in 2001 with Swiss Re was one such case, in which Swiss Re agreed to terms that would see them inject C\$200 million into RBC in exchange for preferred shares if RBC's reserves were to fall below a pre-agreed level. The intellectual foundations for state-contingent 'reverse convertibles' had also been laid out in Mark Flannery's seminal paper (2002) on pre-committed equity injections, by which institutions can lock in advance arrangements to recapitalise themselves if large losses occur.

The idea to introduce contingency into the capital structure of banks crystallised at a meeting in Jackson Hole in August 2008. At this gathering of central bankers from around the globe a scheme was aired, which according to the official proceedings advocated that "for a bank, it may be more efficient to arrange for a contingent capital infusion in the event of a crisis, rather than keeping permanent idle (and hence agency-prone) capital sitting on the balance sheet." (Kashyap, Rajan, & Stein, 2008). The concept of pre-arranged recapitalisation then began to move into the mainstream, as a cost-effective just-in-time life preserver to buoy up banks during bouts of distress.

The Basel Committee on Banking Supervision introduced the new form of hybrid securities called Additional Tier 1 (AT1) in 2009, as a preventative measure to recapitalise credit institutions. In the same year, Lloyds became the first bank to experiment with such hybrids, followed by Credit Suisse and UBS, who issued AT1 notes in 2012. Spanish bank BBVA became the first institution in the European Union to issue AT1s, with a €1.5bn offering in May 2013. The asset class has since grown to well over €200 billion in Europe alone, with 87 banks issuing roughly 267 notes across 19 countries by end-2021. There is also a booming global market for AT1s, as well as for a sister class of securities for the insurance sector called Restricted Tier 1s (RT1s).

All banks governed by the rules of the Basel Committee are required to hold both Tier 1 and Tier 2 loss-absorbing capital. Figure 1 shows the location of Additional Tier 1, as highlighted in darker blue. Note that these securities can be included to meet *both Pillar 1 and Pillar 2 requirements*. Banks may also hold AT1s in excess of minimum requirements if they find such financing cost effective.

FIGURE 1: LOCATION OF ADDITIONAL TIER 1 IN THE CAPITAL STACK



Source: Based on updates from the Bank for International Settlements and the ECB's SREP methodology.

The animating philosophy of the Basel Accords is that market discipline can be encouraged by requiring adequate levels of regulatory capital *as measured* by the Common Equity Tier 1 / Risk-Weighted Assets (CET1/RWA) ratio. A bank's CET1 ratio is assumed to act as a general-purpose gauge of the strength of its balance sheet. Basel Committee guidelines express capital requirements

by using this ratio of ‘liquid loss-absorbing funds’ as a proportion of ‘assets adjusted for risk exposures’. This is the underlying premise on which AT1s were created, to explicitly link triggering mechanisms to levels of the CET1 ratio. The trigger for principal conversion pivots on a pre-specified minimum CET1 ratio. The trigger for coupon restrictions also hinges on the CET1 held in excess of that already used to meet combined buffer requirements. The trigger for extension is the cost of refinancing replacement funds, which reflects the overall financial health of the institution.

The characteristic that distinguishes AT1s from earlier hybrid capital is the nature of their *contingency*. Each type of trigger event has pre-arranged consequences that are agreed in contractual terms with investors. AT1 securities combine several distinct contingencies: interest payments can be reduced or cancelled; the principal can be partially or wholly written down (temporarily or permanently) or converted entirely into equity; and at each call date the maturity may be extended. A combination of trigger events, such as repeated maturity extensions and cancellations of coupons, can thus transform AT1s into an investor’s worst nightmare – zero-coupon perpetuals.

AT1s are a form of contingent convertible capital (CoCos) designed to impose losses on creditors on a firm-by-firm basis outside the bankruptcy process and without recourse to the public purse. *AT1s are designed to restore the CET1/RWA ratio.* In writing down or converting the principal amount, total debt due decreases – lifting the P&L account through retained earnings, which results in an increase in equity. This creates a movement from “liabilities” to “shareholders’ equity”, and hence from AT1 to CET1 capital for regulatory purposes. Similarly, during periods of poor profitability, a bank can cease interest payments to allow it time to rebuild its retained earnings (which are assigned to equity via the P&L) and then resume once its capital base is replenished, without incurring an obligation to retroactively pay the coupons missed. AT1s can also extend their maturity beyond five-years if the economics of redemption are not favourable for the issuer. The provision of ex-ante rules for principal conversion, coupon cancellation and call dates are intended to ensure the orderly recapitalisation of an individual bank while it is still a going concern.

There is an inherent asymmetry in the risk profile of AT1 CoCos as they are engineered with embedded ‘barrier-style’ optionality. Barrier options kick out once a pre-determined trigger is breached, either at any time or on a specified observation date. The defining characteristic of AT1s is that their loss absorption mechanisms are *automatic*, designed to activate once lower-bound capital ratios are hit. The issuing bank buys, in effect, a ‘put’ option with no expiry date on the face value of the note, with a strike set

at the level of the capital adequacy trigger. This also gives the bank a ‘call’ option with an initial five-year maturity, with a strike set at the reset spread. Similarly, each interest payment acts like a series of forwards that ‘knock out’ depending on the proximity to the strike set by the level of the combined buffer requirements. *Asymmetry in the risk profile arises from the fact that it is the issuing bank that holds the rights to exercise the options it has sold*, the mirror opposite situation of traditional convertible bonds and autocallables. The burden of responsibility for accurate valuation is on the investors, who must warehouse the tail risks they have bought. The challenge facing the investors is how to value the ‘premiums’ they receive, in the form of regular coupons, for selling all this optionality to a bank.

Banco Popular – AT1 triggers bypassed

AT1s were developed because the Basel Committee realised the need to realign incentives for all the participants in the market for regulatory capital. Putting some bondholders on the front line for losses was meant to encourage investors to closely monitor the health of banks, and thereby provide feedback to bank management to encourage them to pursue prudent policies. With the introduction of AT1 notes, the intent was for each bank to have a *prefunded rights issue on the balance sheet that could be predictably triggered to restore its financial health without the delays entailed by a consultative decision-making process*. An AT1’s loss-absorbing features could be tailored to match each bank’s credit profile, and in theory priced accordingly, to allow for the efficient allocation of capital. In the absence of these pre-specified mechanics, AT1s would simply be subordinated debt no different than other types of gone-concern bonds that are bail-in-able at resolution. AT1 triggers are designed to activate at an early stage of financial difficulty without excessive discretionary interpretation and associated delays.

This first true test of the AT1 asset class came in June 2017, and it was a failure in that none of the embedded triggers fired as designed. On 3 February 2017, Banco Popular Español reported a substantial €3.5 bn loss for the previous financial year due to impairments on its real estate portfolio, but nevertheless continued to make interest payments on its AT1s. On 5 May 2017, Banco Popular announced a large first quarter loss amid press reports that the bank’s capital needs exceeded its total market valuation. Yet, the AT1s did not convert to aid the ailing bank. The coup de grâce came on 6 June 2017, when Banco Popular was deemed “failing or likely to fail” by the European Central Bank (ECB) and moved directly into resolution. The bank was sold to Santander for €1, effectively wiping out all of its €1.25 billion in AT1 notes in one go. The AT1s of Banco Popular did not cut coupon payments in the prior quarters, nor did they convert into equity in the months leading up to the bank’s entry into resolution. Instead, the notes were written off alongside other subordinated debt.

In the aftermath, members of the European Parliament requested an [investigation into the collapse](#). Though this case was complicated by a run on bank deposits that may have forced the hand of the national authorities, *the apparent inability to cut coupons or convert principal prior to resolution flags up a potential flaw in the features of the new hybrid instruments – the triggering levels may be too low to operate as truly ‘automatic’.*

Conversion triggers still set at pre-crisis levels

The problem that AT1s face is that their trigger thresholds are a legacy of a prior phase of banking reform. Pre-crisis, common equity contributed about 6% of banks’ risk-weighted assets. AT1s were set at launch with triggering CET1/RWA ratios of 5.125% or 7%, for an average threshold of c6.2%. Such low thresholds made sense shortly after the credit crisis of 2007/8 in the context of lower overall requirements at their launch. The new hybrid capital was first introduced into a global framework with only two capital requirements in place. The 5.125% trigger represented the level of the capital conservation buffer at that time, and the 7% trigger represented approximately the combined conservation and countercyclical buffers. Now, however, such low contractual triggers appear rather antiquated. Figure 2 shows the progress made on the CET1/RWA front over the course of a decade, from end-2008 to end-2018. This period saw an 8.2 percentage point increase in the distance to the contingency event of the capital adequacy trigger.

FIGURE 2: CET1 RATIO PROGRESSION – 2008 TO 2018

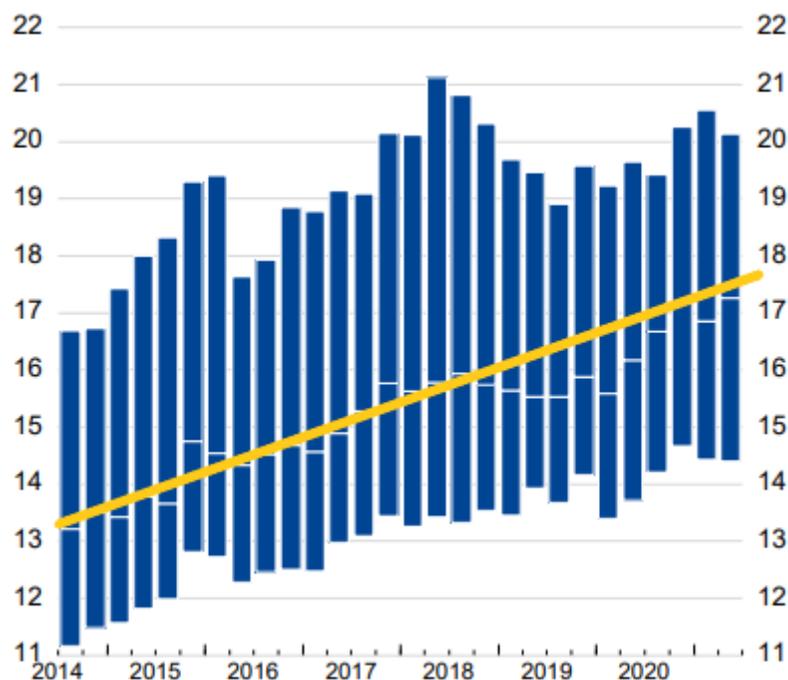


Source: European Banking Authority.

The direction of travel for key capital ratios has been persistently higher since the launch of AT1 CoCos. The rough trend line is clearly in evidence over the past seven years in gold in Figure 3, which shows the interquartile range and median for EU banks. CET1/RWA ratio for pan-European banks are now averaging over 16%. The rise in CET1/RWA ratios translates into an average distance to trigger of c1,013 basis points and median distance of 933bps at Q3 2021 (CreditSights, 2021). Even the weakest capitalised major bank in Europe, Monte dei Paschi, reported a fully loaded CET1 ratio of 10.4% at [end-March 2021](#) – over 500 basis points above the 5.125% trigger level of

its AT1 CoCos. This makes the automatic conversion of an AT1 on a going-concern basis look a very remote scenario indeed, even in the most [adverse scenarios](#). AT1s are increasingly being transformed into gone-concern instruments, to be written off in resolution rather than used to recapitalise a bank while it is still up and running.

FIGURE 3: CET1/RWA RATIOS PROGRESSION – Q1 2014 TO Q2 2021 (% , MEDIAN)



Source: [European Central Bank Statistical Data Warehouse](#). EU credit institutions; last observation: Q2 2021.

Bundesbank asks for an exploration of AT1 design

In its [report for March 2018](#), the Deutsche Bundesbank questions whether the trigger mechanisms of AT1s may be inadequate to provide loss absorption on a going-concern basis. The report by the German central bank asks whether the incentives of the new hybrids are overly complex and their triggers too low to be effective. The authors of the publication question what advantages AT1 notes have over traditional Core Tier 1 capital, stating that “this instrument’s high complexity makes it difficult to steer the transmission and incentive mechanisms in a targeted manner and increases the danger of undesirable side effects.” In consequence, the Bundesbank recommended an exploration into the design of AT1s, and specifically into the triggering mechanisms, to see whether the original

intent of the Basel Committee, to help recapitalise a bank *prior to* entry into formal resolution, is being achieved.

The dilemma of setting effective trigger levels was witnessed in the crisis of 2007/8 in which many troubled banks continued to nominally qualify as well-capitalised. A study by the Bank for International Settlements (BIS) notes that “had Citibank issued CoCos with even a high book-value trigger before November 2008, the loss absorption mechanism of those instruments would not have been activated prior to the government’s injection of capital” (2013). This is a sobering fact about accounting-based barriers – to be effective, the lagging nature of publicly reported disclosures must be taken into consideration. For distressed banks, the previous quarter’s capital ratios released into the public domain will almost always be higher than the deteriorating underlying numbers. As per the BIS back-testing, we know that if banks had held AT1s with triggers based on the book value of equity comparable to the c6.2% average level of CET1 triggers in use today, such securities would not have converted before the government-sponsored capital injections. Therefore, setting appropriate triggering thresholds lies at the centre of any framework for financial stability.

Our thesis is a direct response to the concerns expressed by the EU legislators over the collapse of Banco Popular Español and the doubts raised about the design of AT1s by the German central bank. The automatic trigger levels for contingent capital are a topic of growing relevance, both because AT1s continue to come to the market with low triggers and because the distance to the triggering threshold is increasing amid further changes in loss absorbing capital requirements. The danger of a structural tightening in reset spreads adds a degree of urgency to our investigation.

Supervisory discretion has come to take precedence

The various supervisory bodies, as implied in the Bundesbank report, are worried that AT1s may no longer be relied upon to convert into shares *automatically* to help recapitalise an ailing institution. But, despite these concerns, the capital adequacy triggers remain stubbornly set at pre-crisis levels.

Low triggers remain commonplace. Société Générale, for example, has eight AT1s outstanding at present for a total of c€7.9 bn. [SocGen’s latest AT1 came to the market in May 2021](#) as prefunding for similar notes callable in September. The write-down trigger on the €1 bn in newly issued AT1 notes was set at 5.125%, in keeping with the bank’s existing notes. The distance from SocGen’s current CET1/RWA ratio to the conversion trigger was 836 bp at the time of issuance. That great a distance makes it very unlikely the notes could be triggered prior to invocation of a non-viability

event. Write-down triggers like SocGen's are not outliers. To cite a couple more examples of newly issued AT1s with a 5.125% conversion threshold: [Banco Santander issued €1.75 bn](#) in May 2021, for a c720 bp distance to triggering; [Unicredit issued €750 mn](#) in June 2021, for a 1035 bp distance to triggering. It is not only the triggers that are low, so are the initial coupons and reset rates. For example, La Banque Postale [issued €750 mn in AT1s in September 2021](#), with a coupon of just 3% and a reset spread of only 312 bps over 5-year mid-swaps if not called in 2028. The trend for extremely low triggers, low coupons and tight reset spreads continues unabated.

In terms of capital adequacy trigger levels, c48% European banks have issued notes that reference a CET1/RWA ratio of 5.125%, while c52% reference 7% or slightly higher. As illustrated by the examples cited above, the direction of travel is not to raise the trigger levels. Quite the opposite: the policy trajectory appears to be drifting towards making AT1s de facto gone-concern capital, a complete reversal of the earlier regulatory regime. Without a change in the rules at the ECB that would require higher thresholds for such securities, the trend for low triggers (and accompanying low resets) will persist and AT1s will devolve into instruments bailed in only at resolution rather than being pro-actively converted to recapitalise an institution *prior to insolvency*.

Resistance to revisiting the legacy triggering levels

There are several reasons for the stalemate on triggering thresholds for AT1s: (1) pressure on central banks to stimulate the real economy by encouraging banks to make loans, (2) the advent of another layer of loss-absorbing instruments that is transforming the overall approach to regulatory capital and (3) a benign indifference to the precise levels of capital ratio thresholds given the extreme plasticity of such metrics.

In the first instance, there appears to be innate inertia against change in the AT1 trigger design, considering how hard it has been to establish the governing Basel Accords. The perceived need for quantitative easing to counteract lacklustre economic growth may be forcing the ECB to accept – at least temporarily – that AT1s perform an essential function in permitting banks to remain a transmission channel for credit by continuing to lend to struggling corporates. Bank management are motivated to get AT1 spreads as tight as possible so that these securities become an ever-cheaper source of capital, relative to common equity, with the lower funding costs helping to soften the blow of weakening profitability. Seen in this light, allowing AT1s to debase their automatic triggers is a

necessary ‘gift’ from the regulators, in that it allows banks to fill their required buckets with inexpensive instruments to help meet leverage and total capital calculations.

A second key factor is that the architecture for bank capital is increasing in complexity. Total Loss Absorbing Capital (TLAC) is now necessary for global banks, with a roughly equivalent Minimum Requirement for own funds and Eligible Liabilities (MREL) mandated for all European banks. Neither of these types of regulatory capital existed during the initial engineering of AT1 CoCos. The nature of going and gone concern as distinct categories is evolving with the roll-out of TLAC and MREL, along with the refinements in the role of the EU-wide Single Resolution Board. Revisiting the trigger levels for AT1 CoCos might be viewed by the supervisory authorities as an unwelcome reopening of a debate about the definition of capital requirements and the appropriate interaction between different levels of the capital stack at a time when the prime task is to push for the adoption of total loss absorbing capital.

A third reason for the reluctance to raise capital adequacy barriers may be that regulators see the very notion of an automatic trigger as redundant. Almost any precise number for the CET1/RWA ratio is somewhat arbitrary, as the measure is manufactured by the regulators through their delineation of the rules to calculate both the numerator and denominator – both of which continue to undergo revisions. This means a bank’s key capital ratios can rise or fall even though its credit profile stays the same when, for example, the rules on mortgage risk weights are adjusted. Taking CET1/RWA as a managed ratio to its logical extreme, contingent capital instruments are simply premised on supervisory discretion – with the focal point of such discretion being the interpretation of the point of non-viability (PONV). Almost all prospectuses for AT1s contain contractual non-viability clauses (i.e., conversion/write-down can be triggered if a viability event is declared by the bank’s supervisor). Even for those notes that do not contain formal clauses, loss absorption is still discretionary through statutory bail-in under the EU’s resolution regime; hence all AT1s have either formal or de facto PONV triggers. So, the transformation of AT1 CoCos into PONV debt can be conducted almost by stealth, simply by permitting the capital adequacy trigger to languish at such low levels that the automatic mechanisms become superfluous.

Whatever the combination of factors at play, *the ECB does seem to be rowing back from any commitment to AT1s as going-concern capital and, rather, looks inclined to adopt instruments based on PONV triggers alone.*

AT1s remain classified as ‘equity-like’ for regulatory purposes but are increasingly sold to fixed income investors as being as credit-like as possible by implicitly guiding soft blockers on coupon restrictions in addition to allowing conversion triggers to fade into irrelevance. The seniority of AT1 coupons versus common equity dividends has become unambiguous such that the AT1 interest payments are assumed to almost always be maintained despite declines in profitability. In the absence of any reliable *automatic* triggers to differentiate the general credit risk taken on with AT1 CoCos from that of other subordinated debt, investors in search of yield are incentivised to load up on AT1s as these notes are only *nominally* the riskiest layer in the capital stack. Our research suggests that AT1 CoCos fail to price with much significance their loss-absorbing features, i.e., the asset class trades as if it were gone-concern capital with low coupons and tight reset spreads. By quietly allowing AT1s to sink to the status of gone-concern, the only going-concern capital left is common equity – with all its attendant limitations as a backstop in a crisis. Exceptionally accommodative policy appears to have relaxed investor perceptions of the embedded barriers in AT1s. This apparent failure to adequately price the inherent risks presents a danger, in our view, that if the reset spreads of newly issued AT1s continue to tighten, any increase in refinancing costs once the market exits from its ultra-low interest rate environment could result in a ‘perpetual vintage’ of uncallable AT1s.

Article 104a lowers further the probability of principal conversion

The ECB’s early adoption of Article 104a of the Capital Requirements Directives V in March 2020 is actively stimulating demand for AT1s, as it expands the role for these securities in meeting Pillar 2 obligations. This revision in the rules permits Pillar 2 requirements to be met with capital instruments other than common equity. Pillar 2 must now be at least three quarters Tier 1 capital, but only three quarters of this Tier 1 capital need consist of CET1 (common equity Tier 1). This means that European banks have to meet only 56.25% of their Pillar 2 requirements with CET1 capital, as the remaining 43.75% can be fulfilled with AT1 and Tier 2 instruments held in excess of minimum amounts. The acceleration of Article 104a by the ECB was matched by the Bank of England with similar changes to its Pillar 2A requirement. *Consequently, banks in most jurisdictions can now meet up to 18.75% of Pillar 2 requirement with AT1s.* To illustrate the implications of these revisions, a bank with a Pillar 2 requirement of 1.5% will experience a 66 bp reduction in its CET1 contribution to only 0.84%. With the Pillar 2 requirement at present averaging 2.1% for banks supervised by the ECB, this rule revision will shrink CET1 requirements by c92bp [according to S&P](#). This decline in required CET1, in turn, means the *distance to the capital adequacy trigger will grow*

even greater. To take full advantage of Article 104a, banks are being actively encouraged to issue extra amounts of AT1s and can even use the excess AT1s (more than 1.5% of RWAs) in calculations of their CET1 ratios.

PRA proposal erodes the automaticity of coupon omissions

Another example is the transposition by the UK's Prudential Regulation Authority (PRA) of elements of the EU Capital Requirements Directive V into British law as part of the Brexit process. The loss absorbency of UK banks' AT1s may decrease due to regulatory divergence from the EU. The PRA is proposing to take steps to favour the payment of AT1 coupons by:

- Removing the automatic restriction in the Maximum Distributable Amount (MDA) calculation, which prevents access to CET1 allocated to the combined buffer requirements.
- Changing the MDA definition to calculate CET1 capital based on profits from the past four calendar quarters, thereby increasing the funds available for distribution.

The aim of the PRA's proposals is to allow AT1 interest payments to continue to be paid alongside the release of CET1 from a bank's capital buffers during periods of system-wide stress such as during the Covid-19 pandemic. But the removal of automatic mechanisms would also enable UK banks to continue paying AT1 coupons that might otherwise have been restricted. This could embolden banks to operate with lower management buffers (held above combined buffer requirements) and therefore structurally lower levels of CET1 capital.

The point to highlight is that AT1s are being promoted by the regulators even while, simultaneously, their design features are being eroded. In the belief that AT1s are essential to underpin financial stability, supervisory discretion in the guise of favouring coupons and forbearance on conversion could be undermining the key features of AT1s – the ability to switch off interest payments and write down principal.

We advocate higher trigger levels rather than relying on PONV power

The ECB holds in its hands the trump card to increase the trigger levels to make AT1s relevant as going-concern capital. However, there seems to be a hesitancy to do so for fear that this might spark financial instability in the near term. The European Commission is preparing its next bank capital legislative package, the third Capital Requirements Regulation (CRR III) and the sixth Capital Requirements Directive (CRD VI). [These legislative proposals](#) will eventually be implemented as the final Basel III framework in EU law. This package of reforms would be the logical vehicle within

which to update the trigger levels, rather than move to PONV-only eligible instruments. The political nature of such developments highlights the relevance for us to integrate within our research agenda an analysis of the *supervisory-bank nexus*, the interconnected network of decision-making processes that bind banks together to their prudential authorities across Europe.

Establishing that the trigger levels for coupon cancellation and principal conversion are too low for AT1s to operate effectively as going-concern capital is an essential first step, carried out with our statistical analysis. A survey of the literature on valuation models shows an almost exclusive preoccupation with the conversion of CoCos into equity. Risks related to coupon distribution restrictions or the extension of the time to maturity are barely addressed in existing models. However, our cross-sectional regressions demonstrate that the conversion trigger is hardly a significant factor. All the empirical groundwork is carried out as background for tackling the tougher challenge: *analysing the role of supervisory discretion in shaping the probability of AT1 triggering*. Examining the supervisory-bank nexus at this time is relevant given that the ECB appears to be relying on the PONV trigger on its own as the sole criterion for contingent capital. *Making the case for higher automatic triggers, against the shortcomings of the PONV power approach, therefore forms the focal point of our thesis.*

B. Research Questions

This thesis aims to answer the following overarching, interrelated questions:

1. Is the scope for interpretation and intervention by the Basel Committee and national authorities undermining the pre-arranged contractual consequences of breaching a barrier?
 - a. Is the trigger level for capital adequacy set too low, in relation to the point of non-viability, to allow AT1s to trigger automatically?
 - b. Is the threshold for coupon suspension too open to reinterpretation to operate effectively as a capital conservation tool?
2. How might the parameters of valuation models be modified to more accurately value AT1s?
 - a. What are the relative explanatory powers of variables related to coupon risk?
 - b. How can the metrics for extension risk be incorporated into models?
3. Is there a risk that AT1s may come to market with such tight reset spreads that a cohort of uncallable notes is created?

C. Main Findings

1. *Supervisory discretion undermines automatic conversion when triggers are set too low*

The primary evidence for the erosion of automaticity is that conversion-related metrics such as the CET1 buffer and implied recovery rate are not significant factors in risk pricing. Our interpretation of why the signals for conversion mechanisms are so weak is that the capital adequacy thresholds are set too low such that the anticipation of supervisory action overrides the automatic triggers. Our research implies that the predominant perception among investors is that supervisors will either intervene before contractual barriers are breached ('PONV power') or delay the formal breach until bail-in at resolution ('forbearance'). The erosion of automaticity is being abetted by two key factors:

1. The Basel Accords express capital requirements as a proportion of risk-weighted assets, with the CET1/RWA ratio as the triggering mechanisms for AT1s. The malleability of both the nominator and denominator offers supervisors an easy method to optically raise or lower the bar, to invoke or delay a viability event.
2. The CET1 ratio is a lagging indicator, reported at most quarterly. The asymmetry of information in which bank management can detect the emergence of capital shortfalls and communicate these to their supervisors opens up the possibility of intervention before the breaching of 'strict' triggers.

The benefits of AT1-related loss absorption relative to the adverse effects of acknowledging weakness are finely balanced. Fear of adverse signalling on the part of both management and their supervisors can motivate these actors to play for time and thereby cause AT1s to activate very late in the game. If each stakeholder group has an incentive to forebear, this will delay the onset of the automatic trigger until the resolution stage, when all subordinated debt is bailed in. The incentives for triggering are biased toward forbearance (delay or inaction) and should be realigned to allow triggers to fire freely and encourage early stage recapitalisation.

In our view, the write-down/conversion triggers should be based on a formula rather than a legacy, fixed percentage. We propose a calculation that reflects the input of the Supervisory Review and Evaluation Process and, in particular, the annual stress testing in the setting of an 'SREP' score to establish bank-specific Pillar 2 requirements. We recommend this formula: Capital adequacy trigger = Pillar 1 + the minimum CET1 component of Pillar 2.

Our proposed threshold is above the Pillar 1 requirement but below the Total SREP capital requirement, leaving some scope for a non-viability event to be invoked earlier than the automatic

trigger but much less leeway than at present. *Our proposal would raise the capital adequacy trigger to a CET1/RWA ratio of c9.2%, from the current c6.2% average.* To take the example cited earlier of Monte dei Paschi, using our proposal its capital adequacy threshold would be 9.55% (Pillar 1 of 8% plus [Pillar 2 CET1 of 1.55%](#)); at this level, Monte's AT1s might have triggered in the past – arguably the best outcome given the state-sponsored M&A difficulties of recent years. A formula based on the evolving SREP regime should ensure the triggering thresholds are more futureproof. A higher automatic trigger should help to instil market discipline as risk premia adjust to reflect the greater risk of going-concern conversion. A fairer pricing of risk should, in turn, encourage a better balance of incentives for bank management and investors.

2. AT1 prioritisation by supervisors undermines the automatic cancellation of coupons

A similar dynamic is at play for coupons, in which 'soft stopper' guidance by the supervisors gives the impression that coupons will be prioritised over dividends. Actual stopper clauses are prohibited for AT1s so that the securities will behave similarly to equities. But informal prioritisation of AT1 coupons undermines the disciplining effect of automatic restrictions on distributions. The trigger for the conversion is pre-agreed in AT1 covenants and is measured against the current CET1 ratio, whereas the equivalent trigger for the coupon cut-off depends on the level of the combined buffer requirements and is measured against the surplus CET1 available to service interest payments. The conversion trigger is fixed for the lifetime of the securities, whereas the threshold for coupon restrictions is the outcome of an ongoing Supervisory Review and Evaluation Process (SREP). Under the aegis of the ECB, and the national central banks throughout Europe, there is an annual stress testing exercise during which scenario analysis is conducted to assess the loss-absorption ability of each bank's capital base. The SREP ratio represents the subsequent guidance for the level of capital buffers appropriate for each bank – which, in turn, determines the triggering level for calculating coupon restrictions.

The average SREP ratio was 10.23% for pan-European banks at the end of the third quarter of 2021; this translates into an ample average MDA cushion of 622 bp, or median of 569 bp (CreditSights). Again, distances to triggering thresholds appear to have become excessive. Turning off a coupon to help recapitalise a bank is exceedingly rare. Just one combined bank has done so: BremerLB/NordLB. At the peak of the pandemic in mid-2020 [Norddeutsche Landesbank skipped interest payments](#) on its NDB 8.5% AT1 notes – but this was in the context of the bail-out of the bank the prior year and followed the only other [coupon skip by Bremer Landesbank](#). Bremer LB,

due to its exposure to the faltering shipping market, skipped coupons on its two AT1 notes in mid-2017, in the course of being taken over by Nord LB. When it comes to restricting distributions, aside from the BremerLB/NordLB instances, the paying of AT1 coupons has unequivocally been prioritised over equity dividends. AT1 interest payments have continued throughout the Covid-19 pandemic in contrast to dividends, most of which were cancelled in 2020 on the instructions of national supervisory bodies.

There appears to be great reluctance to cancel AT1 interest payments. Turning off a coupon seems to be seen by the ECB and bank management alike as too little immediate retention of loss-absorbing capital relative to the risk of damaging a firm's reputation in a way that might raise the cost of future refinancing. Moreover, the supervisors seem worried that switching off a coupon at one bank would lead to a repricing of AT1s across the market, which might make the asset class less attractive to fixed income investors. The benefit to the overall stability of the European banking system of having easy recourse to a cheap form of core capital is being balanced against the short-term considerations at a handful of troubled banks, with the broader goal of stability to date having consistently overruled the narrower mechanics of coupon omission.

3. Rise of the SREP ratio: Coupon risks should be at the core of valuation models

When revisions to the coupon-restrictive conditions were announced by the ECB in December 2015, banks were given many years to phase in their requirements, guided by the new supervisory review. With this transition drawing to a close, the fully loaded SREP ratios have raised the tripwire for loss absorption when profitability drops. The distance to the SREP ratio, though still more than adequate, has gradually grown smaller in the course of the phase-in toward fully loaded combined buffer requirements. This contrasts with the triggers for conversion, which have remained fixed since the inception of AT1s such that the distance to the threshold where conversion occurs has increased. *Therefore, the relative risk of coupon omission is steadily rising, whilst the risk of conversion is slowly fading into insignificance.* The situation has thus changed dramatically since the period when most of the valuation models were first proposed. With regards to CET1 metrics, it is all about the coupon now.

Our analysis shows far less relevance in pricing for either of the CET1-related triggers than we expected, but the distance to the SREP ratio for coupon cut-off has greater statistical significance than the distance to the CET1 ratio set for write-down/conversion. As such, *the risk of coupon omission takes precedence over the risk of principal conversion as a driver.* A valuation model is a reference frame with

which to predict and plan for future states. Prediction is an inherent quality in that it presents a way for us to learn where a model is not well fitted to actual outcomes. To improve, valuation models should orient around the immediate risk of coupon omission not only because it is more prominent but also because the two types of CET1-related risks express a degree of correlation. The most likely scenario is that an SREP ratio first drops to a level that causes the suspension of AT1 coupons, which act as the first tranche of loss absorption. Subsequently, if CET1 reserves continue to fall precipitously, principal conversion would eventuate as the main tranche of loss absorption. Given that coupon cancellation is designed to presage principal conversion, it should be a leading indicator.

To operationalise the SREP ratio as a metric in valuation models involves an understanding of the accounting rules for Available Distributable Items (ADI) and the Maximum Distribution Amount (MDA), in the context of changing regulations. Banks now need to calculate separate MDA cushions for each of the CET1, Tier 1 and total capital ratios – with the smallest of these distances being applied as the cut-off for AT1 coupons. Total loss absorbing capital requirements – risk weighted and non-levered – have also been introduced that can make demands on CET1. The recently applied Article 104a can also affect the amount of CET1 available for the calculation of the combined buffers. Taken altogether, *these revisions make the MDA threshold a moving target that is challenging to integrate into models without incorporating some element of scenario analysis.*

Therefore, valuation methodologies should move beyond the mere modelling of capital ratios to understand the supervisory process in its entirety. Supervisors may intervene if a bank fails to meet any of its regulatory requirements – be they total capital, leverage or liquidity related. Supervisors may show discretion, and unless the automaticity of triggers is restored, this overlay of interpretation and guidance will have to be modelled through the inclusion of advanced game theory.

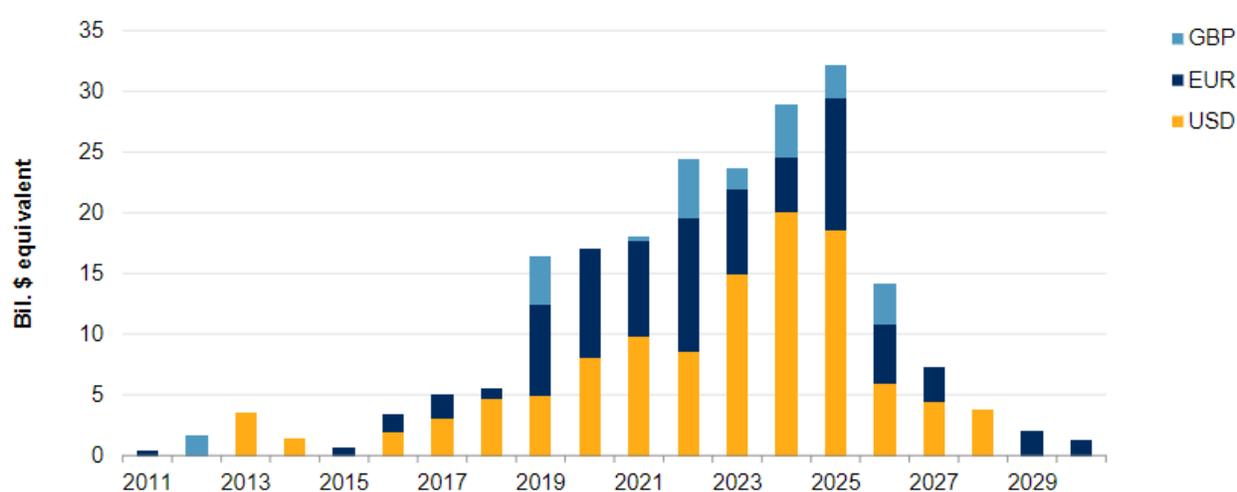
4. Valuation models should reorient to metrics that capture extension risk

The expansion of the AT1 asset class over the past decade has seen banks with very different business mixes issue notes under a wide range of market conditions. A far greater variety of backend resets provides a more diverse dataset with which to assess perceptions of non-call risk. The years immediately following the introduction by the Basel Committee of the new hybrids witnessed heavy issuance as banks set about to satisfy their capital requirements. Given that the initial call dates are generally set at five-year intervals, the market for AT1s began a second phase of replacement issuance that commenced in earnest from around the middle of 2020. The earliest AT1 CoCos,

being experimental, had quite high reset spreads and hence little to no extension risk. But the later and much larger cohort of notes issued from around 2017 onward tend to have tight resets.

The redemption calendar is accelerating into 2022, rising to a peak in 2025 – as shown in Figure 4. Years further out will gradually be filled, as new issues replace the notes being redeemed and the calendar replenishes like a stepping machine alongside higher overall demand spurred on by Article 104a. The growing proximity to a wave of first call dates has offered us an excellent opportunity to analyse the onus that investors place on reset spreads and call dates as valuation drivers.

FIGURE 4: EUROPEAN AT1s – FIRST CALL DATE BY CURRENCY (£, €, \$)

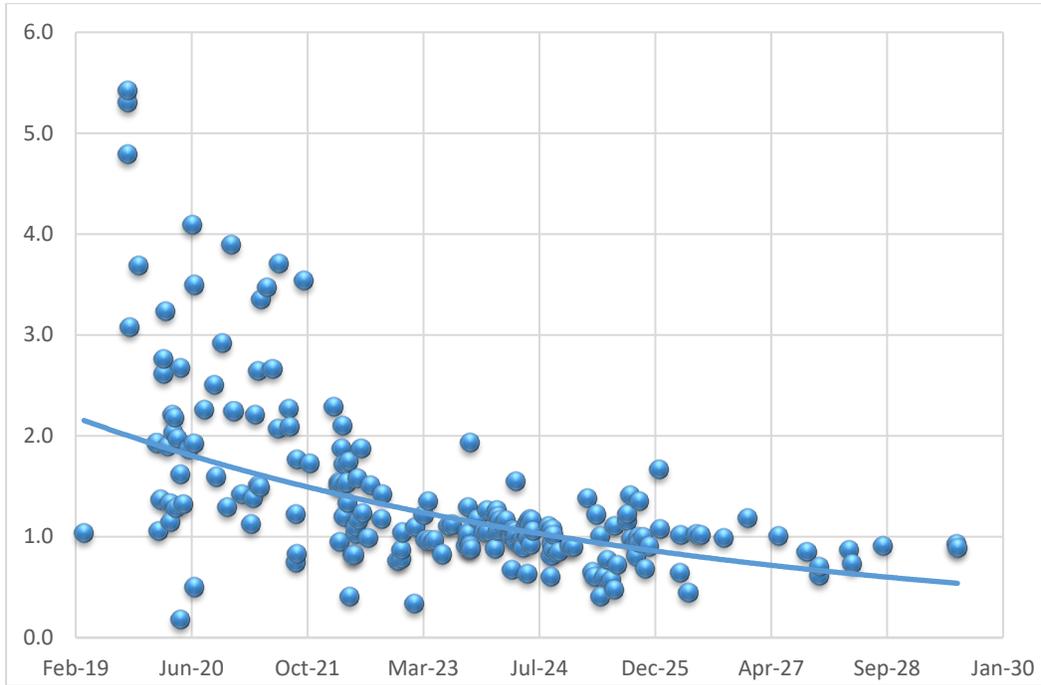


Source: Dealogic, S&P Global (April 2020).

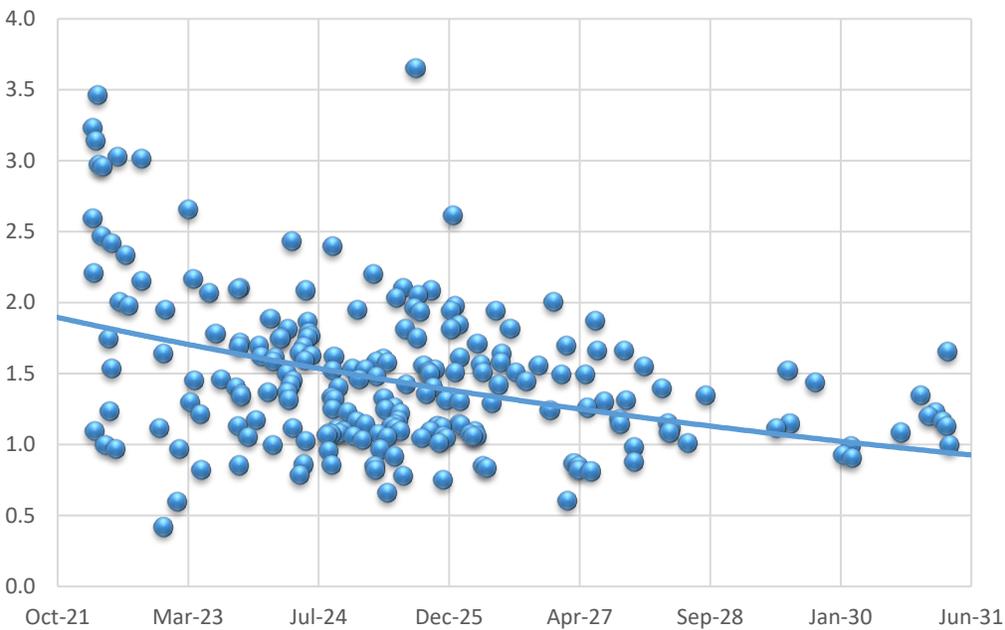
The cost of refinancing AT1s is shaped by two components: a *floating leg*, which is the underlying benchmark treasury swap, and a *fixed leg* to which the coupon resets if the notes are extended past their first call. As an AT1 approaches its first call date, if the implied coupon (current mid-swap + reset spread) is higher than the reset rate of the outstanding notes, the note may not be redeemed. A deteriorating credit profile and/or a rising rates environment may cause disincentives for issuers to call existing notes if they raise the cost of new AT1s. Refinancing-related risks have steadily grown in salience as the initial cohort of AT1s began approaching their first call dates. The stand-out variables in our regressions relate to the risks of maturity extension. Distances to metrics related to capital ratios, such as the CET1 buffer and MDA cushion, have limited explanatory power in comparison to the implied coupon at reset coupled with the time remaining to the next call date. Investors appear to primarily price AT1 notes in relation to the prospect of redemption at the first call.

FIGURE 5: AT1s – RESET/ZSPREAD MULTIPLE BY FIRST CALL DATE

(JUNE 2019)



(APRIL 2021)



The figures plot the ratio of an AT1's reset spread per its current zspread, a measure of the relative cost of refinancing, against the proximity to the first call date. Extension risk is elevated nearer the first call in both samples, it but varies considerably over time.

Source: CreditSights data (top as of 7th June 2019 and bottom as of 1st April 2021).

Our analysis aims to reorient valuation models toward indicators such as the multiple of the reset spread over the current zspread – shown in Figure 5 above – to better incorporate the economics of refinancing. Measured this way, extension risk registers a coefficient of correlation (R^2) of c30%, the most prominent metric in price formation. *A key reason for the prominence of the reset spread in pricing is that it can be continuously monitored against tradable market measures. Also, both the setting of the reset spread and the economics of extending at first (or subsequent) calls are much less affected by the overlay of supervisory discretion.* In the scatter plot from June 2019, shown first in Figure 5, many AT1s are displaying risks of extension. The notes with multiples under 1x are indicating greater degrees of extension risk. The extreme value in the lower left with a multiple of 0.2x is for Deutsche Bank's 6.25% AT1s with a then zspread of 2,402 bp over a reset rate of 435.8 bp, indicating a high risk of not being redeemed at first call scheduled for April 2020. These notes did indeed miss their first call and are not due for a next call until April 2025.

The picture looked better in April 2021, though there were still notes trading with multiples under 1x. This highlights considerable time variance in the perceptions of extension risk. According to sampling taken in June 2019, c23 notes had resets greater than current zspreads, whereas c166 notes had reset rates lower than the current zspreads. In contrast, the sampling taken in April 2021 had c207 notes with resets above zspreads and c24 with resets below – a sharp reversal. By utilising the reset multiple as a variable, we identify the potential for reset spreads to have become so compressed historically in the primary market that AT1 CoCos could become uncallable should any of their embedded risks be reassessed materially or the interest rate curve shift markedly higher.

With the callable nature of AT1 notes, it is difficult to price the option being sold to the issuer over such a long period, typically five years. This posits a long-term exposure, in which investors may be undervaluing the call optionality which they are selling to issuers. Extension risk is regime-specific, with the market pricing in little during periods of calm. The yields to call of AT1s will at times trade comfortably inside their implied coupons, but yields can blow out quickly to perpetuity, with the resulting negative convexity radiating across the asset class. Such contagion is more prone to be sparked in a rising rate environment. Banks by their very nature are asset sensitive and their profitability may well improve when rates rise. But the benefits from central bank hikes introduced in a measured manner are finely balanced against the potential for funding costs to soar. In light of the recent fluctuations of longer dated rates, it is necessary to consider how steepening yield curves might impact the economics of AT1 issuance. The vast majority of notes have reset formulas based

on five-year rate benchmarks: either a swap rate (e.g., five-year fixed vs six-month floating), or a sovereign bond five-year rate. *When yield curves steepen, the economics at the first call date start to favour skipping. Notes issued during periods of tight spreads are particularly prone to extension risk, and notes with short-dated rate benchmarks also carry higher extension risk in a curve steepening environment.*

The cohort of AT1s issued in 2017 through 2019 with very tight reset spreads are due to hit first call dates throughout the course of 2022 and into 2023/24. This could be a trial by fire for the AT1 asset class, in particular if the extension of many AT1 notes were coupled at some credit institutions with coupon cancellation. The central problématique of AT1 CoCos, according to our findings, is their risk of becoming ‘zero-coupon perps’ – bonds paying no interest that might never be called.

D. Contributions

1. Improve techniques for valuing contingent capital

There are two streams of scholarship that this thesis aims to contribute to: research on complex securities and on market discipline.

Complexity premium

Given the challenges inherent in valuing hybrid instruments, the European Securities and Markets Authority (ESMA) took the exceptional step of issuing a statement in July 2014 to warn that “CoCo structures are highly complex” with distinct “valuation risks” and that “investors have been drawn to the instrument as a result of the CoCos’ often attractive yield which may be viewed as a complexity premium”. An analysis of this complexity forms an important contribution of our research. With a conventional security it may be possible to forecast, to some degree, outcomes by knowing the starting conditions and historical volatility. For complex financial products, given the same starting conditions, completely different outcomes may arise “depending on the interactions of the elements” (Sargut & McGrath, 2011). Contingent capital, with its array of embedded barriers, offers a range of pathways through which profits or losses may occur. The P&L pathways, though operating independently, may move in parallel (or interact) to create a cascading effect – e.g., a deterioration in a bank’s credit profile increases the probability of a coupon deferment and simultaneously increases the likelihood that the first call is skipped; the rising risk that maturity could extend by five years expands the horizon over which a principal writedown might materialise, leading conversion risk to rise as well. In other scenarios, what reduces the risk of one type of trigger event may exacerbate the risk of another. For example, when tougher capital requirements

encourage banks to boost their CET1 funding, the distance to the capital adequacy trigger increases and lowers the risk of conversion; however, stricter capital requirements may raise the combined buffers and reduce distances to the threshold for restrictions on coupons. Clearly, the modelling of multiple path-dependent P&Ls is far more complex than linear ‘hockey stick’ payoff diagrams.

Market discipline (‘fair value’)

The problem of complexity can also be viewed in terms of promoting market discipline, one of the pillars of the Basel protocols. If we assume active monitoring by investors, an embedded feature that entails greater risk should trade at wider spreads, greater yields or higher CDS basis. For price discovery to work effectively investors must engage in fair valuations, which should be reflected in efficient pricing. A higher price should be demanded for any increment of additional risk.

Inefficiencies in pricing suggest that investors are not yet able to evaluate the risks inherent in contingent capital. Accounting-based indicators of bank risk are well researched, e.g., Sironi considers the process by which investors “gather and evaluate information” in relation to banks’ traded securities (2003). Our research aims to expand on such studies to establish whether the level of influence in price behaviour is consistent with the risk characteristics to validate the presence of discipline in the market for regulator-sponsored contingent capital.

2. Innovative analysis

With AT1s we are miles away from the uniformity of equity shares. A brute-force approach that pulls in data indiscriminately will struggle to detect clear signals amid the noise. We have developed an integrated database by screening data from Moody’s, Fitch, CreditSights, Scope and Bloomberg – as well as from offering memoranda. This last step has meant sifting through the individual prospectuses of AT1s to obtain the precise figures for conversion prices and reset spreads. The extensive cross-referencing, filtering by liquidity and augmenting of information is labour-intensive but essential to organise data to a degree of fine detail necessary for accurate analysis.

Our access to combined buffer metrics has expanded greatly due to annual stress testing and SREP disclosures. The transitional phase-in period having completed its final stage, with fully loaded levels for each of the components of the combined buffer requirements coming into force, has also given us more accurate estimations of MDA cushions and ADI cover. As such, this study is one of the first to be possible with a fuller, more reliable pool of data for comparison of the CET1-based trigger types for both principal and coupon barriers. Our research has identified that factors related

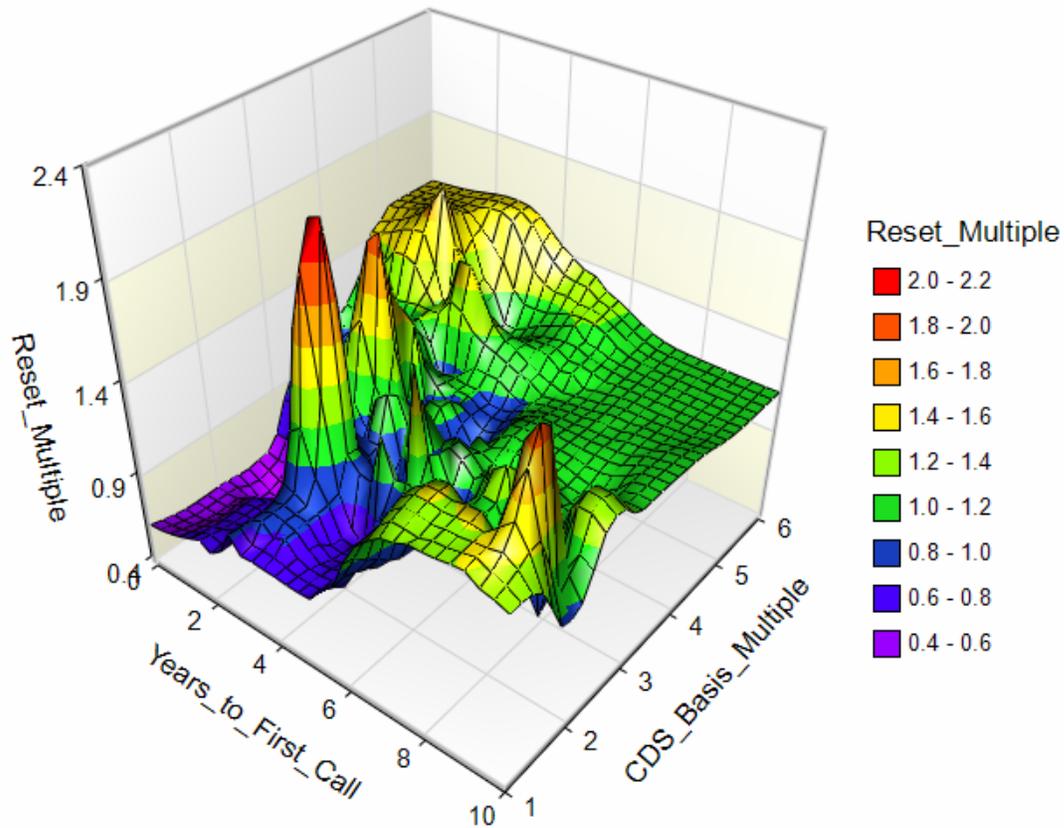
to coupon suspension send a stronger signal than factors related to principal write-down/conversion, though with coupon skips softly ‘stopped’ by supervisors, this risk does not price as significantly as we had expected. We have also introduced features specified in prospectuses, such as conversion rates and write-back clauses, to better estimate recovery rates. We recommend that these metrics be incorporated in valuation models. The weak link between implied recovery rates and price formation – the absence of market discipline – is a core reason for our conclusion that participants’ incentives to fairly value all the risks encapsulated in AT1 CoCos are being undermined.

Utilisation of CDS basis to explore extension risk

We draw on four types of dependent variables: yields to worst, spreads to benchmarks, cash price and CDS basis (to senior and to subordinated debt). There is not a ‘best’ continuous variable, as each will express a reason for which AT1s are held or traded. But our study places emphasis on the CDS basis given that we are investigating variables connected to the loss of the principal amount of a hybrid bond and its potential recovery rate. To calculate the CDS basis, we use default swaps for subordinated debt from the same issuing bank with a tenor that matches the period to the first call.

In Figure 6 we show graphically the interaction between the extension-related factors of the reset rate and proximity to first call, as identified by the CDS basis as the dependent variable. The yellow mound and red peaks identify clusters, which are roughly at the two-year mark from first call dates coupled with zspreads much higher than reset rates. The CDS basis is elevated in these areas, which indicates that extension risk is being perceived by investors and priced in. Our calculations of the basis takes the AT1 zspreads as a multiple of Tier 2 CDS, which will fluctuate across risk regimes. The multiple reached a low of close to 1.0x at the height of the March 2020 correction but returned by mid-2021 to c2.7x. The AT1 zspreads have tended to consistently trade at a multiple to Tier 2 CDS of c3.0x to c3.5x – which at end-September 2021 translated into a spread differential of roughly 150-300 bps on average across European banks.

FIGURE 6: RESET RATE AND TIME TO FIRST CALL VS CDS BASIS



Source: Fitch, Moody's, CreditSights data.

E. Thesis outline

In Chapter II, we sketch out the genesis of CoCos as products of financial engineering that allow banks to synthesise tail risk so that it can be sold on in the form of structured derivative notes with embedded leverage and barriers. We also overview the asymmetrical risk/reward profile of contingent capital and the current state of the market for the CoCo asset class.

In Chapter III, we consider the matrix of incentives for participants. We conceptualise the supervisory-bank nexus as an interconnected network of central banks, national authorities and banks across Europe. We review the scope for risk shifting, ranging from the dilemma of debt overhang to the incentives to gamble for resurrection.

In Chapter IV, we survey the literature on valuation frameworks, together with the key assumptions and inputs used to encapsulate triggering thresholds. Models surveyed fall into two broad buckets,

‘firm value’ and ‘market-implied value’ (or attempts to combine both approaches), and utilise techniques for valuing both credit and equity derivatives.

In Chapter V, we overview the components of our empirical programme. Following this, in Chapters VI and VII, we conduct empirical work to identify how investors are pricing the properties of CoCos. The explanatory power of individual barriers and their constituent elements are designated as variables and pair tested to assess their effect on yields, spreads and CDS basis. We then run multiple regressions in cross section on metrics that reflect the three types of barriers. In this way, the design features and composite risk factors associated with these barriers are catalogued and their relative weighting ranked in terms of patterns of price discovery. Rounding out our analysis, in Chapter VIII, we run time-series tests on market-implied proxies of AT1 loss mechanisms.

In Chapter IX, we interpret our findings to determine whether the triggers are being set at appropriate levels – and evaluate the valuation models in light of our results.

In Chapters X through to XII, we assess the three main embedded barriers: principal, coupon and extension risks. We evaluate the scope for supervisory intervention and the erosion of automatic mechanisms. We establish the implications of early intervention or forbearance on the effectiveness of contractual triggers. We highlight the decisive role of the supervisor in shaping price formation with ongoing guidance and frequent revisions to rules.

In Chapter XIII, we present a case study of Banco Popular – the first and only case of AT1 CoCos being activated. Following which, in Chapter XIV, we overview our conclusions and recommendations, alongside a proposal for a new formula for establishing capital adequacy triggers.

INCEPTION – A SOLUTION TO STAVE OFF FUTURE CRISES

This section sketches out the supervisory-bank nexus in the context of the new breed of contingent capital.

First, we examine the Basel III Accords that classify a structured product for regulatory purposes as if it were common equity while treating the product for tax purposes as if it were subordinated debt.

We also conceptualise the inherent asymmetry of the AT1 risk profile, in which investors sell options in exchange for a ‘premium’. This trade-off gives the issuing bank the right to convert the principal into equity, to cancel coupon payments and to extend a note’s maturity.

Next, we overview the behavioural finance underpinning the inception of the new AT1 asset class. We consider the contending goals of the Basel Committee with its global remit as well as the state-sponsored ‘national authorities’ and the financial firms domiciled within their jurisdictions.

We also review risk-shifting incentives, e.g., shareholders may be motivated to ‘gamble for resurrection’ by taking on excessive risks to resolve a shortfall of capital given that they may stand to profit either if conversion is averted or if financial obligations are eliminated by imposing losses on AT1 holders.

II. Additional Tier 1: Origins, Risk Profile & Market Growth

A. Genesis – Basel Accords, Mark III

The 2007/8 credit crisis brought to light shortcomings in the capital framework for credit institutions. Until then, regulatory capital consisted primarily of two types: going concern and gone concern. Tier 1 had the objective of absorbing the losses of a financial institution while it was still solvent. Tier 2, by contrast, was intended to cover losses after a bank entered into insolvency. Given that only a small proportion of Tier 1 core capital proved effectively loss-absorbing during the credit crisis, its role and nature was rethought. The Basel Committee on Banking Supervision concluded that the severity of the credit crisis was largely due to a build-up of excessive leverage accompanied by a deterioration in the quality and level of the capital base ([BIS, 2011](#)). The Basel Committee therefore introduced a global regulatory framework intended to strengthen capital requirements. In December 2010, the Basel Committee issued an initial set of proposals that called on national authorities to improve the quality, consistency and resilience of bank regulatory capital. The proposals (dubbed “Basel III”) were subsequently transposed into EU law through the Capital Requirements Directive IV ([CRD IV](#)) and Capital Requirement Regulation ([CRR](#)).

Three pillars

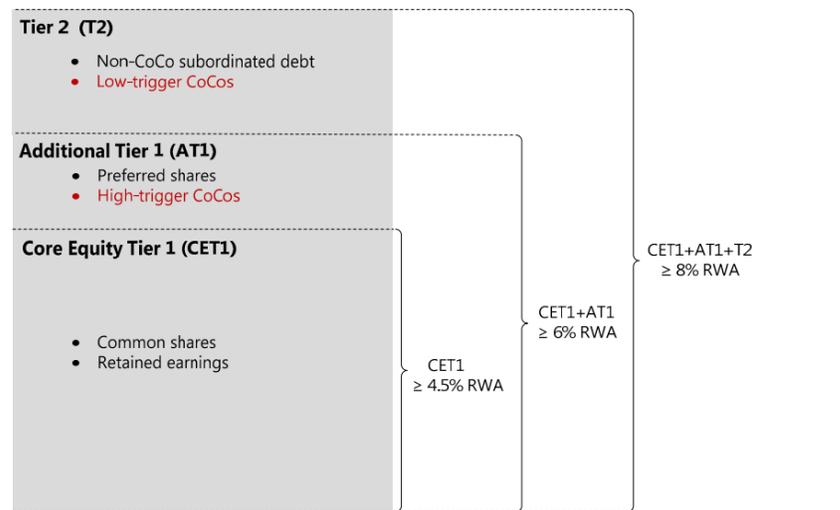
The Basel Accords are international standards that set out a framework for capital and liquidity requirements. These standards comprise three components or ‘pillars’:

1. Pillar 1: This is the minimum capital requirement and covers the prime categories of credit, operational and market risk. Capital requirements can be quantified and set at fixed levels, e.g. a given exposure may attract a specific capital charge, or may fluctuate based on projected losses derived from models.
2. Pillar 2: This consists of the supervisory review process in which banks assess their overall capital adequacy in relation to their risk profile. This assessment may lead to the imposition of further capital requirements, or guidance, where additional risks are identified. These may be risks not fully captured in Pillar 1, or other forms of risk relevant to a firm such as legal risk, concentration risk, counter-party credit risk, etc.

- Pillar 3: This complements the other two pillars and sets out standards of information disclosure. The publication of key risk information should allow market participants to monitor the capital adequacy of a bank and promote market discipline.

Basel III created a new class of capital with ‘contingency’ clauses. The Basel Committee mandated that all non-common Tier 1 and Tier 2 instruments must belong to the ‘contingent capital’ class, in effect *expanding* the category of common equity to include ‘non common’ securities that incorporated certain equity-like criteria. To qualify as *Additional Tier 1*, such securities had to be perpetual in maturity, discretionary in interest payments and able to participate fully in absorbing a bank’s losses *at the point the institution becomes non-viable*, i.e. not viable without recourse to the additional capital. The new definition retained the dichotomy of ‘going concern’ and ‘gone concern’ capital. Going concern recapitalisation is central to the concept of AT1 CoCos. In contrast, a bank can generally only have recourse to preferred shares and other forms of bail-in debt once it is in resolution as ‘gone concern’ (viz ‘bankrupt’).

FIGURE 7: POSITIONING OF COCos IN THE CAPITAL STRUCTURE



Source: EBA (2011). NB: Trigger levels are attributed by tier level on the EBA’s original documentation.

AT1 vs T2 CoCos

CRD IV is an EU legislative package of prudential rules that requires banks to hold permanent capital of at least 8% of risk-weighted assets, of which 6% must be in the form of Tier 1 capital. The Tier 1 component must be composed of at least 4.5% of Common Equity; the remainder may come from other forms of Tier 1 capital. The diagram in Figure 7 shows the location of contingent capital

in a layered ('tiered') capital stack: common equity, at 4.5%, is at the bottom, with Additional Tier 1 at c1.5% and Tier 2 – including Tier 2 CoCos – at c2% forming the next two tiers.

While some CoCos are Tier 2, most sit in a bank's capital structure as Additional Tier 1 – below Tier 2 but above Core Tier 1. Different requirements define the compliance of securities as either Tier 1 or Tier 2 capital:

1. T2 CoCos are subordinated to depositors and general creditors but rank higher than AT1s. AT1s are *junior* subordinated instruments, ranking only senior to shareholders' equity.
2. T2 CoCos typically have a maturity of 10 years and must be issued with a tenor of at least 5 years, whereas AT1s must be perpetual and non-callable for at least 5 years.
3. Coupons are mandatory for T2 CoCos, but fully discretionary for AT1s.

The dominant form of contingent capital now – especially in Europe – is Additional Tier 1 such that CoCos are generally known simply as 'AT1s' to practitioners. Few banks choose to issue Tier 2 CoCos in Europe anymore, as issuing a standard subordinated bond is usually cheaper. The Tier 2 variety of CoCo appears to have been an experiment that has almost run its course. There are only eight Tier 2 CoCos still outstanding as of mid-2021, for an aggregate euro equivalent of €10 bn. Though a rarity, this variant of CoCos does continue to be issued – with the France-based BPCE coming to the market in [October 2021 with new T2 CoCo notes](#). Despite the occasional offering, Tier 2 CoCos appear likely to disappear as they come to maturity and are not replaced.

What is novel about the Basel III definition of AT1s is that it allows for a structured product to be *classified* for regulatory purposes almost as if it were common equity while being *treated* for tax purposes as if it were subordinated debt. This exquisite finessing of the legalese, however, tells us little about the actual nature of the new financial instrument. To be classified as both fish and fowl does not necessarily give a beast scales and feathers, but unfortunately this hybrid legal definition has given rise to a lingering confusion that the labels are synonymous with market behaviour. The distinctive quality for AT1s is their risk asymmetry.

B. Asymmetrical Risk Profile

The initial buzz around CoCos focused on the possibility for debt to convert into equity. A CoCo could begin life as a bond but with a higher yield to reward investors for taking on the risk that if a bank became distressed the notes would then be swapped into shares. The purpose of such a share

swap would be to restore the fortunes of a troubled institution by forcing some of its bondholders to forfeit their claims to be repaid. Regulators, banks and investors all appeared to benefit from this new breed of hybrid securities. For regulators, CoCos help to bridge the gap in capital shortfalls and incentivise bank management to maintain healthy capital ratios. For banks, CoCos are a cheap way to raise regulatory friendly funds – costing roughly half the return on equity demanded by rights offerings, with interest payments on CoCos often tax-deductible. For investors, CoCos offer a yield significantly higher than straight bonds. There is a catch, however: *risk asymmetry*. In calm markets, CoCos behave like a typical coupon-paying corporate bond, but in distressed markets these notes expose investors to equity-like losses that can accelerate non-linearly as capital levels collapse.

CoCos are engineered to recapitalise banks according to a regulatory architecture based on capital ratio requirements and pre-set automatic triggers. These structured notes are designed with in-built triggers which, when touched, boost a bank's capital position. The following two elements are central to the regulatory philosophy on financial stability that underpins contingent capital:

- (1) **Target capital ratio percentages:** There is an assumption that a bank's Common Equity Tier 1 / Risk-Weighted Assets ratio can act as a general-purpose gauge of the strength of an institution's balance sheet. Basel Committee guidelines express capital requirements as a *ratio* – liquid loss-absorbing funds as a proportion of risk-weighted assets. This approach represents both on and off balance-sheet exposures, weighted according to their assigned risk. Capital ratios so defined are believed to be a fair measure of financial health. *This mindset constitutes the animating metaphysics of CoCos, which are designed to explicitly link triggering mechanisms to pre-specified levels of the CET1/RWA ratio.*
- (2) **Recapitalisation as a *going concern*:** The goal of the Basel Committee is to mechanically recapitalise an institution once it encounters distress. The underlying assumption is that weakened balance sheets can be strengthened by reducing fixed liabilities. As a bank's capital position deteriorates, its capital ratio will reach a point when it touches first the threshold for restricting interest rate payments, dividends and employee bonuses. If the ratio continues to deteriorate, it will next reach the threshold at which the principal of the contingent notes is converted into equity or written off. Cancellation of interest payments and conversion of debt are designed to bolster the balance sheet and thereby lower overall leverage.

An upside-down proposition

Despite the use of the term ‘convertible’, it is important to bear in mind that CoCos invert the intuitive understanding of traditional hybrids – offering a quite different proposition. Traditional convertibles have defensive characteristics: they provide bond-like coupon payments and grant *the bondholder the right to convert* into an equity position for additional gain should the share price rise. The regular coupons offer downside protection similar to fixed income debt, alongside the potential to participate in equity appreciation. In contrast, the main purpose of a CoCo is to help protect a bank from becoming insolvent. The investor in a CoCo has ‘sold an option’ to the bank that has strict terms on its exercise. On the other side of the trade, the issuing bank is paying for a form of ‘put protection’, with the excess interest above the rate for standard subordinated bonds the rough equivalent of the premium for such protection. Investors in CoCos face the opposite exposure of traditional convertible bondholders – *CoCo investors give the issuer the right to convert the debt into equity*, to cancel coupon payments or to extend a note’s maturity. In holding a CoCo, the investor is limited on the upside to retaining an ‘oversized’ coupon but is exposed on the downside to a series of potential loss events.

A conventional convertible offers two pathways to profit, the route of a straight bond with a fixed coupon as well as the sweetener of an alternative high road of enhanced pay-out in the event of a sharp share price rise. A regular convertible will behave much like a corporate bond if the equity price does not reach the level where conversion is profitable. The value of a traditional convertible is therefore truly tied to the share price of an issuer. Assessment of the future level of the share price is an important consideration in the price formation of a conventional convertible bond. This is not the case at all for a CoCo. The share price has no bearing on the terms of the note, aside from the calculation of loss at a contingency event. The equity price only comes into play if the capital ratio collapses to the trigger threshold, at which point the shares can reasonably be expected to have severely declined. In contrast to a conventional convertible which offers upside optionality to a range of potential levels should the share price rally, any ‘conversion’ for a CoCo occurs only at a deeply depressed equity price. Continuous monitoring of the share price does not matter much for a CoCo as at no point is there an option for the investor to choose to convert.

A traditional convertible bond can convert into shares of common stock of equal value *at the call of the note holder*. This type of bond is often used by venture capitalists who wish to fund start-ups without establishing an explicit valuation on the assumption that if things go well the ‘in price’ will

be relatively attractive. There is thus a speculative edge to traditional convertibles, which assume that a transfer into equities may be possible in a way that will favour the investor. While the mechanism of conversion superficially resembles that of conventional convertible, the risk/reward proposition of a CoCo is entirely reversed. Conversion is not at the discretion of the investor; it is either according to pre-agreed terms or *at the discretion of bank management and the bank's national supervisor*. Any transfer from debt to equity for a CoCo transpires at terms favourable to the issuer.

Skewed risk/reward

Shareholders hope to receive a higher return in the long run compared to debt investors as compensation for taking on the greater risk of losses. For CoCos, there is far less 'up-beta' – i.e., even if the entire market rallies, CoCos have a capped upside not much beyond their coupons. The return for a CoCos is simply the premium received for selling a form of options to a bank. The best outcome is to retain the full premium by means of regular interest payments and to have the principal returned at the first call date of the note. Although CoCos tend to be syndicated and traded as fixed income instruments, their downside risk is equity-like by definition: the loss of all coupons and principal. However, *the risk/reward profile of CoCos is not symmetrical in the manner of equities. When viewed from the perspective of a probability distribution, CoCos share the 'left-hand' downside core and tail risk of equities but lack almost all of the 'right-hand' positive appreciation and blue-sky potential of equities.*

The skewed reward profile of CoCos begs the question: why would an investor take on the greater risk associated with such an asymmetric return profile? If one believes the prospects of a bank maintaining its capital position far outweighs the prospect of it deteriorating by a considerable degree, then why not just invest in its stock and then partake in both a dividend and possible share price appreciation? Though it goes beyond the scope of this thesis, the attraction of the asymmetric return profile is generally understood to be a function of the current ultra-low interest rate environment combined with the depressed state of the equity market for the European banking sector. These two elements have fuelled a fierce hunt for yield in which investors have been willing to accept risk asymmetries to counterbalance the sharp decline in portfolio management fees. Whatever the source of its attraction, the asymmetry of a CoCo's risk/reward profile is central to understanding the price formation of these instruments.

The yield on a CoCo should be seen in the context of a bank's cost of capital. The estimated cost of equity for developed European banks is circa 10-12%. By comparison, the AT1 CoCos of developed

European banks offer an average yield of circa 5-6%, with the notes of most banks tending to trade in line almost as a single class – e.g., c80% of the AT1 class are at c5% around par, despite a wide range of bank fundamentals. The attraction is therefore clear from an issuing bank’s perspective. AT1s are an efficient source of capital compared to shareholders’ equity, offering financing at roughly half the price. The attraction from the point of view of investors is that, on a total return basis since their inception, AT1 CoCos have outperformed the corporate bonds and even the equities of many European banks. Again, this is largely due to the ultra-low rates environment and weak earnings growth at European banks. With an annual effective yield of 5% or more, CoCos have offered among the best risk-adjusted returns over the past decade *if one assumes the risks of hitting triggers is minimal*. Whether this assumption is accurate, or a mispricing of risk, is a key topic of our investigation.

A product of financial engineering

CoCos are promissory notes, but despite containing promises and in a loose sense therefore being a form of bond, the securities are engineered as a structure of contingent claims – and are referred to as ‘structured notes’ in many prospectuses. An important point for analytical purposes is not to misconstrue the legal classification as Tier 1 hybrids with intrinsic properties. Though often branded as high yielding ‘bonds’, CoCos are *structured products*, products of financial engineering which encapsulate a degree of non-linear optionality not previously available for inclusion in regulatory capital. It is this optionality that operates as a form of embedded leverage in that it boosts the yield for investors as a quid pro quo for taking on exposure to barrier events. *Through CoCos banks are thus able to synthesise their own tail risk and sell it on to other market participants.*

AT1s, as conceived by Basel III, are similar to a structured product known as an autocallable ‘barrier reverse convertible’. Autocalls can automatically kick out prior to their scheduled maturity date if the observed level of the underlying asset to which they are linked touches a pre-determined trigger. By ‘kicking out’, the autocalls expire and pay a residual value according to an agreed formula. Common underlyings for such products include stock indices, commodities and currencies – all of which trade in deep and liquid markets. With most barrier-based notes, there is no expectation of an actual exchange for physicals. A market maker may take on some inventory to hedge in relation to a tracking error, but this is background logistics. The reference to an asset in an autocallable is primarily for the purposes of calculating its P&L. CoCos, on the other hand, are structured products that have been optimised to allow banks to meet regulatory capital requirements at a lower cost of

capital. CoCos use the CET1/RWA ratio in the formula for their triggers, even though this accounting measure has no tradable correlate – and there could be no exchange for physicals, even in theory. Hence, the analogy of a reverse convertible may underestimate the tendency for CoCos pricing to completely dislocate from equities, which are only referenced to calculate losses on conversion. In the case of CoCos, the underlying referenced in its embedded barriers is not traded on any market but rather the accounting metric itself.

Barrier accounting

The accounting treatment of a CoCo varies across banks, with all forms reflecting some P&L fluctuations as a result of marking to market such as by the underlying swap given that the coupon is documented as a spread to a benchmark. This extract from a prospectus acknowledges that:

“...it is possible that the notes will be treated as an investment unit consisting of a debt instrument issued by Barclays Bank PLC and a call option that each holder of notes has issued to Barclays PLC. If the notes are so treated, a portion of the interest paid on the notes would be treated as option premium and taxable as short-term capital gain.” (Barclays, 2010)

Studies of investor behaviour find that end states present simplifications that are used for establishing risk/reward even though such pay-off diagrams miss important information and may lead to miscalculations of probabilities – in particular, an underestimation of mark to market losses during the holding period that can force an exit prior to expiry. It is in the nature of notes with embedded binary options that price adjustments may occur suddenly. It is important to stress that the payoff for a CoCo is not a nice ‘hockey stick’ diagram. CoCos will not only trigger if the barrier is breached at a fixed maturity five years hence, they will trigger if *at any point in time* there is a breach – or if the regulator perceives the capital position to be close to breaching, i.e. not technically in breach but close enough to force a trigger event.

Formal loss occurs if a barrier is touched, or conversion is forced, but once a CoCo is facing the threat of such an event its price will already be discounting the probability. This means that the price may decline precipitously such that exiting a position, due to internal risk parameters being hit, could crystallise a loss almost as severe as if the CoCo had actually been converted. There is, in effect, a ‘corridor’ as described by Carr and Wu into which an AT1 CoCo near its accounting barrier enters as its price gaps down in reflection of the binary nature of the contingency event (2010). This suggests that as capital buffers erode, the prospects of either an automatic or regulator-induced

triggering should be steadily discounted. The trigger event is the final blow, but the bulk of the price action transpires as a barrier is neared.

All barrier notes, and especially down-and-in barrier options of the sort that CoCos resemble, are difficult to price. Barrier notes are known to be very skew-sensitive and short volatility – and therefore critically dependent on gamma (Vallée, 2015). As the exercise of a CoCo's embedded barriers can occur at any time prior to maturity, this makes these notes *heavily path dependent*, and thus very challenging to model quantitatively. Such risks are present in other securities such as convertible bonds, callable bonds or equity options. However, it is the combination of several embedded binary barriers that gives AT1s their distinctive asymmetric profile. As multi-barrier structured products, the components of risk can interact and shift in relative prominence across market regimes.

Definition of an AT1: Multiple barriers

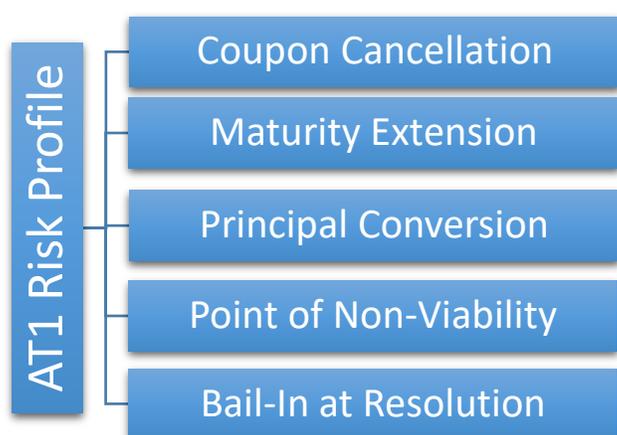
Additional Tier 1 is the type of contingent capital now prevalent among European banks and we therefore focus our research on AT1 securities. We include the Tier 2 variety of CoCos in the first stage of empirical analysis, but T2 CoCos do not require coupon cancellation clauses and have fixed tenors, attributes which our findings suggest leads to a different pricing dynamic. Moreover, T2s are considered to be 'gone concern' capital and the signal characteristic of AT1s is that they are designed with triggers to make them loss-absorbing in a 'going concern' situation. Within the banking sector there are also preference shares that have some features in common with AT1s such as coupon deferral. But 'prefs' do not have automatic constraints to restrict interest payments nor mechanical triggers to convert principal. Bank preferreds also differ in that they are expected to absorb losses on a gone concern basis. Moreover, the regulatory classification and tax considerations are different for prefs, which can be categorised as equity but have taxable coupons.

There are other forms of contingent securities such as Restricted Tier 1 (RT1) notes, which can qualify as capital under Solvency II provisions – another regulatory development driving new forms of financial engineering. Indeed, 'catastrophe bonds' may in some ways be seen as the antecedents of CoCos. As early as 2006, Swiss Re issued \$750m in notes with a trigger set at 125% of the 'Swiss Solvency Test' ratio, a risk-based capital standard based on a valuation of assets and liabilities. RT1s are also loss-absorbing capital instruments that convert into shares or writedown upon breach of a pre-determined solvency ratio. RT1s bear a close resemblance in contractual terms to AT1s, but their issuers all come from the insurance/(re)insurance sector. Munich Re, Allianz SE and other insurance

companies have issued RT1s referencing solvency ratios. The volume of RT1 CoCos is increasing as by insurers/reinsurers are now able to “classify these securities as regulatory-efficient capital.” (Moody’s, July 2015). While the RT1 class of hybrids highlights the growing relevance of contingent capital, for purposes of analysis we limit our study to CoCos issued by credit institutions.

The risk sections in prospectuses highlight that the losses for an investment in AT1-style contingent securities can take *any of the forms* shown in the schematic in Figure 8. These risk factors are barriers that entail a loss mechanism via a trigger event. These are defined below, citing as examples related text as stated in a memorandum ([26 January 2017](#)) for AT1 CoCos issued by Credit Suisse.

FIGURE 8: SCHEMATIC DECOMPOSITION OF LOSS MECHANISMS



Source: Our design, based on company prospectuses.

1. **Cancellation of coupons:**

“The Issuer may elect not to pay interest, in whole or in part, on any Interest Payment Date. The Issuer may make such election for any reason.”

Interest payments are omitted if the distributable reserves are inadequate, leading to a non-recoverable loss. Once the combined buffers are breached, cash distributions become restricted according to a sliding scale and a bank may be no longer obliged to pay AT1 interest payments. Cancelled coupons do not accumulate but are permanently written off.

The conditionality of coupon payments is completely at odds with the guarantees of straight bonds. In a standard bond, cancelling an interest payment has immediate implications for default. The fact that this does not hold for AT1s means that we cannot really speak of a *fixed income* instrument, which limits the relevance of traditional fixed income valuation

approaches. The forgoing of interest payments on AT1s can be as serious as the loss of principal given that the notes are perpetuals.

2. Extension of call dates:

“The interest rate on the Notes will reset on the First Optional Redemption Date ... This reset rate could be less than 7.125 per cent. [initial coupon] and could therefore adversely affect the market value of an investment in the Notes.”

Rising interest rates across the market or deteriorating earnings for a bank (or both) can increase the cost of refinancing, making the implied coupon required for a replacement issue higher than the reset rate of the outstanding notes. The first call date may be skipped if current spreads are too far above the backend rates, extending duration and repricing the yield to a later maturity. AT1s are generally callable at five year intervals. Extension means the receipt of interest payments below the market level demanded for the degree of risk in the credit profile. An AT1 investor could end up having to hold their notes for an extended period of time or even to perpetuity.

Any analogy of a ‘reverse convertible’ breaks down quickly when the perpetual nature of AT1 CoCos is factored in. Although AT1s have call options, in stark contrast to traditional hybrid debt there is no activation of ‘step ups’, i.e. a higher interest rate following a call date as a kind of punishment if the bond is not called. Such incentives to redeem are prohibited for AT1s. For regular callable bonds, extending maturity is a sign of deteriorating credit-worthiness and the reluctance to send such a negative signal (which could also make future issuance more costly) strongly disincentivizes banks from skipping call dates. With CoCos, the disincentive is designed to be radically weaker.

3. Writedown/Conversion of principal:

“The Notes may be subject to a Conversion and upon the occurrence of such an event Holders will be further subordinated and subject to an enhanced risk that they will lose all or some of their investment in the Notes.”

The principal can be either written down by a percentage or converted into equity, once the capital ratio hits a specified threshold, resulting in a non-recoverable loss of varying severity. The mechanism by which losses are incurred may cite either a percentage writedown of principal or a conversion to equities. Writedown clauses may allow for write-back if certain criteria are met. In the event of a conversion, the principal amount is transposed into

common equity. Conversion may have implications for risk shifting, in that it can impact existing stakeholders who face dilution. So, in a sense the mechanism of principal writedown is a one-car crash and that of equity conversion, a two-car collision; however, from the perspective of the AT1 holder both mechanisms result in serious losses.

4. Supervisory intervention:

“[... capable of being converted into equity or written-down/off in the determination of the Regulator, [if the issuer] would have become insolvent, bankrupt, unable to pay a material part of its debts as they fall due or unable to carry on its business.”

Figure 9 shows the approximate location of the main triggers in a representation of the capital stack that emphasises the direction of loss absorption – from top to bottom. There is scope for discretion in the assessment of the above three triggers, which can override the contractual terms, leading to supervisory action being proactive. In effect, investors in AT1s write an endorsed cheque to the national prudential authorities that can be cashed at any time. When the national supervisor believes a bank to be at risk of becoming no longer viable, it has the authority to force the loss absorption of an AT1, even if the most recently disclosed capital ratios are above the triggering threshold. Basel III-compliant AT1s can incur losses upon determination of impending non-viability on a jurisdiction by jurisdiction basis. AT1s are also subject to bail-in as subordinated debt. At formal resolution, AT1s are first in line to be written off as the notes are constructed from an underlying instrument that is deeply subordinated.

FIGURE 9: CAPITAL STACK⁷ – SCHEMATIC OVERVIEW OF TRIGGER LEVELS

| | | | |
|---|--|--|---|
| Bank-Specific | Management Buffer 0-c2% | Determined as part of the risk appetite framework | |
| Bank-Specific (Own Funds) | Pillar 2 (2B) / MREL Guidance (not publicly disclosed) | Breach triggers heightened supervisory attention, e.g. capital conservation plan | |
| Combined Buffer Requirements (CET1) | Counter Cyclical Buffer 0 – 2.5% | Breach triggers a calculation of MDA Sliding scale based on quartile calculations | ← <i>MDA trigger^{1 & 2}</i> (reflects interpretation of accounting rules) |
| | Systemic Risk/ Systematic Risk ⁵ 0 – 5% | | |
| | G-SIB/ G-SII D-SIB/ O-SII SRB | | |
| | Capital Conservation Buffer 2.5% | | |
| Additional Own Funds (CET1, T2, AT1) | Pillar 2 (2A) Requirement ⁶ (max 25% T2 & 18.75% AT1, min 56.25% CET1 of total P2) | Breach is a condition of 'failing or likely to fail' | ← <i>PONV trigger³</i> (discretionary range) |
| Pillar 1 (Minimum Own Funds) | Pillar 1 – Tier 2 (2%) | Breach is a condition for resolution | ← <i>Conversion trigger⁴</i> (fixed level varies) |
| | Pillar 1 – Additional Tier 1 (1.5) | | |
| | Pillar 1 – CET1 (Common stock + Retained Earnings) (4.5%) | | |

Source: Based on updates from Bank for International Settlements and the ECB's SREP methodology.

Notes:

- MDA trigger: Reflects both the 'no double counting' and 'priority rule' as it pertains to TLAC-MREL and discretionary assessment of infraction.
- MDA trigger thresholds:

$$\text{CET1} = \text{Pillar 1 CET1} + \text{Pillar 2 CET1} + \text{CBR CET1}$$

$$\text{Tier 1} = \text{CET1 MDA} + \text{Pillar 1 AT1} + \text{Pillar 2 AT1}$$

$$\text{Total Capital} = \text{Tier 1 MDA} + \text{Pillar 1 Tier 2} + \text{Pillar 2 Tier 2}$$
- PONV trigger: A supervisor can intervene to trigger CoCos when it deems a bank is at risk of being "no longer viable".
- Conversion trigger: Write-down or conversion occurs at the capital adequacy ratio specified in the AT1 prospectus, generally 5.125% or 7%.
- Higher of G-SII, O-SII or SRB; in certain jurisdictions, the sum of SII and SRB.
- EU's Article 104a and the UK's PRA allow for a formula in which at least 56.25% of Pillar 2 /2A must comprise CET1, with no more than 25% in Tier 2 (i.e. 75% comprised of Tier 1 capital); within these limits a maximum of 18.75% of AT1 is also permitted.
- Capital requirements are expressed as a percentage of risk-weighted assets and categories are represented approximately to scale.

Operationalised metrics

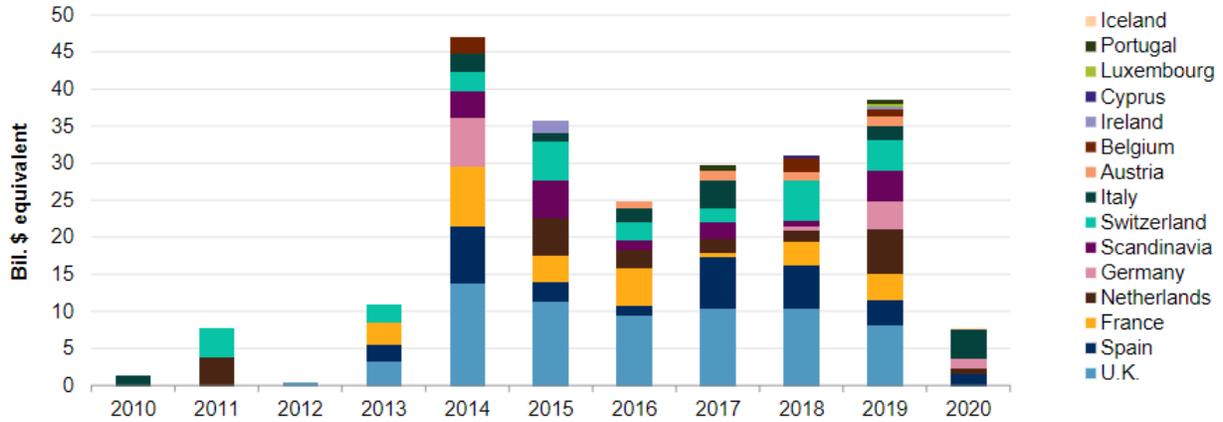
The risks associated with the coupon and principal barriers can be measured by the gap between current capital or leverage ratios and required minimum levels. The extension barrier can be measured by the costs of refinancing new issuance versus an existing note's reset spread. Thus, for each type of risk there is a 'distance to the trigger' that can be operationalised as a measurable metric:

- **Coupon cancellation** – the distance from the current CET1 available to the combined buffer requirement, as a ratio of risk-weighted assets, which if touched will trigger the calculation of a Maximum Distribution Amount (MDA), and also the distance to the minimum figure to be maintained for Available Distributable Items (ADI). A number of metrics are used to determine the MDA threshold – CET1, Tier 1 and Total Capital and leverage ratios – and ADIs are dependent on the prior periods' earnings.
- **Maturity extension** – the distance from the current z-spread to the reset rate, which determines the economics of refinancing at the first call, is the main metric. Another distance is represented by the time remaining to the first call date, as its nearness focuses the mind of investors on the refinancing dynamics.
- **Principal writedown / Conversion to equity** – the distance from the current CET1/RWA ratio to the capital adequacy level at which principal will be written down by percentages or converted to equity. The trigger level and the recovery rate are the key metrics. The implied recovery rate is influenced by the conversion price or write-back clauses.

C. Growth into a Distinct Asset Class

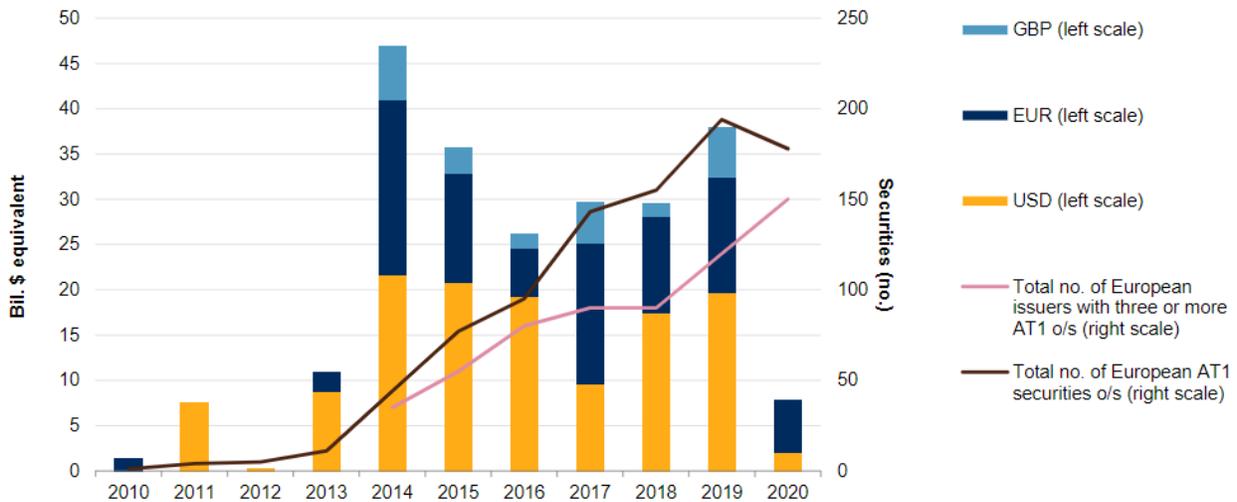
From a standing start in 2012/13, the market for AT1 securities has raced ahead to approach the size of the traditional European corporate high yield market. There have been 45 new AT1 issues from European banks, totalling the equivalent of roughly €30 billion by mid-November 2021. Within Europe alone, this takes the overall market to c€202 bn, with 87 banks issuing 267 notes across 19 countries and 9 different currencies. Since 2017, AT1s totalling c€59 bn (c71 notes) have been called. Taken together, the aggregate amount of AT1s issued to date by European banks equates to c€261 bn (CreditSights, 2021). Every year since their launch, there has been net positive supply, with AT1 CoCos now a core source of bank funding. Figures 10 and 11 overview the distribution of securities across Europe by country and by currency.

FIGURE 10: EUROPEAN AT1 ISSUANCE – BY COUNTRY



Source: Dealogic, S&P Global (April 2020)

FIGURE 11: EUROPEAN AT1 ISSUANCE – BY CURRENCY & NO. OF SECURITIES



Source: Dealogic, S&P Global Ratings (April 2020)

Although the focus of this thesis is on AT1s issued by European banks, it is worth stressing that the market for CoCos is global in nature. Banks have issued approximately half a trillion US dollars in CoCos worldwide to date, with estimates varying due to differences in definitions. Emerging markets account for a third of CoCo volumes; e.g., in December 2015, Industrial and Commercial Bank of China issued the first euro-denominated CoCos by a Chinese bank as part of a \$5.6bn multicurrency deal. Within Europe, almost every major bank now holds AT1s in its capital structure.

The years immediately following introduction by the Basel Committee of the new regulations witnessed a flurry of issuance as banks set about to satisfy their capital requirements. Given the initial call dates are generally set at five-year intervals, the market for AT1s began a second phase of issuance that commenced in earnest from around the second half of 2020 and will carry on through to end-2023. Thus, CoCos are poised to retain their relevance as there remain strong incentives to use these hybrid securities to meet capital requirements. Considering that the costs of issuing AT1 capital is much lower than the costs of equity, in part due to the tax deductibility of their interest payments, European banks are incentivised to use their full allowance of AT1s. Even once the initial 1.5% AT1 buffer is full, there is a further incentive to continue to issue since the enactment of Article 104a. Not only is issuing AT1s rating-positive as it increases the amount of going concern capital, it can also count towards meeting minimum leverage ratios. Moreover, total loss-absorbing capacity requirements are being introduced for global systemic banks and minimum requirement for own funds and eligible liabilities for European banks, both of which boost the demand for AT1s.

CoCo holders are now a broad investor base that has grown well beyond the initial niche of private banks and hedge funds to include mainstream insurance, pension and sovereign wealth funds. Several specialist funds have launched, facilitated by the creation of CoCo indices. For example, the BlueBay CoCo fund launched in January 2015 takes as its benchmarks the BoAML index, initiated during the same month. Yields are relatively high on AT1s, though if an investor needs to hold capital against the position, overall portfolio returns may not be quite as appealing as the optics of the coupon suggest. Knowing that many investors were reluctant to buy AT1 notes in a funded format, in 3Q 2017 market makers such as Goldman Sachs and JP Morgan introduced total-return swaps (TRSs) as a synthetic hedge. AT1s cannot be hedged with credit-default swaps for, among other reasons, the fact that the notes can skip interest payments without triggering a default. The TRSs, however, permit investors to hedge a basket of AT1s without having to tie up large amounts of collateral. These swaps are linked to iBoxx indexes of dollar- and euro-denominated AT1s. The introduction of the TRSs highlights the evolution of the CoCo market and the expansion in investor demand. As another mark of the maturing of the asset class, the first ETF for European AT1s was launched in mid-2018, which reinforces the tendency for AT1s to trade as an asset class.

III. Incentives & Risk Shifting

A matrix of contending motivations

Although instigated by regulators, the design of CoCos reflects detailed input from corporate treasurers and the notes were fully productised by investment bank structurers. For CoCos to be attractive for institutional investors to hold, financial engineers needed an instrument that would be less expensive than issuing equity. Various national authorities obliged by approving contingent barrier notes with embedded leverage to qualify as regulatory capital. The advent of CoCos was facilitated by their classification as debt, which made possible tax concessions on their coupons, and their classification as ‘equity-like’, which allowed them to fulfil Tier 1 requirements. These ‘efficiency’ attributes were key *facilitating* factors for creating a new breed of hybrid securities to substitute for common equity.

To better inform the interpretation of our empirical findings, we explore the appeal of CoCos for each of the constituents who participate in the market for contingent capital:

- A. **Basel Committee:** a capital cushion to help safeguard banks and prevent contagion.
- B. **National governments:** a means of avoiding taxpayer-funded bailouts.
- C. **National supervisors:** a tool to bail-in trouble banks and avoid economic disruption.
- D. **Management:** an instrument to raise loss-absorbing capital that is cheaper than equity.
- E. **Shareholders:** capital for the bank without dilution to their shares – i.e. greater leverage.
- F. **CoCo holders:** a solution to the search for yield in an ultra-low interest rate environment.

1. Supervisory-bank nexus

The logic behind contingent capital

The impetus for the creation of contingent convertible capital came from the Basel Committee on Banking Supervision, with the precise terms agreed on a country-by-country basis by national authorities. The Basel Committee created CoCos to facilitate pre-arranged capital injections in case of a future banking crisis. The catalyst that transformed contingent capital from theory into practice was the failure of the existing hybrid debt to aid in recapitalising distressed banks during the credit crisis of 2007/8. Subsequently, the banking community began a search for ‘bail-in-able’ instruments that were less costly than equity but retained some equity-like characteristics. By ‘bail in’ is meant the conversion of debt into equity or the writing down of debt when losses are taken by the bondholders.

The aim was to create a method of bail-in that works while an institution is still a going concern. Capital that can take a hit while the bank is solvent is called ‘going concern’; less risky instruments that take losses only once an institution is in resolution are called ‘gone concern’. The goal of the new financial architecture is to convert/write-down the contingent capital of a distressed bank in a manner that allows a financial institution to recover without need for resolution or state funding.

The Basel Committee consists of banking supervisory authorities from each member country and its oversight body is the Group of Central Bank Governors and Heads of Supervision (GHOS). Though distinct entities, the Secretariat of the Basel Committee is hosted by the Bank for International Settlements (BIS), a financial institution owned by its participating membership of c60 central banks. The BIS acts as the ‘bank for central banks’, carrying out its goals of facilitating financial interaction and stability through a programme commonly referred to as the ‘Basel process’.

A central aim of the Basel process is to isolate shocks at the firm level to avoid contagion and, should resolution be required, to prioritise bail-in over any recourse to government bailouts. The sovereign states, national supervisory authorities and domiciled banks form a closely interlinked chain of decision making. This operational framework for capital markets represents the exceptionally close interaction between the supervisory function and financial institutions, which *we refer to as the ‘supervisory-bank nexus’ in the sense of an interconnected network of decision-making processes*. The guidance from the Basel Committee, the European Central Bank, the EU Commission, the European Securities and Markets Authority and the European Banking Authority all have an influence in shaping the potential value of CoCos. The dialogue between bank management and their supervisor ultimately dictates contingency events for AT1 CoCos – be it coupon omission, maturity extension, principal conversion or bail-in.

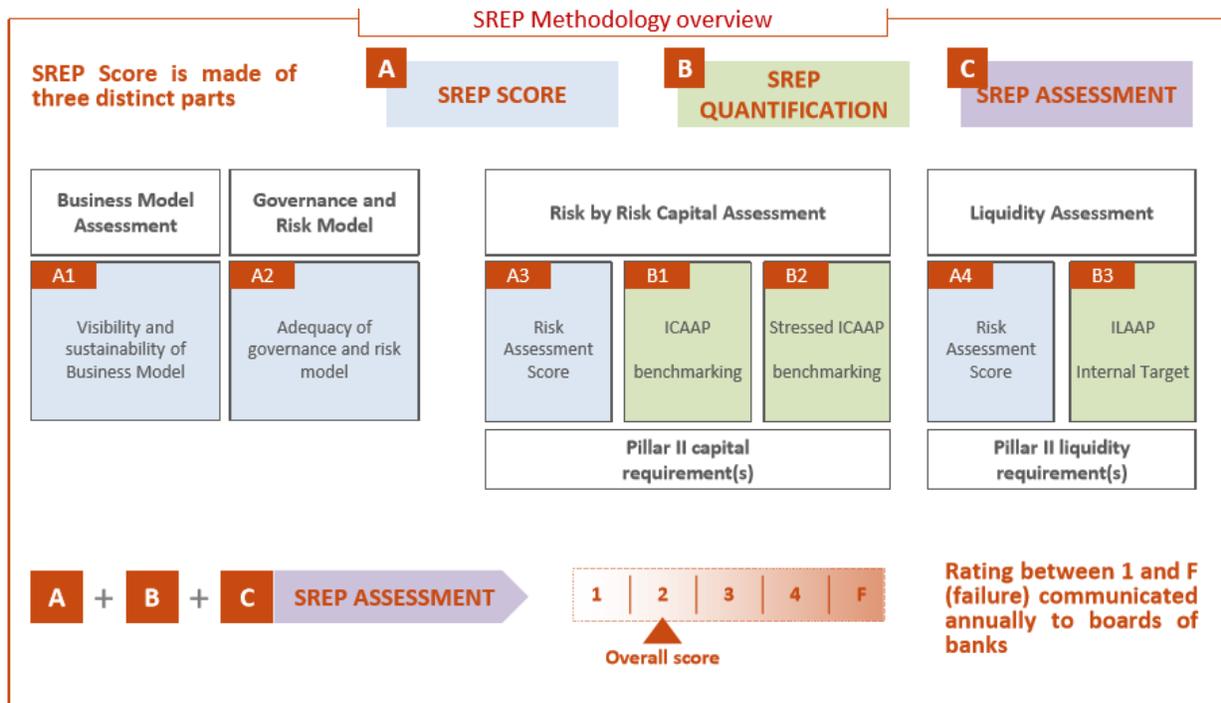
Supervisory Review and Evaluation Process

In the Eurozone, the supervision of the largest banks has transferred from the sole responsibility of national authorities to the ‘Single Supervisory Mechanism’ (SSM) under the aegis of the European Central Bank (ECB). The ECB now supervises the largest (c130) Eurozone banks through a collective approach, referred to as the ‘Supervisory Review and Evaluation Process’ (SREP), based on the guidelines of the European Banking Authority. The ECB developed the SSM SREP to incorporate the best practices of banking supervisors from participating member states. The ‘Common SREP’ encapsulated in the EBA’s guidelines was issued in December 2014 and

implemented to full effect in January 2016. Previously, the review process and the wider Pillar 2 components of the Basel framework varied considerably throughout the EU. By housing the SREP under the Single Supervisory Mechanism, one common methodology and timeline is now applied to all the major banks within the European Union.

The ECB principle is that Pillar 2 requirements under SREP will have to be met before the other combined buffer requirements. The Pillar 2 requirement implicit in the SREP ratio can be backed out from the difference between the SREP ratio and the Pillar 1 combined buffer requirement; at the outset this was generally c2.5% of RWAs but now fluctuates as a reflection of the SREP guidance stemming from periodic stress testing. EU banks must comply with the business model, governance, capital and liquidity requirements – as outlined in Figure 12. The quantitative aspects are based on banks’ regulatory reportings, whereas qualitative assessments stem from supervisory-bank dialogue. The supervisory powers embodied in the SREP include the ability to impose additional capital and liquidity requirements and to mandate changes in risk management practices and business plans. The SSM SREP methodology is continuing to evolve in response to changes in the risks faced by financial institutions, as demonstrated in the case of the Covid-19 pandemic.

FIGURE 12: SUPERVISORY REVIEW AND EVALUATION PROCESS



Source: European Central Bank and ML Advisory.

Single Resolution Mechanism

Should the actions of the Supervisory Mechanism fail to restore a bank, the supervisor may then place the institution into resolution. The ‘Bank Recovery and Resolution Directive’ (BRRD), in force across EU member states, grants the power to national authorities to intervene in banks’ operations to forestall failures. Authorities have the tools to restructure banks, to preserve their most critical functions and to allocate losses to shareholders and creditors under a defined hierarchy. This set of procedures is constituted in the ‘Single Resolution Mechanism’ (SRM), which can handle the winding down of non-viable banks. There are close links across the supervisory and resolution mechanisms. However, the intent is for early supervisory intervention to restore a bank’s viability, with losses limited to the most junior layers of a bank’s capital structure. Banks should only apply to the SRM when experiencing a degree of distress that cannot be accommodate by the SSM.

Stress testing

The EU-wide stress tests are led by the European Banking Authority, who maintains the methodology for analysing capital positions against a baseline scenario set by the European Commission and an adverse scenario set by the European Systemic Risk Board – as a reflection of input from the EBA, ECB, central banks and national supervisors (‘competent authorities’).

Periodic stress testing is an important component of supervision. Stress tests are carried out at least annually to determine the quality of a bank’s capital and set the level of specific buffers. The point of these tests is not to measure how much capital banks have in periods of calm but how much they have on hand when crises materialise. In the stress test scenarios, some banks may trigger their CoCos. The outcome of the testing/review varies by jurisdiction and by institution, by which guidance or extra requirements are applied to each bank. Falling below the total SREP requirements in a stress test does not force a distribution restriction, i.e., it has no ‘automatic’ consequence. If the stress tests suggest there is an imminent risk of a shortfall, the supervisor may instruct a bank to take steps to ensure its own funding requirements are fully met – and call for a capital conservation plan. Thus, the communication of credit risks to the national supervisory authority is given greater formality under regular stress testing.

SREP ratio

The output of the stress tests is the calculation of the SREP ratio, which forms the threshold for coupon omission and informs the CET1 level at which early intervention occurs in the case of

conversion or write down. The SREP ratio is the major regulatory capital constraint for European banks, as it calculates the amount of CET1 that a bank must maintain to fulfil its combined buffer requirements. The combined buffers must consist of CET1 and any demands on CET1 to fill other regulatory buckets may lead to a deficit; therefore, the SREP ratio is the focus for much of our analysis. The difference between a bank's current CET1 ratio and its SREP-derived ratio requirements is the key driver of coupon restrictions; if the cushion is too thin, interest payments on CoCos are switched off.

Supervisors have wide discretionary powers at their disposal in the combined scope of banking directives, which bring together the rules on capital requirements (CRR II/CRD V) and on resolution (BRRD/SRM). These rules are operationalised via the SREP, a process that runs constantly in the background. *It is this finely tuned nexus of scoring, stress tests, early intervention and resolution that is being codified and steadily implemented as a common methodology that constitutes the double helix lattice of the supervisory-bank framework. Right at the core of this regulatory 'DNA' lies the contingent capital that all banks are required to hold as own funds.*

2. National governments

Inherent fragility

Bank failures have been a recurring feature of financial history, leading some scholars to suggest that financial markets are inherently fragile such that proscriptive rules alone will never suffice to forestall future crises (Calomiris and Haber, 2016). This underlying instability may be inherent in the dual nature of banks, which were constructed to both meet social needs and to pursue profits. For example, a bank might facilitate lending to increase home ownership while also maximising its mortgage revenue... leading to ventures into the subprime space. The tension between these twin goals of credit provision and profitability can give rise to recurring problems of moral hazard and occasional lapses in market discipline. Certainly, earnings remain endemically low for a number of European banks due to high operating costs and fragmentation, e.g. in Germany or Italy where ownership by foundations or the public sector has discouraged consolidation. If periodic bouts of financial distress are almost unavoidable, then the banking system needs more than an upgrade to its prudential regime. If regulatory oversight alone has its limits, what else can be done? While restructuring and consolidation remain options to offset the fragmentation in some countries, the favoured solution advanced to date has been higher capital reserves.

Credit rationing

Credit rationing arises when banks are unwilling or unable to provide loans for creditworthy projects. This can be especially damaging to households and small/medium sized enterprises. A long-standing issue in advanced capitalism is how to balance the need for buffers at banks with demands for lending to stimulate growth. There are conflicting demands from the regulatory and governmental authorities both for higher capital ratios to prevent future crisis *as well as* for more lending to spark economic recovery. The benefit of additional capital to shore up stability may be offset by the negative impacts from a less profitable banking system and reduced lending to the real economy. The dilemma is that a mandated increase in common equity capital to prevent the need for future bailouts by governments could have the unintended side effect of contracting the supply of credit. Studies suggest that when capital requirements are raised banks tend to respond by cutting back on lending, not by issuing new equity (Jimenez et al., 2013). In the search for cost-efficient regulatory capital, CoCos were suggested as a form of ‘liability swap’.

Moral hazard

Expectations of public support for banks in stressed conditions can lead to the problem of ‘moral hazard’ whereby banks take on excessive risk, funding their activities with lower than optimal levels of capital or liquidity, knowing that taxpayers will provide a backstop. CoCos were designed to create appropriate incentives to constrain moral hazard, and hence inhibit the transfer of risk from debt holders to taxpayers. CoCos aimed to address the incentive problems of market participants, and in particular, to prevent banks from ‘gaming the system’ by taking undue risks in the knowledge that the government provided a backstop. CoCos offered the potential to reduce the cost associated with taxpayer-subsidised rescues by shifting initial losses onto the shoulders of investors.

As a contract with pre-agreed terms and conditions, CoCos should be able to avoid the expense and delay of protracted bankruptcy proceedings. Barriers based on the economic health of a financial institution should have a mitigating effect by creating incentives for bank management and investors to keep risks under control. As a counterbalance to excessive risk taking, CoCos are designed to play their role while an institution is still up and running. Studies such as that by Albul et al. suggest that properly constructed CoCos can discourage banks from poor decision-making when the triggers are both automatic and hit while an institution is still a going concern (2015). To be most effective in

reducing moral hazard, triggering ought to occur early enough to strengthen the capital structure to prevent a bank slipping into resolution.

Doom loop

Democracies running with high levels of debt-financing rely on the modern banking system to fund government budgets, which can no longer be supported solely by the annual revenues raised through conventional means such as individual and corporate taxation or state-owned enterprises. The increasing dependency of 21st century democracies on permanent debt financing throughout the economic cycle has created a 'Catch 22' situation sometimes referred to as the 'doom' or 'diabolical' loop. Seen through this lens, over-indebted governments encourage domestic banks to hold sovereign debt; in conjunction, weaker banks demand support from the same governments to an extent that may become destabilising. The Greek banking crisis of the past decade is a possible example of this dynamic at play. The flash point in the doom loop is a bank collapse that requires national austerity to cover the costs of state aid, while simultaneously the sovereign itself is struggling to service its debt which is largely held in the collapsing domestic banking system.

During the euro debt crisis, banks' holdings of domestic sovereign debt appeared to amplify the transmission of sovereign stress to bank solvency risk. This sovereign-bank nexus reflects the tendency for a government to borrow from banks supervised by its own national authority, which naturally leads banks to hold disproportionately more sovereign debt of the country in which they are domiciled. The preferential regulatory treatment of sovereign debt in risk weighting has forged an interdependence between governments and their domestic banks, expanding public entities' debt facilities and arguably weakening market discipline. The close link between the two actors was, in some instances, further intensified by public rescue programmes during the euro debt crisis which resulted in partial or full nationalisations. If domestic banks are highly exposed to their sovereign's debt, doubts about government solvency that lead to sovereign debt discounting may inflict considerable losses on such banks; in turn, these losses can increase the likelihood of a government-sponsored bailout of the domestic banks, accentuating the initial concern over sovereign default. The greater a bank's sovereign exposures, the more extensive the feedback loop with the debt of the sovereign in which the bank is domiciled.

Reinforcing the doom loop – recent moves

During the pandemic, the European Banking Federation asked for reserves held at central banks and exposures to government bonds to be temporarily excluded from the denominator of the leverage ratio. A [paper from the European Commission](#) then called for more temporary capital relief for banks, granting an exemption for reserves at central banks from the calculation of the leverage ratio but not for banks' holdings of sovereign bonds. The Association for Financial Markets in Europe joined the lobbying for changes to how leverage ratios are calculated, asking to temporarily exclude banks' holdings of sovereign bonds to ensure that banks can buy long-duration government debt without affecting their leverage ratios. Such a move was intended to allow banks in Europe to provide stable funding to governments, which was deemed essential for the funding of the extensive fiscal stimuli to stave off recession. Having gained the approval of the European Commission, this exclusion perpetuates the zero risk weightings of banks' holdings on sovereign bonds – meaning a bank need not retain anything in reserve to cover its sovereign holdings and can lend out all funds.

Contending cogs in the financial machinery

The broad mandate of the EU-wide Resolution Authority is applied at a local level to meet the twin goals of domestic stability and systemic stability. Within Europe the central banking system is not monolithic in its network of incentives. *There is a division into two camps: the European Central Bank, which orchestrates the overall principles, and the national authorities which are supervisors at the nation-state level through which the rules are implemented.* In the developed democracies of Europe, central banks and prudential regulatory authorities are in an arm's length relationship to the elected governments. They are not ministries directly under the control of politicians. That said, despite varying degrees of semi-independence, these cogs all operate as part of a continuum of the state apparatus. As such, 'competent national authorities' may lobby on behalf of domestic banks while implementing the policies of the internationally agreed upon Basel Accords. *The interaction of the two levels of banking oversight introduces a measure of uncertainty as to how the international/pan-EU and national banking supervisors will interpret rules and raises the possibility that the perceived interests of the two camps may not always align as a crisis nears.* In practice, the national authorities of individual countries may on occasion champion domestic banks.

What that means in practice is that if a bank is on the brink in say Italy, the Italian regulator at the behest of the Italian government may be incentivised to do everything in its power to forestall the

collapse of a domestic bank into resolution, given the potential damage to the local economy. There may be tension among the network of the Basel Committee, the European Central Bank, the elected government in Rome, the Bank of Italy, Italian banks and the specific troubled bank. It could be better for the banking system holistically to trigger a troubled bank's AT1s, but this manoeuvre may meet stiff resistance within the jurisdiction where the pain of a triggering is most concentrated. Moreover, to subject a large 'systematically important' bank to early intervention might risk sparking contagion, the ECB might resist such a step if it was seen to be counterproductive to restoring confidence in the banking system. National authorities in conjunction with the Basel Committee and ECB must negotiate an agreed course of action by balancing out all of the competing motivations.

3. National supervisory authorities

Recapitalisation in response to an isolated shock

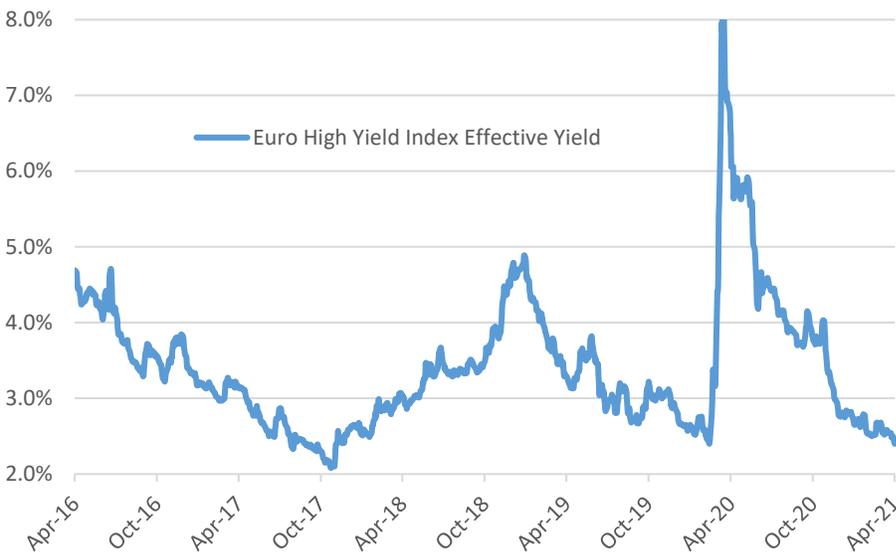
Discussion papers just after the 2007/8 crisis cited the interconnectedness of financial institutions as one of its root causes; at peak times of turmoil, the risk parameters used to hedge were positively correlated. If one bank needed to sell assets into a thinly traded market, prices tended to fall and other institutions were forced to mark down similar assets. This reinforcing spiral of risk discounting made it almost impossible to establish a clearing price for distressed assets and led to a collapse in value for securitised products and default swaps. The forced sale of difficult to price assets is widely understood to have been a key reason why the bankruptcy of Lehman Brothers sparked fears of contagion across the banking system, given that other institutions traded similar products and shared credit lines. In their examination of the bail-in process, Goodhart and Avgouleas stress that bail-in regimes will fail to eradicate the need for an injection of public funds if a number of banks, in particular those with cross-border businesses, simultaneously enter into difficulties (2014). They emphasise that for a bail-in method to be effective, *the risk of failure must remain idiosyncratic to an issuing institution* and not pose a threat to the overall system. CoCos were proposed as a kind of life preserver that might rescue *individual banks* from going under and thereby keep the financial system afloat by preventing waves of systemic risk. The claim was that contingent capital offered "a substitute mechanism by which to prevent a localized shock from causing a cascade of falling financial dominoes" (Coffee, 2013). Known as the 'isolated shock' argument, it was a central motivation in the creation of a new tool that could pre-arrange bank recapitalisations through contingent securities.

To meet this anti-contagion criteria, CoCos must: (1) peel off from the rest of the capital structure of a bank, without pulling down the senior debt – i.e., not cause contagion across a bank’s own assets; and (2) trigger at one bank without fuelling dislocations across the entire CoCo asset class, either due to cross-holdings or outright panic selling. A CoCo is better placed to safeguard a loss of confidence in the financial system if it triggers early, as conversion would take place at a stage when most other institutions are still relatively sound. An early stage triggering might then check a downward spiral in a distressed bank’s other instruments and help to stabilise overall financial conditions. With this aim in mind, CoCos were introduced as central constructs in the post-crisis bail-in regime in Europe with the express goal of containing financial distress at the firm level.

Transfer of tail risk: embedded leverage

Just as elected politicians would prefer to sidestep the perils of austerity inducing bailouts, central banks are keen to avoid holding the tail risk associated with the capital shortfalls of individual banks. The Basel III Accords created a form of capital with contingent barriers in answer to the problems of government bailouts. But a regulatory requirement to hold such capital alone was insufficient, as there was no natural market for it. For banks to include CoCos on their balance sheets to meet regulatory capital requirements, there needed to be a buyer for these securities. Who would want to hold a complex structured note that can have its coupon cancelled, be extended to perpetuity or have its principal written down? There was no natural market; however, fortuitously, the ECB stepped in to stimulate demand for the CoCo. The combined policies of ultra-low rates and purchase programmes has led the debt for many sovereigns to scrape levels just above zero or even to dip into negative yields. As a consequence, belying its name, the high yield bond market saw extreme downward pressure on yields – as shown in Figure 13. Such easy monetary policy also served to reduce overall volatility and, as a result, lower risk premia. Against this background, asset managers faced growing pressure and were forced into a hunt for higher yielding assets. As a result, the past decade has seen increasing demand for high beta bonds, including junk, hybrid and periphery debt – and for one of the highest yielding assets: the newly devised CoCos.

FIGURE 13: HIGH YIELD BOND MARKET (APR 2016 – APR 2021)



Investment is being stimulated by the on-going compression of 'high yield' bonds, as AT1s offer 2x their yield on average.

Source: ICE BofA Euro High Yield Index Effective Yield. Federal Reserve Economic Data.

Pre-crisis, investors were mostly leveraging up to buy highly rated assets. Unlike the pre-crisis period, the search for yield since 2009 has manifested itself primarily as a search for securities with a higher beta to the market. This has driven investment flows into high nominal yield products, some of which embed leverage. Monetary easing – lowered interest rates and deposit ratios – has encouraged private wealth, pension funds, insurance companies and other institutional investors to pursue higher returns by shifting into riskier assets with embedded leverage, rather than leveraging up to buy greater amounts of less risky assets. This trend is one factor that has encouraged demand for the leverage embedded in hybrids such as CoCos. The embedded barriers can mask the tail risk, allowing investors to enjoy a level of leverage they might otherwise be prohibited from holding. The net effect is that the financial engineering to create CoCos transfers tail risk onto asset managers.

In sum, the design objectives for CoCos to satisfy governments and central banks include: (1) dampen moral hazard, (2) encourage 'going concern' conversion, (3) isolate shocks to an individual bank to limit contagion and (4) transfer tail risk onto the investors hungry for yield.

Intervention: Early vs delayed

The national authorities charged with supervising banks in their jurisdictions will have to weigh the merits of an early intervention to convert CoCos before a contractual trigger is reached, against the

option of permitting management the opportunity to find other means to steady a bank hit with losses. Supervisors will likely be contacted by bank management once internal models detect extreme losses, ahead of the quarterly disclosures of capital ratios. At this earlier stage, supervisors may opt to pull the triggers in advance of an automatic threshold being formally breached. If a supervisor instead decides to delay intervention despite a deterioration in fundamentals to allow time to broker a solution, the conversion might not happen until the bank is already insolvent – with CoCos simply bailed in at resolution. The disciplining effect of CoCos could be diminished if the contingency triggers in its covenants are completely bypassed and the fate of a bank purely hinges on its supervisor’s interpretation of “failing or likely to fail”. A full discussion on the incentives for the national authorities to intervene early or to forebear until resolution is presented in the chapter on ‘Principal Risk’.

4. Bank management

There is a direct relationship between the cost to issue a CoCo and the perceived risk for the investor. This leads to an upper and lower bound for CoCo pricing at issuance. The ceiling is capped by the cost of equity, as there would be no reason to use CoCos at all if they were as expensive as straight equity issuance. The lower end is floored by the current levels for straight bonds given that investors have no cause to buy CoCos at the same price as non-hybrid debt from the same issuer.

Broadly speaking, the greater the probability of trigger events and the lower the potential recovery rate, the higher the cost of financing. In particular, a call provision on a high yield note can be very valuable, as it provides an opportunity to refinance debt whenever the issuer chooses, in order to save interest expenses. This is reflected in the trade-off taken by the CoCo holder in order to receive a higher coupon: the investor must accept the higher risk for losing all or part of the principal, interest payments and/or skipped call dates. The trade-off is analogous to the issuing bank *buying* a form of put protection from an investor. In this analogy, the issuing bank owns the put and the CoCo investor receives a premium for, in effect, writing the option. So, a CoCo investor should demand a relatively higher premium from a bank with a riskier credit profile; if not, the bank management gets the better side of the bargain.

The primary catalyst for banks to issue CoCos is their official qualification as regulatory capital. In addition to their special regulatory treatment, CoCos help banks to optimise the overall cost of capital for two reasons: (1) the lower costs of CoCos relative to equity due to tax deductibility, and

(2) the timely facilitation of debt reduction and fresh equity raising. CoCos in the guise of hybrid *debt* get a tax break, and as hybrid *equity*, boost effective leverage. Taken in tandem, these ‘efficiencies’ encourage banks to borrow via CoCos rather than share profits and shoulder taxes by raising common equity. CoCos also present issuers with the capacity to ‘pre-position’ during stable periods of financing, which can help to mitigate: (a) debt overhang and (b) adverse signalling problems.

Tax shield

To fill the 1.5% bucket of additional Tier 1 capital, a bank can simply issue more common equity. But equity is considered expensive. Instruments classified as interest paying (bonds and loans) tend to be subsidised in most jurisdictions. Borrowing expenses can be claimed to reduce taxable income. Whenever fiscal authorities treat CoCos as debt, the interest expense for the issuing bank is typically tax deductible. This presence of a ‘tax shield’ has a significant impact on the after-tax interest expenses of issuing banks – thereby encouraging CoCo issuance. According to current US tax codes, on the other hand, CoCos are not tax-deductible as debt and are as costly as equity; consequently, no US banks have issued CoCos, instead opting for a form of state-contingent ‘preference shares’.

The removal of the tax exemption for CoCos is under discussion in some European jurisdictions such as Sweden and has been implemented in the Netherlands. However, even after the removal of the exemption Dutch banks did not redeem early as the tax shield is only a facilitating factor. Even with neutral tax treatment of coupons, CoCos may still have a lower cost of funding than equity.

Balance sheet efficiency

The less equity outstanding the more profit is available for existing shareholders, which is why banks are generally reluctant to raise additional common equity. By counting CoCos as equity on the premise that the notes might convert at a future date, the actual leverage can, in effect, be kept higher. Bankers pay attention to return on equity (ROE), which is a main measure of performance and often linked to senior management compensation. Issuing equity decreases ROE by increasing the denominator. In contrast, issuing CoCos has no effect on the denominator and can help to maximise ROE if the coupons paid are not too high (paying interest decreases earnings in the numerator). While CoCos are more expensive than debt, they can be more attractive than equity even without a tax shield. Moreover, CoCos are designed to raise equity only when necessary. This ‘timely facilitation of an equity raising’ should save an institution the cost of having to hold additional equity during stable periods, when it is not required, and also lower the cost of raising

equity during turbulent market conditions, when doing so could be prohibitively expensive. In this sense, CoCos are a more efficient method to absorb losses than retaining paid-in capital on the balance sheet through all phases of the financial cycle. *By meeting regulatory capital ratios at a lower cost than straight equity, CoCos allow banks to run with higher leverage in better times while still offering relief from debt servicing obligations and a buffer to absorb losses in the event of deep downturns. Such cost effectiveness may enable banks to earn higher returns.*

Debt overhang

A debt overhang problem may emerge if a bank has an investment opportunity with a positive net present value, but debt holders are expected to claim the bulk of cash flows resulting from this opportunity. This tension is always present but is especially prominent during periods of deep distress given that the value accruing from injections of equity is seen to disproportionately benefit debt holders. The additional equity lowers the likelihood of bankruptcy and thus increases the prospects of the debt being repaid. Given that the leakage from equity to bonds would be visible almost instantly in a situation of debt overhang, recapitalisation will likely be delayed. According to one study, “a considerable injection of funds is required, in excess of what could be achieved through simple triggering, in order to motivate shareholders to recapitalise their bank” (Berg, 2015). Therefore, a disincentive to raise new equity can arise, especially at the unfavourable terms generally prevalent during a crisis.

Investors in a recapitalisation may be even more unwilling to inject new equity if the net effect of their investment is to prop up not only bondholders but also CoCo holders. This could further discourage investors from putting fresh equity into a bank with a CET1/RWA ratio close to the trigger threshold of a CoCo. Investors would not want to subsidise CoCo holders through a fresh equity raising, in the face of potential losses for shareholders whose claims on the bank are diluted at the conversion of a CoCo. The net effect could be to delay recapitalisation at the very time it is needed most. Besides being an obstacle to recapitalising ailing banks, debt overhang can incentivise management to dispose of assets to raise funds, or even to cut lending activity. Such actions may further curtail investment and shrink the supply of credit. Given that banks with shrinking amounts of capital tend to reduce new lending, this scenario can exacerbate a credit crunch – creating negative feedback. Hence, CoCos have to be designed to *trigger early* and be of *sufficient size* such that no other equity is required, in order to solve the debt overhang problem. Prescott (2012) notes that

such attributes would have aided banks during the 2007/8 financial crisis when they were required, but largely unable, to issue new equity.

Adverse signalling

Although a conversion or writedown aims to restore solvency, it may also stigmatise a financial institution. If confidence is undermined, future refinancing will be difficult. The desire to avoid an adverse investor reaction should provide a strong incentive to manage capital in a countercyclical manner and engage in prudent risk management. However, this same desire to preserve confidence might also make bank management reluctant to allow CoCo triggers to fire, even when exigencies demand such action, as was apparently the case in February 2016 when Deutsche Bank opted to redeem senior unsecured debt rather than omitting interest payments on, or converting, its CoCos. One reason for the hesitancy may be that the earnings retained due to coupon cancellation, or even conversion, may be insufficient to meet a bank's ongoing capital needs. The benefits of bolstering capital must be balanced against the possibility for negative signalling, and concerns over tipping the balance toward adverse signalling is probably what led Banco Popular to continue to pay its CoCo coupons despite being on the cusp of collapse. Thus far, bank management have gone to great lengths to avoid trigger events no matter how dire their straits.

Negative signalling can also occur if the maturity of a CoCo is extended. AT1s include a call 'barrier' which gives the issuer the right to decide when to repay the face value, allowing management the leeway to refinance when the cost of borrowing falls. This option for issuers must be approved by the regulator and comes at the expense of the CoCo holders. If the creditworthiness of the issuer deteriorates, and borrowing costs rise, the issuer is under no obligation to redeem at the call date and can defer repayment into perpetuity. However, rather than restoring confidence, an extension could deepen concerns among depositors about the asset quality of a bank.

5. Investors: Shareholders vs CoCo holders

CoCo holders should be incentivised to monitor the decisions taken by issuing banks, keeping an eye out for early signs of distress, given the potential loss of principal. If the risk premium for CoCos closely tracks the risk profile of their issuing bank, it should have a disciplining effect. On the other hand, common shareholders who might otherwise favour increased leverage may tread more cautiously if the threat of conversion counterbalances the pressure to ramp up profits. The central determinants of 'principal risk' are the trigger level for conversion and the conversion price or write-

down clauses, which dictate the degree of dilution and the implied recovery rate; these components should be carefully optimised to discourage risk-shifting.

Risk shifting

Koziol and Lawrenz (2012) wrote one of the first theoretical papers on the drawbacks of distorted risk-taking incentives. The authors contend that when manager-owners have discretion over a bank's investment program, CoCos may actually increase the probability of financial distress, potentially destabilising the banking system. Such an undesirable outcome might follow from rational decisions about the wealth transfers upon conversion, i.e. burden-sharing. Himmelberg and Tsyplakov (2012) similarly aver that, although CoCos with dilutive conversion terms for pre-existing shareholders can mitigate the ex-post conflict between shareholders and CoCo holders, CoCos with a write-down mechanism can induce shareholders to 'burn assets', accelerating the triggering event to generate a windfall wealth transfer. Himmelberg and Tsyplakov argue that the 'write-down' type of loss mechanism could aggravate the debt overhang problem, and hence magnify the incentives that can result in risk shifting, underinvestment and higher social cost at default.

On the other hand, Chen, Glasserman, Nouri and Pelger (2013) suggest that the lower default risk and reduced bankruptcy costs help to increase firm value – and that these benefits accrue not only to CoCo holders but also to equity holders due to the lower cost of debt rollovers. The study by Chen et al. claims that an increase in a bank's total debt load is the key determinant of the timing for conversion. These authors assert that default will precede conversion when a bank's total debt load raises the default boundary above the conversion boundary. To avoid what they term "debt-induced collapse", *the conversion trigger must be set at a height that optimises the relationship between the two boundaries*. Chen's conclusions are shared in a similar study by Hilscher and Raviv (2014), which argues that financial institutions that issue going-concern CoCos should have lower default probabilities than those that issue gone-concern subordinated debt. Hilscher and Raviv assert that with carefully chosen parameters, CoCos shareholders' motivation to increase risk can be eliminated. With a low conversion ratio, shareholders have an incentive to increase asset risk; however, a high conversion ratio leads to an incentive to reduce risk-taking.

Roggi, Giannozzi and Mibelli (2013) also argue that CoCos with a conversion price set at a significant discount to the price prevailing at issuance minimise risk shifting incentives for both bank management and shareholders, as a trigger event would be dilutive and share the burden of losses

across all stakeholders. Roggi et al. (2013) propose a design to minimise the negative impact on bank stability, though they acknowledge their proposal could generate a multiple equilibrium problem similar to that identified by Sundaresan and Wang (2010) for CoCos with a market trigger.

The main argument of all these papers is that contingent convertibles if properly designed can create strong incentives for banks to pursue prudent measures. *We should stress that these views on risk shifting are all premised on the assumption that the incentive effects of CoCos are created by varying the main design features: the trigger levels, the dilution rate at conversion or writedown/writeback clauses.* To explore this topic of burden-sharing/wealth transfer further, we consider separately two scenarios – minimally versus highly dilutive conversions.

1) Low dilution – Shareholder friendly

Dilution is limited when the conversion price is set near the share price level at time of issuance, as this would be far above the prevailing share price at the time of a trigger breach. In this case, CoCo holders face large losses as they receive relatively few shares. The initial shareholders are left with a lower level of debt, which may create incentives for them to encourage triggering in order to reduce debt payments. This situation introduces a form of ‘risk shifting’ – i.e., risky investment decisions that maximize equity shareholder value at the expense of debtholders’ interests. The risk-shifting perspective contends that in the context of limited liability, highly leveraged firms have incentives to shift their asset profiles toward riskier forms of financing. As it pertains to CoCos, risk-shifting incentives arise from the wealth transfers that shareholders receive upon conversion. The higher the potential gain from the wealth transfer, the greater the penchant to take on risk. Risk-shifting effects can play a greater role when CoCo issuance represents a large proportion of a credit institution’s total market capitalisation.

Gambling for resurrection

Shareholders might be tempted to ‘gamble’ or take on excessive levels of risks, given that losses incurred after the conversion point would be shared with CoCo holders forced to convert into common shares. However, the CoCo holders would not participate in potential gains from such risk-taking if the conversion is avoided. Research by Berg and Kaserer suggests that CoCos might incentivise banks to lend out funds to increasingly risky ventures in an attempt to recover profitability – this is the ‘gamble for resurrection’ (2014). If the risky endeavour is unsuccessful, and conversion occurs, it still leads to a reduction in outstanding debt given that losses can be imposed

on the CoCo holders. Such an increase in risk appetite would make conversion more likely given that shareholders stand to profit, potentially, from either the risky activity itself or the reduction in interest-bearing securities. There may even be an incentive to trigger conversion ‘early’ in order to limit dilution risk before the share price were to fall further; this incentive might be especially strong if the conversion price were high relative to the current share price.

Speculative attack

Shareholders might stand to profit from a speculative attack, since it would deleverage the firm and possibly spark an eventual rebound in a bank’s share price. The incentive for stock price manipulation – to short-sell underlying shares in order to depress their price to the point at which a market-value threshold is breached – is more relevant for CoCos with market-based triggers (Glasserman, 2011). While a speculative attack could force conversion if a CoCo had a trigger based on a share price, the influence of such an attack would be indirect for triggers based on metrics of balance sheet strength. Moreover, to constrain the dilution impact, the covenants in a prospectus often stipulate a floor price; this sets a limit to the maximum number of shares that can be issued, capping the possible dilution. Awareness of risk shifting is also leading to efforts to mitigate the potential for such destabilising side-effects; for example, many recent CoCo offerings include an option that neutralises dilution by allowing for shareholders to also participate at the conversion price. Such anti-dilution clauses preserve the stakes of initial shareholders and are intended to align shareholder incentives with those of CoCo holders.

Limits to coordination

Although shareholders may prefer a particular outcome, there may be no practical method by which holders of equity can decisively shape events. The coordination of a large number of bank shareholders poses a threat in theory, but their methods to influence the decisions on risky activities is limited. Shareholders can exert pressure over management in their nomination of board members or periodic votes at general meetings; however, these channels may be too infrequent to be effective. Moreover, Furstenberg (2017) notes that the tendency to take on more risk “...may be counterbalanced by the fear of regulators and the CFOs of banks to avoid blame for having caused a creditor run through premature or opportunistic conversion of CoCos.” Furthermore, any major transfer of wealth would occur in the context of massive value destruction such that existing equity holders might be almost annihilated anyway; i.e., a further transfer of value when the value is so

small might not amount to much of a motivation. Rather than dwelling on CoCo conversion, equity holders in a distressed scenario are more likely to focus on measures to restore financial stability.

Non-dilutive

A paper published by Chan and Wijnbergen (2016) claimed that CoCos with principal writedown and non-dilutive equity-conversion mechanisms create ‘perverse’ incentives for shareholders to take on more risk and even to extract cash through excessive dividends. They deem the writedown feature undesirable as it induces uncompensated risks that create a conflict of interest between shareholders and CoCo investors. A principal writedown does not inject cash to an ailing bank, it rather reshapes the capital structure and lowers the overall leverage. Debt reduction is the sole outcome. Avdjiev et al. (2015) appear to agree, suggesting that risk-shifting incentives stemming from CoCos with principal write-down mechanisms cause the greatest increase in the probability of default. A similar line of logic has led Goncharenko (2016) to claim that equity conversion is a less risky loss type of loss absorption mechanism, and that the debt overhang problem is more pronounced for CoCos with principal writedown mechanisms. Taking the perspective of the national supervisor, Martynova and Perotti (2018) argue that write-down mechanisms with no dilution offer superior incentives as this method ensures the maximum deleveraging. In sum, there is a body of theory that suggests participants in the CoCo market prefer one type of loss mechanism over another.

2) High Dilution – CoCo noteholder friendly

The conversion ratio dictates the number of shares at conversion, and the value of equity issued to CoCo holders is calculated at the point of triggering; therefore, the incentive for shareholders to avoid conversion is at its maximum just above the triggering point. Severe dilution occurs if the conversion price is close to the share price at the time of conversion, as might happen if it were set at the trailing average of the preceding month. The potential for dilution should incentivise existing equity holders to take steps to avoid a trigger event. While such disciplining effects could be positive, in the face of punitive dilution, management may be reluctant to provide new funds for projects and pull back sharply from investment plans in order to avoid a bank’s CET1 ratio from reaching the conversion threshold. This risk of diluting shareholders may put pressure on management to scale back risk-weighted assets, to boost the CET1 ratio. This could have negative knock-on effects on

financial markets or the economy, such as cutting credit lines to reduce lending, or fire sales on assets to quickly raise funds. This loss of risk appetite could exacerbate a credit crunch.

Potential for a change of control

Considerable dilution of existing equity holders could leave CoCo holders as the dominant post-conversion shareholders. If the conversion price is low, conversion can significantly shift the ownership and transfer the control of a financial institution to CoCo investors at an earlier stage of distress. Dilution in excess of 50% would result in control devolving to the erstwhile CoCo holders at the expense of incumbent shareholders. When a dilutive conversion is combined with a high CET1 trigger for the conversion event, CoCo holders could effectively take over a bank which still retains considerable residual value. That said, in terms of actual issuance such highly dilutive CoCos are rather uncommon.

While excessive risk-taking could be more prevalent for CoCos with little or no dilution (high conversion prices) or with permanent write-down features, the scope for recovery potential after the contingency event may be limited for either mechanism. In the case of conversion, there is theoretically the prospects of participating in a share price recovery. It should be noted though that shares can be quickly exchanged for cash, or even be immediately converted into a cash figure as stated in Lloyds' prospectus: "if all of the Ordinary Shares to be issued and delivered on Conversion are sold in the Conversion Shares Offer, the pro rata share of the cash proceeds from the sale [can be received]." The potential for recovery in the share price post conversion may not be relevant from the perspective of incentives, since the CoCo holder is not obliged to retain the shares. Holding equity is usually not in accordance with the mandates of fixed income funds such that fund managers may be forced to sell immediately; even for cross-asset funds that are able to continue to hold the equity, fund managers may choose to pursue better investment opportunities elsewhere. Therefore, for CoCos with conversion mechanisms, the recovery value at point of conversion is all that can be taken as certain.

This contrasts with the write-down mechanism, which is often stipulated as 'temporary' and therefore does offer some scope for future recovery, albeit the immediate prospects for a bank that has faced a near-death experience are unlikely to be promising. Hence, the presence of a write-back clause is generally seen to be, all things equal, preferable as it offers at least some slight possibility for a return of principal and with that a return of coupon payments. Fixed income investors, in

particular, should prefer a writedown of principal if the CoCo notes include a clause for write-backs, given most fixed income dedicated funds only permit bond-like notes. This difference in recovery potential post the contingency event is worth bearing in mind, in relation to the motivation of participants. In particular, the prospects of a write-back would depend heavily on how early the event occurred – either as an automatic triggering or the invoking of a non-viability event. *As with the conversion price, for the write-back clause to be perceived to have value, the contingency event must occur when the bank is still a going concern.*

Death spiral

It is difficult to hedge all the risks of CoCos given their concentrated tail-risk. Short selling the underlying equity of the issuer may be a natural hedge for CoCo holders, at levels close to the trigger threshold (Maes, 2012). To rebalance a delta hedge, shorts would have to be increased. This could produce further pressure on the shares, sparking a downward price spiral. In the case of a dilutive CoCo, as conversion nears, existing shareholders who fear being impacted could also try to sell their shares. In a worst-case scenario, this combination of hedging and proactive selling could lead to a self-reinforcing drop in the stock price as the trigger level nears – culminating in a ‘death spiral’.

While excessive delta hedging is a concern in theory, it may be less of a factor in practise. CoCo holders may not actually be able to hedge their equity delta. Many fixed income investors may not be allowed, by the terms of their mandates, to dynamically hedge with equity or equity derivatives, or may not have the trading expertise. Rather than hedging too much, the problem might be not hedging at all. Another factor to bear in mind is that CoCos tend to be issued by larger financial institutions, most of which would have liquidly traded shares. Unless CoCos form a considerable part of their capital stack, the impact of the delta-hedging on the underlying share price is unlikely to be material. We do note, however, the emergence of total-return swaps (TRSs) that can act as a synthetic hedge by benchmarking against an index of CoCos.

In summary, given the matrix of incentives, especially near the barriers, several factors that could prevent banks from recapitalising after suffering substantial losses must be borne in mind: (1) perceptions of moral hazard, (2) the debt overhang problem and (3) various risk-shifting incentives. The range of motivations of the participants in the CoCo market is a theme referred to throughout this thesis, specifically the supervisory-bank nexus which drives the exercise of discretion.

EMPIRICAL ANALYSIS OF THE ASSUMPTIONS OF VALUATION MODELS

We first survey the literature on CoCo valuation techniques, the main streams of which can be grouped as follows:

1. *Structural ('firm value') models, which focus on asset volatility and develop a stochastic process to capture triggering events.*
2. *Models based on derivative pricing methods:*
 - a. *Credit models that focus on the extra yield on top of the risk-free rate, calculating the default intensity at which CoCos would convert.*
 - b. *Equity models that substitute the share price as a proxy by which to estimate both the timing of the contingency event and the value transfer at conversion.*
3. *Hybrid models that combine credit and equity derivatives inputs.*
4. *Add-ons: The same logic of earlier efforts to model the conversion of principal as applied to coupon cancellation and maturity extension.*

The assumptions and parameters of these models are then assessed in our empirical sections. We begin with t-tests before moving onto multivariate analysis of propositions within the framework of a multiple barrier paradigm: CET1 buffer, MDA cushion, ADI cover, Reset ratio and Time to First Call. We address the question: 'what is the explanatory power of AT1 contractual features and the components of theoretical valuation models?'

We find that features such as the conversion price, write-back clauses and types of loss mechanisms appear to have little empirical significance. Importantly, the 'distance to the CET1 trigger level' does not have a very significant effect on pricing behaviour and attempts to adjust the triggering by share price volatility appear of little utility.

In time series, we find that AT1 spreads do not correlate with proxy assets such as equities and default swaps.

However, the sovereign debt of a bank's country of domicile does strongly correlate with AT1 spreads – indicative of an interconnection between the sovereign-bank nexus and the supervisory-bank nexus.

IV. Literature Review: CoCo Valuation Techniques

Survey of assumptions and input parameters

The aim of this chapter is to survey the academic literature on CoCos to identify the assumptions and inputs used in the valuation models proposed to date. These parameters will subsequently be evaluated empirically to gauge their relevance in price formation.

To understand the development of models for pricing CoCos, it is useful to recall how the new asset class evolved. Initially, there were only a handful of institutions experimenting with contingency in the covenants of hybrid bonds immediately following the 2007/8 credit crisis. Concurrently, regulators began discussions about new bail-in instruments. During this period academic papers speculated on hypothetical bonds with share-price triggers, which later led to a preoccupation with triggering processes based on stock price movements even though that form of market trigger *never actually received regulatory approval*. Even once it became apparent that the barrier for principal-related risk would be a core capital ratio, the literature continued to focus on ‘market implied triggering’ that relied on the share price as a proxy. Hence, models tend to dwell on equity conversion even though percentage writedown eventually became the more common ‘loss mechanism’. For CoCos with percentage writedown as the mechanism, the write off and write back of capital that determines losses has no relationship to stock levels.

A. Modelling the Capital Adequacy Trigger

Main model types

Almost all research on CoCos from 2000 to 2015 concentrated on modelling ‘conversion’, building from the large pre-existing body of literature on the pricing of default for corporate bonds. The original wave of valuation proposals all took much the same path of focusing on some form of stochastic process to model the triggering event. Pricing the risk of conversion was seen as the central challenge, with some version of the Black-Scholes formula taken as a starting point. Scant attention has been paid to coupon cancellation or maturity extension as independent risk events, aside from attempts to bolt-on additional parameters to the earlier models. Although there is much overlap, the approaches can be grouped broadly into those that try to generate predictions for the determinants of spreads and those that try to calibrate to high frequency data:

1. *Structural models* interpret CoCos as a deleveraging tool and take the change in assets on a bank’s balance sheet structure as the main driver, developing a stochastic process to capture

the contingency event. This approach is oriented to the issuer-level risk profile and does not incorporate the specific features of notes.

2. Models based on *derivative pricing methods* that split into two streams:
 - a. Credit models that attempt to encapsulate the default intensity to which bonds are subject, and which focus on the extra yield on top of the risk-free rate necessary for investors to accept the additional risk of losses associated with a CoCo conversion.
 - b. Equity models that interpret the CoCo as a kind of long position in the shares that is knocked in at conversion. The share price is substituted for the CET1 ratio as a proxy to both calculate the triggering process and estimate the recovery rate.

1. Structural ('firm value') models

Given that CoCos express their triggers in terms of a pre-determined capital to assets threshold, structural models would seem to provide a natural pricing framework. Structural models input the asset values, firm leverage and asset volatility, and output a default probability which is used to calculate a theoretical credit spread. The structural models share common assumptions that asset values are stochastic, which is generally taken to be geometrical Brownian motion under risk neutral probability. In addition, such modelling tends to assume that trading in the underlying assets is possible and that all assets on the balance sheet have the same maturity. Given the emphasis on default, it is further assumed that leverage drives the credit spread and that investors should demand a wider credit spread to compensate for increased leverage.

As applied to CoCos, these contingent securities are viewed as if the investor is long a bond and short a put to the issuer, whereby, when the CET1 barrier is hit, the issuer can put to the CoCo holders some value, which at default could be zero, in exchange for releasing the issuer from further liabilities. The CoCo's price is thus approximated by using the barrier options pricing formulae, based on standard Black-Scholes assumptions (frictionless markets, no arbitrage, etc.).

Black, Scholes and Merton developed methods to value equity and debt using contingent claims analysis. Default occurs when the value of assets falls below the value of liabilities, in which case bondholders assume control of the company in exchange for its residual value. The default threshold is defined as a function of the debt outstanding, which is decomposed into a risk-free claim and a put on the firm's assets that is sold to the equity holders. This put option gives equity holders the right to 'put the firm' at the value of the risk-free claim; for creditors, the upside is

limited to the face value of the debt. As volatility broadens the range of potential outcomes, higher volatility raises the probability of default and thus the value of the theoretical ‘put option’ – with credit spreads assumed to widen as asset volatility increases. Changes in the risk-free rate level and term structure and the maturities of a firm’s debt are seen to drive credit spreads.

Both fundamentals-based and market-based structural models have been extended to model CoCos. The fundamental approach estimates inputs using first principles and then computes theoretical prices of CoCo securities, for example, by simulating the evolution of assets and deposits toward a target asset to deposit ratio. Although the process for arriving at a firm value could take the accounting measure of the CET1 ratio itself as its primary reference, a market proxy is most often assumed to facilitate calibration. The market approach observes the prices of financial instruments and solves for the parameters that allow calibration to these prices. For example, given the price of a particular CoCo, the leverage that recovers its price is inferred. In the case of a market price, it may either be assumed that investors continuously take the prospects of default into account in advance of the event (i.e., no jumps), or alternatively, a jump-diffusion premium may be incorporated.

We next summarise the main papers published on structural approaches to CoCos. Note that some models have been put forth to evaluate the potential for increased ‘risk-taking’ or ‘risk-shifting’ incentives, such as death spirals, and are therefore aimed at improving our theoretical understanding of the CoCo asset class rather than intended for use by practitioners to price individual securities.

Pennacchi (2010)

Pennacchi was among the first to modify the structural model to incorporate contingent capital. Pennacchi posits that a bank’s assets are invested in a portfolio of loans, securities and off-balance sheet positions whose rate of return follows a jump-diffusion process with the default-free interest rates taken as stochastic. He argues that permitting a bank’s assets the possibility to jump, thus reflecting sudden large losses in asset value, better captures the effect of financial crises. Using this process, *Pennacchi constructs an accounting trigger as a ratio of the bank’s current assets to deposits*. In this approach, triggering of the CoCo depends on some book value to asset value ratio. As a result of the jump-diffusion process to account for tail risk, Pennacchi reasons that CoCos should show higher credit spreads and lower firm values at conversion. As for establishing the parameters of the process, he suggests that estimates of each bank’s asset return jump-diffusion process be derived from

information on a bank's stock returns, debt prices, and/or credit default swap spreads; but this he leaves for future research.

Pennacchi, Vermaelen and Wolff (2014)

In a 2014 paper, Pennacchi et al. examine the possibilities of a Call Option Enhanced Reverse Convertibles (COERCs). As a trigger event, this form of simplified CoCo gives existing shareholders the option to purchase newly issued shares at the note's par value. The capital ratio simulation follows his earlier approach, but in contrast to Pennacchi (2010), an implementation is attempted by taking data on three large U.S. banks to estimate the model's parameters. The authors assume that the market return on the bank's total assets equals that of its total liabilities. After obtaining daily return estimates of the bank's total liabilities, they used this data to calculate the jump parameters of the jump-diffusion process to obtain theoretical prices.

Hilscher and Raviv (2011 draft/ 2014)

Hilscher and Raviv study the effect of introducing CoCos on the balance sheet and conclude that, if designed properly, CoCos can reduce the probability of default. Hilscher and Raviv also present a way of pricing CoCos by modelling the balance sheet by expanding the barrier approach of Black and Cox to include the triggering process for contingent capital. They consider a hypothetical bank that finances its assets through the issue of three types of claims as part of its capital structure: a single zero-coupon deposit, convertible debt and a residual equity claim. The pricing of the different liabilities depends on the stochastic process (geometric Brownian motion) of the underlying asset with reported accounting metrics as proxies for the triggering threshold. This allows for closed form solutions for European-style options (i.e., convertible only at maturity). The authors select base-case parameter values and then perform sensitivity analysis around these values.

Albul, Jaffee & Tchisty (2010 draft/2013)

Albul et al. presented one of the first formal models for pricing contingent convertible bonds based on the structural approach. The authors focus on capital structure decisions. Their model investigates a simplified capital structure that includes only common equities and straight bonds, to which is added contingent securities. A hypothetical firm's productive assets are assumed to follow geometric Brownian motion, and a closed form solution for CoCos prices is derived in scenarios where the bank can issue some combination of equity, bonds or CoCos. A market-based conversion trigger is assumed, which depends directly on the stock price. *Albul et al assume two conditions that must*

hold, “monotonicity of equity value” and “no default before conversion”. These two simplifying assumptions – that the share price (or market capitalisation) can be taken as a proxy for the CET1 ratio and in turn that the trigger event purely parallels the share price movement, with no supervisory overlay – have come to underpin most valuation models of CoCos.

Glasserman and Nouri (2010 draft/ 2015)

Glasserman and Nouri price CoCos with a structural model by focusing on the capital ratio trigger and assuming partial and on-going conversion. In their model, sufficient debt is converted into equity so that minimum capital requirements are fulfilled every time the threshold is breached. This ‘continuous conversion’ approach is employed to derive closed-form expressions for spreads by adding a consistency requirement that market and book values of debt agree at issuance and at maturity. This partial and ongoing conversion feature is taken as an input value but is heavily stylised in its application. The starting point is a stochastic process, the geometric Brownian motion that models the book value of the bank’s assets. Volatility and interest rates are fixed inputs, and the model does not incorporate jumps in asset values. The book value of assets is compared to the market value of assets to determine the probability of conversion, and thereby the valuation of the CoCo. The parameters used are not calibrated but are intended to be representative, based on data for the 20 largest banks in the United States by assets, to end 2006.

Sundaresan and Wang (2010 draft/ 2011)

Sundaresan and Wang use a structural approach to analyse the design of CoCos that uses a stock price as a trigger and conclude that such a market-based trigger can lead to multiple price equilibria. According to the authors, the absence of equilibrium arises because economic agents are not allowed to choose a conversion policy in their best interests. The multiplicity of equilibrium makes the point of conversion unreliable, which introduces the potential for price manipulation, market uncertainty and inefficient capital allocation. In practice, no CoCos have ever been issued with any form of share-price or market-based triggers. Nonetheless, the notion of taking the share price as a proxy is retained along with the assumption that the CET1 ratio is monotonic with the share price.

Buergi (2012/2013)

Building partly on Pennacchi’s earlier work, Buergi assumes the following: (1) an issuer’s total asset value follows a geometric Brownian motion; (2) in times of financial distress fair economic values are well represented by book values such that the worse financial condition a firm is in, the more the

actual and the disclosed value of assets converge; and (3) that the asset value equals the sum of the firm's market capitalisation and its disclosed liabilities. In line with Albul and others working within the structural approach, Buergi assumes that a reliable linear relationship exists between the CET1 ratio and a bank's share price – and in this way models the conversion mechanism with the share price as proxy.

Brigo, Garcia & Pede (2013)

A structural approach first published by Fitch Ratings Agency and later by Brigo et al. uses an analytical first-passage time model to specify a time dependent threshold. The model is modified to value contingent capital considering both the probability of default and the probability of conversion. These authors explicitly consider three features to estimate the regulatory capital position: the leverage ratio, conversion time and the equity price at the conversion time. They use standard Brownian motion as the asset value process but introduce a copula approach as a way of modelling non-linear dependence. This allows more flexibility in the calibration and pricing process.

Gupta, Akuzawa and Nishiyama (2013)

Gupta et al. suggest an extension of existing derivative pricing models, consistent with Black-Scholes (i.e., standard Brownian motion). The authors propose an approximation of the trigger event as the simplest mean-reverting process that fluctuates around the target CET1 ratio. The notion of a capital structure decision is employed, such that an investment in CoCos must be justified by sufficient compensation. The valuation method is specifically based on hurdle Sharpe ratios in the context of an expansion of investors' efficient frontiers. The approach of these authors mirrors standard models for convertible bonds. It tries to capture risk factors affecting the CET1 ratio in three parameters that are labelled: target, volatility, and resilience (mean reversion). Sample calculations are presented.

Cheridito & Xu (2013)

Cheridito and Xu study the pricing of CoCos as typical hybrid products exposed to different types of risk: interest rate risk, equity risk and conversion risk. The authors develop intensity-based and first-passage time models driven by a finite-dimensional Markov process. Hedging is considered in some detail. The market-based implementation strategies are more advanced than some earlier proposals, but a similar dependence on proxies to construct a triggering mechanism is retained with both the issuing bank's stock price and CDS substituting as inputs to model the CET1 ratio.

Metzler and Reesor (2013 draft/2014)

The valuation of the specific case of zero-coupon contingent capital bonds is studied within the structural framework. The authors simulate the evolution of assets and deposits by linking the latter to a target asset to deposit ratio. Using a martingale stopping theorem (and making no assumptions on asset value dynamics, the terms of conversion or the conversion trigger) the authors express the value of a CoCo in terms of the effective loss imposed on investors at conversion and quantify the impact that contingent capital has on straight debt and common equity. Some sample calculations are provided.

Wilkins, S. and Bethke, N. (2014)

Wilkins and Bethke take a similar tack as Metzler and Reesor, and others working within the structural approach, and attempt to synthesise the balance sheet. The values for assets are represented as the sum of the daily total liabilities and the daily market capitalization of a bank; the latter is available on a daily basis whereas the former is linearly interpolated between reporting periods to arrive at daily values. Some sample pricing is considered and compared for accuracy.

Chung and Kwok (2016)

The authors present a hybrid equity-credit model to evaluate the capital-ratio triggering for conversion of a CoCo based on two-dimensional stochastic processes. The accounting trigger is modelled using a structural approach: as the capital ratio hits a contractual threshold value from above (as in a reduced form approach), the trigger is considered as a Poisson arrival with specified conversion intensity. In this way, a joint process of the stock price and capital ratio is proposed under different equity conversion payoffs. A sensitivity analysis of the price functions under varying values of the model parameters is also examined. Their bivariate equity-credit model provides a flexible pricing framework that can incorporate specific contractual features, and tests for potential pricing properties by constructing Fortet algorithms and finite difference schemes rather than predicting real market pricing.

Jang, H. J., Na, Y. H and Zheng, H. (2018)

The authors propose a model which computes the CET1 ratio based on a 'hidden random' threshold. The variable is generated by geometric Brownian motion in a process that takes a 'risk-neutral martingale measure'. A post-conversion risk premium is formulated by measuring the

probability of a bank's CET1 ratio breaching a default threshold that triggers conversion. The CET1 ratio is set as follows, where M is the total number of shares and St is the share price at time t:

$$\text{CET1 ratio} = \frac{St \times M}{\text{Total RWA}} = \frac{St}{\frac{\text{Total RWA}}{M}}$$

In their set-up, the 'total RWA' denominator is progressively estimated using available balance sheet information. As the RWA is unknown on a future evaluation date, its distribution is modelled by using a bank's equity price as a proxy. This relationship is restated as the market capitalisation ([total number of shares issued] x [the share price at time 't'] divided by an extrapolation from the latest reported RWA figure). This can be restated as the 'RWA-per-share' value of the CoCo-issuing bank, i.e., the total RWA amount divided by the number of shares outstanding – 'total RWA/M'. Given that the denominator is unlikely to change much on a quarterly basis, the dynamic component is the share price. So, once again we have a triggering mechanism dependent on share price movements. Jang et al. try to account for dilution post-conversion, though they do not seem to be aware of the anti-dilution clauses common in actual contracts.

Structural approach – Summary

Structural approaches try to incorporate CoCos within the traditional framework of determining bond prices by the composition of a bank's balance sheet (assets, equity and debt). The key inputs are the asset value and asset volatility. In a fundamentals-oriented implementation, the asset value is estimated based on consolidated balance sheet information; in the more common market-implied variant, asset values are inferred from the share price. The emphasis is almost entirely on principal risk, but actual CET1 ratio levels specified in CoCo memorandums are rarely direct inputs.

Parameters & assumptions

Setting aside some differences in parameter estimation, structural models as applied to CoCos tend to all share the following characteristics:

1. The parameters to value the assets are extrapolated from the historical balance sheet metrics of individual banks, or set equal to benchmark values assumed to be representative.
2. The share price, or market capitalisation, is taken as a proxy for the CET1 ratio and considered to have a linear, non-inverse one-to-one correlation.
3. The trigger process is typically simulated by geometric Brownian motion, but may incorporate adjustments such as log-normal jump diffusion.

4. The volatility input is either calculated from a bank's share price, or occasionally from a bank's credit default swaps. Some models run Monte Carlo iterations.

Potential problems

Many of the papers surveyed are theoretical discussions and not really intended as practical proposals for valuation techniques and therefore rely on a number of simplifying assumptions:

1. *Inputs at the issuer level are all that are required.* Characteristics specific to a particular CoCo note are not incorporated. For example, the trigger level specified in each contract is rarely considered, despite there being two different levels in common practice – with roughly c48% set at 5.125% and c52% at higher levels, generally 7%. Neither conversion prices nor write-back clauses (though both vary widely by contract) are considered as inputs.
2. The emphasis is almost entirely on principal conversion; if coupon cancellation or maturity extension are considered, these possibilities are depicted as another threshold for a trigger based on the CET1 ratio – even though this is not the actual triggering mechanics for either of these contingent events.
3. The share price is taken to be a reliable monotonic proxy for the CET1 ratio and serves as the 'threshold' that determines conversion.
4. The volatility input is either backed out from a bank's share price or its CDS history or simulated, underscoring the heavy reliance on capital ratio proxies as a core determinant.

2. Derivatives ('option pricing') models

Another class of models apply option pricing to tackle the valuation of CoCos, either credit or equity derivatives techniques. These methodologies all take market data (share prices, CDS levels and implied volatility) to calculate theoretical prices. The appeal of purely market-implied models is that they can bypass the estimation of leverage and other financial metrics, which are the focus of structural approaches. De Spiegeleer and Schoutens were the first to apply derivatives frameworks for valuing CoCos, with the aim of calibrating risk estimations such as VaR (value at risk). The approaches can be grouped into two types, along with attempts to combine elements of both:

- 1) Credit derivatives ('reduced form')
- 2) Equity derivatives ('digital knock-in barriers')
- 3) Hybrid (JP Morgan and Axioma)

1) Credit derivatives framework

One way of tackling the valuation of CoCos is to price the default probability of the issuing institution, within a framework based on default swaps. This method tries to find the extra spread (or yield) required above the risk-free rate for the probability of incurring a loss due to the exercise of the conversion trigger. Intensity modelling is applied, by focusing on the probability of the triggering event ('default') linked to the credit instruments trading in the market. Intensity based techniques assume that the default event is governed by an exogenously defined process, which is not correlated to the asset value of a company. This contrasts somewhat with the structural models, in which the default event is connected to the asset and debt levels of a company.

Credit instruments are often quoted by their credit spread over the risk-free interest rate. A credit spread is a form of add-on to the existing risk-free curve, such as the Libor or the swap curve, to discount the prospects of future cash flows. In the valuation of credit default swaps, a relationship has long served as a rule of thumb for switching between spreads (a first guess at the hazard rate). Its premise is that there is a link between a credit spread (CS), the recovery rate (RR) and changes in default probability (λ) – the three corners of the 'credit triangle'. The credit spread can be linked to the probability of default and the loss at default in the following formula:

$$CS = \lambda(1 - RR)$$

The intensity parameter λ is used when modelling default, and the recovery rate is the percentage amount of invested money one can expect to recover. The default intensity is based on an underlying Poisson process, $V(t)$, which represents the number of events (V) that occurred up to time (t) – with dt the time over which the measurement is taken. The interval periods between two Poisson events are independently distributed. The probability that a bond defaults in the time interval $[t, t + dt]$ while surviving up to the time t is equal to λdt . The process starts at 0, has independent increments and a probability of an event in the timestep dt equal to λdt . According to the intensity-based credit approach, given a value of λ we can calculate the survival probabilities. (In practice, the term structure of default intensities is extracted from a bank's CDS term structure.)

When applying this approach to CoCos, some tweaking of the variables is required. Breaching the buffer to trigger conversion is considered a special case of default with its own unique measure of probability. The default intensity λ is replaced by a 'conversion trigger' intensity (λ_{trigger}), which is

deemed to have a higher value than the corresponding default intensity (λ_{default}). This assumption is made since a CoCo is designed to trigger before default happens.

The trigger intensity is linked to the probability of hitting the trigger (p_{trigger}), in the following way:

$$p_{\text{trigger}} = 1 - e^{-\lambda_{\text{trigger}}T}$$

where (e) is Euler's number and (T) is the time to maturity for the CoCo. At this point, however, the proxies enter. The barrier is taken to correspond to the (estimated) share price at conversion. Assuming a geometric Brownian motion for the stock process under risk neutral probability, a closed form solution was developed by De Spiegeleer and Schoutens (2011). Accordingly, the authors express the trigger intensity as a function of the stock properties and time as:

$$\lambda_{\text{trigger}} = -\log(1 - p_{\text{trigger}}) / T$$

Next, the recovery rate (R_{CoCo}) is determined as a function of the conversion price (C_p) and the share price at conversion (S_{trigger}). When conversion takes place, the CoCo holder will receive (C_r) shares per CoCo. These shares would be trading at (S_{trigger}), with the face value of the shares being (N). The loss (L_{CoCo}) for the CoCo holder stemming from the conversion is expressed by:

$$L_{\text{CoCo}} = N - C_r S_{\text{trigger}}$$

From which, the following equation is obtained by inserting $C_p = N/C_r$:

$$L_{\text{CoCo}} = N - C_r S_{\text{trigger}} = N(1 - C_r S_{\text{trigger}}/N) = N(1 - a S_{\text{trigger}}/C_p)$$

and the equation for the credit spread of the CoCo ($C_{\text{S CoCo}}$) then becomes:

$$C_{\text{S CoCo}} = \lambda_{\text{trigger}}(1 - R_{\text{CoCo}}) = -\log(1 - p_{\text{trigger}}) / T \times (1 - a S_{\text{trigger}}/C_p)$$

This approach is based on standard Black-Scholes assumptions, but also assumes a Poisson process for the conversion event and a flat risk-free interest rate curve. It builds on the theory that the credit spread is the product of the percentage loss ($1-R$) and the probability of the loss, λ .

Credit derivatives – Summary

Parameters & assumptions

1. The credit spread is calculated using only the default intensity factor and the recovery rate.
2. Neutral probabilities are assumed, along with geometrical Brownian motion.

3. Based on the premise that the CoCo spread will mirror the behaviour of credit default swaps, given that both reflect the financial health and default probability of the issuer.
4. This relationship “ $\lambda_{\text{trigger}} > \lambda_{\text{default}}$ ” is assumed to hold in all instances.

Potential problems

1. The conversion trigger as specified, a distinctive feature in each CoCo contract, is not used even though its level could play a role in determining the probability of conversion.
2. Coupon cancellation and maturity extension as separate trigger events are not considered.
3. The stream of future coupon payments forfeited at the conversion event is not incorporated, nor is the possibility that coupons could be restored in the case of a write-up clause.
4. The scenario of the CoCo conversion and default occurring simultaneously is not incorporated.

2) Equity derivatives framework

De Spiegeleer & Schoutens (2012) were the first to work out the pricing of CoCo notes in a smile-adjusted Black-Scholes equity model. In this framework, a CoCo is modelled as a bullet bond and a series of knock-in options. Shares are received at the trigger date; coupons are cancelled when the conversion occurs. The payoff replication is divided into three parts, with each part valued separately as outlined below:

1. Face value and coupons: long a straight bond
2. Loss absorption at the trigger event:
 - a. Conversion into equity: long a knock-in forward
 - b. Writedown of principal: short a binary down-and-in barrier option
3. Cancellation of coupon payments: short a strip of binary down-and-in options.

The equity derivatives approach offers the advantage of a closed-form solution and straightforward parameterization. The pricing formula essentially requires only two inputs: an implied trigger level and volatility. A market trigger replaces the CET1 ratio trigger, such that a CoCo is converted when the stock price drops below a certain level. The two events are deemed to be equivalent, with the bank’s equity and the accounting measure trigger assumed to have a linear relationship. The share price level that serves as the conversion trigger is implied from the market prices of existing CoCos, in the sense that a new CoCo would price off the prevailing market price of a previous CoCo issued

by the same bank or a similar financial institution. On this basis, the likelihood of a conversion is estimated using standard Black-Scholes, which can then be used to estimate the theoretical spread of a CoCo. This can be rewritten as $CS_{CoCo} = S_T^* / C_P$ with

S_T^* = expected share price when the bond is converted

C_P = conversion price (which can be approximated by ‘N / n’ with N the face value of the CoCo and n the number of shares received at conversion)

Therefore, the loss from conversion to the CoCo holder can be written as:

$$Loss_{CoCo} = N - n S_T^* = N (1 - S_T^* / C_P) = N (1 - R_{CoCo})$$

The probability of hitting S^* is modelled with the share price as a proxy for the CET1/RWA ratio. Using a standard Black-Scholes formula to estimate the trigger probability $\lambda_{trigger}$, and p^* to denote the probability that the trigger S_T^* is touched during the life T of the CoCo note gives the equation:

$$p^* = N \left[\frac{\log\left(\frac{S_T^*}{S}\right) - \mu T}{\sigma \sqrt{T}} \right] + \left[\frac{S_T^*}{S} \right]^{\frac{2\mu}{\sigma^2}} N \left[\frac{\log\left(\frac{S_T^*}{S}\right) + \mu T}{\sigma \sqrt{T}} \right]$$

$\mu = r - q - \sigma^2/2$
 q = continuous dividend yield
 r = continuous interest rate
 σ = stock return volatility
 T = maturity of the CoCo
 S = current share price

Since

$$p^* = 1 - \exp(-\lambda_{trigger} T)$$

then,

$$\lambda_{trigger} = -\log(1 - p^*)/T$$

To illustrate this, here is a sample calculation adapted from De Spiegeleer & Schoutens (2011):

CoCo: 10-year maturity

Conversion price = \$100 (same as current price of stock)

Stock: Current price: $S = \$100$

Conversion trigger: share price falls 75%, i.e. $S_T^* = \$100 \times 25\% = \25

$\sigma = 30\%$ (annualised volatility)

$q = 0$ (no dividend)

Interest rate: $r = 2\%$

1. Probability of hitting the trigger, as derived the equation above: $p^* = 48.3\%$
2. Trigger intensity (λ_{trigger}) = $-\log(1 - 0.4830) / 10 = 0.066 = 6.6\%$
3. Recovery rate (RR): $S_T^* / CP = 25/100 = 25\%$
4. Credit spread (CS): $6.6\% \times 25\% = 1.65\%$
5. Total yield: $r + CS = 2\% + 1.65\% = 3.65\%$

McDonald (2010)

McDonald uses a derivatives approach similar to De Spiegeleer & Schoutens (2011) to replicate a type of CoCo with a dual ‘micro and macro’ price trigger, which converts if two conditions are met: a bank’s share price hits a trigger level and a bank’s index also hits a trigger level. The stock price and the index price are taken as two correlated geometric Brownian motions, and McDonald calibrates the model using historical data.

Gallo (2011)

Gallo assumes that credit risk can be fully described as a share price jumping to zero. The author assumes the correlation between share prices and capital ratios will tend to be higher during financial crises, as the market will focus on solvency rather than the profitability of a bank. Gallo therefore replicates a CoCo as a portfolio of positions in bond coupons along with a short position in as many European digital puts on the stock as reflect the value of the bond’s coupon, a short position in European up-and-in digital calls, a short position in American down-and-in puts, and an American digital put. The overall design is similar to that of De Spiegeleer and Schoutens, with somewhat more subtlety in handling the options and volatility computations. Gallo uses a stochastic volatility model with jumps calibrated on credit and volatility data to calculate CoCo prices.

Equity derivatives – Summary

Parameters & assumptions

In the equity derivatives framework, the most important assumptions are:

1. The accounting trigger, as per the structural approach, is turned into a market trigger. This assumes a positive monotonic relationship between a bank’s share price and its CET1 ratio.

2. Unlike the structural approach, details of the conversion price are incorporated. This allows for some differentiation between CoCos of the same issuer in the estimation of conversion probability or recovery rates.
3. The binary down-and-in options reflect the cancellation of the coupon payments after the conversion event occurs, but no allowance is made for cancellation as an independent event.
4. Earlier versions did not consider jumps, but later variants have incorporated copulas etc.

Potential problems

There are a number of potential issues related to the reliance on equities in this approach:

1. As with structural models, the CET1 ratio is assumed to be strongly correlated with the share price such that the entire model operates as if CoCos had market-based triggers.
2. Down-and-in barrier put options are known to be very skew-sensitive and heavily depend on the appropriate input of volatility, for which again the share price volatility is taken as proxy.
3. Multiple implied trigger levels may result; non-unique solutions ('multiplicity') can stem from the nature of the Black-Scholes modelling of the trigger probability.
4. The recovery rate is seen to be important to calculate, which implicitly assumes the conversion price will be set close to the level of the share price at conversion – however, the conversion price in practise is more commonly set closer to the share price at issuance.
5. There is no consideration of coupon cancellation prior to conversion. Although the shares received could pay dividends in future and a temporary write-down/write-back CoCo could restore coupons, these possibilities are not accommodated.

3) Hybrid Credit-Equity Frameworks

Far out-of-the-money (OTM) puts with long-dated maturities are not really liquid for individual banks whereas five-year CDSs are more readily available for companies active in the bond markets. This quandary has led to the development of hybrid frameworks, which calibrate models by implying deep OTM put prices from the traded prices of credit default swaps.

J.P. Morgan model

The Credit Research department at J.P. Morgan was among the first to address the issue of pricing contingent convertible capital. Henriques and Doctor (2011) proposed a pricing approach based on American equity put option-pricing methodologies that links directly to default probabilities implied

by credit default spreads. They decompose a CoCo into a portion that gets written down and a portion that gets converted into equity upon a trigger event. The zero-recovery portion is priced by combining quoted CDS spreads with option pricing methodologies to infer information of the underlying stock distribution.

Henriques and Doctor propose the following four steps to arrive at the final running spread.

1. Calculation of the up-front CDS payment

Calculating the equivalent up-front CDS payment from a quoted running spread involves calculations similar to those outlined in the credit derivatives approach. Specifically, the credit triangle equation is used to determine a flat hazard rate/volatility. Using traded CDS spreads, the cost for a CDS with no running spread but only an upfront payment is calculated; this pays 100% in the case of a default event and 0% otherwise. The standard recovery rate for subordinated corporate bonds equals 20% and must therefore be scaled up to 100% to reflect a full insurance contract.

2. Backing out the implied volatility at default, from a binary put option

A key assumption the authors make is that the implied volatility at default is equal to the implied volatility at the time of conversion. For this they set the level at which a default occurs to 5% of the current stock price. The implied volatility of a binary put option that pays 100% if the strike price K (i.e. the conversion price) gets hit is taken as a function of the required CDS upfront payment from step one. The resulting volatility of this approximation is equated with the assumed volatility that will prevail at the point of default. This volatility at default is then used to price a binary put option that pays 100% in the case that the stock falls below a defined barrier S^* .

3. Pricing of another binary option at the conversion threshold

Given the volatility at default computed in step two, another digital put option is priced at the conversion threshold S^* . The authors suggest that the trigger level S^* of the CoCo ought to be a function of the required loss that the solvency variable (the CET1 ratio) has to suffer in order to hit the trigger. A close correlation between the share price and the CET1 ratio is assumed. The trigger level S^* will be calibrated such that the model price meets the initial market price of the CoCo under consideration.

4. Conversion of the cost of the digital put option into an implied running spread

The prior step calculates the upfront price of a digital put option, whose strike lies at S^* and that pays 100% if it hits the strike. Next, the cost of the option is again converted into a running spread using CDS pricing methodologies. This yields the spread of the zero-recovery part of the CoCo.

This four-step process establishes the zero-recovery component. Pricing of the remaining component, which is converted into equity, including an estimation of the share price at conversion, is similar to the method used in the equity derivatives model described earlier.

Corcuera, De Spiegeleer, Ferreiro-Castilla, Kyrianiou, Madan & Schoutens (2012/13)

These authors adapt the earlier De Spiegeleer & Schoutens paper, but the underlying stochastic process is changed from the traditional Black-Scholes to a smile conform model. Specifically, the authors use a class of Lévy processes, incorporating jumps and a payoff more sensitive to heavy tails. Their belief is that Lévy models are, from a modelling perspective, more appropriate for CoCos as they can better capture the volatility smile. Employing an equity derivatives model, a CoCo note is decomposed into a series of barrier-type derivatives to capture and model the trigger effect; however, the information on the CDS is mapped into implied stock price data. This mapping effect is accomplished by equating the price for insuring against default, calculated from the CDS spread, into a premium to be paid for a deep out-of-the money digital put. The authors' intent is to keep the model focused on the credit aspect of CoCos, given its stress on hedging via CDS, such that we can consider this a hybrid equity-credit framework. Another dimension is added to the assumptions of highly correlated proxies: the payoff of a digital put along with the CDS are considered highly correlated events, in addition to both being correlated with the CET1 accounting ratio. We thus have a three-way correlation assumption.

Axioma model

Robert Stamicar (2016), working in Multi-Asset Class Research at Axioma, published a hybrid model that builds on that of JPM's Credit Research department. The Axioma version introduces an implied barrier that represents the leverage of the firm. The emphasis on implied leverage as an early warning signal mirrors the structural approach. In a sense the Axioma approach is a market-based structural model, but its use of equity barrier options and calibration with CDS spreads reflects elements of the hybrid derivatives framework.

Leverage, defined as long-term debt to market capitalisation, is initially taken from the latest published balance sheet; however, to calibrate the model an implied leverage is backed out from daily market data. Key inputs include the equity price, equity volatility, and the five-year CDS spread of a bank. From these parameters, an implied asset volatility is calculated that recovers the initial CDS spread. Asset volatility is kept fixed even as equity and CDS prices change. The upfront premium is assumed to correspond with that of a deep out-of-the-money digital put, akin to the JPM approach. However, the Axioma approach takes into account the CDS term structure rather than using the CDS quote closest to the CoCo maturity, and it sets the strike of the digital put by mapping each instrument rather than always taking the 95% OTM digital put option. So, there is somewhat greater precision in the calibration of the Axioma model versus that of JPM.

Hybrid derivatives models – Summary

Parameters & assumptions

The ‘equity to credit’ hybrid models together share certain aspects of structural as well as derivatives approaches, and therefore reflect similar assumptions:

1. Share prices or default swaps can be used as proxies for the CET1 ratio in a valuation model, as these are exogenous variables subject to the same risk drivers.
2. These proxies will retain a one-to-one linear relationship with the CET1 ratio, even as a bank enters into a financial crisis – i.e., across risk regimes.
3. CDS premiums equate to the prices of far out-of-the-money digital puts with a similar maturity as the CDS contract, from which implied volatility can be determined.
4. The recovery rate forms a central focus of the hybrid approach. Both the JPM and smile conform models compute the loss function by considering the conversion price and adjusting the strike price for high and low trigger CoCos.
5. For greater precision, the Axioma approach tries to map CDS maturity and put strike levels.
6. Jumps are included to reflect discontinuities in the diffusion process.

Potential problems

Despite their greater sophistication, the potential pitfalls of the hybrid models are similar to those of all market-implied valuations, both structural and derivatives based:

1. The proposed proxies – share prices and CDSs – may respond differently to certain fundamentals, such as leverage, and their sensitivity or correlation may not remain stable across changes in market regimes.
2. The hybrid models address only the capital adequacy trigger associated with principal conversion or write down. The CoCo's price metrics are assumed to primarily reflect this triggering probability and expected loss in the case of a contingency event. The possibility of the coupons independently cancelling is not modelled at all.
3. The interest rate is taken as fixed, with no modelling of extension risk in the context of a changing interest rate environment, or the evolution of an institution's own credit profile.

All of the models surveyed thus far either apply general credit metrics or treat share/CDS prices as inputs to predict the probability of the contingent event, as a parallel to credit default. Next, we turn our attention to a few more papers that consider barriers beyond the one for principal conversion.

B. Efforts to Incorporate Coupon Cancellation & Extension

The earlier models were built to address the capital adequacy ratio and the risk of principal loss. Attempts were later made to adapt these models to reflect some element of coupon-associated loss, given that stopping the stream of coupons reduces the value of a CoCo even without the loss of principal, and to acknowledge the possibility that maturity could be extended. Below we summarise these efforts to consider the coupon and call related risks of CoCos, at least in theoretical terms.

Corcuera, De Spiegeleer, Fajardo, Jönsson, Schoutens, Valdivia (2014)

Corcuera et al. provide a closed-form formula to examine the impact of a coupon skip on pricing. The components are similar to earlier papers on CoCos, the sum of 'binary down and out call options' plus 'a zero-coupon bond' plus 'a series of knock-in forwards'. They posit a stochastic process such that each coupon payment can be cancelled due to its own 'mini' trigger event. With respect to the application of stochastic volatility on the pricing, the authors suggest incorporating the implied volatilities either from equity options or from liquid default swaps via some unspecified calibration procedure. The triggering is defined as the first passage time of a process below a pre-specified barrier. The authors substitute the share price of the bank as a proxy for the CET1 ratio, which is the actual contractual barrier:

“In order to make the model operationable, the regulatory trigger is replaced with a market-based trigger; we monitor the stock price process and triggers take place when the stock

price hits certain barrier levels. *Hence conversion and cancellation events are triggered by movements of the stock process and happen when certain barriers are crossed.*” (Corcuera et al., 2014)

This mirrors the conventional approach to modelling coupon deferral in corporate convertible hybrids, with no reference to the actual, rather complex rules governing distributions out of regulatory capital for European banks. The paper claims to demonstrate that the death spiral effects are mitigated when coupon deferment is incorporated into the model.

Corcuera, Fajardo, Schoutens and Valdivia (2016)

The authors address callable nature of CoCos after a series of pre-defined dates by framing this feature within a structural approach. Credit events that comprise the risks of principal conversion are also applied to coupon cancellations and maturity extension. Decisions to postpone an interest payment or delay a call are assumed to be based on the same mechanics as principal conversion. All such events are modelled as a function by taking the share price as the source of the stochastic process that defines each trigger event, via the probability density function of a random variable (Radon-Nikodym derivative). This study draws on established approaches to valuing callable bonds. The emphasis is on finding market triggers as proxies, with the risk of extension linked to share price levels and not in relation to the backend rates that are stated in actual prospectuses.

Ritzema (2015)

Ritzema expands on the analytically tractable first-passage time model, as developed by Brigo et al., with extension risk assumed to be driven by the CET1 ratio. An extra threshold is set for the CET1 ratio that would trigger a non-call. The paths of this extra CET1 ratio are simulated with Monte Carlo runs. Ritzema calibrates the model's parameters to levels current in the markets, e.g., the implied risk neutral default probabilities collected from CDSs. Should the CET1 ratio be below this simulated threshold on a future call date, the issuer will not call the CoCo on the basis that the bank is insufficiently well capitalised. Though the balance sheet strength of a bank is a factor in the decision to call, in practise there is no direct relationship with the prevailing CET1 level. Note also that most redemptions of outstanding CoCos are accompanied by refinancing with a newly issued CoCo – so, there is no real impact on a bank's CET1 ratio when a prefunded AT1 is called. The cost of funding the replacement CoCo note might rise, but the CET1 ratio itself would stay flat.

De Spiegeleer and Schoutens (2014)

The authors claim that inclusion of extension risk to their earlier model allows for a comparison of Tier 1 and Tier 2 CoCos from similar issuers to obtain a cost-estimate of the callable feature. They posit that AT1 CoCos have a split coupon structure with a fixed coupon paid out before the first call date and a floating coupon thereafter. The volatility of the credit spread for a CoCo is assumed to follow geometric Brownian motion. The central assumption is that the behaviour of the credit spread is characterised by a realised volatility input. The projected coupon after the first call is deemed comparable to a ‘call strike’. Given that the credit spread will influence the probability of an early call, as it indicates the cost of financing a new issuance, they calculate this influence in relation to the call strike by running an iterative series of estimates of the credit spread and years to maturity that would make a non-call economical. The authors view this estimate as an intersection of two curves, at which “this particular equilibrium point delivers the answer to the question what the CoCo spread for a particular contingent convertible should be.” So, in this way, the authors integrate extension risk into their earlier valuation models.

There is an intentional circularity to the formulation. The spread is dependent on the maturity and the estimated maturity itself depends on the spread. The circularity is dealt with by applying an iterative process that tries to locate the equilibrium where the inputs of the spread and the maturity intersect. The outcome of the iterations is to find the value of the CoCo that incorporates both the possibility of a principal writedown and a maturity extension. The final theoretical value of this callable CoCo bond is arrived at by discounting the coupon stream.

De Spiegeleer, Schoutens and Van Hulle (2011, 2014)

In their Handbook of Hybrid Securities, the authors attempt a treatment of coupon cancellation risk that involves a Monte Carlo framework. A Monte Carlo simulation is used to deal with the discontinuity of a negative jump in the share price at conversion. One chapter suggests techniques such as the Longstaff and Schwartz approach as a method of dealing with hybrid products with an early exercise probability in a multi-factor setting. The extra risk dimension is added without direct reference to an issuer’s combined buffer requirements; rather it is applied at a generalised level based on a volatility input derived from the bank’s share price. (Note that this approach was developed prior to the widespread disclosure of SREP-MDA ratio related requirements.)

De Spiegeleer, Forys, Marquet, Schoutens (2017)

The approach here mirrors that of earlier efforts, but the valuation is oriented more toward the “quantification of the trigger probability” and the expected loss of a principal writedown. This paper moves beyond the assumption of constant volatility by employing the ‘volatility of variance’. The authors make use of the Heston version of stochastic volatility with its variables for smile and skew, on the assumption that the CoCo price is sensitive to the skewness of the implied volatility surface. The usual suspects of market data are employed, with the quotes of listed equity option prices combined with CDS data. The Heston parameters are backed out of the CDS spreads and the implied barrier of the options are computed with a Monte Carlo calibration; similarly, the probability of the stock-proxy falling below the implied barrier is also calculated by a Monte Carlo simulation.

De Spiegeleer, Hocht, Marquet and Schoutens (2017)

The paper begins with the observation that the distance to the capital adequacy trigger alone will not be enough to explain the value of a CoCo, and that a ‘risk-adjustment’ of the distance is therefore required. Next, an analogy is made between an equity option and a CoCo price. The distance between the current equity price and the strike price of an option is supposed to equate to the distance between the current CET1 ratio and triggers that causes principal writedown or coupon cancellation: both are claimed to reflect an intrinsic value. In conventional options theory, the implied volatility can be backed out from the current price of a call or put option. The authors apply this approach with CoCos by backing out a parameter from a Black-Scholes-like model which they call ‘an implied CET1 volatility’. They use a barrier option pricing variant of Black-Scholes to price a match with the market quotes to estimate what they term a ‘risk-adjusted’ distance to trigger.

It is important to highlight that the spread of the CoCo in the market is taken as *an input as if it were similar to a call option price*. So, this is obviously not a valuation approach by which one might price a CoCo because the spread is already assumed to be available. The CoCo spread input is applied to derive a parameter which the authors claim: “reflects the view of the market on the dynamics of the CET1 ratio”. This ‘implied volatility of the CET1 ratio’ is then used to adjust the actual distances to the contingency trigger. This is a method of volatility adjusting the distance to triggering. The authors claim that the difference in the implied CET1 volatility value for CoCos issued by the same bank with different trigger levels resembles the skew seen in equity option prices.

Finsterbusch and Henriques (2019)

Similar to the work by De Spiegeleer and Schoutens, analysts in the research department of JP Morgan developed a relative value approach that uses estimates of refinancing levels of issuers to make a linear regression that compares how much the extension risk is priced into an AT1 CoCo relative to the market. In this approach, the aim is not to compute prices based on proxy parameters but to take advantage of the market prices and study their relevance to each other and their deviation from the market averages. The two parameters studied are called ‘extension premium’ and ‘buffer to extension’, defined as:

- Extension premium = AT1 refinancing estimate - spread to call
- Buffer to extension = reset spread - AT1 refinancing estimate

Comparing individual AT1 notes against these averages gives some indication of how the market is pricing the risk of a particular note being called in comparison to other notes with a similar maturity. The updated JPM approach differs from that of De Spiegeleer and Schoutens in its proxy for the refinancing spread. JPM calculate ‘refinancing estimates’ for each issuer and compares these to the actual reset spread specified in each note. The notes of each issuer are then grouped together and a regression is made to find the averages in each dimension. One obvious flaw acknowledged by Finsterbusch and Henriques is the circularity that arises when the spread of an AT1 CoCo converges to the market average; e.g., should the spread to call widen, the refinancing spread will widen too. However, the authors do not consider this to be a damning criticism given that a large swing in the spread of one note should not excessively impact the overall average.

Recent efforts to incorporate coupon and call risk – Summary

Parameters & assumptions

In the improved methodology of De Spiegeleer and Schoutens, the parameter called ‘implied CET1 volatility’ is acknowledged to be an abstraction: “Despite the fact that one knows the value of the CET1 ratio on a quarterly basis, we model this ratio as a continuous geometric Brownian motion in the absence of any drift.” *So, their abstract value is not intended to have any connection to the real-world rise and decline of the CET1 ratio that is reported quarterly, nor to reflect the fact that for most banks this ratio has a strong positive drift due to regulator-guided efforts to bolster capital levels.* The emphasis of the authors is on theoretical levels. Their ‘implied CET1 volatility’ is not related to movements in risk-weighted capital as reported in the real world, but is a parameter that describes an abstract ‘volatility number’ which

solves the Black-Scholes barrier options model for a given CoCo, as already priced in the market. As such, this approach appears to be intended as a heuristic device to aid in understanding the risk drivers, rather than a valuation method. On the other hand, the relative approach taken by Finsterbusch and Henriques does attempt to include the reset rates recorded in the contractual terms and is intended as a practical gauge of attendant ‘relative’ extension risk.

Potential problems

None of the adaptations of earlier approaches model coupon risk in a way that reflects any of the regulatory mechanisms such as the calculation of a maximum distribution amounts based on the combined buffer requirements or the depletion of available distributable reserves. This lack of reference is due to limited disclosure of these items at the time the models were developed.

De Spiegeleer et al. (2015) treat the distant to a trigger level rather like valuing an option on the difference between the strike and current value of the underlying security. Saying a CoCo is like an option could be a useful heuristic, but to apply the Black-Scholes model as if the CET1 ratio itself can serve as the underlying seems to stretch this metaphor too far. CoCos are not options contracts on an underlying instrument that is market traded with continuous pricing. In the conventional use of Black-Scholes, the implied volatility is not an abstract ‘risk metric’, it represents an estimate of future variability of the underlying that can be used to delta hedge and will play an actual role in price formation. It is possible to calculate the volatility of risk-weighted capital, but the CET1/RWA value is only reported quarterly and is characterised by long periods of stability punctuated by abrupt changes often in response to updated guidance from the supervisory authority. De Spiegeleer et al. are not using the real-world realised volatility of the CET1 ratio, but only the concept of ‘implied CET1 volatility’ to inject a kind of ‘volatility adjustment’. It is unclear if it is theoretically sound to designate an implied volatility in a Black-Scholes model that has *no relationship to any forward or realised volatility*. The validity of such calculations without any relationship between realised, implied and future volatility remains uncertain.

V. Empirical Programme – Overview

A. Universe of CoCos

Data pool and selection procedure

To compile a comprehensive universe of European contingent capital instruments, information is drawn from the following sources: Fitch, Moody's, Credit Sights, Scope, Bloomberg and the [ECB Statistical Data Warehouse](#). The Fitch dataset comprises well over 300 capital instruments with percentage write-down or conversion triggers, totalling over US\$300 billion, half of which are rated. The Moody's database is more comprehensive, comprising approximately 500 different instruments totalling more than \$400 billion in notes outstanding. Both Fitch and Moody's data also includes non-European issuers. We have merged the information pooled from across the datasets by using each instrument's unique International Securities Identification Numbers (ISINs) as an identifier. Filtering further by liquidity and the availability of disclosures reduces our pool of data somewhat, but drawing on a range of vendors allows for the information to be cross checked and any discrepancies to be further double checked with original source material. The one exception to sourced data is the recovery rate, for which we have made our own calculations based on estimates of market capitalisation at the time of conversion and likely dilution, and on the estimated prospects for the writeback of principal.

Sample population: Europe

Contingent capital is a global asset class. The notes have been issued by institutions from around the world, with Asian banks particularly large participants; Bank of China is one of the largest issuer of CoCos globally (Hwang, 2017). Some European specialist funds will hold CoCos issued by banks in emerging markets, such as Brazil and India but the idiosyncrasies of local accounting in each region makes comparisons difficult. Therefore, for the sake of consistency, the market in Europe is studied in depth. Within Europe, some bonds are excluded, such as those of Russian banks (although occasionally listed in Ireland) and restructuring vehicles such as SAREB (the 'bad bank' of the Spanish government). Similarly, building societies or specialist lenders such as the Coventry Building Society and Aldermore are only included in the t-tests but not in the regressions given that such institutions, reliant solely on mortgages and savings accounts to retail customers, are rather different from commercial and institutional banks. Although Canadian and Australian banks hold CoCos with

contract features fairly similar to European designs, these are also excluded. Again, this exclusion should help standardise the dataset.

Within Europe, only the contingent capital of banks is investigated, though it should be noted that ‘Solvency II’ in the insurance industry has promoted Restricted Tier 1 securities (RT1s), which are rather similar to AT1s. To create a consistent dataset, however, we do not include RT1 notes from insurers and reinsurers.

Representative issuance

With such a young asset class, the universe of instruments is limited. This may lead to the temptation to use every piece of available information, but collecting data is not quite as straightforward a matter as including all notes from all banks. The distribution of issuance in the AT1 market in its raw form is not balanced. To help resolve the problem of overcounting tranches, we have carefully organised the notes by issuer to identify representative notes. To avoid price distortions due to illiquidity, we have also filtered out notes with irregular trading histories or abnormally low volatility.

Variants

In preparing a dataset of AT1s, aggregating all the notes per bank will give a poor result. We have aimed for representation from each bank by including examples of all *distinctive* issuances. By ‘distinctive’ we mean attributes which clearly distinguish the note from other notes issued by the same institution. Some banks prefer to come to the market less frequently in notes of larger size, whereas other banks might issue a series of smaller tranches of what is essentially the same note, with each tranche sharing almost the same features. Small differences such as a tweak on the coupon of less than 50bps or an issuance in a secondary currency are too minor to be worthy of inclusion. For variants to be included as representative, the characteristics must be distinctive – unique first call dates, reset rates, conversion prices or antidilution measures. If notes from the same issuer are almost identical and highly correlated, then we may take a weighted selection of representative notes from the same bank to avoid skewing the analysis. This approach allows for a fairer comparison between single-tranche and multi-tranche issuers, avoiding the overcounting of multi-tranche ‘small size’ issuers.

The data must be carefully managed to avoid double counting. Sometimes a bank will issue equivalent notes with different ISINs due to differences in currency denomination, benchmark reference, exchange jurisdiction or other such documentation. In this context, it is important to note that larger banks tend to come to the market with private placements or with Reg S filings that are intended to be fungible with parallel, more widely available instruments.

In particular, banks may run parallel tranches in multiple currencies, stipulating the exchange rate formula in the prospectus. This amounts to essentially the same note twice with two ISINs – with almost all contract details identical – but have one denominated in sterling or euros and the other in dollars. By cross-section, the yields and spread levels tend to appear essentially the same for such twinned notes, but a time series of the cash price can show striking divergences in the reaction function of the two sets of stakeholders. For example, a US fund may weigh the importance of yield differently than a European fund, due to the backdrop of a tightening Fed interest rate cycle. Such cash price gaps tend to be arbitrated away over time, but it is worth noting the presence of these preference factors. For currency variants, the most actively traded is selected, which tends to be the US dollar denominated notes.

Size and Liquidity

Among European banks, there are both global and local players. The notional for notes can range in size from well over €1 billion to less than €20 million. Notes with larger notional amounts are more likely to be included in the major indices and of greater relevance in the price formation of the overall market. Inclusion/exclusion from a CoCo index can cause wide variations in liquidity, which impacts the reliability of pricing data. Illiquid instruments with low trading volume might not convey changes in risk perceptions as readily as the spreads for heavily traded contracts. This problem can reduce the reliability of calculations. That said, given one of our purposes is to test how distinctive characteristics are reflected in market pricing, it is important to include notes from mid-tier banks that are reasonably liquid to broader out our comparative study.

Volumes and Volatility

As mentioned above, notes that are similar except for currency denomination (and reference benchmark) can display different price action, due to different investor bases. Data on trading volumes is available, though this is sketchy due to the over-the-counter nature of the AT1 market. A lack of liquidity shows up as either a long series of days with virtually no change in price (extremely

low volatility) or as days with prices missing altogether. When running correlation analysis, the notes with extremely low volatility have a distortive effect as do the names with missing prices that rely on interpolation. Such notes tend not to respond readily to changing market conditions as they are either tightly held or do not report trades. Filtering by volume and volatility levels serves as a screen, to check that an instrument is relevant and capable of reflecting price discovery. A presence in established funds or indices is also considered in selected the most representative notes.

Issuer vs Issuance

Some metrics are calculated at a firm level and represent elements of an institution's credit profile, whereas other metrics are unique to each note. For example, Tier 1 equity and distributable reserves vary bank by bank but first call dates and backend resets are specific to a particular note. All notes from the same bank will carry roughly the same degree of coupon risk but rather different degrees of extension risk. While issuer level factors might be better assessed with only one representative note per bank, analysis of features unique to each note will be more statistically reliable with the inclusion of multiple instruments per bank. When building our dataset, we have looked for a transparent method for incorporating issuer versus issuance level variables. In our approach for coupon risk, we have tried to balance the issuer and issuance dimensions by calculating ADI cover as a ratio of the total annual coupon for all outstanding notes per the available reserves held by the bank – in this we hope to 'normalise' the metric for comparison purposes.

Summary

When analysing variations in AT1 pricing care must be taken to create a balanced dataset for testing issuer and issuance level variables. We aim to incorporate information from as many issuers as possible, while filtering out duplicate and illiquid instruments. A methodical screening of notes guards against dampening from duplicates and distortion due to interpolated or incomplete price histories. In this way, we avoid overrepresentation by a few dozen heavily issuing banks and establish panel data of greater diversity. Our core dataset represents a full spectrum of contracts features from 223 instruments.

B. Continuous (dependent) variables

The analysis of AT1s poses some problems in the selection of a dependent variable. The challenge reflects the fact that these notes are hybrids that embed equity-like characteristics but lack basic attributes of the fixed income asset class, i.e. the income is not really fixed. A bank is able to stop

interest payments for a period of time while it rebuilds its capital base and then resume once the base is strengthened without incurring an obligation to retroactively pay the coupons missed. Their hybrid nature means that an AT1 may be traded for its cash price, yield, spread or basis. We have therefore run the paired t-tests and regressions using four types of pricing, to reflect the potential for investors to express a view on risk across a range of metrics.

1. Cash Price

There is generally an element of total return to consider for high yield bonds and most AT1s are rated below investment grade. As volatile, risk-sensitive instruments, CoCos can be traded solely for the action in their cash price over very short holding periods. Such rapid turnover mirrors the way in which event driven bonds are traded in the 'special situations' side of the high yield market. The entry point and holding period will be important in determining the total return. For example, a hedge fund might take a position in a bank's AT1s as the notes drop down to c75 and hold the position for a few months in the hopes of seeing a quick move back into the 90s. In this case, the AT1 is not being held for its coupon, as the hedge fund will not be holding the contracts long enough to receive interest payments. Rather, the hopes of profit are pinned on a sharp price response to perceptions of risk at the issuing bank. This sort of short-term trading by sophisticated investors is an important part of price formation, but it may not help us to detect differences in risk pricing for variables related to coupon risk.

The cash price as a dependent variable is more sensitive to near-term credit risk and better at picking up changes in the economics of the reset at first call. For example, the note of a distressed issuer might appear attractive for a hedge fund looking to profit from a near-term price response to favourable re-financing that factors in the extension risk associated with a low backend rate. Despite its limitations, the cash price may illuminate aspects of the AT1 market over intervals with sharp corrections, given that the marginal buyers for CoCos in some instances may be investors who stress the carry income they can achieve.

2. Yield to Worst

AT1 CoCos are issued as perpetuals with periodic call dates, whereas T2 CoCos have fixed maturities. Investors expect to be compensated with higher yield for taking on greater risk, and will choose the most appropriate yield metric based on their assessment of a note's most likely duration.

Yield to maturity (YtM) represents the total return anticipated on a bond if held until maturity. It is similar to an internal rate of return. Yield to call (YtC) is the estimated yield an investor would receive if a bond is called by the issuer before its maturity, at the first available call date or a later date prior to the bond's maturity. AT1s are sometimes valued on a Yield to Perpetuity (YtP), especially when anxiety over extension risk is rising. Investors may use the spread between YtC and YtP as a gauge of risk. Indeed, if a number of AT1s skip their first call dates market participants could shift to a perception that upcoming notes might not be called, in which case YtP can quickly become the norm. To err on the side of caution, we tend to use yield to worst (YtW) throughout. The YtW is an estimate of the *lowest* yield expected from a bond if held to maturity, absent a default. With callable bonds, YtW is commonly used in place of either YtM or YtC, to represent the worst possible return to expect – and will revert to YtP when the asset class is under stress.

The market for AT1s has experienced several bouts of extension fears that have shifted sentiment temporarily towards yield to perp, especially for notes close to their first call dates. However, while there is merit in using YtP, or a spread between YtC and YtP, we will use YtW in most instances for ease of interpretation. This is still a conservative approach, but it involves fewer assumptions in its calculation and is less volatile than a spread (or ratio) of two types of yield.

3. Spread to Benchmark

Fixed income securities trade in relation to a spread, for ease of comparison. This can take many forms, such as the asset swap spread – a function of a bond's current price, yield and cashflows calculated assuming the implied interest rate of zero-coupon bonds. Such spreads are generally understood to represent the return an investor is willing to accept for taking on greater risk, such that widening spreads tend to reveal growing doubts about the ability to service debt.

Practitioners routinely use a z-spread which makes use of the zero-coupon yield curve. This curve is in turn derived from the interest-rate swap curve for treasuries. The z-spread is the basis point spread required to be added to this implied spot yield curve so that the discounted cashflows of a bond equals its current market price. By using a z-spread, a 'zero volatility spread', market participants are able to see the degree to which the overall credit risk of a given bond is being valued. *In general, a steeper yield curve leads to a higher z-spread.* The spread between callable and non-callable bonds will narrow if interest rates are expected to rise and will widen when they are expected to fall. An

increase in interest rate volatility will also tend to increase the value of the embedded call option feature of callable bonds and thus increase the yield spread over non-callable bonds. For the purposes of this thesis, we use the z-spread in the calculation of the ‘spread to benchmark bond’ and also in ‘spread to CDS’ based on the ‘Yield and Spread Analysis’ (YAS) function in Bloomberg, with each cashflow discounted according to its own appropriate zero-coupon rate.

The ‘spread to benchmark’ represents the additional compensation an investor receives over a treasury bond of similar maturity from the same country and currency in which the CoCo was issued. It is possible to use a more uniform benchmark, such as five-year U.S. Treasury note. However, we have chosen a benchmark that better reflects relative value. For consistency, the benchmark is matched by maturity to the treasuries of the country of domicile of the issuing bank (or in some cases, the currency in which the note is denominated). In this way, a Swedish bank can then be assessed in its domestic context as can a Spanish bank, taking into account the close connection between a domestic bank and its sovereign. The spread is calculated by subtracting a maturity matched generic government bond (‘risk-free benchmark’) from the AT1’s yield to call. Changes in the treasury rate could impact the measure, but the prolonged period of ultra-low rates in both Europe and North America has relegated this to a minor concern for our study.

4. CoCo Basis

The basis is measured as the spreads between CoCos and other risky securities from the same issuer, such as senior unsecured bonds. In our analysis, we consider the basis over CDS spreads, i.e., the basis point difference between CoCo and CDS spreads.

Credit default swaps (CDS) are derivative contracts that can be purchased to protect against the default of a bond. The buyer of such protection pays the seller a regular amount; if the reference bond defaults, the seller pays out an agreed portion of the face value of the bond. Sellers of protection on relatively safer issuers should demand lower premiums than on riskier credit names. According to theory, the spread of a CDS should therefore fluctuate in relation to the increasing or decreasing probability that a reference entity might default. As a consequence, default swaps are often used as a proxy to gauge perceptions of a bank’s credit risk.

In selecting a reference bond, one could use the spread over a senior or subordinated bond from the same issuing bank with a similar maturity to the first call date. This method could be helpful in

detecting risk perceptions that arise for AT1s in advance of concerns for bonds of greater seniority. Though a sound approach, it is not easy to implement due to the difficulty of matching maturities of subordinated bonds. Therefore, CDS are preferable to subordinated bonds for the reference because they provide a standardised value with which to match maturity.

Spread to sub CDS

There is a degree of ‘circular feedback’ at play when considering the relationship of AT1s with their issuing bank’s CDS, in that the very act of issuing an AT1 ought to lower the risk of default somewhat. Indeed, according to a paper prepared by the Bank for International Settlements, CoCo notes result in “statistically significant declines in issuers’ CDS spreads, indicating that they generate risk-reduction benefits and lower costs of debt” (Avdjiev, 2017). AT1s are designed to kick-in while a bank is still a ‘going concern’, offering additional loss absorbing capital. The likelihood of the AT1 triggering, if this event were to lower the degree of leverage, could create a perception of risk reduction relative to default probability that leads to CDS spreads narrowing. Some self-referencing is inescapable, as the AT1 are a core part of the capital structure of the bank for which the CDS is presumed to be pricing the credit risk. This tendency for circular feedback is unlikely to manifest itself in conditions of market calm; however, for a distressed bank edging closer to triggering its CoCos, the AT1-specific risk could influence a move in the issuing bank’s CDS spread. Near the conversion threshold, at least theoretically, the triggering of AT1s would be beneficial for default swaps and therefore the spread between the two types of instruments could diverge sharply.

Calculating the CDS basis

In calculating the basis point difference between the z-spreads of AT1s and the CDS from the same issuer, there are two choices to make: 1) to use the swaps on senior or subordinated bonds; 2) to use standard or matched maturities. The magnitude of variation tends to be small for the senior CDS, in that they trade tighter and are somewhat less volatile. As we are concerned with the conversion risk of AT1s, a hybrid form of subordinated debt, we tend to rely more on the default swaps for subordinated debt despite their noisy shortcomings. But we also run our analysis with the senior CDS basis, to see if this picks up information overlooked in the noisier sub CDS basis. The question of whether to use a standard period or an adjusted period for maturity is more problematic. We have decided to use matched maturities. To calculate the basis, we use CDS for the subordinated debt from the same issuing bank with a tenor that matches the period to the first call as the AT1 note.

Though we generally use a spread, we sometimes express the CDS basis as a *multiple*. To illustrate this alternative approach, consider the BNP-Paribas note with a coupon of 7.375% and first call date of 19 August 2025:

- Take the current z-spread of 588bp (as of October 2017)
- Then select for a matched maturity the subordinated 8-year CDS with a spread of 209bp

This gives us two spreads, for a basis multiple of **c2.8x**. For European banks, the average multiple calculated in this manner at that time was c3.5x. So, the BNP note is trading inside the average.

Though this gives us a gauge of the AT1-specific risk in relative terms, it can magnify differences across notes, sometimes disproportionately. If we take another example from the same pricing point (October 2017), the BNPP AT1 with a 7.625% coupon and a first call on 30 March 2021 had a z-spread of 561bp (similar to the longer-dated AT1); when matched to a reference 4-year subordinated CDS of only 151bps (considerably less than the 8-year) we get a multiple of **c3.7x** that is outside the average. The multiple approach highlights the relatively heightened risk in the AT1 with the nearer call date. But the fluctuation in the denominator may exaggerate the differences in risk perceptions. Though mindful of its potential for exaggeration, we the CDS basis expressed as a multiple for cross-sectional regressions and time series analysis. When expressed as a ratio to the subordinated CDS, the higher the multiple, the more risk is priced into the AT1. In a time series, if the basis is fairly flat that indicates that the perception of risk in the CoCo and CDS prices are moving in relative lockstep, whereas a widening of the basis suggests a shift in risk perceptions.

Emphasis on CDS basis

The explanatory power of an *independent* variable will reflect the ways in which AT1s can be held for yield or traded for gain. There is not a 'best' *dependent* variable, as each has its merits. At inception, AT1 CoCos tended to be valued on yield. In recent years, anecdotal evidence suggests that as the investor base migrates from private wealth funds and hedge fund toward institutional participants more emphasis is being placed on spreads. Institutional asset managers tend to think about relative value and compare CoCo securities by using spreads – to benchmark against other bonds or CDS. Although we make use of several dependent variables, *our study places greater emphasis on the CDS basis given that we are primarily investigating whether the conversion trigger and recovery rate inherent in the risk of principal loss are significant factors.*

Figure 14 summarises the definitions of the main continuous variables used to gauge risk. We use the total return of the cash price only sparingly.

FIGURE 14: CONTINUOUS DEPENDENT VARIABLES

| <i>Type</i> | <i>Variable</i> | <i>Description</i> |
|--------------------------|---------------------|--|
| Yield | Yield to Worst | YtW_{CoCo_i} = The lowest potential yield that can be received on a bond, i.e., the lower of yield to call and yield to maturity. In the worst case scenario, this could be 'yield to perpetuity'. |
| Spread | Spread to benchmark | $Spread_{CoCo_i}$ = The difference between the yield to maturity of the AT1 and that of a treasury security with a similar maturity of the country corresponding to the currency in which the note is denominated. |
| CDS Basis | Zspread | $Basis_{CoCo_i}$ = The difference in the z-spread of the AT1 to subordinated (or senior) CDS of the same issuer, with a similar maturity as that of the first call date of the AT1. |
| Total Cash Return | Cash Price | $Total\ Return_{CoCo_i}$ = The cash price plus coupon returns over a one year period. |

We will begin with two sample t-tests on key design features of CoCos and then extend our analysis into multiple regression on metrics related to the probability of trigger events.

VI. Paired T-Tests

1. CET1 trigger

We will first compare each of the main design feature included in a CoCo contract, in isolation. To facilitate this, the dataset of CoCos will be sorted into subgroups by design features and compared against the means of pricing indicators. In terms of presentation, we state as propositions the relationships that we would expect to find based on the academic literature. We also include, for clarity, the formal null hypothesis (H_0), which is tested for statistical significance. $H_0: \mu_1 = \mu_2$ where μ_1 is the mean of one population and $\mu_2 =$ that of another. To reject the null hypothesis, the mean of the riskier component – listed first in each pair – should be significantly higher.

We run t-tests before the regression to sense check the variables. We use the paired tests as a method to validate whether the explanatory variables in Figure 15 play a meaningful role in shaping price formation. Following this initial assessment of pricing dynamics, we will conduct multiple regression analysis to elucidate our initial findings.

FIGURE 15: INDEPENDENT VARIABLES

| <i>Barrier</i> | <i>Variable</i> | <i>Description</i> |
|-----------------------------|----------------------------|--|
| Tier Ranking* | | |
| | Tiering | Ranking in the capital structure as either Tier 2 or Additional Tier 1 |
| Principal Conversion | | |
| | Trigger level | 5.125% versus 7% and above |
| | Loss mechanism | Principal writedown or equity conversion |
| | Conversion price | Fixed or floored (floating type is included with floored) |
| | Conversion ratio | Low or high (the lower the ratio, the fewer shares post conversion) |
| | Period of writedown | Temporary or permanent |
| | Degree of writedown | Partial or complete |
| | Recovery rate | Estimated based on conversion ratio or period and degree of writedown |

* Tier 2 CoCos have fixed maturities and compulsory coupons whereas AT1 CoCos are perpetual with discretionary coupons.

Capital Ranking

There is a clear difference in risk-pricing for the two tiers of CoCos: AT1 vs T2.

H_0 : The Basel classification of capital ranking for CoCos does not correlate significantly with pricing indicators.

RATIONALE

The two types of CoCos tend to be viewed as distinct risk propositions. Tier 2 CoCos rank higher in seniority in the capital structure than AT1s. T2s are considered to be ‘gone concern’ capital that triggers only in a situation of insolvency when a bank is put into resolution, whereas AT1s are

designed to trigger at an earlier stage of distress when a bank is still a ‘going concern’. Tier 2s not only entail less risk due to their seniority but embed fewer risk features. T2s pay mandatory coupons, whereas AT1 coupons are discretionary. Though some T2s do have the option to call at earlier dates, they have a fixed maturity as opposed to the perpetual nature of AT1s. Given their less risky characteristics, T2 CoCos ought to price at a material discount to their AT1 cousins.

FINDINGS

We would expect the mean to be greater for the higher risk component; in this case the mean is higher for the AT1s vs the T2s. Investors are compensated for taking on the greater risk associated with the subordinated tier of CoCos. These results indicate capital tiering as a decisive factor, correlating significantly across three price indicators for the complete CoCo universe. The null hypothesis for tiering can thus be rejected.

FIGURE 16: CAPITAL RANKING COMPARISON (FULL COCO UNIVERSE)

| <i>Design Feature</i> | <i>Component</i> | <i>Yield to Worst (%)</i> | <i>Spread to Benchmark¹ (bp)</i> | <i>CDS Basis – Multiple² (x)</i> | <i>Total No. of Notes</i> |
|------------------------|-------------------|---------------------------|---|---|---------------------------|
| Capital Ranking | Additional Tier 1 | 5.8% | 582.2 | 3.1 | 202 |
| | Tier 2 | 3.8% | 304.6 | 1.2 | 21 |
| | AT1 vs T2 | 52.6% | 91.1% | 158.3% | |
| | Mean difference | 1.97 | 277.60 | 1.910 | |
| | Standard error | 0.514 | 59.36 | 0.351 | |
| | T-statistic | 3.8367 | 4.6763 | 5.460 | |
| | Probability level | 0.00016 | 0.00001 | 0.000 | |
| | Reject Ho at 1% | Yes | Yes | Yes | |

Source: Credit Sights, Moody’s, Fitch, Scope, Bloomberg and prospectuses.

1: To treasury of local currency, with similar maturity.

2: Zspread as a multiple of subordinated CDS, matched maturity (as of 20-Mar-19).

This finding is further strengthened when the analysis is run on a subset of issuers who have both AT1 and T2 notes, as shown in the table above. Again, the null hypothesis can be confidently rejected for all four risk pricing indicators.

FIGURE 17: CAPITAL RANKING COMPARISON (ONLY ISSUERS OF BOTH AT1 AND T2)

| <i>Design Feature</i> | <i>Component</i> | <i>Yield to Worst (%)</i> | <i>Spread to Benchmark¹ (bp)</i> | <i>CDS Basis – Multiple² (x)</i> | <i>Total Return³ (YoY, %)</i> | <i>Aggregate Average (%)</i> | <i>Total No. of Notes</i> |
|------------------------|-------------------|---------------------------|---|---|--|------------------------------|---------------------------|
| Capital Ranking | Additional Tier 1 | 6.0% | 519.9 | 3.1 | 9.9% | | 31 |
| | Tier 2 | 3.7% | 286.4 | 1.1 | 6.7% | | 18 |
| | AT1 vs T2 | 62.2% | 81.5% | 181.8% | 47.8% | 93.3% | |
| | Reject Ho at 1% | Yes | Yes | Yes | Yes | | |

Source: Credit Sights, Moody's, Fitch, Scope, Bloomberg and prospectuses.

1: To treasury of local currency, with similar maturity.

2: Zspread as a multiple of subordinated CDS, matched maturity (as of 20-Mar-19).

3: From 28-Jan-18 to 29-Jan-19.

To further illustrate the pattern, the sample set of CoCos issued by Barclays is shown in the table below, with its notes sorted by tier. Again, the null hypothesis for tiering can be rejected.

FIGURE 18: BARCLAY'S – CAPITAL RANKING COMPARISON OF ITS AT1 AND T2

| <i>Instrument</i> | <i>Capital Ranking</i> | <i>Yield to Worst (%)</i> | <i>Spread to Benchmark¹ (bp)</i> | <i>CDS Basis² (x)</i> | <i>Total Return³ (YoY, %)</i> | <i>Aggregate Average (%)</i> | <i>Total No. of Notes</i> |
|----------------------------|------------------------|---------------------------|---|----------------------------------|--|------------------------------|---------------------------|
| BACR 6 1/2 12/29/49 | Tier 1 | 6.2% | 778.3 | 5.2 | 10.1% | | |
| BACR 6 5/8 06/29/49 | Tier 1 | 7.2% | 740.9 | 5.1 | 5.7% | | |
| | | | | | | | |
| BACR 7 06/15/49 | Tier 1 | 6.5% | 846.6 | 5.8 | 8.8% | | |
| BACR 7 7/8 12/29/49 | Tier 1 | 7.3% | 691.3 | 3.3 | 13.6% | | |
| BACR 7 7/8 12/29/49 | Tier 1 | 7.3% | 553.2 | 2.8 | N/A | | |
| BACR 8 1/4 12/29/49 | Tier 1 | 5.9% | 473.6 | 3.8 | 6.9% | | |
| BACR 8 12/15/49 | Tier 1 | 6.1% | 669.5 | 3.6 | 10.5% | | |
| | <u>Mean</u> | 6.6% | 679.1 | 4.2 | 9.3% | | 7 |
| BACR 7 3/4 04/10/23 | Tier 2 | 3.2% | 202.6 | 1.6 | 6.1% | | |
| BACR 7 5/8 11/21/22 | Tier 2 | 5.5% | 361.2 | 1.7 | 4.4% | | |
| | <u>Mean</u> | 4.3% | 281.9 | 1.7 | 5.2% | | 2 |
| | AT1 vs T2 | 53.5% | 140.9% | 147.1% | 78.8% | 105.1% | |
| | Reject Ho at 1% | Yes | Yes | Yes | Yes | | |

Source: Credit Sights, Moody's, Fitch, Scope, Bloomberg and prospectuses.

1: To treasury of local currency, with similar maturity.

2: Zspread as a multiple of subordinated CDS, matched maturity (as of 20-Mar-19).

3: From 28-Jan-18 to 29-Jan-19.

INTERPRETATION

That the risk premium for Tier 2 prices consistently lower establishes the salience of the AT1 versus T2 divide and hence the seeming relevance of going vs gone concern capital. The higher capital ranking itself may play a role as well, but when it comes to assessing the differing risk profiles, anecdotal feedback from investors suggests the key differentiating features are discretionary (AT1) vs mandatory (T2) coupons, and extendable (AT1) vs non-extendable (T2) maturity. The gap in pricing between the two tiers can be viewed as a proxy for the perceptions of coupon cancellation and extension risk. The Basel III designation of capital tiers should be included as an input to accurately model the risk profile of CoCos.

2. Loss Mechanism

The loss absorption mechanism (conversion or writedown) plays a role in risk pricing given risk shifting incentives and the alignment of stakeholder interests.

H₀: The type of loss absorption mechanism does not have a significant correlation with pricing indicators.

RATIONALE

Equity conversion and percentage writedown are *methods of calculating* the loss of principal and may be viewed differently by investors. There are contending arguments as to why a conversion of principal into equity might be viewed differently than a percentage writedown of principal:

- (1) Convertible CoCos can retain at least some value whereas full & permanent writedowns definitely do not. This suggests conversion should be preferred as a mechanism, however partial or temporary writedowns might be more attractive.
- (2) Some studies suggest the presence (or perception) of risk-shifting incentives or agency costs that could cause differences in premiums. For example, equity conversion may be valued for its alignment of stakeholder interest, in turn lowering overall operating risks.
- (3) Another possibility is that one of the mechanisms might be valued for its transparency. For example, a partial writedown mechanism does not require stochastic modelling of the prevailing share price level at the contingency event.

FINDINGS

In considering the loss absorption mechanism in isolation, the mean should be greater for the higher risk component of the pair. As shown in the table below, equity conversion is priced at a significant

premium to percentage writedown across three of the dependent variables. On the face of this, equity conversion appears to be perceived meaningfully different than percentage writedown and we can reject the null hypothesis.

FIGURE 19: LOSS ABSORPTION MECHANISM ACROSS FULL COCO UNIVERSE

| <i>Design Feature</i> | <i>Component</i> | <i>Yield to Worst (%)</i> | <i>Spread to Benchmark¹ (bp)</i> | <i>CDS Basis – Multiple² (x)</i> | <i>Total No. of Notes</i> |
|-----------------------|------------------------|---------------------------|---|---|---------------------------|
| Loss Mechanism | Equity conversion | 7.1% | 664.8 | 3.6 | 56 |
| (all CoCos) | Principal writedown | 5.1% | 500.4 | 2.6 | 167 |
| | EC vs PW | 39% | 33% | 39% | |
| | Mean difference | 1.95 | 164.36 | 0.025 | |
| | Standard error | 0.323 | 40.643 | 0.227 | |
| | T-statistic | 5.941 | 4.044 | 4.507 | |
| | Probability level | 0.000 | 0.000 | 0.000 | |
| | Reject Ho at 1% | Yes | Yes | Yes | |

Source: Credit Sights, Moody's, Fitch, Scope, Bloomberg and prospectuses.

1: To treasury of local currency, with similar maturity.

2: Zspread as a multiple of Tier 2 CDS, matched maturity (as of 20-Mar-19).

INTERPRETATION

There are many possible explanations for the findings. Some of the reasons for equity conversion having a higher risk premium are as follows:

1. Asset class preferences

Fixed income investors might prefer to avoid any obligation to hold equity due to the nature of their fund mandates. Some funds may not even permit hybrid instruments if they are not allowed to hold equity securities at all. While such criteria might exclude participation, most prospectuses make allowance for a brief holding period for equity, after which it will be converted to cash. For example, as stated in the Lloyds prospectus: “if all of the Ordinary Shares to be issued and delivered on Conversion are sold in the Conversion Shares Offer, the pro rata share of the cash proceeds from the sale [can be received].” In other words, the shares can be almost immediately sold; there is no requirement to hold the equity. At most there might be some further slippage in the recovery value during the short time in which the transaction takes place. Critically, there is no requirement for an AT1 holder to continue to hold the shares post conversion.

2. Transparency vs uncertainty

Equity conversion implies ‘some recovery’... a positive that should be valued somewhat. However, investors may attribute greater importance to transparency in assessing recovery rates such that uncertainty in the calculation of loss demands a higher premium. While this appears plausible, it is not readily apparent that conversion is less reliable than writedown when it comes to recovery rates:

1. in an equity conversion, no matter how high the conversion price or how low the underlying share price, there will be some small amount of principal recovered even if de minimis.
2. in a permanent writedown of 100% of principal, the recovery rate is definitely zero.

On this simplistic basis, equity conversion should be slightly preferred to percentage writedown as the mechanism for loss calculation. However, to estimate recovery in the case of equity conversion depends on other features. The conversion feature might reduce the marketability of a note if investors felt that modelling a stochastic process was less transparent than a percentage write-off. It is possible to posit a large percentage drop in the underlying stock, but it is not straightforward to know whether the prevailing share price will be 50% or 90% lower than at the time of issuance.

Although the assessment of the writeback clause is subjective as well, investors may be valuing a partial or temporary writedown of principal more highly than the prospects of recovery under conversion. For temporary write-down AT1s, there is uncertainty over the time required for a write-up to occur and scepticism as to whether a write-up would actually happen at all. Although specified criteria must be met, a write-up is largely at the discretion of the issuer and regulator. A bank might be incentivised to write-up in order to regain access to capital markets. If a bank did not restore the principal of its outstanding AT1 holders, this would send a negative signal to investors and cast a shadow over future issuance. Based on anecdotal feedback, write-back clauses tend to be considered of limited utility given the uncertainty associated with the timeline over which this might occur.

Equity conversion could be valued for trading purposes as write-back could take a long time and provide no better recovery rates. That said, provisions for partial or temporary writedowns should have some bearing on assessments of recovery potential. The estimation of recovery rates, whether based on conversion prices or write-back provisions, is imprecise. We will investigate the implied recovery rate more thoroughly with the next variable; however, we note that on aggregate we estimate the recovery rate for an AT1 triggered while a bank is a going concern averages c35% for

equity conversion and c33% for percentage writedown – i.e., about the same when conversion price and write-back clauses are factored in.

3. Risk-shifting incentives.

There might be investors who take into account the alignment of management motivations and wish to guard against risk-shifting incentives. (See the chapter on Incentives for a full discussion.)

CAVEATS

It is important to caveat the apparent difference in risk premium by loss mechanism by considering the uneven nature of the data and the possibility for correlated variables as the primary drivers:

1. Equity conversion is an option only among AT1s and not Tier 2 CoCos. This fact alone might explain much of the difference in risk pricing, as AT1s are associated with coupon cancellation and extension, neither of which apply to T2s.
2. Most notes with equity conversion also have high trigger levels – again, reflecting the preferences of national authorities. This might be introducing collinearity.
3. The pattern of issuance over time has favoured percentage writedown, with it becoming prevalent from 2014 onwards. The pattern of issuance, with call dates nearer in the equity conversion category, might make extension risk relatively more concentrated – another instance of possible collinearity.
4. When listing in US dollars there appears to be a preference for using the equity conversion mechanism in order to ensure coupon quality for a tax shield, yet another possible collinearity given that holding patterns of investors may differ by currency/region.
5. In the evolving market for CoCos, national authorities have encouraged certain design features. Although countries such as Switzerland, Sweden and Belgium do use equity conversion, Britain, Spain and the Netherlands have a high concentration of notes using this mechanism. Spain has one of the most distressed banking sectors in Europe and Britain hosts nationalised or semi-nationalised banks; therefore, having all the Spanish and British names gathered into the subcategory of equity conversion may distort the analysis.
6. Banks with more difficult credit stories, and already depressed stocks, may find it easier to come to the market with equity conversion *coupled with attractive conversion prices*.

3. Recovery Rates

- a. Floor prices have a bearing on risk assessments.
- b. A high conversion price demands a greater risk premium.
- c. A 'full' writedown demands a greater risk premium than 'partial' or 'progressive'.
- d. A 'permanent' writedown demand a greater risk premium than 'temporary'.
- e. The implied recovery rate is a factor in investors' assessment of risk.

H_0 :

- a. The presence of a floor price does not correlate significantly with pricing indicators.
- b. The level of the conversion price does not correlate significantly with pricing indicators.
- c. The degree of writedown (full vs partial) does not correlate significantly with pricing indicators.
- d. The period of writedown (permanent vs temporary) does not correlate significantly with pricing indicators.
- e. The potential recovery rate does not have a significant correlation with pricing indicators.

(1) Convertible mechanism

RATIONALE

As the primary driver of the recovery potential for conversion CoCos, the conversion price should be given credence by investors in assessing risk. We categorise floor/conversion prices into two buckets – high if they are 0%-40% below current levels and low if they are more than 40% below current levels.

FIGURE 20: CONVERSION PRICE

| Design Feature | Component | Yield to Worst (%) | Spread to Benchmark ¹ (bp) | CDS Basis – Multiple ² (x) | Total No. of Notes ³ |
|-------------------|-------------------------|--------------------|---------------------------------------|---------------------------------------|---------------------------------|
| Conversion | Fixed price | 6.8% | 634.5 | 3.4 | 35 |
| | Floored price | 6.8% | 730.8 | 4.1 | 19 |
| | Fixed vs Floored | 0% | -13% | -17% | |
| | Reject Ho at 5% | No | No | No | |
| | Conv price - High | 7.2% | 710.4 | 4.0 | 35 |
| | Conv price - Low | 6.1% | 555.5 | 2.7 | 16 |
| | High vs Low CP | 18% | 28% | 48% | |
| | Mean difference | 1.032 | 154.860 | 0.284 | |
| | Standard error | 0.344 | 65.790 | 0.482 | |
| | T-statistic | 2.998 | 2.354 | 2.662 | |
| | Probability level | 0.004 | 0.023 | 0.011 | |
| | Reject Ho at 5% | Yes | Yes | Yes | |

Source: Credit Sights, Moody's, Fitch, Scope, Bloomberg and prospectuses.

1: To treasury of local currency, with similar maturity. 2: Zspread as a multiple of Tier 2 CDS, matched maturity (as of 20-Mar-19).

NB: The number of notes may not add up to the full dataset for all features due to some unusual contract characteristics or missing details. For example, some convertible CoCos are for banks which do not have listed shares but rather convert into Core Capital Deferred Shares ("CCDS").

We should note that shares for some banks will have trended down since the time of CoCo issuance, such that conversion price levels at issuance are measured against higher reference share prices at the issuing date. By using current levels that are relatively depressed as the reference point, our assumption for a high trigger is less severe than if referenced to the levels at issuance – i.e., 40% below a current price in some cases would be 60% below the price at issuance.

Our analysis uses the fixed or floored conversion prices, which we extract from each prospectus. The inclusion of the floor price may appear reassuring in the prospectus, but given that the share price will almost certainly be through the floor in a contingency event, flooring the conversion price has the same effect as fixing the price. While the floor may protect shareholders from extreme dilution, it acts the same as a conversion price from the perspective of CoCo holders. Some prospectuses may also cite a form of ‘floating’ conversion price based on the price near the time of conversion, such as the average share price of the prior ninety days; however, in such formulations there tends also to be a floored value given – i.e., the higher of either the floating or floored.

FINDINGS

a) Floor vs conversion prices

The presence of a floor price versus a fixed conversion price registers no significant difference in the means when measured by YtW, and as a small but insignificant negative with the other dependent variables. The null hypothesis is thus confirmed.

b) High vs low conversion/floor prices

One of the most salient findings in the paired t-tests is that the conversion price shows a significant correlation, especially by CDS basis — which is 48% greater for high conversion prices. The null hypothesis can be rejected for the conversion price, for all three of the dependent variables.

INTERPRETATION

That conversion floors are not significant is no real surprise. That floored conversion actually prices as slightly riskier might reflect some collinearity, given that Iberian banks tend to use floors.

The level of the conversion price may vary widely by issuance, even from the same institution. AT1s may have punishingly high conversion prices or ones set well below the equity price prevailing at the

issuing date. The level represents differing market conditions and investor appetites. For example, BBVA has four AT1 notes with conversion prices ranging from €3.75 to €5.00. These conversion prices were approximately c26% (26-Apr-13), c50% (11-Feb-14), c54% (10-Feb-15) and c31% (7-Apr-16) below the share prices at the announcement date – as shown in brackets. As the primary driver of the recovery rate for convertible AT1s, and a variable with a wide range of values, it is noteworthy that the conversion price itself correlates with some significance – a finding investigated further in the regression analysis to determine whether the market does distinguish between high and low recovery rate potential.

(2) Writedown mechanism

RATIONALE

For CoCos with a principal writedown mechanism the degree of recovery rests on two design features: (1) the percentage written down, initially or in stages, and (2) the nature of any write-up provisions. Partial writedown, in theory, results in a non-negative value; therefore, investors should favour partial over complete writedown. Similarly, where a writedown is temporary, a CoCo holder stands to regain part or all of its original principal – so temporary write-down should be favoured. This write-back process could take a long time, or never occur at all, but one would expect investors to attribute some value to a write-up clause. The two elements come in combinations, such as complete and permanent or partial and temporary, so combinations are also run as additional tests. We would expect the combination of riskier features would price higher.

FINDINGS

a. Writedown period

Rather remarkable is our finding that CoCos whose writedowns are permanent are priced with a lower risk premium than those that are temporary across all dependent variables, in particular YtW (-33%) and credit spreads (-41%).

b. Writedown amount

Equally striking is our finding that a full writedown is priced with a lower risk premium than a staggered or partial writedown of principal across all dependent variables – e.g. credit spreads (-26%)

and CDS basis (-28%). *For the write-down features taken in isolation, the null hypothesis is rejected but the sign is in the wrong direction! The riskier category is significantly cheaper.*

FIGURE 21: WRITEDOWN TERMS

| <i>Design Feature</i> | <i>Component</i> | <i>Yield to Worst (%)</i> | <i>Spread to Benchmark¹ (bp)</i> | <i>CDS Basis – Multiple² (x)</i> | <i>Total No. of Notes³</i> |
|-----------------------|-------------------------|---------------------------|---|---|---------------------------------------|
| Writedown | Permanent | 4.0% | 350.5 | 2.3 | 48 |
| | Temporary | 6.0% | 598.3 | 2.7 | 119 |
| | Perm vs Temp | -33% | -41% | -15% | |
| | <u>Reject Ho at 5%</u> | Yes⁵ | Yes⁵ | No | |
| | Full | 4.8% | 403.5 | 2.1 | 63 |
| | Partial | 5.2% | 544.2 | 2.9 | 97 |
| | Full vs Partial | -8% | -26% | -28% | |
| | <u>Reject Ho at 5%</u> | No | Yes⁵ | Yes⁵ | |
| | Permanent-Full | 4.3% | 330.8 | 2.0 | 29 |
| | Permanent-Partial | 3.3% | 358.8 | NA ⁴ | 17 |
| | Perm-F vs Perm-P | 30% | -8% | - | |
| | Mean difference | 0.025 | -28.044 | - | |
| | Standard error | 0.0069 | 46.971 | - | |
| | T-statistic | 3.614 | -0.597 | - | |
| | Probability level | 0.001 | 0.554 | - | |
| | <u>Reject Ho at 5%</u> | Yes | No | - | |
| | Temporary-Full | 5.2% | 720.3 | NA ⁴ | 34 |
| | Temporary-Partial | 5.8% | 592.2 | 2.9 | 80 |
| | Temp-F vs Temp-P | -10% | 22% | - | |
| | Mean difference | 0.618 | 128.107 | - | |
| | Standard error | 0.371 | 119.649 | - | |
| | T-statistic | 1.666 | 1.071 | - | |
| | Probability level | 0.098 | 0.288 | - | |
| | <u>Reject Ho at 5%</u> | No | No | - | |

1: To treasury of local currency, with similar maturity.

2: Zspread as a multiple of Tier 2 CDS, matched maturity (as of 20-Mar-19).

3: The number of notes may not add up to the full dataset for all features due to unusual contract characteristics or missing details.

4: If sample size is less than 10, this precludes a calculation and is indicated with a 'NA'.

5: On a two-sided test, the null hypothesis is rejected; however, the sign for the pricing indicator is 'wrong' in relation to risk profile.

Features taken in combination

Combined into four categories the findings are less puzzling. *In tandem, we can reject the null hypothesis for 'permanent-complete' vs 'permanent-partial' based on yields*; we tested not only yield to worst but also yield to call and yield to maturity with all three rejecting the null hypothesis at a 5% confidence level.

Although the differences are not significant for temporary-complete vs temporary-partial, at least the directional sign is appropriate with the higher risk category pricing slightly richer.

INTERPRETATION

Why would either *permanent* or *complete* writedowns price with much lower risk premiums than *temporary* and *partial*? This is counterintuitive and appears to call into question whether such clauses have any bearing on risk pricing. Temporary writedown is a complicated procedure that does not lend itself easily to simplifying assumptions. This is likely why this writedown mechanism tends to be neglected in the academic literature on valuation models, even though the majority of CoCos are principal writedown. The difficulty in predictive modelling may be the reason why CoCo holders appear to ascribe limited value to the write-back feature, given the lack of clarity on how the resolution process will be managed.

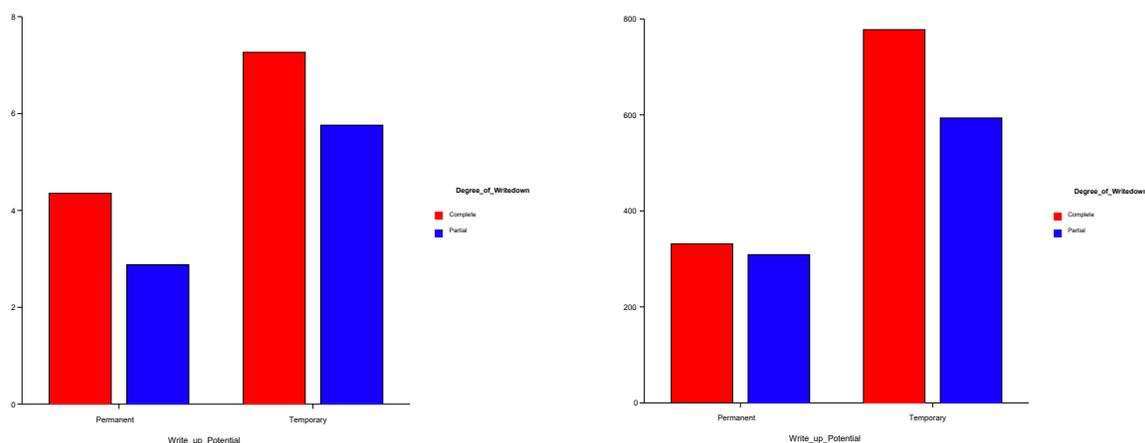
The conditions that apply to the write-back clause are rather restrictive. Although the phrasing varies from prospectus to prospectus, the writeback is based on a formula in which the amount of net income that may be put forth to pay either coupons or to write up principal is determined by the proportion of CoCo securities in the capital structure. For example, if CoCo instruments constituted 15% of Tier 1 then the maximum amount available for coupons or writeback would be 15% of net income. This implies that a bank with a weak balance sheet could take many years to write back principal and restore coupons – and might possibly never be able to. While a bank would be motivated to reinstate the principal of a written-down AT1 as a precursor to a return to capital markets in order to secure cheaper financing, a write-back is not a requirement and the regulators might not approve. As such, though the presence of a write-back clause is better than its absence, in practice the clause may not be seen to provide much protection.

Likewise, partial or staggered writedowns may be a better option theoretically, but investors may not put much store in this feature given that once a distressed bank descends down the slippery slope of triggering its CoCos, the instrument will likely need to be written down in full. In the scenario of a partial writedown, a prospectus may reference intervals of 15% or 25%; however, such small writedowns are unlikely to be sufficient to bring the capital position of a distressed bank back into line. Indeed, even the entire layer of AT1 capital may not be enough to rebalance a troubled bank's balance sheet. As such, a partial or staggered writedown may not be seen by investors to offer much additional value from complete writedown.

Part of the problem in assessing the percentage writedown mechanism may lie in the fact that features are combined. Clearly, a complete and permanent writedown at the touch of the trigger

barrier poses more risk than a partial writedown staggered in stages with the possibility to write the principal back up to its original level. The least amount of risk, in theory, would be temporary-partial writedown. Taking the two components together does improve the results, though not unambiguously. As shown in Figure 22, the design features show a slightly better representation of risk properties in that complete writedown is higher yielding for both permanent and temporary.

FIGURE 22: WRITEDOWN BY DEGREE AND WRITE-UP POTENTIAL, YTW & SPREADS



Source: Our analysis, based on data from CreditSights, Moody's, Fitch, Scope, Bloomberg and prospectuses.

This slight improvement in the combined features comes with two caveats:

- Tier 2 CoCos are almost all permanent writedown, which introduces collinearity for coupon cancellation (a T2 CoCo cannot skip) and extension risk (T2 CoCos have fixed maturities).
- Temporary and partial are generally combined, and this combination is the most common variant for writedown such that it forms a broad 'catch-all' category. The relevance of these writedown clauses may send too small a signal to overcome the diversity of other factors.

a) Recovery rates – Across mechanisms, in combination

RATIONALE

The recovery rate represents the amount of principal or equivalent value in equity an AT1 holder can access post writedown or conversion. The recovery rate itself should take precedence over the method by which loss is calculated. The loss absorption mechanisms can be reconceptualised in terms of potential recovery rates, as outlined below.

Conversion

In the case of a conversion to equity, the recovery rate is a function of how many shares CoCo holders receive, and the share price at and immediately post conversion. We posit a 70% decline in share price and market capitalisation from current levels at time of conversion across the board for all the banks in order to estimate a recovery rate. By standardising the stock price decline, the two drivers of recovery specific to an individual AT1 are the conversion price and the total amount of CoCos issued by a bank. The conversion/floor price can be gleaned from each prospectus. For CoCos with a convert to equities clause that contains a 'floor' in the formula, we take this to be the conversion price. The conversion or floored price is – in effect – the 'strike price' by which losses can be calculated.

To calculate the total degree of dilution, the make-up of the capital structure is taken into account. In estimating the recovery rate, the market capitalisation post conversion is adjusted by the *aggregate* amount of all the outstanding CoCo issuance for each bank. Anti-dilution measures are applied in some instances, as per covenants, but no further declines in the stock price after the conversion are assumed. The share price could be very volatile, falling further in the days after conversion or perhaps even bouncing back; however, the likelihood of a distressed bank's stock, freshly diluted, correcting in a way that quickly recoups initial losses appears rather slim. In any case, post conversion, most holders of CoCos would transfer out of the equity almost immediately given that fixed income funds generally cannot hold equity.

Writedown

The writedown mechanism has two moving parts, the degree and the duration, both of which need to be estimated. In estimating the potential recovery rate for writedowns, we take in tandem the features of degree (partial/full) and period (temporary/permanent). While the recoverable amount for a temporary/partial writedown cannot be determined precisely, it must be more than the 'zero' recover in the case of a permanent/complete writedown. Considering the scepticism of investors in writeback provisions, we have assumed a roughly '1 in 3' chance of write-up occurring. In the case of partial writedown, we assign only 25% retention of principal in our analysis. Assuming a c33% chance of writing back the principal lost, and that any writeback might be partial, we arrive at c40% $\{33\% + (66\% \times 25\%)\}$ as a rough approximation of the implied recovery rate for a combination of temporary and partial provisions. The absence of historical precedence makes estimation a

subjective exercise and hence our rough estimates should be understood as mid-points in a wide range of possible outcomes.

FINDINGS

An analysis of recovery rate across both mechanisms shows almost no correlations with pricing indicators, aside from CDS basis for AT1s (at a statistically significant c32% difference in mean). The null hypothesis is therefore accepted – the recovery rate does not appear to be a factor in risk pricing – except for the dataset of AT1s (ex T2 CoCos) by the CDS basis indicator only, for which the null hypothesis can be rejected.

FIGURE 23: RECOVERY RATE: COMBINED FEATURES FOR WRITEDOWN AND CONVERSION

| <i>Design Feature</i> | <i>Component</i> | <i>Yield to Worst (%)</i> | <i>Spread to Benchmark¹ (bp)</i> | <i>CDS Basis – Multiple² (x)</i> | <i>Total No. of Notes³</i> |
|---|------------------------|---------------------------|---|---|---------------------------------------|
| Recovery Rate – AT1s & Tier 2s | | | | | |
| | Low | 5.4% | 515.9 | 3.2 | 112 |
| | High | 5.6% | 584.9 | 2.8 | 106 |
| | Low vs High RR | -4% | -12% | 14% | |
| | Reject Ho at 5% | No | No | No | |
| Recovery Rate – AT1s only | | | | | |
| | Low | 5.5% | 570.5 | 3.7 | 95 |
| | High | 5.9% | 597.4 | 2.8 | 104 |
| | Low vs High RR | -7% | -5% | 32% | |
| | Mean difference | 0.378 | 26.935 | 0.835 | |
| | Standard error | 0.266 | 39.386 | 0.224 | |
| | T-statistic | 1.421 | 0.684 | 3.725 | |
| | Probability level | 0.157 | 0.495 | 0.000 | |
| | Reject Ho at 5% | No | No | Yes | |

Source: Credit Sights, Moody's, Fitch, Scope, Bloomberg and prospectuses.

1: To treasury of local currency, with similar maturity.

2: Zspread as a multiple of Tier 2 CDS, matched maturity (as of 20-Mar-19).

3. The number of notes may not add up to the full dataset of 223 for all features due to instances of unusual contract characteristics or missing details. The total number in each category is given for YtW and may differ somewhat for the other pricing indicators.

INTERPRETATION

In the case of conversion CoCos, the estimated recovery rate is a more accurate representation than the conversion price alone as it includes the effects of dilution. The different set of assumptions for writedown and conversion, however, makes a comparison across mechanisms difficult. Even so, the

pair t-test results suggest that the degree of loss at the capital adequacy trigger event is not a driver of risk premiums for AT1s. For the recovery rate when combining the mechanisms to have inconclusive results is counterintuitive. That said, it is still noteworthy that the recovery potential priced significantly for the CDS basis indicator; this could be due to the fact that only the largest and most liquid AT1s are issued by banks with traded CDS basis; hence, this t-test excluded some of the smaller issuers. It is therefore critical to see how this factor scores in a full regression.

4. Trigger Levels

- a) *There should be a risk premium separating high and low trigger CoCos.*
- b) *When controlling by loss mechanism, the risks associated with the trigger level should be more apparent.*
- c) *At high triggers, there should be a sharp distinction between notes with little to no recovery rates and those with reasonable recovery potential.*

H₀:

- a. *The level of the CET1 ratio trigger does not correlate significantly with pricing indicators.*
- b. *When controlled by loss absorption mechanism, the CET1 ratio trigger level does not correlate significantly with pricing indicators.*
- c. *The combination of trigger levels and implied recovery rates does not correlate significantly with pricing indicators.*

(1) Contingency triggers in isolation

RATIONALE

High triggers are intended to convert while the bank is still a going concern – activating the loss mechanism at an earlier stage of capital deterioration. This makes the exercise of a high trigger more likely – suggesting a higher premium be required to compensate investors for the greater risk.

FINDINGS

When taking the trigger level in isolation, there does not appear to be much in the price. For YtW and credit spreads there is little to no correlation at all. Only when measured by CDS basis is a relationship of some significance shown between trigger levels and the risk premium.

FIGURE 24: CAPITAL RATIO TRIGGER LEVELS COMPARISON (FULL CoCo UNIVERSE)

| <i>Design Feature</i> | <i>Component</i> | <i>Yield to Worst (%)</i> | <i>Spread to Benchmark¹ (bp)</i> | <i>CDS Basis – Multiple² (x)</i> | <i>Total No. of Notes</i> |
|---------------------------|------------------------|---------------------------|---|---|---------------------------|
| CET1 trigger (All) | 7% or above | 5.9% | 566.0 | 3.3 | 73 |
| | 5% to 7% | 5.5% | 542.9 | 2.7 | 150 |
| | 7%+ vs 5% | 7.3% | 4.3% | 22.2% | |
| | Mean difference | 0.400 | 23.106 | 0.662 | |
| | Standard error | 0.324 | 40.542 | 0.229 | |
| | T-statistic | 1.236 | 0.5709 | 2.891 | |
| | Probability level | 0.218 | 0.569 | 0.004 | |
| | <u>Reject Ho at 5%</u> | No | No | Yes | |

Source: Credit Sights, Moody's, Fitch, Scope, Bloomberg and prospectuses.

1: To treasury of local currency, with similar maturity.

2: Zspread as a multiple of Tier 2 CDS, matched maturity (as of 20-Mar-19).

INTERPRETATION

The c185bps between high and low triggers is supposed to represent the difference between 'going concern' and 'gone concern' capital. It ought to represent a fault line for risk. Yet when tested in isolation, the level of the CET1 ratio which triggers the contingency event – despite the eminence attributed to it in valuation models – does not price consistently as a discrete risk. Yields and credit spreads do not correlate with the level of the capital adequacy trigger, when tested on its own.

The faint signal when using CDS basis might reflect the somewhat superior quality of the sample data for this measure. There are fewer names disclosing CDS data, which indirectly filters out the smallest banks to create a set of larger and more liquid CoCos. It might also be the case that CDS basis is a better measure of risk for CoCos and hence more sensitive to its design characteristics.

The distance to the contingency trigger may be of greater relevance than the trigger level on its own, as the distance represents the overall strength of the credit profile. While a CoCo with a high trigger level is more vulnerable to a contingency event, this feature could be counterbalanced if a bank maintains a higher CET1/RWA ratio. From this perspective, the risk of a contingency event encompasses both the design feature of high or low trigger and the probability that the trigger is touched. It may be that the trigger level is being subsumed into the measure of the capital buffer and

the likelihood of the buffer being depleted. Such composite variables are explored in the multiple regression analysis.

(2) Triggers in conjunction with mechanisms or recovery rates

RATIONALE

The other proposition to test is whether the trigger level, as a filter, should draw out some differentiation by loss mechanism and/or recovery potential. For example, at high triggers, temporary write-down could be perceived to have better prospects of write-back given that the contingency event would occur at an earlier stage of distress. With low triggers, on the other hand, notes would convert at a later stage after very severe price declines that could make equity conversion carry a greater risk premium.

FINDINGS

When the trigger level is run in combination with the loss mechanism and recovery rates, no clear patterns appear – as summarised in Figure 25. *Split out by trigger levels, loss mechanisms show no differentiation by any of the pricing indicators.* Among the convertible CoCos, the two cases in which we can reject the null hypothesis have the ‘wrong sign’ in which the higher risk profile is priced with narrower spreads.

FIGURE 25: CAPITAL RATIO TRIGGER LEVELS COMPARISON (FULL CoCo UNIVERSE)

| <i>Design Feature</i> | <i>Component</i> | <i>Yield to Worst (%)</i> | <i>Spread to Benchmark¹ (bp)</i> | <i>CDS Basis – Multiple² (x)</i> | <i>Total No. of Notes</i> |
|------------------------------------|------------------------|---------------------------|---|---|---------------------------|
| Conversion | 7% or above | 7.0% | 658.7 | 3.7 | 40 |
| | 5% to 7% | 7.3% | 682.1 | 3.3 | 14 |
| | 7%+ vs 5% | -4% | -4% | 12% | |
| | <u>Reject Ho at 5%</u> | No | No | No | |
| Writedown | 7% or above | 4.5% | 423.4 | 2.7 | 32 |
| | 5% to 7% | 5.3% | 522.0 | 2.6 | 135 |
| | 7%+ vs 5% | -15% | -19% | 4% | |
| | <u>Reject Ho at 5%</u> | No | No | No | |
| Low Recovery (Convertible) | 7% or above | 7.2% | 677.3 | 4.1 | 29 |
| | 5% to 7% | 6.9% | 870.3 | 3.8 | 10 |
| | 7%+ vs 5% | 4% | -22% | 8% | |
| | <u>Reject Ho at 5%</u> | No | Yes³ | No | |
| High Recovery (Convertible) | 7% or above | 6.0% | 539.0 | 2.8 | 8 |
| | 5% to 7% | 6.3% | 615.4 | 3.0 | 8 |
| | 7%+ vs 5% | -5% | -12% | -7% | |
| | <u>Reject Ho at 5%</u> | No | No | No | |
| Low Recovery (Writedown) | 7% or above | 4.5% | 337.4 | 2.4 | 16 |
| | 5% to 7% | 3.8% | 357.2 | 1.9 | 32 |
| | 7%+ vs 5% | 18% | -6% | 26% | |
| | <u>Reject Ho at 5%</u> | No | No | No | |
| High Recovery (Writedown) | 7% or above | 4.5% | 561.0 | 3.0 | 16 |
| | 5% to 7% | 5.8% | 604.3 | 2.8 | 103 |
| | 7%+ vs 5% | -22% | -7% | 7% | |
| | <u>Reject Ho at 5%</u> | Yes¹ | No | No | |

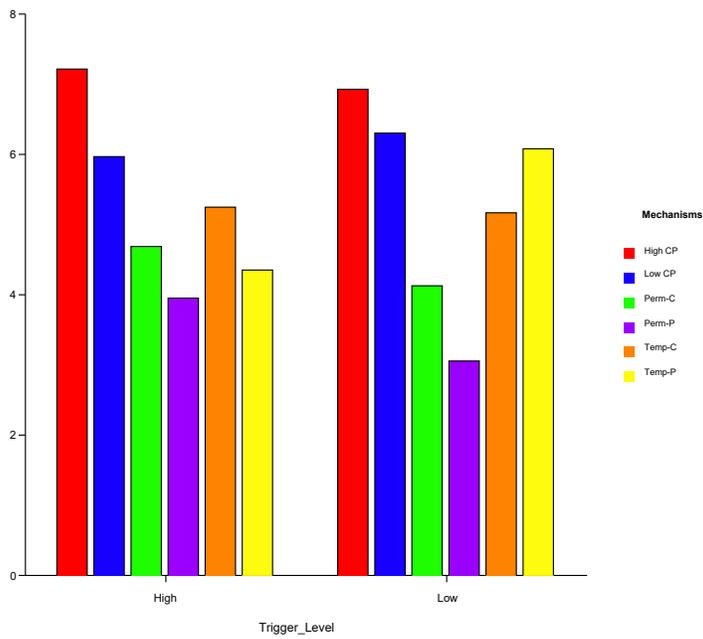
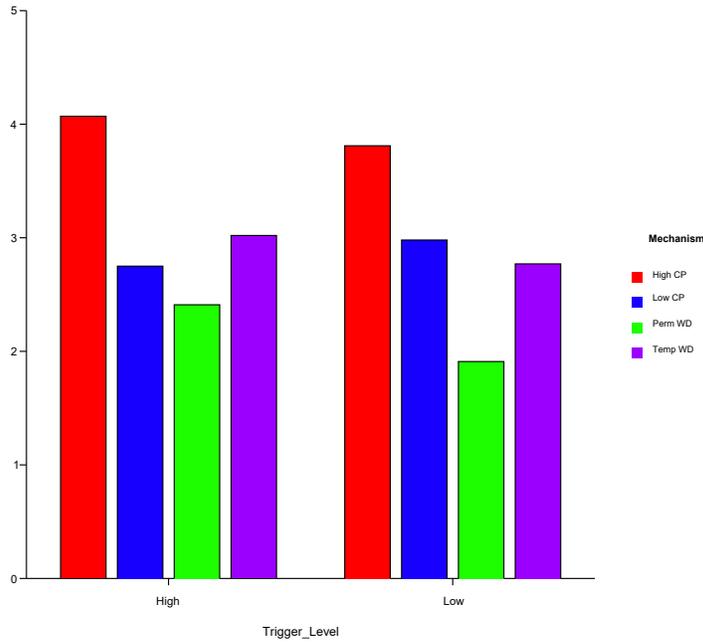
Source: Credit Sights, Moody's, Fitch, Scope, Bloomberg and prospectuses.

1: To treasury of local currency, with similar maturity.

2: Zspread as a multiple of Tier 2 CDS, matched maturity (as of 20-Mar-19).

3: On a two-sided test, the null hypothesis is rejected; however, the sign for pricing indicator is 'wrong' in relation to risk profile.

FIGURE 26: CAPITAL RATIO TRIGGERS BY KEY RECOVERY RATE FEATURES, CDS BASIS



Legend:

CP = conversion price (high implies low recovery); WD = writedown;

Perm = permanent; Temp = temporary;

C = complete (full writedown to '0');

P = partial (staggered writedown in stages)

Source: Data from Credit Sights, Moody's, Fitch, Scope, Bloomberg and prospectuses. Our analysis.

INTERPRETATION

The significance earlier attributed to conversion prices looks less clear in the filtering by trigger level. Collinearity may be muddying the waters given the overrepresentation of Swiss, UK and Danish names in the high trigger category; and this imbalance also means a high trigger tends to be associated with a conversion mechanism. When controlled by conversion mechanism and implied recovery rate, the level of the capital adequacy trigger begins to be reflected in the risk pricing. The two bar graphs above show the beginnings of a pattern, with the conversion price maintaining its differentiation when the trigger level is added and some dispersion for permanent writedown (although not significantly so). Temporary writedown is by far the largest category for CoCos and, as mentioned earlier, therefore the most diverse; it is likely the wider range of credit profiles for issuing banks makes this category insensitive to a single feature. With multiple regression in the next section, we aim to identify stronger signals.

Overall summary

We find that the high/low trigger levels give almost no signal, with only slight signs when using the CDS basis as the dependent variable. *That there is almost no clear pricing pattern for high and low trigger thresholds is quite striking, given the commentary that one is 'going' and the other 'gone concern' capital.* Factors associated with recovery potential get mixed results. A higher conversion price does appear to be associated with greater risk premiums, albeit this is a faint signal. Notes with partial writedown or writeback clauses price as riskier than those without – which does not make sense. This indicates collinearity is overriding any influence from the clauses for the period and degree of writedown. Pricing patterns do differ sharply between CoCos with discretionary coupons and perpetual maturity (AT1s) versus those with mandatory coupons and fixed tenors (Tier 2), which suggests coupon and extension barriers are the most distinguishing characteristics.

VII. Multiple Regression Analysis

A. Methodology

Our t-tests call into question the very notion that design features related to the CET1 trigger are key pricing determinants. The sole reliable finding from the t-tests is the significant gap in risk premium between the two types of CoCos – Additional Tier 1 versus Tier 2. This gap raises the prospect of coupon and extension characteristics being of greater importance, given these features only apply to AT1 CoCos. Considering the significant difference in risk pricing, and the market’s waning interest in T2 CoCos, we reorient our analysis to focus solely on AT1 CoCos.

Our aim in this section is to evaluate the pricing mechanism in relation to assumptions made in the valuation models.

Is it valid to assume that all features of the AT1 CoCo contracts influence pricing? To answer this question, we exam the explanatory power of operational variables to reflect the risks related to principal loss, coupon omission and maturity extension are defined in Figure 27.

FIGURE 27: EXPLANATORY (INDEPENDENT) VARIABLES

| <i>Analysis</i> | <i>Barrier</i> | <i>Variable</i> | <i>Description</i> |
|------------------------|--------------------------------|---|--|
| Paired T-Tests | <u>Tier Ranking*</u> | Tiering | Ranking in the capital structure as either Tier 2 or Additional Tier 1 |
| | | <u>Principal Conversion</u> | |
| | | Trigger | 5.125% versus 7% and above |
| | | Loss mechanism | Principal writedown or equity conversion |
| | | Conversion price | Fixed or floored (floating type is included with floored) |
| | | Conversion ratio | Low or high (the lower the ratio, the fewer shares post conversion) |
| | | Period of writedown | Temporary or permanent |
| | | Degree of writedown | Partial or complete |
| | | Recovery rate | Estimated based on conversion ratio or period and degree of writedown |
| Cross-sectional | <u>Principal Conversion</u> | | |
| | | WDC buffer | Distance of current CET1 ratio to CET1 trigger level for the write-down or conversion of principal |
| | <u>Coupon Omission</u> | | |
| | | MDA cushion | Distance of current CET1 ratio to SREP ratio, which defines the MDA threshold (difference between available CET1 and combined buffer requirements) |
| | | ADI cover | Annual coupon payments as a multiple of reported distributable items |
| | | ADI cover - LN | Natural log of ADI cover |
| | <u>Maturity Extension</u> | | |
| | | Reset ratio | Backend rate as a ratio of the current z-spread |
| | | Time to first call | Time remaining to the next call date as measured in years |
| | | Time to first call - Squared | Square of time remaining to the next call date |
| | Call schedule frequency | Time to subsequent call if first call date is skipped | |
| | <u>Credit Profile</u> | | |
| | Agency rating | Rating by a major rating agency (Fitch, S&P, Moody’s) as standardised | |

* Tier 2 CoCos have fixed maturities and compulsory coupons whereas AT1 CoCos are perpetual with discretionary coupons.

We run a series of multiple regressions to check whether the independent variables have any effect at all. The count is c135 representative AT1 notes, with further notes included where relevant. Our methodology is to remove one by one those variables with the highest P-values and the lowest R-squared (R^2), after manually checking the graphical distribution to ensure that the pattern of datapoints has a sound conceptual basis. The steps of this method can be summarised as follows:

1. The P-value is given priority as a test of significance. The P-value gives an indication of how extreme the coefficient is if the population is zero, i.e., the probability of the coefficient occurring at random. If the P-value is less than the level of significance – generally 5%, in our research – then we can reject the null hypothesis.
2. We use R^2 primarily as a filter for selecting promising independent variables. R^2 is an initial guide by which to gauge the proportion of variation ‘explained’ in the dependent variable by the continuous variable. A value of R^2 near zero indicates a complete lack of fit, whereas a higher R^2 is associated with greater explanatory significance. That said, the closeness of fit to a line may not necessarily tell the whole story.
3. We check scatter plots and histograms carefully, in some cases running 3D plots that combine explanatory variables on x and z axes against a dependent variable on the y axis, to see if patterns exist that are not strongly reflected in the linear fitted tests. R-squared represents the degree of scatter around the regression line, but for noisy data there may still be a trend even though the R^2 value is somewhat low.
4. The *adjusted* R-squared, which measures the increase in explanatory power in relation to each additional variable, is also considered in the selection of one among two highly correlated variables. The matrix of correlation is also utilised in our evaluation. For highly correlated variables, the one with the highest R^2 *if regressed separately* is generally selected.
5. We include an analysis of variance (ANOVA) to determine the effects of each variable. Here, a higher F-value is a sign of significance. As values of F increase above 1, the evidence is increasingly inconsistent with the null hypothesis.

By following the above steps, we are able to identify as significant the specifications captured in this core equation:

$$\text{Basis}_i = \alpha + \beta_1(\text{WDC Buffer}_i) + \beta_2(\text{MDA Cushion}_i) + \beta_3(\text{ADI Cover}_i) + \beta_4(\text{Reset Ratio}_i) + \beta_5(\text{First Call}_i) + \beta_6(\text{Agency Rating}_i) + \varepsilon_i$$

We next overview our hypotheses, rationales and metrics – then summarise our findings.

B. Main Regression Variables

A. Principal Write-Down/Conversion Buffer

1. *The distance to the CET1 ratio trigger for principal write-down/conversion should be inversely related to credit spreads.*

Ho: The distance between the current CET1 ratio and the capital adequacy trigger level does not have a significant correlation to credit spreads, yields or CDS basis.

RATIONALE

The CET1 buffer measures how far a bank's CET1 ratio needs to fall in order to touch the threshold for triggering the write down or conversion of an AT1's principal. Regulatory capital is accepted as the primary indicator of a bank's health and a higher CET1 ratio is generally seen to suggest a stronger credit profile. A greater distance from the current CET1/RWA ratio to the trigger level should reduce the likelihood of a contingency event. As such, a larger CET1 buffer should be associated with a narrower credit spread, higher yield and lower basis.

METRICS

CET1 Buffer

We compute for each bank the distance from the CET1 ratio to the contingent barrier for a write-down/conversion (WDC) of an AT1's principal:

- Distances are compared in basis points to avoid distortions from bank size.
- The group CET1/RWA ratio is referenced, unless covenants specify otherwise.
- Both phased-in and fully loaded levels are considered – for CET1 and SREP ratios.

This buffer takes into account two elements, the variation in CET1 ratios across banks and in trigger levels across instruments, to determine if the distance narrowing acts to catalyse the pricing.

Expressing the capital buffer as a percentage point is common across the industry but as a testable variable the relationship may also be expressed as a ratio. For example, in the table below Bank A has a CET1 ratio of 13% and a trigger level of 7% and thus a buffer of '6%' – meaning '6 percentage points' or 600 basis points. If we restate this in terms of a ratio, when comparing across banks, this gives greater prominence to the trigger level. For example, in the table below, Banks A and Bank B have the same distance in basis points but the one with a higher trigger level has a ratio closer to the

‘1x’ at which a contingency event would occur. The shortcomings of the ratio, however, is that it can flatter a relatively troubled bank that has a low trigger. The table also shows Banks C and D with ratios of 2x; this makes their risks appear the same, even though one has a lower CET1 ratio. In sum, both spread and ratio metrics have their merits. Though we make use of both ways of expressing the capital buffer, the spread tends to be more sensitive in picking up signals for the principal write-down/conversion barrier due to the acceleration in risk perceptions as the CET1 ratio nears 200bps for 7% trigger AT1s – a point perilously close to the implied PONV.

FIGURE 28: CAPITAL BUFFER METRIC AS SPREAD VS RATIO

| | <i>Bank A</i> | <i>Bank B</i> | <i>Bank C</i> | <i>Bank D</i> |
|--------------------|---------------|---------------|---------------|---------------|
| Current CET1 ratio | 13% | 11% | 14% | 10% |
| Trigger level | 7% | 5% | 7% | 5% |
| Distance | 6 ppt | 6 ppt | 7 ppt | 5 ppt |
| Distance (ratio) | 1.86x | 2.2x | 2x | 2x |

B. MDA-ADI Barriers

The MDA cushion in combination with the ADI cover should strongly influence the prospects of coupon cancellation. *Both measures can constrain coupon payments and thus operate as separate variables.* Due to differences in national accounting practices it is quite possible to have CET1 comfortably in excess of the combined buffers but still lack adequate distributable reserves – or vice versa.

For this exercise, only issuers with MDA and ADI figures are included – either published or estimated. It is essential that the methodology for calculating the MDA and the ADI be consistent, such as the use of transitional or fully loaded values; this entails working with one data source at a time. Given that we have access to several databases, there was a temptation to create a ‘superset’ to get the maximum number of issuers. However, the regressions were run in a series of instances rather than with a single, combined dataset as this is the only way to get reliable results. It is especially important for the CET1 ratio be from the same source as the SREP ratio – otherwise the MDA cushion calculation will not be calculated consistently across all issuers. Although each regression is consequently a bit smaller, the benefit of this approach is the ability to cross check the results across several iterations measured at different reporting dates.

MDA Cushion

1. *The AT1s issued by a bank with risk weighted capital close to its combined buffers should be perceived as having greater coupon omission risk.*

Ho: The distance between the current MDA calculation and the level at which coupon restrictions occur does not have a significant correlation to credit spreads or CDS basis.

RATIONALE

The combined buffer requirements of European banks are set by the European Central Bank. From a market discipline perspective, AT1s issued by credit institutions with smaller margins to breaching their requirements should be less preferable to the notes of banks better capitalised. Breaching the combined buffers may lead to a partial or full restriction on coupon distributions; this connection to the loss potential of an AT1 note should be picked up in a note's risk pricing.

METRIC

A SREP ratio is calculated according to the ECB's "supervisory review and evaluation process" methodology – this calculation is used to determine the combined buffer requirement. The combined buffers sit on top of a shifting stack of regulatory capital and its required overall level sets the trigger point for calculating the maximum distributable amount (MDA). The SREP ratio is calculated by taking the lowest of the CET1, Tier 1 and Total Capital ratios. The SREP calculation takes account of any CET1 capital that must be utilised to cover shortfalls in AT1 and Tier 2 capital to meet minimum capital requirements. If a bank has not issued at least 1.5% of AT1 or up to 2% of Tier 2, any shortfall below those percentages will raise the threshold. To be precise then, the MDA cushion measures the amount of the *available* CET1 capital above the MDA threshold, at which point AT1 coupon restrictions kick in – as illustrated in the case of BNP below, the cushion is 151 basis points (a current capital ratio of 11.74% minus the SREP ratio of 10.23%).

FIGURE 29: MDA CUSHION – SAMPLE CALCULATION, BNP PARIBAS (Q3 2018)

| <i>Financial statement</i> | <i>Transitional</i> | <i>Fully Loaded¹</i> | <i>Comments</i> |
|---|---------------------|---------------------------------|--------------------------------------|
| Common Equity Tier 1 (CET1) ratio | 11.75% | 11.74% | |
| SREP CET1 Requirement | 9.55% | 10.23% | |
| MDA threshold based on CET1 only ² | 9.16% | 9.83% | |
| MDA Threshold ³ | 9.55% | 10.23% | Figure used to calculate MDA cushion |
| Base Common Equity Tier 1 | 4.50% | 4.50% | |
| Capital conservation buffer | 1.875% | 2.50% | |
| Countercyclical buffer | 0.03% | 0.08% | |
| Systemic risk buffer | 0.0% | 0.0% | |
| G-SIB or D-SIB buffer | 1.50% | 1.50% | |
| Pillar 2 Requirement | 1.25% | 1.25% | |
| Additional Tier 1 as % of RWAs | 1.34% | 1.34% | |
| Tier 2 as % of RWAs | 1.76% | 1.76% | |
| Shortfall in AT1 v. 1.5% of RWAs | 0.16% | 0.16% | |
| Shortfall in non-CET1 capital v. 3.5% of RWAs | 0.24% | 0.24% | |
| CET1 cushion above MDA restrictions % | 2.20% | 1.51% | MDA cushion for regression analysis |
| CET1 cushion above MDA restrictions (€mn) | 14,199 | 9,740 | |

Source: Credit Sights and Fitch, as of 30 September 2018.

1. On basis of projected fully phased-in requirements, for 2019 or thereafter.
2. Calculation assumes no CET1 capital is being used to meet minimum Tier 1 and total capital requirements.
3. Calculation *takes into account* any CET1 capital used to meet minimum Tier 1 and total capital requirements.

The dynamic of the MDA cushion reflects *two* moving parts: the bank's available CET1 and its MDA threshold, which will rise and fall as informed by the SREP ratio and the composition of a bank's capital stack. Distances to the combined buffer requirements are compared in basis points to avoid distortions arising from differences in the size of bank holdings or in currency translations.

The MDA cushion can be used as a metric on its own (in basis points) or expressed as a percentage of risk-weighted assets – i.e., $(CET1 - SREP) / RWA$. Expressed the latter way better reflects RWA sensitivity but also makes the metric more challenging to interpret. As such, we stick with the spread metric in our regressions. Note that the MDA trigger is not a binary switch; once the MDA threshold is touched the restrictions apply in graduated degrees such that a bank might not have to cut all AT1 coupons at once – it could be able to make partial payments.

ADI Cover

1. *The AT1s issued by a bank with limited Available Distributable Items should be perceived as having greater coupon omission risk.*

Ho: The amount of ADIs relative to the total demand for interest payments on CoCos does not have a significant correlation to credit spreads or CDS basis.

RATIONALE

Coupons are paid out of Available Distributable Items (ADIs). These are the reserves to draw on for making discretionary payments for dividends, employee bonuses as well as AT1 coupons. To pay the annual interest payment on all outstanding AT1 and T2 CoCos, ADIs must be at sufficient levels.

We need to consider the total amount of distributable items available to pay coupons, with regards to the total payment demands in terms of coupons on outstanding AT1s. It should be noted, however, that while this calculation of ADI cover gives an indication of availability it does not evaluate the quality of the items. In some jurisdictions, accounting methods allow for the booking of deferred tax losses and other forms of complex provisioning that might obscure the profits actually available for distributions.

METRICS

1. ADI cover

To quantify a bank's ability to pay coupons on its AT1s we use a measure of 'coupon cover'. To compare levels across banks, we express ADIs as a percentage of each bank's outstanding contingent capital securities. In the calculation of interest payments, the aggregated issuance reflects all the coupon paying CoCos issued by the bank. Even though T2 CoCos are not subject to coupon omission, there is some ambiguity on the possibility of T2s making a demand on ADIs and so we err on the side of caution and include T2 CoCos in our calculations of ADI cover. *The number of times the annual interest payments on CoCos could be paid out with existing reserves constitutes the degree of coupon cover, i.e. this is a ratio of ADI to annual coupon obligations.*

A bank may have a number of AT1 notes, each issued with a different coupon. To allow for a clearer expression of risk by instrument, ADI cover can also be calculated for each AT1 issuance. The intuition with this approach is that a high coupon paying AT1 will make a greater demand on reserves than a lower paying coupon, even if from the same issuer. Both approaches, taking ADI cover by issuer or by issuance, are conceptually sound; however, ADI cover by issuance picks up specific characteristics (e.g., the coupon size and the amount of face value) between notes from the same issuing bank and so is our preferred method.

Another method is to calculate the ratio of distributable items to the amount of AT1s issued. This approach is an approximation as it does not consider the coupon obligation, which can vary from a

few percent per annum to well into the teens. As such, we prefer the precision of calculating with the actual coupon payment across all outstanding notes.

2. ADI cover - LN

This is the same metric as ADI cover but with a natural log. The reason to use the log is to address the extreme range of values, with outliers on both the low and the high end. For example, the ADI cover for Deutsche Bank as an issuer is c3x whereas for ING Group it is c200x; taken as a log this becomes c1.1x vs c5.3x. A log transformation thus reduces the influences of these extremes and improves the predictive potential of our observations.

C. Reset and First Call Barriers

1. *AT1s with higher backend rates are more likely to be redeemed at their first call and will therefore price with tighter spreads and lower basis.*

Ho: The reversionary 'reset' ratio (backend spread vs z spread) does not correlate significantly with yields, credit spreads or CDS basis.

RATIONALE

AT1s with a forward coupon higher than their present z spread (plus benchmark) make economic sense to refinance and, barring intervention from the regulator, a bank is likely to call such notes.

As a rule of thumb, AT1s with high backends should have a higher probability of being called relative to those with low backends. However, as the decision to call takes place in the future – in some cases many years hence – in assessing the probability of a call it is essential to bear in mind the beta of a bank's AT1s' spreads to broader market moves as well as an AT1's own historical volatility. *This is a strikingly different from the measures of regulatory accounting ratios, as the reset spread is in effect a market implied trigger – and therefore capable of continuous monitoring and valuation.* Non-call prospects can be monitored by comparing the backend spread with swaps in the secondary market, which will give an indication of the likely future spread for a new offering. In this way, bank management, the national authority and AT1 investors can continuously assess the economics of a call or non-call decision.

METRIC

Reset ratio (Backend/Z-spread)

The closer the contractual reset relative to the current z-spread, the greater the risk. If the reset spread is lower than the latest zspread the bank may elect to skip a call to avoid refinancing at a higher interest rate. The relationship can be understood as a spread but for analytical purposes is better expressed as a multiple. The higher the reset/zspread ratio the more likely the notes are to be called; at 1x the risk is finely balanced and below parity there is a clear risk of a non-call. The use of a ratio allows for clustering into more meaningful categories, as rebasing by a denominator serves to standardise the data for comparison across notes issued under very different financing conditions.

2. *AT1s with less time to first call dates should price with more risk.*

Ho: The time remaining until the first call does not correlate significantly with credit spreads or CDS basis.

RATIONALE

The remaining years to the first call date should factor into an evaluation of the likelihood of redemption. As is the case with call and put options, there is a non-linear dimension to theta.

METRIC

Time to First Call

This metric is stated in terms of the *number of non-call years* left, e.g. 18 months to the first call date is expressed as 1.5 years. Given the non-linear nature of this metric, we also include a version in which the time remaining is squared.

D. Agency Ratings (Fundamentals/ Credit Profile)

1. *Instruments with lower agency ratings ought to price with higher risk.*

Ho: The agency rating does not correlate significantly with pricing indicators.

RATIONALE

Perceived as a form of debt, AT1s should show interest rate sensitivity and a degree of dependence on credit risk. Therefore, an issuer's credit fundamentals should offer some indication of the likelihood of incurring losses. Fundamental factors such as leverage, non-performing loans to total assets, free cash flow, return on assets and similar such familiar financial measures are all likely to have a bearing on risk pricing. Rather than test each of these individually, given there is already a

large body of research supporting the application of such metrics in the valuation of securities, we include as an aggregator variable the ratings per security by the main agencies.

The agencies compare CET1-related buffers relative to peers but base their risk assessment on fundamentals rather than trigger levels or loss mechanisms, which are regulatory driven. Agency ratings will therefore reflect the fundamentals of the issuer, such as its cashflow (EV/EBITA ratio), but *not the specific design features of an AT1 note*. Even factors such as *extension risks are excluded by the agencies* in their designation of a rating. Given that specific features are not incorporated, the rating by itself expresses only part of the overall opinion as agencies convey much of their assessment in risk discussion in written commentary.

For context, it is worth noting that issuers pay rating agencies for coverage; that is how the agencies fund their research. Hence, there is a potential conflict of interest that needs to be finely managed. Ex-employees of rating agencies are peppered across the origination and trading desks of banks, and thus the criteria by which ratings are established are widely understood – and this creates possibilities for ‘gaming’. It is partially to reduce the scope for gaming that the Federal Reserve refuses to release the full details of its stress testing model, to reduce the avenues by which the metrics can be anticipated and steps taken to recalculate in advance.

METRIC

The credit ratings are standardised by assigning a number that ranges from 1 to 9. The majority of AT1 notes range from B- to BBB+ (S&P and Fitch) or from B3 to Baa1 (Moody’s). If only one rating agency has rated the bond, then the bond’s rating equals that value. If more than one rating agency has rated the bond, the value of a given bond’s rating is the average of these ratings.

With the lack of precedents, it is difficult for agencies to assess a scenario in which AT1s default without the whole bank defaulting. This conundrum is expressed in the typical ratings being ‘high yield’ on individual AT1s even though most of the issuers are rated ‘investment grade’. The implication is that the probability of default on CoCos should be similar to that of other high yield rated bonds. But the lack of cases of CoCos triggering presents a challenge for agencies in evaluating the prospects of AT1 conversion compared to default on bonds in the rest of the high yield market. We thus have the anomaly of ‘high yield’ ratings on the securities of an investment grade issuer, despite the seemingly remote prospects of firing an AT1 independently.

C. Findings from Cross-Sectional Regressions

In the summary table below, the T-statistic measures the size of the difference relative to the variation in our sample data. It is the regression coefficient divided by the standard error, in effect a ‘standardised’ coefficient represented in units of standard error. The greater the magnitude of the T-stat – positive or negative – the less likely the null hypothesis and therefore the more significant the variable. The probability levels show the likelihood of attaining the given T-stat when sampling. We take 5% as the limit by which to establish significance and eliminate the variables that do not fall within this range. The averaged results present relatively high T-stats for the key variables identified, indicating a decent accuracy of the coefficient estimates and sign in the appropriate direction.

Based on our regressions, there are the only six parameters that show a statistically significant impact on AT1 spreads, with reasonably high precision. Somewhat surprisingly, most of the key variables emit weak signals with only extension-related measures showing a robust relationship to risk pricing. We summarise the results here, discussing them in greater detail in the chapters on interpretation.

By following the process of elimination outlined earlier, we can remove the recovery rate and its associated features such as conversion/floor prices and partial/temporary write-down clauses. That the recovery rate is not a factor in risk pricing is an important finding of our research as it suggests that methodologies which dwell on calculating a recovery rate are modelling for something that investors do not currently factor into their pricing. (For a description of our approach to estimating recovery rates across the two types of loss mechanisms, see the previous section on t-tests.) It is also notable that the type of loss mechanism – conversion versus writedown – gets completely subsumed into other variables. This finding calls into question the view that risk-shifting motivations vary by mechanism, which was discussed at length in the chapter on incentives. Most likely the lack of a signal from the type of loss mechanism is due to the underlying failure for the recovery prospects to feature as a factor in pricing. It is also worth noting, though it comes as no surprise, that the level of the capital adequacy trigger is in no way significant as both of the levels in use at present are extremely low. What is rather puzzling is that the frequency of the reset post first call does not price. The reset frequency may start to feature at significance levels in future though, if call skips become more commonplace.

FIGURE 30: REGRESSION COEFFICIENTS T-TESTS (BY CDS BASIS)

| Independent Variable | Regression Coefficient | Standard Error | Standardised Coefficient | T-Statistic to Test | Probability Level | Reject H0 at 5%? | Power of Test at 5% |
|---------------------------|------------------------|----------------|--------------------------|---------------------|-------------------|------------------|---------------------|
| Intercept | 844.4 | 105.5 | 0.00 | 8.00 | 0.000 | Yes | 1.00 |
| WDC Buffer | 3104.1 | 1143.8 | 0.26 | 2.71 | 0.008 | Yes | 0.77 |
| MDA Cushion | -2218.6 | 1115.7 | -0.19 | -1.98 | 0.048 | Yes | 0.51 |
| ADI Cover | -8.4 | 4.2 | -0.16 | -2.00 | 0.047 | Yes | 0.51 |
| Reset Ratio | -140.9 | 16.1 | -0.69 | -8.73 | 0.000 | Yes | 1.00 |
| Time to First Call | -23.9 | 6.5 | -0.29 | -3.69 | 0.000 | Yes | 0.96 |
| Agency Rating | -7.2 | 1.7 | -0.28 | -4.24 | 0.000 | Yes | 0.90 |

Note: The CDS basis taken is to the matching maturity of the Tier 2.

FIGURE 31: REGRESSION R-SQUARED RESULTS (BY CDS BASIS)

| Independent Variable | Total R ² for this IV and IVs Above | Increase in R ² if this IV Included with IVs Above | Decrease in R ² if this IV was Removed | R ² if this IV was Fit Alone | Partial R ² if Adjusted for All Other IVs |
|----------------------|--|---|---|---|--|
| WDC Buffer | 0.0% | 0.0% | 2.9% | 0.0% | 5.6% |
| MDA Cushion | 4.9% | 4.9% | 1.6% | 2.6% | 3.1% |
| ADI Cover | 11.8% | 6.8% | 1.6% | 5.5% | 3.1% |
| Reset Ratio | 36.1% | 24.4% | 30.1% | 28.4% | 37.9% |
| Time to First Call | 43.6% | 7.5% | 5.4% | 0.8% | 9.8% |
| Agency Rating | 50.7% | 7.1% | 7.1% | 12.0% | 12.6% |

Note: The CDS basis taken is to the matching maturity of the Tier 2.

FIGURE 32: ANOVA RESULTS (BY CDS BASIS)

| Independent Variable | Degrees of Freedom | R ² Lost if Term(s) Removed | Sum of Squares | Mean Square | F-Ratio | Probability Level | Power (5%) |
|---------------------------|--------------------|--|----------------|------------------|---------------|-------------------|--------------|
| Model | 6 | 50.7% | 2423414 | 403902.4 | 21.406 | 0.000 | 1.000 |
| WDC Buffer | 1 | 2.9% | 138959 | 138958.6 | 7.364 | 0.008 | 0.7682 |
| MDA Cushion | 1 | 1.6% | 74605 | 74605.3 | 3.954 | 0.048 | 0.5053 |
| ADI Cover | 1 | 1.6% | 75574 | 75573.6 | 4.005 | 0.047 | 0.5104 |
| Reset Ratio | 1 | 30.1% | 1438246 | 1438246.0 | 76.224 | 0.000 | 1.000 |
| Time to First Call | 1 | 5.4% | 256631 | 256630.7 | 13.601 | 0.000 | 0.9554 |
| Agency Rating | 1 | 7.1% | 338910 | 338909.7 | 17.961 | 0.000 | 0.9876 |
| Error | 125 | 49.3% | 2358598 | 18868.8 | | | |
| Total (Adjusted) | 131 | | 4782012 | 36503.9 | | | |

Note: The CDS basis taken is to the matching maturity of the Tier 2.

FIGURE 33: MATRIX OF CORRELATION: REGRESSION VARIABLES AND T2 CDS BASIS

| | WDC Buffer | MDA Cushion | ADI Cover | Reset Ratio | Time to First Call | Agency Rating | T2 CDS Basis |
|--------------------|------------|-------------|-----------|-------------|--------------------|---------------|--------------|
| WDC Buffer | 1.00 | 0.71 | 0.55 | 0.08 | -0.10 | 0.09 | 0.00 |
| MDA Cushion | 0.71 | 1.00 | 0.44 | 0.05 | -0.07 | 0.27 | -0.16 |
| ADI Cover | 0.55 | 0.44 | 1.00 | 0.20 | -0.12 | 0.13 | -0.23 |
| Reset Ratio | 0.08 | 0.05 | 0.20 | 1.00 | -0.59 | -0.03 | -0.53 |
| Time to First Call | -0.10 | -0.07 | -0.12 | -0.59 | 1.00 | 0.13 | 0.09 |
| Agency Rating | 0.09 | 0.27 | 0.13 | -0.03 | 0.13 | 1.00 | -0.35 |
| T2 CDS Basis | 0.00 | -0.16 | -0.23 | -0.53 | 0.09 | -0.35 | 1.00 |

Note: The calculation of the CDS basis takes the matching maturity of the Tier 2 to the time remaining to first call on the AT1s.

Retained variables

As cited earlier, these independent variables form our core regression equation:

$$\text{Basis}_i = \alpha + \beta_1(\text{WDC Buffer}_i) + \beta_2(\text{MDA Cushion}_i) + \beta_3(\text{ADI Cover}_i) + \beta_4(\text{Reset Ratio}_i) + \beta_5(\text{First Call}_i) + \beta_6(\text{Agency Rating}_i) + \epsilon_i$$

WDC BUFFER

The distance to the trigger for writedown or conversion of principal (“WDC buffer”) gives a weak signal that is far from statistically robust. The R-squared and F-ratio suggest this variable is of limited relevance. So, it can hardly be viewed as the main variable to model in a valuation.

MDA CUSHION

The MDA cushion does register some significance but also sends a rather weak signal. We see little evidence for the proposition that the distance to the combined buffer requirements is particularly relevant for pricing indicators. That said, considered in combination the MDA cushion and ADI cover overshadow the WDC buffer.

ADI COVER

ADI cover appears to be a more important variable than the MDA cushion in pricing in the prospects of an issuer skipping a coupon. That said, the signal is not very strong, though the significance of ADI cover increases somewhat when taken as a natural log.

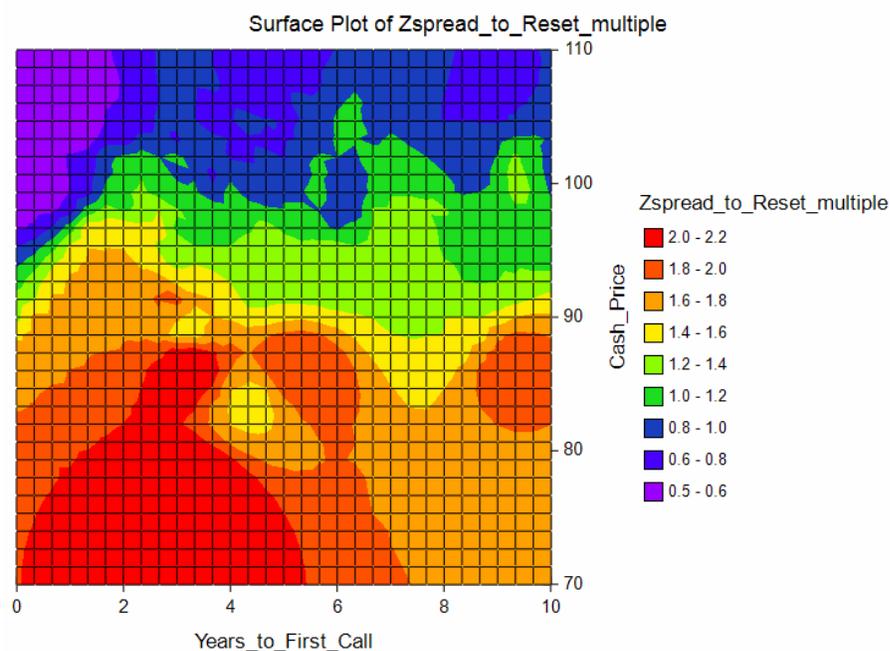
RESET RATIO

The back-end spread appears to be the primary driver of AT1 pricing. Note that higher reversionary rates reflect the credit profile of the issuer and/or the risk regime at issuance. Therefore, the reset ratio is

likely to interact with the time remaining to the first call, giving greater urgency to the relationship as the decision on whether or not to refinance will be more pressing if the call date is relatively soon.

In the surface plot shown in Figure 34, the mound coloured in red indicates a cluster of AT1s at the two- to three-year mark with zspreads much higher than backend resets and prices trading well below par. This combination appears to be a recipe for a call skip. *The dual risk of a relatively low reset ratio in combination with a first call in the near future is clearly being reflected in pricing indicators.*

FIGURE 34: RESET RATE AND TIME TO FIRST CALL VS CDS BASIS – 2D IMAGE



Source: Moody's, Fitch, Scope and Bloomberg.

AGENCY RATINGS

Agency ratings show a relatively high R-squared and very low P-values. The capital and leverage ratios are likely being picked up as significant information, with a degree of multicollinearity with the CET1-related variables. In particular, *the agency ratings may be stealing the thunder somewhat from the MDA cushion.* The matrix above shows the MDA Cushion with a correlation of 0.27 to the Agency Rating, but only -0.03 for the Reset Ratio.

In interpreting the findings, it is essential to bear in mind the methodology of the rating agencies. They do consider coupon non-payment to be an event applicable to an issue's credit rating;

therefore, the distance to the SREP-MDA threshold is a consideration in evaluation of risk and the assignment of a rating. Moreover, the assessment is forward-looking, as the agencies forecast expected profitability and capital retention based off of the capital targets announced by bank management. Omission of interest payments qualifies as a form of default despite being a contractual right, therefore coupon non-payment risk is reflected “by applying a gap of at least four notches between the stand-alone credit profile (SACP) of a bank and the ratings on its AT1 hybrids”, ([S&P, 2000](#)). However, while coupon risk is notched for, *agencies do not notch for non-call risk*: “Extension risk is not factored into our ratings, but AT1 issuance is central to capital planning at many banks”, ([Fitch, 2016](#)).

VIII. Time Series of Market-Implied Proxies

Positive monotonicity – A core assumption

The CET1/RWA ratio has no ‘continuous market pricing’. There is no publicly disclosed daily update but only quarterly or in some cases semi-annual disclosures. To calculate the theoretical price of a CoCo bond, market-implied models take as inputs easily observable share prices and their volatility to proxy for changes in the CET1/RWA ratio levels. Market-implied models use the high frequency equity data as a proxy for two purposes: 1) as a substitute for the CET1 ratio, to predict the triggering of a conversion event and 2) as a means to estimate the potential recovery rate. For example, as outlined in the seminal paper by De Spiegeleer and Schoutens, the equity derivatives approach models the triggering process by taking the share price as a fitting parameter:

An accounting trigger where a core Tier 1 ratio drops below a minimum level, could be replaced by an equivalent event where the stock price drops below a barrier S^* . Linking a market trigger S^* to an accounting trigger.” (2011)

The established CoCo valuation techniques tend to rely on this ‘proxy logic’ that assumes not only a close correlation between a bank’s share price and its capital ratios but *monotonicity*, in which if the equity value is rising or falling the capital ratios follows in the same direction. Albul et al. (2013) in their paper on market-implied conversion triggers state that a core conditions for the approach to be valid: is “monotonicity of equity value” with the capital ratios. This is explained as a one-to-one correspondence between equity value and asset value, which allows for the share price to replicate the conversion trigger. The market-implied techniques thus rely on a simplifying assumption, that there is a close correlation between equity and core capital, by which the CET1/RWA ratio can be modelled as a function of the share price (or market capitalisation).

A. Market-implied proxies for the CET1 ratio

1. A positive monotonic relationship exists between a bank’s CET1 ratio and its share price.
2. A stable correlation exists between CET1 ratios and AT1 spreads across market regimes.
3. AT1 are closely correlated with the sovereign debt of their issuing bank’s country of domicile, reflecting the supervisory-bank nexus.

H₀:

- a. A bank’s CET1 ratio and its share price do not have a positive monotonic relationship.
- b. A bank’s CET1 ratio does not correlate significantly with its AT1 CoCo’s spreads.
- c. AT1 notes do not correlate significantly with sovereign debt.

RATIONALES

CET1 ratio and share price

Almost all CoCo valuation models developed to date depend on share price movements to estimate both the probability of triggering conversion and the subsequent recovery rate. In some approaches, estimates of deeply ‘out of the money’ puts are backed out of CDS spreads, i.e., a proxy is used to get a value for another proxy.) As the CET1/RWA ratio parameter is not directly observable outside of quarterly or bi-annual disclosures, these ‘market implied’ models posit that the capital ratio falling below a trigger level can be *inferred* by an issuer’s share price performance. This assumption prevails as a means by which to calibrate an infrequently available accounting measure to a continuously observed, readily available datapoint. *The accounting-based trigger is thereby translated into a market trigger.*

CET1 ratio and AT1 spreads

Given that the underlying philosophy of the Basel III Accords is that market discipline can be encouraged by requiring adequate levels of regulatory capital as measured by the CET1 ratio, and that this is the premise on which AT1 CoCos were created, one would expect to see a fairly strong correlation between capital ratios and CoCo pricing indicators. That said, the infrequent disclosure of capital ratios makes such metrics only an approximation as between quarterly reporting there may be many macro developments that will also influence the perception of likely changes in the credit profile of the issuer and these views will shape the pricing behaviour of the instruments.

AT1 spreads and sovereign bonds

In light of the close dialogue between national authorities and the banks within their jurisdiction and the various linkage through these institutions’ holdings of the sovereign debt of the governments of the countries in which they are domiciled, one would expect to see some correlations emerge. The banks within the Europe are generally thought of in terms of ‘core’ and ‘periphery’, which loosely translates into northern and southern, and we might tend to see similar categorisation for AT1s.

METRICS

We conduct these correlation checks on a representative sample of the most liquid securities within the AT1 universe. To establish a consistent sample set, we remove illiquid names and then separate the notes into US dollar and non-dollar denominated series. The latter are largely Euro but also Sterling, Swiss and Nordic currency denominated. The time series are taken over the longest period for which we can obtain reliable data, so are of differing length for the share price and AT1 histories

given that CoCos only launched broadly from around 2015. Note that AT1 notes have been increasingly issued throughout the examined period, which makes the dataset tilted towards a larger pool in more recent observations. We also run comparisons at the index level, using the Markit iBoxx Contingent Convertible Liquid Developed Europe AT1 Index, the S&P Eurozone Sovereign Bond Index and the Euro STOXX Banks Index – all of which are market value weighted.

FINDINGS

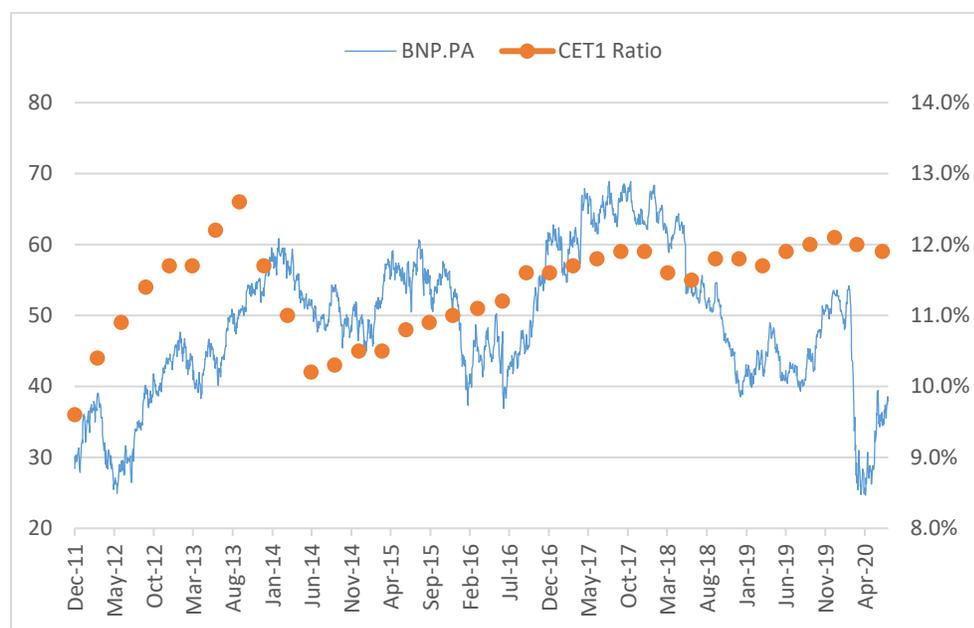
1. Correlation CET1 ratio with share price

Correlation coefficient of CET1 ratio to share price (17/06/2015 to 17/7/2020): **0.19**

Correlation coefficient of CET1 ratio to share price (15/12/11 to 15/12/2020): **0.16**

Even a casual glance at a graph of any European bank's capital ratios relative to stock performance over the past decade will reveal that the share price and the CET1 ratio do not rise and fall in tandem. In the case of BNPP shown below, as a representative example, although the correlation appears a bit better from 2001 to 2014 it remains weak throughout the course of the decade.

FIGURE 35: BNP PARIBAS – CET1 RATIO VS SHARE PRICE



Source: BNP Paribas disclosures and Bloomberg.

If we calculate the correlation of share prices to CET1 ratios over the main period of adoption for AT1s (from the start of 2015) it is only 0.19 on aggregate. With a sector average correlation of less

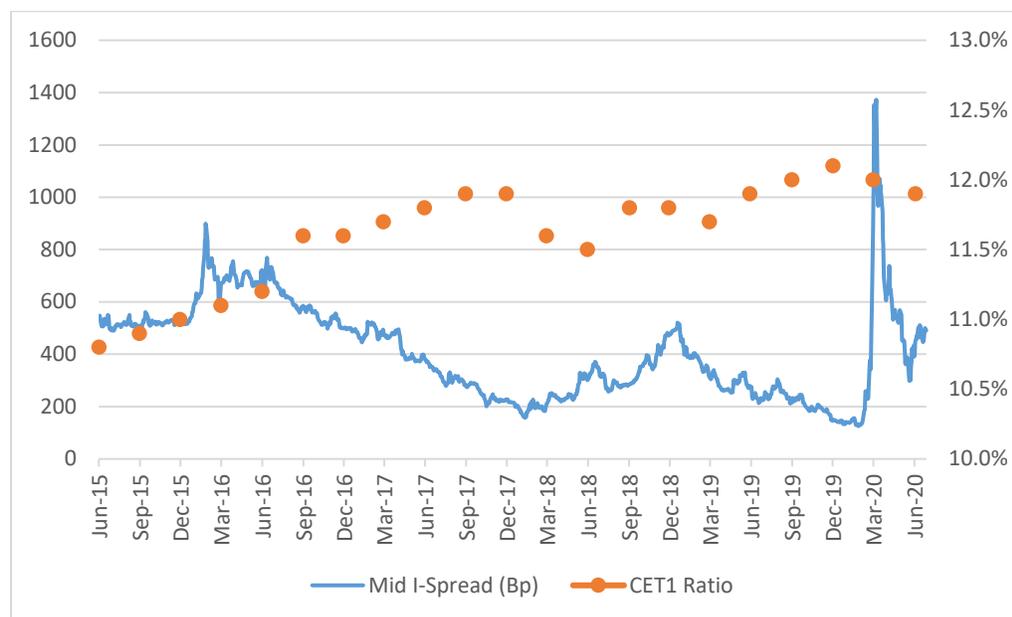
than 0.16 with a time series taken over an 10-year period, at best rising to c0.40 for the less volatile Scandinavian institutions, it appears that a bank’s CET1 ratio and its share price are not consistently correlated – and the null hypothesis must be accepted. Importantly, share prices routinely do not move in the same direction as the capital ratio. *There is clearly no basis whatsoever on which to assume positive monotonicity and thus share prices are not a reliable proxy for valuing the conversion probability for regulatory capital. This raises serious doubts on the soundness of valuation models that use equity as a proxy for calculating the conversion trigger and the recovery rate.*

2. Correlation of CET1 ratio with AT1 spreads

Correlation coefficient of CET1 ratio to AT1 spreads (17/06/2015 to 13/7/2020): **-0.45**

The movement of CET1 ratios have a modest correlation to AT1 spreads at -0.45. The sign is negative as spreads tighten as the ratio rises. We can therefore reject the null hypothesis. We show below the example of BNP again, for comparison. In observing three-month intervals, *it is readily apparent that AT1s do not respond much to the fresh information of CET1 quarterly reporting.* This suggests that AT1 notes might only react to large swings in CET1 ratios, possibly in relation to sector averages, or to when the ratio starts to reach extremes. In sum, CET1/RWA ratios are considerably more closely correlated to AT1 CoCo spreads than to equity prices, but not nearly as closely as one might expect given the embedded barriers that directly reference this capital ratio.

FIGURE 36: BNP PARIBAS – CET1 RATIO VS AT1 (BNP 6 1/8 PERP)



Source: BNP Paribas disclosures and Bloomberg.

3. Correlation of AT1 and Sovereign Debt spreads

S&P Eurozone Sovereign Bond Index to iBoxx Europe AT1 Index (6/7/2018 to 6/11/2020): **-0.46**

AT1s to Sovereign debt spreads – matched by domicile (6/7/2018 to 6/11/2020): **-0.76**

If we calculate the correlation at the level of indices, the correlation is moderate at -0.46; however, if we run this analysis by matching AT1s with the sovereign debt of the sovereign domiciles of their issuing banks, the correlation rises to a robust -0.76. This aggregate correlation is especially well supported by periphery banks' AT1s, such as those in Italy and Spain. The evolution of sovereign bond yields and AT1 spreads is therefore fairly strongly correlated, and we can reject the null hypothesis. *This finding underscores the importance of the interconnecting relationships within institutions and the national authority of their country of domicile – the supervisory-bank nexus.*

We next examine two salient shortcomings of the assumption of positive monotonicity:

- A. A reluctance to accept the persistent dislocation in the movements of an issuer's CET1 ratio and its share price, which make relying on 'market implied' proxies untenable.
- B. In calculating recovery rates, key inputs such as conversion prices and write-back clauses are ignored in favour of abstract notions of simulated recovery levels.

We leave for the chapters on automaticity a thorough investigation of the location of the point of non-viability but *should stress here that a triggering event above the contractual capital adequacy barrier would also be a violation of another assumption in the current body of literature on valuation models.*

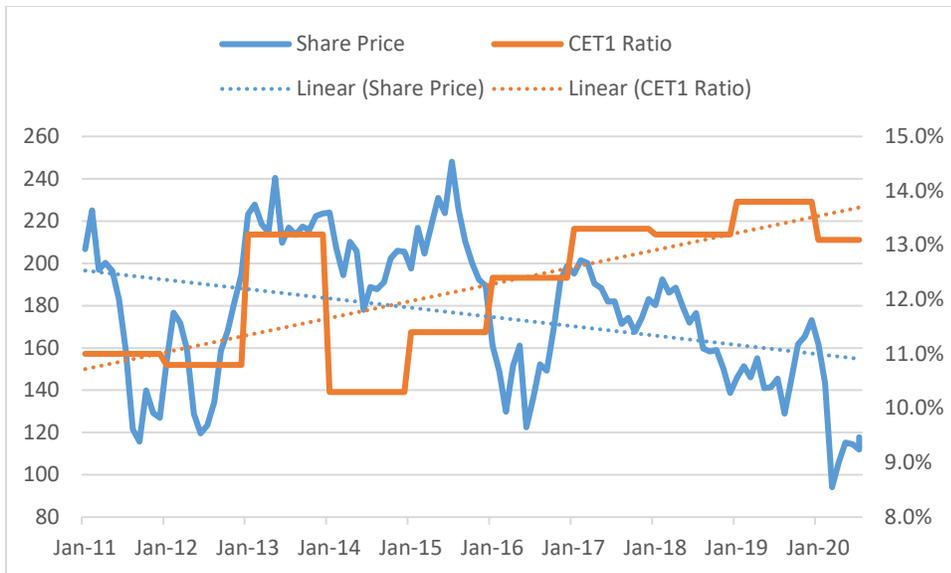
A. Lack of correlation between share prices & CET1 ratios

No CoCos have ever been issued with share price triggers or any other form of market-implied barriers, yet this notion received prominent attention in the first wave of academic papers, leading to the prevailing assumption that the share price is somehow a useful proxy for capital ratios. *According to our findings, there is no foundation on which to take the share price as a direct proxy for the CET1/RWA ratio given that the assumption of a monotonic correlation is not validated empirically.*

The reformulating of the CET1 trigger into a 'market implied' trigger that follows share price movements falls flat at the first hurdle. Not only is the correlation not strong, changes in the CET1 ratio and the share price of an issuer do not have a 'positive monotonic' relationship. There is clear evidence that share prices routinely have the 'wrong sign' – i.e., move in the opposite direction to

CET1 ratios. This makes the share price a poor proxy for modelling a triggering mechanism. This complete lack of fit is illustrated in the graph of Barclays below – the trend line does not even show a vaguely similar pattern. While there may have been a loose fit for some banks in the 2010-14 period, as noted earlier, subsequently any ‘monotonic’ relationship has completely broken down. The lack of correlation and monotonicity reflects differences in the drivers of CET1 movements and share price performance in the current era of tightly regulated bank capital. *In the absence of an empirical foundation to support the use of share prices to proxy the capital ratio triggering mechanisms, valuation techniques should orient to market traded correlates with predictive power that reflect fundamentals such as the implied coupon.*

FIGURE 37: BARCLAYS PLC – CET1 RATIO VS SHARE PRICE



Source: Barclays Plc disclosures and Bloomberg.

The shortcut of taking the stock as a proxy for the CET1 ratio can create the pretence that the ‘problem’ of pricing CoCo is solved when it is only being sidestepped. Indeed, Jose Corcuera et al. acknowledge in their paper on smile conform modelling that estimating the capital ratio by using a share price can be misleading, in part due to the mismatch with book share value; the authors admit that “although one could argue that the capital ratio trigger, for example, is implicitly captured by the trigger share price ... such reduced-form models cannot by design provide very rich behavior” (2013). The assumption of a stable, monotonic correlation between the CET1 ratio and listed equity is perhaps the most salient shortcoming of the legacy valuation models. There is little utility in

modelling an accounting trigger as if it correlated monotonically with an easily observable parameter such as a share price, or credit default swap, if this relationship is not borne out in the real world.

1. Capital ratios drifting higher

The CET1 ratio is being driven by regulatory requirements that boost core capital in the nominator and gradually inflate the risk weightings in the denominator. On balance, this has led to a sector-wide tendency for the ratio to remain relatively stable if not drift higher since the launch of the AT1 market. Bank shares, on the other hand, over the same period have not only generally traded down but have also been much more volatile than capital ratios. The frequent declines in share price are so sharp for many European banks that straightforward backtests of market-implied models would dictate dozens of CoCo conversions, yet this has hardly been the case. That investors have sold bank stocks off even while capital ratios have risen demonstrates the weakness in any assumption that share prices can proxy the CET1/RWA ratio.

The direction of change in the capital ratios are not consistently reflected in share prices, which routinely move in the opposite direction for long periods. Shifts in the CET1 ratio following mandatory annual stress testing highlight how movements in the ratio are shaped by factors different than those influencing the share price. For example, a bank which performs poorly in a periodic stress test might be required by a supervisory authority to take steps to raise its CET1. Higher CET1 ratios often reflect regulatory requirements to shore up capital at weaker institution; however, improvements in the optics of the capital ratio may not dispel perceptions of underlying weakness in the credit profile of such issuers. Consequently, a bank's shares may discount the perceived weakness by trading down. The equity market may interpret such a recent health warning in a stress test as a cause for concern despite the subsequent improved optics of a regulator-led increase in the CET1 ratio. That supervisors tend to demand increases in core capital from banks with weaker fundamentals is one reason why the CET1 ratio can become dislocated from the share price. *The CET1 and the RWA are not taking some 'random walk' that can be modelled stochastically, regulatory capital is well understood to be the product of a heavily managed process – there is a steady uptrend in the CET1/RWA ratio because regulators guide banks to push the metric higher.*

2. Equities react to different drivers

Differences in priorities among the investor base for bonds versus equities is what has allowed banks with poorly performing shares but strengthening capital to come to market with well-

subscribed AT1 issuance. Regulatory changes have encouraged deleveraging, but credit and equity instruments respond differently to changes in leverage. For example, an increase in the Basel Committee's supplementary leverage ratio requirement to 5% (from 3%) means more capital is required; this is a positive for credit investors but a negative for shareholders.

For credit, the cost of funding and the outstanding supply of paper relative to demand for new issuance are key factors. But these factors are less likely to impress stockholders, who tend to value gearing and growth more favourably. For equities, the outlook for earnings at a bank and the prospects for profitability across the sector are key factors. Short-term newsflow is more likely to be reflected in the stock price, in particular the anticipation of and reaction to an earnings event, whereas AT1s respond more to changes in cashflows and EBITDA metrics. With structurally weak earnings at most European banks, the market has tended to favour credit over equity in recent years. The general trend across the European banking sector is one of rising regulatory capital against a backdrop of deteriorating fundamentals. CET1 buffers have gone up as regulatory requirements are implemented, in parallel with share price declines as bank profitability comes under pressure in an environment of ultra-low interest rates and slow economic growth.

Equities and AT1s are interlinked by the balance sheet profile of the issuing bank but may respond differently to events. For example, a rights issue is often negatively received by existing shareholders due to the prospects of dilution, but it could be received positively by AT1 investors as a means of bolstering capital. Given the deep subordination and interest payment discretion of both equities and AT1s, investors with the flexibility to invest across asset classes may eventually foster a closer correspondence in the valuation of the different instruments. There is indeed the beginnings of an awareness of the arbitrage opportunity for traditional income funds as they take on exposure to AT1 notes which offer similar risk/return via CoCo coupons rather than stock dividends from the same issuing bank – but this has yet to really happen to an extent that would shape pricing behaviour.

3. Logical fallacy

Of course, all traded instruments of a bank will react to a crisis. Given that both securities are associated with the same issuing entity, there is bound to be some correlation between a bank's CET1 ratio and its equities and AT1s. But is anything gained by using the stock price to model the probability of the contingency event? *It seems unlikely that the stock price would tell us any information relevant to triggering prospects that the CoCo price has not already discounted.* Even if we were to see high levels

of correlation during bouts of duress, the CoCo would adjust its spreads to reflect a deterioration in the CET1 ratio at much the same time as any share price correction. The signal could be detected directly in the CoCo price without having to use the share price as an intermediary ‘proxy’ input in a valuation model.

Therefore, aside from the lack of evidence of a high correlation coefficient for CET1 ratios and share prices, there is also a lack of logic in using the share price as a proxy for the capital ratio. Even if the beta were 1x for the CET1 ratio and the share price, for this to be relevant for modelling a trigger event on a CoCo, there would need to be a similar beta between both the CET1 ratio and the CoCo price and share price and CoCo price. If there were such a perfect three-way beta, then it would not make sense to use the share price at all as an input to predict the triggering event as it would offer no additional information. What would be true for the share price would apply as much for the CoCo price – and it would obviously be nonsensical to take the CoCo price as an input to value the CoCo itself! Why try to model a three-legged race? If the share price of a bank is taken to proxy its CET1 ratio, to gauge the risk of conversion, and thereby calculate the CoCo price on the basis of a high correlation of all three factors, there cannot really be any predictive power.

AT1 and CDS

Some authors, such as Henriques and Doctor (2014), advocate extracting a market-implied triggering event from an AT1-issuing bank’s credit default swaps. In the JP Morgan approach, CDS are used together with equities to proxy CET1 ratio movements. A triggering event for a CoCo is assumed to parallel an event of default, as a subset of default risk, such that conversion probability can be derived from CDS spreads. As put options with five-year tenors are not available for many banks and even when traded they are illiquid, the pricing for a deep out of the money put is backed out from CDS spreads. While it is true that CDS should reflect overall default risk, there is a limit to the conceptual link with AT1s given that CDS – according to theory – ought to get a boost when a CoCo converts as this would help to restore the financial health of the issuer. The triggering of the CoCo is intended to be a discrete event, not an incident that pulls the rest of the debt outstanding down with it. Thus, although CDS could correlate with CoCos during periods of initial distress, the behaviour close to the contingency event could be much more complex.

4. *A fixation on equity conversion*

Given the lack of correlation with reg cap, how did the academic literature come to be so reliant on the use of share prices as a proxy? Early discussions of the new contingent capital dwelt on the notion of ‘converting to equity’ and its link with equities was magnified in the initial papers from 2010 to 2013; this initial thinking appears to have anchored the mindset. Of course, there were a few researchers who realised that AT1s are structured products with multiple barriers, but it has proven difficult to overcome the notion that somehow AT1s involve debt to equity convertibility as their distinguishing quality and therefore ‘equity’ must somehow be a core input to a valuation model.

That the exchange in value may refer to equities is not all that relevant, given that this is not a debt for equity swap under normal market conditions. AT1s are *equity-like* in their deeply subordinated *properties*, not because of the presence of equity conversion as a loss mechanism. The mechanism itself – whether equity conversion or principal writedown – was introduced to justify the inclusion of contingent securities in the Tier 1 category of the capital stack, which had hitherto excluded structured notes. Being capable of absorbing losses in a similar way to common equity (including coupon cancellation) is what has entitled AT1s to be classified as Tier 1. The legal classification does not make the behaviour of the structured notes the same as ordinary listed stock. The legalese of regulatory categories is not the determinant of an instrument’s pricing dynamics. Any references to equity in the prospectus of an AT1 refer only to the *calculation* of loss at conversion and potential recovery thereafter. Such references have nothing whatsoever to do with the triggering of the conversion, which is an event entirely based on the level of the CET1/RWA ratio or the discretionary invocation of non-viability.

B. Neglect of conversion prices & writeback clauses

Another short-coming of the legacy models is that the recovery rate and the reset rate are both *dealt with abstractly*. Trying to model the share price at conversion adds a false precision to forecasting that overly complicates a valuation without contributing much. Most legacy models do not take the actual reset rates cited in the CoCo prospectuses as inputs. By ignoring these contract features, CoCos from the same bank with the same trigger level would price the same – purely off the proxy of share price volatility. Most legacy models simulate only the share price level at conversion to determine loss for conversion CoCos, taking no account of dilution clauses. Such models also make the simplifying assumption that all write-down CoCos equate to zero recovery, rather than

incorporating the possibility of partial or temporary writedowns. The prime determinant of the recovery rate for a convertible CoCo is the conversion price and for a write-down CoCo the degree of writeback – these features should both be inputs to any valuation.

Prospectuses often cite that on conversion the listed stock need only be retained for a brief holding period. This is sometimes stated as a risk factor, e.g. ‘shares may have to be held for a few days during which time the stock price might vary’, but the implication is that the stock will be sold as soon as possible. There is no reason for an AT1 holder to retain the stock received at conversion. The exchange for physicals into equities is not important in establishing value – the value is determined based on the conversion price – if high, the principal is totally written off; if low, there may be a residual value. While the precise amount of principal recovered remains uncertain, it is possible to estimate an approximate recovery rate based on the conversion price. In modelling the recovery rate for CoCos that convert to equity, those with high conversion prices have almost no ability to recover principal. Therefore, the risk premium should reflect the level of the conversion prices – and this feature ought to be an essential input to any valuation.

Anti-dilution measures

Not only should the conversion price be given greater emphasis as an input, to the extent that estimating the recovery rate is a useful exercise the dilution effects of conversion should also be factored in. The prospectuses of equity conversion CoCos often include anti-dilution clauses, such as the option for rights offerings for existing shareholders. The dilutive impact (ratio of new shares to existing shares) could add to the overall risk assessments given the possibility of meaningful shifts in incentives near the contingency event. The scale of total AT1 issuance outstanding in relation to the market capitalisation should also be a consideration in formulating better metrics.

Several studies surveyed expressed concerns over the ‘gamble for resurrection’, ‘debt overhang’ and other motivational influences of conversion mechanisms but without adequate attention being paid to the conversion rate and anti-dilutive provisions. These authors assume highly dilutive conversions, whereas there are few notes with low conversion prices. In practice, the most common combination is high conversion prices and anti-dilution clauses for ‘conversion’ notes, or zero dilution for ‘percentage writedown’ notes. Taken together, these features mitigate strongly against risk shifting incentives. In keeping with the fixation on equity conversion, papers on incentives have focused on a type of CoCo that never really came to exist.

Write-back potential

A number of financial institutions issuing AT1s do not even have listed stock and roughly half of AT1s make no reference at all to equity and have a loss absorption mechanism that refers solely to percentage-based write downs of principal. Even when market-implied approaches are extended to include write-down mechanisms, it is assumed all are total, permanent writedowns and given zero recovery conversions. Partial or temporary writedowns are ignored – whereas write-back clauses are present in the majority of write-down mechanisms. So, to come to grips with recovery rates, legacy valuation models must consider partial or temporary writedowns. Though the likelihood of writing back up AT1s may be slim, the greater prospects of recovery for this variant of note should still be modelled. The early orientation towards equity as a proxy for the CET1 ratio and the concomitant emphasis placed on modelling the share price at conversion has led to assumptions that needed to be revisited and revised to improve our methods of valuing AT1s. Valuation models should include the write-back feature as an input in estimating recovery potential.

AUTOMATICITY, INTERVENTION AND FORBEARANCE

In this section we assess the degree to which the ‘automatic’ triggers are subject to discretionary overlays. The failings of the legacy valuation methodologies are that they ignore the PONV trigger, sidestep the nuances of regulatory accounting and pay scant attention to the scope for supervisors to interpret and intervene.

We evaluate the prospects for ‘early intervention’ while a bank is still a going concern as opposed to ‘forbearance’ in which no action is taken until a bank has entered formal resolution. In attempting to locate the point of non-viability, we evaluate the degree of automaticity of CET1/RWA triggers at their current levels given the increases in regulatory capital across the board over the past decade.

We next investigate the implications for the MDA threshold due to the inflation of the SREP ratio in light of changes in Pillar 1 and 2 requirements, such as those related to global TLAC and EU-originated MREL requirements. We address scenario-based interpretation of CET1 allocation and the possible prioritisation of coupons over dividends. Specifically, we highlight the erosion of equity-like characteristics due to the ‘forward guidance’ of a favourable bias for AT1s.

Lastly, we look at the economics of refinancing and the substantial degree of subjective supervisory discretion regarding redemptions and new issuance. The decision to extend an AT1’s maturity depends on both a bank’s fundamentals and the refinancing conditions near the time of the first call. We examine the danger of tightening reset rates leading to a vintage of uncallable AT1s, as the market begins to exit from an environment of ultra-low interest rates.

IX. Evaluating the Assumption of Automatic Triggers

Interpreting our empirical findings

In this section, we assess and critique the assumptions of the models surveyed earlier based on our empirical findings and identify further areas for improvement. Specifically, we consider the implications of the CET1 Buffer having such little significance in our regression analysis, relative to both the MDA Cushion and ADI Cover as well as the Reset Ratio and Time to First Call. *That the distance to the contractual contingency event barely prices is a stark challenge to the core assumptions underpinning all the models surveyed.* The shortcomings of the suppositions of existing valuation models are overviewed, before a deep dive into the mechanics of each barrier:

- A. The prominence of PONV power in the context of far greater distances to contractual contingency triggers is not acknowledged.
- B. Key measures related to coupon cancellation are not properly integrated, and the advent of the TLAC-MREL regime is neglected.
- C. The practical economics of extension risk are not fully incorporated, despite the primacy of reset spreads in price formation.

A. Modelling as if supervisory discretion didn't exist

The CET1 Buffer, which measures the distance to the capital adequacy trigger, weighs in with a coefficient of correlation (R-squared) of c5%. This means that c95% of the pricing indicators such as CDS basis are explained by other factors. Other variables associated with principal risk, namely the loss mechanisms and recovery rates, do not show any significance in our regression analysis.

The primacy of 'PON-V' power

The first condition posited by Albul, Jaffee & Tchisty is that there is “*no default before conversion*” (2010 draft/2013). This assumption overlooks the fact that the non-viability event could occur at the behest of the supervisory authorities before the automatic capital adequacy trigger, as specified in the covenants of most AT1 contracts and explicitly laid out in the bail-in rules of the EU's single resolution mechanism. This is more than a simplifying assumption, to assume no intervention can occur before the contractual threshold is simply wrong. Writing at a time when capital ratios at banks were still being rebuild, early attempts at CoCo valuations might be forgiven for assuming the contractual contingency would always supersede a discretionary intervention; however, *the current gap between implied PONV and automatic triggers is far too large to be ignored.*

In the case of the Credit Suisse prospectus (2017) referenced in Chapter II, the term ‘contingency event’ is cited c140 times and ‘viability event’ c111 times. The inclusion of viability alongside almost every mention of contingency as a trigger of equal importance should hammer home the fact that the ‘point of non-viability’ cannot always be assumed to be below a contingency trigger. Logically, if the viability event were always below the contingency event there would be no need for prospectuses to document a contractual clause on a non-viability trigger so thoroughly. PONV power gives the supervisor the *same ability to intervene while a bank is a going concern as it has in resolution* – the implications of this power for the ‘automatic’ triggering of AT1s is central to our investigations.

A key reason we must consider the supervisory framework is that, unlike in the corporate sector, the interpretation of the capacity to absorb losses (‘loss absorbent capital’) and the consequences of stressed or near default situations in modern banking are intricately interwoven with regulatory action. Compliance with formal capital requirements always remains important; however, of even greater import is the continuous dialogue between the regulator and management with respect to the business model, strategy, liquidity, governance and controls, and resilience to stress scenarios. The current Basel Committee-led financial system entails almost constant two-way feedback between the supervisory mechanism and systematically important banks. In this context, valuation techniques *must move beyond the modelling of capital ratios to understand the supervisory process in its entirety*. This exigency underscores the challenge for accurately interpreting the supervisory-bank nexus that has emerged, in which the Basel-led supervisory bodies interact with national authorities and their domiciled banks. The contractual types of triggers are all ultimately subject to the discretion of the national authority for bank supervision – and this capacity for regulatory action introduces an interpretative overlay, with broad scope for supervisory intervention to shape the outcome for all the barriers embedded in AT1s.

Discretionary overlay

By ‘automaticity’ is meant the mathematical calculation of the probability of loss based on the barriers as strictly defined in the contractual terms of prospectuses. By ‘discretion’ is meant the power of supervisory bodies by forward guidance, soft/strict interpretations or direct intervention to override the pre-defined barriers to either accelerate or delay a triggering event. Supervisory discretion operates as an overlay which can, in effect, change the level of the barriers. This scope for mediation blunts the precision of valuation models that rely purely on automatic trigger levels.

A distinctive design feature of AT1 CoCos is that their value ultimately rests on the judgements of the authorities within the Supervisory Review and Evaluation Process (SREP). The determination of a contingency event for principal conversion is at the discretion of the supervisor – and a non-viability event can be declared at any time. Coupon restrictions are also at the discretion of the supervisor, as are redemptions at each call date. Even when a financial institution is not in formal breach of its CET1/RWA-related triggers, supervisors have the authority to intervene if a bank does not meet *all* of its regulatory requirements – be they total capital, leverage or liquidity related. The PONV trigger may not only be higher than the automatic CET1 trigger ‘theoretically’, PONV power is now almost certainly to be exercised before a publicly disclosed CET1 ratio reaches the contractual triggering levels. Hence, the underlying driver for AT1 pricing is the intent of the ‘competent national authority’ itself – as manifest in the EU-wide directives for supervision and resolution. *A reorientation to the layer above the fundamentals of the banking sector – to the supervisory framework – is essential to accurately value AT1s, though it may break with certain assumptions about free markets. As the asset class of contingent capital matures, the role of supervisory discretion must be examined and integrated into our valuation models.*

B. SREP-MDA ratio is not incorporated as an input

In our analysis of coupon risk, issuers with thin MDA cushions of less than 100-150bps, or those that inadequately disclose their SREP requirements, price with higher risk premiums. Less than ample ADI cover also registers for risk pricing, such that when taken together the MDA and ADI levels are clearly relevant. *The MDA-ADI barriers are more significant than the WDC barrier and therefore valuation models must reorient to coupon-related contingency triggers.* That said, the MDA-ADI barriers are not as significant as one might expect for reasons we explore further in the chapter on coupon risk.

The tax deductibility of coupons makes the funding costs of AT1 instruments more attractive. Classification as ‘debt’ helps the structured notes to qualify for the tax shield on offer for coupon payments. In most EU jurisdictions (e.g., France, Germany, Italy, Spain) interest payments on AT1 instruments are tax-deductible. This categorisation has helped to achieve the widespread adoption of a new form of regulatory capital. That other jurisdictions such as the United States have refused to allow the structured notes to be classified as debt underscores the contentiousness of this categorisation. Indeed, coupons are no longer tax-deductible in the Netherlands, Sweden and Denmark. The label of ‘debt’ for tax purposes should not be confused with the behaviour of the

instrument. AT1 notes are not fixed income securities; the income is *not* fixed. *Thus, forecasting the probability of coupons being paid should be central to any valuation of AT1s.* Below we overview the shortcomings of the legacy valuation models and make suggestions for improvements.

1. Coupon conversion also modelled as if based on a market-implied trigger

Almost all valuation approaches presented to date assume that coupons are cancelled at conversion, with no modelling of coupon cancellation as an independent event that could occur *prior to conversion* or for the possibility that coupons might be restored in the event of a writeback. Later versions of the equity derivatives ‘closed form’ model, as presented by Corcuera et al., employ the same trigger mechanism and stochastic processes for coupon cancellation as used for principal conversion:

We shall assume that trigger mechanism is defined as the first-passage time of a process below some pre-specified barrier. In order to make the model operationable, the regulatory trigger is replaced with a market-based trigger... Hence *conversion and cancellation events are triggered by movements of the stock process* and happen when certain barriers are crossed (2014).

The stochastic process in this approach calibrates to the stock price level of the issuer, but the implied barrier is relative to any current price; i.e., not based on a fixed strike at the time of issuance but just to a level lower than at the time the process is run. If the ‘percentage downside’ for triggering is left to float off of any starting level, it might never be reached. This ambiguity on the anchoring of the reference price limits the predictive power of this approach. As mentioned previously, if a fixed level were taken as of the date of issuance and backtested, given the poor share price performance across the European banking sector, a number of institutions would by now have breached such an abstract barrier, yet this has clearly not been the case in practice. Many banks will see their share prices fall and therefore theoretically be at risk of a coupon miss, but the closed form model seems a cumbersome calculation just to restate the obvious: banks with poor fundamentals are riskier. In any case, the actual decision to switch-off coupons reflects the rules on MDA and ADI calculations as well as supervisory guidance on prioritising the retention of profits.

One of the rare instances of a coupon omission on an AT1 came in June 2017 from Bremer Landesbank due to massive losses on its shipping loans. Setting aside the glaring problem that Bremer had no listed stock by which to calibrate a ‘market implied’ coupon skip, the volatility on its AT1 notes had actually decreased in the lead-up to the decision to cease interest payments as the likelihood of the miss was already priced in. Presumably, had Bremer a share price it would also have been hammered into quiescence well in advance of the eventual cancelation of the AT1 coupons.

Applying the same mechanism for all types of triggers, despite the lack of fit

The market-implied models rely on either Monte Carlo techniques or historical share price volatility to project forward probabilities of a cancellation. This raises another limiting factor – if the same triggering mechanism is being based off of the same share price, the two barriers of cancellation and conversion cannot be differentiated. In the case of BremerLB, though the interest payments were stopped the principal was not written down. If we consider Banco Popular, the bank actually paid out its coupon in March 2017 just months before converting the principal to zero in June of the same year. A shortcoming of using the share price is that it cannot differentiate between a case such as Bremer LB that cancelled coupons as its profits were eliminated yet remained solvent, and Banco Popular that paid out coupons as it had sufficient distributable reserves though it was soon deemed insolvent. In practice, the different contingency events need separate triggering mechanisms that include as inputs the specific features of each note and track the actual mechanics of each barrier.

The application of the same ‘market implied’ calculation for all barriers is a limitation of the De Spiegeleer et al. (2015) model surveyed earlier. Their approach applies a ‘volatility adjustment’, but the price of a CoCo can only be linked to the distance of one trigger at a time. When this method is used to solve for the write-down trigger, the assumption is that principal writedown is the only risk to be priced – and the trigger related to coupon cancellation is ignored. Similarly, when this model is used to find a theoretical adjustment for the distance to coupon cancellation, the conversion trigger is ignored. Since this approach cannot cope with the triggers taken together, it is unclear exactly which unit the ‘volatility adjustment’ factor is calculating. Moreover, the calculation of the triggering event for coupon cancellation takes no inputs from ADIs nor does it consider the CET1 allocation across the capital stack that would determine the level of the MDA threshold; hence, the calculated result can only be understood as an abstract notion of ‘coupon-related risk’.

2. Coupon omission is not equivalent to deferment of stock dividend

Another shortcoming of the market-implied approach is that it neglects the differences in the response of a share price to a cut in dividend versus that of an AT1 to the prospects of a coupon miss. When earnings take a hit, the share price of a bank often responds with a much sharper correction than the prices of its AT1s. The reason for this is that a stock can directly bake in expectations of an upcoming dividend such that when it appears unlikely due to an announcement of a loss, the ‘drop point’ element of the share price is almost immediately removed in a similar

manner to a share trading ex-dividend. For an AT1, even when earnings take a haircut, there tends not to be a sudden repricing on anticipation that coupons will be cut. This lack of an incremental reaction function is due to the ‘tail risk’ quality of coupon skips, given that cancellation represents a severe event of loss and the ‘soft stopper’ guidance from the regulators makes such cuts unlikely. A share price can bounce back despite a dividend cut as a skipped distribution can be recouped, whereas an AT1 that ceases its interest payments would see its price crushed.

When a dividend on a stock is not paid out, it does not necessarily make the shareholder worse off – the funds are retained and can be reinvested to fuel growth and be distributed at a later date. Indeed, many growth-oriented companies do not pay out dividends as a policy for this express reason. Not paying a dividend changes the method by which equity investors can realise value, via direct cash pay-outs or share price appreciation. Dividend pay-outs can be deferred, to be later compensated for with a jumbo dividend paid at irregular intervals (or a share buyback), whereas there is no recouping a missed AT1 coupon. Not only is the AT1 interest payment lost forever but the retained earnings may, at a later date, make their way to the shareholders. The nature of the non-cumulative coupons creates a situation in which AT1 holders stand to lose real value when capital is constrained; future super dividends may even transfer value to shareholders. In this sense, AT1s can be subordinated to equity – a form of capital inversion.

Even if both types of distribution – stock dividends and AT1 coupons – are simultaneously restricted the consequences are not the same. This bifurcation of outcomes could pose a moral hazard, in that shareholders or senior bond holders might encourage temporary restrictions on distributions. Cancelling a coupon on an AT1 is *favourable* for the equity investor because the retained cash may potentially be accessed via future dividends. Similarly, not distributing the interest payments on the AT1 makes the senior bondholder better off because value will then be retained inside the bank to help service the senior debt. When an AT1 coupon is missed the CoCo holders no longer have any right or means to access the lost value. AT1 investors suffer disproportionately as they cannot gain from the restriction on dividend distributions. As ‘fixed income’, an AT1 investor will be permanently worse off when the MDA restriction is applied because AT1 coupons are non-cumulative. AT1 investors suffer an irrevocable loss from the skipping of a coupon payment.

To help solve the problem of moral hazard, updated processes for AT1 coupon restrictions could be introduced. For example, in some hybrid capital instruments up to around 2009, deferred coupons could be settled by proceeds from the sale of common shares, in a process known as an ‘alternative coupon satisfaction mechanism’. This is an interesting alternative worthy of future research.

The implication for legacy approaches is that the optionality over coupons must be properly modelled, to incorporate the property that when interest payments are missed they can never be recouped even if the AT1 is not converted. The cessation of interest payments on CoCos serves as the first tranche of loss, as the combined buffers should be preserved at the expense of coupon distributions. It is therefore of central importance in the valuation of AT1s. *The key scenario to model is coupon cancellation coupled with maturity extension – i.e., the zero-coupon perp scenario – as this can involve losses as extensive as a full write down of principal.*

3. No calculation of MDA or ADI thresholds

Existing valuation models do not incorporate combined buffer or distributable reserve requirements. There is no attempt to quantify the changes in Pillar 2 guidance following from stress test results. Rather than consider the distance to the combined buffer requirement as a valuation metric as important as the distance to the write-down/conversion trigger, valuation models have thus far not incorporated the nuances of accounting that underpin the coupon cancellation mechanism. Nor is there yet any consideration of coupons being switched back on, after combined buffers or distributable items are restored. This means the possibility for temporary writedown AT1s to subsequently resume coupon payments at write-back is entirely missing.

At the time when the first attempts at CoCo valuation models were developed, banks were not required to disclose publicly the outcomes of the SREP, so such information was only released sporadically. The distance to the MDA threshold was *unobservable* for most market participants until the advent of stress testing toward the end of 2016. Subsequently, the inflow of pertinent information on combined buffer requirements has created the latitude for AT1s to decouple from other subordinated securities and respond to different information or to the same information differently. In February 2020, the ECB disclosed the Pillar 2 requirements of the nearly 120 significant institutions that it supervises – with fully loaded levels coming into full force for most banks. We are now able to gather up from across the main issuers the data that shapes the SREP ratio and influences a bank’s ability to make regular interest payments on AT1s. Given the greater

transparency on capital requirements, it is possible to operationalise the MDA and ADI variables. Therefore, valuation models should look to measure the components of the combined buffer as well as to leverage ratios as breaches of *either of these ratios* under current rules could trigger coupon restrictions. TLAC maturity profiles must also be monitored as this regulatory capital sits underneath the combined buffer requirements and any non-compliance in TLAC would affect payments on the whole of the capital stack.

C. The economics of extension risk are not incorporated

Most models assume AT1s are redeemed at first call

After the first call, the coupon payments typically switch from fixed to floating. Any assumption of a fixed maturity breaks down when the potential perpetual nature of AT1s is factored in. Therefore, modelling redemption is central to computing the value of an AT1. Yet, there are few attempts to acknowledge extension risk in existing valuation models. Most legacy models assume that AT1s will be redeemed at the first call date, and that notes are all set at five-year maturities, although this is an oversimplification. AT1s can be issued with first calls out to 10 years or more; hence, there are a wide range of times to the first call date. The subsequent non-call periods also differ, from quarterly to once every five years. A next call date being exercised say semi-annually would reduce the overall risk associated with skipping a call date given that there are many more opportunities post a skip than in the case of an AT1 with the next call date in another five years. This lack of standardisation of resets and reset clauses complicates the modelling of extension risk, but the key features cannot be ignored. *A complete model should take into consideration the reset rates, distances to first call and the frequency of the reset periods.*

Barriers tacked onto earlier valuations as abstracted risks

The two main papers on extension risk were written by Spiegeleer & Schoutens (2014) and by Corcuera, Schoutens & Valdivia (2016). Both rely on volatility measures to establish a probability of extension. Call provisions are a familiar concept in bond analysis; investors should demand a premium to take on the risk of a callable bond as principal may be returned early resulting in exposure to lower interest rates. The paper by Corcuera et al. builds on conventional bond analysis, positing ‘call credit events’ as those occurrences which may affect the solvency of an issuer, again using the share price as the trigger mechanism formulated with a modified Black-Scholes equation:

we consider CoCo bonds with cancellable coupons and extension risk. We obtain an expression for their payoff and their price *that depends on the value of the stock* at the call dates and certain credit event times... *when the value of the stock hits some lower barriers* (2016).

De Spiegeleer & Schoutens and Corcuera et al. express the extension risk as formulae, but do not address the economic dimension of the cost to the issuer of refinancing a replacement AT1 instrument versus the cost of rolling the existing AT1 notes. Maturity extension is tacked on without attempting to value the call option that the investor has sold to the issuer.

Forward coupons tend to be set close to the original coupon, such that high backends are more likely for banks with problems at the time of issuance. To avoid a skipped call, an institution therefore needs a flat to improving credit profile in the years leading up to the first call of its AT1 notes and/or an improving macroeconomic situation in the country in which the bank is domiciled. The market environment over the intervening years also needs to be stable or improving. If the credit profile of the bank or sovereign and/or macro environment deteriorates, then a higher spread may be demanded to re-issue – triggering an extension of maturity. *Hence, balance sheet fundamentals along with future funding needs of each issuer have much more weight for pricing than historical volatility, which is backward looking. The “yield-to-call versus the yield-to-maturity” or similar such metrics using ‘yield to perpetuity’, known to be directly associated with the likelihood of refinancing an AT1 bond, should constitute a core part of valuation techniques.*

According to our findings, AT1 zspreads are moderately correlated with the CET1 ratio. However, small shifts in the CET1 ratio are not significant for the pricing of CoCos in time series regressions. If the risks are known for an issuer and discounted into the price of its securities, then volatility may be modest – i.e., the zspreads may have blown out wide but can subsequently remain relatively stable. The zspread level will still represent the various risks of an issuer relative to other issuers, *but the volatility of the zspread might not contain much information.* It should also be stressed that some AT1s are so tightly held their spreads can appear pinned for long periods, with extremely low realised volatility whereas other AT1s are widely traded on macro themes and can experience high volatility despite strong credit profiles. Moreover, bouts of contagion across the asset class have seen the spreads of AT1s issued by banks with solid balance sheets tossed around for no issuer-specific reason, yet these periods of turbulence can generate high realised volatility.

CET1 volatility as proxied

In an attempt to apply volatility measures to CoCo valuation, a risk-adjusted distance to trigger is defined by De Spiegeleer, Hocht, Marquet and Schoutens (2017). The authors introduce a term called the “implied volatility of the CET1 ratio”, which is a function of the realised volatility of the z-spread for a given CoCo. The volatility parameter is backed out of a Black-Scholes-like formula that lets the model price match with the market quotes of actual CoCo prices. A wider zspread for a CoCo in the market results in a larger ‘risk adjustment’. The general notion pursued by De Spiegeleer et al. is that higher asset volatility increases the range of outcomes and therefore the probability of touching a barrier, from the conversion and coupon triggers to the option to call. To quantify the probability, the distance to a trigger is redefined as a ‘volatility-adjusted distance’. Due to the low frequency of reporting for an issuing bank’s CET1 ratio, the authors take the realised volatility of a CoCo’s own zspread as the proxy: “Doing so, one makes abstraction of the volatility of the CET1 ratio” (2014). Therefore, despite the name, this fitted parameter has no relationship to the realised volatility of the real-world CET1 ratio of the issuer. De Spiegeleer et al. appear to be suggesting a kind of heuristic tool, to build on their pioneering efforts at conceptualising CoCo valuation, rather than a practical method by which to calibrate the characteristics unique to each note as input parameters.

Notes with multiple embedded barriers require more sophisticated methods

Embedded barriers in CoCos somewhat mirror those in structured products such as autocallables; however, autocallables reference a continuously tradable underlying such as stock or bond indices, currencies or commodity prices. The method of pricing a conventional autocallable cannot be applied when the underlying is a non-tradable accounting measure. There is no tradable hedge for the CET1 ratio and without that one cannot plug in the requisite inputs for a Black-Scholes calculation. Saying a CoCo is “like a derivative” does not make it an option on a tradable underlying. Stocks, bonds and CoCos are all securities that only have a single price at any point in time. Call options on equities and default swaps on debt can be modelled with reference to the volatility of the underlying instrument, and there is some evidence to suggest that the volatility of credit default swaps and stock options can be used as proxies for each other when modelling tail risk (Carr and Wu, 2011). However, though there is a nascent market in CoCo options, AT1s do not have actively traded derivatives similar to stock options and credit default swaps. The valuation we are exploring is of the security itself, not an imaginary option/swap that might be based on the underlying CoCo.

Furthermore, derivatives models that rely on historical volatility are not appropriate for structured notes with digital barrier options. A barrier note is structured to embed discontinuous jumps: the future event is unknown and needs to be evaluated as a one-off, either a threshold is hit or it is not. The potential outcomes are ‘barbarreled’, or binary, as opposed to distributed normally around zero. Implied volatility in the vanilla Black-Scholes formula, which assumes a normal distribution around zero, is much less relevant when large definable binary outcomes are involved. The potential impact of the upcoming event will dwarf whatever learnings may be gleaned by past smaller movements. Probability in a binary barrier note cannot be extracted purely from historical data. Thus, a plain Black-Scholes model will not work well for low frequency ‘tail risk’ events. The only spike in volatility that really matters for an instrument such as an AT1 is the final jump when a barrier is hit – for which historical volatility may not provide much foresight.

Nassim Talib has highlighted the challenges in pricing barrier options: “in a mean-reverting market, the barrier component of a barrier option is overpriced. In a trending market, it is underpriced” (1996). Barrier notes are known to have a very skewed profile, as per the risk asymmetry discussed in Chapter II, and require a different approach to volatility. A key sensitivity is to directional bias – as such, extreme estimators that measure trending such as the Parkinson number or Sortino ratio might offer more information. Talib explains that if the volatility levels are lower than the Parkinson number, the barrier is underpriced by standard methods as the underlying is displaying drift. The Sortino ratio, a variation of the Sharpe ratio, differentiates ‘downward movements’ from the overall volatility of a portfolio by using the downside deviation instead of the total standard deviation of returns. Though it goes beyond the scope of our thesis, it should be noted that both the Parkinson number and the Sortino ratio show some significance in regressions on AT1 risk pricing, depending on the continuous variable – with CDS basis showing the greatest sensitivity.

Overlooking the nuances of accounting for regulatory capital amid shifting regimes

The valuation models proposed to date tend to deal with risks as ‘abstractions’ rather than delving into the intricacies of accounting to reflect with more nuanced measures of the distances to combined buffer requirements as triggering thresholds. One exception to this trend is the latest updates to the valuation techniques at JP Morgan, which appear promising given that the JPM team are trying to forecast refinancing spreads. That said, the aim is to compare in ‘relative value’ terms the attendant risk of extension rather than to present a comprehensive valuation model for use in both the primary and secondary markets.

In the coming chapters we investigate the CET1/RWA ratio triggers in the context of changes in the regulatory capital regimes, in part to stress the extreme plasticity of both the numerator and the denominator. The uncertain nature of both constituents of the capital ratio – ‘CET1’ and ‘RWA’ – make modelling its movements rather complicated. Capital ratios typically require several thousand parameters to compute and will reflect the full range of bank operations (Haldane & Madouros, 2012). Sprawling financial institutions often contain a labyrinth of legal entities, introducing ambiguity over which group and subgroup entities count toward a ratio’s calculation. Furthermore, the securities that can be counted towards CET1 vary according to ‘competent supervisory authorities’ across the European Union; at present there are over 130 variants ranging from ‘state aid’ to ‘silent participation’ with standards routinely revaluated and changed. In addition, risk weights are the subject of much conjecture – varying from 0% to over 150% depending on the type of instrument – and the ‘risk-weighted’ figure is prone to all manner of arbitrage in complete markets, as banks find workarounds to gain access to an activity while nominally offsetting the associated risk. In sum, the tidiness of the round percentages referenced in the directives of the Basel Committee mask the underlying messiness of a bank’s actual operations.

The complexity of the construct of capital ratios as the basis for automatic ‘triggers’ lies at the heart of the supervisory-bank nexus. We explore in the coming chapters the tension between automaticity and discretion in terms of the main components of risk: principal conversion, coupon payments and maturity extension.

X. Principal Risk – ‘Going’ vs ‘Gone Concern’ Capital

Three forms of conversion/writedown

According to the legislation governing AT1s, there are three ways by which the face value can be converted or written down: (1) breaching a contractual contingency trigger with a publicly disclosed CET1/RWA ratio; (2) invoking the power to declare a non-viability event while an institution is still solvent; (3) bailing in as a consequence of a bank being moved into resolution. The [Bank Recovery and Resolution Directive](#) specifies criteria for an instrument to be categorised as Additional Tier 1. Instruments must be able to fully absorb losses at the **contingency event**, the **non-viability event**, and **bail-in at resolution** as determined by mechanical *and* discretionary formulations:

- A. **Contingency event:** Occurs when the designated trigger level is touched, which must be set at a minimum CET1 ratio of 5.125% but may also be set at higher levels such as 7%.
- B. **Non-viability event:** Occurs when the regulator determines that standard measures to improve capital adequacy are inadequate and a writedown of principal is essential to prevent a bank from becoming insolvent.
- C. **Bail-in at resolution:** This tool empowers the Resolution authorities to write down or convert into equities the debt owed by a bank to creditors to reduce the liabilities of the failed bank. Subordinated debt is first in line for bail in. Any specific features, such as the conversion price or write back clauses in the case of AT1s, are overridden.

Why does the distance to trigger not register as more significant?

To address the above question, *we examine in detail the loss mechanics for the face value of an AT1 of each of the above three formulations to determine how the contractual trigger has been subsumed into PONV power and the new paradigm for bail-in debt.*

A. Automaticity for AT1 Principal – Capital Adequacy Barrier

The “contingency trigger”, as it is often referred to in prospectuses, determines the point at which write-down or conversion of the invested sum (the principal) occurs. This trigger has attracted the lion’s share of attention in academic papers despite it having the lowest likelihood of occurrence among the three main barriers. Touching this threshold requires the greatest degree of financial distress, but if breached it results in the largest losses. As such, a deeply ingrained assumption that has formed the foundation for most modelling is that the risk to the principal is the distinguishing

characteristics of CoCos and central in price formation – and therefore that the levels for the *automatic* trigger must be a key factor. Yet, our findings run contrary to this long-held belief.

The features associated with the loss of some or all of the face value amount of an AT1 are: (1) the trigger level for the capital ratio, (2) the choice of loss absorption mechanism and (3) the implied recovery rate as influenced by either conversion rates or write-back clauses.

According to our tests, *none of these factors registers as particularly significant explanatory variables:*

1. High versus low trigger types for conversion/writedown do not price at all, even though these levels should to some extent demarcate the transition from going to gone capital.
2. The distance to the capital adequacy barrier has some significance but coupon-related risks have superseded principal-related risk, as the SREP ratio that determines the MDA threshold is now well above the CET1 ratio levels set for automatic conversion/write-down.
3. Features related to the recovery rate have virtually no significance, including the conversion price (high vs low) or whether the conversion price is fixed, floating or floored; the period of the writedown (temporary/permanent) or the degree of writedown (partial or complete).

Regulatory capital and bank funding

Banks have recourse to a variety of funding sources to finance their business activities. Activities can be funded from customer deposits and other forms of borrowed money, which the bank must someday repay in full. Capital, in contrast, can be classified as a bank's 'own funds' – i.e., not money lent to the bank that must be repaid. Were a bank to fund itself purely from borrowing, should large losses be incurred, it might not be able to repay on time those from whom it had borrowed and the bank would become 'balance sheet insolvent'. However, with a capital base a bank can sustain losses for a considerable period yet still retain greater assets than liabilities, maintaining solvency.

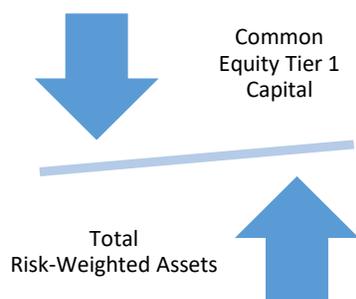
The term 'capital' can be used in many ways to broadly refer to retained earnings and ordinary shares, representing the slice of the profits that are reinvested today to create the profits of tomorrow. For the purposes of this thesis, it is *regulatory capital* that is most relevant: the categories of financial instruments that banks are required to hold to meet the rules and guidance of the Basel Accords. Regulatory capital is measured in a more conservative way than a general accounting of 'assets minus liabilities', as *reg cap* comprises only capital that is at all times freely available; assets that do not have a stable value in stressed circumstances, or whose gains are not yet realised, cannot be

recognised. The formulas for regulatory capital evolve over time, but their objective stays the same: to create sufficient capital cushions – “total loss-absorbing capacity” – for the banking system to withstand shocks throughout the course of economic cycles. As it pertains to CoCos, therefore, *regulatory capital means the capacity to absorb losses*.

Capital adequacy as a ratio

The established convention is to express regulatory capital as a percentage to create a standardised metric that can be used to compare across financial institutions. This ratio expresses a bank’s common Tier 1 capital as a fraction of its risk-weighted assets. As highlighted in the image below, there are two independent drivers of this capital ratio.

FIGURE 38: CET1 RATIO – FORMATION



Tier 1 capital represents a bank’s core capital, including common stock, disclosed reserves, and non-redeemable non-cumulative preferred stock (in certain calculation methods). Tier 1 capital differs from Tier 2 capital, which may include loan-loss and revaluation reserves or undisclosed reserves. The Tier 1 capital ratio can be formulated in many ways, but the form that serves as the trigger threshold for most contingent capital is the *common equity Tier 1 ratio* or ‘CET1’ ratio. This ratio excludes preferred shares and non-controlling interests, and essentially includes only ordinary shares and retained earnings. The other measures occasionally employed as triggers are the total Tier 1 capital ratio and the total risk-based capital ratio.

The CET1 ratio is generally seen to be a fair indicator of a bank’s health given that equity and earnings are a purer form of loss-absorbing capital. The denominator of risk-weighted assets (RWA) is calculated by allocating and adjusting an appropriate measure of risk for each asset class, including off-balance sheet exposures, in order to determine an aggregate estimate of a bank’s potential for real-world losses. As a simple illustration, assume a bank has €1000 in common capital and €10,000

in loans with a risk weighting of 70%. In this case, the bank's capital ratio would be calculated as "CET1/RWA": $1000 / (10,000 \times 0.7) \times 100 = 14.3\%$.

Tier 1 capital requirements

The main components of CET1 represent ownership (ordinary shares) and profits that are not distributed (retained earnings). To be eligible as CET1, a security must be:

1. **Perpetual:** For as long as a bank continues in business, it is not obligated to repay the original investment. Only in resolution, after all creditors have been repaid, can a residue amount be returned to investors.
2. **Discretionary:** Distributions of profits to investors, e.g., dividends to shareholders, are not obligatory and may vary over time depending on the bank's earning ability.
3. **Subordinated:** All Tier 1 capital must have the ability to absorb losses on a going-concern basis, thus the securities are the least senior in the capital structure.

1. Trigger levels

The conversion into equities or write down of principal happens when the CET1 ratio touches the trigger level pre-specified in a prospectus. Reflecting guidance from a bank's national regulators and feedback from initial indications in the primary market, the trigger may be set at a minimum of 5.125% or 7%. These two levels predominate, although there are some legacy notes roughly mid-way at c6% or as high as 8.25%. In theory, the barrier should be set high enough to trigger before stresses are too severe to be remedied without resolution, but not so high that the barrier is touched prematurely in a mild downturn.

2. Loss mechanism

The loss-absorption mechanism determines what happens if the capital ratio threshold is hit. There are two methods of calculating the loss: *conversion of the principal into equity at a pre-specified price, or a write down of a pre-specified percentage of principal.* The designation of a loss mechanism codifies for legal purposes a method of calculation. According to the Basel Committee: "In cases where capital instruments have a permanent write-down feature, this criterion is still deemed to be met by common shares" (BIS, 2011). Just as the Basel III terms define writedown as if it were a form of equity conversion, prospectuses often blur the distinction between the two loss mechanisms, treating them as effectively interchangeable:

“for the purposes of calculating the Write-Down Amount, the Full Loss Absorbing Instruments will be treated (for the purposes only of determining the write-down of principal or conversion into equity, as the case may be, among the Securities and such other Parity Loss Absorbing Instruments on a pro rata basis) as if their terms permitted partial write-down or conversion into equity...” ([Bank of Ireland](#))

Either mechanism can serve as the method for calculating losses and the recovery rate.

A. Equity conversion

The degree of recovery depends primarily on two parameters: (1) level of the conversion price and (2) decline in the underlying share price. A secondary factor is the presence of anti-dilution clauses.

Conversion price

The conversion price, C_p , dictates the number of shares an investor will obtain if a breach of the capital ratio threshold occurs and therefore the calculation of the expected severity of the loss. The conversion price is a provision in a prospectus, and takes the following main forms:

1. **Fixed value:** Setting a conversion price at the time of issuance. Some CoCos have a clause specifying the number of shares to be issued at conversion, which is essentially the same as specifying a conversion price.
2. **Floating value:** Setting the conversion price in advance of the contingency event is known as ‘par conversion’. This option may include a discount or premium to the prevailing share price. To deter share price manipulation, it can be taken as the average share price over a certain period, e.g., the ‘volume weighted average price’ 30 days before conversion.
3. **Floor value:** In addition to a formula to calculate the floating value, prospectuses may specify a floor price or a discount/premium that limits the range of the conversion price.

Conversion ratio

The rate at which a note may be exchanged into shares is the conversion ratio, ‘ Cr ’, calculated by dividing the notional principal of the bond with the conversion price: $Cr = \alpha N / C_p$. For example, a bond with par price of \$1000 that can convert into stock at \$25/share has a conversion ratio of 40x.

The conversion value ‘ C_v ’ is the equity value after the conversion: the conversion ratio multiplied by the prevailing share price ‘ St ’ – taking into account any dilution: $C_v = Cr \times St$. As an example, if the conversion price is €20 a CoCo holder with a par value of \$100 will receive 5 shares at the trigger event (€100/€20). The CoCo holder would receive 10 shares if the conversion price is €10

(€100/€10). Therefore, the lower the conversion price the better for a CoCo holder, with the converse being true for the shareholders of a bank, who favour a higher conversion price to avoid dilution post-conversion.

The formula can be represented as a variable number of shares with a maximum number, or a share price near the time of conversion and a floor price. A floored conversion price takes this form: “ $= \max(S_t, S_f)$ ” where S_t is the share price at time of the capital ratio contingency event and S_f is the share price floor. Such formulations place a cap on the number of shares resulting from conversion.

One such case is the initial Credit Suisse CoCo offering, which had a conversion price floored near the absolute lows of 2008. The conversion price is set as the maximum of either the weighted average price of the Credit Suisse stock in a 30-day period prior to conversion, S_t , or 20 Swiss francs or 20 US dollars: $C_p = \max(S_t, 20 \text{ CHF}, 20 \text{ USD})$. Although this formulation could be beneficial to CoCo holders if the shares trade higher than the floor, this seems improbable given the poor fundamentals likely present for a bank in breach of its capital ratio trigger. Shares of Credit Suisse have since traded well under 20 CHF, averaging less than 10 CHF in 2021 – well below the floor. The flooring of the price is done mostly to reassure shareholders as it places a limit on the potential for dilution. In effect, a floor acts much the same as a fixed conversion price.

Conversion: *Implied recovery rate*

The loss upon conversion directly reflects the combination of the conversion/floor price and the share price prevailing at the time of conversion. A fixed conversion price that is punishingly high will offer poor prospects of recovery of the CoCo’s face value, whereas existing shareholders will be only slightly diluted. The converse is also true, a very low conversion price can largely preserve the CoCo’s principal while deeply diluting existing shareholders. Dilution of the stake held by pre-existing shareholders can occur from the new stock issued to CoCo holders at conversion. Dividing the principal amount of a CoCo by its conversion price yields the number of shares of common stock issued at conversion – and is a rough gauge of the impact, setting aside anti-dilutive features such as a voluntary rights issue for existing stakeholders.

To illustrate the implied recovery rate, ‘RR’, consider the following example. Assume a CoCo note with a face value of €1000, with a share price at issuance of €100. The note is subsequently triggered, and the stock price prevailing at this time is €25. Assume further that the price floor is set at €35.

The table below shows the recovery rate for each of the three methods cited above. The sample calculations illustrate that in the event of a conversion, CoCo investors stand to benefit the closer the conversion price is to the prevailing market price.

FIGURE 39: RECOVERY RATES: SAMPLE CONVERSION PRICES

| | Fixed Conversion | Floating Conversion | Floating with a Floor |
|------------------|------------------|---------------------|-----------------------|
| Notional value | 1000 | 1000 | 1000 |
| Conversion price | 50 | 25 | 35 |
| Prevailing price | 25 | 25 | 25 |
| No. of shares | 20 | 40 | 28.57 |
| Value of shares | 500 | 1000 | 714.3 |
| Recovery rate | 50% | 100% | 71.4% |

A decline in the share price can either be modelled or posited; for the purposes of our analysis, we posit a 70% decline. We take current levels as the reference point, though the share and market cap levels at time of issuance are an alternative reference. As mentioned, some notes contain terms that allow existing shareholders to take up a pro-rata offering to avoid full dilution. Some notes have anti-dilution protection for the conversion itself, but only if circumstances such as a takeover or rights issue come into play at some point prior to the contingency event – i.e., to adjust the conversion price appropriately to account for such circumstances. For the purposes of estimating recovery across the dataset, full dilution is posited (the worst case). To calculate the effect in aggregate, the dilution of each CoCo note must be calculated individually and then the prevailing price estimated at conversion further adjusted to account for the aggregate dilution.

Let's consider a sample calculation to illustrate the method applied in our analysis. [Barclays' 6.5% euro-denominated AT1 CoCo](#) has a conversion price fixed at €2.02 per conversion share and its translation into euros is fixed an exchange rate of £1.00 = €1.2231, establishing a conversion share offer price £1.65. At the date of issuance in mid-June 2014 the Barclays share price was c£2.35. Assuming 1000 at par, this fixed price translates into 606 shares per note upon conversion. With a

decline in the share price of c70% from the issuance date, the prevailing price at conversion would be £0.705, and 606 shares would be worth c£427 – implying a recovery rate of c43%. We adjust this figure to account for the dilution of the outstanding shares by the new shares issued at conversion; to calculate this, we need to consider *all* the AT1s issued by the bank. For Barclays, this includes seven separate notes for our calculation, some of which have conversion prices denominated in currencies other than sterling. The aggregate dilution is thus calculated at approximately 23%. This reduces our final estimate of the recovery rate to around 33%.

B. Percentage writedown

If a CoCo is subject to a writedown of principal upon breach of the contingency trigger, the loss is based on a pre-specified percentage that may be as high as 100%. There is no dilution of the equity shareholders. When a writedown occurs, the obligation to repay the CoCo holders is cancelled as is the schedule of coupon payments. If there is a write-back clause and the bank later recovers from distress, then payment of coupons may be reinstated. But missed coupons are never restored.

There are two main features, which occur in combinations:

- 1) Degree of writedown
 - a. **Partial:** A percentage of the notional is written down.
 - b. **Complete:** The full face value is written down.
- 2) Period of writedown
 - a. **Temporary:** The principal can be written back to its initial value once the bank's capital base is strengthened, with net profits used to reinstate the amount.
 - b. **Permanent:** An amount of principal is irretrievably written down.

The most common combinations are partial & temporary, followed by full & permanent, with a few cases of partial & permanent and full & temporary – as highlighted in the examples below.

1. Partial & temporary:

The temporary write-down AT1 issued by the [Bank of Ireland](#) (2015) states that “the Prevailing Principal Amount of each Security shall be immediately and mandatorily Written Down” at the contingency event by an amount that “would be sufficient to cure the Trigger Event” – under certain circumstances the amount may be written back. Similarly, the temporary AT1 issued by [BNP Paribas](#) (2019) allows for noteholders to “lose some or all of

their investment” and following such a reduction, at a later date “some or all of the principal amount of the Notes may, at the Issuer’s discretion, be reinstated”.

2. Full & permanent:

Most of the Swiss banks tend to have full write-down provisions, as stated in the prospectus of a [Credit Suisse AT1](#): “the full principal amount of each Note will automatically and permanently be written-down to zero.” Similar phrasing is used in [Santander’s AT1 prospectus](#): “Once the Principal Amount of a Security has been Written Down, it will not be restored in any circumstances, including where the Loss Absorption Event ceases to continue.”

3. Partial & permanent:

In some cases, a writedown may be staggered and occur in pre-defined stages. For example, in a note issued by Zuercher Kantonalbank, the face value is written down in multiples of 25% until the bank’s capital ratio recovers to a point where the capital trigger is no longer in breach. Another example is a note issued by Rabobank, in which the writedown is the product of a formula that takes into account the aggregated book value of all equity capital.

4. Full & temporary: Under the terms of the AT1 notes issued by Danske Bank, the principal amount will be written down when its CET1 ratio breaches the 7.0% trigger. At the issuer’s discretion, the principal may be written up to a maximum of the original amount.

Accounting for the loss effect on the balance sheet

CoCos are constructed such that they increase equity in a contingency event, to restore capital ratios. In writing down the principal, total debt due decreases – lifting the P&L account through retained earnings, which results in an increase in equity. If an equity conversion occurs, the debt value represented by the CoCo note disappears from the balance sheet and the equity value will be recalculated to incorporate any dilution effects. For either loss absorption mechanism, there would effectively be a movement from “liabilities” to “shareholders’ equity”, or from “other equity” to “shareholders’ equity” (in cases where AT1s are classified as equity), and from AT1 to CET1 capital for regulatory purposes. The accounting treatment of the two types of mechanisms might be somewhat different – a writedown would presumably be treated as a capital gain, in the same way as a discounted buyback – but the ultimate effect would be the same for either mechanism. Both boost the CET1/RWA ratio.

Upcoming coupon payments will also be cancelled, thereby lowering the interest expenses of the bank. By lowering these costs as well, retained earnings increase. The retained earnings are, through the P&L account, assigned to equity. For all banks, there will be some P&L fluctuations as a result of marking to market, such as by the underlying swap given that the coupon is documented as a spread to a benchmark. AT1s issued by UK banks are all equity accounted, which can create volatility due to timing mismatches – i.e., the hit is taken at a later date. The exact accounting treatment will vary, in part depending on whether the instruments are classified as derivatives.

3. Implied Recovery Rates

Given that the conversion prices and write-back clauses should play a key role in shaping the balance of incentives and the recovery rates, we will delve into each in more detail.

FIGURE 40: RECOVERY RATE: CONVERSION PRICE VS SHARE PRICE AT CONVERSION

| Conversion price | Prevailing price at time of conversion | | | | | | | | | |
|------------------|--|-------|-------|-------|-------|-------|-------|-------|-------|------|
| | 100 | 90 | 80 | 70 | 60 | 50 | 40 | 30 | 20 | 10 |
| 100 | 100% | 90% | 80% | 70% | 60% | 50% | 40% | 30% | 20% | 10% |
| 90 | 100%+ | 100% | 89% | 78% | 67% | 56% | 44% | 33% | 22% | 11% |
| 80 | 100%+ | 100%+ | 100% | 88% | 75% | 63% | 50% | 38% | 25% | 13% |
| 70 | 100%+ | 100%+ | 100%+ | 100% | 86% | 71% | 57% | 43% | 29% | 14% |
| 60 | 100%+ | 100%+ | 100%+ | 100%+ | 100% | 83% | 67% | 50% | 33% | 17% |
| 50 | 100%+ | 100%+ | 100%+ | 100%+ | 100%+ | 100% | 80% | 60% | 40% | 20% |
| 40 | 100%+ | 100%+ | 100%+ | 100%+ | 100%+ | 100%+ | 100% | 75% | 50% | 25% |
| 30 | 100%+ | 100%+ | 100%+ | 100%+ | 100%+ | 100%+ | 100%+ | 100% | 67% | 33% |
| 20 | 100%+ | 100%+ | 100%+ | 100%+ | 100%+ | 100%+ | 100%+ | 100%+ | 100% | 50% |
| 10 | 100%+ | 100%+ | 100%+ | 100%+ | 100%+ | 100%+ | 100%+ | 100%+ | 100%+ | 100% |

Note: For illustrative purposes only.

Conversion – estimating recovery

The schematic in Figure 40 above shows the conversion price and share price prevailing at conversion as a percentage of the share price at time of issuance. For example, if the conversion price were the same as the share price at issuance it would be 100%. For illustrative purposes, these two factors are combined in a matrix to calculate a recovery rate (assuming no dilution, for simplicity). At high conversion prices face values are all but eliminated, whereas at low conversion prices meaningful values can be recovered. CoCo investors stand to benefit the closer the conversion price or floor price is to the prevailing market price at the contingency event. The matrix

highlights that conversion prices drives the recovered value; therefore, *a valuation model should consider the conversion price as a primary input*, rather than be preoccupied with estimates of the share price level as is the case with the legacy literature. The conversion price is a known, published number cited in a prospectus. The prevailing share price, though unknown, will almost certainly be far below the price at issuance.

Writedown – estimating recovery

In the absence of any historical precedence for an AT1 with a writeback clause being triggered, it is difficult to estimate the potential for recovery. However, we can safely assume that the recoverable amount for a partial or temporary writedown is more than that for a complete and permanent writedown. The table below arranges the features into buckets to indicate the implied recovery rates.

FIGURE 41: RECOVERY RATE MATRIX – PERCENTAGE WRITEDOWN

| Recovery Potential | | Higher | Lower |
|--------------------|--------------------------|----------------------------|----------------------------|
| | | <u>Temporary Writedown</u> | <u>Permanent Writedown</u> |
| Higher | <u>Partial Writedown</u> | Temporary & Partial | Permanent & Partial |
| Lower | <u>Total Writedown</u> | Temporary & Total | Permanent & Complete |

Notes: For illustration purposes.

Clearly, *the recovery rate is dependent on the provisions in the prospectus*. Across the two types of loss absorption mechanisms, we can see overlapping scenarios – e.g., a partial and temporary writedown offers roughly the same recovery potential as a low conversion price in a severe share price decline. Therefore, CoCo investor preferences should be ranked roughly into the following categories:

- (1) low conversion price/no anti-dilution and temporary/partial writedown
- (2) temporary/full writedown and permanent/partial writedown
- (3) high conversion price/anti-dilution and permanent/full writedown

The capital adequacy trigger is being undermined

Given the degree of documentation of conversion and writedown loss mechanisms in memorandums, why is the mechanical capital adequacy trigger not a more significant factor in pricing in our regressions? We conclude that the lack of significance is due to the trigger levels being set too low. Specifically, we can identify the following reasons:

1. *The blurring of the distinction between ‘going’ and ‘gone’ concern capital*
2. *Investor perceptions that the non-viability event occurs before the contingency event*
3. *Recovery rates are irrelevant as investors are assuming bail-in at resolution*
4. *Risk-weights in the denominator are not trusted*
5. *The conversion CET1 trigger is subsumed into the SREP-MDA trigger, which kicks in earlier*
6. *The rise of the TLAC-MREL regime is eroding the older notions of ‘Tier 1’ and ‘Tier 2’*

The first four points we consider below. Points 5 and 6 are covered in the next chapter. Suffice it to say here that switching off interest payments following a breach of the MDA threshold is the first line of defence. In conjunction with the introduction of new ratios by which to measure the MDA threshold, the combined buffer requirements are transitioning to fully loaded levels that are considerably higher than at the inception of AT1s – bringing to the forefront the risk of coupon cancellation. *Given that the MDA threshold is above the capital adequacy trigger for principal conversion, it makes sense for the MDA cushion to predominate in risk pricing.* Moreover, with the rise of the new TLAC-MREL paradigm, pre- and post-resolution states are less discrete quanta.

B. PONV Power: Early Intervention

Going concern capital

The previous generation of Tier 1 bonds lacked clear language on going concern conversion in their documentation. The *raison d’être* for the creation of the AT1 CoCo class was to counteract this deficiency. The European Union’s initiative to transfer the responsibility for banking policy from the national to the EU level (European Banking Union ([BU](#)) envisions an enhanced level of intervention in a *going concern* situation – with AT1s a layer of capital that can detach and trigger independently at times of crisis without taking down the whole capital stack. AT1s are intended to play a critical role as the ‘first loss’ tranche, distinct from general bail-in capital.

In addition to mechanical triggers, CoCos have clauses defining a ‘point of non-viability’ event. Originally a clause only in Tier 2 CoCos, since January 2013, there has been a contractual PONV present in almost all CoCo memorandums. Non-viability is often regarded as the point immediately before an event of default, i.e., the core capital ratio deteriorating to a level that makes it impossible for the bank to continue as a going concern without the injection of fresh funds. In practical terms, non-viability is the moment at which the relevant authority determines that an ailing bank ceases to

be viable if capital instruments are not converted to help recapitalise the institution. A contractual point of non-viability stipulates that a viability event can be declared by a bank's regulator based on its assessment of the bank's solvency prospects. PONV conversion power is designated as a separate trigger in almost all AT1s prospectuses:

“To qualify as additional tier 1 under Basel III, capital instruments must provide for principal loss absorption through a conversion into common equity or a write-down of principal feature. The trigger for such conversion or write-down must include a CET1 ratio of at least 5.125% as well as *a trigger at the point of non-viability*.” – Credit Suisse memorandum

The viability event was made implicit within the rules on bank bailouts that were rolled out in 2015 such that an explicit ‘point of non-viability’ clause is no longer required to activate this form of loss mechanism for the principal. The current concept of non-viability was defined in two EU directives. To counter ambiguities about the classification of instruments in the write-down sequence, the European Banking Authority issued a document in April 2017 on the interrelationship between the earlier Capital Requirements Directive (CRD IV) and the resolution framework of the Bank Recovery and Resolution Directive (BRRD):

“when applying the bail-in tool or *the PONV conversion power*, the resolution authority should treat capital instruments which belong to the same category of the sequence established by Article 48 or Article 60 of the BRRD and which rank equally in insolvency in the same way, whatever their other qualities” (EBA, 2017)

The BRRD established the power of early intervention when an institution is likely to infringe on capital requirements. Under the BRRD, the power to write down or convert capital instruments may be exercised either independently of resolution action or together with a resolution action. CRD IV is more prescriptive and explicitly bestows on supervisors a range of powers in a going concern situation. In combination, resolution authorities are empowered to write down or convert subordinated debt such as AT1 and T2 CoCos *prior to a bank entering into resolution* if an institution is deemed to be failing or likely to fail.

Two main rules detail how bail-in would be applied upon the declaration of a PONV event:

1. The first guiding rule is that when applying the conversion power at PONV, the resolution authority should write down all instruments at the same time regardless of other untriggered contractual terms. This would override any legacy clauses, such as those that specify higher trigger CoCos have to be triggered before the low trigger ones.

2. The second rule is that instruments be written down to the same extent irrespective of their nuanced terms of conversion. Whatever the contractual clauses, therefore, AT1s would be bailed in entirely alongside other subordinated debt. Not only can the non-viability trigger be pulled at the discretion of the national supervisor, it completely trumps any other loss mechanisms.

Factors encouraging intervention vs waiting for automatic triggers

Though there are some stipulations for a resolution scenario, the conditions for early intervention are less proscriptive. There is no formal ‘forward guidance’ on what exactly would constitute grounds that would lead the supervisors to intervene. That said, annual stress testing is facilitating greater transparency as to what capital thresholds would motivate an early intervention. If the SREP score stemming from a stress test is low, this can function as both a leading indicator of a potential action or even as the actual cause for an early intervention. Should a financial institution’s performance show evidence of material and rapid deterioration in stress tests, the supervisor would have the ability to agree a restructuring plan. Specifically, a breach in the guidance set for Pillar 2 requirements would likely lead a supervisor to request a bank to present a capital conservation plan.

The inherent delay in reporting of an accounting ratio and the intimate nature of the supervisory-bank nexus both argue in favour of early intervention. Supervisors aim to avoid entry into resolution and are likely to intervene at an early stage of distress so long as negative signalling does not overwhelm the benefits of proactive involvement. It seems reasonable to think that a systemically important financial institution is not likely to be allowed to fail without extensive attempts at recapitalisation. Early intervention could come no later than at the point of non-viability and so presupposes a PONV higher than the current contractual levels of the capital adequacy trigger.

1. Asymmetry of information

The main reason CoCo covenants allow for regulatory discretion is the asymmetry of information. Senior management at a bank would be able to see the balance sheet between quarterly reporting dates. Bank management can detect the emergence of capital shortfalls and share such detailed information on asset value with their national authority. The supervisor can then converse with management about a course of action, with the decision-making largely behind closed doors. A bank might find many methods to bolster its capital position with actions directed toward either the numerator or denominator. Measures such as a capital increase, asset sale, a shake-up of

management or *a writedown of AT1 securities* could all be requested by the supervisor. A proactive solution could also include sovereign-sponsored restructuring or some form of capital raising, which pre-empts the de jure CET1 ratio trigger. The supervisor could request such prescriptive measures well before a bank reached outright insolvency.

The distinction between automatic thresholds and supervisory discretion may thus prove tenuous in practice due to the inherently lagging nature of disclosures. Conversion can only occur once a bank admits publicly to failing to satisfy certain requirements. Prior to making such an admission, bank management is almost certainly to have spoken with its national supervisor. As agreeing the next steps after such an admission is impossible without supervisory sign-off, ‘automaticity’ is rendered de facto a discretionary decision as it is dependent on the go-ahead from the supervisor. This challenges the proposition that a quarterly reported accounting metric can ever really function as the actual trigger. The effectiveness of any metric depends on the frequency with which it is disclosed, which in the case of the CET1 ratio is at best quarterly. In a roiling market the lagging nature of the CET1 ratio may make it an afterthought.

2. *Lagging indicator*

A central problem with accounting-based triggers is that the metrics may fail to capture the true financial condition of a bank in a timely manner. Capital ratios ultimately depend on the availability and quality of balance sheet information. With accounting standards and methods varying across regions, the interpretations of a risk-weighted ratio are inherently subjective. While stocks and bonds are valued by forecasts based on reported earnings and cashflows, what distinguishes AT1s from other securities is that they embed automatic triggers based on *reported* (not forecasted) CET1 ratios. The calculation of key capital ratios will always, by definition, occur before the publication of results. Given the several months between the end of each quarter and the next, the conditions for a contingency event are more likely to have happened in between quarterly disclosures. This structural lag, with the reported CET1 always backward-looking in nature, means the actual state of a stressed institution may not be publicly revealed in a sufficiently timely manner for AT1s to trigger due to their publicly disclosed capital ratios.

Indeed, the problem with lagging disclosures was clearly evident in the financial crisis of 2007/8. Several large UK banks – Northern Rock, Lloyds and RBS – reported sufficient regulatory capital in the months leading up to their government rescue by capital injection. The five largest US financial

institutions that either failed or were forced into government-assisted mergers in the last credit crisis – Bear Stearns, Washington Mutual, Lehman Brothers, Wachovia and Merrill Lynch – all had total risk-based capital ratio ranging from 12.3% to 16.1% as of their prior quarterly disclosures, well above the regulatory minimums at the time (Kuritzkes and Scott, 2009). In short, had these banks held contingent capital with triggers based on the book value of equity, such CoCos would not have converted before the taxpayer-funded capital injections.

3. *Other risk metrics could trigger PONV*

A further incentive to intervene early is that other measures of capital strength might start to discount impending insolvency. Non-viability cannot be defined purely in terms of the CET1/RWA ratio; a broad range of credit metrics must be monitored to signal the moment when an issuer's credit fundamentals materially deteriorate to a point at which the supervisor intervenes. Bank failures may occur for reasons other than a lack of regulatory capital in reported numbers, such as liquidity concerns or funding markets freezing due to a collapse in confidence. Any combination of negative scenarios could cause enough concern for a supervisor to invoke its PONV powers such as unauthorised trading losses, litigation fees, changes in tax laws etc.

The regulator's open-ended definition of viability might expose investors to a range of interventions based on measures of financial health other than CET1 ratios. The decision to declare a non-viability event has, historically, been heavily influenced by whether or not there is a run on bank deposits. Regulators are more prone to intervene to safeguard retail investors. If there appears to be a risk of a run on deposits, a viability event is likely to be invoked, as in the instance of Banco Popular. That episode highlighted how deposit flight and liquidity can come into play.

C. Bail-in Capital: The Tendency for Forbearance

The supervisor might delay intervention much longer in practice, in attempts to resolve problems behind the scenes or due to an inability to reach agreement among the interested parties. A study by McCunn suggests that forbearance incentives undermine the distinction between going and gone concern capital, which could cause CoCos to activate 'late in the game' (2016). If each stakeholder group has an incentive to forebear, this will delay the onset of writedown or conversion until the resolution stage, when the regulator bails all debt in. *Forbearance could lead to AT1s not being triggered at all, by PONV or contractual terms, but simply bailed in along with other subordinated debt.* While the Basel Accords take a tough stance on regulatory capital levels, it is unclear how national authorities will

respond to the plight of an ailing domestic ‘national champion’. The non-viability trigger could be held back as a last resort, until it blurs with the bail-in option. The dilemma is that there might be no loss absorption for AT1s before outright default. *A perception by market participants that no automatic trigger, nor even early intervention, is forthcoming would greatly diminish the intended prudential benefits of CoCos.* The motivation to forbear could arise from any combination of the following incentives:

1. Fear of contagion

Once contingent capital proliferates across the banking system, there is an element of dependency on the weakest link: a rogue bank skipping a coupon or converting an AT1 could reverberate across the asset class. Amid a growing awareness of the attendant risks, the European Markets Authority has warned about: “... potential price contagion and volatility to the entire asset class is possible” (ESMA, 2014). There are many channels of contagion:

- The triggering of an AT1 at one bank might spark a revaluation of risk in the notes of other banks, leading to unwarranted value destruction. There are also widespread cross-holdings of AT1s by banks, which could cause correlated knock-on effects.
- A related factor is that the AT1 market tends to attract ‘tourist’ money from funds that are chasing yields. As a largely off-benchmark asset class with a relatively small dedicated base of investors, if the AT1 market as a whole began to draw down, index-orient funds could return to benchmark weightings to avoid further underperformance.
- There is a latent risk of short-selling by CoCo holders of the equity of the bank that issued the instrument, as a hedge against the possibility of loss from conversion; this could potentially amplify the downward spiral of a bank’s stock and send systemic reverberations across to the shares of other banks. This is the ‘death spiral’ risk discussed earlier in the section on incentives.
- A spike in equity price volatility during periods when AT1s start to trade closer to trigger thresholds is possible. While price volatility for other debt instruments might stem from situations in which CoCos are nearing conversion thresholds, share prices are more liquid than bonds and therefore a more accessible way to express a view on potential conversion.
- Liquidity risk could arise in relation to bond funds unable to hold equity. Fixed income funds might be unable to warehouse the risk of AT1s converting into equity, making them in effect ‘forced sellers’ should conversion risk rise sharply – in turn, igniting contagion.

2. AT1s may not be sufficiently discrete

AT1s were intended to be a discrete component of the capital structure. However, in February 2016, concerns over the cancellation of coupons on Deutsche Bank's AT1s fuelled a sell-off across the bank's securities that soon spread to the CoCos of other issuers. Rather than isolating the risk around distributions by simply allowing the coupon barrier to be hit in order to help replenish the bank's capital position, Deutsche Bank hesitated. Once uncertainty over interest payments on its AT1s surfaced, other bonds in the bank's capital structure started to trade down. The bank tried to defend its AT1s for fear that a sign of vulnerability in one debt-like instrument might lead to a widespread loss of confidence in all of its bonds. Deutsche Bank did not allow its AT1 CoCos to fire independently. Instead, as an expedient, it redeemed other subordinated debt to improve its reserve levels to ensure it could service the interest payments on its AT1s. Also, in response to the market-wide correction in the asset class, the EBA issued fresh guidance on the calculation of the combined buffers that was more lenient in the phasing in of fully loaded CET1 levels.

The episode of turbulence sparked by worries over Deutsche Bank's AT1 coupons was one of the first tests of the new instruments, to see if pressures to resolve capital shortfalls would overcome the consequences of adverse signalling of financial weakness. Its outcome called into question the notion that a coupon can easily be cancelled or that a CoCo will be allowed to break off from the rest of the capital stack and convert in isolation – i.e., that AT1 triggering can be a discrete event.

3. The AT1 layer may be too thin

Is the AT1 layer large enough to restore the fortunes of a faltering bank? The motivation to delay may lie in the thinness of the AT1 layer. There may not be enough AT1s to make early intervention worthwhile, as these notes may not on their own solve the causes of a capital shortfall. A balance sheet may be too damaged to be repaired solely by triggering AT1s. Writing down 1.5% to 2.5% of the capital stack might not suffice to steady a bank that is in danger of capsizing. It may be that the frontier between survival and failure is too stark to admit an experiment by bank managers and their supervisors to test whether a bank can survive as a going concern by only impairing its AT1s at the risk of jeopardising the rest of its capital structure. Such uncertainty may deter early triggering.

Recovery rate doesn't price as investors assume bail-in at resolution

If we assume 'market discipline' applies, the recovery rate should be essential in the valuation by investors of the coupon required to take on the risk of a loss of principal. Hence, the features which

drive the recovery rate are specified in the prospectuses of AT1s – and many researchers assume that the incentives related to principal risks are important factors in pricing behaviour. Our finding that the recovery rate is not a driver of pricing poses serious doubts about the role of market discipline in the current design of AT1s. Why is the recovery not a prime factor?

There may be some behavioural economics at play, given that at the time of issuance the thought that the issuing financial institution's share price might collapse is not easy to countenance. Believing a bank is fundamentally sound to warrant investment whilst also assessing the prospects of an extreme tail-risk event is not an easy task. This balancing act may be why banks do not seem to be pressured to adopt CoCo-friendly conversion prices. Take the example of RBS; it came to the market in August 2016 with an AT1 note whose conversion price was the sterling equivalent of \$2.284 (c£1.75) when the current price was about £1.90. Hence, the conversion price was only about 8% below the share price prevailing at the date of issuance (subject to limited anti-dilution provisions). With such a high conversion price, the AT1 holders would be virtually wiped out in the event of the capital adequacy threshold being breached. Note also that in an earlier AT1 issuance by RBS, the conversion price was fixed at c£2.75, c20% below the prevailing share price but subsequently well above the share price at the time of the latter issuance – so investors in the August 2016 AT1s should have had this risk well flagged. That both tranches of RBS AT1s were heavily subscribed despite extremely high conversion price levels underscores how little the recovery potential is a factor in investors' perceptions.

The failure of the recovery rate to price may also reflect a general perception that any bank sufficiently stressed to trigger its CoCos would likely see its equity severely decline and its write-up prospects severely constrained – making all CoCos converge on 'wipe out'. The case of Banco Popular Español in June 2017 would support such a view, as its convertible AT1 holders were left with a worthless asset. The bank's equity was written down to effectively zero, such that the conversion price level never came into play at all. In this case, the conversion ('floor') prices for Banco Popular's two CoCos were already c100% above the stock price by March 2017. Once bailed in at resolution, CoCo holders can expect zero recovery value but would be no worse off than creditors holding other Tier 1 or even Tier 2 securities. *The reason why the recovery rate does not price may be that it is presumed to be negligible if not zero.*

At what point is non-viability invoked?

The current framework requires all AT1 and T2 securities to have a PONV trigger (explicitly or implicitly). This effectively gives the local banking supervisor the discretion to intervene if they doubt an issuing bank's ability to remain solvent. This option *empowers regulators to override any other formulation* of the loss absorption mechanism and is intended to counteract the limitations of accounting measures with respect to timeliness and reliability. This discretionary power, while meant to reassure, also injects uncertainty over the actual timing of the activation of the viability event. In a valuation model, to assume the trigger level will strictly be at a reported CET1 level exactly as stated in a prospectus encourages a false precision. The non-viability point is difficult to determine, let alone quantify in advance, given that supervisory judgements may differ by jurisdiction and there are a multitude of scenarios in which it can be invoked, including liquidity-related crises.

For conversion to be activated by a low trigger, the supervisor would need to allow the reported CET1 figure to decline to 5 1/8th percent. It is difficult to image a high-profile bank publicly posting losses that slashed its CET1 ratio that low without a collapse in confidence in its securities. A bank entering into such an advanced state of duress would probably already have its AT1s marked down to next to nothing. A comment by one of the rating agencies gives voice to this widely held view: “Since the trigger [5.125%] is below the Swiss minimal requirements, *we view the possibility of these notes being permanently written-down as highly theoretical (except in resolution)*” (Scope, June 2016). Similarly, Moody's states that the 5.125% triggers are likely at or below the point of non-viability: “Our view is that Basel III's suggested 5.125% common equity Tier 1 trigger meets the threshold for a trigger that is close enough to the point of nonviability for us...”

Although investors prior to the inflation in capital stacks tended to think non-viability was between 5 1/8th and 7%, perceptions of the PONV trigger level have adjusted higher to account for the large buffers. However, it is not certain if PONV is above the 7% level. AT1s with so-called ‘high’ conversion triggers are supposedly constructed to absorb losses *prior to resolution*. Although rare, there might be situations in which the CET1 ratio dipped to 7% without a bank going into formal resolution. For example, if the reallocation of capital within a group led to a sudden collapse of an affiliate's CET1 ratio. In the case of Unicredit in May 2019, the CASHES component of the bank was under consideration to be made ineligible as CET1 capital. One option open for Unicredit was to declare a conversion of the group's AT1 securities due to an increased burden event, though that

might have faced legal counterchallenges from CASHES investors. Another example is that of ABN Amro, which disclosed in September 2019 that it was subject to an investigation by the Dutch public prosecutor into allegations of violations of laws about the prevention of money laundering and financing of terrorism – this could have led to very large penalties. It is thus conceivable that an intragroup reallocation, heavy fines or even a failure to refinance could take a bank's CET1 down to c7%, if the supervisory authorities permitted this course of events.

If the viability event were above the pre-agreed contractual threshold, the conversion trigger would be irrelevant. AT1s with 5.125% triggers comprise almost half of the asset class. Investors may see the risk/reward ratio on such CoCos as more compelling, premised on the belief that before the capital ratio can breach the low trigger, the supervisor would have stepped in to place the bank in resolution. If an investor is comfortable with the credit profile of an issuing bank, then it may make sense to buy its riskiest subordinated instruments to get the highest yield on offer on the premise that in a stressed scenario all subordinated debt is essentially wiped out anyway. According to this line of logic, getting paid a premium over a straight bond is attractive if there is hardly any difference in the risk profile between CoCos and a plain subordinated debt.

In practice, there may be two almost concurrent contingency events. The bail-in provisions to banks' capital instruments means that if the going concern becomes a gone concern, then there is for all AT1s an implicit 'second contingency clause,' the point at which a national authority judges that a bank needs to enter resolution. An AT1 may be bailed in with the rest of the bank's subordinated debt if the bank goes into resolution. A conversion price or write-back clause on a going concern security provides investors with a manageable approach to estimating recovery values; however, *if conversion/writedown and bail-in happen simultaneously, a conversion price or write-back lacks any meaning.* Any principal recovered would be wiped out by a decision of the supervisor to bail in all subordinated debt in resolution. In the instance of the Banco Popular forced conversion, we saw such an application of the rules. The credit hierarchy was disregarded, with Tier 2 debt written down at the same time as its AT1 notes, and the PONV trigger exercised even though the bank's reported risk-weighted equity was nowhere near the level for a contingency event. *This precedent narrows the gap between all forms of TLAC-MREL-eligible securities.*

RWA sensitivity – A fulcrum for competing incentives

The entire regulatory framework is based off a representation of capital as a ‘percentage of RWA’. This approach considers assets with regards to their credit risk on the assumption that risk weighted assets provide a better means to compare provisioning across institutions, given that each bank engages in a different mix of business activities. This approach is also supposed to incentivise banks to hold less risky assets on their balance sheets. A bank can cut back on risky loans or sell a portfolio of non-performing loans – such actions would reduce its RWAs.

As the CET1/RWA ratio has two components, banks can boost their core capital ratios in two ways: (1) retaining profits/issuing new shares or (2) reducing assets/adjusting risk weights. Either the common equity has to rise, or the risk-weighted assets decline. Vice versa, although it is common to refer to shortfalls in required ratios in terms of the amount of core capital, an increase in the risk-weighted assets can also lead to an erosion of capital cushions. A consequence of risk weighting is that the denominator of the CET1 ratio is subject to redefinitions and rebasing in light of changes in rules. In assessing the prospects for principal conversion or an MDA restriction, therefore, equal consideration must be given to the prospects of a rapid inflation of the RWA: “*The trigger could be activated either through a material loss in capital as represented in the numerator or an increase in risk weighted assets as measured in the denominator*” (ESMA, 2014).

Optimisation

The calculation of RWAs can lack transparency and consistency across banks. Banks can opt to use internal models or standardised approaches, either of which must be approved by the national authorities. The figures disclosed are generally modelled outcomes, with assumptions differing by institution. Optimisation methodologies are employed in relation to a bank’s business activities. There are more opportunities to optimise at large institutions with investment banking franchises, which tend to rely on optically increased capital ratios by reducing risk-weighted assets. Some institutions with investment banking operations have RWAs of only 20% of total assets, although the rough average across the sector is c30% RWAs. This means a capital ratio of 10% is equal to 3% of total assets or as little as 2% for some banks. Such low RWA intensity is abetted by the long-standing zero risk weight for sovereign debt. This contrasts with the high RWA intensity in the case of loans to small businesses. The hoarding of sovereign bonds is ‘capital light’, whereas lending for

the real economy is capital intensive. *The subjective aspects of risk weighting assets and its feed through to the CET1 ratio makes risk-weighting the fulcrum around which contrasting incentives may become unbalanced.*

RWA inflation

The absolute amount of capital raised has increased in recent years off the back of a regulatory push, causing the CET1/RWA ratio to trend higher across European banks. However, there are also projects to toughen standards for risk weighting, which may cause downward pressure on the ratio. Reforms referred to as ‘Basel IV’ cite stringent criteria and apply a tougher accounting methodology to calculate RWAs. The use of internal models is more limited under Basel IV and must include minimum values for important parameters, such as the probability that certain types of loans might go bad. If a bank’s internal model to calculate credit risk yields a figure below a specified level, an agreed floor will be used instead. The output floor should limit the degree of deviation from a standardised approach to risk weights. The aim of the reforms is to constrain the ability of banks to excessively reduce capital requirements by gaming via internal risk models. While this development should improve the assessment of credit risk on the whole, low quality assets sometimes benefit from the standardised approach. The planned implementation called for a 50% floor to come into effect in January 2022, followed by subsequent increases up to a final floor of 72.5% in 2027. The threat to RWAs from Basel IV was delayed due to the Covid-19 crisis and has now been pushed all the way out to 1 January 2025, *some three years on from the initial target*, taking the pressure off of RWAs. There will still be leeway, particularly for mortgage lending, as the regulation allow for discretion, i.e., a “supervisory specified risk weight” can be applied by the national authority.

Potential impact

Banks are starting to see higher risk weights off the back of the ECB’s TRIM exercise ([Targeted Review of Internal Models](#)) and the roll-out of regulatory mortgage floors in some jurisdictions. TRIM is estimated to reduce the CET1 ratio of EU banks by a paltry average of c20-25bp, with a diverse spectrum of impact across the banking sector. The move toward harmonisation of internal risk models along with changes to calculations for market and operational risk is resetting the base for risk-weighted assets. In its quantitative-impact study, the Basel Committee on Banking Supervision has estimated that the proposed floor will cause RWA inflation of between c25% to c30% through to full implementation. This means European banks will see an aggregate adjustment higher for their RWAs in coming years, and hence downward pressure on their CET1/RWA ratios.

The dispersion between banks is considerable though, ranging from single digits up to almost 50% at individual banks.

The impact of RWA inflation will be uneven and heavily influenced by national jurisdictions. This has roused questions about the weighting of specific assets, e.g., deferred tax assets in the south of Europe. Although there is a prolonged phase-in period, some jurisdictions may move faster than others. For example, the Dutch regulator (DNB) plans to introduce risk weight floors for domestic mortgages not covered by its national scheme. The DNB believes that the risks inherent in the mortgage portfolios of Dutch banks may be underestimated and is therefore increasing to 14-15% on average from the current 11% the risk weights on mortgage loans, via a floor. This change came into force in autumn 2020, bringing forward risk-weight floors that will eventually be rolled out Europe wide. Similarly, in the UK, a review of risk weights for commercial real estate may impact the RWAs of British banks sooner than in other jurisdictions.

RWA inflation may be counterbalanced by even greater inflation in regulatory capital. According to some estimates, Basel IV might only increase banks' capital requirements by c9% on average by 2030 at the end of a 5-year transitional period. The reference CET1 is being rebased against not only Basel IV revisions but also by updates to accounting methodologies in IFRS 9, which may front load the booking of expected losses. Taken together, these changing standards are introducing volatility into a metric at the heart of AT1 triggers: risk-weighted assets. Not only the capital adequacy trigger but also the logic of coupon restrictions is impacted by RWA-related redefinitions. The current cohort of AT1 contingent capital, with its fixed capital adequacy triggers, was not designed to be completely futureproof against such regulatory-driven changes.

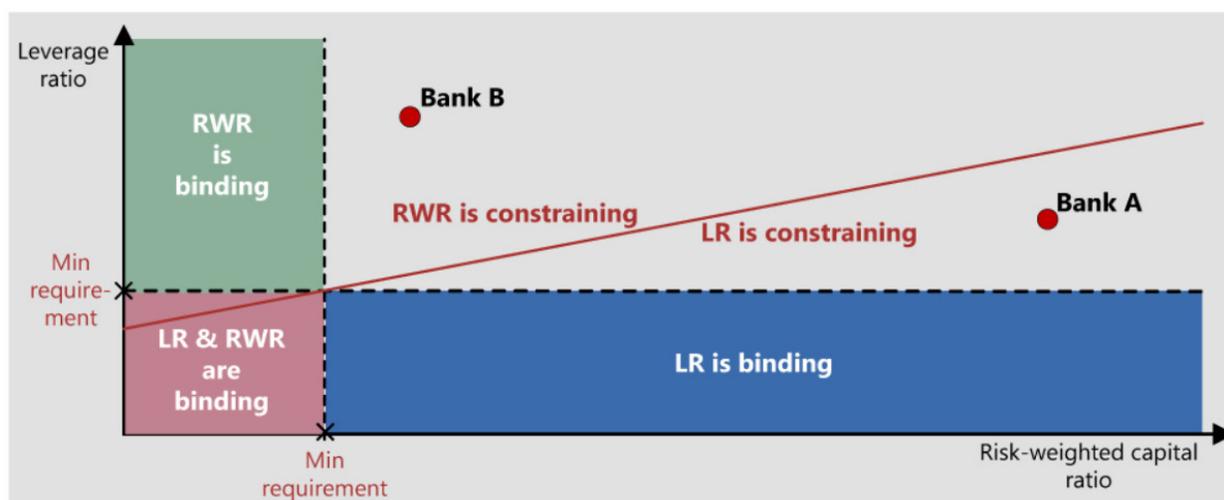
Leverage ratio

In addition to the scrutiny on the risk weights, leverage ratios and other measures of bank health must now be included in any assessment of AT1 risks. Even while a bank might not be in breach of its combined buffers, *supervisors may become concerned if a bank does not meet its leverage or liquidity requirements*. Inclusion of the leverage ratio as a strict requirement is intended to help remove the distortions of risk weights for assets. The leverage ratio is calculated by dividing a capital measure by a total exposure measure. This exposure measure is the 'sum of the exposures of all assets and off-balance sheet items'. Basel III introduced a 3% ratio on non-risked total exposure as a backstop to

risk-based capital measures. This minimum has been adopted internationally with the level for systematically important financial institutions set at 6%.

The diagram below represents the method of calibration in setting the related requirements. The RWA densities are calculated as the ratio of risk weighted assets to total assets by bank. RWA density will increase as the changes introduced by the regulators are implemented. The diagonal line represents combinations of the leverage ratio and the CET1 ratio for which the banks' density ratio equals the minimum threshold (leverage ratio requirement divided by CET1 requirement). This visual representation roughly represents which of the two ratios – leverage or CET1 – is likely to form a constraint. In this schematic, both banks meet minimum requirements, but Bank A may become constrained by the leverage ratio whereas Bank B may be constrained by the CET1 ratio.

FIGURE 42: LINKAGE OF THE LEVERAGE RATIO TO CET1 RATIO



Source: Bank for International Settlements (2015).

Risk weighing can be subject to ‘manipulation’, as was a paramount concern during the 2007/8 credit crisis. Leverage is more straightforward and does not rely as much on risk modelling, so it should provide a clearer picture when comparing across institutions.

The relevance of RWA inflation depends on how close a bank’s CET1 ratio is to the minimum requirements within its jurisdiction. Consider the Nordic banks, with their CET1 ratios far above the European average. Relative to most other countries in Europe the reported capital ratios are high for the Nordics, with CET1 ratios from 16.4% to as high as 19.4% with 18.2% and 18.9% for Danske

Bank and DNB ASA (as of Q3 2020 disclosures). These elevated capital ratios are largely due to the extensive use of internal ratings-based models for risk weighting. So, although there is a greater risk of depletion of the CET1 ratio due to RWA inflation for the Nordic banks, this will be against a high base. These same banks normalise with leverage ratios between 4.3% (Danske) to 6.8% (DNB), close to the average of c5.0% for a wider European peer group. The straight leverage ratios suggest that Nordic banks are not as robust as the risk-weighted capital ratios indicate; reinforcing the point that CET1 ratios partially depend on favourable assumptions built into internal methods for the risk weighting of assets.

Banks may accelerate deleveraging efforts to mitigate the effects of RWA inflation. In most jurisdictions, Additional Tier 1 can count toward the ‘Tier 1’ numerator of the leverage ratio. Therefore, banks are encouraged to issue more AT1s as a means of meeting their leverage ratio requirement. It may well be cheaper to issue AT1s than common equity and hence preferable to use AT1s to address leverage ratio targets, even after the 1.5% AT1 bucket is already filled. Their lower funding costs is one reason why some banks are already holding greater amounts of AT1.

CET1/RWA ratio is too ‘managed’ to drive quarterly swings

Although intended as a broad gauge of overall health, the CET1/RWA ratio is not like other financial items on the balance sheet in that it is a *regulatory accounting measure*. It is managed in a manner that can make it somewhat removed from the economic environment and commercial realities facing a bank, as the ratio is sensitive to changes in the rules as stipulated or guided by the supervisory authorities. Accounting changes planned by the Basel Committee influence capital calculations. Capital ratios can change levels merely by an alteration in rules. As cited earlier, the ‘Basel IV’ update to the calculation of risk weighted assets may see RWAs inflate by c30% in the coming years because the regulator has decided that it wants to be more conservative on risk weights across the whole banking sector. Given the heavy degree of supervisory discretion involved, it is no surprise that the ratio is not really trusted enough for investors to trade its quarterly changes – though changes in the level do influence the outlook on a bank’s credit profile over time.

Moreover, there is the prospect of a simultaneous shock to both the numerator and the denominator, e.g., sovereign debt could be written down and/or re-evaluated in relation to risk weightings in the wake of a future crisis. Indeed, netting assets versus the liability side of the balance

sheet implies that at times of stress – when liabilities will remain, but assets will decline in value or vanish – a dual shock to both components of the CET1/RWA ratio is even likely.

Conclusion: Automaticity vs discretion for principal risk

That the contingent trigger is not being priced as a tripwire implies an expectation that the supervisor will intervene before the pre-agreed capital adequacy barrier is breached. If the viability event occurs at a higher CET1/RWA ratio than the contingency event, then the capital adequacy trigger levels are superfluous. To function autonomously, the CET1 ratio threshold at which the automatic triggering occurs needs to anticipate the levels at which the PONV power is likely to be exercised. *The absence of a prominent pricing effect for the capital adequacy trigger suggests that the market perceives the viability event to be higher than either of the established automatic triggering levels – 5.125% or 7%. A mix of PONV power and bail-in provisions makes the existing high/low triggers price the same and the distance to the capital adequacy trigger hardly price at all. There is almost no significance in our regressions for loss mechanisms, trigger levels or buffer sizes due to a perception that the supervisor will determine the timing of conversion irrespective of pre-agreed contractual terms. These findings compel us to conclude that the design of the triggers must be revisited.*

According to the rating agency Fitch: “High expected loss severity, *relative to senior unsecured debt*, and full management discretion regarding coupon omission are overriding credit factors for this asset class.” Investors and agencies must expect losses to be imposed on AT1s well in advance of resolution for distinct contact features to be accurately discounted. If AT1 CoCos are perceived to be only subject to bail-in at resolution, the unique loss absorption mechanisms that distinguish the instruments from ordinary subordinated debt will fail to price. Indeed, it is precisely this failure to price that we are detecting in our empirical findings. Among the consequences of a perception that invocation of PONV power may be delayed until resolution is that it negates the notion of recovery value. The later the conversion, the lower the recovery rate. At resolution, irrespective of conversion rates or write-back clauses contained in individual prospectuses, all AT1s end up with zero recovery. There should be clear water between AT1s with high recovery potential and those with low or no recovery rates. That this is not the case calls into question the presence of appropriate market discipline. *That we find recovery potential is not a factor in pricing suggests a view among investors that conversion will not occur until resolution.* At present levels, the distance to the principal write-down/conversion trigger is not a significant variable to be modelled in valuation. *The capital adequacy trigger must be raised in accordance with a formula that reflects SREP scores for the first generation of CoCo valuation models to have any*

relevance. Unless these steps are taken soon, AT1s as gone concern capital would be “...reduced to an overly complex version of bail-in debt, enabling tax deductibility as debt (at least in Europe) while only pretending to be equity” (Glasserman, 2013).

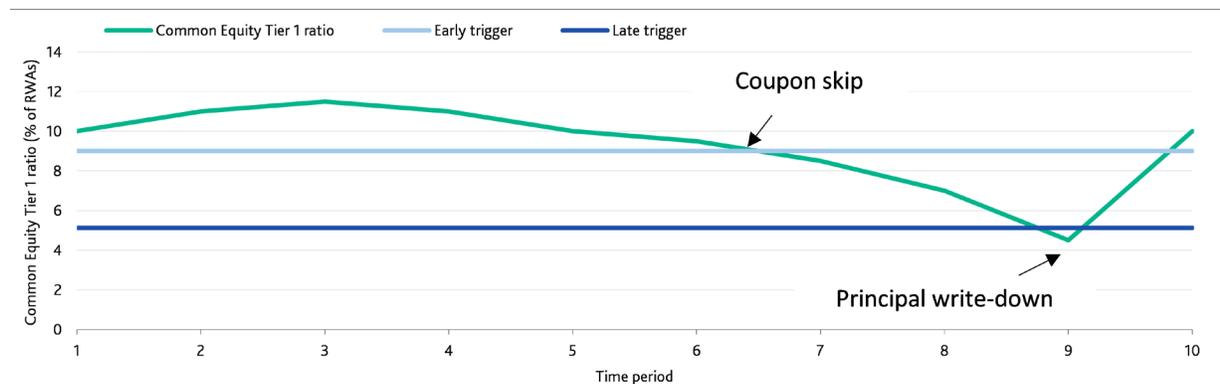
We conclude that AT1s cannot be valued purely by quantitative models because not all of the relevant numbers are publicly available in a timely manner, and much can be done by management behind the scenes proactively with the supervisor prior to disclosure, unless the triggers are set higher. A bank’s supervisor can decide to convert early before the automatic trigger, or late when the bank is already in resolution. How can one model in advance a supervisory authority pulling the non-viability trigger on a CoCo bond? Although ‘catbars’ adjustments could be introduced into a quantitative model, analysis of the full spectrum of scenarios and the matrix of incentives involved in each situation is required to adjust priors and improve predictions as in advanced game theory. It is not our view that the earlier models are wrong per se, although the overreliance on equities to reformulate a market-trigger is flawed and the incorporation of coupon and reset triggers is incomplete. *Our view is that the overlay of supervisory discretion tends to undermine automaticity, and that this tendency is especially pronounced when the capital adequacy triggering thresholds are set too low.*

XI. Coupon Risk – The MDA Threshold, A Moving Target

A. Automaticity for AT1 Coupons – MDA & ADI Barriers

Basel III introduced mandatory restrictions on distributions and these rules were transposed into EU legislation by the Capital Requirements Directive (CRD IV) in the form of the Maximum Distributable Amount (MDA). The purpose of the MDA restriction is to ensure that capital in the combined buffers is restored from the ongoing earnings of a bank. Once the combined buffers are breached, a bank is no longer obliged to pay certain liabilities in full – dividends to shareholders, bonuses to employees and *interest payments to AT1 holders*. The MDA threshold shares the attribute of automaticity as a defining characteristic with the trigger for the principal writedown. Both triggers are designed to automatically inject/retain high-quality capital once a pre-defined threshold is breached. Given that interest payments on AT1s have a higher capital hurdle to clear and are fully discretionary, coupons should be written off *before* the contingent event of conversion/writedown. The loss of future interest payment streams on AT1s can be as serious as the loss of principal and should be modelled as a central feature in valuation techniques.

FIGURE 43: CAPITAL TRIGGERS – COUPONS TAKE THE HIT EARLIER THAN PRINCIPAL



Source: Moody's.

AT1 coupons are non-cumulative, and their cancellation does not constitute an act of default as it would for most debt instruments. Coupon omission occurs as an independent event. As shown conceptually in Figure 43, the mechanism of coupon omission runs parallel to the mechanism of principal writedown. Cancellation of AT1 coupons is intended to be the first line of defence, triggered when retained earnings decline sharply. If profitability problems persists and lead to a sharp erosion of capital, then writedown kicks in to replenish a bank's reserves. This sequence of

losses is intended to mirror that of equities, in which the dividend payments take the first hit before any contemplation of a rights issue.

Coupons are also subject to the risks associated with a principal conversion or writedown. In the event of a conversion to equity, coupons are cancelled. In a writedown that is temporary, a period of coupon omission will last until the AT1's face value is written back up. The loss of coupon can occur on any payment date and any number of times, such that each interest payment is, in a sense, subject to its own small trigger event. When one of two pre-specified barriers related to profitability and capitalisation are breached, the coupon knocks out – just as in the case of a typical structured note. AT1 holders could see their coupons written off for a year and then payments resume once the requisite capital levels are restored. An unlucky AT1 holder could, however, see coupons written off for the life of the note – the maturity of which might even be extended beyond the first call date to perpetuity. Hence, the combination of 'coupon miss' and 'call skip' can result in considerable losses.

To illustrate this, consider that most AT1s are issued with high coupons per annum with five years to the first call date and if skipped, the subsequent call date is generally five years later. An AT1 with a coupon of 7% and a maturity of five years would pay out roughly 35% of notional up to its first call date. An early cancellation of all the coupon payments, coupled with an extension from the first call date out another 5 years, would forgo as much as 70% of coupon payments – a similar impact to a principal conversion with a 30% recovery rate. A fund that invests in an AT1 note for which the coupon barrier is breached early will have effectively paid par value for a perpetual zero-coupon bond – thereby losing most of the investment value even without a full-blown writedown.

In sum, for AT1s the coupon is both more vulnerable to a trigger event than the principal and in aggregate a cancellation of coupon payments can entail losses almost as large as the conversion of principal. Hence, coupon-related barriers are central components in the loss absorbing capacity of AT1s and should be reflected in risk premiums – and be key inputs into any valuation methodology.

The determinants of coupon risk take the form of two, separate barriers that gauge the level of distributable reserves. Restrictions may be applied to payments on AT1s when an institution:

- A. does not fully comply with its 'combined buffer requirements' (CBR), or
- B. has insufficient profits in the form of 'available distributable items' (ADI).

Coupon restrictions occur if *either* the CBR barrier *or* the ADI barrier are breached.

1. Combined Buffer Requirement (CBR)

The new rules of Basel III left unchanged the total capital required as a percentage of risk-weighted assets (RWA) at 8%. However, several buffers were initiated to top up this core requirement: (1) the capital conservation buffer, (2) the countercyclical capital buffer and (3) the buffers for systemically important institutions. These three additional buffers vary by institution and jurisdiction but have been gradually phased in across European banks. The combined buffers – conservation, countercyclical and systemic buffers – sit *on top of the requirements* of Pillar 1 and Pillar 2. Under Basel III, banks must disclose their ‘CBR’ on at least the same frequency as minimum capital requirements. The CBR is an extremely important element of regulatory capital for AT1 CoCos since this buffer has a direct bearing on a bank’s ability to make discretionary payments.

Capital conservation buffer

The capital conservation buffer is typically set at 2.5%, although some banks have been allowed an extended transition period to achieve this level. Banks may draw down this buffer in periods of market distress, to allow them to lend to the real economy and continue other critical financial services. However, banks that draw on this buffer will be subject to distribution restrictions to ensure that the conservation buffer is rebuilt in due course.

Countercyclical buffer

The purpose of this buffer is to counteract the influence of the economic cycle on lending activity, making the supply of credit less volatile. The countercyclical buffer is time-varying and is intended to be built up during a period when an economy is booming and credit growth is strong. When the economic cycle turns or threats arise to a bank’s resilience, this buffer may be drawn down to permit lending to continue (or at least be less adversely affected). The supervisory authority fixes the level in accordance with the underlying economic cycle, ranging from 0% to 2.5%. For example, the Bank of England cut the countercyclical requirement for UK banks to 0% following the EU referendum result to reflect the increase in economic uncertainty.

Countercyclical buffers have rarely been above zero in most jurisdictions in Europe in light of the persisting sluggish economic environment. This has begun to change as sectoral countercyclical capital buffers become more prevalent. A sectoral approach provides for the possibility to address segments such as mortgages and corporate lending that do not track closely overall credit cycles. For example, banks under the supervision of the Swiss FINMA are obliged to hold a countercyclical

capital buffer equal to 1% of their risk-weighted mortgage-backed positions secured by residential property in Switzerland. Countercyclical buffers set in one jurisdiction may be applied to a bank's relevant exposures in those jurisdictions. If a bank lacks sufficient capital to fill the countercyclical buffer, the same distribution restrictions apply as for the conservation buffer.

Systemically important / Systemic risk buffers

Buffers are required for banks deemed to be systemically important financial institutions (SIFIs), i.e., those whose failure is likely to be associated with systemic contagion. The allocation into categories of “SIFI-ness” is in conformity with the G-20 agreed criteria that include size, cross border activities and interconnectedness. The purpose of the mandatory ‘surcharge’ is to reduce the moral hazard of implicit support from sovereigns by forcing banks to set aside extra reserves; it consists of two types:

1. The ‘G-SIB’ buffer applies to banks deemed to be ‘global systemically important’, as designated by the [Financial Stability Board](#). Many banks issuing AT1s are classified as systemically important on a global level, with others considered regionally or domestically important. The Board’s provisional list of c28 global SIFIs includes c19 European global SIFIs. The G-SIB buffer ranges from 1% to 3.5%.
2. There is also a buffer for an O-SII (other systemically important institution), which may be set by national authorities for domestically important banks up to a maximum of 2% of RWAs. This gives national bodies the flexibility to impose higher capital requirements on banks under their direct supervision. Such a requirement might be relevant in cases where a bank has large market shares within areas that are critical for the economy of a country.

There is a separate category for systemic risk not captured by the two SIFI buckets, called the systemic risk buffer (SRB), which can impose additional capital requirements on the entire banking system of a country. The SRB is not set on an individual bank basis but rather is applied to an entire financial sector or a subsector, in order to cover structural risks. Given its greater flexibility, national authorities may adapt this buffer to address local concerns. For example, the Netherlands has set a 3% systemic risk buffer to mitigate the long-term noncyclical systemic risk resulting from its large and concentrated banking sector. In the case of Switzerland, where the sheer scale of its leading banks dwarfs the domestic economy, the national regulator requires even greater capital reserves – the so-called ‘Swiss finish’. Thus, while the SRB tends to be fixed at close to 3%, it can be as high as 5% of RWAs in some jurisdictions.

In most instances, the highest of either the ‘systemically important institution’ buffer or the ‘systemic risk’ buffer will apply; however, if the systemic risk buffer applies only to domestic exposures, the overall requirements may be cumulative. As such, the overall SIFI/systemic risk requirements can vary widely by bank. Any shortfalls in capital for these buffers similarly result in constraints on distributions.

Breach of the combined buffers

Article 141(1) of the current Capital Requirements Directive states that an institution cannot make a distribution “in connection with Common Equity Tier 1 capital” if doing so would lower the level of CET1 to a point at which the combined buffers would be breached. Therefore, any payments must come from *own funds above the level of the combined buffer*. A shortfall in any of the buffers may prevent a bank’s from making distributions – i.e., paying out senior staff bonuses, pension rights, stock dividends, share buybacks or *AT1 coupons*.

SREP-MDA trigger

The maximum distributable amount (MDA) is the formal term for the restriction that comes into play when a bank is operating below the sum of its Pillar 1, Pillar 2 and combined buffer requirement. This threshold is variously known as the overall capital requirement (OCR) or more commonly as the SREP-MDA given that the OCR is set during the annual supervisory review and evaluation (SREP) process. The total SREP capital requirement consists of the Pillar 1, Pillar 2 and the combined buffer requirements.

The concept of the MDA was introduced in Article 141 of CRD IV, with the technical standards developed by the European Banking Authority and adopted in legislation by the European Union, to encourage banks to take steps to retain earnings as a means of restoring capital levels. The mandatory limitation on voluntary distributions is intended to enable banks to preserve high-quality capital. Distributions may be cancelled for any reason and for any period of time to slow the pace of capital depletion. While a distribution restriction might offer only minor benefits relative to a bank’s overall capital deficits, it is meant to instil discipline in the event of a loss which, if left unresolved, might lead to tougher measures or even insolvency. The ring-fencing of cash on the balance sheet should serve as an initial safety net. Strictly speaking, MDA is an EU directive and therefore not a Swiss concept. But Swiss banks are also prohibited from making coupon payments on AT1s if minimum regulatory capital requirements are not met.

The MDA represents the maximum amount an issuer can pay out and is calculated once a breach occurs. The greater the shortfall in common equity or income, the lower the amount of 'high quality capital' available for distribution. There is a sliding scale based on how far below the combined buffers a bank's capital has fallen, such that if a bank is slightly below the buffers and is retaining some earnings, it may still be able to make limited payments; whereas if a bank is far below the buffer requirements or not reporting any profit, AT1 interest payments will cease. Such restrictions remain in place until combined buffers are restored and/or available reserves replenished.

MDA formula

A formula calculates the degree to which the CET1 ratio is below the combined buffer requirement, as measured in quartiles. According to Article 141(4), the MDA is calculated as the sum of: (1) interim profits not included in CET1 capital and (2) year-end profits not included in CET1 capital minus (3) amounts that would be payable by tax if 1) and 2) were to be retained, *multiplied by a factor* set at: zero if the CET1 ratio not used to meet the own funds requirement is within the first quartile (i.e. the lowest) of the CBR; 0.2 if the CET1 is in the second quartile; 0.4 if the CET1 is in the third quartile; and 0.6 if the CET1 is in the fourth quartile. Put another way, the restriction on distributions is immediately set at 60% on breach of the CBR and once the lower bound quartile is reached no distribution is permitted at all.

Hurdle for CBR rises

On 18 December 2015 the European Banking Authority published a document stating its opinion on the interaction of Pillar 1, Pillar 2 and CBR on restrictions and distributions. Pillar 2 was split into guidance (P2G), which sits above the CBR, and requirements (P2R) which sit below. The boost in the level of the CBR significantly reduced the distance to the MDA threshold, compared with previous methods of calculation, which caused a great deal of anxiety at the time. However, this concern was ameliorated by the four-year phase-in schedule and a range of adaptations across national jurisdictions. Indeed, the splitting can be interpreted as part of the Pillar 2 interacting with Pillar 1 to become the de facto capital conservation and counter cyclical buffers. Such an interpretation is reinforced by the nature of the four-year phase-in that saw a roughly proportional lowering of the P2R with a raising of the CBR until the combined buffers were fully loaded for most banks by the end of 2019. By coordinating the phase-in of the capital conservation buffer, the MDA threshold shifted at a pace that allowed most banks to build up their capital reserves.

2. Available Distributable Items

Even if a bank fulfils its MDA requirements, it must also have sufficient Available Distributable Items (ADIs). EU banks may only pay coupons on AT1 instruments out of their ADIs, with coupons *mandatorily* cancelled if these reserves are insufficient. ADIs can pose a primary constraint when a bank is unable to generate earnings, such as when an operating loss or costly litigation eliminates profits. The quantum of ADIs is thus an immediate gauge of risk for AT1s in jurisdictions that have narrow accounting definitions, and it has proven to be a volatile number. While a link between ADIs and the ability to pay optional coupons is not new with Basel III as there have been similar restrictions applied to some legacy hybrid instruments, this accounting measure needs to be a central feature in the valuation methodology of AT1s.

Definition of profits

In formal terms, ADIs are defined as: “the amount of the profits at the end of the last financial year plus any profits brought forward and reserves available for that purpose before distributions to holders of own funds instruments less any losses brought forward...” CRR (Art. 4.1-128). In practice, ADIs are generally understood to consist of interim and year-end profits *not yet allocated to CET1 capital*. Institutions cannot use profits already allocated to CET1 capital requirements for distribution purposes. But this notion is still somewhat vague and has been subject to varying interpretation. What is clear though, is that a bank must measure its ‘maximum’ distributable amount based on the firm’s distributable profits in a given year. Whenever the sum of post-tax profits not yet included in CET1 is zero, any breach of the combined buffers will immediately entail an MDA of zero. The capacity to make discretionary payments is constrained by these reserves, which are in turn the reference sum multiplied by the MDA factor (0, 0.2, 0.4 or 0.6). So, in a sense *the MDA is ultimately bounded by the amount of the ADIs, in that the most that could ever be paid out is all of the retained income from the prior year.*

B. The MDA Trigger – A Game of Moveable Goalposts

MDA thresholds are now taken as the highest of several capital ratios

The coupon risk can be gauged by the distance to the MDA threshold. In an approximate sense, the MDA cushion is a bank’s current CET1 ratio less its CBR requirement. However, the height of the combined buffers is not fixed and will reflect changes in the CET1 allocation to minimum Pillar 1 and Pillar 2 requirements as well as for each of the components within the combined buffers. The

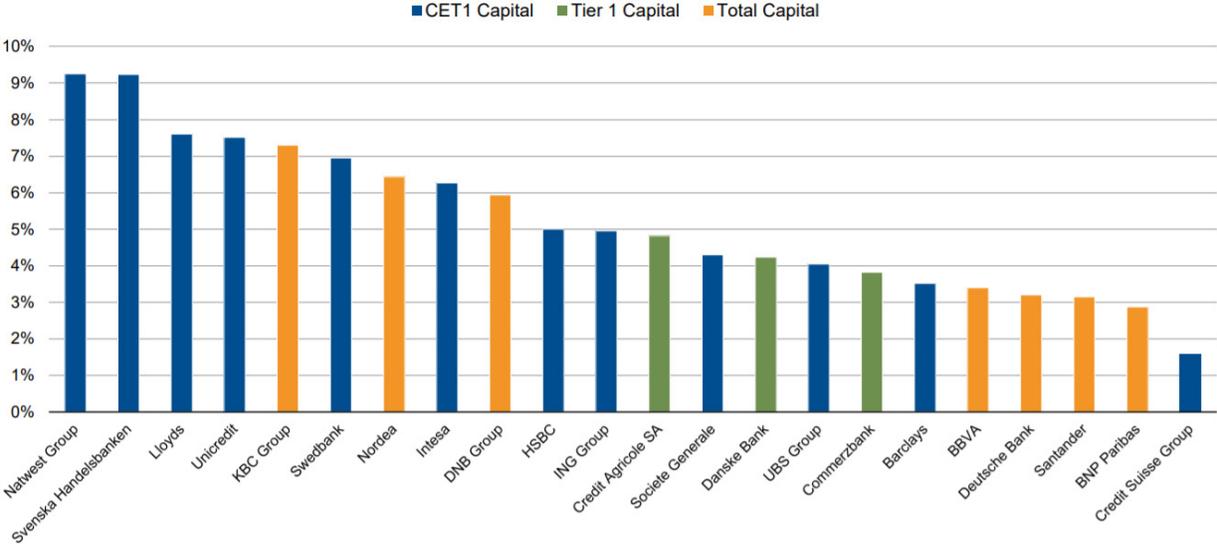
SREP-MDA trigger level is calculated by taking the highest of the CET1/RWA, Tier 1 and Total capital ratios. A breach of *any of these three metrics* may lead to coupon cancellation.

- i. CET1/RWA ratio = **Pillar 1** CET1 + **Pillar 2** CET1 + **CBR** CET1
- ii. Tier 1 ratio = CET1 MDA + Pillar 1 AT1 + Pillar 2 AT1
- iii. Total Capital ratio = Tier 1 MDA + Pillar 1 Tier 2 + Pillar 2 Tier 2

The MDA cushion will therefore be taken as the ‘narrowest’ of the distances to any one of these three ratios. That said, there is an element of holistic thinking here as elsewhere in the supervisors’ assessments. Discretion could be shown for a bank with a narrowing of headroom on its Tier 1 and Total Capital thresholds, to allow it to issue more AT1 or Tier 2 to boost its position. Similarly, if a bank’s calculation of CET1 were close to one of the minimum ratios, this might be deemed as tolerable for an institution growing its earnings compared to a bank with weak earnings capacity. *The point to stress, as it relates to our thesis, is that the level of the MDA trigger is shaped by the guidance of the supervisor in relation to a suite of capital ratios.*

The chart below shows the range of distances to the MDA threshold for a selection of European banks. Although there is a tendency to orient toward the CET1/RWA ratio in measuring the MDA trigger, the headroom to the Tier 1 and Total Capital requirements may be more relevant – as is the case for those banks highlighted in orange or green. The average MDA threshold was just over 10% at mid-2021 – for an average distance to the most relevant capital ratio of over 3 percentage points.

FIGURE 44: MDA CUSHIONS – DISTANCE TO MOST RELEVANT RATIO



Source: Reported earnings per bank for fiscal 2019, [Scope Ratings \(as of July 2021\)](#)

Studies of AT1s to date have dwelt on banks' CET1 capital positions. However, solely focusing on the CET1/RWA ratio will no longer suffice now that total loss absorbing capital requirements and leverage measures must be factored in. The implementation of MREL requirements constitute a constraint, in the form of an 'MREL-MDA'; a breach here could also lead to coupon omission, immediately or after a nine-month grace period. Furthermore, both the EU and the UK have proposed the introduction of a binding leverage-based MDA threshold ('L-MDA'), a breach of which triggers restrictions similar to the SREP-MDA. We discuss these new measures next.

Although still in flux, the evolving regime for loss-absorbing capacity and leverage is relevant in several ways to the valuation of AT1s, given that these developments:

1. **Raise the MDA threshold:** The foremost consequence is that mandatory restrictions on coupons could apply more frequently due to higher total SREP capital requirements.
2. **Add yet another layer of discretion:** Banks may be forced to maintain new forms of capital buckets that have their own rules, for which to interpret compliance.
3. **Spark demand:** AT1s can also qualify towards the extra loss-absorbing capacity and this is likely to boost their supply in the coming years.

1. The MREL-TLAC Regime: Implications for AT1 Coupons

Two closely aligned standards for recapitalisation are now being promoted, which impact the probability of AT1 coupon payments. One is the Total Loss Absorbing Capital ("TLAC") standard, which was adopted at the G20 level and is binding for the world's top banks. The other standard is the Minimum Requirement for own funds and Eligible Liabilities ("MREL") that applies to banks operating within the European Union. (British banks continue to be subject to MREL, though the [UK framework is under discussion](#).) A bank must fulfil these requirements at all times to ensure that it has sufficient recapitalisation resources. The two standards are closely related and share common objectives but take different approaches. The key difference is that TLAC applies to global systemically important banks with greater uniformity, whereas MREL applies only to banks active in the European Union and is institution-specific – with G-SIBs in the EU having to comply with *both* TLAC and MREL requirements.

TLAC

TLAC is an initiative by the Financial Stability Board (FSB) under the aegis of the G20 forum to ensure adequate capital at the world's top c30 banks. These G-SIBs are the financial institutions

identified by the Basel Committee on Banking Supervision as being ‘too big to fail’. Announced in November 2015, the requirements aim to ensure ailing banks have the capacity to recapitalise once any haemorrhaging of losses has been stemmed. In a bail-in scenario for G-SIBs, TLAC may convert or be written down. However, it is still the Basel III minimum capital that takes the first hit when a bank is failing; TLAC is intended to activate during resolution.

Constituents

TLAC was developed as a Pillar 1 measure and so capital held for Basel III requirements can also count towards TLAC requirements. TLAC consists of instruments that can be written down or converted into equity and may comprise going concern capital (CET1, AT1) and gone concern (T2, long-term unsecured debt). To count toward TLAC debt must be subordinated, unsecured and have a residual maturity of more than one year. CoCos can satisfy these conditions. In addition to a variety of approaches in the US and elsewhere, there are country variants within Europe being implemented or under discussion. For instance, France has introduced a law that will see banks able to issue bail-in-eligible Tier 3 notes, which rank between senior and subordinated bonds – and these instruments have been successfully [brought to market](#). [In accordance with the FSB](#), the phase-in across Europe has targeted 16% of a bank’s consolidated RWAs for G-SIBs since January 2019, increasing ultimately to 18% – in conjunction with corresponding leverage ratios. With the onslaught of Covid-19, the timelines for implementation have been pushed out somewhat.

Leverage-related MDA (L-MDA)

In the lead-up to the financial crisis banks raised exposures (loans, derivatives, guarantees etc.) while raising little additional capital, thereby becoming heavily leveraged. This underlies the introduction of a binding leverage measure as a backstop to risk-weighted capital requirements. The leverage ratio requirement must be met in parallel and be disclosed publicly. The reason for the leverage ratios is to discourage the gaming of RWAs, a problem during the 2007/8 credit crisis. The minimum leverage ratio for non G-SIBs is 3% of Tier 1 capital, an internationally agreed level confirmed by the European Commission. This is binding for all institutions and must be met in parallel with risk-based capital requirements. Almost all banks have a leverage ratio above this level, so this is not a particularly high hurdle. The leverage ratio requirement for G-SIBs will range from 3.5% to 4%, which may pose a challenge for some banks. For example, Deutsche Bank reported a fully loaded leverage ratio on 31 March 2019 that was below its minimum requirement (3.9% versus 4.0%)

although [subsequently the bank](#) was allocated to a lower risk bucket that dropped its ‘additional capital buffer’ to 1.5% (from 2%), which then reduced its leverage ratio requirement to 3.75%. Beyond this there is the Leverage Ratio Exposure (LRE), the denominator of the leverage ratio buffer for G-SIBs, which is expressed together with the loss absorption capacity *as the higher of*:

- 6% of LRE or TLAC of 16% of RWAs – as of 2019
- 6.75% of LRE or TLAC of 18% of RWAs – from tentatively 2023

(See the section on RWA densities in the Principal Risk chapter for a fuller discussion of leverage.)

MREL

The EU resolution framework – consisting of the Bank Recovery and Resolution Directive and the Single Resolution Mechanism Regulation – requires banks to hold readily ‘bail-in-able’ instruments, to ensure that losses can be absorbed and banks recapitalised once placed into resolution. In parallel to Basel III, the BRRD was enacted in Europe in 2014 to impede the insolvency of financial institutions and prevent the need for government-funded bailouts. This directive requires loss-absorbing capacity in the form of a *minimum amount of bail-in debt to contribute to recapitalisation*, based on funded liabilities, in order to be entitled to access the Single Resolution Fund – this capacity constitutes the minimum amount of equity and subordinated debt a credit institution must maintain to support an effective resolution, i.e., its *MREL*.

Agreement has been reached on MREL rules such that banks with consolidated balance sheets above €100bn will be subject to a subordination requirement of 8% of total liabilities and own funds capped at 27% of RWAs – with flexibility for national supervisors in its implementation. On the whole, the MREL requirements tend to currently be in the range of 25% to 28% for most banks.

Relationship to TLAC

For European G-SIBs, TLAC is – in effect – incorporated into the MREL framework but as a Pillar 1 requirement. EU G-SIBs are subject to global TLAC requirements, plus a bank-specific supplementary MREL requirement as a Pillar 2 ‘add-on’. In many respects, MREL is the European equivalent of TLAC that applies to regionally strategically important institutions across the European Union. However, there are differences:

1. MREL applies to all of Europe’s c6000 banks while TLAC is set for [Europe’s c13 G-SIBs](#).
2. MREL leaves greater scope for national resolution authorities to decide what funds and liabilities are eligible as bail-in debt.

3. Calibrating MREL is institution-specific and determined by national authorities through an analysis of the risk profile of banks active in their jurisdiction.
4. National authorities inform institutions of supplementary MREL requirements, but MREL guidance is not required to be publicly disclosed.
5. MREL is not a Pillar 1 metric, so the outcomes of an infraction are less proscriptive; national authorities may tailor responses depending on the cause and frequency of the infringement.

Constituents

There are two components – requirements and guidance. MREL *requirements* for G-SIIs are calibrated in accordance with the TLAC term sheet, and Domestic Systemically Important Institutions (‘D-SIIs’) and other European banks have their requirements set by national authorities based on bank resolvability analysis. MREL *guidance* is at the discretion of national resolution authorities, which may ask banks to hold eligible instruments in excess of requirements in accordance with two types of buffers: additional loss absorption amounts, and/or additional recapitalisation amounts.

Calculation

MREL targets are also calculated on a fully loaded risk-weighted basis, and broadly speaking should be at least twice the Basel Pillar 1 and 2 requirements plus an additional capital buffer. More precisely, the Single Resolution Board defines MREL as the sum of the *loss absorption amount* (LAA) and the *recapitalisation amount* (RCA):

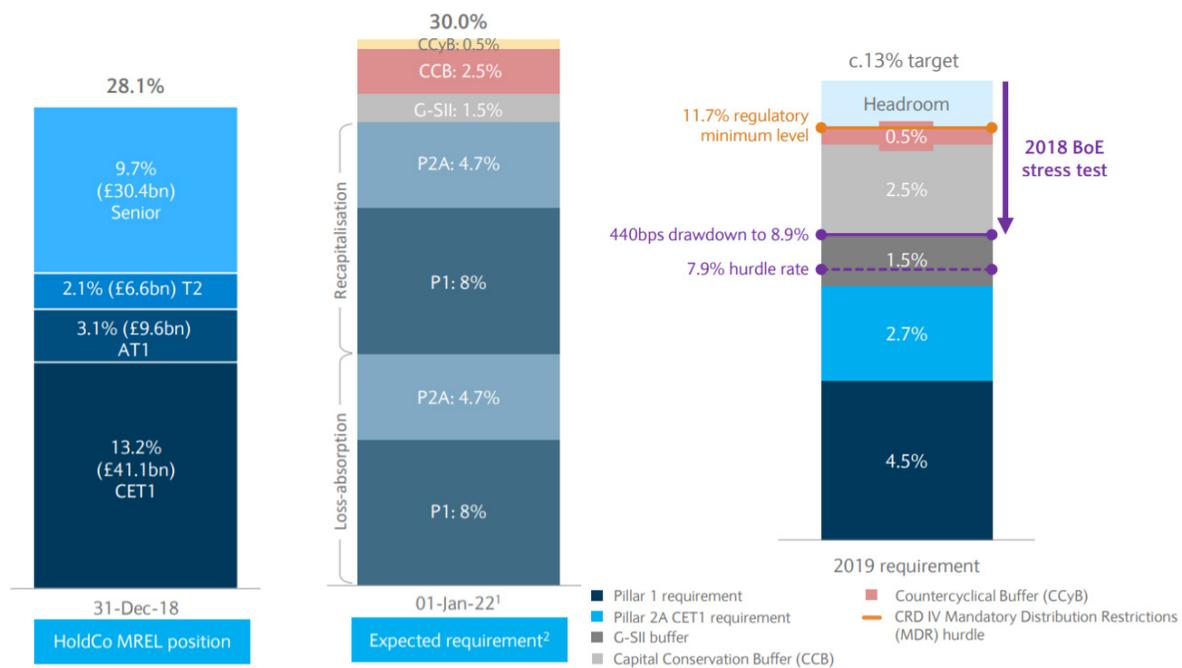
$$\text{MREL} = \text{LAA} + \text{RCA}$$

The LAA comprises Pillar 1 and Pillar 2 requirements, plus the combined buffer requirements. The RCA comprises Pillar 1 and 2 requirements, plus a *market confidence charge*. The latter is the amount intended to regain market confidence after recapitalisation – the sample calculation provided by the Resolution Board sets the level as the combined buffer excluding its countercyclical component. This makes the charge an adjusted version of the combined buffer requirement, i.e., CBR less c125 basis points. Since in most countries the countercyclical buffer is lower than 125 bp if not zero, this approach to the confidence charge could result in lower net MREL requirements. However, the charge can be tailored by the resolution authority upwards or downwards. The confidence charge thereby gives regulators the ability to set MREL requirements at the level they perceive as appropriate – *this discretion is the essential element to understand, with regards to MREL’s impact on AT1s.*

The Single Resolution Board may retain its current formula or make further adjustments in future. In addition to the evolution of the Resolution Board’s guidance, there are country variants such as in the UK where the Prudential Regulation Authority (PRA) defines the two components of MREL somewhat differently. The PRA defines the loss-absorption amount as the higher of the sum of Pillar 1+2A risk-weighted capital requirements; leverage requirement; or Basel I floor. It then defines the recapitalisation amount in a range from 0% to 100% of the loss-absorption amount, depending on a firm’s resolution strategy, as prescribed by the Bank of England. *With the components of MREL varying by jurisdiction and the combined buffers varying from bank to bank, modelling the implied coupon risk requires the application of steadily evolving accounting rules.*

We show the transition for Barclays below to illustrate these dynamics. For the reported period to end-2018, note that 3.1% of the capital stack is allocated to AT1s, well above the 1.5% minimum. For the projected 2022 figures in the middle, the loss absorption (LLA) is indicated as “P1 + P2A” for a total of 12.7% with the recapitalisation (RCA) show as also equalling 12.7%. On the right, the Mandatory Distribution Restrictions (MDR) hurdle – which is the PRA’s term for the MDA – is calculated as 11.7%, highlighting how CET1 is gathered into one calculation for determining the hurdle for distribution restrictions.

FIGURE 45: BARCLAYS – MREL POSITION & MDA THRESHOLD



Source: FY 2018 result presentation, 21 February 2019. CET1/RWA ratio at end FY18 reported at c13.2%.

Raising the bar for restrictions

As has been noted by Mesnard and Magnus, the probability that any given bank will fail to meet its MDA threshold directly depends on where the trigger point is set by the evolution of regulatory requirements and interpretations (2016). Transposing the MDA mechanism to fit in with the TLAC-MREL framework may effectively lead to a rise in the threshold for restrictions in several ways: decisions on which securities are eligible to fill the buckets; shifts in the definitions of buffers; interpretations of CET1 allocation in the stacking order. The risk of accelerating MDA restrictions has been acknowledged: "...restrictions might be triggered at higher CET1 levels than is currently the case or might arise from a failure to roll over or issue sufficient MREL-eligible debt rather than any specific erosion in the level of CET1 that composes the CBR" (EBA, 2016).

Subordination ambiguity

The criteria that dictate what instruments can be eligible for MREL purposes is still evolving. Subordination is generally required to meet G-SIIs MREL requirements, to align with TLAC. For D-SIIs/O-SIIs, however, country- and bank-specific interpretations come into play and resolution authorities have the final say on defining 'sub-senior'. National authorities are allowed a degree of latitude in categorising MREL instruments, such that they may permit senior unsecured debt as it is subordinated to senior secured. This classification of 'subordinate' matters as it designates what instruments can absorb losses while an institution is a going concern and which are available only as gone concern capital. Resolution authorities are empowered to write down or convert *subordinated debt* such as AT1 CoCos *prior to a bank entering into resolution*. On the other hand, both preferred and non-preferred senior debt can only be bailed in once a bank has entered resolution.

Domino effect of possible change to cumulative systemic risk buffers

Another development that could inject uncertainty about the MREL calculation is a change in the method of accounting for the Systemic Risk and the G-SII/O-SII buffers. The Systemic Risk buffer generally ranges from 1% to 3% of risk-weighted assets across Europe, with some national levels currently at 0% and Norway [with a high of 4.5%](#). There have been moves across European jurisdictions to build up the Systemic Risk buffer in recent years, although reprieves have been granted during the Covid-19 crisis. As mentioned earlier, the general guidance has been to take the higher of the two buffers (Systematically Important Institution and Systemic Risk) on the assumption that banks would only have to comply with one of the 'systematic/systemic' risk

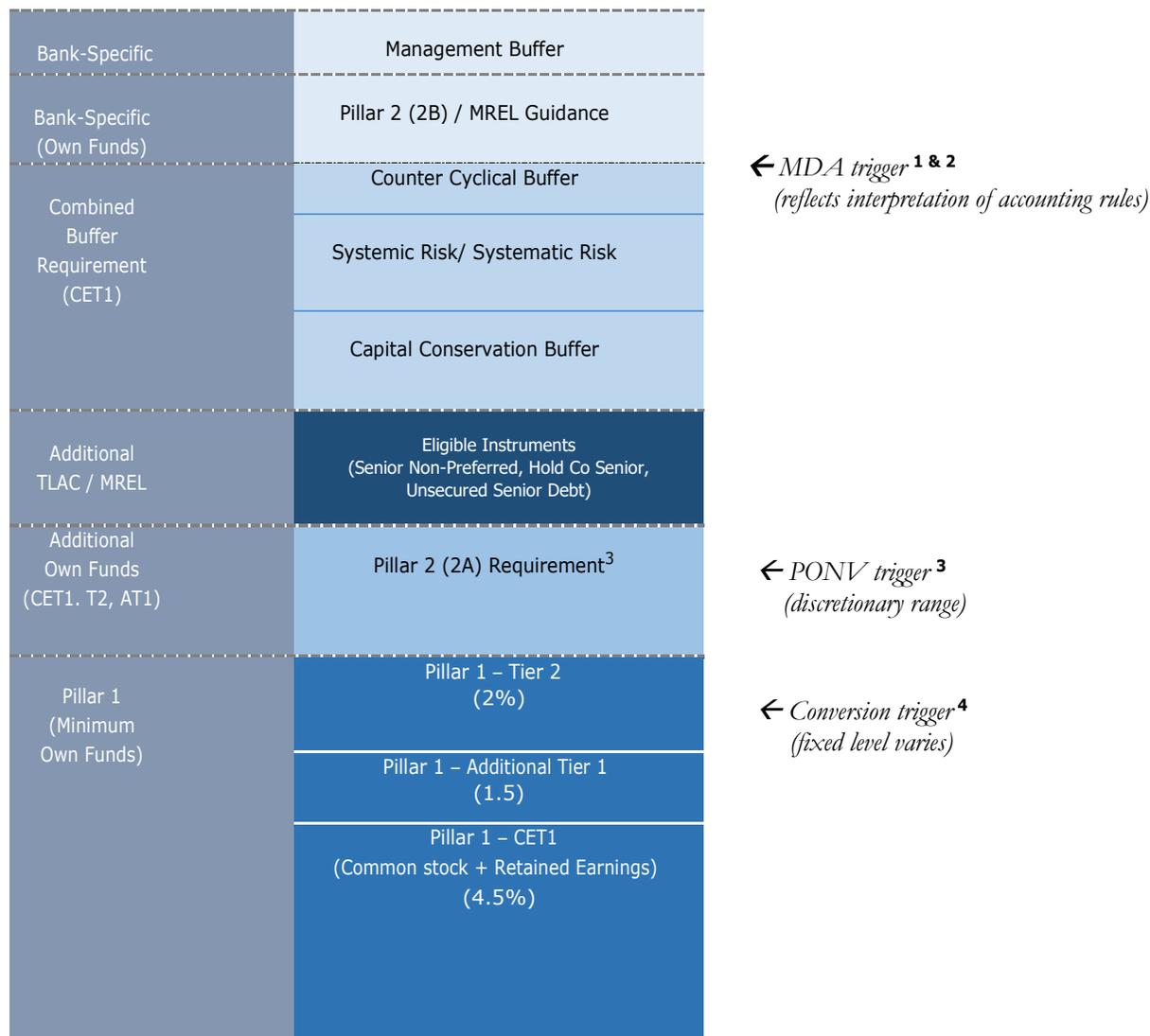
requirements. If the cumulative approach were adopted, as is under discussion in some jurisdictions, the impact would be material. For example, both Sweden and the Netherlands have set the Other-SII buffer at 2% and the Systemic Risk buffer at 3%. Going by the earlier guidance, the O-SII buffer would be ignored as the higher of the two buffers would be taken, but if the Swedish and Dutch authorities made the requirements cumulative and added the O-SII buffer on top of the Systemic Risk buffer, then the MREL requirement would increase by a full 4 percentage points; i.e., the 2% O-SII would be added twice – once for the loss absorption amount and again for the recapitalisation amount. Such a hike in the MREL would drive up the combined buffer requirements, raising the MDA threshold (referred to as the [‘M-MDA’](#) regime) and hence the risk of AT1 coupon omission.

Stacking order – The height of the MDA trigger

In November 2016, the European Commission proposed a package of banking reform to harmonise the Capital Requirements Regulation II and Capital Requirements Directive V with the Bank Recovery and Resolution Directive II and Single Resolution Mechanism Regulation II. The European Parliament subsequently announced in December 2018 an agreement on the banking package with the European Council and from May 2019 commenced a transitional period of 18 to 24 months, depending on jurisdiction, which was subsequently extended due to the impact of Covid-19. Included in the banking package was an additional clause (Article 141a, CRD II) that states a stacking order *with the combined buffers sitting on top of MREL*. Although there had been discussion of a parallel approach, the stacking order waterfall that was adopted has ‘TLAC-MREL requirements below the combined buffer requirements, with MREL *guidance* above.

Figure 46 is *stylised to emphasise the direction* of loss absorption, from top to bottom, to highlight the transition to a new loss absorption regime that includes ‘TLAC-MREL as a form of de facto Tier 3. The dark blue illustrates the insertion of ‘additional TLAC-MREL’, although these requirements in practice overlap with Pillars 1 and 2. The mechanics of the MDA trigger are based on CET1 held in excess of requirements, so it is best to imagine the capital stack as if it were a series of ‘buckets’ that holds ‘water’. The ‘TLAC-MREL requirements may draw CET1 from other buckets, so banks now need to ‘pour in more water’ to maintain the required overall level of the combined buffers.

FIGURE 46: CAPITAL STACK¹ – INSERTING TLAC/MREL (SCHEMATIC)



Source: Based on updates from Bank for International Settlements and the ECB's SREP methodology.

Notes:

- MDA trigger: Reflects both the 'no double counting' and 'priority rule' as it pertains to TLAC-MREL and discretionary assessment of infraction.
- MDA trigger thresholds:

$$\text{CET1} = \text{Pillar 1 CET1} + \text{Pillar 2 CET1} + \text{CBR CET1}$$

$$\text{Tier 1} = \text{CET1 MDA} + \text{Pillar 1 AT1} + \text{Pillar 2 AT1}$$

$$\text{Total Capital} = \text{Tier 1 MDA} + \text{Pillar 1 Tier 2} + \text{Pillar 2 Tier 2}$$
- PONV trigger: A supervisor can intervene to trigger CoCos when it deems a bank is at risk of being "no longer viable".
- Conversion trigger: Write-down or conversion occurs at the capital adequacy ratio specified in the AT1 prospectus, generally 5.125% or 7%.

The order by which the buffers are stacked on top treats MREL-TLAC in a 'contiguous and integrated' manner. It assumes both the *no double-counting rule* and the *priority rule* apply to CET1.

1. No double counting

Banks in the EU are not able to use the same regulatory capital to meet the minimum requirements for own funds and also to meet the combined buffer requirement, i.e., there can be no ‘double counting’ of CET1 toward both MREL and the CBR. The TLAC term sheet also states that distribution restrictions will be applied when there is a deficient in TLAC-eligible debt, specifically, Section 7 states that “if debt that matures or no longer qualifies as TLAC is not replaced, a G-SIB may breach its buffer requirements in the same way that it may breach its buffer requirements if maturing Tier 2 instruments that count towards the Basel III total capital requirement are not replaced”. Therefore, CET1 to be taken into account in the calculation of the MDA factor is limited to the amount *held in excess* of the CET1 already used to meet TLAC/MREL requirements.

2. Priority rule

Article 141a states that an institution must first satisfy TLAC-MREL requirements to be considered to be meeting the combined buffer requirements. This is referred to as the priority rule and is *a direct consequence of TLAC-MREL stacking below the CBR*. The rule implies that CET1 is effectively used first to meet these Pillar 1 and 2 minimums. TLAC and MREL are hard minimums to be met at all times, in contrast to the combined buffers whose depletion and replenishment can occur whilst the institution remains a going concern. The consequence is that available CET1 should be used to extinguish any shortfalls in MREL requirements before being used to count towards the combined buffers. If there are insufficient eligible liabilities to comply with TLAC/MREL, CET1 capital being used to meet the combined buffer requirement should be reallocated to meet TLAC/MREL requirements – *such prioritisation may thus indirectly lead to an infringement on the combined buffer requirement*.

Management buffer

The job of the combined buffers is to absorb losses sufficient to avoid breaching minimum Pillar 1 requirements. However, the capital conservation buffer should only be drawn on in times of crisis and otherwise acts as a cushion of capital that should not be expended. The term “buffer” could thus be considered a misnomer given that banks are encouraged by their supervisors to endeavour to avoid dipping into the CET1 held in the combined buffers. Indeed, there is a management buffer perched atop the capital stack, as shown in Figure 46. The allocation of capital to the management buffer is part of the determination of the risk appetite framework that is agreed with the national supervisor. Its size will vary by institution to sustainably balance prudence with the pressures to meet returns on equity. Although the management buffer could be set as low as zero, in practice it

tends on average to be in the 1% to 2% range. *Even once the management buffer is burned through, there is lingering ambiguity as to whether a restriction on interest payments would be automatic, discretionary or involve a form of 'delayed automaticity'.*

Possible outcomes at breach of TLAC or MREL

Under a strict reading of the stacking order, CET1 may be taken from the combined buffers to avoid non-compliance of TLAC & MREL requirements. This could, in turn, cause the MDA restriction to be triggered – leading to automatic restrictions on distributions, in line with the Basel Accords. But the restriction on distributions would be the *indirect* consequence of non-compliance with TLAC/MREL due to the principles of no double counting and prioritisation.

This is a familiar problem that also exists in the case of a bank who's AT1 and Tier 2 buckets are not filled. Any common equity used to meet the AT1 and T2 buckets is excluded from a calculation of the CET1 ratio. In such cases, CET1 is taken away from the combined buffers to substitute for inadequate AT1/T2 levels. The most efficient capital structure is, therefore, for banks to issue sufficient AT1 capital to cover the 1.5 percentage point gap between CET1 and Tier 1 requirements and sufficient Tier 2 capital to cover the 2 ppt gap between Tier 1 and total capital requirements. This form of allocation avoids having to deploy CET1 capital to fill the AT1 and T2 layers.

A similar principle is being applied with regards to TLAC/MREL. Any common equity used to meet the TLAC and MREL buckets is excluded from a calculation of the CET1 ratio. The application of this principle here, however, can create a conflict between going and gone concern capital. A sharp drop in the combined buffers is not designed to prompt supervisory measures as severe as would be expected in the case of a violation of Pillar 1 or Pillar 2. At breach of the combined buffers a bank is required to implement a capital restoration plan to take capital levels back above the requirement. The implementation of TLAC/MREL could thwart the intended functioning of the components of the CBR if compliance with 'gone concern' capital requirements prevented the 'going concern' combined buffers from being available to be drawn down in periods of stress. For example, the countercyclical capital buffer is designed to decline in downturns in the credit cycle in order to reduce the risk of the credit supply being constrained. If MREL were temporarily below its minimum due to an inability to issue new debt, then drawing on CET1 from the countercyclical capital buffer to fill a void in MREL might make macroprudential tools less effective. Automatic reallocation of CET1 might constrain lending to businesses at a time when it is critically needed. In

order to help preserve the usability of the combined buffers, and not undermine the role of the banking sector in supporting the real economy, *scenarios have been introduced to manage the risk of an inopportune, indirect breach of the combined buffers.*

‘Delayed automaticity’ – A grace period

Although a bank should maintain an appropriate maturity profile of MREL-eligible liabilities, it could still face difficulty rolling its maturing MREL eligible liabilities due to circumstances beyond its control, reflecting market conditions rather than structural weakness at the institution. The automatic reallocation of CET1 to MREL may aggravate matters and lead to financial instability. Therefore, the regulations allow for a scenario in which if a breach originates from a *temporary* inability to issue new MREL-eligible debt, there is *no automatic triggering* of the MDA restriction. The supervisory authority may grant a bank a nine-month grace period during which it could attempt to repair its balance sheet by issuing the requisite MREL-eligible debt. During this grace period of no longer than nine months, a bank would not be in contravention of its CBR, thereby forestalling MDA restrictions. *The stated aim of the supervisor is to preserve the principle of automaticity while allowing for the possibility of MDA restrictions to be delayed in the case of the non-renewal of maturing debt.*

Automatic restrictions – when shortfalls are due to losses

The regulations differentiate between non-compliance with TLAC/MREL due to a shortfall in fixed term debt rather than a shortfall in capital instruments. When the CBR is in breach because available CET1 is redeployed to address a shortfall in TLAC/MREL-eligible debt *due to incurred losses*, MDA restrictions *apply automatically* until the deficit is remedied. There is no grace period if the bank’s capital base takes a hit. Such a scenario is more likely to arise for a bank that relies largely on capital instruments to meet its MREL obligations. Capital instruments are perpetual, and non-compliance through a reduction of Tier 1 capacity tends to reflect ‘permanent’ losses, whereas debt securities with fixed terms are subject to refinancing risk. *The implication here is that automaticity might still be in force, depending on the nature of the TLAC/MREL shortfall.*

Illustration – Metro Bank Plc

In the UK, MREL requirements are part of the Threshold Conditions for institutions to be permitted to perform regulated activities as set by the Prudential Regulation Authority and the Bank of England. The UK policy categorises banks by size. Smaller banks are not required to hold a recapitalisation amount in addition to the going concern capital requirements.

To illustrate the above criteria, we can consider the case of Metro Bank and its efforts to raise qualified debt to reach its compliant 21.5% interim MREL target. Metro filed a prospectus stating its plans to raise MREL-eligible senior non-preferred debt of at least £500mm by end-2019 and a further £3 billion by end-2020. Metro then decided to postpone its debt transaction given ‘current market conditions’. According to press reports, the transaction had received insufficient demand despite setting a relatively high 7.5% yield. This left the bank with a shortfall relative to its year-end MREL target of approximately £300mn. Inability to access financing caused the shortfall. However, it was not immediately obvious whether the reason for failing to issue was solely due to market conditions or if the lack of demand reflected inherent weakness and fear of pending losses at the bank. *The local supervisor had to assess the situation* to determine if the likely breach of MREL would be interpreted as a failure to meet ‘Threshold Conditions’ that required a move into resolution or whether leniency should be shown in fulfilling interim MREL requirements. Metro was facing potential fines as a result of its RWA miscalculation. Hence, the national authority was having to decide on multiple aspects of the bank’s conduct: financial health, fines and financing. Aside from permitting more time for issuing qualifying debt, the supervisor could call for an asset sale to raise capital or, as was speculated in [The Times](#), to arrange for Metro Bank to be merged with Clydesdale and/or the Co-operative Bank in a regulator orchestrated roll-up of troubled banks. In practice there can be a wide range of options and scenarios under discussion within the ‘supervisory-bank nexus’.

Within two weeks of its initial failure to complete refinancing, Metro successfully went back to the market with a rescheduled sale of senior non-preferred debt, upsizing the six-year issue to £350mn but having to accept a higher coupon than when the deal was pulled due to lack of demand. The new coupon of 9.5% was unprecedentedly high for non-preferred debt issued by a UK bank. The sale of a mortgage portfolio was announced alongside the refinancing, with the two transactions taken together allowing Metro to reach its 21.5% interim MREL requirement. Such a punishingly high coupon and sudden portfolio sale was followed by the resignation of top management – with [The Times](#) reporting that the announced departures were a quid pro quo agreed with bond investors to subscribe to the new debt deal. The review of this episode for Metro Bank underscores the role of the supervisor in shaping the outcome for MDA restrictions.

PRA proposal to weaken automatic mechanisms

Under CRD IV the maximum distribution is restricted to a percentage of profits made since the bank’s last distribution. [Under CRD V](#) this is adjusted to interim and year-end profits, net of

distributions, that are not included in CET1 capital. The CRD V modification could increase the maximum distributable amount. Both CRD IV and V preclude a bank from making distributions that would result in the CET1 in the combined buffers falling below requirements. However, the Prudential Regulation Authority (PRA) has discussed plans to remove this restriction, to enable British banks to pay coupons even if that were to cause CET1 levels to temporarily dip below the combined buffer requirement. The PRA has also proposed a change in the definition of the MDA to include certain profits already recognised as CET1 capital. Under the modified definition, the calculation would include the sum of profits from the past four calendar quarters net of distributions, increasing the MDA and making the payment of AT1 coupons more likely.

The removal of some ‘automaticity’ would enable UK banks under stress to continue paying AT1 coupons that might otherwise have been restricted, and therefore loss-absorbing, and could also allow banks to operate with lower management buffers over combined buffer requirements and structurally lower levels of CET1 capital. That said, banks might still suspend coupons to conserve capital if the reason for breaching combined buffers was due to severe idiosyncratic losses.

Conclusion – MDA Trigger: Automaticity vs Discretion Risk

The CRD/CRR framework provides for buffers that can release funds without entry into resolution, whereas the BRRD provides for MREL as a minimum requirement that must be met at all times. The combined buffers are meant to be used on a going concern basis whereas TLAC/MREL is part of the gone concern framework. Given these conflicting capital constraints, the CET1 allocated to the combined buffers may interact with MREL-TLAC demands in a manner that leads to either immediate or delayed restrictions on the distributions of AT1 coupons. The national supervisor retains the option to permit the automatic consequences or to override the MDA mechanisms, depending on the nature of the CET1 non-compliance. Unless a grace period is invoked, a shortfall in TLAC/MREL-eligible debt would take priority and require CET1 from the combined buffers to be reallocated. Given CET1 cannot be double counted, this could drop the CET1 available to the combined buffers down to the threshold triggering calculation of the maximum distributable amount. The national supervisor may thus delay the reallocation of CET1 to allow the combined buffers to fulfil their purposes such as supporting lending to businesses, preventing the MDA trigger from firing. Thereby, a bank would not be subject to automatic distribution restrictions for a grace period of up to nine months even though it is in breach of its capital requirements. *In sum, the*

interpretation of CET1 allocation to TLAC/MREL eligible securities is yet another area in which supervisory discretion plays the dominant role in assessing the probability of AT1 coupon payments.

2. Coupon vs Dividend Seniority

The restriction on cash payments once the MDA is triggered is not an absolute prohibition. Instead, a bank will be required to calculate the maximum amount it can distribute according to a sliding scale. Given that some payments may be possible raises the question of which type of investor will be paid first: might AT1 coupons be senior to equity dividends?

Capital structure inversion

The order in which distributions are made also shapes the probability of AT1 coupons being paid. AT1 interest payments could be made junior to equity dividends. That holders of AT1s could shoulder losses to preserve CET1 before shareholders can be viewed as a type of ‘capital inversion’. The European Securities and Markets Authority has identified this risk: “contrary to classic capital hierarchy, CoCo investors may suffer a loss of capital when equity holders do not.” (ESMA, 2014) This quote refers to the hierarchy of losses being reversed such that an AT1 could trigger before common equity is entirely eliminated. But this notion of capital inversion also applies to the possibility of stock dividends taking precedence over interest payments on AT1s. Could a bank decide to suspend AT1 coupons after suffering a revenue shortfall but not cut dividends? According to the letter of the law, this is conceivable. Article 53 of the Capital Requirements Regulation (CRD IV) prohibits AT1 CoCos from including dividend pusher or dividend stopper clauses. CRD IV, in principle, allows management discretion to turn off coupons on AT1s while continuing to pay dividends on common equity. (NB: only Swiss AT1s include a contractual dividend stopper, which is permitted as the Swiss are outside the EU.) The ambiguous ranking of coupons with respect to dividends breaks with the traditional hierarchy of subordinated debt being senior to common equity.

From the perspective of shareholders, looking at the return on equity, the cost of building up the combined buffers is weighing on the share prices of banks. The decline in leverage is also a negative for shareholders. On the other hand, the rebuilding of regulatory capital is supportive for CoCo investors. *If a higher capital bar causes distribution restrictions and AT1 coupons are favoured, then shareholders might see themselves as being unfavoured twice over.* In this context, AT1 coupons could be seen as a competing financial product to dividends on common equity. Indeed, the market for equity income

investors, once the preserve of high dividend paying stocks, has begun to expand to include AT1 coupons as a substitute – though the potential for such arbitrage is only nascent.

AT1 seniority – Shift in guidance

According to regulations, there is no hierarchy for restrictions on cash distributions – impairments may occur on a pro-rata basis by quartile or in any manner chosen by bank management and agreed with their supervisor. Stock dividends, employee bonuses and AT1 coupons are treated equally.

However, in November 2016, the guidance began to shift. The European Commission tabled an amendment to give interest payments on AT1s priority over dividends and bonuses. The proposal – an update to Article 141(3) – sought to specify a pecking order in which AT1 coupons would be at the top. The proposed update stated that, after having calculated the MDA, an institution should not distribute dividends or variable remuneration prior to paying interest on AT1s. If the entire amount of MDA were restricted, AT1 coupons would still be omitted, but when distributions resumed in future, coupons would again take priority. Such a provision would rank AT1 coupons de-facto senior to dividends and further differentiate CoCos from equity – as enunciated by Adam Farka in a speech at an ECB-sponsored conference: “The Commission’s proposal... introduces the ranking of distribution restrictions that should support the AT1 market going forward.” (15 May 2017).

In response to this development, the European Banking Authority also published a paper in May 2017 which argued that an alteration in the discretionary nature of AT1 coupon payments “could create the expectation that coupons will always be paid”. In the EBA’s opinion, the full flexibility of payments on AT1s should not be weakened. Making AT1 coupons senior to dividends would privilege AT1 investors. The EBA felt this could increase moral hazard, disproportionately favouring AT1 holders at the expense of shareholders as well as shaking investor confidence in the loss-absorbing capacity of AT1s. So, while a proposal to prioritise AT1 payments was put forth it has never been formalised into law. *There is a recurring pattern in which proposals are made to reassure investors of a particular set of procedures though not formalised into law, rather acting as a form of ‘soft’ forward guidance on the likely outcome of discretion.* Though not in the technical standards, the messaging from the European Commission that they are supportive of AT1s seems unambiguous. Consequently, once the CBR is touched and the MDA calculated, if the restriction on distributions is partial investors may well believe that banks will prioritise coupons over dividends.

Covid-19 response – AT1s favoured

The response to the Covid-19 pandemic highlights the central role of supervisory discretion and supports the view that AT1 investors remain favoured. National authorities have strongly *guided banks to retain capital by not paying dividends* for fiscal year 2019 and to defer dividends for fiscal year 2020. To preserve ‘retained earnings’, banks were also instructed to limit bonuses to employees and to pause share buybacks. However, tellingly, *supervisors allowed AT1 coupons to continue to be paid*. So, *through the Covid crisis we have seen AT1 coupons prioritised by the supervisors*.

The ECB published a [press release](#) on 12 March 2020 stating that banks will be allowed to operate temporarily below the level of capital defined by the capital conservation buffer and the liquidity coverage ratio. For AT1 investors, the most relevant relaxations in capital requirements were those that applied to the combined buffers. Across jurisdictions, the *countercyclical* and *systemic* buffers have been reduced or eliminated to help weather the pandemic. There has also been explicit permission given to Eurozone and Swiss banks as well as implicit messaging to UK banks that the capital conservation/PRA buffers can be drawn down. Full replenishment will be gradual, in consideration of each bank’s circumstances.

Furthermore, the final implementation of the Basel III framework has been delayed by one year to January 2023, with the associated transitional arrangements for the output floor also extended by one year to January 2028. The revised standards for operational and credit valuation adjustment (CVA) risks as well as the output floor will be drivers of increased capital requirements. The EBA had estimated in December 2019 that full implementation would increase minimum capital requirements by c24% on average between 2022 and 2027. For G-SII, the increase is driven largely by changes to CVAs as well as the output floor. For O-SII, the output floor alone accounts for more than half of the increase. When eventually implemented, guidance from the regulators thus far suggests there will remain room to potentially lower Pillar 2 requirements, especially if the amended framework captures risks which were not previously included.

In addition, the EU’s resolution authority has stated that it will postpone specific MREL requirements on an individual bank basis due to the adverse market conditions. The ECB also brought forward implementation of the relaxation in rules on the counting of AT1 and T2 instruments toward their Pillar 2 requirement (Article 104 CRD), easing some banks’ CET1

requirements by 1 percentage point or more. *The effect of lowering some components alongside encouragement to deplete others equates to a supervisor-managed reduction in risks for breaching the combined buffer.*

Coupons: Early intervention vs forbearance

AT1 coupons are *wholly discretionary*, which means that interest payments could be switched off ‘early’ before the formal MDA factor is calculated. According to the EBA’s opinion, “Competent authorities can take additional supervisory measures where necessary, *including before breaching the combined buffers*” (2015). If a breach appeared probable in the near future, perhaps as detected during stress testing, a supervisory authority may well take early-stage measures. This makes it a very real scenario that a supervisor could exercise its early intervention powers and prohibit the payment of AT1 coupons *prior to* formal MDA/ADI mechanisms. AT1s make up at least 1.5% of the total capital base of almost all European banks, and their annual interest payments are roughly in the range of 3%-12% on the amount outstanding. While this outlay is not large relative to the overall capitalisation of a bank, if profits take a heavy hit then AT1 coupon payments could represent a considerable amount of the available reserves. If the depletion of a bank’s capital is accelerating, with the margin of risk-weighted capital above the MDA becoming tighter and tighter, a supervisor may request an immediate cap on distributions ahead of formal MDA restriction. *The trajectory and pace of capital depletion could become key factors in the supervisor’s decision of whether or not to request a bank to omit coupons.*

There may be a preference for an intermediate stage in which the supervisor works with a bank to develop a recovery plan, leading to a delay in applying restrictions despite crossing the formal threshold. Supervisors may be unwilling to have banks take loss absorption through coupon cancellation if that might lead to a loss of confidence in the institution. Suspension of interest payments sends a signal to all fixed income investors that the bank has severe problems. A bank could suffer reputational damage if it chose not to pay coupons and face hostility from investors. Funding costs, including for senior debt, could be impacted by skipping a coupon. The amount of cash preserved by switching off coupons may not be sufficient in the short term to assist in capital recovery, to warrant the danger of losing future market access. Therefore, bank management and their supervisory authority might only support coupon omission if a firm is in a deeply distressed state. This seems to have been the case with Banco Popular, which was able to maintain a positive MDA cushion in January 2017 despite poor profitability thanks to ‘flexible interpretations’ of its CET1 allocation to Pillars 1 and 2. This margin of flexibility appears to have been allowed by its

national supervisor because the benefit of coupon cancellation was deemed too small to be worth the risk of negative signalling.

The discretionary powers of supervisors to allow banks leeway to continue to pay coupons despite poor profitability is not captured in existing valuation models, nor is the potential for the supervisor to play a proactive role to instigate a block on coupon payments prior to formal MDA restrictions. *To accommodate the range of possible outcomes, scenario analysis must be introduced into the modelling of the probability of coupon payments.* The nuances of the accounting rules and their scope for interpretation based on the nature of a capital shortfall should both be analysed thoroughly.

Pillar 2 split – ongoing flux of guidance & rules

Changes in guidance or revisions in rules can cause the distance to the threshold at which coupon restriction occurs to rise or decline. The split of Pillar 2 into requirements and guidance is a case in point. In December 2015, the EBA published a document stating its opinion that Pillar 1, 2 and the CBR were all de-jure minima, the breach of which would *automatically* lead to capital conservation measures. The imposition of Pillar 2 buffers would raise the combined buffer requirement, meaning that all banks' MDA cushions deflated compared to prior calculations. Following some months of uncertainty, further guidance came out that reinterpreted the initial announcement into a split of Pillar 2 into requirements (P2R) and guidance (P2G). P2G was positioned above the MDA threshold line. The insertion of P2R below the combined buffers would still cause the MDA threshold to rise, but much less dramatically. To further allay fears, the split was phased in gradually over four years. During the early transition period, as the requirements for components in the combined buffers were stiffened, the P2R was relaxed. The end-state, despite delays and temporary reprieves, was still an overall rise in the MDA threshold for European banks.

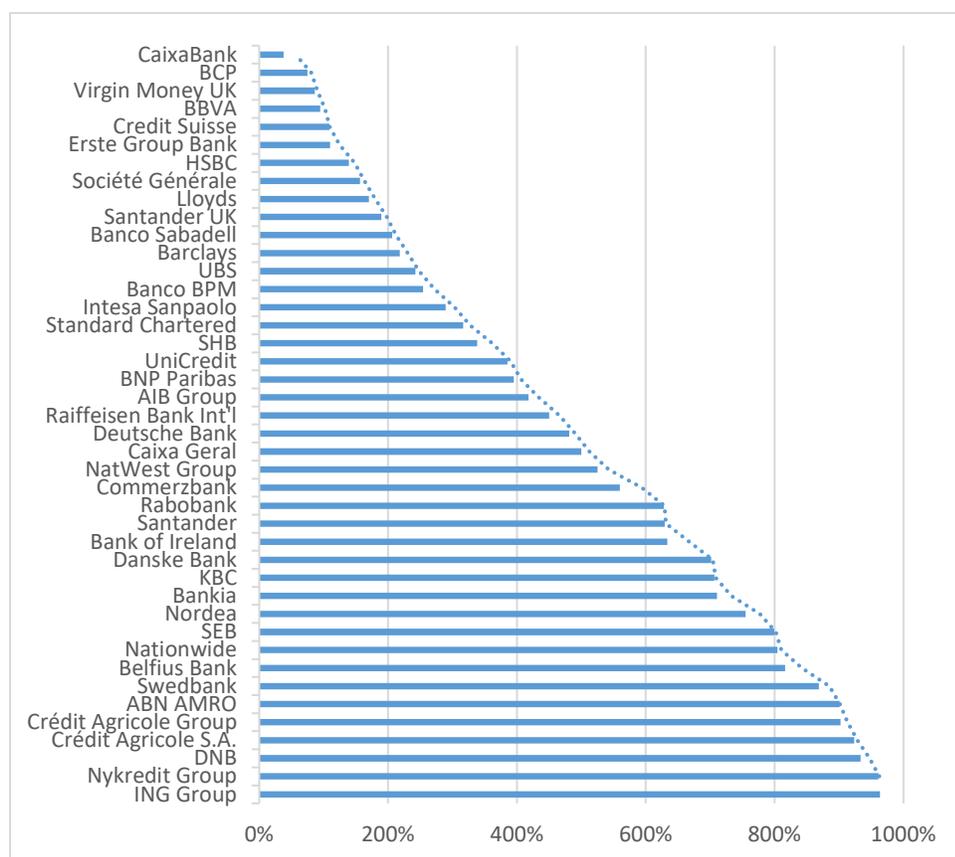
This episode highlights how supervisors may moderate policy, if it causes an immediate correction in the asset class. Informal communications on the seniority of coupons and the phasing in requirements over many years reinforces the notion that the supervisory authorities are supportive of the AT1 investors. The potential to delay the MDA triggering for a nine month grace period depending on the nature of the MREL infraction or due to concerns on the signalling function reinforces this impression. *Such messaging on the likely outcome of future discretion ('forward guidance') has parallels with forbearance in relation to the viability event and could lead to further erosion of AT1's equity-like characteristics.* The perception of a regulatory bias in favour of CoCos may also weaken the market

discipline to appropriately pricing risk premiums for the equity-like aspects of AT1s. CoCos are designed to cease their fixed coupon obligations when the stream of profits at a bank ebbs. *The overlay of supervisory discretion can create uncertainty over the automaticity of the MDA-ADI mechanisms in a way that parallels the problems that plague the principal loss mechanism.*

C. ADIs – Another Dimension of Coupon Risk

How much of a restricting factor are ADIs? This depends on the country of jurisdiction and on interpretations of conflicting regulations over the ability of banks to transfer funds out of non-distributable accounts. Although this risk has dissipated somewhat for most banks since 2019 with the wider use of the IFRS definition of distributable reserves, ADIs continue to pose a risk for banks with ongoing earnings weakness. Figure 47 below shows the range of values for this metric.

FIGURE 47: MAJOR EUROPEAN BANKS – ADI AS A PERCENTAGE OF AT1s



Source: Bank disclosures for a selection of European banks, CreditSights (as of Q4 2020)

ADIs resonant more for banks whose ability to generate retained earnings is under pressure. For most issuers for much of the time, the risk of coupon cancellation due to a lack of reserves in

distributable items should be manageable. However, retained earnings can be a strikingly volatile number depending on the mix of commercial versus investment banking. Riskier products, positions or strategies can result in unanticipated losses that rapidly deplete distributable reserves. An event outside a bank's control could eliminate available items, such as an operating loss in unfavourable trading conditions or litigation costs larger than planned provisions. For example, the Royal Bank of Scotland halved distributable reserves in a single quarter in late 2016 with no prior warning. In such cases, it may take time to obtain the required regulatory approvals to transfer funds from non-distributable reserves to distributable accounts. Moreover, ADI-related risk is connected to the rest of the capital stack, in that the calculation of these items may be limited to profits or surplus capital not already allocated to meet Pillar 1 & 2 and other buffer requirements.

Potential misalignment in definitions

The European Banking Authority has highlighted the potential for a misalignment between the definition of profits given in the Capital Requirements Directive IV relative to that given in the Basel III framework, with the former appearing more restrictive (23 May 2017). The Capital Requirements Regulation defines ADI reserves as: "The amount of the profits at the end of the last financial year plus any profits brought forward..." (Article 4). Conversely, the original Basel III formulation does not constrain so strictly the period of profits, nor does it explicitly exclude profits already allocated to CET1 from the MDA calculation.

Larger institutions tend to affirm undistributed profits on a quarterly basis, thereby including such funds into CET1 capital. In addition, there may be a number of other dates around which distributions are decided (and allocated) for the paying of variable remuneration, dividends and AT1 coupons. Banks are motivated to regularly include interim profits into own funds, as this will improve their regulatory ratios. *Under current CRD provisions, the more frequently a bank verifies profits for inclusion into its CET1 capital, the briefer the eligible period for ADIs and thus the smaller the funds available for use in the MDA calculation.* The consequence of a shorter lookback period is that profits are more at risk of being low, or even zero, in the period prior to distributions even when the combined buffer levels are far from being breached. This could lead to partial or even total restrictions on AT1 coupons despite otherwise healthy capital ratios. This emphasis on the most recent period is especially problematic for AT1s paying quarterly or biannual coupons.

The initial phrasing of the EBA proposal was that the MDA calculation should be based on ‘interim profits plus year-end profits not included in CET1 capital since the last distribution of profits’. To strike a balance, the European Banking Authority has since suggested a change in the definition of profits, so that the MDA calculation is based on ‘interim and year-end profits not included in CET1 capital’, deleting the reference to profits generated since the most recent decision on distributions. This gives greater flexibility on the lookback period while still prohibiting institutions from accessing profits already included in CET1 capital for cash distribution purposes. Though ameliorating the timing tensions, banks would still have to choose whether or not to include interim profits in CET1 capital. The EBA suggestion appears to have been taken on board as the latest accepted guidance, though it is not yet formalised.

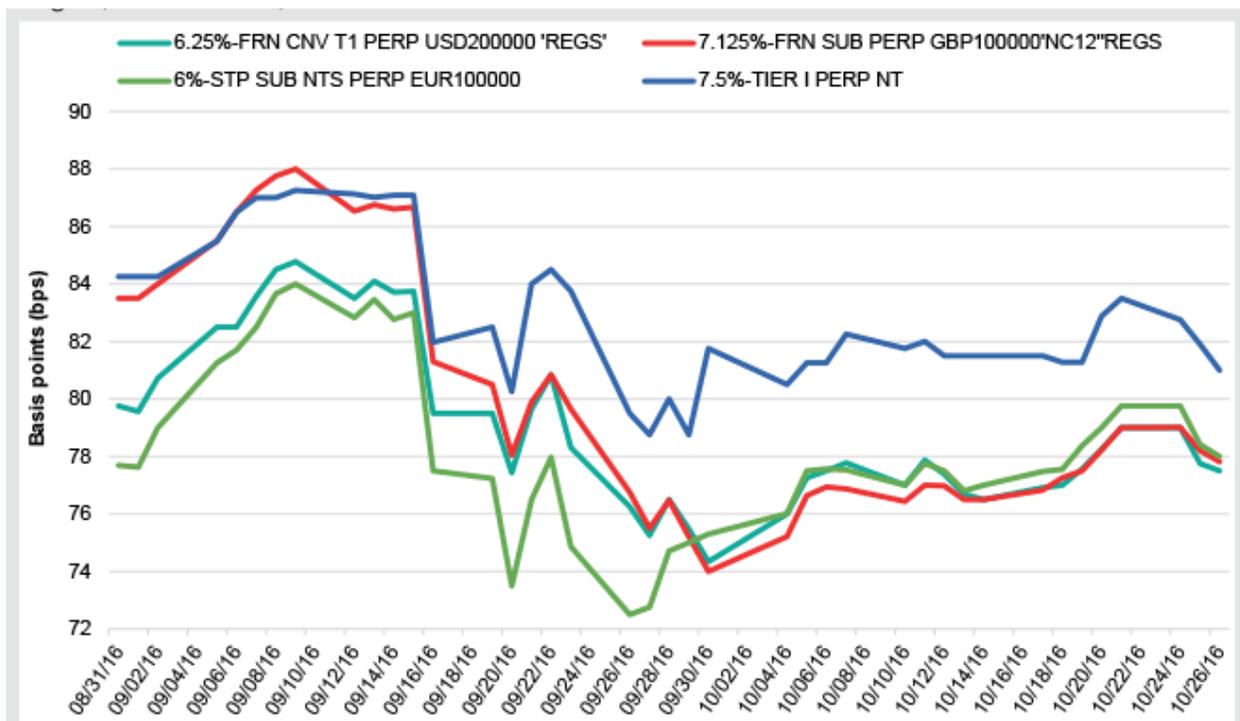
Country & corporate specific

The compositions of distributable reserves can vary materially between institutions, depending on their domicile and corporate structure. ADI estimation depends on the local accounting treatment, as the items can be based on national or international accounting as well as bank-specific by-laws. In Italy, for example, the share premium reserve arising from business combinations is only distributable for the amount exceeding goodwill (Troiano and Ruocco, 2016). This can call into question the distribution ability of the share premium account for some banks depending on the accounting for recent business combinations. This may constitute a considerable sum for some Italian banks, arising from the mergers which led to combinations such as Unicredit/Capitalia or Intesa/Sanpaolo. Moreover, tax deferred assets have built up in the banking systems of southern European countries and can be given loose interpretations under local GAAP. Deferred assets that are available for unrestricted and immediate use to cover losses are not deducted from regulatory capital and can have an influence on the assessment of profitability – and the calculations of reserves and provisions (Scope, 2016).

On the other hand, Germany has had the most restrictive ADI laws. German (and to a lesser extent Austrian) accounting principles differ from standards typically used in other European jurisdictions. The Germanic approach can block banks from making discretionary distributions due to deductions for internally generated intangible assets, unrealised gains on assets held for pension liabilities or deferred tax assets. However, ADIs are being somewhat harmonised across the EU as part of the amendments in the Capital Requirements Regulation (CC2), which has made German/Austrian banks less subject to the vagaries of local GAAP accounting.

The manner in which ADIs were calculated in Germany contributed to a bout of anxiety across the asset class in 2016. Concerns over the ability of Deutsche Bank to pay interest on its AT1s caused a sharp correction in all the bank's debt instruments – see graph below – and forced the bank to disclose provisional ADI figures to restore confidence. The AT1s market experienced a sharp selloff in response to the possible ADI-induced distribution restrictions for Deutsche Bank. The confusion during this episode subsequently sparked the drive towards harmonisation of ADI accounting.

FIGURE 48: CORRECTION IN DEUTSCHE BANK'S AT1s IN THE WAKE OF ADI-RELATED WOES



Source: Bloomberg

Disclosures on ADIs are not easy to obtain or to interpret. ADIs tend to be based on the accounts at the parent company and on the legal issuing entity's audited unconsolidated accounts – not on group consolidated accounts. The corporate structure can complicate the treatment of negative items in shareholders' equity. This may mean that valuation reserves related to defined-benefit-plans, when positive, are not non-distributable. Despite this implication, some banks do deduct the defined benefit reserve from their calculation of ADIs when negative given that it reduces total equity. The ad hoc nature of the ADI calculation, a process of inspecting parent accounts and national legislation, to correctly identify and separate distributable from non-distributable reserves, reduces

transparency and the ease of making comparisons across banks. Given this lack of consistency in the way ADIs are calculated, most European banks are making the transition to using IFRS standards on consolidated accounts instead of local GAAP at a mix of parent and unconsolidated levels.

Conclusion – ADI Trigger: Automaticity vs Discretion

Steps are being taken to harmonise the accounting on distributable items. Toward this end, a change in the definition of ADI in the Credit Requirements Regulation II appears in Article 4, which states that distributable items should be calculated “with respect to the specific category of own funds instruments”. The new phrasing of ‘own funds instruments’ now allows firms such as Deutsche Bank to report a more [comfortable ADI level](#). That said, harmonisation across borders will take some time – leaving the calculation of ADIs the preserve of specialist accountants and the servicing of AT1 coupons a bane for quantitative models.

The savings to a credit institution due to coupon omission occurs in small increments over a long period of time. The amount and pace of capital saved may be far too small and slow to recapitalise a troubled institution and therefore not worth the risk of negative signalling that could accelerate a loss of confidence at a critical time. The quantum of ADIs to make coupon payments can be a harbinger of risk for banks in jurisdictions that have stricter definitions of distributable reserves, but the rules on the eligibility of certain reserves are ultimately open to interpretation by the supervisor. The national authority may be inclined to show flexibility or even override the formula for calculating a coupon restriction, depending on the amount of outstanding AT1 notes and their coupon rate – and the degree of distress at a particular bank. *The components of ADIs can thus be subject to conservative or liberal treatment at the local level as well as unfavourable or favourable interpretations from the European Banking Authority. Once again, supervisory discretion and soft guidance play a decisive role.*

XII. Extension Risk – Reset Rates & Future Credit Profiles

As callable perpetuals, AT1 CoCos may end up with much longer maturities than the five-year minimum. The repayment of principal may not occur at the first call or other call dates further along the schedule. If a bank is not able to refinance at a lower rate, it will extend the maturity of its notes; this means an investor will receive interest payments below the market level for the degree of current credit risk. The possibility of an AT1's maturity lengthening is known as 'extension risk'. A structural dimension to extension also exists, in which a bank's credit quality fails to improve for a prolonged period or market conditions change rapidly. A protracted period of weak profitability or a repricing of risk premiums may mean that some AT1 notes might never be called. If a de facto 'perpetual vintage' emerged, funds without mandates to hold outright perps could be forced sellers.

A. Automaticity for Maturity – Implied Coupon at First Call

The issuer has the right but not the obligation to redeem. The earliest the 'first call' can occur is 5 years from the date of issue, though some notes may have the first call at intervals of 7, 10 or even 12 years. Interest rate payments on an AT1 are fixed up until the first call date. This is an obvious difference from common equity, which has no call date, but this also *differs from conventional callable bonds in which the risk is predominantly of an early call*. For a conventional callable bond, the extension of maturity is deterred by step-ups (disincentives written into the contract) and so rarely occurs. A coupon step-up makes interest payments higher than the face coupon if a bond is not redeemed. For AT1s, step-ups are prohibited. A key feature of AT1s is that they are not allowed any incentives to redeem. *With AT1s, the predominant risk is of a 'non-call' event* and thus the extension (not curtailment) of maturity. Therefore, an investor cannot simply apply the regular logic of a callable bond. If the life of an AT1 extends, market conditions or fundamentals may deteriorate over the time horizon of a longer maturing instrument – making the coupon received unattractive.

To summarise, the following characteristics distinguish the embedded call options in AT1s:

1. *The issuer 'owns' the option to call.* The investor in an AT1 has, in effect, 'sold' the option and therefore has no influence over its exercise.
2. *AT1s lack step-up incentives to redeem*, which makes the probability of a non-call much higher as it only depends on an economic pretext with no overt penalties against which to counterbalance self-interest.

3. *The maturity may double.* If the first call date is skipped, the next date could be as soon as quarterly but for most notes it tends to be on a five-year anniversary thereafter.
4. *AT1s are perpetuals,* with a potentially infinite horizon. This differs from other types of callable bonds which more often have an ultimate fixed maturity.
5. *The supervisor can veto the decision of the issuer,* if it disagrees with the economic case, has doubts over the bank's capital adequacy, or has concerns over contagion across the sector.
6. *An early call is not the main risk.* The minimum period of five years fixes the initial calculation of yield, although 'tax call' clauses make an early call also a concern.
7. *Automaticity can be delayed,* following the introduction of a six-month window during which to redeem an AT1 rather than strictly at the first call date.

Taken together, these distinctive traits make extension *the* overarching risk for AT1s. Contractual features such as the reset rate and the proximity of the first call are the most significant variables in our analysis. According to our findings, investors considerate extension to be the main capital management tool; i.e., a bank is more likely to extend its AT1 notes past their call dates than to make cuts in coupons. *The ability to continuously monitor the relative risk of extension, given that the α spread is a function of market dynamics, makes the callable optionality of CoCos the soundest foundation on which to build a valuation model.* The key features shaping the risk of extension are:

- the reset or 'back-end' rate, which determines the coupon after the first call date;
- the benchmark swap rate, which reflects the domicile of the bank or the denomination of the notes;
- the years to first call, with AT1s having a minimum of five years at issuance – with some notes as long-dates as 10 or 12 years;
- the schedule of subsequent call dates, which can vary in frequency from quarterly to every five years;
- the presence of a 'tax call' or similar such clauses, which can lead notes to be redeemed early.

Establishing the backend spread

When an AT1 is launched the yield to the first call date is measured against an underlying interest rate swap to the same date as the first call and the spread recorded. In practice, in the initial feedback channels, the then current swap rate curve is referenced as represented either by notes of the same firm or close peers. In this manner, the forward coupon is established by a combination of

the swap rate prevailing at the call date five-years hence and the ‘margin spread’ agreed to in the prospectus. At the first call date, the forward coupon is applied. This reversionary or ‘reset’ rate is specified in the prospectus as the sum of ‘the swap + x bps’. The combination of mid-swap and margin constitute the hurdle at the first call date. Hence, there are two components coupled together:

1. The **reference rate**: Usually a domestic swap curve, such that at call dates the reset rate is adjusted to reflect the latest market conditions.
2. The **margin**: Stated in the contract as a spread at the launch of an AT1, reflecting expectations of future interest rates but often set somewhat higher to encourage take-up.

For example, in February 2020 [BNP Paribas S.A. issued \\$1.75bn](#) in 4.5% AT1 notes callable in 10 years, with a reset formula of “CMT Rate + 2.944%”. The ‘CMT’ is the five-year constant maturity treasury rate, which at issuance of this AT1 was around 1.5% – so, the forward coupon 10-years hence would be roughly the same as that at issuance, ceterus peribus.

There are two moving parts: (1) the *swap rate* itself and (2) the *spread* between it and the yield calculated over the time to the first call date. The interest rate swap referenced differs by note and will be the most relevant benchmark for the bank, such as that of its country of domicile or the note’s denomination. The future market rate of interest – the swap level five years hence – is unknown. Swap rates can fluctuate widely over time in tune with the economic cycle and this represents broader macro risk. The margin is pre-set in the terms of the contract and therefore is ‘known’. The reset spread post the first call date, also referred to as the ‘backend spread’, is a *unique value* that depends on the bank’s credit profile and the market conditions at the time of issuance. The point of comparison is an AT1’s backend spread versus its current zspread, which defines the risk of an AT1 being extended past its first call. When a call date is reached, an AT1 is either called at par or if not called, its coupon is reset for a further period. *The risk for the AT1 holder is that the level at which the coupon resets will be lower than the implied coupon of a new AT1 note.*

To recap, though there are variations, the general approach when an AT1 is launched is:

1. an interest rate swap is selected, such as a domestic swap of similar maturity e.g., Euribor;
2. yield to the first call date is calculated at issuance based on feedback and early indications;
3. the ‘yield to call’ is measured against the underlying mid-swap rate (e.g., YtC – 5-yr govvie);

4. this 'spread' is recorded and cited in the prospectus as the 'margin';
5. *the reset interest rate is thereby established as the sum of the mid-swap and the margin.*

The supervisor has the final say

The European Central Bank sets the rules which are refined into technical standards by the European Banking Authority, but it is the job of the national authorities to approve or refuse the exercise of a call. There is a substantial degree of supervisory oversight regarding redemptions. Prior permission from a national authority must be obtained for a bank to redeem its AT1s at their call dates. Banks are not allowed to exercise a call option unless *both* these criteria are met (BIS, 2011):

A. Contractual:

1. A new instrument of the same or better quality replaces the called AT1 note, prior to or concurrently, and the income capacity of the bank is sustainable, or
2. Without a replacement issue, the bank demonstrates that its capital position will remain above the minimum capital requirements after the AT1 is called.

B. Discretionary:

1. The option to call is based on a sound economic assessment by the issuer, and
2. Supervisory approval is received prior to the exercise of the right to redeem.

In short, the bank's management *and* its supervisor must agree on the economic logic of a call. If a bank can refinance the existing AT1 at more favourable terms, the regulator will probably allow the note to be called. However, if the implied costs favour extending the existing note, any request by a bank to make the call will likely be refused. The call policy consists of a purely economic equation based on the gap between the reversionary rate and the level at which a new issue can be financed. This calculation constitutes the 'automatic' element; however, there are other subjective overlays that make modelling extension risk a challenge. *Call decisions are taken based on numerous factors, including the impact on profitability, future capital recognition, replacement costs, foreign exchange effects, short-term market conditions and execution certainty.* Even the narrow assessment of the bank's fundamentals will include some consideration of sentiment for the banking sector as a whole and an assessment of the strength of the sovereign in which the bank is domiciled.

Compelling rationale: Stand-alone refinancing vs overall funding costs

The decision to refinance a note with a new issue or extend the existing AT1 beyond the call date is based on economic justifications. In broad terms, banks will be motivated to call their AT1s when they can issue a new offering at a lower cost of funding in the primary market. Prior to calling an

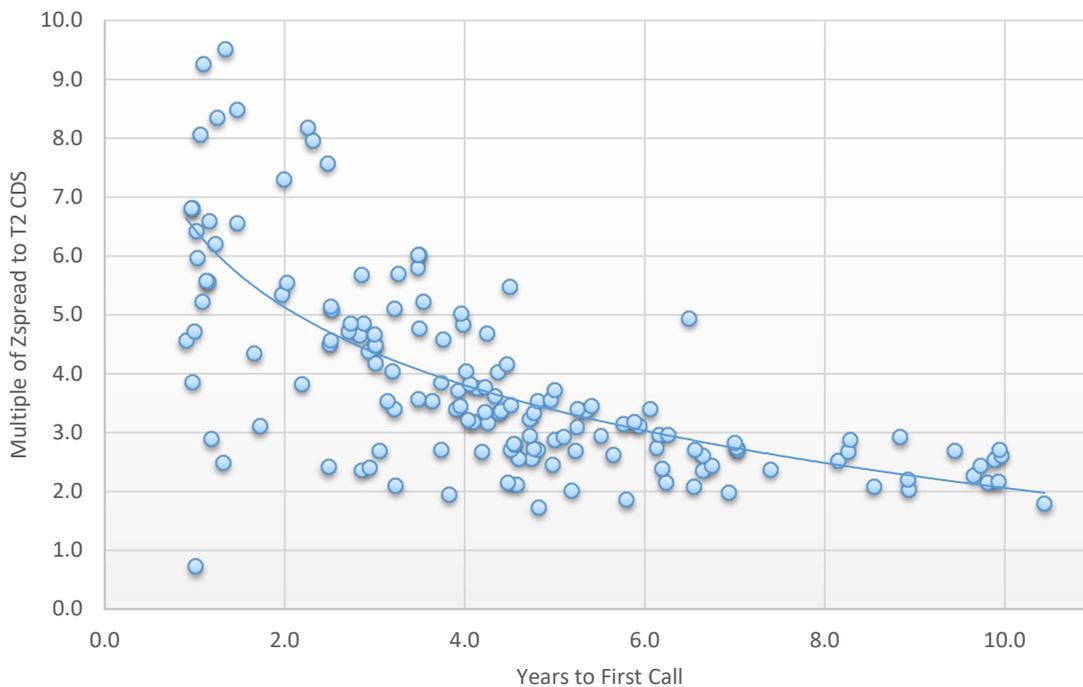
instrument, a bank must send a capital plan for review. The supervisor may take several months to evaluate the plan. A bank will often need to issue a replacement security to achieve approval for a call on an existing AT1. During the period of evaluation, however, a bank is not literally obliged to prefund an issue before calling it, although when this does occur it will result in carry costs. *Rather than formal prefunding, the profitability of a bank is evaluated – specifically, the bank’s ability to generate CET1 each quarter in an amount that, assuming a stable RWA, would make it possible to call the AT1 notes at the upcoming date without impairing its combined buffer requirements.* There is a note-for-note assessment, in which the economics of the current versus reset spreads come into play, but also a consideration of the institution’s future funding needs and costs. The supervisor will assess how to best optimise the capital stack, and in that context how best to reduce the overall spread for the bank, given that most banks will manage their costs on a spread basis.

The EBA published [Regulatory Technical Standards](#) in 2013 to indicate the criteria supervisors should consider when assessing an application from an issuer to exercise a call: the margin compared to capital requirements, the global conditions of the banking sector, a bank’s profitability and capital planning. The standards do not refer to a formula but rather to a cost sustainable by the ‘income capacity’ of the institution, taking into consideration the impact on a bank’s future funding costs. The wording is not proscriptive and leaves supervisors a degree of flexibility to interpret the meaning of “sustainable for the income capacity of the institution” as it relates to profitability, despite recent comments on the technical standards ([EBA, 2021](#)). This seems to imply that, in exceptional circumstances, the regulator might allow a call even without an economically compelling replacement issue. One such scenario might be in cases where the AT1 would no longer be needed due to a long-term change in a bank’s capital policy. Another scenario might be a shift in scope such that the size of the capital base shrinks due to closure or the disposal of a business.

The rules suggest that supervisors will normally withhold permission to call if AT1s are not prefunded at similar or lower spreads compared to the reset of an outstanding issue. So, if the reset spread is higher than the current spread as the bank’s profile and or the market conditions have improved, then refinancing is attractive. The cut-off point might not be exact since supervisors could accept replacement with spreads moderately wider than those of the outstanding note in light of the potential negative signalling effects of a non-call. Although national authorities are unlikely to give much leeway, under difficult market conditions they could be lenient with regards to the economics of replacement issues. An economic rationale is open to interpretation.

Given that two sets of incentives – those of bank management and their supervisor – need to be aligned, the risk of extension is inherently greater than a simple calculation of the reset versus refinancing spreads. In some circumstances, optics can come into play. Banks with high backends tend to be domiciled in the periphery or to have had troubled histories, which is why high resets were inserted into the contracts in the first place. For example, the Spanish bank BBVA came to the market in 2016 with a [record high reset](#) (917.5 bps over mid-swaps) in order to reassure investors that the firm would be very likely to redeem at first call or, failing that, its notes would at least look attractive from a perpetuity perspective. Even in cases such as this, the country- and bank-specific risks that lead to the high reset may still be present at the time of the first call, which could make refinancing just as hard. In such conditions, the supervisor may opt to prohibit a redemption to prevent the burden of even more exacting interest payments.

FIGURE 49: EUROPEAN AT1s – CURRENT ZSPREAD/T2 CDS (x) BY TIME TO FIRST CALL (YRS)



Source: CreditSights, Bloomberg, data as of 1st April 2021.

Figure 49 shows the trend line for time to first call date versus the multiple of a bank’s AT1 zspread to its Tier 2 CDS spread. This CDS basis is a key metric used in our regression analysis. Seen against this pricing parameter, the lower the multiple the less the perceived risk. Note that the multiples are

markedly higher the nearer the first call date, as shown on the x-axis – especially when the interval falls within two years.

B. Key Determinants in the Decision to Call or Skip

A. Non-call probability

The issuer's decision to redeem at a call date rests on its assessment of immediate economic advantage. A bank would compare the costs of borrowing under the current market conditions with all the associated costs of continuing with the existing note. There would be an incentive for the bank to refinance if its creditworthiness has improved to such an extent that it can pay out a lower coupon on its AT1s. This weighing of economic incentives is the central factor shaping the probability that an issuer will redeem or not at the first call date. But it is not the only factor. Bank management will also consider the impact that not calling could have on the rest of the capital structure, specifically the increasing cost of financing future offerings if the bank is perceived as being at greater risk of a non-call. As a rule of thumb, the flow of factors is: bank fundamentals + future funding costs + macro environment => economics of issuance.

1. Bank fundamentals

The point of departure for the decision to call will be the bank's balance sheet strength. Should the credit quality at the issuer remain the same or even improve, the bond will likely be called at par at the first opportunity and likely exchanged for newly issued debt. Should the credit quality decline leading up to the call date, the spread over swap demanded by the market as compensation for an increase in perceived riskiness will tend to exceed the fixed reset rate. In this situation, the issuer is inclined to skip the call date given that the funding costs are more expensive than extension. The broader market backdrop at the time of first call could, however, complicate the assessment.

The decision on whether or not to call a note is fairly straightforward for the issuer if the security in question is trading at or above par prior to the call date as this implies it would be cheaper for the issuer to redeem the security and issue a new note with lower coupon. If an AT1 is trading below par that would tend to be an indication of credit concerns or a change in market conditions; for a fixed income instrument, yield rises when its price falls, and a bank would need to pay a higher coupon if it issued a new note to replace one trading below par. The further below par, the more yield likely required for investors to hold a new issue note. Therefore, those AT1s trading at levels considerably below par imply a greater expense to refinance.

2. Future funding costs

The economic rationale behind a decision to call must be evaluated in terms of both the note in question and future funding costs. Issuers must consider the pricing of other outstanding debt and all forms of securities going forward. Should a bank skip a call, the next time it went to the market investors might ask for a higher return to account for the heightened risk of future non-calls. The logic of skipping cannot be assessed solely on the basis of one AT1, the economics must consider the context of a bank's overall capital strategy. Historically, in addition to step-ups, the reputational repercussions were a key reason for banks to redeem at the first scheduled call date. There is a stigma associated with skipping a call. Failure to call at the first instance is perceived as a sign of weakness. So, if it is not much more expensive for the issuer to call, it may be in its long-term interest to redeem in order to safeguard future access to capital markets.

While investors may be growing more forgiving due to the difficult economic conditions of recent years, the overall reputation of a bank may well be more relevant than the fine-tuning of immediate funding levels. Thus, we expect that consideration of the potential impact on a bank's future funding costs will remain central to decisions to call or skip. Smaller institutions that issue less often might focus on immediate economic gain and favour the certainty of cost savings over long-term investor relations. But frequent, large issuers are likely to remain reluctant to non-call.

3. Macro environment

The credit risk part of refinancing may also increase at a faster pace if sentiment in the banking sector is hit hard or the sovereign credit of the country in which a bank is domiciled suffers. For example, peripheral banks may be particularly vulnerable to downturns in sentiment amid concerns over high levels of non-performing loans. If either the bank's own credit profile deteriorates or the interest rate on the benchmark swap rises, a material shift in the risk-reward ratio may arise. The credit spread could stay stable, but if treasury yields rose the AT1 price could still drop below par. The two drivers of the implied coupon, the credit spread and the underlying government bond yield, may even widen in a mutually reinforcing way in response to macro factors.

Bank fundamentals vs the market environment

What happens if the credit profile of the bank is sound, but market conditions deteriorate near the call date? For example, suppose the AT1 note referenced earlier – BNP 4.5% US\$ perp Feb-30 – are nearing their first call and in the 10 years since the notes were issued profitability has improved at

the bank and its capital position is stronger, but because of exogenous market shocks such as extreme currency volatility the risk premia have risen and the cost of refinancing is more than ‘CMT + 294.4bps’. That would not be economic on a note-for-note basis. Given the improvement in the bank’s metrics, the supervisor might consider a call to be more in the spirit of the rules, in particular if not calling might lead to a deterioration in the overall cost of funding for the issuer. The amount of difference in spreads that could be tolerated, if the effect on profitability were relatively minor, is uncertain – and up to the discretion of the supervisor.

In sum, having a narrowly defined economic rationale and meeting regulatory capital requirements at the call date may not be sufficient to convince a supervisor to approve a call. Management and supervisors are apt to assess matters more holistically and take into account the entire curve and future funding costs, not only the economic logic of a particular instrument at one point in time.

B. Early exercise

Complicating the risks associated with the extension of maturity, most CoCo contracts also contain clauses which allow for the early exercise of a call. AT1 / RT1 CoCos typically have early redemption clauses in case of the removal of tax deductibility. The typical phrasing is along these lines: “The bonds can be called at any time following the occurrence of certain tax events...” (Nordea prospectus, 2018).

Tax events

The ‘tax call’ constitutes a separate risk that would result in an early call – hence, it is the polar opposite of extension risk. As far as we are aware, tax calls are typically at par rather than at make-whole prices – thus these could well be loss events for CoCo holders. That said, issuers could offer market-based tenders in cases where a call was noticeably unfavourable for investors. AT1s with high backend spreads tend to trade above par, rewarded in part for their lower extension risk. But the tax call logic could negate the attractiveness of such notes by counteracting the protection from extension risk that a high reset offers with the risk of pulling forward the call date in a tax event. *The influence of these contending call-related risks needs to be borne in mind when modelling duration for AT1s (and their insurance company counterparts, RT1s).* Instruments with higher initial rates and high reset rates may be refinanced more cheaply, reducing extension risk but increasing the risk of a call in a tax event.

State aid rules can remove tax breaks

Tax calls will continue to be a risk until the EU Commission and local legislators provide greater clarity on their commitment to the tax deductibility of CoCo coupons. For example, in the prospectus for its RT1 note issued in April 2018, Vivat cites that the EU Commission in 2015 raised concerns about the tax deductibility of CoCo coupons; if the deductions were to be classified as state aid the benefits may have to be recovered by the Dutch state and the tax benefit denied going forward. The [Vivat prospectus](#) also explains that a state aid repayment may cause the company to redeem the notes at the earliest possible date. Indeed, there have since been changes in the taxation of coupons in jurisdiction such as the Netherlands. The Dutch government announced in late 2019 that coupons on CoCos for both banks and insurance companies will no longer be tax deductible, given concerns over the EU Commission's rules on state aid, and explained that the removal of tax deductibility for AT1s was intended to stimulate financial firms to hold more equity. Subsequently, most Dutch issuers chose not to take advantage of the formal tax call but rather to absorb the higher charge. However, the 'tax call' risk that transpired for Dutch CoCos highlights the early call risks for other European issuers. Issuers could choose to price new issuance higher, or even in future forgo CoCos, given the higher cost of capital in the event of a loss of the instrument's tax shield.

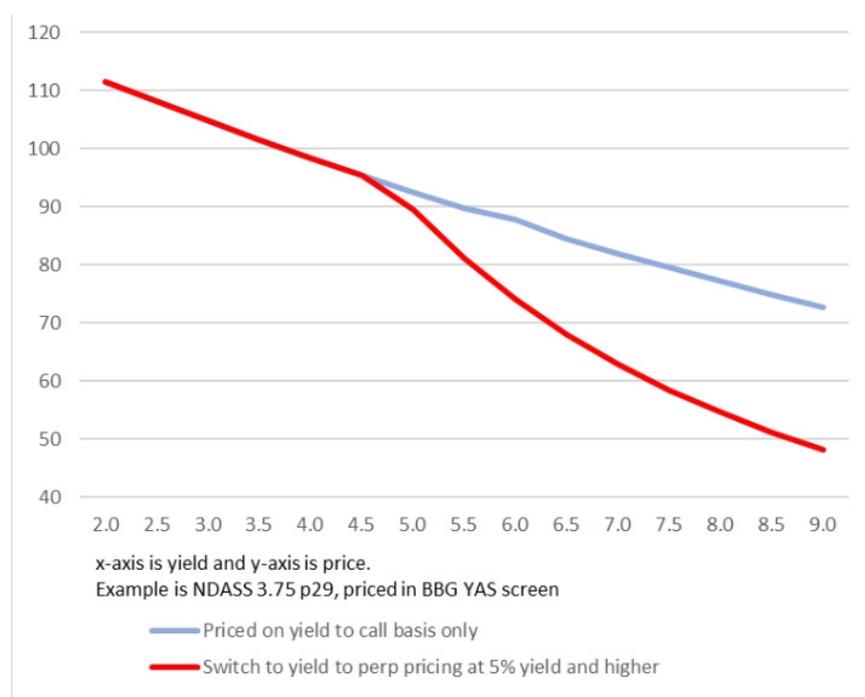
C. Curvature risk

Duration is the number of years it will take the cash flow from a fixed income instrument to repay its purchase price. Duration indicates the sensitivity to interest rate changes; it is not linear and changes uniquely for each security. Duration fluctuates according to the probability of a security being called away and tends to move higher with increasing market interest rates. Callable bonds usually exhibit negative convexity at lower yields into a rising interest rate environment. If an AT1 with a first call in say 2023 is expected to skip its call date, then the pricing of the note will take into account the added duration and associated credit risk over the longer period to the next call date.

Non-call risk therefore gives AT1s an element of *price convexity* from an investor point of view. *In Basel terminology, convexity is considered a form of 'curvature risk' – a category for non-linear risks.* Curvature risk incorporates second-order risks arising from large moves in the price of the underlying. Specifically, as the zspread on an instrument moves materially beyond that of the reset, the immediate implication is that the issuer is less likely to call these instruments at the first call date. As such, the notes will reprice to the subsequent call date in the schedule – often five years hence. In normal

times, AT1 CoCos will generally experience a ‘pull to par’ in relation to the call date. But the tendency for repricing can become more pronounced the further an AT1 trades from par. This non-linearity at the point at which investor perceptions toggle from ‘yield to call’ to ‘yield to perpetuity’ is highlighted in the graph below. As the credit profile deteriorates, the non-call scenario becomes ever more likely and notes will rapidly reprice to *yield to perpetuity*. AT1s with extension risk that flip to ‘yield to perp’ may face significant mark to market risks, leading to losses for note holders. It is thus important to recognise that *investors can suffer immediate losses when perceptions of extension risk rise in prominence, even without the actual call skip occurring*.

FIGURE 50: AT1 CoCos – NON-LINEAR EXTENSION RISK



Source: Bloomberg, Stifel Nicolaus Europe Limited.

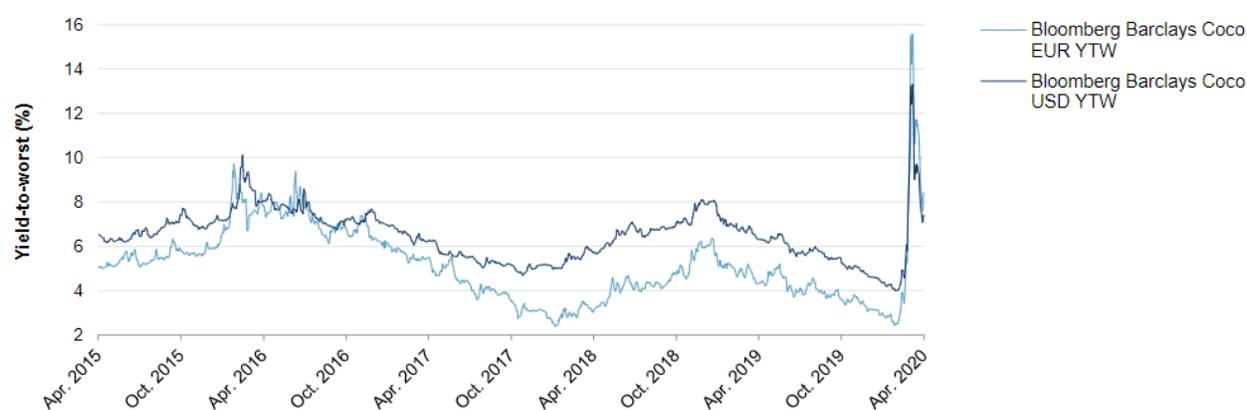
Negative convexity creates a negative feedback loop

AT1s have experienced periodic bouts of negative convexity when the cost of refinancing spikes, either at one large bank or across the sector. Such negative convexity tends to accelerate selloffs as wider credit spreads imply greater probabilities of extension risk, which in turn leads to further declines in pricing. The central source of contagion across the AT1 asset class in February 2016 were concerns over the ability of Deutsche Bank’s AT1s to make coupon payments, as all the risks embedded in AT1s were perceived to simultaneously re-price (concerns over coupon led to fears over maturity extension). *As*

the risk premium associated with coupon omission repriced higher, this drove the implied future coupon for re-issuance notes higher as well. The prospects of higher refinancing costs, in turn, raised the risk of extension.

AT1s experience episodes of sudden reassessment of extension risks. The asset class saw a correction in late 2018 that was exacerbated by increased pricing to perpetuity, which pushed spreads even wider as investors demanded compensation for a potentially longer holding periods. This self-reinforcing effect raised the cost of refinancing, further fuelling extension risk as the negative feedback loop disproportionately impacted notes with lower resets. There was also a cross-asset selloff that marked the first wave of Covid-19 pandemic, highlighted in the graph below, which shows the ‘yield to worst’ for AT1s spiking from all-time average lows of 4.5% in euros and 5.5% in US dollars into the mid-teens in a matter of weeks in April 2020.

FIGURE 51: EUROPEAN AT1s – YIELD TO WORST (\$ & €)



Source: Bloomberg (April 2020). Note: ‘YtW’ equates to ‘YtP’ in extremis.

D. Frequency of reset dates

Thus far the track record of AT1 calls is almost perfect, but there is no guarantee that this sterling record will necessarily continue. In February 2019, the market experienced the first call skip for a major European bank when Santander announced that it would not exercise the call of its SANTAN 6.25% perp Mar-19 notes, which had a re-set spread of 541bps. This was unequivocal evidence that investors should not rely solely on pre-funding being in place to predict non-calls. This skip came as a surprise given that Santander had only months before issued a new \$1.2bn AT1 security, which was thought to be prefunding for the upcoming redemption, and the new AT1 traded only slightly below par with a spread to call more or less in line with the reset spread of the existing AT1.

Santander's Mar-19 notes dropped almost 5% on the day the extension was announced. The bank stated that its decision was taken with "an obligation to assess the economics and balance the interests of all investors." The factors at work seem to have been a desire to wait for more favourable market conditions to then issue a lower interest-paying note, coupled with the unusually brief reset period post first call, with much higher frequency 'quarterly' call options rather than the five-year period to the next call date common for most AT1s.

Here we have yet another risk clause to consider – the reset frequency, post first call. In the instance of Santander, the extension need not be extensive as there is an opportunity to revisit the call in only three months' time; after spooking investors, the bank subsequently announced that it would call the skipped note in one year. A year on, the bank did indeed secure more attractive pricing on the replacement issue – justifying its decision to delay the call, though at the expense of the existing holders of the 6.25% notes. *In the construction of models, a variable should be included to take account of the fact that not all AT1s will extend at five-year intervals; some will be callable again quarterly or bi-annually, or even 'at any time' after the first call.* Securities with shorter interval may be more prone to having their first calls postponed – a factor to include when calculating extension risks. If the first call is skipped, the timing of the next call date – the call schedule – will come into play along with an assessment of whether the problems causing the skip are short-lived (credit profile vs market conditions) such that redemption is likely at subsequent call dates. While the reset interval is another relevant variable, in our regressions this feature did not have a discernible influence on pricing.

Whilst Santander's AT1 was notable for the uncommon property of three-month intervals on subsequent reset periods, later instances of skips have come from either distressed banks or during market distress for which calling would have been considerably more expensive than extending:

- NordLB [decided not to call](#) its AT1s in March 2020, at the height of the Covid-19 related market disruption; its notes reset annually post the first call.
- Deutsche Bank [decided not to call](#) its \$1.25bn of 6.25% coupon AT1s at their first call on 30 April 2020 on economic grounds; these notes reset every five years.
- Aareal Bank [decided not to call](#) its 7.625% coupon AT1s at their first call on 13 November 2020 also on economic grounds; these notes reset annually post the first call.
- Lloyds [decided not to call](#) its 6.375% coupon AT1 on 22 May 2020, citing "the extraordinary market challenges presented by Covid-19"; these notes reset every five years.

'Delayed automaticity' – A rule change to widen the window

The adoption of a six-month call window in September 2019 means that AT1s issued in the past two years should be better placed to make calls in the future. The update to the rules allows banks to call the AT1 at any time during a six-month period between the first call date and the coupon reset. This opens up a window of opportunity for banks to delay making a call decision during a temporary period of market volatility. *This rule change bears a strong resemblance to the nine-month 'grace period' introduced in the case of the MDA mechanism, and also operates as a form of 'delayed automaticity'. The introduction of a six-month window, while it allows greater flexibility to manage refinancing, also highlights the propensity of the regulators to change rules to favour the AT1 asset class.*

C. Structural Dimension: The Spectre of a Perpetual Vintage

Shift in long-dated treasury yields

As mentioned earlier, while AT1s were constructed to be equity-like, these notes can display bond-like features as well – their callable features can price with negative convexity. This tendency is more pronounced for notes with low reset rates, when overall market rates are perceived to be likely to rise. Therefore, the overall interest rate environment has a bearing on the cost of refinancing. Swap rates fluctuate in relation to base rates, which are in turn influenced by the underlying trajectory of economic cycles. *Investors in AT1s thus take an implicit view on future interest rates.*

The first wave of AT1s had high reset rates given that investors demanded a higher premium for the newly emerging asset class. Although a few banks issued at 10-year maturities, most banks opted for the minimum five years to avoid locking in for longer than required. In the first phase of issuance, investors tended to look at the all-in yield and perhaps not pay as much attention to the implicit call option being sold to the bank that was issuing the notes. The difficulty in trying to assess extension risk is to forecast what the market may look like five years hence. During the initial wave of issuance, a sense prevailed that credit conditions were more likely to improve than market rates were to rise. This implied forecast was largely proven correct and the inaugural AT1s have almost all been called. However, the subsequent cohort of AT1 CoCos have not yet passed this test.

The inherent danger with the asset class is that if refinancing costs rise across the board by the time of the first call, investors may have mispriced the credit curve. In the ultra-low interest rate environment that has persisted since the 2007/8 crisis, the reference swap rate for AT1s is a small component. The change in credit profile is the main factor driving the setting of the level for

coupon payments. However, we may start to see this pattern shift when overall rates start to rise. *An environment of rapidly rising interest rates will tend to increase extension risk as it raises the overall cost of refinancing.* There is always an inherent risk that the spread to benchmark could be far higher at refinancing. As a consequence, *the issuing of AT1s with lower coupons during the extended era of quantitative easing is creating a structural risk of extension in that refinancing in future will occur in the context of ever-tighter reset spreads;* this pattern at some point must reach a natural limit as issuers are asked to call to refinance at ever cheaper levels.

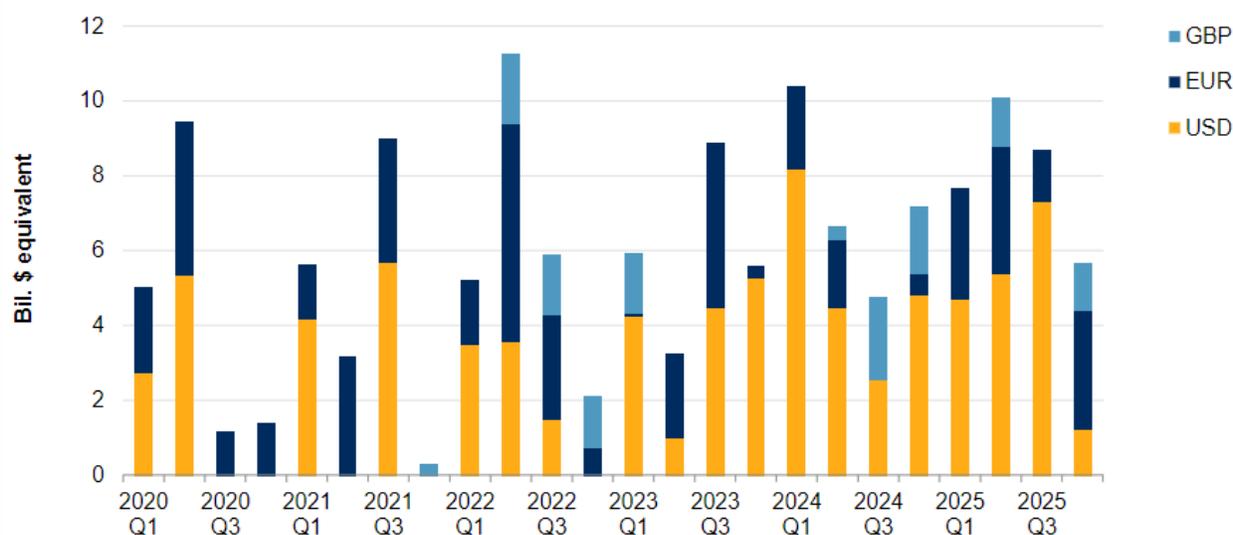
An analogy can be made to the period prior to the credit crisis of 2007/8, in that an issuer views a callable security much like a property owner would a mortgage. Low interest rates offer an opportunity to refinance. This is the advantage of the call feature for an issuer, as the bank has the option to call away the outstanding higher coupon AT1s and replace the notes with a cheaper form of capital. If we consider the era leading up to the 2008 credit crisis, many mortgages were originated at exceedingly low ‘teaser interest rates’ that were subject to much higher reversionary rates in future; an environment had inadvertently been created that made an entire vintage of mortgages at risk of defaults if conditions were unfavourable when the mortgages were scheduled to reset. Once the failure of US sub-prime businesses began, a systemic wave followed with hundreds of specialist mortgage brokers failing and the market for asset-backed commercial paper freezing up. *A perpetual vintage of AT1s could pose similar contagion risks, in which the decision not to call at one bank might reinforce the decision to non-call at another,* leading to frequent extensions with associated impacts on pricing not only in the secondary but also in the primary market. *A repricing of risk premia related to principal conversion and coupon cancellation, were triggering levels raised and imposed more strictly, could drive reset spreads higher on future AT1 issuance.*

Wave-like pattern in reset rates

One difficulty for assessing extension risk is the comparison of the reset spread of an outstanding issue versus the likely cost of a potential replacement issue. The cash price of the older issue does not appear to be a good indicator near the call date, since it would typically be distorted by pull to par expectations. To get an idea of spread levels demanded by the market, one can plot the new issue spreads / reset spreads of the existing AT1 universe. The resulting graph below shows a wave-like pattern of reset spreads, beginning with wider spreads in 2013 followed by tightening levels in 2014-15, before spread levels widened again in 2016, after which a new tightening phase set in. The spreads commanded at issuance are somewhat cyclical and vary in relation to overall economic

The annual amount of AT1 is set to increase from c\$17bn in 2020 to c\$30bn in 2025 – as forecast by S&P Global as of April 2020. This estimate may not fully reflect the scope for new issuance due to the roll-out of the TLAC-MREL regime that will likely more than replenish the calendar – i.e., as AT1s are called, new AT1s will be issued as replacements as well as the potential pick up in overall demand following the early enactment of Article 104a etc. that has expanded the role of AT1s.

FIGURE 53: EUROPEAN AT1s – CALL CALENDAR BY CURRENCY (£, €, \$)



Source: Dealogic, S&P Global Ratings (April 2020)

An explosive cocktail – rising rates & poor profitability

Refinancing AT1s at ever-tighter reset spreads may eventually reach a limit at which point the notes are virtually perpetuals in that banks are disincentivised from ever calling. Some fixed income funds do not have mandates to hold outright perpetuals and could become forced sellers, if non-calls became prevalent. ‘Perpetual vintage’ is a term used to refer to AT1s priced with such tight backend spreads that banks have no incentive to call for long periods. A perpetual vintage could arise if non-call decisions become increasingly frequent due to a combination of factors:

1. Structurally low resets embedded during an extended period of exceptionally accommodative monetary policy and quantitative easing start to face persistently higher refinancing costs.
2. A repricing of risk premia off the back of higher capital adequacy triggers or stricter enforcement of MDA restrictions – i.e., a reassertion of automaticity.

3. Supervisors come to prioritise capital conservation over the pure maths of refinancing. The retention of capital amid a climate of recession could trump all other considerations.
4. An erosion in the view that, outside of extreme distress, the skipping of call dates should be avoided to preserve a bank's reputation.
5. Once the prospects of principal repayment become unlikely, some fixed income funds are forced to sell their AT1s if their mandates forbid them from holding perpetuals.

The currency in which an AT1 is denominated also plays a role, in that the reference swap rate will vary by note and its level can influence the exposure to rising treasury rates. AT1s have embedded FX costs when issued in US dollars – or any currency other than the one in which the bank runs its accounts – and will be exposed to major currency moves, which may make it inopportune to call depending on how the foreign exchange exposure is hedged.

A potentially disruptive combination facing many European banks is a mix of sovereign indebtedness and widespread economic sluggishness, which could cause deteriorating credit profiles across the sector set against a backdrop of rising *real* interest rates. This scenario could increase the cost of refinancing and make the case for retaining AT1 notes with lower reset rates irresistible.

CASE STUDY OF FIRST AT1 CoCo CONVERSION

In June 2017, the European Central Bank determined that of Banco Popular Español was “failing or likely to fail” and moved the bank directly into resolution. The sequencing of coupon curtailment prior to principal conversion was upended under the authority of the national supervisor – most probably to avoid a run on the bank by its depositors. The bank’s AT1s converted into equity with no value and investors were left with zero recovery. An institution should not have to collapse, as Banco Popular did, for its AT1s to trigger.

Popular did not do anything unlawful by continuing to pay interest on its AT1s despite being essentially devoid of profits. The reluctance to cut reflects a short-coming in the overlay of discretion: if not entirely mechanical, then a ‘decision’ to cancel coupons can send an adverse signal to the market that causes more harm than the benefits of the earnings retained. The annual interest expense on Popular’s two AT1s amounted to only €119 mn, not nearly enough to remedy its woes.

The case of Popular implies that, in practice, the fear of sparking depositor flight may be as important in assessing the probability of an AT1 conversion as any drawdowns in capital. The concentration of funding from large corporate depositors can be the decisive factor, as was also at a factor for both Lehman and Northern Rock. AT1s are currently designed solely to restore solvency rather than to help to solve problems with liquidity.

XIII. Banco Popular Español – Patient Zero

First use of AT1s fails to deliver on their promise

To illustrate discretionary power at play, we consider the case of Banco Popular Español, which did not defer its coupon despite pressure on its combined buffer – with the tacit support of the national authority – and yet, a quarter later, its AT1 CoCos were converted even though the formal capital ratio threshold had not been breached. The national authority delayed action on coupon restrictions, likely to avoid signalling weakness, but a few months later the same supervisor declared the bank non-viable even though the Popular’s most recently reported CET1 ratio was 8.2% – some distance above the 5.125% and 7% triggers on its AT1s. Supervisory discretion, in the form of ‘flexibility’ and ‘forbearance’, lowered the barriers for both the coupon cancellation and principal conversion.

The Bank Recovery and Resolution Directive ([BRRD](#)) rule book was applied for the first time on 7 June 2017, when supervisory authorities zero-ed the AT1 notes of Spain’s Banco Popular Español. The sequencing that market participants had been expecting failed to materialise. Popular was still current on its AT1 coupons, yet its two AT1s instruments were wiped out without warning in a single day. According to the spirit of the regulatory framework in place, the natural course of events would see AT1 coupons cancelled and then, if the bank’s capital position continued to weaken to breach pre-defined trigger levels, the AT1s would be converted automatically into equity to recapitalise the bank while still a going concern. Instead, the European Central Bank invoked a non-viability event in accordance with [Article 18 \(1\)](#) of the Single Resolution Mechanism Regulation and placed Popular directly into resolution, rendering its AT1s de facto gone-concern capital. This decision gives us pause to reflect on the underlying mechanics of contingent convertible notes and underscores our motivation to analyse the current state of the industry’s valuation models.

Underlying weakness

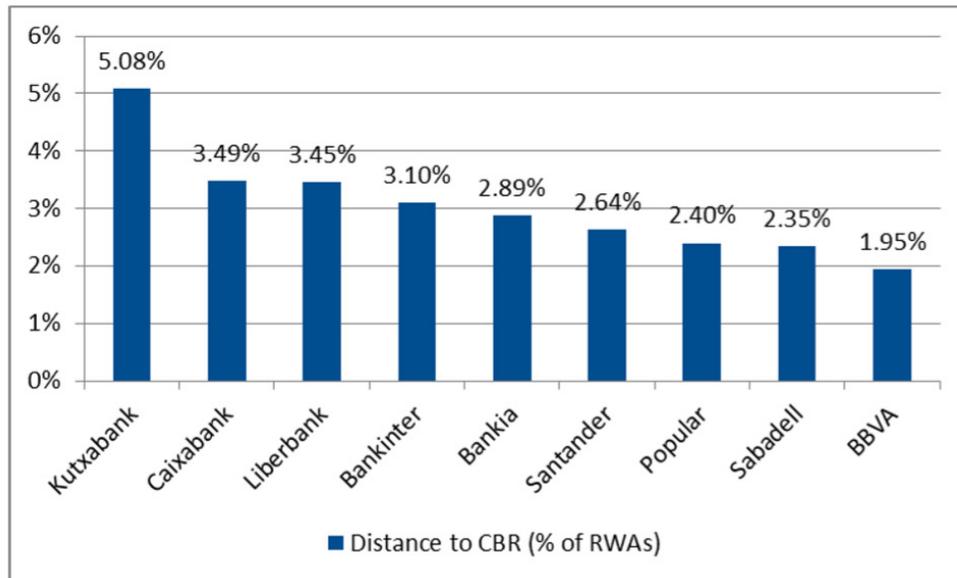
Popular had been struggling with non-performing assets related to its real estate exposure. The bank had €37 billion in foreclosures and other non-performing assets accumulated during Spain’s housing downturn earlier in the decade and booked large losses in 2016 in its mortgage portfolio. Stress tests carried out that year under the aegis of the ECB had highlighted “alarming levels of debt” and determined that under an adverse scenario, Popular’s capital would fall perilously close to minimum requirements. In view of these concerns, the bank completed a capital raise of €2.5 billion in June 2016. The problems with non-performing loans worsened, however, when Popular indicated that its

internal audit had uncovered a provision shortfall that could lead to CET1 deductions. This elicited press speculations that considerable additional provisions were required in its real estate portfolio. Then, in its Q1 2017 quarterly disclosures, the bank revealed that it indeed had a provision shortfall of €160 million alongside €145 million in “de-recognition of collateral” on top of the €496 million in further provisions booked during the quarter. Though its capital position was coming under continuing pressure, the [press reports](#) at the time claimed that the core franchise of the bank was profitable and delivering solid returns. Popular had various options to deal with the shortfalls such as disposing of non-performing loans, securitisations, another capital raising or a merger.

Coupon not cancelled

The bank booked accounting losses of €3.5bn for 2016 in early 2017, which stoked fears in the Spanish press that this would eliminate the €3.5bn pool of Additional Distributable Items out of which coupons are paid. But on the contrary, Popular went to great lengths to make its €120m of annual AT1 interest payments due in 2017, with the tacit support of the Spanish national authority, even though cancellation of these non-cumulative coupons is an option to preserve capital. A spokesperson for the bank stated at the time: “we can and will transfer share-premium to reinforce the level of ADIs so that the overall volume remains unchanged versus September’s level even after the extraordinary losses of the quarter” ([Reuters, January 2017](#)). The bank moved equity between reserves in this somewhat unorthodox manner (share premium is the difference between the nominal value of a share and the price paid) to avert a missed AT1 interest payment. The other measure determining a bank’s ability to distribute coupons is the proximity of its combined buffers to the threshold that triggers an ‘MDA’ calculation. The chart below shows that in the preceding year, Popular’s coupon cover was weak but not the weakest of the Spanish banks. Indeed, the cushion on the date of the Q1 2017 payment was estimated by CreditSights to have improved to within 3.25%-4.75%, trending toward the mid-range of its Spanish and European peers.

FIGURE 54: SPANISH BANKS: MDA CUSHION



Source: [Scope Ratings estimates](#). MDA = Maximum Distributable Amount; CBR = Combined Buffer Requirements

Resolution: Protection for senior creditors

On 6 June 2017, the ECB informed the Single Resolution Board ([SRB](#)) of its decision that Popular was “failing or likely to fail.” The ECB press release shortly afterwards states the determination was premised on “the significant deterioration of the liquidity situation” and that the bank “would have, in the near future, been unable to pay its debts or other liabilities as they fell due.” In its capacity as a resolution authority, the Spanish Executive Resolution Authority ([FROB](#)) subsequently facilitated the transfer of all shares and capital instruments of Banco Popular to Banco Santander the following day. In this manner, Popular was forcibly acquired by Santander in an overnight auction conducted by the SRB, under the framework for the recovery and resolution of credit institutions and investment firms ([Directive 2014/59/EU](#)). It is worth stressing that all these decisions were taken at the same time: Banco Popular was officially put into a resolution scheme, its AT1s were zero-ed and *simultaneously* the bank was acquired by Santander.

On 7 June 2017, when the European Commission approved the resolution scheme, it noted that no aid from the Spanish state or the Single Resolution Fund was draw on. That no state money was used was certainly a benefit for the Spanish taxpayer. In addition, the bank’s senior debtholders and depositors were left unscathed. The resolution authorities were confronted with a situation where the only way to prevent a state-assisted bail-out and senior debt default was to sell Popular to a

larger bank. Popular's status as an M&A target offered a way out. However, prior to the transfer of ownership, the ordinary shares, AT1s and Tier 2 CoCos were written off. To protect its capital ratios, Santander performed a €7bn equity raise to mostly cover a €7.9 billion loan loss provision to strengthen reserves and allow for Popular to be absorbed as a fully owned subsidiary of Santander SA. Therefore, the overall impact on the CET1 for Santander was neutral.

Trigger levels not breached

Popular had two AT1 instruments outstanding, both convertible into equity: one had a capital adequacy trigger of 7% and the other a 5.125% trigger – as summarised in the table below. In the event, *the trigger differential did not come into play at all*. With Popular, we have unequivocal evidence that AT1s can be converted before their contractual CET1 triggers are touched. *This scenario creates a grey area, which makes it challenging for investors to rely on the distance between a trigger point and the reported capital position as a transparent indication of risk, and in particular the distinction between high and low trigger thresholds.*

FIGURE 55: BANCO POPULAR - AT1 METRICS

| Coupon | Amount mn | Issue Date | First Call | Current Price | Conversion Trigger | Yield to Call | Z- Spread AT1 | Multiple of Tier 2 CDS | Multiple of Senior CDS | Conversion Terms | |
|---------|--------------|---------------|---------------|------------------|-----------------------|---------------------|---------------------|---------------------------------|---------------------------------|------------------|-------|
| | | | | | | | | | | Fixed/Floor | Price |
| 11.500% | €500 | 10-Oct-13 | 10-Oct-18 | 104 | 7.000% | 9.03% | 917 | 3.1 | 6.7 | Floor | €2.02 |
| 8.250% | €750 | 5-Feb-15 | 10-Apr-20 | 88 | 5.125% | 11.96% | 1204 | 2.9 | 6.4 | Floor | €1.89 |

Source: Moody's and Bloomberg; as of 26 May 2016.

Popular reported a CET1 ratio of 10.02% in its presentation of its results for Q1 2017 on 31 March 2017, consisting of €6.1 bn of *transitional* CET1 against €61 bn of risk-weighted assets. On a *fully loaded* basis, CET1 amount to only €4.5 bn, which would have translated into a ratio of only 7.33%. The difference between the transitional and fully loaded amounts are a function of the phase-in period of capital deductions under Basel III. In the prior year's regulatory stress test, Popular's CET1 ratio under the adverse scenario displayed a similar figure of 7.01%, optically still adequately capitalised though obviously with a hair's breathe of breaching the 7% trigger. However, it must have been fairly obvious to all the relevant parties that the bank needed an immediate capital injection – the AT1s were at hand, designed to do just this, but were left untouched.

It certainly lay within the power of the supervisory regime to declare a non-viability event in May 2017 and convert Popular's AT1s *prior to the depositor flight* on the basis of the bank being 'likely to fail'. Indeed, this step might well have been initiated at the time of the stress testing a year prior, or

at the first quarter results in March 2017. It was not necessary for the institution to be placed into formal resolution for its AT1s to be converted – the notes could have converted while Popular remained a going concern with the national authorities taking the initiative to intervene early.

To hammer home this point, consider that in mid-May 2017 analysts at CreditSights estimated that Popular required at least another €5 bn of capital to cover further provisions against real estate assets and related exposures to non-performing loans. Their figure was based on the bank’s own statements at its first quarter update in March, which stated that Popular’s reserve coverage on foreclosed real estate stood at 38.5% and must be brought up to the level of peers. To get to the then peer average coverage level of 53% implied an increase in Popular’s reserves of roughly €3 bn. This estimate by CreditSights was validated by the provisions taken by Santander at the time of its acquisition less than a month later, when the coverage on foreclosed real estate was raised to 65% at a cost of €4.7 bn and on non-performing loans raised to an average of 68% at a cost of €3.2 bn, for a total of €7.9 bn – as overviewed in the table below.

FIGURE 56: BANCO POPULAR – PROVISIONING OF REAL ESTATE ASSETS AND LOANS

| EUR Bn | Popular Pre-deal (Q1'17) | | Popular Post-adjustments | | | Peers |
|--------------------------------|-----------------------------|------------|-----------------------------|------------|-------------|------------|
| | Gross value | % Cov. | Provision | % Cov. | Net value | % Cov. |
| Total RE Assets | 17.7 | 39% | 4.7 | 65% | 6.2 | 52% |
| <i>Non-performing RE loans</i> | <i>12.1</i> | <i>55%</i> | <i>2.5</i> | <i>75%</i> | <i>3.0</i> | <i>51%</i> |
| RE assets + RE NPLs | 29.8 | 45% | 7.2 | 69% | 9.2 | 52% |
| NPLs ex Real Estate | 7.0 | 46% | 0.7 | 56% | 3.1 | 51% |
| NPA | 36.8 | 45% | 7.9 | 67% | 12.3 | 52% |
| <i>Performing RE loans</i> | <i>3.8</i> | <i>0%</i> | <i>0</i> | <i>0%</i> | <i>3.8</i> | |

Source: [Santander analyst presentation](#), slide 28.

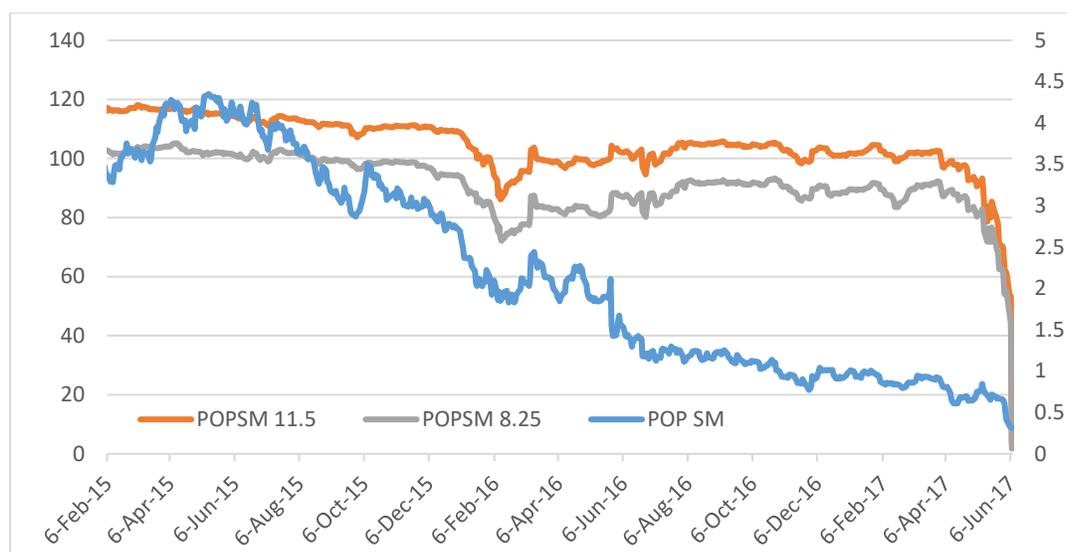
Equity conversion as a going concern did not occur

Popular’s AT1s were such that the investors were supposed to receive shares while the bank was still a going concern. The conversion price and floor price are cited in prospectuses to inform investors of the approximate recovery rate to expect if a contingency event occurs. In the case of Popular, the

floor prices shown in Figure 55 were even lowered to adjust for the decline in its equity since its AT1s were launched. The floors were revised down on 19 September 2016 to €1.653 from €2.015 for the 11.5% notes and to €1.549 from €1.889 for the 8.25% notes. *The lower floors were intended to improve the recovery prospects in the event of a going concern conversion.* But such contractual terms were rendered moot by the failure to convert until resolution.

The graph below shows the precipitous decline of Popular’s share price and its two AT1 notes. Down from over €4 two years earlier, the share price traded at €0.61 at end-May 2017. The floored conversion prices for its AT1s by March 2017 were close to 3x *higher than* the share price, implying recovery rates of only c13%. Earlier in the year, the z-spread multiples to subordinated CDS stood at 3.5x and 3.9x for the 11.5% and 8.25% notes, respectively, not far above the 3.4x average for the European AT1 universe (3 February 2017). Two months on, the z-spread multiples to subordinated CDS had actually declined to 3.2x and 2.8x respectively, to lower than the European average (3 April 2017). In the days prior to the announcement of the bank’s resolution, Popular’s AT1s remained marked at a cash price of close to 50% of par, and its T2s were quoted at c70% of par – these levels did not appear to reflect investors’ anticipation of imminent loss.

FIGURE 57: BANCO POPULAR’S SECURITIES – SHARE PRICE AND AT1s



Source: Bloomberg.

Note the relatively low correlation of the share price with AT1 prices and zspreads, as shown in the table below. *This weak relationship calls into question the notion of using the stock dynamics to predict the probability of an AT1 triggering event.* The shares of Popular declined from late 2015 to early 2017, along

with those of many firms in the financial sector based in the periphery of Europe, but without a material drop in the price of its AT1s until just weeks before the bank’s demise.

FIGURE 58: BANCO POPULAR’S SECURITIES – CORRELATION OF % DAILY RETURNS

| | AT1 Prices | | AT1 Z-Spreads | |
|-----------------------------|------------|------------|---------------|------------|
| | POPSM 11.5 | POPSM 8.25 | POPSM 11.5 | POPSM 8.25 |
| Share Price (POP SM) | 42.4% | 40.3% | -40.2% | -41.0% |

Source: Bloomberg, calculated for the period of 2 January 2015 to 7 June 2017.

Once in resolution, the €1.25bn of AT1 CoCos were converted into common equity and then cancelled and the c€716m in Tier 2 notes were converted into newly issued shares and then sold for a token €1. (The total price was simply €1, not ‘per share’.) A nominal conversion took place at this token value with the newly issued shares immediately written down to zero to avoid the paperwork of distributing fractions of cents. For Popular’s AT1s, the pre-agreed terms for equity conversion were overridden. The conversion to equity occurred at the same instant as the cancellation of ordinary shares – meaning the AT1s converted into shares that were worthless. The severity of the loss was total, with no prospect of recovering initial losses through claims on the outstanding equity. The loss provisions included in the prospectus were not respected. The AT1 features were superseded by the powers of the resolution authorities. This willingness on the part of the national authorities to forebear the exercise of their ‘PONV power’ calls into question the nature of any pricing differential between the clauses related to conversion prices and writebacks – or measures of distances to triggering thresholds.

Liquidity may be a bigger issue than solvency

Popular’s financial weakness may be attributable to a lack of liquid assets rather than capital per se. Indeed, the supervisory intervention appears to have been in response to concern over the bank’s liquidity, not its solvency, stemming from an inability to meet short-term obligations. According to ECB Vice President Vitor Constâncio: “There was a bank run. It was not a matter of assessing the developments of solvency as such, but the liquidity issue.” The issue was a surge in withdrawals by large corporate depositors. Under the deposit guarantee scheme, deposits up to €100,000 or

equivalent for each account holder were insured. Corporate (and to a lesser extent retail) withdrawals were likely motivated by the bad loans piling up, with state-linked organisations leading the way in the rush to withdraw deposits. The Spanish press reported that a coordinated decision to withdraw large deposits by a few public clients such as local authorities and social security funds may have contributed to destabilising the bank. FROB, the Spanish restructuring fund and resolution authority, disclosed that the bank had lost €18bn in deposits over the course of a few days – almost 25% of total deposits. Popular thus entered resolution due to high levels of deposit withdrawals, as emergency central bank funding was quickly depleted.

The case of Popular suggests that, in practice, the line between a solvency and a liquidity crisis may be extremely fine. The propensity for depositor flight may be as important in assessing the prospects of an AT1 conversion as the value of assets which feed into capital ratios. The breadth and granularity of the depositor base – i.e., the concentration of large corporate depositors – can be the deciding factor. Although different dynamics were at play in the bankruptcies of Lehman Brothers and Northern Rock Building Society, it is noteworthy that the final blow in both the Lehman and Northern Rock cases was also the withdraw of liquidity by large players in their wholesale banking relationships. It is also worth stressing that *converting the AT1s into equity can help to restore solvency but does nothing to solve problems with liquidity.*

The supremacy of supervisory intervention

European regulators will act swiftly if a bank's financial situation deteriorates beyond a certain point. Popular was determined to have reached the point at which authorities could say it was no longer a viable business — the point of non-viability. PONV reigns supreme because supervisory authorities have great latitude in subjectively judging the moment to intervene and force losses on subordinated debt holders to protect taxpayers and deposit holders. Non-viability is discretionary in the BRRD and the spectrum of tools available to supervisory authorities is broad. Forcing a sale is just one of the resolution tools available. National authorities can also create a bridge bank, wind down businesses or bail in parts of a bank's liability structure.

Invoking non-viability early vs declaring bail-in at resolution

Bank management and their supervisors can decide to impose losses on AT1 holders at an early stage of distress. AT1s can be exercised prior to resolution at the discretion of a national authority. It is not necessary to declare a non-viability event and move into resolution *concurrently*. PONV

power and the bail-in at resolution, though they serve similar purposes to aid in the restoration of an institution, can be applied independently of each other and are distinct tools. According to theory, their implementation should follow a sequence. A move onto the bail-in tool, to make holders of subordinated capital instruments absorb losses before senior debt holders, should only occur once the PONV-related write-downs are deemed insufficient to restore viability. The European Banking Authority [guides that](#): “the write-down or conversion in Article 59 applies to relevant capital instruments (AT1 and T2) while the bail-in tool applies to eligible liabilities as defined in Article 2(1)(71)”. *Under Article 59, an AT1 conversion is not a resolution action, whereas the bail-in of subordinated debt does constitute a resolution action.* PONV conversion and bail-in tools can be invoked when a bank is “failing or likely to fail”, i.e., at risk of being “no longer viable unless that power is exercised.” However, *PONV conversion should be invoked first. Only after steps such as the conversion of AT1s are deemed insufficient to ensure a return to viability should the bail-in tool and other resolution tools then be applied.*

Tier 2s were taken out at the same time as Addition Tier 1s

The tiering of bank capital was blurred in the Popular case, and the defining line between going and gone concern capital that AT1 and T2 represent was overridden. Despite the different seniorities of the notes, both AT1 and T2 investors suffered simultaneously. Tier 2 bonds are senior to AT1s. Unlike AT1s, T2s have a fixed maturity date and cannot skip coupon payments. They thereby tend to pay a lower coupon than AT1s to reflect their theoretically lower risk. Such bonds are exposed to severe losses but only if a bank collapses; therefore, Tier 2 bonds are defined as ‘gone concern’ capital. In the case of Popular, the difference in the amount of provisioning to trigger an AT1 while preserving a T2 was so narrow that both instruments were zero-ed together. This inconsistency is a salient point for investigation as it suggests that there was no operational distinction between ‘going’ and ‘gone’ concern capital in the treatment of the two tiers of capital in the case of Popular.

AT1s were designed to cushion losses when a bank is still a going concern, providing the necessary boost to CET1 to prevent an institution from failing. In the case of Popular, the AT1 notes were only converted once the bank was already insolvent. The failure to trigger the AT1s prior to resolution, nor even to skip coupons at the previous quarterly payment date, calls into doubt the ability of AT1s to fulfil their responsibilities as going concern capital. Can the sequencing of coupon curtailment prior to CET1-triggered conversion be taken seriously? Can a financial institution’s reported capital levels be relied upon to have ‘automatic’ consequences, or will the national authorities intervene at a time of their own choosing irrespective of reported CET1 ratios?

KEY OBSERVATIONS

So then, why did the AT1s fail to fire as designed whilst Popular was still a going concern? Though every instance of a bank in crisis has its own idiosyncratic characteristics, the underlying reasons appear to be that: (1) coupon skips do not retain sufficient amounts of capital to be worth the risk of negative signalling; (2) re-strengthening the balance sheet according to the metric of regulatory capital may not be relevant in all scenarios, in particular liquidity crises; (3) thresholds for both the coupon cancellation and the conversion are set too low to kick in ‘mechanically’ prior to resolution.

1) Coupon savings are too meagre to overcome negative sentiment

The expected pattern of a coupon skip prior to principal being hit was not followed. By continuing to pay interest on its AT1s despite being deeply distressed, Popular did not do anything unlawful. AT1 coupons are different in nature to stock dividends. If a regular dividend goes unpaid, the funds are retained by the bank and remain accessible to shareholders. Once dividends are restored, a bank can pay a super dividend. If a coupon goes unpaid, this represents a permanent loss to AT1 holders that can never be recouped. Consequently, the decision to suspend coupons has far greater repercussions and could even limit a bank’s access to future debt financing. The scale of the cost savings is also an important distinction. Depending on a bank’s pay-out policy, the suspension of dividends will typically represent a saving of c50 to 100 basis points of CET1. On the other hand, *the suspension of coupons is an order of magnitude lower* at roughly c5 to 10 basis points of CET1 – assuming a full 1.5% AT1 bucket. In short, a coupon omission could impair a bank’s ability to refinance yet result in an insubstantial amount of retained funds. *This is one of the potential flaws in the design of AT1s: a coupon skip may not be worth the risk of negative signalling for a bank teetering on the brink of collapse.* The annual coupon cost on Popular’s two AT1s amounted to €119 mn, nowhere near enough to remedy on their own the ills plaguing the bank.

The skipping of AT1 coupons is a central design characteristic of the AT1s, so the delay in acting on coupon restrictions in the case of Popular is quite striking. Why were interest payments never restricted? On March 2017, coupons continued to be paid on the bank’s AT1s despite obvious warning signs. Popular was only able to maintain a positive MDA cushion despite poor profitability thanks to ‘flexible interpretations’ of allocations to Pillars 1 and 2 – tacitly approved by its national supervisor because the benefits of cancellation were apparently perceived to be too small to be worth the risk of negative signalling. There is a fine balance to be struck between the actual cash

value a restriction preserves and the indirect impact of a distribution restriction on the confidence of investors. This balance is also at play in considering a capital injection via a principal conversion in light of the possible knock-on consequence for future financing. *The tension in the logic of AT1s is that the boost to capital ratios from exercising their triggers must outweigh the risk of shaking investor confidence at critical moments or exacerbating depositor outflows.*

2) Liquidity squeezes may be exacerbated if CoCos are converted

Capital-boosting securities such as AT1s rely on the strengthening of a balance sheet in accordance with the metric of regulatory capital. Aside from the distortions of a ratio relying on internal modelling and risk weights, a bank's balance sheets hold a vast array of assets, many of which are not easily marked-to-market on a quarterly basis. The reported CET1/RWA ratio may not be reliable during times of distress. As mentioned above, in an overnight move by the SRB, extra provisioning was demanded in order for Santander to take on Popular's non-performing assets; these additional reserves would have crushed the nominal CET1 levels had they been imposed on Popular as a stand-alone entity. Indeed, S&P calculations indicate Popular's actual CET1 when it was placed into resolution was a paltry 2%, as implied by the writedowns later taken by Santander (Rosca, 2017). Therefore, *the CET1 ratios reported by Popular prior to its collapse were not only misleading to market participants but actively prevented an automatic triggering. This calls into question the utility of regulatory capital disclosures in assessing the immediate risks of triggering.*

A financial crisis can take many forms, with liquidity often playing a central role in the final stages. However, CoCos do not increase liquidity. At coupon cancellation, interest payments can be retained. At principal loss, the liability structure is changed with an exchange of debt for equity or a write down of the face value amount. In neither event is there a fresh injection of cash. Therefore, AT1s have little role to play in resolving a liquidity drought.

Even if recapitalisation through liability conversion assuages investors, it could still ignite depositor flight – *potentially raising the spectre of contagion.* The EU-wide resolution authorities have the challenge of managing the micro-prudential decisions for each bank in the context of the possible macroprudential consequences. With roughly half the AT1s issued by European banks held by other European financial institutions, these crossholdings could give rise to the type of ripple effects that precipitated the credit crisis of 2007/8. A paper by Chan and van Wijnbergen (2015) argues that

CoCo conversion can contribute to liquidity problems and raise the probability of a bank run. Steps to remediate a shortfall on a bank's balance sheets risk spooking depositors, leading to a flight to safety that drains an institution of more asset value than is gained by the remedial action. This is a variant of the 'negative signalling' dilemma, with an emphasis on the fact that capital depletion and a liquidity shrinkage do not necessarily follow a linear relationship.

3) Conversion would have kicked in earlier with higher hurdles

Coupon omission and principal conversion must occur well before liquidity constraints kick in, to avoid a fear-inspired downward spiral in confidence in the troubled institution. Without the first step in the sequence of CET1-related triggers of cancelling coupon payments, investors in Popular's AT1s struggled to properly gauge the rising risk of a principal conversion and so were caught off guard by the sudden move into resolution. The MDA cushion and ADI amounts, which determine distribution restriction, were disclosed as adequate in the first quarter of 2017 – at which time, the bank announced that it was working on a strategic plan that included asset disposals to boost its capital ratios. The bank's CET1 ratio was reported at acceptable levels of over 10%, well above the thresholds of 7% and 5.125% on its two AT1 notes. Neither of these two contractual CET1 ratio triggers come into play. Technically, however, *Popular's AT1s must have breached their CET1 triggers at some hypothetical point in the process, given the extra provisions required of Santander as a pre-condition for the takeover.* We therefore recommend that triggering thresholds should be set higher to allow for transparent, predictable triggering at an earlier stage of an unfolding crisis. *Had the contingency trigger been set at 9% for its AT1s, Popular might have been able to recapitalise as a going concern.*

The case study of Banco Popular informs us that the valuation of AT1s cannot be modelled merely by measuring the distances to triggers in isolation. We must bear in mind the scope for supervisory interpretation and intervention. The intricate latticework of rules binding banks together to their prudential authorities, the supervisory-bank nexus, must be at the centre of analysis. AT1 securities have rules related to non-viability with a PONV clause inserted in all notes; therefore, *investors must look at the institution not only the instrument when considering viability.* When trying to evaluate the point of non-viability, a broader assessment of liquidity should play an increasingly central role.

Piraeus: 'Hive Down' process converted CoCos to effect nationalization

For completeness, we draw attention to the recent conversion of a form of contingent capital by a Greek credit institution. On 4 January 2021, Piraeus Bank was effectively 'nationalised' via a [CoCo swap of debt for equity](#). The Piraeus CoCo had a number of unique design features:

- The instruments already counted towards the CET1/RWA ratio, so their conversion had no bearing on the overall strength of the capital base.
- The triggering event had no relationship to the breaching of a capital ratio. The reported CET1/RWA ratio at the prior reporting period was 14.1% (end-September 2020).
- The CoCos contained a clause that linked conversion to the second cancellation of a coupon, with supervisory approval required to make any annual interest payments.

During the quasi bail-out of Piraeus in November 2015, contingent capital with a nominal value of €2.04 bn was put in place as part of the bank's regulatory CET1 requirements. These CoCos were entirely held by the Hellenic Financial Stability Fund (HFSF), which had the right to convert them into equity through to 2022. These CoCos contained a stipulation that if the bank cancelled its interest payments twice the securities automatically converted into ordinary shares at €6 per share. A coupon payment was missed in 2018, so it was well-flagged that a second cancellation would trigger conversion. Thus, when the ECB rejected a cash payment in December 2020 this decision was tantamount to a forced conversion of the state-owned CoCos. As a result, the HFSF's ownership rose to 61.3% from 26%, which gave the fund a majority stake.

The conversion had no effect on regulatory capital as the CoCos were already treated as Common Equity Tier 1. There was a cost savings from not having to pay the 8% annual coupon, which the bank estimated as equivalent to c40bps of additional CET 1 capital per annum – to be applied to accelerate further the reduction in its non-performing exposure. The savings was a small positive for creditors at the expense of equity investors, who saw their holdings heavily diluted. In sum, though the technical triggering event was coupon related, the event of conversion was orchestrated as a means for the HFSF to formalise arrangements. The Piraeus CoCo conversion was a convenient solution to a rather specific situation and has little read-across to the AT1 CoCo class.

CONCLUSION – A PROPOSAL FOR RAISING THRESHOLDS

The distance from a bank's current CET1/RWA ratio to the capital adequacy triggers on its AT1 notes barely registers as significant in our regression analysis. If the contingency event is not likely to trigger automatically when a bank is still a going concern, the significance of the recovery rate is undermined. This is what our findings reveal: conversion prices and write-back clauses do not feature at all as factors in pricing.

Coupon cancellation occurs in too small of increments to restore a bank to stability or, it seems, to even warrant the risk of adverse signalling. The banking sector needs the conversion or write-down of principal as the main mechanism to deleverage in the event of financial difficulty. To stave off the next credit crisis, the automaticity of AT1s must be restored and their principal write-down/conversion triggering levels raised to CET1 ratios that are based on a formula which reflects the evolving Supervisory Review and Evaluation Process.

We propose the capital adequacy triggers be calculated as "Pillar 1 plus the minimum Common Equity Tier 1 component of Pillar 2". Pillar 1 requirements apply to all banks whereas Pillar 2 requirements are bank-specific, calibrated as part of the comprehensive supervisory review to identify and evaluate risks inherent in a particular bank's business model. The CET1 requirement within Pillar 2 is the most important in signalling relative riskiness across national jurisdictions.

XIV. Concluding Thoughts - A New Basis for Calculating Triggers

Raising the bar on the triggering threshold

According to the Deutsche Bundesbank [report](#) cited in the opening chapter: “it should be examined how much the mechanical CET1 threshold has to be raised in order to ensure that CoCo bonds have the effect regulators intend – to act as *a loss absorbing instrument for banks on a going-concern basis.*”

The questions raised in the German central bank’s report remain as relevant as ever, with the trend for low triggering thresholds and tight reset spreads continuing unabated. AT1s keep coming to market with capital adequacy triggers set at 7% or less, accompanied by compressed reset spreads. For example, Nordea reported a CET1 ratio of 18% at end-June 2021, yet it chose to issue \$1 bn in AT1s in September with [a 5.125% CET1 trigger](#) – such a considerable distance to the capital adequacy barrier makes any automatic conversion of principal an exceedingly distant prospect. The Nordea notes, callable in 2029, also carried the *lowest ever* reset spreads over US Treasuries of a mere 260.2 basis points. On 15 November 2021, even the perennially troubled Deutsche Bank was able to issue €1.25 bn in new AT1s callable in 2026 [with a 5.125% CET1 trigger](#) and a reset spread of the five-year Euro swap rate plus 455.2 basis points.

Our research leads us to conclude that excessively low triggers and tight resets are a recipe for future market dislocations. The capital adequacy trigger should be raised in accordance with a formula based on SREP scoring and reset spreads should adjust to reflect the full range of embedded risks.

1. Valuation approaches must continue to evolve

Valuation models were originally designed to price the contingency event related to principal conversion. The shift in capital conditions has made the first generation of valuation models outmoded. These models are no longer working as intended given the vast distances to the capital adequacy trigger. Triggering levels and recovery rates must be significant factors in pricing for these valuation models to work effectively again. Raising the hurdle for the contingency event would certainly help to restore their relevance. However, there are other aspects that need updating as well.

Early efforts to value AT1 CoCos dwelt almost entirely on equity as a ‘market-implied’ proxy for the loss mechanisms. Assuming the CET1-based triggers can be treated as if market-based by using the share price (or CDS) as a proxy would only be a reasonable assumption if the CET1/RWA ratio and such securities had a stable correlation, which they do not – as our time series analysis shows.

Substituting the share price, or its realised volatility, to replicate a familiar market-implied model with small changes in the names of terms is not particularly useful. The rapid drop in share price once tail risk is manifest is simply the coup de grâce and is not predictive. The persistent discontinuities in the movements of an issuer's CET1 ratio and its share price make relying on 'market implied' proxies untenable. We conclude that modelling needs to move away from share prices as proxies to focus on actual contractual features. Valuations should take the actual contract features, such as conversion prices and write-back clauses, as key inputs in conjunction with the credit profile of the issuer.

Thus far, the original models have only been tinkered with. Not enough attention has been paid to coupon and extension risks. The current incorporation of ADI, MDA and reset triggers is incomplete. *A central driver of pricing is now understanding how the SREP ratio restriction rules work – in the context of the supervisory-bank nexus.* The main uncertainty in the past was how SREP ratios and Pillar 2 requirements should be factored into the calculation of the maximum distributable amount; following the full phase in of fully loaded levels, the uncertainty has shifted to the impact of MREL-TLAC implementation on the MDA threshold. Valuation techniques must reflect much more sophisticated assessments of banks' capital positions to calculate the distance to the MDA threshold – as well as the distance between the backend rate and current zspread – to construct models that are able to anticipate growing risk sufficiently far in advance for investors to take action.

2. Coupon risk mechanics should be incorporated into models

Although the second 'Co' in the original abbreviation of CoCo referred to 'convertible' it is more accurate to think of this second 'Co' as being a reminder of the contingent nature of interest payments, given that the 'Co' in coupon-related risk now takes precedence over the risks of principal conversion in price formation. The MDA threshold, the cut-off point for coupon payments, reflects the CET1 utilised to maintain the combined buffer requirement. While the build-up of CET1 capital encouraged by the regulators has caused the threat of conversion to recede *the inclusion of more loss-absorbing funds in the capital stack has had the converse effect of raising the combined buffers and thereby narrowing the gap to the MDA threshold.* The average MDA trigger level for European banks at end-September 2021 was 10.23%, resulting in an average MDA cushion of c590 bp (CreditSights). The distance to coupon cut-off has a narrower margin than the distance to principal conversion and takes precedence as a risk factor.

This study is among the first to empirically test the coupon-related barriers of MDA cushion and ADI cover. We find them to be, combined, twice as significant as the proximity to the trigger for principal loss. We have thus been able to prove conclusively that valuation techniques should be retooled to better include the risks of coupon omission. That said, the MDA cushion (distance to the SREP ratio) does not price as significantly as we would have expected. This may be due to the coupon barrier being undermined by a reluctance on the part of supervisors to enforce the existing rules that would lead to a restriction on interest payments.

A calculation based on reported figures is only an estimate of where a bank might be called upon to restrict coupon payments. A number of intangibles go into the calculation of the combined buffers, such as goodwill and deferred tax assets. This makes it challenging to determine what degree of buffer, in absolute terms, is sufficient. There is also much scope for supervisors to interpret the nature of the infraction, e.g., if it relates to refinancing in tough market conditions. The strictness of the national authority is as much of a factor as a bank's actual fundamentals. This overlay of local supervisory discretion is why we see sound banks with thin MDA cushions alongside troubled banks with optically thicker cushions. By optics is meant the visual presentation of information, which may not represent the quality of the numbers underlying the calculation. Moreover, *ADIs operate as a separate constraint such that the probability of an MDA restriction should be put into the context of a forward-looking view on a bank's future earnings power.*

Though the MDA and ADI metrics are more significant than those related to principal conversion/writedown, the relevance of coupon risk in price formation is still modest. In our view, this limited relevance is mostly due to the fact that the cancellation of interest payments on AT1s is of too small a benefit to offset the risk that any sign of weakness may unfavourably impact future funding. To overcome this stigma, coupon skips should be purely mechanical and occur often. *The supervisors appear to 'favour' AT1 coupons in order to cultivate an appetite for the asset class. But soft-stopper guidance should cease. The MDA should be calculated strictly, without excessive re-interpretations.*

3. Maturity extension is the most salient risk

According to our findings, the primary risk for AT1s is now the extension of maturity. Extension risk, measured as a multiple of the reset spread over the current zspread, registers with a coefficient of correlation (R^2) of c0.30 – by far the most prominent metric in price formation. The key critique that we make of legacy models is that they do not incorporate extension risk in terms of features

specific to contracts such as the stipulated spread at reset (mid-swap plus margin), the proximity to first call and the frequency of call dates. *The reaction function to changes in the implied coupon is strong and dynamic, giving this market-driven variable more predictive potential. Therefore, reset spread metrics must be more thoroughly incorporated into valuation models.*

AT1s were initially issued with coupons of 8% or more; however, the ultralow rate environment has tightened spreads such that coupons as low as 3% to 4% have become common place. AT1s issued during the extended era of quantitative easing have, according to our research, created a structural risk as the market enters into a period of rapidly rising interest rates. *Forward coupons are all but priced to perfection, with embedded barriers for conversion or cancellation discounted as extremely low probability tail risks. AT1s continue to come to market with increasingly tighter backend spreads, creating a cohort that could form a 'perpetual vintage' of uncallable notes.*

Future refinancing will occur in the context of extremely tight reset spreads. Treasury swap rates are slated to rise as central banks reverse their easing policies. A higher benchmark swap is essentially neutral for AT1 refinancing and arguably beneficial for profitability to varying degrees, depending on the business mix of a given bank. However, the implied coupon at refinancing is bound to trend higher as *real* interest rate rise. Hence, it may become economically compelling for most banks across Europe to extend their old notes. The balance of influences will vary by instrument, since not all have the exact same re-set yield mechanism. But the overall effect might well be a sudden re-orientation to yield to perpetuity for the current cohort of notes, with mounting uncertainty as each call date nears. This is a central conclusion of our research, that the structural tightening of reset spreads in the primary market must be carefully monitored. Stricter enforcement of coupon restrictions, updates to capital adequacy triggers as well as a steeping yield curve could all contribute to a much tougher environment for new issues of AT1s.

4. The role of the supervisor remains decisive

Supervisory bodies can request the suspension of interest payments or the write down of principal, and prior permission of the supervisor must be obtained to redeem. Supervisory oversight plays a decisive role in price formation as it shapes the perceptions of the risks regarding coupons, conversions and calls. Messaging on the likely outcome of future discretion ("forward guidance") has led to an erosion of AT1's equity-like characteristics. Supervisory intervention or forbearance can override the automatic triggers. The market perceives that the point of non-viability comes before

the contractual trigger is reached, and therefore the ‘PONV power’ at the disposal of the supervisory authority is the dominant factor. *Having the implied point of non-viability above the triggers renders their automatic design irrelevant. Our findings suggest that the discretionary PONV is well above the contractual contingency event. We also find that sovereign debt is more closely correlated with AT1 spreads than a bank’s own share price, which underscores the interrelationship between constituents of the supervisory-bank nexus.*

The loss mechanisms for AT1s cannot easily be reduced to point values to plug into traditional quantitative models. The market for contingent capital is a special one borne of regulatory design. The shaping of price formation in the AT1 market entails constant two-way feedback between the supervisory framework and systematically important banks. While this asset class is trying to find its own pricing dynamic, the investor base lacks well-defined tools to value these complex contracts. Valuation techniques should move beyond the inputs of capital ratios to understand the supervisory review process in its entirety. Even if triggering thresholds are raised, evaluation of the potential exercise of discretionary powers will remain essential. We hope our research will contribute to a better understanding of the need for scenario analysis of the supervisory-bank decision-making process, to capture the nuances of accounting rules and their potential for ongoing re-interpretation.

5. Lack of market discipline is a symptom of design flaws

We have investigated the nature of the price discovery process by parsing AT1-specific risks to form a collection of explanatory variables, considering not only the distance to the CET1/RWA ratio trigger cited in the Bundesbank report but also the distances to the MDA-SREP ratio and ADI triggers as well as the multiple of the zspread to reset spread and the proximity to first call – among other features. Our research establishes that most of the risk characteristics designed into AT1s are not sufficiently well reflected in pricing to validate the presence of market discipline. Investors do not appear to monitor the risks associated with most of the contract-specific features of AT1s – with the components related to principal writedown/conversion showing hardly any meaningful significance.

The persistent ultra-low interest rate environment has encouraged investment in AT1s for their high yield; this artificial spurring of demand is one reason why the risks inherent in contract features are not fully factored in. But the primary reason, we conclude, is that the conversion or write-down of AT1s on a going concern basis has become a remote scenario given that the average distance to the

automatic trigger is now over 1,000 basis points. Triggering level have remained stagnant, against a backdrop of steadily rising CET1/RWA ratios.

The variables capturing the types of loss mechanisms, equity conversion or principal writedown, show some significance in paired t-tests but this disappears when collinearity by country of domicile is considered. Convertible AT1s are more commonly issued by banks in Spain, UK, Denmark and the Netherlands. In Switzerland and elsewhere in the EU and EEA, banks tend to use percentage write-down mechanisms – generally partial and temporary. The difference in the two types of capital adequacy trigger levels (5.125% versus 7%) is not picked up in the paired t-tests nor in regressions. The distance from a bank's current CET1/RWA ratio to the capital adequacy triggers on its AT1 notes barely registers as significant in our regression analysis. Our research indicates that write-down/conversion triggers are far too low for the contingency event that forms the foundation for 'contingent capital' to achieve the aim of recapitalisation. *The nature of the contingency event is being undermined when the 'point of non-viability' is perceived to be higher than the contractual triggers.* The principal-related risk cannot be a factor in AT1 valuation if the barriers are so deeply 'out of the money'.

This relative lack of significance for the distance to the capital adequacy trigger is mirrored in our findings that that implied recovery rates are barely a factor in paired t-tests and do not factor at all in regressions. Neither conversion prices nor write-back clauses, both of which determine the recovery rate of the principal, give a significant signal. Pricing the potential recovery value only makes sense for a security that could be written down or converted while an institution remains solvent. The conversion rate and write-back provisions become meaningless if triggering is delayed until the bitter end, when the face value of a note and its coupon streams are entirely wiped out. In a scenario of bail-in at resolution, the recovery rate will always be zero. *If the capital adequacy trigger is not able to fire while a bank is still a going concern, the features determining recovery potential are no longer drivers of pricing.*

Our findings lead us to conclude that the triggering thresholds for AT1-eligible CoCos must be recalibrated to reflect the changes over the past decade in the capital stack, which include both higher overall levels of CET1 and the introduction of other forms of loss absorbing instruments such as MREL and TLAC. AT1s should not be allowed to devolve into 'gone concern' capital. In our view, an increase in trigger levels is essential to restore discipline in the pricing of capital buffers and features related to the recovery rate. *We therefore advocate for the contractual triggers for principal*

conversion/write-down to be allowed to function free from discretionary oversight. We propose that the capital adequacy triggers be raised to CET1/RWA ratios that better reflect the scoring that stems from the supervisory review process.

Article 104a CRD makes AT1 ‘automatic’ conversion even less likely

Our view that the capacity for automatic triggering as a going concern should be strengthened does not have many advocates at present. The direction of travel is towards a further weakening of the ‘going concern’ attributes of AT1s. Indeed, the Basel Committee recently introduced rule changes that will both lower the probability of conversion being triggered *and* encourage extra amounts of AT1 to fill gaps in regulatory capital. Scheduled to go into force in January 2021, the amendment to [Article 104a](#) of CRD IV was brought forward to March 2020. Pillar 2 requirements can now be partially met with capital instruments other than common equity. In most jurisdictions, banks can now meet up to 18.75% of Pillar 2 requirement with AT1s and up to 25% with Tier 2 securities – with only 56.25% required as CET1. With the average Pillar 2 requirement being 2.1% for banks supervised by the ECB, *this will result in the pure CET1 component of Pillar 2 declining on average by 92bp to only c1.18%*. Although supervisors retain the discretion to require a higher proportion of Tier 1 or CET1 capital for specific institutions, if they deem it necessary, the immediate effect of the change will be a concomitant boost to most banks’ CET1/RWA ratios.

New paradigm of MREL-TLAC blurs the distinction between going and gone concern

The stated motivation for the creation of AT1s as a new form of contingent capital was for the securities to hit their contingency triggers while a bank is still solvent. The aim of the asset class is to incentivise bank management to monitor risk, as represented by CET1/RWA levels, and to avoid the curtailment of lending to the real economy that occurs when an institution fails to recapitalise in a timely manner. AT1s written off after a bank has failed would no longer serve such purposes. If AT1s become pure bail-in debt, only triggered in resolution, they will be just like other MREL or TLAC eligible instruments and offer no advantages in the remediation of idiosyncratic problems nor in the prevention of contagion.

For AT1 CoCos to work effectively, there needs to be a moment of transition between an institution being ‘going-concern’ and the move to ‘gone-concern’ during which automatic barriers can be activated. If the sequence is so short as to be simultaneous, then AT1s are written down and bailed in as a single event. The two triggers – automatic and discretionary – converge. The ‘jump to resolution’ scenario, in which a bank enters resolution without going through a coupon cancellation

or principal writedown, renders all AT1s gone concern capital. In the Banco Popular case, its AT1s did not cut coupons nor convert while the bank was still viable; instead, the notes were bundled into the bail-in package. An unconvertible CoCo is simply subordinated debt. To play the equity-like role the Basel Committee intended, AT1 CoCos must provide going concern conversion – otherwise the hybrid instruments lose their purpose as alternatives to conventional equity or subordinated debt.

With the introduction of TLAC/MREL requirements, the sharp distinction between going and gone concern capital is being supplanted. To some extent, the regulators may see a certain allure to allowing AT1-style contingent capital to drift into de facto PONV debt. The power to invoke a viability event and bail-in provisions are both included in AT1 prospectuses already, such that benign neglect will gradually diminish going-concern features. The European Central Bank should not allow the AT1 asset class to drift into becoming de facto PONV debt that relies solely on the supervisor's discretionary invocation of the point of non-viability. A purely discretionary instrument leaves the decisions to activate in the hands of national supervisors or the European-wide resolution authorities. Given the possibility of adverse signalling, not only for a failing institution but for the banking sector as a whole, the regulatory incentives on their own tend towards forbearance and avoiding triggering until resolution. There needs to be a better balance of incentives to encourage either the acceptance of automatic triggering or earlier intervention.

In our view, for AT1s to retain a vital role, automaticity should be respected. Higher triggers and less intervention should help to restore market discipline and lead to a repricing of the risks embedded in AT1s. The restoration of market discipline, in effect 'fairness' in valuations, should permit the new breed of contingent capital to fulfil its purpose as a prudential tool – to encourage management to follow sound business strategies, avoid recourse to the public purse and facilitate the recapitalisation of credit institutions while they are still solvent.

6. A formula for raising the capital adequacy threshold

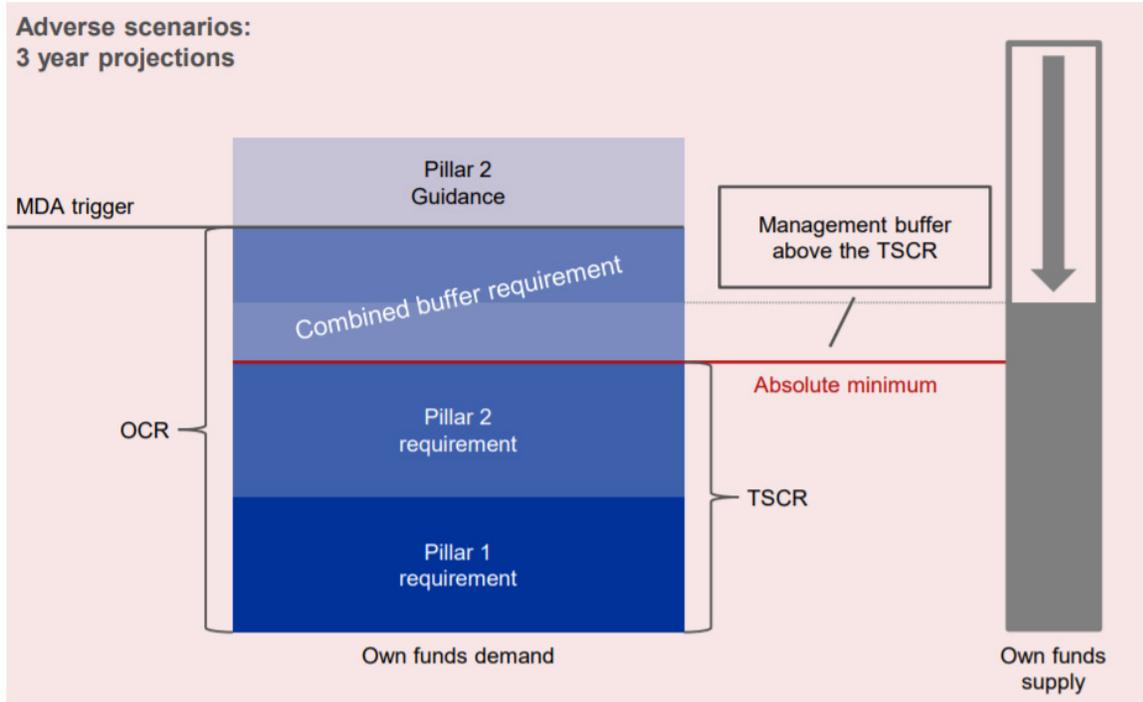
We propose a method of calculating the triggering threshold for write-down or conversion of an AT1's principal amount premised on the notion that the contingency event should occur early on, as a bank enters into severe financial difficulties. With this 'going concern' conception in mind, our recommendation is that capital adequacy trigger levels should be based on a simple calculation: Pillar 1 requirements plus the minimum Common Equity Tier 1 component of Pillar 2 requirements:

$$\textit{Capital adequacy trigger} = \textit{Pillar 1} + \textit{P2R CET1}.$$

To recap, the Total SREP (Supervisory Review and Evaluation Process) Capital Requirement forms the underlying framework for determining the capital structure for banks across Europe. The ‘TSCR’ is composed of two elements. First, a Pillar 1 requirement equal to 8% of RWAs that applies to all banks irrespective of their systemic relevance. Second, a Pillar 2 requirement (P2R) that is a *bank-specific* obligation, applied on an institution-by-institution basis to capture idiosyncratic risks. P2R is calibrated as part of the comprehensive review process to identify and evaluate risks inherent in an individual bank’s business model, corporate structure or balance sheet. Among the capital components set by the European Central Bank, P2R is the most important in establishing the relative riskiness of banks across national jurisdictions. *P2R is a clear reflection of the supervisor’s assessment of each bank. A high P2R results in a high SREP capital requirement, both in terms of CET1 and total capital.*

The simplified schematic in Figure 59 highlights the core components and their stacking order. A bank is expected to meet its TSCR under all but the most adverse scenarios. The aim of the management and combined buffers is to act as a constraint to avoid breaching total SREP capital.

FIGURE 59: STACKING ORDER OF REGULATORY CAPITAL REQUIREMENTS



Source: [ECB](#). Dimensions are for illustrative purposes only.

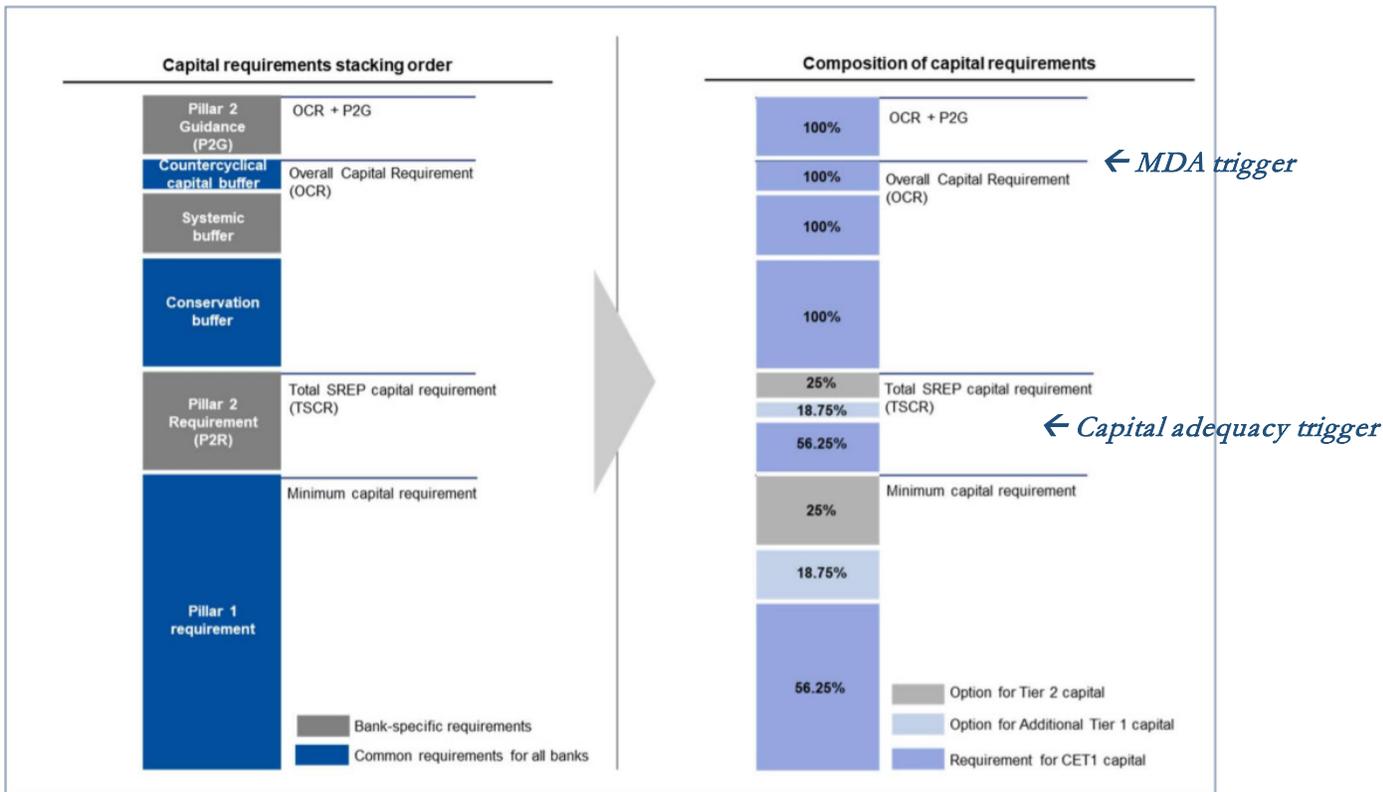
The designated bucket for AT1s in the current capital stack is 1.5%, though any given bank could hold less than that or even no AT1s at all if it decided to pursue alternative funding methods. Moreover, many banks opt to hold much more of their own funds in AT1s – with 2% or even 3% becoming relatively common. Since [12 March 2020](#), such ‘excess’ AT1s now qualify to meet a portion of P2R. The proportional allocation is the same as that applied for Pillar 1, P2R must be met with a minimum of 56.25% by CET1 with up to 18.75% by AT1 capital.

P2R is an output of the supervisory review and unlike Pillar 2 guidance, it is binding and “breaches can have direct legal consequences for banks” ([ECB](#)). Credit institutions are required to disclose this amount annually. Since January 2020, with consent each SREP cycle, the ECB now publishes the P2Rs of all the banks within its coverage. *Thus, the Pillar 2 amount is a highly transparent number based on firm theoretical foundations and clearly communicated across the industry. It is the CET1 minimum of the bank-specific Pillar 2 requirement that we propose should be added to the industry-wide Pillar 1 requirements to determine the capital adequacy triggering threshold.* By converting into equity or writing down the face value of AT1s at this critical point, a bank’s balance sheet could meaningfully deleverage before its remaining own funds held as CET1 were fully depleted. Hence, the contingency event could occur while an institution remains a ‘going concern’ without having to await the subjective discretionary invocation of a non-viability event.

Sample calculations and comparison with MDA thresholds

To illustrate our approach, we first consider the simplified capital stack schematic below and then run through a sample calculation. In Figure 60, the location of our proposed capital adequacy trigger is indicated in the context of the composition of the key components of the capital stack. *Note that this threshold is above the Pillar 1 minimum but below the Total SREP capital requirement, leaving some scope for a non-viability event to be invoked earlier than the automatic trigger but much less leeway than at present.*

FIGURE 60: COMPONENTS AND COMPOSITION OF CAPITAL REQUIREMENTS



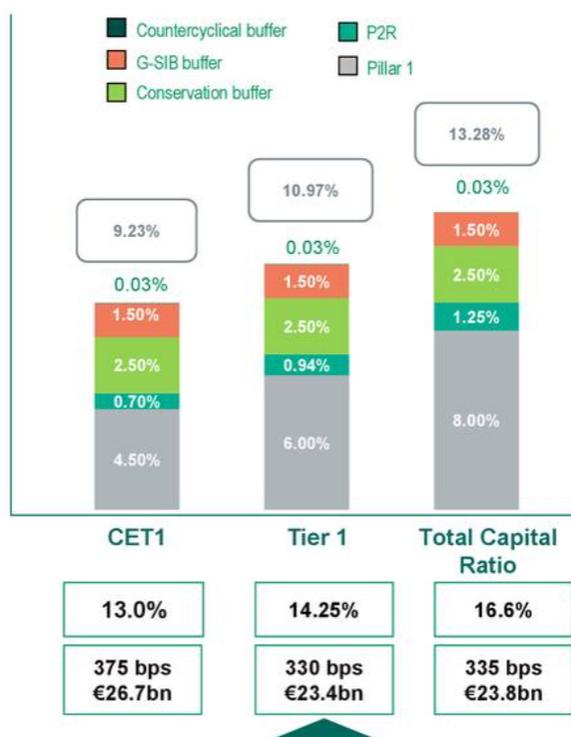
Source: [EBI Working Paper Series](#) – no. 89 (12 April 2021).

The triggering threshold will vary by institution as P2R is set annually at a level optimal for its credit profile. The P2R is linked to the SREP score assigned during stress testing and *the Pillar 2 requirements will tend to correlate with the overall SREP score – falling as the score improves and rising as it worsens*. If a bank is assigned a lower P2R, in turn its SREP capital requirements concomitantly reduce. *There would be a coherent linkage between a credit institution’s SREP assessed risk and its current triggering threshold and an objective criterion for comparability across banks*. The triggering level is dynamic in nature such that if a bank’s fundamentals deteriorate, in the yearly round of stress testing its Pillar 2 requirements should rise accordingly. Conversely, a bank whose fundamentals improve should see a commensurate decline in its trigger level. This introduces a uniform method to determine the threshold appropriate for each bank, following a similar methodology as that used for calculating the MDA threshold. P2Rs are readily comparable measures of bank-specific risk, suitable for formulating a triggering threshold.

To illustrate this with a sample case, we can compare the ‘capital adequacy’ and ‘maximum distribution amount’ thresholds for BNP Paribas – with reference to Figure 61. At end September

2021, the [total SREP capital requirement](#) of BNP Paribas amounted to Pillar 1 of 8% plus a Pillar 2 Requirement of 1.32%, of which the minimum CET1 component was 0.74%. According to our proposed methodology, a CET1 ratio of 8.74% would form the threshold for capital adequacy at which point the bank's AT1s would write down. This is in contrast to the *current* capital adequacy trigger for BNPP's AT1s, which is a CET1 ratio of 5.125%. Under our proposal, the triggering threshold would be raised some *361.5 basis points*. In our view, raising the threshold to this higher level would be in keeping with the overall inflation of capital reserves. BNPP's CET1 ratio stood at 9.6% in December 2011 and at 13.0% in September of 2021, a *340 bp* rise. Hence, *our proposed increase in the capital adequacy threshold is proportionate, given that it represents a similar increase as the inflation in the reference CET1/RWA ratio.*

FIGURE 61: BANCO BNPP – CAPITAL REQUIREMENTS AS AT 20 SEPTEMBER 2021



Source: [BNPP investor presentation](#).

The example of BNPP is representative of the broad state of affairs. The P2R has remained relatively stable in recent stress testing, at an average of c2.1% for SREP 2021. With the frontloading of the revised Capital Requirements Directive (CRD V) rules, the Common Equity Tier 1 component of the P2R [now averages c1.2%](#). If our proposed methodology were introduced, the average capital adequacy trigger would be c9.2%: the average minimum CET1 of P2R of c1.2% plus

the standard Pillar 2 requirement of 8%. On balance, the capital adequacy trigger would rise some 300 bp from an average of 6.2% to c9.2%. With the average CET1 ratio at 16.3% for the 45 main issuers of AT1s in Europe as of Q3 2021 (CreditSights), our proposed capital adequacy threshold narrows the distance to a contingency event to a still ample average of c710 basis points.

To put the conversion risk in the context of coupon cancellation risk, the average MDA threshold stands at c10.2% as of Q3 2021 (CreditSights). Should our proposed methodology be adopted, the average capital adequacy trigger of 9.2% would be c100bp below the current average MDA trigger. Under the proposed formula, coupon omission would occur earlier enough for bank management to respond with appropriate measures. A distance to the capital adequacy trigger a full percentage point below the MDA trigger is hardly onerous, given that MDA restrictions have almost never occurred, yet it would certainly refocus investor attention on the potential for AT1 writedowns or conversions – and encourage fairer valuations and market discipline. A weakness of the current approach is that by inserting a fixed number (5.125% or 7%) there is less ability to adapt the triggering process in light of broader changes in the regulatory capital regime. *By using a formula that incorporates a component from the regular SREP, the threshold for capital adequacy should be more futureproof.*

Our proposed formula might also open up the possibility to fire some AT1s in a constructive way in the wake of poor SREP scoring. The triggering process could be coordinated to help avoid an ‘all or nothing’ scenario in the wake of a full-blown crisis, given that waiting – as in the instance of Banco Popular – tends to lead to problems of liquidity that make restoring solvency even harder. A credit institution should be able to meet its core capital requirements *post the triggering of its AT1s*. There will be hesitancy on the part of both bank management and supervisory bodies to trigger AT1s if this action results in the collapse of a bank into insolvency; therefore, a bank should remain a going concern post write-down or conversion of the face value of its AT1s. This means that the capital levels ought not to be deeply in breach following a contingency event.

Our methodology is consistent with the aims of SREP scoring via stress testing

The conditions for exercising early intervention powers are directly linked to the total SREP capital requirements. Article 27 of BRRD [can be interpreted](#) to mean that when a CET1/RWA ratio touches a level 1.5% above “minimum own funds requirements”, this is cause for intervention measures such as a request for a bank to restructure its debt or make change to its business strategy. A breach of the total SREP requirements is also documented as a factor to consider in the decision-

making to invoke a viability event and declare a bank “failing or likely to fail”. Given that the Pillar 1 component is the same across all banks, it is the P2R component of the total SREP capital requirements that drives the probability of early intervention – and with the CET1 minimum stipulated at just over half of P2R, setting the automatic trigger as per our recommendation would align closely to the latest ECB guidance. Our approach would also be consistent with the aim of regular stress testing, which is to ensure capital adequacy in adverse circumstances.

A recent study by Nordine Abidi et al. comparing the Pillar 2 requirements suggests that supervisors have valuable knowledge of the banks they supervise and hence investors can exploit the increased disclosures of P2Rs across the industry (2021). Banks with lower SREP capital requirements are required to hold less CET1 and total capital. Banks operating with less capital see their return on equity rise, as they can hold less equity, and their MDA threshold decline, making distribution restrictions less likely. The appearance of greater profitability and greater assurance of coupon streams enhances the attractiveness of an institution for investors, contributing to lower funding costs for capital instruments such as AT1s. The multiple benefits of lower P2Rs should motivate bank management to pursue policies to attain favourable SREP scores. *Our proposal is in keeping with the intended implications of the SREP scoring, from both a normative and quantitative perspective, given that the attainment of a lower CET1 P2R would also lower a bank’s capital adequacy triggers on its AT1s.*

Bibliography

Abidi, Nordine, Ixart Miquel-Flores, Quentin Vandeweyer and Livia Amato (2021). The Bright Side of Transparency: Evidence from Supervisory Capital Requirements (1 July 2021, preliminary draft).

Acharya, V., Cooley, T., Richardson, M. and Walter, I (2010). Manufacturing Tail Risk: A Perspective on the Financial Crisis of 2007–2009.

Acharya, V. and Sascha Steffen (2014). The “Greatest” Carry Trade Ever? Understanding Eurozone Bank Risks.

Albul, Boris, Dwight M. Jaffee, and Alexei Tchistyi (2010/2013). Contingent Convertible Bonds and Capital Structure, Working Paper 1–45. University of California at Berkeley.

Ammann, M., Ehmann, C., Blickle, K. (2015). Announcement Effects of Contingent Convertible Securities: Evidence from the Global Banking Industry. Swiss Institute of Banking and Finance.

Avdjiev, S., Kartasheva, A. & Bogdanova, B. (2013). “CoCos: a primer.” In: Bank for International Settlement. Quarterly Review.

Avdjiev, S., Bolton, P., Jiang, W., Kartasheva, A., and Bogdanova, B. (2015). Coco bond issuance and bank funding costs: An Empirical Analysis. Bank for International Settlement and Columbia University working paper 1–59.

Avdjiev, S., Bolton, Bogdanova, B., Bolton, P., Jiang, W., Kartasheva, A. (2017 draft/2020). CoCo issuance and bank fragility. Journal of Financial Economics, 138(3), 593-613.

Allen & Overy LLP. (2012). Tax Treatment of Additional Tier 1 Capital under Basel III.

Bank for International Settlement (2016). Global systemically important banks: assessment methodology and the additional loss absorbency requirement.

Bank for International Settlement (2017). Basel III Monitoring Report December 2017: Results of the cumulative quantitative impact study.

Bank of England (June 2018). The Bank of England's approach to setting a minimum requirement for own funds and eligible liabilities (MREL).

Bank of England – Prudential Regulation Authority (July 2021). The PRA’s methodologies for setting Pillar 2 capital

Bank of Ireland (2015). €750,000,000 Fixed Rate Reset Additional Tier 1 Perpetual Contingent Temporary Write-Down Securities, Prospectus dated 16 June 2015.

Barclays Bank PLC (2010). \$3,000,000,000 7.625% Contingent Capital Notes due November 2022, Prospectus Supplement.

BNP Paribas (2019). US\$1,500,000,000 Perpetual Fixed Rate Resettable Additional Tier 1 Notes, Prospectus directive dated 19 March 2019.

Barucci, E. and Del Viva, L. Countercyclical Contingent Capital. (2012). *Journal of Banking & Finance*, 36:1688–1709.

Basel Committee on Banking Supervision (2011). Basel III: A Global Regulatory Framework for More Resilient Banks and Banking Systems.

Berg, Tobias, and Christoph Kaserer (2014). Does contingent capital induce excessive risk-taking?, *Journal of Financial Intermediation*, 24 November 2014.

BlueBay Asset Management (2020). Cocos in 2020 Superior yield in a dislocated world.

Blundell-Wignall, A. and Atkinson, P. (2010). Thinking Beyond Basel III: Necessary Solutions For Capital And Liquidity. *OECD Journal: Financial Market Trends*.

Bolton and Samama (2012). Capital Access Bonds: Contingent Capital with an Option to Convert. *Economic Policy*, Vol. 27, Issue 70, pp. 275-317.

Bond Advisor (15 June 2017). Banco Popular: First European AT1 Hybrid (CoCo) Triggered.

Boyson, Nicole M., Ruediger Fahlenbrach, and Rene M. Stulz, 2016, Why don't all banks practice regulatory arbitrage? Evidence from usage of trust-preferred securities, *Review of Financial Studies* 29, 1821–1859.

Brieden, T. D. (2019). CoCo Issuance and Recovery Rate Effects. Copenhagen Business School.

Brigo D., Garcia J., Pede N. (2013). CoCo bonds valuation with equity- and credit-calibrated first passage structural models.

Buergi M. (2012). A tough nut to crack: On the pricing of capital ratio triggered contingent convertibles.

- Buergi, M. (2013). Pricing Contingent Convertibles: A General Framework for Application in Practice. *Financial Markets and Portfolio Management*, 27: 31–63.
- Bulow, J. & Klemperer, P. (2015). “Equity Recourse Notes: creating countercyclical bank capital”. In: *The Economic Journal* 125, pp. 131–157.
- Carr, Peter and Wu, Liuren (2011). A Simple Robust Link Between American Puts and Credit Protection. *The Review of Financial Studies* / v 24 n 2.
- Calomiris, C. W. and Herring, R. J. (2013). How to Design a Contingent Convertible Debt Requirement That Helps Solve Our Too-Big-to-Fail Problem. *Journal of Applied Corporate Finance*, 25 (2), Spring 2013.
- Caporale, G. M., & Kang, W. Y. (2021). On the preferences of CoCo bond buyers and sellers. *Journal of International Financial Markets, Institutions and Money*, 72, 101314.
- Célérier, C and Vallée, B (2013). What Drives Financial Complexity? A Look into the Retail Market for Structured Products.
- Chan, S. & Wijnbergen, S. van (2015). Cocos, Contagion and Systemic Risk.
- Chan, S. & Wijnbergen, S. van (2016 draft/2017). “CoCo design, risk shifting and financial fragility”. In CMI Working Paper No. 2, January 2017.
- Chen, N., Glasserman, P., Nouri, B. & Pelger, M. (2013). “CoCos, bail-in, and tail risk”. Office of Financial Research Working Paper 0004.
- Cheridito, Patrick and Xu, Zhikai (2013). Pricing and Hedging CoCos.
- Chung, T.K. and Kwok, Y.K. (2016). Enhanced equity-credit modelling for contingent convertibles. *Quantitative Finance* 16(10): 1511-1527.
- Corcuera, J. M., De Spiegeleer, J., Ferreira-Castilla, A., Kyprianou, A. E., Madan, D. B., and Schoutens, W. (2013). Efficient Pricing of Contingent Convertibles Under Smile Conform Models. *Journal of Credit Risk*.
- Corcuera, J. M., Jan De Spiegeleer, José Fajardo, Henrik Jönsson, Wim Schoutens, Arturo Valdivia (2014). Close form pricing formulas for Coupon Cancellable CoCos.
- Corcuera, J.M and Valdivia, A. (2015). Pricing CoCos with a market trigger.

Corcuera, J. M., Fajardo, J., Schoutens, W., Valdivia, A. (2016). CoCos with Extension Risk. A Structural Approach.

CreditSights (17 May 2021). Banco Popular AT1 Bonds: Damage Control.

CreditSights (2021). Euro Bank Capital Model 3Q21: Steady State, 1 December 2021.

Credit Suisse (2017). U.S.\$1,500,000,000 7.125 per cent. Perpetual Tier 1 Contingent Convertible Capital Notes (Prospectus, January 2017).

Culp, C. (2009). Contingent capital vs contingent reverse convertibles for banks and insurance companies. *Journal of Applied Corporate Finance*, 21(4): 17-27.

Derksen, M., Spreij, P., & van Wijnbergen, S. (2018). Accounting Noise and the Pricing of Cocos.

De Spiegeleer, J. and Schoutens, W. Contingent Convertible (CoCo) Notes: Structure and Pricing (2011). Euromoney Institutional Investor PLC.

De Spiegeleer, J. and Schoutens, W. Pricing Contingent Convertibles: A Derivatives Approach. (2012). *The Journal of Derivatives*, 20(2):27–36.

De Spiegeleer, Schoutens and Van Hulle (2014). *The Handbook of Hybrid Securities: Convertible Bonds, CoCo Bonds, and Bail-In*.

De Spiegeleer, J., Hocht, S., Marquet, I., Schoutens, W. (2017). CoCo bonds and implied CET1 volatility. *Quantitative Finance*, 17(6), 813-824.

De Spiegeleer, J., Forsys, M. B., Marquet, I., & Schoutens, W. (2017). The impact of skew on the pricing of CoCo bonds. *International Journal of Financial Engineering*. Vol. 04, No. 01, 1750012.

Deutsche Bundesbank (March 2018). Contingent convertible bonds: design, regulation, usefulness.

European Banking Authority (2015). Opinion of the European Banking Authority on the interaction of Pillar 1, Pillar 2 and combined buffer requirements and restrictions on distributions.

European Banking Authority (2016). Final report on MREL: Report on the implementation and design of the MREL framework.

European Banking Authority (2016). Opinion of the European Banking Authority on the interaction of Pillar 1, Pillar 2 and combined buffer requirements and restrictions on distributions.

European Banking Authority (2017). Opinion of the European Banking Authority on own funds in the context of the CRR review.

European Banking Authority (2017). Final Guidelines concerning the interrelationship between the BRRD sequence of writedown and conversion and CRR/CRD.

European Banking Authority (2017). Opinion on revisions to the Union crisis management framework.

European Central Bank (2018). ECB Guide to the internal capital adequacy assessment process (ICAAP), November 2018.

European Banking Authority (2018). Final Report – Guidelines on the revised common procedures and methodologies for the supervisory review and evaluation process (SREP) and supervisory stress testing, 19 July 2018.

European Commission (2019). Adoption of the banking package: revised rules on capital requirements (CRR II/CRD V) and resolution (BRRD/SRM).

European Parliament Economic Governance Support Unit (2016). What to do with profits when banks are undercapitalized: Maximum Distributable Amount, CoCo bonds and volatile markets.

European Parliament Economic Governance Support Unit (2017). The resolution of Banco Popular.

Fajardo, J., & Mendes, L. (2020). On the propensity to issue contingent convertible (CoCo) bonds. *Quantitative Finance*, 20(4), 691-707.

Fender, Ingo and Lewrick, Ulf (2015). Calibrating the leverage ratio. *Bank for International Settlement*.

Fiordelisi, F., Pennacchi, G., & Ricci, O. (2020). Are contingent convertibles going-concern capital?. *Journal of financial intermediation*, 43, 100822.

Financial Conduct Authority (2015). Two plus two makes five? Survey evidence that investors overvalue structured deposits.

Financial Stability Board (2015). Total Loss-Absorbing Capacity standard for global systemically important banks. Commonly referred to as: TLAC.

Financial Stability Oversight Council (2012). Report to Congress on Study of a Contingent Capital Requirement for Certain Nonbank Financial Companies and Bank Holding Companies 19.

Finsterbusch, A and R Henriques (2019). “The Extension Premium Framework - An AT1 Relative Value Tool”.

Fitch (February 2016). Special Report: “Eurozone Bank AT1 Instruments”.

Fitch (December 2020). Special Report: “UK Reduces Likelihood of AT1 Coupon Skip” and Special Report: “UK Authorities Signal AT1 Divergence from EU Bank Rules”.

Flannery, M. J. (draft 2002/published 2003). No Pain, No Gain? Effecting Market Discipline Via ‘Reverse Convertible Debentures’. University of Florida.

Flannery, M. J. (2009). Stabilizing Large Financial Institutions with Contingent Capital Certificates. Federal Reserve Bank of New York Research Department.

Gallo, Alberto et al. (2014). The Revolver: European banks: Still too big to fail. RBS European Credit Research, 23 January 2014.

Gallo, Giorgio (2011). Contingent Capital: Pricing and Risks.

Giacomini, E. & Flannery, M.J. (2015). “Maintaining adequate bank capital: an empirical analysis of the supervision of European banks”. *Journal of Banking & Finance* 59, pp. 236–249.

Glasserman, P., Nouri, B., and Pelger, M. (2015). Contingent capital, tail risk, and debt-induced collapse. Columbia Business School Research Paper, (13-90).

Glasserman, P., and Nouri, B. (2016). Market-triggered changes in capital structure: equilibrium price dynamics. *Econometrica* 84(6), 2113-2153.

Glasserman, P., & Perotti, E. (2018). The unconvertible CoCo bonds. In *Achieving financial stability: challenges to prudential regulation* (pp. 317-329).

Glenhill, Alice (25 January 2017). “Banco Popular at pains to protect AT1 coupons” Reuters.

Goodhart, Charles and Avgouleas, Emiliios (2014). A Critical Evaluation of Bail-Ins as Bank Recapitalisation Mechanisms.

Goncharenko, R. (2016). Contingent Debt and Investment. Preliminary version.

- Goncharenko, R. (2020). Fighting fire with gasoline: Cocos in lieu of equity. *Journal of Money, Credit and Banking*.
- Goncharenko, R., Ongena, S., & Rauf, A. (2021). The agency of CoCos: Why contingent convertible bonds are not for everyone. *Journal of Financial Intermediation*, 48, 100882.
- Greene, Robert W. (2016). Understanding CoCos: What Operational Concerns & Global Trends Mean for U.S. Policymakers.
- Gupta, Akuzawa and Nishiyama (2013). Quantitative evaluation of contingent capital and its applications. *The North American Journal of Economics and Finance*, Volume 26, December 2013, Pages 457-486.
- Haldane, A. G. Capital Discipline (2011). Based on a speech given at the American Economic Association, January 2011. <http://www.bis.org>.
- Hau, H., & Hrasko, G. (2018). Are CoCo Bonds a Good Substitute for Equity? Evidence from European Banks. Evidence from European Banks (October 16, 2018). Swiss Finance Institute Research Paper, (18-67).
- Hesse, H. (2018). Incentive effects from write-down CoCo bonds: An empirical analysis.
- Indergand, M., & Hrasko, G. (2021). Does the market believe in loss-absorbing bank debt? (No. 2021-13).
- Henriques, R. and Doctor, S. (2011). Making CoCos Work: Structural and pricing considerations for contingent capital securities. J.P. Morgan: Europe Credit Research.
- Hilscher, J. and Raviv, A. (2014). Bank stability and market discipline: The effect of contingent capital on risk taking and default probability. Brandeis University, 2014.
- Himmelberg, C. and Tsyplakov, S (2014). Incentive Effects and Pricing of Contingent Capital.
- Hori, Kenjiro and Jorge Martin Ceron (2016). Contingent Convertible Bonds: Payoff Structures, Agency Costs and Non-admissible Debt-to-Equity Swap.
- Hwang, S. (2017). Bail-in to End the “Too Big To Fail” Dilemma. KDI Focus.
- Ineke, J., Street, L., Simpson, F. and Blackman, N. (2010). European Banks Tier 1 – A New Paradigm. Morgan Stanley Research.

Ingves, Stefan (2 December 2016). Finalising Basel III: Coherence, calibration and complexity. Keynote speech at the second Conference on Banking Development, Stability and Sustainability.

Gabriel Jiménez, Jose Lopez and Jesús Saurina (2013). How does competition affect bank risk-taking? *Journal of Financial Stability*, vol. 9, issue 2, 185-195.

Gledhill, Alice (April 2016), BBVA sets bar for peripheral AT1 market. *Reuters* 8 April 2016.

Jang, H. J., Na, Y. H and Zheng, H. (2018). Contingent convertible bonds with the default risk premium. *International Review of Financial Analysis* 59 (2018) 77–93.

Jaworski, P., Liberadzki, K., & Liberadzki, M. (2017). How does issuing contingent convertible bonds improve bank's solvency? *Economic Modelling*, 60(1), 162–168.

Jung, H. J. (2012). Pricing of contingent convertibles. *Wharton Research Scholars Journal*, Scholarly Commons, University of Pennsylvania.

Karlsson, M., & Strömquist, A. (2019). Contingent Convertibles-Liability or Equity? A study of the CoCo markets reaction to banks earnings announcements.

Kashyap, A., Rajan, R. & Stein, J. (2008). “Rethinking capital regulation”. In: *In Proceedings - Economic Policy Symposium - Jack Hole*, (pp. 431-471). Federal Reserve Bank of Kansas City.

Kazato, M. and Yamada, T. (2018). The Implied Bail-in Probability in the Contingent Convertible Securities Market. *Bank of Japan: Institute for Monetary and Economic Studies*.

Khah, S. A. M., Vermaelen, T., & Wolff, C. C. (2019). The Determinants of CoCo Bond Prices.

Kind, A., Oster, P., & Peter, F. J. (2021). The determinants of banks' AT1 CoCo spreads. *European Financial Management*.

Koziol, C. and Lawrenz, J. (2012). Contingent Convertibles: Solving or Seeding the Next Banking Crisis? *Journal of Banking & Finance*, pages 90–104.

Koziol, C., & Weitz, S. (2021). Does model complexity improve pricing accuracy? The case of CoCos. *Review of Derivatives Research*, 1-24.

Leung, C.M. and Kwok, Y.K. (2017). Numerical pricing of CoCo bonds with Parisian trigger feature using the Fortet method. *International Journal of Theoretical and Applied Finance* Vol. 20, No. 07.

- Li, Jingya, Metzler, A. and Reesor R. (2015). A structural framework for modelling contingent capital.
- Liu, Cindy (2019). European Bank MREL: The Great EU Fudge. CreditSights 23 May 2019.
- Ludolph, M. (2021). Effects of regulatory policies on bank-specific risk and financial stability.
- MacDonnell, Stuart (2008 / 2009). Up- & Down-Beta vs Implied Volatility; Beta Asymmetry. Citi Investment Research and Analysis.
- Madan, D. B. and Schoutens, W. (2011). Conic coconuts: the pricing of contingent capital notes using conic finance. *Mathematics and Financial Economics*, 4 (2):87–106.
- Magnus, M. and B. Mesnard, A. Margerit (2017). The resolution of Banco Popular. Economic Governance Support Unit (EGOV) of the European Parliament.
- Maes and Schoutens (2012). *Contingent Capital: An In-Depth Discussion*.
- Mäkinen, Mikko and Solanko, Laura (2017). Determinants of bank closures: Do changes of CAMEL variables matter?
- Maragopoulos, Nikos (2021). When the banking gets tough, the large get going: How capital regulation is driving consolidation. EBI Working Paper Series – no. 89 (12 April 2021).
- Martino, E. (2020). The bail-in beyond unpredictability: Creditors' incentives and market discipline. *European Business Organization Law Review*, 21(4), 789-828.
- Martynova, N., & Perotti, E. (2018). Convertible bonds and bank risk-taking. *Journal of Financial Intermediation*.
- McCunn, Ayowande (2015). Temporary write-down CoCos and the incentive to monitor and discipline.
- McCunn, Ayowande (April 2016). Forbearance Incentives: Undermining the distinction between going and gone-concern capital.
- McDonald, R. L. (2010). Contingent Capital with a Dual Price Trigger. In: *Journal of Financial Stability* 9.2, pp. 230–241.

- Mendes, L. D. S. (2021). Essays on contingent convertible bonds and bank regulation (Doctoral dissertation).
- Merton, R. C., & Thakor, R. T. (2021). No-fault default, chapter 11 bankruptcy, and financial institutions. *Journal of Banking & Finance*, 106066.
- Mesnard, B. and Magnus, B. (2016). What to do with profits when banks are undercapitalized: Maximum Distributable Amount, CoCo bonds and volatile markets.
- Metzler and Reesor (2014). Valuation and Analysis of Zero-Coupon Contingent Capital Bonds.
- Miginiac, Romain (2019). Extension Risk: Looking Beyond AT1 CoCos. *Atlanticonium*, 26 February 2019.
- Milanov, K., Kounchev, O., & Fabozzi, F. J. (2019). A complete model for pricing coco bonds. *The Journal of Fixed Income*, 29(3), 53-67.
- Neuberg, R., Glasserman, P., Kay, B. S., and Rajan, S. (2016). The Market-implied Probability of European Government Intervention in Distressed Banks. OFR Working Paper 16-10, Office of Financial Research.
- Oster, P. (2020). Contingent Convertible bond literature review: making everything and nothing possible?. *Journal of Banking Regulation*, 21(4), 343-381.
- Oster, P. (2020). When all concern is gone: the impact of call provisions on gone-concern Tier 2 bond spreads in Europe. *The European Journal of Finance*, 26(15), 1529-1568.
- Pagano, Marco (July 2016). The Sovereign-Bank Nexus and the Case for European Safe Bonds.
- Pazarbasioglu, C., Zhou, J., Le Leslé, V., and Moore, M. Contingent Capital: Economic Rationale and Design Features. International Monetary Fund, 2011.
- Pennacchi, G. (2010). A Structural Model of Contingent Bank Capital. FRB of Cleveland Working Paper No. 10-04.
- Pennacchi, G., Vermaelen, T. & Wolff, C. (2014). “Contingent capital: the case of COERCs”. In *Journal of Financial and Quantitative Analysis* 49.03, pp. 541–574.
- Pennacchi, G., and A. Tchisty (2015). A reexamination of contingent convertibles with stock price triggers, working paper.

Pennacchi, G., & Tchisty, A. (2019). Contingent convertibles with stock price triggers: The case of perpetuities. *The Review of Financial Studies*, 32(6), 2302-2340.

Prescott, E.S. (2011), "Contingent Capital: The Trigger Problem", *Economic Quarterly*, 98(1) (First Quarter 2012), 33-50.

Richter, Wolf (September 2016). Deutsche Bank's CoCo Bonds Speak of Fear of the Worst.

Ritzema, B. P. (2015). Understanding Additional Tier 1 CoCo Bond Prices using First-Passage Time Models.

Roggi, O., Giannozzi, A. and Luca Mibelli, L. (2013). CoCo Bonds, Conversion Prices and Risk Shifting Incentives - How Does the Conversion Ratio Affect Management's Behaviour? *Financial Markets, Institutions & Instruments*, Vol. 22, Issue 2, pp. 143-170.

Rosca, Matei (3 August 2017). CoCo Calculations Change as Flops Bring Bank Risks to Forefront, S&P Global.

Santander (7 June 2017). Banco Popular acquisition: Creating shareholder value through in-market consolidation, Analyst Presentation.

Sargut, Gökçe and McGrath, Rita (2011). Learning to Live with Complexity. *Harvard Business Review*.

Serjantov, A. (2011). On Practical Pricing Hybrid Capital Securities. *Global Derivatives Trading and Risk Management*.

Sironi, A. (2003). Testing for market discipline in the European banking industry: Evidence from subordinated debt issues. *Journal of Money, Credit, and Banking*, 35(3), 443-472.

Spiegeleer, J. de & Schoutens, W. (2014). "CoCo bonds with extension risk". *Wilmott* 2014.71, pp. 78-91.

Squam Lake Working Group on Financial Regulation (2009). An Expected Resolution Mechanism for Distressed Financial Firms: Regulatory Hybrid Securities. Working Paper, Squam Lake Working Group on Financial Regulation.

Stamcar, R. and C. Finger (2006). Incorporating equity derivatives into the CreditGrades model. *Journal of Credit Risk* 2(1).

Stamincar, Robert (2016). COCO RISK: Practical Approaches to Measuring Risk. Axioma.

Su, L. and Rieger, M. O. (2009). How likely is it to hit a barrier? Theoretical and Empirical Estimates. Technical Report No. 594, Financial Valuation and Risk Management, October 2009.

Sundaresan, S. and Wang, Z. (2011). On the Design of Contingent Capital with Market Trigger. Federal Reserve Bank of New York, Staff Report no. 448, November 2011.

Taleb, Nassim (1996). Dynamic Hedging: Managing Vanilla and Exotic Options.

Troiano, Marco and Ruocco, Danilo (2016). Identifying and Calculating Available Distributable Items: The Example of Italian Banks. Scope Research, 15 January 2016.

Troiano, Marco and Theodore, Sam (2016). Spanish Banks' Capital Regime: More Clarity Entering 2016. Scope Research, 13 January 2016.

Troiano, Marco (2021). EU bank stress tests: four key takeaways for investors. Scope Research, 2 August 2021.

Vallée, Boris (2015). Contingent capital trigger effects: Evidence from liability management exercises.

von Furstenberg, G. M. (2011). Contingent Capital to Strengthen the Private Safety Net for Financial Institutions: Cocos to the Rescue? Deutsche Bundesbank Discussion Paper.

von Furstenberg, G. M. (2017). Managing the Terms for Converting CoCos. Journal of Advances in Economics and Finance, Vol. 2, No. 3.

Williams, B., Tan, S. L., & Fenech, J. P. (2018). Why Do Banks Issue Contingent Convertible Bonds?. Available at SSRN 3187667.

Wilkens, S. and Bethke, N. (2014). Contingent Convertible Bonds: A First Empirical Assessment of Selected Pricing Models. Financial Analysts Journal, 70(2):59–77, March/April 2014.

World Economic Forum (2016). The future of financial infrastructure: An ambitious look at how blockchain can reshape financial services. Section on “Contingent Convertible (“CoCo”) Bonds”.

Wright, John and Edwards, Giles (2020). Europe's AT1 Market Faces The COVID-19 Test: Bend, Not Break in S&P Global commentary, 24 April 2020.

Wu, Joanne (2018). Investors: Trash, Taxpayers' Treasure: The Banco Popular Wipeout and Contingent Convertible Bonds.

Zeng, Jing (2014). Contingent Capital Structure. Working paper.

Zeitsch, P. J., & Davis, T. P. (2021). The price determinants of contingent convertible bonds. Finance Research Letters, 102015.

Zhang, B., Zhou, H., Zhu, H. (2009). Explaining credit default swap spreads with the equity volatility and jump risks of individual firms. The Review of Financial Studies 12, 5099- 5131.

Résumé

Nous étudions un nouveau type de capital conditionnel, les Fonds Propres Additionnels (AT1, de l'anglais « Additional Tier 1 »), conçus dans le but d'éviter les renflouements financés par les contribuables en cas de futures crises financières. Les AT1 sont conçus avec des déclencheurs automatiques pour conversion du principal, annulation du coupon et prolongation de l'échéance. Notre enquête est motivée par l'effondrement de Popular Español en juin 2017, ses AT1 n'étant pas parvenus à réduire les coupons ni à passer en capital tant que la banque était encore solvable.

Nous examinons les hypothèses des modèles d'évaluation existants, en exécutant une analyse de régression sur la tarification des fonctionnalités AT1 et les mécanismes de perte. Nos objectifs sont triples : (1) évaluer si les ratios CET1/RWA utilisés comme seuils de déclenchement sont fixés trop bas pour que les AT1 agissent comme des fonds propres « en continuité » ; (2) déterminer l'importance de l'omission des coupons et des barrières de réinitialisation dans la formation des prix ; (3) évaluer si la portée du pouvoir discrétionnaire de surveillance compromet les mécanismes de déclenchement automatique.

Nos travaux empiriques suggèrent que les investisseurs n'évaluent pas les caractéristiques de conception qui déterminent le potentiel de perte ou le taux de récupération de la valeur principale, telles que le niveau de déclenchement, le prix de conversion ou la clause de réécriture. Nos résultats indiquent que le « point de non-viabilité » est supérieur au niveau de déclenchement de l'adéquation des fonds propres, de sorte que le facteur-clé qui détermine la probabilité d'un événement imprévu est le pouvoir collectif des banques centrales d'invoquer le « PONV » (de l'anglais « Point Of Non-Viability »). Nous recommandons que le déclencheur d'adéquation des fonds propres soit basé sur une formule : les exigences du Pilier 1 plus la « composante minimale de fonds propres de base de catégorie 1 de l'exigence du Pilier 2 ». Notre proposition relèverait le seuil de déclenchement automatique d'environ 300 points de base à des ratios CET1/RWA d'environ 9,2 %, afin de permettre aux investisseurs d'évaluer plus précisément le risque de perte en principal. En utilisant une formule qui intègre une composante du processus annuel d'examen et d'évaluation prudentiels (SREP, de l'anglais Supervisory Review and Evaluation Process), menée sous l'égide de la BCE, le seuil d'un événement d'urgence devrait être plus évolutif.

La distance au ratio SREP pour l'omission de coupon a une signification statistique beaucoup plus importante que la distance au ratio CET1 pour la dépréciation/conversion. Les modèles devraient donc s'orienter autour du seuil d'omission des coupons, qui reflète déjà les niveaux combinés de coussin de fonds propres guidés par le SREP, mesurés par rapport au CET1 « excédentaire » disponible pour assurer le service des paiements d'intérêts. Cependant, en évaluant la capacité automatique des calculs du montant maximum distribuable (MDA, de l'anglais « Maximum Distributable Amount »), nous constatons que la possibilité pour les organes de surveillance de modifier les perceptions des investisseurs avec des orientations prospectives ou d'empêcher les réductions induites par les MDA par abstention sape la pertinence du ratio SREP. À notre avis, les signaux de « soft stopper » des banques centrales érodent l'effet disciplinant des exigences de ratio MDA-SREP - par conséquent, la position adoptée par la BCE devrait être durcie pour éviter l'impression que les AT1 sont « favorisés » et que les restrictions de coupon ne seront jamais vraiment appliquées.

La proximité croissante d'une vague de premières dates d'échéance nous a offert une excellente opportunité d'analyser la charge que les investisseurs font peser sur le risque d'un allongement de maturité. Notre analyse montre que le spread réinitialisé qui établit le coupon à terme est la caractéristique qui domine le plus dans la formation des prix AT1. Nous identifions le danger selon lequel si les réinitialisations des AT1 nouvellement émises sont fixées à des spreads extrêmement serrés, toute augmentation des coûts de refinancement une fois que le marché est sorti de son environnement de taux d'intérêt ultra-bas pourrait entraîner un « millésime perpétuel » d'AT1 non remboursables. La « convexité négative » résultante d'événements non liés à un appel pourrait, à son tour, provoquer une contagion à travers la classe d'actifs. Nous recommandons donc que les techniques d'évaluation se réorientent vers des indicateurs tels que « le multiple du spread réversif par rapport au z-spread actuel » afin de mieux intégrer l'économie du risque d'extension.

Notre thèse plaide en faveur de seuils plus élevés et plus strictement appliqués, contre les lacunes d'une approche de puissance purement PONV, pour aider à recapitaliser les banques en période de détresse. Nous concluons que les déclencheurs automatiques devraient pouvoir fonctionner librement pour restaurer la discipline de marché dans l'évaluation des mécanismes de perte intégrés au capital conditionnel de type AT1.

Mots clefs : Stabilité financière, fonds propres conditionnels, modèles d'évaluation, discrétionnaire de surveillance, point de non-viabilité

Résumé en anglais

Risk Asymmetry in the Design of Contingent Capital:

An evaluation of trigger thresholds and the role of supervisory discretion

We investigate a new type of contingent capital, Additional Tier 1 (AT1), which is engineered with the aim of avoiding taxpayer-funded bailouts in the event of future financial crises. AT1s are designed with automatic triggers for principal conversion, coupon cancellation and maturity extension. Our investigation is motivated by the collapse of Popular Español in June 2017, given that its AT1s failed to cut coupons or convert to equity while the bank was still solvent.

We examine the assumptions in existing valuation models, by running regression analysis on the pricing of AT1 features and loss mechanisms. Our objectives are threefold: (1) to assess whether the CET1/RWA ratios used as trigger levels are set too low for AT1s to act as ‘going concern’ capital; (2) to determine the prominence of the coupon omission and reset barriers in price formation; (3) to evaluate if the scope for supervisory discretion is undermining the automatic triggering mechanics.

Our empirical work suggests that investors do not price the design features that determine the loss potential or recovery rate of the principal value, such as the triggering level, conversion rate or write-back clause. Our findings indicate that the “point of non-viability” is above the level of the capital adequacy trigger, such that the key factor shaping the probability of a contingency event is the central banks’ collective power to invoke “PONV”. We recommend the capital adequacy trigger be based on a formula: *Pillar 1 requirements plus the minimum Common Equity Tier 1 component of the Pillar 2 requirement*. Our proposal would raise the automatic triggering threshold c300 basis points to CET1/RWA ratios of c9.2%, to enable investors to assess the risk of principal loss more accurately. By using a formula that incorporates a component from the annual Supervisory Review and Evaluation Process (SREP), conducted under the aegis of the ECB, the threshold for a contingency event should be more futureproof.

The distance to SREP ratio for coupon omission has far greater statistical significance than the distance to CET1 ratio for write-down/conversion. Models should therefore orient around the threshold for coupon omission, which already reflects the SREP-guided combined capital buffer levels as measured against the ‘surplus’ CET1 available to service interest payments. However, in evaluating the automatic capacity of Maximum Distributable Amount (MDA) calculations, we find that the scope for supervisory bodies to shift investor perceptions with forward guidance or to forestall MDA-induced cuts by forbearance is undermining the relevance of the SREP ratio. In our view, ‘soft stopper’ signalling from the central banks erodes the disciplining effect of MDA-SREP ratio requirements – hence, the stance taken by the ECB should be toughened to avoid the impression that AT1s are ‘favoured’ and coupon restrictions will never really be applied.

The growing proximity to a wave of first call dates has offered us an excellent opportunity to analyse the onus that investors place on the risk of an extension of maturity. Our analysis shows that the reset spread which establishes the forward coupon is the feature that most dominates in AT1 price formation. We identify the danger that as the resets of newly issued AT1s are being set at extremely tight spreads, any increase in refinancing costs once the market exits from its ultra-low interest rate environment could result in a ‘perpetual vintage’ of uncallable AT1s. The resulting ‘negative convexity’ from non-call events could, in turn, cause contagion across the asset class. We thus recommend that valuation techniques reorient toward indicators such as ‘the multiple of the reset spread to the current zspread’ to better incorporate the economics of extension risk.

Our thesis makes the case for higher and more strictly enforced thresholds, against the shortcomings of a purely PONV power approach, to help recapitalise banks during bout of distress. We conclude that the automatic triggers should be allowed to function freely to restore market discipline in the valuation of the loss mechanisms embedded in AT1-style contingent capital.

Key words: Financial stability, contingent capital, valuation models, supervisory discretion, point of non-viability