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Conic coconuts: the pricing of contingent capital notes using conic finance

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Abstract In this paper we introduce a fundamental model under which we will price contingent capital notes using conic finance techniques. The model is based on more realistic balance-sheet models recognizing the fact that asset and liabilities are both risky and have to be treated differently taking into account bid and ask prices in a prudent fashion. The underlying theory makes use of conic finance which is based on the concept of acceptability and distorted expectations. We recall the theory and give a brief overview of the related literature. Next, we discuss and propose some potential funded and unfunded contingent capital notes. Traditionally, the conversion trigger of contingent capital notes is in terms of the Core-Tier 1 ratio. We argue that this ratio is maybe not optimal, certainly when taking into account the presence of risky liabilities. As an alternative we introduce triggers based on capital shortfall. The pricing of seven variations of funded as well as unfunded notes is overviewed. We further investigate the effect of the dilution factor and the grace factor. In an appendix we show conic balance sheets including contingent capital instruments.

Keywords Contingent capital · Bid and ask pricing · Conic finance

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1 Introduction

Contingent Capital or contingent core notes (coconuts) have been put to the fore in the discussion of the aftermath of the credit crunch crisis. The main idea is that by means of a financial

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instrument (derivative), one ensures that in times of heavily distressed markets, corporations in trouble automatically are provided with fresh capital. A contingent capital note is by contract triggered when a certain capital related indicator, like for example the Core-Tier 1 ratio, falls below a certain level (say 5%). At that point in time for example new capital comes in, in return for equity according to a rule fixed when the contract is struck; some deals don't bring in equity but cancel some outstanding debt. Many variations are possible. The deal is made upfront and one avoids the need of going to the capital markets in such distressed situations, when it is extremely hard, if not impossible, to raise new funds.

Contingent capital has not come out of the blue. The G20 announcement in September 2009 stated specifically that they would be examining contingent capital and comparable instruments. In November 2009, Lloyds Banking Group issued a Lower Tier 2 hybrid capital instrument called Enhanced Capital Notes. These include a contingent capital feature and will reportedly convert into ordinary shares if Lloyds' published consolidated Core-Tier 1 ratio falls below 5%. This instrument will not be included in the regulatory Core-Tier 1 ratio until a conversion occurs. The conversion price is based on LBG's stock price at the issue date. Mid 2010 also Rabobank has issued a contingent core note and in October 2010, a Swiss government-appointed panel, proposed the first capital surcharge on too-big-to-fail banks. Switzerland's biggest banks should hold total capital equal to at least 19% of their assets. By 2019, the lenders need to have a common equity ratio of at least 10% and the rest in contingent capital. One expects Swiss banks to issue about SFR 72 billion in contingent capital to meet these new standards.

There is not much literature about these new products. A pioneering paper proposing such securities is by Flannery [11]. In [13], a form of contingent capital that converts from debt to equity if two conditions are met is proposed. To convert, the firm's stock price and the level of a financial index should be both simultaneously below their respective trigger values. Such a structure gives "protection" during a crisis, when all are performing badly, but during normal times permits a badly performing bank to go bankrupt.

Acharya et al. [23] have suggested that while contingent capital does restore some market discipline, both contingent capital and equity capital may have incentives to take excessive risks at the expense of taxpayer money. Schoutens [22] has pointed out several potential problems that could arise near the trigger level, were one can anticipate the volatility will be high. Triggering one bank, can lead to speculation on other banks. Timing of publishing capital ratios should be synchronized. If one bank reveals it is triggered this increases the triggering probability of other financial players dramatically in a systematic crisis due to high correlation. Further, the most straightforward way coconut holders could hedge against potentially being triggered and baring some heavy losses, is shorting the underlying stock. This could bring stock prices even down further and hence the company actually closer to the trigger level; a kind of death-spiral effect could arise. Furthermore, if coconuts are mainly held by the financial players, the triggering of a few will lead to potential losses on the balance sheets of the others, who held these. This could lead to a domino effect of triggering either new coconuts or defaults. Also some critical analysis is made in [12] on the mechanics of their operation and the market implications. Bond et al. [1] have argued that if agents were to use market prices when taking corrective actions, prices will adjust to reflect such a use and may become potentially less revealing. Maes and Schoutens in [21] discuss issues of counterparty risk, effectiveness, moral hazard, contagion and systemic risk, as well as death-spiral issues arising from the hedging strategies of the investors.

In this paper we introduce a fundamental model under which we will price contingent capital notes using conic finance techniques. The model is based on more realistic balance-sheet models recognizing the fact that asset and liabilities are both risky. One has to treat them differently taking into account bid and ask prices in a prudent fashion. We remark in this context that in a classical Mertonian balance sheet model, assets are risky but liabilities are not. In reality however liabilities are risky and can be even unbounded (long-short hedge funds or insurance companies are some examples). Recently, new balance sheet models have been proposed ([19]) where liabilities are assumed to be risky and correlated to the asset dynamics. Furthermore, in the so-called conic finance balance sheet model, the one-price-market idea is abandoned and one assumes that there are bid-ask spreads (related to the liquidity of the market and the risk appetites of the players in these markets). This theory makes use of the concept of acceptability and distorted expectations, which we discuss in Sect. 2. In Sect. 2, we also overview the literature on conic finance and its applications. In Sect. 3, we overview some potential funded and unfunded contingent capital notes. Section 4, first elaborates on the trigger ratio. We argue that the traditional Core-Tier 1 ratio may not be optimal, certainly when taking into account the presence of risky liabilities; as an alternative, we introduce triggers based on capital shortfall. The pricing of 7 variations of funded as well as unfunded notes is overviewed in the second part of Sect. 4. Section 5, investigates the effect of the dilution factor and the grace factor. In an appendix we show conic balance sheets including contingent capital instruments.

2 Conic finance

In this section, we summarize the pricing theory relevant for two price markets as set out in Cherny and Madan's papers, [3] and [4], that is here employed to value contingent capital contracts. In the theory of two price markets, the market is the counterparty for economic agents in all financial transactions, and takes the opposite side of the trade. Each transaction involves the purchase or sale of a state contingent cash flow seen as random variables on a probability space $(\Omega, \mathcal{F}, P)$. For continuity we first recall the classical model of the market.

In the classical model, financial markets are seen as a passive counterparty and economic agents may transact with the market any amount of a traded cash flow at the going market price. The law of one price prevails and one may transact in both directions at the same price. If in addition we have complete markets then we have a unique risk neutral or pricing measure Q equivalent to P such that the set of zero cost cash flows deliverable to the market consists of all cash flows X for which

$$E^{Q}[X] \geq 0.$$

One may deliver to the market at zero cost any cash flow X with a positive price or equivalently any positive alpha cash flow.

This classical model is marginally revised in the theory for two price markets. First note the following properties about the set of cash flows deliverable to market at zero cost. This set of cash flows is closed under scaling, addition, and contains the set of nonnegative cash flows. It is therefore a convex cone of cash flows. But by virtue of trading in both directions at the same price the set of cash flows that are just acceptable is also closed under negation. The set of acceptable cash flows is then a half space of random variables.

For two price markets, we model markets as accepting at zero cost a convex cone of cash flows containing the nonnegative cash flows but as we do not trade at the same price in both directions, the set of zero cost cash flows just deliverable to market is not closed under negation. It is then a proper convex cone that is not as large as a half space.

The abstract model for the set of zero cost marketed cash flows then consists of all cash flows X for which

$$E^{Q}[X] \geq 0$$

for some convex set of measures $Q \in \mathcal{M}$. The convex set $\mathcal{M}$ contains the supporting measures, which can be seen as a set of test-measures under which the cash-flow needs to have positive expectation to deliver acceptability. As we wish to enforce that this set of cash flows is strictly contained in a candidate for the classical model, we assume that the set $\mathcal{M}$ of test measures contains a risk neutral measure. In fact without loss of generality we suppose that P our original base measure is a risk neutral measure and $P \in \mathcal{M}$.

The next advance in the theory for two price markets occurs with the formulation of operationally definable convex cones of zero cost marketable cash flows. For this we focus attention on the probability law $F(x)$ of the proposed cash flow represented by the random variable X. We then ask what probability distributions are deliverable to the market at zero cost or equivalently belong to the convex cone of cash flows acceptable to the market. A resulting operational model tests the distribution function for the positivity of an expectation after a concave distortion.

One chooses a concave distribution function on the unit interval, $\Psi(u)$ and X is deliverable to market or acceptable if and only if

$$\int_{-\infty}^{\infty} x \mathrm{d}\Psi(F(x)) \geq 0.$$

For a specific application we need to choose a specific distortion and a first choice, that is quite intuitive takes

$$\Psi(u) = 1 - (1-u)^{1+\gamma}.$$

Positive expectation under this distortion may be easily described. One has a positive expectation under this distortion just if the expectation of the minimum of γ independent draws from the distribution is positive. This distortion is termed $MINVAR$.

However, expectations under a concave distortion are also expectations under a measure change with the measure change being $\Psi'(F(x))$. For x tending to negative infinity and $F(x)$ tending to zero the reweighting induced by this measure change just rises to the finite level of $1+\gamma$. Hence this distortion is too lenient towards large losses and so we formulate an alternative distortion that has $\Psi'(u)$ tending to infinity as u approaches 0 and tends to zero as u approaches unity. The former property we call risk aversion, while the latter we call absence of gain enticement. This is the two parameter distortion called $MINMAXVAR2$ with

$$\Psi^{\lambda,\gamma}(u) = 1 - \left(1 - u^{\frac{1}{1+\lambda}}\right)^{1+\gamma}. \tag{1}$$

The parameter λ calibrates the degree of risk aversion while γ addresses the absence of gain enticement. A class of one parameter distortions including $MINVAR$ and $MINMAXVAR$ were introduced in [3]. The two parameter distortions were employed by Cherny and Madan in [4], and by Madan and Schoutens in [19].

Interestingly, one is free to model different markets using different cones of marketed or acceptable cash flows without fear of introducing arbitrage between the markets. All that is required to keep the ask from one market being crossed by the bid of another market is a nonempty intersection of the set of supporting measures. For our distortions this is guaranteed

Table 1 Absence of gain enticement and loss aversion for different markets

Market	λ	γ
Equity	2.5 %	2.5 %
Debt	10 %	20 %
Convertible	6.25%	11.25 %
Taxpayer	75%	75 %

by the presence of the base measure in all the sets of supporting measures. Hence we can model different markets using different parametric cones.

We will assume, that the firm operates and raises capital in four different markets:

- Equity market (S) : tolerant to losses and enticed by gains;
- Debt market (D) : quite tolerant to losses but not really enticed by gains;
- Convertible Bond Market (C) : moderately tolerate to losses and moderately induced by gains;
- Taxpayers (T) : most loss aversion and highest absence of gain enticement.

In the numerical examples presented, the parameters of Table 1 are assumed.

We may now employ these distortions to obtain practically computable expressions for the ask and bid price as follows. For a cash flow X the ask price a is the smallest value a such that $ae^{rT} - X$ is acceptable or

$$\int_{-\infty}^{\infty} x d\Psi^{\lambda,\gamma}(F_{ae^{rT}-X}(x)) \geq 0 \tag{2}$$

$$\int_{-\infty}^{\infty} x d\Psi^{\lambda,\gamma}\left(F_{-X}(x - ae^{rT}\right) \geq 0 \tag{3}$$

$$\int_{-\infty}^{\infty} (ae^{rT} + y) d\Psi^{\lambda,\gamma}\,(F_{-X}(y)) \geq 0 \tag{4}$$

$$a \geq -e^{-rT} \int_{-\infty}^{\infty} y d\Psi^{\lambda,\gamma}\,(F_{-X}(y)) \tag{5}$$

from which we arrive at the computationally feasible representation:

$$ask(X) = -e^{-rT} \int_{-\infty}^{\infty} x d\Psi^{\lambda,\gamma}(F_{-X}(x)) \tag{6}$$

We now see the ask price directly as the negative of the distorted expectation of the cash flow $-X$. By a similar argument one infers that

$$bid(X) = e^{-rT} \int_{-\infty}^{\infty} x d\Psi^{\lambda,\gamma}\,(F_X(x))\,. \tag{7}$$

Note that if $\lambda = \gamma = 0$, $\Psi^{0,0}(u) = u$ and hence $ask(X) = bid(X)$.

Here the cash-flow of buying X at its bid price is acceptable in the relevant market : $X - bid(X) \in \mathcal{A}$. One can prove that the bid and ask prices of a positive contingent claim X with distribution function $G(x)$, $x \geq 0$ can be calculated as:

$$bid(X) = \int_0^{+\infty} (1 - \Psi^{\lambda,\gamma}(G(x))\mathrm{d}x$$

$$ask(X) = \int_0^{+\infty} \Psi^{\lambda,\gamma}(1 - G(x))\mathrm{d}x$$

The above distortion based closed forms for bid and ask prices appeared in [4]. They were also used to model clientele effects in the markets for debt and equity in [19]. Other applications are described in [14] and [8] where capital requirements were defined using concave distortions and the value of the taxpayer put was evaluated for the major banks. Eberlein et al. in [9] show that valuation of debt liabilities at ask prices using distortions mitigates the problem of profit taking on one's own credit deterioration. Madan and Schoutens in [20] employs these distortions to price and hedge cliquets. Similarly Madan in [17] use these concepts to price and hedge basket options and further in [18], complex claims on multiple underliers are hedged using similar methods. Carr et al. employ in [2] the theory of two price markets to define up front profits on derivative trades along with required capital set asides. Madan goes on in [15] to show that capital minimization as a hedging objective leads to gamma adjusted deltas in markets that are left skewed. The modeling of trading execution costs where prices depend on the size of a trade along with its direction and acceptable risks are modeled by convex sets as opposed to cones is done in [16]. Movements in cone parameters were used to model changing market liquidity by [5]. It is shown there from equity options data on major US indices that the cone of acceptable risks severely contracted at the heat of the crisis in October 2008 pointing to a severe dry-up of liquidity at that period. Eberlein et al. extend this work in [10] to synthesize the modeling of credit and liquidity employing movements in cone parameters to capture liquidity effects while movements in hazard rates capture credit effects. An empirical analysis of options data revealed that the Lehman default was primarily a liquidity effect for the remaining banks. Madan and deJong employ distortions in [6] to redefine risk weighted assets for the computation of capital adequacy ratios as well as showing that the use of equity as capital is erroneous as it incorporates the option to put losses back into the economy as capital. This leads us here to model contingent capital triggers on more fundamental notions of capital and not Core-Tier one ratio.

3 Contingent capital

In this section we discuss a variety of different forms of contingent capital. The main idea is to provide fresh capital in times of stress. This can be achieved in different ways. In a funded or unfunded form, either by bringing in new capital, new equity, canceling debt or by taking over assets and/or liabilities. We start with overviewing the funded notes, next we move to the unfunded case. Funded notes are hybrid kind of debt instrument where an investor buys the note and receives regular coupons until trigger date or maturity which ever is first. In case the trigger is hit, the investor will get instead of the face value, some equity, some assets or liabilities or just only a fraction (or even zero) of the original face value. In case the note matures without being triggered, the investor gets back the face value.

Table 2 Payoff—funded equity for debt coconut

Investor	Payoff in case of no trigger	Payoff in case of trigger
Debt	$\min(V_T, F)$	$\min(V_T, F)$
Convertible	$(\min(V_T - F, F_C))^+$	$\frac{\tilde{N}}{N+\tilde{N}}(V_T - F)^+$
Equity	$\frac{1}{N}(V_T - F - F_C)^+$	$\frac{1}{N+\tilde{N}}(V_T - F)^+$

Later on, we elaborate on the pricing of some of these notes in detail. Here we describe the payoff of these notes in a simplified capital structure. We assume that the firm holds some capital and has invested in risky assets and moreover also has some risky liabilities. Denote the firm value by $V = \{V_t, t \geq 0\}$. V_0 is then the initial value of the firm. The firm's liquidation value at time T is

$$(M \exp(rT) + A_T - L_T)^+$$

and the firm value at time $0 \leq t < T$ equals

$$V_t = E_Q[(M \exp(rT) + A_T - L_T)^+ | \mathcal{F}_t],$$

where M is the capital put aside at time zero; $A = \{A_t, t \geq 0\}$ is the risky asset price process and $L = \{L_t, t \geq 0\}$ is the risky liability price process. The firm typically will have issued some ordinary debt and some equity. In case of contingent or junior debt, we assume that ordinary debt holders have a higher seniority than contingent debt holders, which are more senior than equity holders.

3.1 Funded coconuts

3.1.1 Funded equity for debt coconut

In case of being triggered, the holder of the *funded equity for debt coconut* gets new equity, but will not receive back the face value of the note (nor any further coupons). Here there is a clear dilution effect, because new equity is created. The Lloyd's deal is a clear example of such structure.

We analyze this case in a zero-coupon-bond (ZCB) structure. We assume ordinary ZCB debt's face value is given by F and contingent capital's (ZCB) face value is F_C. Assume, for the sake of the illustration, that the maturity for both debt forms is T. In case of triggering, we assume that at time zero we have N stocks and in case of being triggered $\tilde{N}$ new stocks are issued.

The cash flow at time T of ordinary bond holders is $\min(V_T, F)$. The ordinary bond holder has the highest seniority. Next comes, the coconutholder and hence the payoff of coconut holder is : $(\min(V_T - F, F_C))^+$ if no conversion took place and equals in case of the conversion $\frac{\tilde{N}}{N+\tilde{N}}(V_T - F)^+$. This is the typical equity payoff with a factor $\frac{\tilde{N}}{N+\tilde{N}}$ taking into account the dilution effect. An equity holder has per stock either the payoff $\frac{1}{N}(V_T - F - F_C)^+$ in case of no conversion of the coconut and $\frac{1}{N+\tilde{N}}(V_T - F)^+$ in case a conversion took place before maturity time T. We give a survey of these payoffs in Table 2. An overview of the main ingredients at time zero and at maturity in case of trigger and no trigger are given in Table 3; here the outstanding debt (with or without being triggered) indicates the maturing face value.

Table 3 Overview—funded equity for debt coconut

	At time zero	At time T in case of no trigger	At time T in case of trigger
Number of stock	N	N	$N + \tilde{N}$
Capital	M	$\exp(rT)M$	$\exp(rT)M$
Risky Assets	A_0	A_T	A_T
Risky Liabilities	L_0	L_T	L_T
Ordinary debt	F	F	F
Contingent debt	F_C	F_C	0

Table 4 Payoff—funded debt reduction coconut

Investor	Payoff in case of no trigger	Payoff in case of trigger
Debt	$\min(V_T, F)$	$\min(V_T, F)$
Convertible	$(\min(V_T - F, F_C))^+$	$(\min(V_T - F, \kappa F_C))^+$
Equity	$\frac{1}{N}(V_T - F - F_C)^+$	$\frac{1}{N}(V_T - F - \kappa F_C)^+$

Table 5 Overview—funded debt reduction coconut

	At time zero	At time T in case of no trigger	At time T in case of trigger
Number of stock	N	N	N
Capital	M	$\exp(rT)M$	$\exp(rT)M$
Risky Assets	A_0	A_T	A_T
Risky Liabilities	L_0	L_T	L_T
Ordinary debt	F	F	F
Continent debt	F_C	F_C	κF_C

3.1.2 Funded debt reduction coconut

In case of being triggered, the holder of the *funded debt reduction coconut* just looses all or part of its face value, but doesn't receive any equity (nor any further coupons). Here there is no dilution effect, because no new equity is created. The Rabobank deal is an example of such structure.

The cash flow at time T of ordinary bond holders is $\min(V_T, F)$. The cash flow of coconut holder is : $(\min(V_T - F, F_C))^+$ if no conversion took place and in case of being triggered the holder receives $(\min(V_T - F, \kappa F_C))^+$, with $0 \leq \kappa < 1$. An equity holder has per stock either the payoff $\frac{1}{N}(V_T - F - F_C)^+$ in case of no conversion of the coconut and $\frac{1}{N}(V_T - F - \kappa F_C)^+$ in case the coconut has been triggered before maturity T (Tables 4 and 5).

3.1.3 Funded troubled asset reduction coconut

In case of being triggered, the holder of the *funded troubled asset reduction coconut* gets instead of his face value, a fraction $0 < \kappa \leq 1$ of the assets, (which are assumed to have low value). κ could be for example F_C/A_0. Here there is no dilution effect, because no new

Table 6 Payoff—funded troubled asset reduction coconut

Investor	Payoff in case of no trigger	Payoff in case of trigger
Debt	$\min((M\exp(rT) + A_T - L_T)^+, F)$	$\min((M\exp(rT) + (1-\kappa)A_T - L_T)^+, F)$
Convertible	$\min((M\exp(rT) + A_T - L_T - F)^+, F_C)$	κA_T
Equity	$\frac{1}{N}(M\exp(rT) + A_T - L_T - F - F_C)^+$	$\frac{1}{N}(M\exp(rT) + (1-\kappa)A_T - L_T - F)^+$

Table 7 Overview—funded troubled asset reduction coconut

	At time zero	At time T in case of no trigger	At time T in case of trigger
Number of stock	N	N	N
Capital	M	$\exp(rT)M$	$\exp(rT)M$
Risky Assets	A_0	A_T	$(1-\kappa)A_T$
Risky Liabilities	L_0	L_T	L_T
Ordinary debt	F	F	F
Contingent debt	F_C	F_C	0

equity is created. The coconut outstanding debt is canceled. This note is very similar to the TARP or bad bank construction, where troubled assets are transferred, here to the coconut holder in return for the cancelation of the outstanding debt.

We now have that the firm's value $V_T = (M\exp(rT) + A_T - L_T)^+$, if no conversion took place and equals $V_T = (M\exp(rT) + (1-\kappa)A_T - L_T)^+$ in case of being triggered. The cash flow at time T of ordinary bond holders is $\min(V_T, F)$, with $V_T = (M\exp(rT) + A_T - L_T)^+$ in case of no trigger and $V_T = (M\exp(rT) + (1-\kappa)A_T - L_T)^+$ if the coconut has been triggered; The cash flow of coconut holder is : $(\min(V_T - F, F_C))^+$ in case of no trigger ($V_T = (M\exp(rT) + A_T - L_T)^+$) and κA_T in case of triggering. An equity holder has per stock the payoff $\frac{1}{N}(M\exp(rT) + A_T - L_T - F - F_C)^+$ in case of no trigger and $\frac{1}{N}(M\exp(rT) + (1-\kappa)A_T - L_T - F)^+$. We see here that the trigger affects ordinary debt holders as well as the contingent debt holders and the equity holders (Tables 6 and 7).

3.2 Unfunded coconuts

3.2.1 Unfunded equity for cash coconut

In case of being triggered, the holder of the *unfunded equity for cash coconut* gets new equity in return for cash. The deal is similar to a CDS, but in case of being triggered new equity is transferred for cash. This cash amount can come along with a periodic fee payment during the life time of the deal.

The cash flow of coconut holder is : $\exp(rT)C$, if no conversion took place and where C is the present value of the periodically paid fees. In case of the conversion the coconut holder gets $\frac{\tilde{N}}{N+\tilde{N}}((M+\tilde{M})\exp(rT) + A_T - L_T - F)^+ - \exp(rT)\tilde{M}$, where $\tilde{N}$ is the number of new stocks and $\tilde{M}$ is the present value of agreed cash injection net the fee payments.

The payoff at time T of ordinary bond holders is $\min(V_T, F)$, with $V_T = (M - C)\exp(rT) + A_T - L_T$ in case of no triggering and $V_T = (M + \tilde{M})\exp(rT) + A_T - L_T$ in case of triggering.

Table 8 Payoff—unfunded equity for cash coconut

Investor	Payoff in case of no trigger	Payoff in case of trigger
Debt	$\min(((M-C)\exp(rT)+A_T-L_T)^+, F)$	$\min(((M+\tilde{M})\exp(rT)+A_T-L_T)^+, F)$
Convertible	$\exp(rT)C$	$\frac{\tilde{N}}{N+\tilde{N}}((M+\tilde{M})\exp(rT)+A_T-L_T-F)^+$ $-\exp(rT)\tilde{M}$
Equity	$\frac{1}{N}((M-C)\exp(rT)+A_T-L_T-F)^+$	$\frac{1}{N+\tilde{N}}((M+\tilde{M})\exp(rT)+A_T-L_T-F)^+$

Table 9 Overview—unfunded equity for cash coconut

	At time zero	At time T in case of no trigger	At time T in case of trigger
Number of stock	N	N	$N+\tilde{N}$
Capital	M	$\exp(rT)(M-C)$	$\exp(rT)(M+\tilde{M})$
Risky Assets	A_0	A_T	A_T
Risky Liabilities	L_0	L_T	L_T
Ordinary debt	F	F	F

An equity holder has per stock either the payoff $\frac{1}{N}((M-C)\exp(rT)+A_T-L_T-F)^+$ in case of no conversion of the coconut and $\frac{1}{N+\tilde{N}}((M+\tilde{M})\exp(rT)+A_T-L_T-F)^+$ in case a conversion took place before maturity time T. We note that the coconut holder can have a negative cash-flow at maturity (Tables 8 and 9).

3.2.2 Unfunded debt coconut

In case of being triggered, the holder of the *unfunded debt coconut* gets new junior debt in return for cash. The deal is similar to a CDS, but in case of being triggered new junior debt is transferred for cash. This cash amount can come along with a periodic fee payment during the life time of the deal.

The payoff at time T of ordinary bond holders is $\min(V_T, F)$, with $V_T = (M-C)\exp(rT)+A_T-L_T$ in case of no triggering and $V_T = (M+\tilde{M})\exp(rT)+A_T-L_T$ in case of triggering and where C and $\tilde{M}$ are the present value of the periodically paid fees and the present value of agreed cash injection respectively net the fee payments. The payoff for the coconut holder is : $\exp(rT)C$, if no conversion took place. In case of the conversion the coconut holder gets $(\min((M+\tilde{M})\exp(rT)+A_T-L_T-F, F_J))^+ - \exp(rT)M$, where F_J is the amount of junior debt and $\tilde{M}$ is the present value of agreed cash injection net the fee payments. An equity holder has per stock either the payoff $\frac{1}{N}((M-C)\exp(rT)+A_T-L_T-F)^+$ in case of no conversion of the coconut and $\frac{1}{N}((M+\tilde{M})\exp(rT)+A_T-L_T-F-F_J)^+$ in case a conversion took place before maturity time T (Tables 10 and 11).

3.2.3 Unfunded troubled asset reduction coconut

In case of being triggered, the holder of the *unfunded troubled asset reduction coconut* gets in return for cash, a fraction $0<\kappa\leq 1$ of the assets, (which are assumed to have low value). The deal is similar to a CDS, but in case of being triggered, troubled assets are transferred

Table 10 Unfunded debt coconut

Investor	Payoff in case of no trigger	Payoff in case of trigger
Debt	$\min((M - C)\exp(rT) + A_T - L_T, F)$	$\min((M + \tilde{M})\exp(rT) + A_T - L_T, F)$
Convertible	$\exp(rT)C$	$(\min((M + \tilde{M})\exp(rT) + A_T - L_T - F, F_J))^+$
Equity	$\frac{1}{N}((M - C)\exp(rT) + A_T - L_T - F)^+$	$\frac{1}{N}((M + \tilde{M})\exp(rT) + A_T - L_T - F - F_J)^+$

Table 11 Overview—unfunded debt reduction coconut

	At time zero	At time T in case of no trigger	At time T in case of trigger
Number of stock	N	N	N
Capital	M	$\exp(rT)(M - C)$	$\exp(rT)(M + \tilde{M})$
Risky Assets	A_0	A_T	A_T
Risky Liabilities	L_0	L_T	L_T
Ordinary debt	F	F	F
Junior debt	0	0	F_J

Table 12 Payoff—unfunded troubled asset reduction coconut

Investor	Payoff in case of no trigger	Payoff in case of trigger
Debt	$\min((M - C)\exp(rT) + A_T - L_T, F)$	$\min((M + \tilde{M})\exp(rT) + (1 - \kappa)A_T - L_T, F)$
Convertible	$\exp(rT)C$	$\kappa A_T - \exp(rT)\tilde{M}$
Equity	$\frac{1}{N}((M - C)\exp(rT) + A_T - L_T - F)^+$	$\frac{1}{N}((M + \tilde{M})\exp(rT) + (1 - \kappa)A_T - L_T - F)^+$

for cash. This cash amount can come along with a periodic fee payment during the life time of the deal. Here there is no dilution effect, because no new equity is created. This note is a kind of TARP swap.

We now have that the firm's value $V_T = ((M - C)\exp(rT) + A_T - L_T)^+$, in case of no trigger and $V_T = ((M + \tilde{M})\exp(rT) + (1 - \kappa)A_T - L_T)^+$ in case of being trigger, where C and $\tilde{M}$ are the present value of the periodically paid fees and the present value of agreed cash injection respectively net the fee payments.

The cash flow at time T of ordinary bond holders is $\min(V_T, F)$, with V_T as given above in case of trigger and no trigger. The cash flow for the coconut holder is : $\exp(rT)C$ in case of no trigger and $\kappa A_T - \exp(rT)M$ in case of triggering. An equity holder has per stock the payoff $\frac{1}{N}(V_T - F)^+$, with V_T again as given above in case of trigger and no trigger (Tables 12 and 13).

3.2.4 Unfunded liabilities reduction coconut

In case of being triggered, the holder of the *unfunded liabilities reduction coconut* gets, a fraction $0 < \kappa \leq 1$ of the liabilities; in return he gets a (periodic) fee. Here there is no dilution effect, because no new equity is created. This note is a kind of TARP swap, but now on the liabilities side.

Table 13 Overview—unfunded troubled asset reduction coconut

	At time zero	At time T in case of no trigger	At time T in case of trigger
Number of stock	N	N	N
Capital	M	$\exp(rT)(M-C)$	$\exp(rT)(M+\tilde{M})$
Risky Assets	A_0	A_T	$(1-\kappa)A_T$
Risky Liabilities	L_0	L_T	L_T
Ordinary debt	F	F	F

Table 14 Payoff—unfunded liabilities reduction coconut

Investor	Payoff in case of no trigger	Payoff in case of trigger
Debt	$\min((M-C)\exp(rT)+A_T-L_T, F)$	$\min((M-C)\exp(rT)+A_T-(1-\kappa)L_T, F)$
Convertible	$\exp(rT)C$	$\exp(rT)C-\kappa L_T$
Equity	$\frac{1}{N}((M-C)\exp(rT)+A_T-L_T-F)^+$	$\frac{1}{N}((M-C)\exp(rT)+A_T-(1-\kappa)L_T-F)^+$

Table 15 Overview—unfunded liabilities reduction coconut

	At time zero	At time T in case of no trigger	At time T in case of trigger
Number of stock	N	N	N
Capital	M	$\exp(rT)(M-C)$	$\exp(rT)(M-C)$
Risky Assets	A_0	A_T	A_T
Risky Liabilities	L_0	L_T	$(1-\kappa)L_T$
Ordinary debt	F	F	F

We now have that the firm's value $V_T = ((M-C)\exp(rT)+A_T-L_T)^+$, in case of no trigger and $V_T = ((M-C)\exp(rT)+A_T-(1-\kappa)L_T)^+$ in case of being trigger, where C is the present value of the periodically paid fees.

The cash flow at time T of ordinary bond holders is $\min(V_T, F)$, with V_T as given above in case of trigger and no trigger. The cash flow of the coconut holder is: $\exp(rT)C$ in case of no trigger and $\exp(rT)C-\kappa L_T$ in case of triggering. An equity holder has per stock the payoff $\frac{1}{N}(V_T-F)^+$, with V_T again as given above in case of trigger and no trigger (Tables 14 and 15).

4 Contingent capital pricing

4.1 Trigger ratio

The Lloyds coconut and some others use the Core-Tier 1 ratio as the trigger. Essentially this level is based on the ratio of equity to (risk weighted) assets. Risk-weighted assets are the total of all assets held by the bank which are weighted for credit risk (according to a formula determined by the regulators).

Table 16 Simple balance sheet

Assets		Liabilities	
Risky Assets A	10	Risky Liabilities L	15
Capital M	7	Equity J	2
Total	17	Total	17

For us risk weighted assets are just assets marked at bid and the risk weighting is equivalent to the shaving of value done by bid prices relative to prices. We note in this context that risk weighted assets in the Basel computations include risky liabilities at a market value plus and add on that deJong and Madan [6] take to be in total the ask price of risky liabilities. For an all-equity firm with risky assets risk weighted at A and equity at J with zero debt we have a balance sheet showing risk weighted liabilities marked at ask and cash reserves M. Later on we will introduce and elaborate more on some more "advanced" balance sheets, but for the sake of the next argument we will use the simple balance sheet as in Table 16. We have $M + A = L + J$.

The Core Tier 1 ratio could be $J/(M + A) = 2/17 = 11.76\%$ and this could be perceived as totally fine but the firm could be in trouble as $A - L = -5$, and default occurs when $A - L = -7$ (because $M = 7$). Hence the "distance to default" is $2(= J)$.

The volatility under zero correlation is proportional to $A + L = 25$ and $J/(A + L) = 8\%$ and with an 8% volatility we are hence only one standard deviation from default.

We therefore argue that the trigger of a contingent capital note in order to be effective should better be set on the basis of the required capital. We hence introduce the notion of require capital and capital shortfall. The former is the capital needed to set up limited liability at a given time, the later is the positive part of the difference of this number with the actual capital held. If this deviates too much (below governed by the grace parameter β) the coconut is triggered. In the light of this discussion, we note that balance sheets should therefore also report on the asset side the capital shortfall. On the liability side this equivalent amount could resort under the heading *grace equity*.

4.2 Conic finance pricing

We now analyze how limited liability firms should be set up and how their capital structure is formed. We will at the end have a firm that has issued normal debt, contingent capital debt and equity. We assume that assets are risky as usual but now also that we have risky liabilities. Key in the argument is that we abandon the one-price-market idea and assume that there are bid-ask spreads (related to the liquidity of the market) as explained in the Sect. 2. We hence will make extensive use of the theory of acceptability and distorted expectations.

First we determine the capital required for existence. Remark that the classical Mertonian firm has no need for capital reserves. Throughout the paper an example will be used based on correlated geometrical Brownian motions, but the theory can be readily applied for other (e.g. fat-tailed) models as well. Assume we want to set-up a firm with risky assets A and risky liabilities L. We will denote with A_t the value of the assets at time t and with L_t the value of the liabilities at time t. $A = \{A_t, t \geq 0\}$ and $L = \{L_t, t \geq 0\}$ are (dependent) stochastic processes. For the example, we take $A_0 = 100$; $L_0 = 90$ and

$$A_t = A_0 \exp\left((r - \sigma_A^2/2)t + \sigma_A W_t\right) \quad \text{and} \quad L_t = L_0 \exp\left((r - \sigma_L^2/2)t + \sigma_L \tilde{W}_t\right),$$

where $\sigma_A = \sigma_L = 25\%, r = 3\%$ and $W = \{W_t, t \geq 0\}$ and $\tilde{W} = \{\tilde{W}_t, t \geq 0\}$ are two standard Brownian motions with correlation parameter equal to $\rho = 50\%$.

The regulatory body granting limited liability has to set the capital M^* such that the firm's total cash-flow is acceptable to the tax-payer (with e.g. a one-year horizon : $T = 1$). Therefore M^* is set such that

$$\exp(rT)M^* + A_T - L_T \in \mathcal{A}_T,$$

where $\mathcal{A}_T$ is the set of acceptable risk maturing at time T.

M is calculated by distorted expectation:

$$M^* = ask(L_T - A_T)$$

This value M^* is dependent of course on the stochastic processes chosen for the risky assets and liabilities. Under the chosen model (here the geometrical Brownian motions) it can be seen as a function of the model parameters (interest rate r, the volatilities of the risky assets and liabilities σ_A and σ_L and the correlation parameterρ), the preset maturity ($T = 1$) and the start ($t = 0$) values of the risky assets and liabilities, resp. given by A_0 and L_0. To stress the dependency on the later, we will later on therefore write $M(A_0, L_0)$. Actually, we will be recalculating the value for the newly revealed A_t and L_t's at certain points t in time (using the same parameter and maturity assumptions). If we just write M^*, we always refer to $M(A_0, L_0)$.

The firm will approach the equity market which has final limited liability cash flow

$$V_T = (M^* \exp(rT) + A_T - L_T)^+;$$

Using distorted expectation we calculate the bid and ask price in the equity market of this cash flow. We receive the bid (bJ) and mark the liability at ask (aJ). The "all-equity' firm comes into existence provided

$$M^* + A_0 - L_0 + aJ - bJ \leq bJ;$$

The option to put losses back to the taxpayer has payoff

$$(-M^* \exp(rT) - A_T + L_T)^+.$$

This is an asset of the firm to be valued at the bid price and is called the Taxpayer put option (see [8]).

Assume we have a firm that can exist as an all equity firm. Next, we consider the debt issuing. We assume two kinds of debt will be issued. First classical debt, a pure zero coupon bond with face value F maturing at T and secondly, a contingent equity for debt note with face value F_C (no coupons), which in case the conversion trigger is hit, converts into equity. Assume there are N numbers of stock issued for the moment; at the time there is a conversion αN new stocks are issued and we have a dilution effect. We assume there are a number of trigger dates, $t_i, i = 1, \ldots, n$ (in the example quarterly), on these dates one checks if the firm needs extra capital. The conversion happens the first time

$$(1 + \beta)M^* \exp(rt_i) < M(A_{t_i}, L_{t_i}).$$

This means, that if we would re-calculate at the monitor date t_i the required capital needed to be granted limited liability, it can not deviate too much (governed by the grace parameter $\beta > 0$) from the original capital held. To be precise $(1 + \beta)$ times the original capital M^* should suffice otherwise a conversion of the debt into equity occurs.

Table 17 Bid and ask prices funded notes

	Funded Bid	Equity for debt Ask	Funded Bid	Debt R. $\kappa = 0$ Ask	Funded Bid	TAR $\kappa = 5\%$ Ask
Equity	26.29	29.45	26.31	29.47	26.26	29.42
Debt	51.37%	66.50 %	51.37 %	66.50 %	51.23 %	66.39 %
Convertible	48.95 %	58.76 %	48.52 %	58.22 %	58.22 %	68.28 %

Table 18 Bid and ask prices unfunded notes

	Unfunded Bid	Equity for cash Ask	Unfunded Bid	TAR $\kappa = 5\%$ Ask	Unfunded Bid	TLR $\kappa = 5\%$ Ask
Equity	27.47	30.98	28.79	32.14	28.79	32.14
Debt	50.09 %	65.47 %	50.24 %	65.60 %	50.17 %	65.54 %
Convertible	0.32	1.02	0.89	1.37	0.85	1.37

The cash flow at time T of ordinary bond holders is $\min(V_T, F)$. The cash flow of coconut holder is : $(\min(V_T - F, F_C))^+$ if no conversion took place and equals in case of the conversion $\frac{\alpha}{1+\alpha}(V_T - F)^+$. This is the typical equity payoff with a factor $\alpha/1+\alpha$ taking into account the dilution effect (governed by the parameter α, the conversion factor). Equity holders have either the payoff $(V_T - F - F_C)^+$ in case of no conversion of the coconut and $\frac{1}{1+\alpha}(V_T - F)^+$ in case a conversion took place before maturity time T.

These cash flows have bid prices (bD, bC, bE) and ask prices (aD, aC, aE), which are calculated as in Sect. 2. We incorporate the fact that the market to which the cash-flow belongs are different by using different distortion functions reflecting the difference of loss aversions and absence of gain enticements among the three markets.

For these issues the funds raised must cover the cost and we require that

$$M^* + A_0 - L_0 + (aD - bD) + (aC - bC) + (aE - bE) \le bD + bC + bE$$

A similar pricing can be done for the other variations of the coconuts described in Sect. 3, by replacing the above payoff formulas with the corresponding ones.

As illustration, we show the pricing of the funded notes in Table 17 and the unfunded ones in Table 18. We assume $F = 10$, $F_C = 5$, $T = 5$ years, $\alpha = 10\%$, $\beta = 6$, $C = 2$ and $\tilde{M} = 10$. The prices of the debt instruments are given as percentage of the face value. For the convertible this is also the case for funded notes, but for unfunded notes is just given in currency units. The probability the coconuts are converted, with the given grace parameter, is around 10%.

5 Analysis

Next, we investigate the sensitivity of the dilution factor α and the grace factor β to the pricing of a equity for debt funded note.

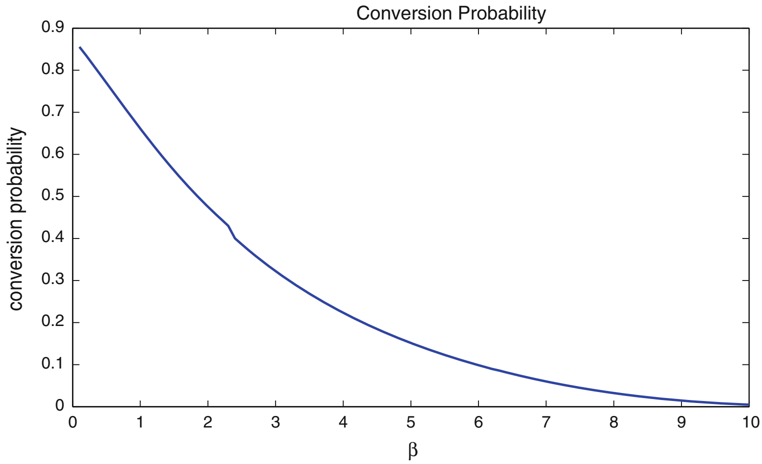

Fig. 1 Conversion probabilities for a range of β values

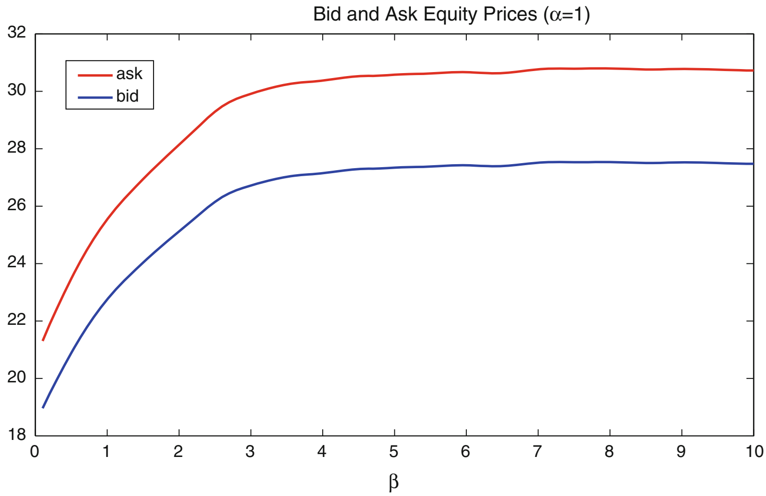

Fig. 2 Effect of β on equity price

In Fig. 1 we have plotted the conversion probability for a range of β values. We clearly see that increasing β decreases the probability that a conversion will take place. We note that the conversion probability is independent from the dilution parameter α.

In Fig. 2 we show the effect of β (which is controlling the conversion probability) on the equity prices. We plot both bid and ask prices. We observe that the more unlikely conversion is, the higher the equity price. This is very natural because the probability of being diluted as equity holder then becomes smaller.

In Fig. 3 we see the dilution effect (α) on the price of the convertible. We observe that the price increases the more equity one obtains in case of a conversion. We note that as can be expected we don't see any effect on the ordinary bond price. For low and moderate α, the convertible price is lower than the ordinary bond price reflexing a high risk and hence

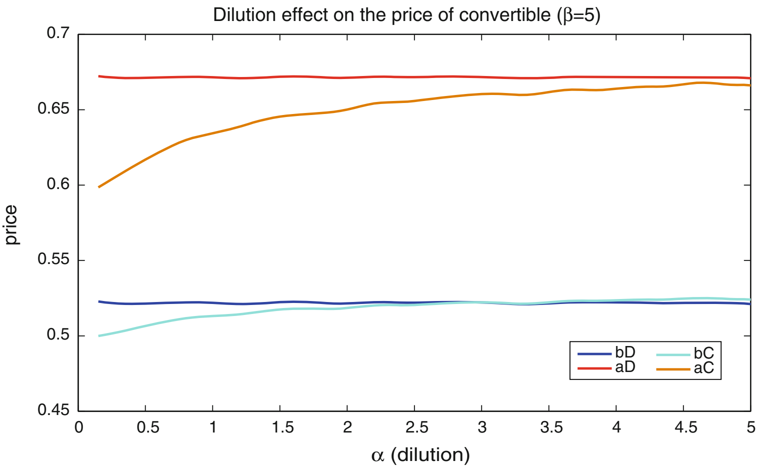

Fig. 3 Dilution effect on bond prices. ($\beta = 5$)

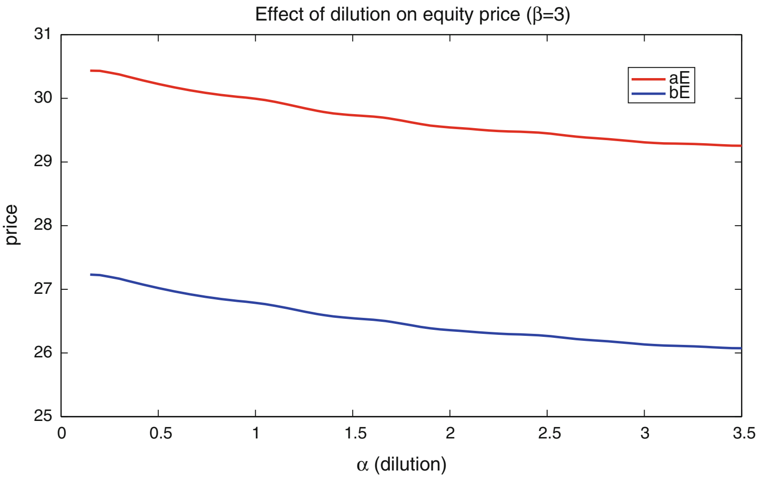

Fig. 4 Dilution effect on equity price. ($\beta = 3$)

a higher yield. However, for extreme high α, we see that the bid price of the convertible is actually higher than the bond's bid, because the high amount of stock the convertible holder gets in case of conversion.

In Fig. 4 we see the dilution effect (α) on the price of the equity. We observe that the price decrease since as equity holder one gets more diluted.

Appendix: Conic corporate balance sheets

In this appendix, we show how balance sheets as developed in [19] are now extended with contingent capital instruments. As discussed above, we also argue that balance sheets should report on the asset side the capital shortfall and on the liability side an equivalent amount as grace equity. In the balance sheets below both numbers are equal to zero; we report balance sheets at initiation when there is by construction no capital shortfall. However, as time progresses, capital shortfall can become positive. See Tables 19, 20, 21, 22, 23, 24.

Table 19 Funded equity for debt coconut balance sheet

Assets		Liabilities	
Risky Assets A_0	100	Risky Liabilities L_0	90
Capital M	16.63		
Taxpayer Put bP	9.63		
Cost of Equity $aE - bE$	3.28	Equity aE	30.65
Cost of Debt $aD - bD$	1.51	Debt aD	6.66
Cost of Coco $aC - bC$	0.48	Coco aD	2.96
		Synthetic Equity	1.27
Total	131.53	Total	131.53

Table 20 Funded debt reduction coconut balance sheet

Assets		Liabilities	
Risky Assets A_0	100	Risky Liabilities L_0	90
Capital M	16.63		
Taxpayer Put bP	9.63		
Cost of Equity $aE - bE$	3.28	Equity aE	30.66
Cost of Debt $aD - bD$	1.51	Debt aD	6.66
Cost of Coco $aC - bC$	0.48	Coco aD	2.94
		Synthetic Equity	1.26
Total	131.53	Total	131.53

Table 21 Funded asset reduction coconut balance sheet

Assets		Liabilities	
Risky Assets A_0	100	Risky Liabilities L_0	90
Capital M	16.63		
Taxpayer Put bP	10.03		
Cost of Equity $aE - bE$	3.28	Equity aE	30.62
Cost of Debt $aD - bD$	1.51	Debt aD	6.65
Cost of Coco $aC - bC$	0.49	Coco aD	3.43
		Synthetic Equity	1.24
Total	131.94	Total	131.94

Table 22 Unfunded cash for equity coconut balance sheet

Assets		Liabilities	
Risky Assets A_0	100	Risky Liabilities L_0	90
Capital M	16.63		
Taxpayer Put bP	9.04		
Cost of Equity $aE - bE$	3.35	Equity aE	32.17
Cost of Debt $aD - bD$	1.53	Debt aD	6.57
Cost of Coco $aC - bC$	0.70	Coco aD	1.02
		Synthetic Equity	1.47
Total	131.25	Total	131.25

Table 23 Unfunded TAR coconut balance sheet

Assets		Liabilities	
Risky Assets A_0	100	Risky Liabilities L_0	90
Capital M	16.63		
Taxpayer Put bP	9.42		
Cost of Equity $aE - bE$	3.25	Equity aE	32.14
Cost of Debt $aD - bD$	1.54	Debt aD	6.56
Cost of Coco $aC - bC$	0.48	Coco aD	1.37
		Synthetic Equity	1.34
Total	131.42	Total	131.42

Table 24 Unfunded TLR coconut balance sheet

Assets		Liabilities	
Risky Assets A_0	100	Risky Liabilities L_0	90
Capital M	16.63		
Taxpayer Put bP	9.39		
Cost of Equity $aE - bE$	3.36	Equity aE	32.14
Cost of Debt $aD - bD$	1.54	Debt aD	6.55
Cost of Coco $aC - bC$	0.52	Coco aD	1.37
		Synthetic Equity	1.37
Total	131.43	Total	131.43

References

1. Bond, Ph., Goldstein, I., Prescott, E.S.: Market-based corrective actions. Rev. Financ. Stud. (2009)
2. Carr, P., Madan, D.B., Vicente Alvarez, J.J.: Markets, profits, capital, leverage and return. Working Paper, Robert H. Smith School of Business. SSRN report. http://ssrn.com/abstract=1679503 (2010)
3. Cherny, A., Madan, D.B.: New measures of performance evaluation. Rev. Financ. Stud. **22**, 2571–2606 (2009)
4. Cherny, A., Madan, D.B.: Markets as a counterparty: an introduction to conic finance. Int. J. Theor. Appl. Finance. **13**(8), 1149–1177 (2010)

5. Corcuera, J.M., Guillaume, F., Madan, D.B., Schoutens.: Implied liquidity towards stochastic liquidity modeling and liquidity trading. EURANDOM Report, SSRN report. http://ssrn.com/abstract=1679503 (2010)
6. de Jong, K., Madan, D.B.: Capital adequacy of financial institutions. Working Paper, Robert H. Smith School of Business (2010)
7. De Spiegeleer, J., Schoutens, W.: The Handbook of Convertible Bonds—Pricing, Strategies and Risk Management. Wiley, New York (2011)
8. Eberlein, E., Madan, D.B.: Unbounded liabilities, capital requirements, and the value of the taxpayer put option. Working Paper, Robert H. Smith School of Business. SSRN report. http://ssrn.com/abstract=1540813 (2010)
9. Eberlein, E., Gehrig, T., Madan, D.B.: Pricing to acceptability: with applications to valuing one's own credit risk. Working Paper, Robert H. Smith School of Business. SSRN report. http://ssrn.com/abstract=1540778 (2010)
10. Eberlein, E., Madan, D.B., Schoutens, W.: Capital requirements, the option surface, market liquidity and credit risk. Working Paper, Robert H. Smith School of Business (2010)
11. Flannery, M.J.: No pain, no gain? Effecting market discipline via reverse convertible debentures. In: Scott, H.S. (ed.) Chapter 5 of Capital Adequacy beyond Basel: Banking, Securities, and Insurance. Oxford: Oxford University Press (2005)
12. Goodhart, C.A.: Are CoCos from Cloud Cuckoo-Land? VoxEU, June, 10, 2010. http://www.voxeu.org/index.php?q=node/5159 (2010)
13. MacDonald, R.L.: Contingent capital with a dual price trigger. working paper, Kellogg School of Management, Northwestern University. SSRN report. http://ssrn.com/abstract=1553430 (2010)
14. Madan, D.B.: Capital requirements, acceptable risks and profits. Quant. Finance **9**, 767–773 (2009)
15. Madan, D.B.: Conserving capital by adjusting deltas for gamma in the presence of skewness. J. Risk Financ. Manag. to appear (2010)
16. Madan, D.B.: Execution costs and efficient execution frontiers. Ann. Financ. Econ. to appear (2010)
17. Madan, D.B.: Pricing and hedging basket options to a prespecified level of acceptability. Quant. Finance **10**, 607–615 (2010)
18. Madan, D.B.: Joint risk-neutral laws and hedging. Trans. Inst. Ind. Eng. to appear (2010)
19. Madan, D.B., Schoutens, W.: Conic financial markets and corporate finance. EURANDOM Report 2010-009. SSRN report. http://ssrn.com/abstract=1547022 (2010)
20. Madan, D.B., Schoutens, W.: Simple processes and the pricing and hedging of cliquets. Math. Finance to appear (2010)
21. Maes, S., Schoutens, W.: Contingent capital: an in-depth discussion. SSRN report. http://ssrn.com/abstract=1653877 (2010)
22. Schoutens, W.: The pricing of contingent capital notes. In: ICBI Global Derivatives Trading & Risk Management 2010 Presentation. Paris, France (2010)
23. Viral, V.A., Cooley, T., Richardson, M., Walter, I.: Real time solutions for financial reform. An NYU Stern Working Group on Financial Reform (2009)