Contínget Convertible (CoCo) Bonds

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Overview

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Introduction

The debt instrument known as *Contingent Convertible (CoCo)* has been introduced in the market to enhance more stability.

- Upon the appearance of a trigger mechanism, related with the insolvency of the issuer, a *CoCo* is converted into a predefined number of shares (or it suffers a write-down) .
- An important feature of this contract is that conversion is mandatory, as opposed to convertible bonds, where conversion is a choice that the investor has.

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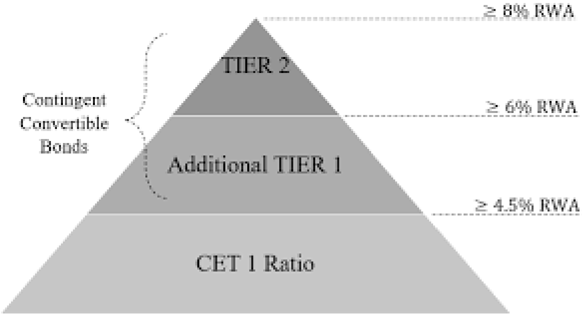
In 2007 a financial crisis, originated in the U.S. home loans market, quickly spread to other markets, sectors and countries, forcing the Federal Reserve and the European Central Bank to intervene in response to the collapse of the interbank market. This gave rise, in 2010, to new regulation rules, known as Basel III, that would change the financial landscape.

This is when *CoCos* started to play an important role. Basel III, among other regulating measures, proposed the inclusion of *CoCos* as part of Additional Tier 1 Capital.

Basel III


≥ 8% RWA
TIER 2
≥ 6% RWA
Contingent Convertible Bonds
Additional TIER 1
≥ 4.5% RWA
CET 1 Ratio

CoCo Bond Market

- USD521bn market $\approx$ 3% US GDP (2015)
- 61% write-down, or “write-off”(52%-48%-2019)
- Created to reduce the need for bail-ins

CoCo Bond Market

- Since 2009 more than 160 banks (primarily from the EU) made about 350 issues of contingent convertible bonds (CoCos)
- CoCos are issued primarily by large international banks

CoCo Bond Market

- Most CoCos paid a coupon of between 6 and 9 percent in early 2019, roughly double or even triple that of more secure senior bank bonds.
- While Europe opted for CoCos to boost Tier 1 capital, U.S. banks are employing a form of preferred stock and Chinaś lenders are using a cross between the two.
- While CoCos are technically bonds (and thus interest payments can be made from pretax earnings), they display many of the properties of an equity.

CoCo Issuance

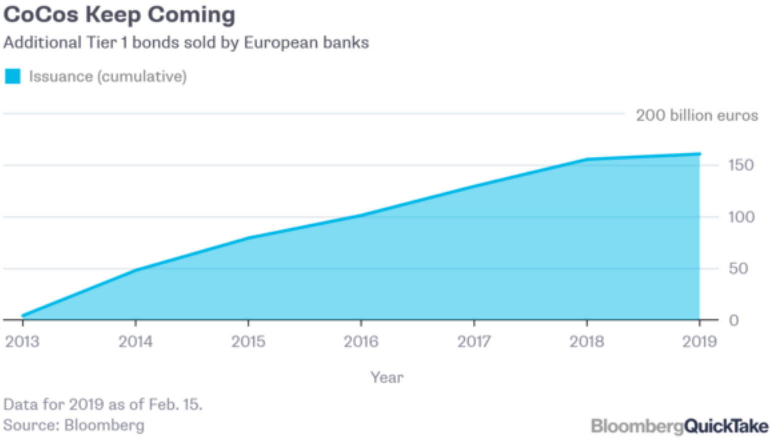


Figure:

Trigger Event

- Market Trigger
- Accounting Trigger
- Regulatory Trigger

Trigger Event

There is a disagreement about how to establish the trigger event. It is perhaps the most controversial parameter in a *CoCo*. Some advocate conversion based on book values, like the different capital ratios used in Basel III.

Others defend market triggers like the market value of the equity. Flannery (2005, 2009) introduced contingent capital with a market based trigger (a bank's stock price), based on the view that the market value of equity provides a better indicator of a bank's capital adequacy.

Accounting or Market Trigger?

- When using market triggers, there exist the risk of market manipulations of the equity price trying to force the conversion or undesirable phenomena like the *death-spiral effect*
- Also, stock price is itself affected by the possibility of conversion.
- One argument against accounting triggers is that monitoring is not continuous, there is always a delay in the information. Moreover, in the recent crisis these triggers did not provide any signal of distress in troubled banks.
- Finally, there is the problem of wealth transfer between equity holders and CoCo investors (Sundaresan and Wang (2015), Berg and Kaserer (2015)).

Regulatory Trigger

- The discretion of a National regulator can activate the trigger. This clause is also called Point-of-Non-Viability (PONV)
- The regulatory trigger can be set to a higher levels than the ones of previous categories.Indeed, it is linked to the ability of the issuer of keeping a good quality of additional TIER1 and TIER2 capital.
- Obviously, the existence of such triggers erodes the value of the CoCo bond,being difficult to estimate the time when the loss-absorption mechanism will happen.

Equity Conversion

The conversion prices C_p has typically two possible forms:

- $C_p = \alpha S_0$, where S_0 is the stock price at issue date. For the old Lloyds CoCos $\alpha = 1$, for many other CoCos, $\alpha = 2/3$. Why? Probably, because one could convince the regulator that it makes sense and once there was a precedent it was copied.
- $C_p = \max(S^*, K)$, with S^* the stock price at trigger and K some stock price level (typically below S_0), the max with S^* makes the recovery rate 100% if the CoCo triggers when the stock price is still above K.

  This gives CoCo-investors confidence that if the regulator triggers too early they do not suffer a loss. If the regulator triggers when the stock price has already fallen below K, they recover S^*/K.

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Write-Down

- Triggering automatically produces a pay-off zero for the investor
- $C_r = 0$

Maturity

- $T < \infty \Rightarrow$ AT2
- $T = \infty \Rightarrow$ AT1

CoCo Bond Pricing

For an intensity approach, when modelling the conversion time, see for instance:

- De Spiegeleer, J., Schoutens, W.: Pricing contingent convertibles: a derivatives approach. Journal of Derivatives 20(2), 27-36 (2012)
- Cheridito, P., Xu, Z.: A reduced form CoCo model with deterministic conversion intensity. The Journal of Risk 17(3), 2015, p. 1–18.

For a structural approach:

- Chen, N., Glasserman, P., Nouri, B., Pelger, M.: CoCos, bail-in, and tail risk. OFR Working paper. U.S. Department of the Treasury (2015). Forthcoming RFS

Some Formulas

De Spiegeleer & Schoutens (2011) used Merton (1974) approach to credit risk in order to estimate the $p(trigger)$ with a market-based trigger (not accounting-based).

$$p(trigger) = N\left(\frac{log\frac{S^*}{S} - \mu T}{\sigma\sqrt{T}}\right) + \left(\frac{S^*}{S}\right)^{\frac{2\mu}{\sigma^2}} N\left(\frac{log\frac{S^*}{S} + \mu T}{\sigma\sqrt{T}}\right) \tag{1}$$

$$\mu = r - q - \frac{\sigma^2}{2} \tag{2}$$

Where:
q: continuous dividend yield
r: continuous interest rate
σ volatility
T: maturity of the CoCo
S: current share price

Model

The definition of a *CoCo* requires the specification of the following parameters.

- K *Face value* of the *CoCo*.
- C_p *Conversion price*: the prefixed price of the share, for the investor, in case of conversion.
- T *Maturity of the CoCo.*
- $(t_i, c_i)_{i=1}^m$ *Coupon structure:* defines the time t_i at which an amount c_i is payed as coupon, $i = 1, ..., m$.
- τ_c *Conversion time*: the random time that defines when the *CoCo* conversion takes place. In other words, τ_c defines when the trigger mechanism takes place.

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The contract has final payoff given by

$$K + \sum_{i=1}^{m} c_i \exp\left(\int_{t_i}^{T} r_u \mathrm{d}u\right) \mathbf{1}_{\{t_i<\tau_c\}} + \left(\frac{K}{C_p} S_T - K\right) \mathbf{1}_{\{\tau_c \leq T\}}.$$

The difference among the contributions in the literature are the way they model the conversion time, τ_c, the evolution of the stock $(S_t)_{t\geq 0}$ and the interest rates, $(r_t)_{t\geq 0}$.

Deutsche Bank February,8th 2016

- Deutsche Bank may miss coupon payments on some of its CoCos. The worry built Monday, as Deutsche Bank's CoCos began to trade at less than 75 cents on the euro.
- On Monday, the bank said its payment capacity for 2016 was expected to be around 1 billion euros, plenty to service an AT1 coupon of about 350 million due April 30. For 2017, the bank said it expected its AT1 payment capacity at about 4.3 billion before this year's operating results.
- Five-year CDS on Deutsche Bank debt more than doubled to 457 basis points on Monday from 202 basis points at Friday's close.

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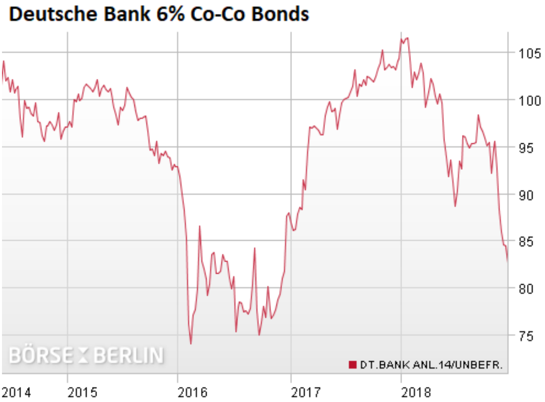
Deutsche Bank CoCo Bond



Coupon Cancellation Risk

Corcuera, J. M., De~Spiegeleer, J., Jönsson, H., Fajardo, J., Shoutens, W., Valdivia, A.: Close form pricing formulas for coupon cancellable cocos. Journal of Banking & Finance 42 (2014) 339-331.

a system of coupon cancellations is proposed in order to alleviate "Death spiral effect".

Coupon Cancellation Pricing

We shall assume that the i^{th} coupon cancellation time, τ_i, occurs as soon as the process $(S_t)_{t\in[0,T]}$ hits trigger barrier $(\ell_t^i)_{t\in[0,T]}$, $i \in \{1, ..., m\}$. That is to say,

$$\tau_i := \inf\{0 \le t \le T_i \ : \ S_t \le \ell_t^i\}, \tag{3}$$

and

$$\frac{\ell_{i+1}}{\ell_i} < \exp\left(-\int_{T_i}^{T_{i+1}} \kappa(u)\mathrm{d}u\right), \ i \in \{1, ..., m-1\}, \text{ and } \ell_m < \frac{N}{C_r},$$

so that $\ell_t^1 > \ell_t^2 > ... > \ell_t^m$.

Recall that we set the conversion time as τ_m and notice that this choice of the trigger barriers ensures us that the if τ_j is finite then $\tau_j < \tau_{j+1}$, $j \in \{1, ..., m-1\}$.

Pricing Formula

A general expression for the CoCa CoCo's arbitrage-free price is given by

$$\pi_t = \pi_1(t) + \pi_2(t), \tag{4}$$

where

$$\begin{aligned} \pi_1(t) &= \sum_{i, T_i > t}^{m} c_i B_t \mathbb{E}^* \left[\frac{\mathbf{1}_{\{\tau_i > T_i\}}}{B_{T_i}} \middle| \mathcal{F}_t \right], \\ \pi_2(t) &= B_t \mathbb{E}^* \left[B_{\tau_m}^{-1} C_r S_{\tau_m} \mathbf{1}_{\{\tau_m \le T_m\}} \middle| \mathcal{F}_t \right] + B_t \mathbb{E}^* \left[B_{T_m}^{-1} N \mathbf{1}_{\{\tau_m > T_m\}} \middle| \mathcal{F}_t \right]. \end{aligned}$$

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Extension Risk

All the mentioned papers consider a fixed maturity of the bond. However bonds often do not just have a legal maturity but can have also different call dates. In such cases, the bond can be called back by the issuer at these dates prior to the legal maturity. This is even more the case with perpetual instruments (AT1).

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Santander CoCo 2019

- Banco Santander SA reminded investors that juicy bonds can come with nasty surprises.
- The Spanish lender rattled the bank Additional Tier 1 market by saying it will skip an option to call 1.5 billion euros ($1.7 billion) of perpetual contingent-convertible notes next month, sending the bonds tumbling.
- “The handling of the situation was truly disastrous,” said Timothee Pubellier, a portfolio manager at Financiere de LA Cite SAS, which holds Santander CoCos. “Credit investors will need some serious new issue premium to touch that name again."

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Santader CoCo Bond

CoCo bonds with extension risk-Pricing

Let $\pi(t; c, K, T)$ be the price, at time t, of a corporate bond with face value K that pays a coupon c and with maturity time T. Then we are going to consider a contract that pays a coupon c_1 before T_1 and at T_1 can pay K or to postpone the payment and to continue until T_2 but paying a higher coupon c_2 before T_2 and to pay the face value K at T_2. To postpone or not the payment depends on which is better for the issuer of the contract. In other words at time T_1 the payoff is

$$\min\{K, \pi(T_1; c_2, K, T_2)\} = K - (K - \pi(T_1; c_2, K, T_2))_+ .$$

So, if we consider two call dates T_1, T_2 and a maturity time T_3 we can write the payoff of this contract as

$$c_i \text{ in } (T_{i-1}, T_i) \text{ if } S_{T_0} < M_0, ..., S_{T_{i-1}} < M_{i-1}, i \geq 1$$
$$K \text{ at } T_i \text{ if } S_{T_1} < M_1, ..., S_{T_{i-1}} < M_{i-1}, S_{T_i} > M_i, i \geq 1$$

for certain constants M_i that depend on K and $c_{i+1}, .., c_3$ and the price formula $\pi(T_i; c_{i+1}, ..., c_3, K, T_{i+1}, ..., T_3)$:

$$M_i = \max\left\{S_{T_i} \ : \ \pi(T_i; c_{i+1}, ..., c_3, K, T_{i+1}, ..., T_3) < K\right\}, i = 1, 2.$$

and the convention $M_0 = +\infty, M_3 = 0$.

CoCos with Extension Risk-Pricing

Then we will have that the payoff of this contract can be written as

$$c_{ij}\mathbf{1}_{\{\tau_{ij}>T_{ij},S_{T_{ij}}>M_{ij},S_{T_0}<M_0,\ldots,S_{T_{i-1}}<M_{i-1}\}} \text{ at times } T_{ij}, i \geq 1,$$

$$K\mathbf{1}_{\{\tau_c>T_i,S_{T_0}<M_0,\ldots,S_{T_{i-1}}<M_{i-1},S_{T_i}>M_i\}} \text{ at } T_i, i \geq 1,$$

$$\frac{K}{C_p}S_{\tau_c}\mathbf{1}_{\{\lceil\tau_c\rceil\leq T_N,S_{T_0}<M_0,\ldots,S_{\lceil\tau_c\rceil-1}<M_{\lceil\tau_c\rceil-1}\}} \text{ at } \tau_c.$$

where $\lceil\tau_c\rceil$ is the element of $\{T_1, T_2, ..., T_N\}$ such that $\lceil\tau_c\rceil - 1 < \tau_c \leq \lceil\tau_c\rceil$, and by convention $M_0 = \infty$ and $M_N = 0$.

CoCos with Extension Risk-Pricing

So, on $\{t < \tau_c \wedge \tau\}$, where τ is the *call time*,

$$\tilde{V}_t = \sum_{i,j: T_{ij} > t} c_{ij} \mathbb{P}^* \left(\tau_{ij} > T_{ij}, S_{T_{ij}} > M_{ij}, S_{T_0} < M_0, ..., S_{T_{i-1}} < M_{i-1} \middle| \mathcal{F}_t \right)$$
$$+ \sum_{i: T_i > t} K \mathbb{P}^* \left(\tau_c > T_i, S_{T_0} < M_0, ..., S_{T_{i-1}} < M_{i-1}, S_{T_i} > M_i \middle| \mathcal{F}_t \right)$$
$$+ \frac{K}{C_p} \mathbb{E}^* \left[S_{\tau_c} \mathbf{1}_{\{\lceil \tau_c \rceil \leq T_N, S_{T_0} < M_0, ..., S_{\lceil \tau_c \rceil - 1} < M_{\lceil \tau_c \rceil - 1}\}} \middle| \mathcal{F}_t \right].$$

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Infinite Horizon

The case of an infinite horizon can be treated using the results in

Peskir, G. and Shiryaev, A. N. (2006). Optimal Stopping and Free-Boundary Problems. Birkhäuser, Basel.

The details can be found in

Corcuera, J.M., Fajardo, J., Schoutens, W., Valdivia, A.: CoCos with extension risk: A structural approach. “The Fascination of Probability, Statistics and Their Applications. In Honour of Ole E. Barndorff-Nielsen’s 80th birthday”. Eds. Podolskij, M., Stelzer, R., Thorbjørnsen, S., Veraart, A.E.D.

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Empirical Papers in CoCo- Bond market

- Avdjiev et al. (2015), Hesse (2016), Fajardo and Mendes (2017), study CoCo bonds' design features and their impact at risk premium and at CDS spread
- Vallée (2015), Fajardo and Mendes (2016), Avdjiev et al. (2017) and Goncharenko et. al. (2017), address determinants of CoCo bond issuance
- Ammann et al. (2015), abnormal bank stock return around coco bond issuance.
- Fajardo and Mendes (2018), CoCo Bond issuance and systemic risk.

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Fajardo and Mendes (2017)

	Equity Conversion		Write Down		Diff	
	Mean	SD	Mean	SD		
Yield (issue at maturity)						
Europe	6.636	0.152	6.512	0.182	0.123	
Global	6.582	0.097	7.328	0.150	0.745	***
IBRD	5.910	0.115	8.968	0.158	3.058	***
BRICS	5.910	0.115	9.422	0.157	3.512	***
GSIB	7.031	0.140	7.158	0.299	0.127	
Yield (next to call)						
Europe	5.453	0.161	6.546	0.612	1.092	
Global	5.531	0.091	7.109	0.440	1.578	***
IBRD	5.433	0.098	8.163	0.215	2.730	***
BRICS	5.433	0.098	12.135	1.209	6.702	***
GSIB	5.936	0.125	4.943	0.505	0.993	*

Then

$$Yield = \alpha + \beta_1 DummyCoco + \beta_2 DummyWriteDown + \beta_3 BankControls$$
$$+ \beta_4 CocoFeatures + FEs + \epsilon$$

Banco Popular CoCo Bond

The Banco Popular CoCo bond, so-called Additional Tier 1 capital instrument (AT1).

- Perpetual: The AT1 bonds have an issuer call, but this in complete abscence of a so-called incentive to redeem.
- Trigger: In the case of Banco Popular the trigger level was set at a CET1 ratio of 7

Banco Popular CoCo Bond

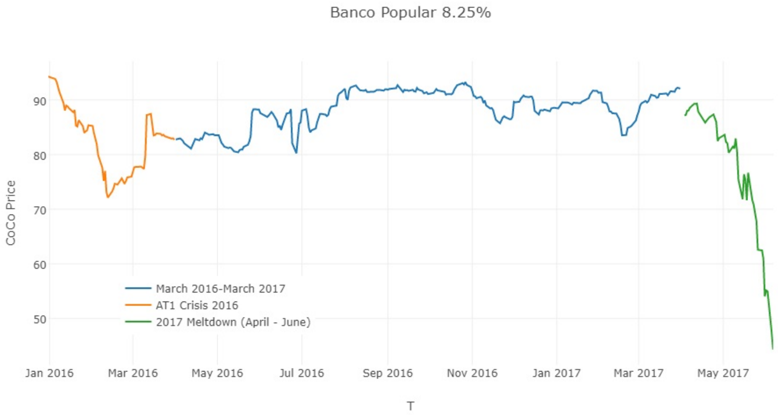
- The loss absorption mechanism in this particular Banco Popular CoCo was such that the investors would receive shares. The conversion price could not be lower than 1.549 EUR.

  On March 31st, 2 months before the SRB would step in, the share price was already trading far below this conversion price (0.91 EUR).The CoCo bond itself had a market price equal to 92.00 on this day.
- Coupon Cancellation

Banco Popular CoCo Bond

- Regulatory trigger: Though the purchase of a CoCo bond, the investor is implicitly writing out a cheque to the regulators.
- When the regulator considers a bank to be no longer viable, it has the authority to force the loss absorption of a CoCo bond, even if the most recent published CET1 is above the trigger level.
- This scenario is what took place at Banco Popular when Europe's Single Resolution Board moved in.

Banco Popular Scenario



Banco Popular CoCo Bond

- Fist CoCo Trigger ever
- Regulator set $\alpha = 0$.Why Regulator decided to do that?
- First, the event was such that not only the triggering of the CoCo was enough to cover all the losses and also subordinated debt holders were affected (they also got zero!) and therefore in order to have clarity and have some logic in the seniority they just wrote down every CoCo also to zero.
- Second, it could be a discussion what the stock price was and how one could trade that, since Santander took over Banco Popular for 1 euro.
- What are the consequences?

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Corcuera, Fajardo and Schoutens (2019)

- Pricing of CoCos with *unexpected* write-down
- How to improve regulation

CoCo Bond with Unexpected Write Down (UWD) Risk

A general expression for the CoCo-UWD's arbitrage-free price is given by

$$\pi_t = \pi_1(t) + \pi_2(t), \tag{5}$$

where

$$\pi_1(t) = \sum_{i, T_i > t}^{m} c_i B_t \mathbb{E}^* \left[\frac{\mathbf{1}_{\{\tau_i > T_i\}} \mathbf{1}_{\{\tau^{UWD} > T_i\}}}{B_{T_i}} \middle| \mathcal{F}_t \right],$$

$$\pi_2(t) = B_t \mathbb{E}^* \left[B_{\tau_m}^{-1} C_r S_{\tau_m} \mathbf{1}_{\{\tau_m < \tau^{UWD} \wedge T_m\}} \middle| \mathcal{F}_t \right] + B_t \mathbb{E}^* \left[B_{T_m}^{-1} N \mathbf{1}_{\{\tau_m > T_m\}} \mathbf{1}_{\{\tau^{UWD} > T_m\}} \middle| \mathcal{F}_t \right],$$

where we can define the unexpected write down time as

$$\tau^{UWD} := \inf\{0 \leq t \ : \ \tilde{S}_t \leq \ell^{UWD}\}, \tag{6}$$

CoCo Bond with Unexpected Write Down Risk

We shall assume that the following condition (**F**) holds.

(**F**) There are not dividends after the conversion time τ_m.

Notice that under the Condition (**F**), to receive $C_r S_{\tau_m}$ at time τ_m is equivalent to receive $C_r S_{T_m}$ at time T_m. Hence, in this case, the summand π_2 of (5) may be rewritten as

$$\pi_2(t) = B_t \mathbb{E}^* \left[B_{T_m}^{-1} C_r S_{T_m} \mathbf{1}_{\{\tau_m < \tau^{UWD} \wedge T_m\}} \middle| \mathcal{F}_t \right] + B_t \mathbb{E}^* \left[B_{T_m}^{-1} N \mathbf{1}_{\{\tau_m > T_m\}} \mathbf{1}_{\{\tau^{UWD} > T_m\}} \middle| \mathcal{F}_t \right].$$

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Joint Probability of Two First Passages Times

In the BM case, we can compute the below probability using Kou and Zhong (2016).

$$P^*(\tau_m < T, \tau^{UWD} < T) = \int_0^T \int_0^T f_{\tau_m, \tau^{UWD}}(t, s) dtds \approx$$

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Joint Probability of Two First Passages Times

Similarly for

$$P^*(\tau_m < \tau^{UWD} < T) = \int_0^T \int_t^T f_{\tau_m, \tau^{UWD}}(t, s) ds dt$$

Conclusions

- CoCo Bond Market
- Pricing with Unexpected Write-Down
- Improve Regulation

- Why do investors demand CoCo Bonds?
- How to manage CoCo Bond's Risks?
- Optimal CoCo design
- General and Welfare analysis