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KAP 414
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"Contingent Capital with Endogenous Trigger"

Abstract: We examine a model of a dynamic economy in which the lenders become, by enforcement, share owners when a predetermined trigger event documented in the contract between the lenders and the borrowers occurs. We characterize the sufficient as well as necessary condition in the contract design under which there exists unique equilibrium. We present the unique dynamic equilibrium price process for both debt and common stock precisely. The dynamic interaction between liquidation, automatically debt conversion, and go-on within the original capital structure turns out to be an efficient mechanism by which both the borrowers and lenders can be benefited, the borrower's risk-taking incentive is controlled, and the cost of financial distress is reduced. Therefore, our model demonstrates positively some key components in the recent regulatory effort to address the "too big to fail" issue.

Contingent Capital with Endogenous Trigger

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October 8, 2012

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Topics

- ▶ What is Contingent Capital?
- ▶ Why Contingent Capital?
- ▶ Examples and Design of Contingent Capital Debt
- ▶ Objective and Relevant Literature
- ▶ A Basic Model
- ▶ A Full Model
- ▶ Discussions
- ▶ Conclusions

What is Contingent Capital?

Contingent Capital (CC) is a debt security that will be automatically converted into equity when a **pre-determined trigger event** occurs. It is a junior debt. The “trigger event” depends on one of the following three measures: “Capital-based”, “Regulatory discretion-based”, and “Market-based”.

Examples

Examples of Trigger Event:

- ▶ Equity price falls below a specific level; (market-based)
- ▶ Capital ratio fall below a specific level; (capital-based)
- ▶ Credit rating drops to a specific level; (market-based)
- ▶ Stress tests from supervisor do not meet some standard; (Regulatory discretion-based)
- ▶ Systematic market factors have been adversely changed;(Regulatory discretion-based)
- ▶ Pre-determined condition on financial sectors (or the banking system) are satisfied;
- ▶ two or more than two conditions above...

A new kind of debt instrument

Typically, Debt investors receive interest payment and initial investment. They have no control right. Equity investors are owners of the firm. In **convertible debt instrument**, debt investor has option to become share holder (in a **good**) business environment).

In CC, debt investor **must be** share holder in a **“bad”** business environment. CC emerged as a possible solution to the “too big to fail” problem.

Why Contingent Capital?

CC provides an “automatic” mechanism for increasing equity capital and reducing debt of a financial institution in times of stress.

Regulatory's Perspective

- ▶ Systemically important financial institutions (SIFI) could be required to issue contingent capital, such as debt-like securities that convert to common equity... (Ben S. Bernanke)
- ▶ Contingent capital would have been converted automatically into common equity If these contingent buffers were large, then the worse aspects of the banking crisis might have been averted. (William C. Dudley)
- ▶ More prudent corporate governance on the bank (shareholder's dilution concern and debtholder's conversion concern).

From Bank's Perspective

- ▶ Before conversion, CC could be a nondilutive source of capital for existing shareholders, so corporate control has not been changed at the issuance
- ▶ It might be cheaper
- ▶ It might be acceptable as Pillar 2 capital for supervisory stress tests

Swiss Contingent Capital Proposal (Oct 4, 2010)

- ▶ Total capital to 19 percent
- ▶ 10 percent in Common Equity Tier 1
- ▶ 9 percent in contingent-convertible bonds (CC), including 3 percent with a high level triggers, and 6 percent with a low level trigger
- ▶ Basel II, 8%; Basel III, 10.5% (4.5 % for common share, 6% Tier 1 capital ration). See next slide.

Regulatory Capital Requirement

- ▶ Basel III-Contingent capital requirement (the capital ratio might be greater than 13% by increasing contingent capital or related).
- ▶ USA, United Kingdom, Canada, etc.
- ▶ At least 1 trillion contingent capital is required if these contingent capital requirements are implemented (S & P, Report 2011). According to Goldman Sachs, the potential issuance of loss-absorbing securities could be between \$926 billion and \$1.9 trillion.

Examples

Lloyd, Nov 20, 2009

7.5 billion Euros contingent capital, converts into common shares if the bank's core tier 1 capital ratio falls below 5%.

Ranobank, March 12, 2010

1.25 billion Euro, contingent capital debt with coupon 6.875%, write-down of 25% of par if the bank's equity ratios falls below 7% (it was 12% on March 12, 2010). The investor would loss three-quarters of initial investment, not convert to equity.

Credit Suisse, Feb 2011

6.2 billion Euro, contingent capital in total

- ▶ 3.5 billion with coupon 9.5 percent
- ▶ 2.7 billion with coupon 9 percent

If the bank's Basel III common equity Tier 1 ratio falls below 7 percent, these debts will convert into shares.

Objective and Relevant Literature

To look at CC seriously, we plan to answer the following questions in this paper from a theoretical aspect.

- ▶ How to design CC?
- ▶ How to price CC and other contingent claims in the capital structure?
- ▶ How CC affects investors, banks and market dynamics?

We consider the following trigger event: when the common stock prices S_t falls below a trigger K_t , CC will convert into m_t numbers of common shares.

The setting encompasses many other trigger events.

Current Literature

- ▶ Design problem. (Sundarsan-Wang, 2010) assumes the default event has been known.
- ▶ Price problem. (Boris-Jaffee-Tchisty, 2010; McDonald, 2009; Pennacchi, 2010;) consider the trigger based on asset price, or specify the stock price as given, or conversion event has been given exogenously.
- ▶ Other relevant literature. Flannery (2005, 2009); Admati, DeMarzo, Hellwig and Peleiderer (2011), Bolton and Samama (2011), Coffee (2011), etc.
- ▶ **The right answer should be:** The common stock price, CC price, trigger event, default, conversion probability are determined **endogenously and simultaneously**.

Relevant Literature

- ▶ Performance-Sensitive Debt (Manso, Strulovici, Tchisyi, RFS, 2010) assumes asset price trigger event for coupon payment.
- ▶ Rating Trigger Debt (Bhanot, and Mello, JFE, 2006) assumes asset price trigger event.
- ▶ Positive Net-Worth Debt Covenant (Leland, JF, 1994) assumes default is triggered by the firm's asset value falls the market value of debt at its issuance (endogenous).
- ▶ Equity trigger covenant (Detemple, Tian and Xiong, FS, 2012)

Main Results

- ▶ Solve the Design Problem (m_t, K_t) for which equilibrium prices (common stock, debts) exist and unique.
- ▶ Characterize the equilibrium price process.
- ▶ Characterize conversion probability, default probability, cost of financial distress.

Implications

On the Positive Side (to some extent):

- ▶ Reduce the cost of financial distress
- ▶ Enhance the equity value and debt value
- ▶ Reduce risk-incentive of bank

On the Negative Side:

- ▶ No clear effect to senior debt investor.
- ▶ Whether issuance of CC is a negative signal?
- ▶ Whether death spiral?

Overall, a careful design of CC should be a good thing to address the “too big to fail” problem.

Basic Model

- ▶ Discrete time economy market $t = 0, 1, \dots, T$.
- ▶ The firm's asset value process V_t is given exogenously.
- ▶ Capital structure: common stocks (total number 1), and CC debt (total number 1).
- ▶ CC Debt: face value L and coupon rate c .
- ▶ When $S_t \leq K_t$, CC debt is converted into m_t numbers of common shares.
- ▶ K_t is a general adapted stochastic process.

At maturity T

The firm has to liquidate the firm.

- ▶ If $V_T > L + K_T$, equity's price $V_T - L > K_T$.
- ▶ If $V_T \leq L + K_T$, the equity's liquidation price is supposed to be $V_T - L \leq K_T$. **However**, by CC covenant,
 - CC debt is converted into m_T number of shares, in total $1 + m_T$ common shares.
 - The equity price becomes $\frac{1}{1+m_T}V_T$;
 - Consequently, $\frac{1}{1+m_T}V_T \leq K_T$.
 - **Question.** What if $\frac{1}{1+m_T}V_T > K_T$?
 - If $(1 + m_T)K_T < V_T \leq L + K_T$, there is no solution for the stock price!

At maturity T when $m_T K_T \geq L$

- ▶ For $V_T > (1 + m_T)K_T$, no conversion and the equity's price is $V_T - L$.
- ▶ For $V_T \leq L + K_T$, no liquidation and the equity's price is $\frac{1}{1+m_T}K_T$.
For $L + K_T < V_T \leq (1 + m_T)K_T$,
 - The common stock price can be $V_T - L$, which stays above K_T ;
 - The common stock price can be $\frac{1}{1+m_T}V_T$ by conversion (as it is smaller than K_T).
 - There are two possible prices for common stock. Which stock price is the right one?
 - If the bank has right to choose, as $V_T - L > \frac{1}{1+m_T}V_T$ for this range of V_T , the bank might want to liquidate the firm optimally.

At time t

We assume the firm can always change the capital structure into one without debt investors (liquidation or conversion) at time t .

ASSUMPTION: $m_t K_t \geq L$ for all time t .

This assumption ensures this is possible.

- ▶ When $V_t > L + K_t$, liquidation is plausible;
- ▶ When $V_t \leq L + K_t \leq m_t K_t + K_t$, conversion is also plausible;

By contrast, if $m_t K_t < L$, the bank can't change the capital structure at time t for $(1 + m_t)K_t < V_t \leq K_t + L$.

Importantly, this assumption is the sufficient and necessary condition to ensure the unique price equilibrium.

Definition of Market Equilibrium

A sequence of common stock prices, CC debt prices, and the optimal decision for the bank to change the capital structure, $\{S_t, C_t, \tau_t^e\}$ such that

- ▶ S_T, CC_T are given as above
- ▶ For any $t \leq T$, $S_t \leq K_t$ ensures that $S_t = \frac{1}{1+m_t}V_t, CC_t = \frac{m_t}{1+m_t}V_t$
- ▶ The bank maximizes the stock price S_t for all **feasible decisions** under CC covenant constraint in the future and current time t .

Feasible conditions at time t

If τ is the stop policy for the firm, as has been explained, the firm value will be dropped by $(1 - \theta)cLR(t, \tau)$ where $R(t, s)$ is defined as the time t value of cash flows \$1 at time $t, \dots, s - 1$ for $s > t$ with discount rate r and $R(t, s) = 0, \forall s \leq t$. Hence, the time t value of the stock under the policy τ is represented by

$$f(V_t, t, \tau) = \mathbb{E}_t \left[e^{-r(\tau-t)} g_\tau(V_\tau) \right] - (1 - \theta)cLR(t, \tau).$$

A stopping time τ is admissible for the bank at time t if and only if $\tau \in \mathcal{D}_t$, where

$$\mathcal{D}_t = \{ \tau \in \mathcal{S}_t : \{ \tau > \rho \} \subseteq \{ f(V_\rho, \rho, \tau) > K_\rho \text{ a.s.} \}, \forall \rho \in \mathcal{S}_t \}.$$

Equilibrium Price of Common Stock

For $t < T$

$$S_t = H(g_t(V_t), e^{-r}\mathbb{E}_t[S_{t+1}] - (1 - \theta)cL; K_t) \quad (1)$$

where

$$g_t(V_t) = \begin{cases} V_t - L & \text{if } V_t > L + K_t \\ \frac{1}{1+m_t}V_t & \text{if } V_t \leq L + K_t \end{cases}$$

is the payoff, or “exercise time”, at time t and

$$H(x, y; F) = \begin{cases} \max\{x, y\} & \text{if } y > F \\ x & \text{if } y \leq F \end{cases}$$

θ is the tax-shield rate on CC.

Optimal decision τ_t^e

Assume the firm has the capital structure before time t , then the best decision for the bank at time t is to change the capital structure at time

$$\tau_t^e = \inf \{s : t \leq s < T, S_s = g_s(V_s)\}, \text{ and } \inf \phi = T. \quad (2)$$

The conversion time for CC is

$$\tau_t^{cc} = \inf \{s : t \leq s < T, S_s \leq K_s\}, \text{ and } \inf \phi = T. \quad (3)$$

Equilibrium Price of CC

Assume the firm has the capital structure before time t , the equilibrium price of CC at time t is

$$CC_t = \mathbb{E}_t [cLR(t, \tau_t^e)] + \mathbb{E}_t \left[e^{-r(\tau_t^e - t)} (V_{\tau_t^e} - g_{\tau_t^e}(V_{\tau_t^e})) \right] \quad (4)$$

The tax benefit at time t is

$$\theta cLR(t, \tau_t^e) = \frac{\theta}{1 - \theta} \left\{ \mathbb{E}_t \left[e^{-r(\tau_t^e - t)} g_{\tau_t^e}(V_{\tau_t^e}) \right] - S_t \right\}.$$

Implications: Good thing

- ▶ No default at any time.
- ▶ Equity price can be increased, CC can be higher than straight debt with the same coupon and face value—tax benefits and zero cost of default

Example. $T = 4, V_0 = 100, u = 1.2, d = 0.8, r = 0$. The tax-shield rate $\theta = 0.4$ and the cost of default percentage $\alpha = 0.4$. $c = 2\%, L = 90, K_t = 25$ and $m_t = L/K_t = 3.6$ for all time $t = 0, 1, 2, 3, 4$.

Both the common stock and CC price, with capital trigger covenant, are higher than the corresponding common stock price and the standard debt price.

Both the common stock and CC price are higher than the corresponding common stock price and the regular debt price.

Contingent Capital

Equity	Debt	Default?	Tax-benefit
25.793	75.287	No	0.18

Standard Debt

Equity	Debt	Default?	Tax-benefit
17.100	70.845	Yes	-12.055

Bad thing: risk-taking incentive

Bank might want to take risky project by increasing the volatility of the firm value, so as to the continue value and the equity value.

Design Problem

$m_t K_t \geq L$ is a **necessary and sufficient condition** to ensure the existence and uniqueness market equilibrium.

If $m_t K_t < L$, when the “continue value” $e^{-r} \mathbb{E}_t[S_{t+1}] - (1 - \theta)cL \leq K_t$, there is no equilibrium value for the common stock.

Example. $T = 1, V_0 = 100, u = 1.2, d = 0.8$. CC debt: $c = 0, L = 90, K = 25, m_1 = 3.6, m_0 = 2$.

- ▶ The common stock at time one is: 30 or 17.39.
- ▶ The continue value at time zero is $23.70 < 25$. Hence the bank can't continue.
- ▶ At time zero, the bank liquidating yields value $20 < 25$; conversion yields value $33 > 25$.

A Full Model

- ▶ Additionally, one senior debt with coupon c_d and face value L_d .
- ▶ Assuming the same maturity and same tax-shield rate for senior straight debt and junior CC debt.
- ▶ Same assumption: $m_t K_t \geq L$.
- ▶ More general situations can be discussed (such as short-term senior debt maturity, multiple conversions, CC with options).

At time t

The bank has THREE choices to change the capital structure.

- ▶ *Liquidate* ensures no senior debt and no CC debt (could be default): no debt, only shares left or default.
- ▶ *Conversion* CC into common stocks but keeping senior debt: one senior debt, $1 + m_t$ shares.
- ▶ *Keep the same capital structure* into the next time period: senior debt, junior debt, 1 share of common stocks.

CC covenant affects the feasibility and payout function in each situation at time t .

Liquidation at time t

Liquidation Values (D_t^l, CC_t^l, S_t^l) :

- ▶ If $V_t > L + L_d + K$, then $(D_t^l, CC_t^l, S_t^l) = (L_d, L, V_t - L_d - L)$
- ▶ If $L_d < V_t \leq L + L_d + K$, then

$$(D_t^l, CC_t^l, S_t^l) = (L_d, \frac{m_t}{1 + m_t}(V_t - L_d), \frac{1}{1 + m_t}(V_t - L_d))$$

- ▶ If $V_t \leq L_d$, then $(D_t^l, CC_t^l, S_t^l) = ((1 - \alpha)V_t, 0, 0)$, where αV_t is the default cost.

Conversion at time t

Conversion Values (D_t^c, CC_t^c, S_t^c) :

$$(D_t^c, CC_t^c, S_t^c) = (\tilde{D}_t, \frac{m_t}{1 + m_t} \tilde{S}_t, \frac{1}{1 + m_t} \tilde{S}_t)$$

where $(\tilde{D}_t, \tilde{S}_t)$ is the equilibrium price in a standard capital structure.

Conversion at time t is feasible only when $S_t^c \leq K_t$.

Continue at time t

Continue Values are: $e^{-r}\mathbb{E}_t[D_{t+1}] + c_d, e^{-r}\mathbb{E}_t[CC_{t+1}] + c, e^{-r}\mathbb{E}_t[S_{t+1}] - (1 - \theta)(cL + c_dL_d)$.

Continue at time t is feasible only if the stock price is strictly greater than K_t .

The “stop value” at time t is given by the next slide:

Stop value at time t : $S_t^s = g_t(V_t)$

Stop value “s”

Firm Value	Common Stock	Senior Debt	CC
V_t	$\max(S_t^l,$ $S_t^c \mathbf{1}_{\{\frac{1}{1+m_t} \tilde{S}_t \leq K_t\}})$	D_t^s	$\max(CC_t^l,$ $CC_t^c \mathbf{1}_{\{\frac{1}{1+m_t} \tilde{S}_t \leq K_t\}})$

$$D_t^s = \begin{cases} \tilde{D}_t & \text{if } S_t^l < \frac{1}{1+m_t} \tilde{S}_t \leq K_t \\ \begin{cases} L_d & \text{if } V > L_d \\ (1 - \alpha)V, & \text{if } V \leq L_d \end{cases} & \text{otherwise} \end{cases}$$

Market Equilibrium

The *equilibrium* in this full model is a sequence of stock prices, senior debt prices, CC prices and the bank's optimal decision τ_t^e to change the capital structure from the time t perspective, $\{S_t, D_t, CC_t, \tau_t^e; 0 \leq t \leq T\}$ such that (1) $(S_T, D_T, CC_T) = (S_T^l, D_T^l, CC_T^l)$ and $\tau_T^e = T$, (2) For all $t < T$, if $S_t \leq K_t$, then $CC_t = m_t S_t$, (3) At time $t < T$, S_t solves the following optimization problem under constraints in \mathcal{M}_t

$$S_t = \text{esssup}_{\tau \in \mathcal{D}_t} f(V_t, t, \tau), \quad (5)$$

where

$$f(V_t, t, \tau) = \mathbb{E}_t \left[e^{-r(\tau-t)} (g_\tau(V_\tau)) \right] - (1 - \theta) (cL + c_d L_d) R(t, \tau)$$

and τ_t^e is the corresponding optimal stopping time.

What is \mathcal{D}_t basically?

This is a technical issue in this “endogeny” covenant. \mathcal{D}_t is the set of all admissible policies (to change the capital structure) for the bank at time t .

$g_t(V_t) = S_t^s$, the stop price at time t .

Example. $\tau = t \in \mathcal{D}_t$ means that the bank change the capital structure at time t . However, in each feasible policy in \mathcal{D}_t , we don't specify which way to change the capital structure: liquidate or convert, which depends on feasibility and which one leads to high value.

Equilibrium

The unique equilibrium price of contingent claims are $(S_T, D_T, CC_T) = (S_T^l, D_T^l, CC_T^l)$ at its maturity, for all time t prior to maturity,

$$S_t = H \left(g_t(V_t), e^{-r} \mathbb{E}_t[S_{t+1}] - (1 - \theta)(cL + c_d L_d); K_t \right). \quad (6)$$

The optimal time for the bank to change its capital structure by get rid of CC from time t perspective is

$$\tau_t^e = \inf \{s : t \leq s \leq T, S_s = g_s(V_s)\}. \quad (7)$$

The equilibrium price of the senior debt at time t is

$$D_t = \mathbb{E}_t [c_d L_d R(t, \tau_t^e)] + \mathbb{E}_t \left[e^{-r(\tau_t^e - t)} (h_{\tau^e}(V_{\tau^e})) \right] \quad (8)$$

The equilibrium of the junior CC debt at time t is

$$CC_t = \mathbb{E}_t [cLR(t, \tau_t^e)] + \mathbb{E}_t \left[e^{-r(\tau_t^e - t)} (u_{\tau^e}(V_{\tau^e})) \right]. \quad (9)$$

Default time

At time t , the optimal default time in this capital structure is

$$\tau_t^d = \inf \{s : t \leq s \leq T, S_s = 0\}. \quad (10)$$

It is possible that the firm default because of its obligation to the senior debt.

Discussions

- ▶ Design of CC.
- ▶ Cost of Financial Distress.
- ▶ Moral Hazard.

Design

We want

$$m_t K_t \geq L. \quad (11)$$

Hence, the following proposals are not good, from the equilibrium perspective:

- ▶ $m_t = 0$, write-down of principle.
- ▶ $0 < m_t K_t < L$, convert CC into common stocks with smaller market value.

Why CC investor should like it?

- ▶ In good time, it does not matter.
- ▶ In a bad time, it is a contingent buffer, so the bank pays some premium on it.
- ▶ CC investor shares the same interests as equity investor.
- ▶ The premium and future payout are priced at the right price levels of stocks and debts.
- ▶ In some recent proposals, central banks could be CC investors.

Why CC investor should like it? (Continue)

- ▶ CC investor does not want wealth transfer from debtholder into stockholder.
- ▶ If all CC investor expect such a wealth transfer they would not willing to participate into CC market (central bank might be exceptional).
- ▶ So a reverse wealth transfer from stockholder to debtholder seems more admissible for the design of CC, as long as all risks can be priced appropriately in the first place for all market participants.

Cost of Default

$$E \left[e^{-r\tau^d} V_{\tau^d} \right] \quad (12)$$

depends on $\{c, c_d, L, L_d, m_t, K_t, T, T'\}$, which can be reduced significantly.

From the taxpayer's perspective, to reduce the cost of default or minimize the cost of default is a reasonable criteria for the optimal design of CC, while bank might want to maximize the common stock price.

Moral Hazard

In the equilibrium equity price, increasing the volatility leads to

- ▶ increase the conversion value (as in the standard capital structure);
which reduces the conversion probability, so reduces the stop value.
- ▶ increase the continue value (as option value).

The balance between stop value and continue value yields a hump shape of common stock with respect to volatility.

Figure 1: The figure depicts the equity payoff, or stop price, at time t in the full model. Parameters are: $L = 5, L_d = 10, K = 2$ and $m = 2.5$.

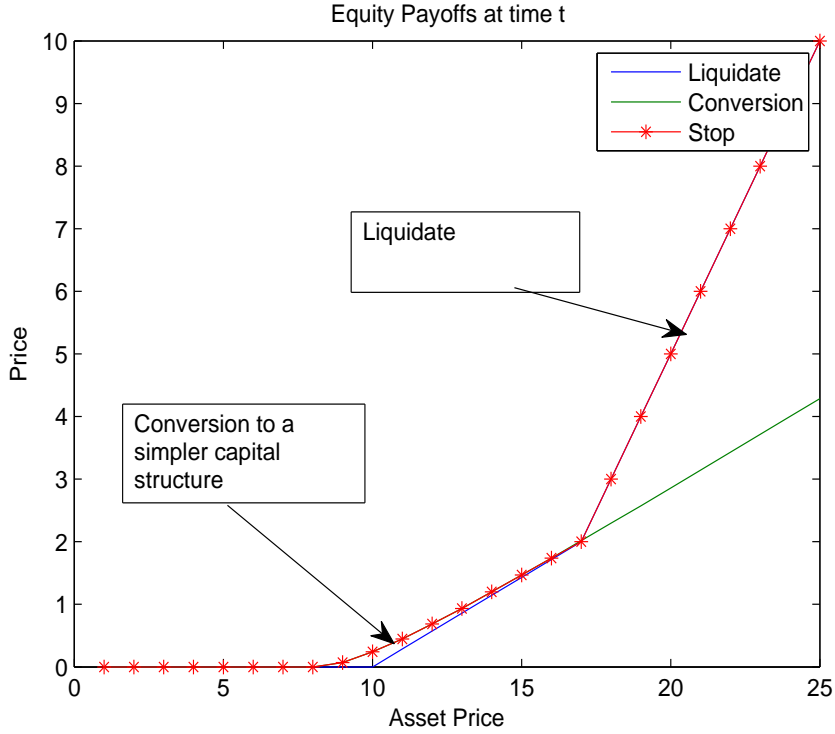


Figure 2: The figure depicts the equity price with respect to the trigger K

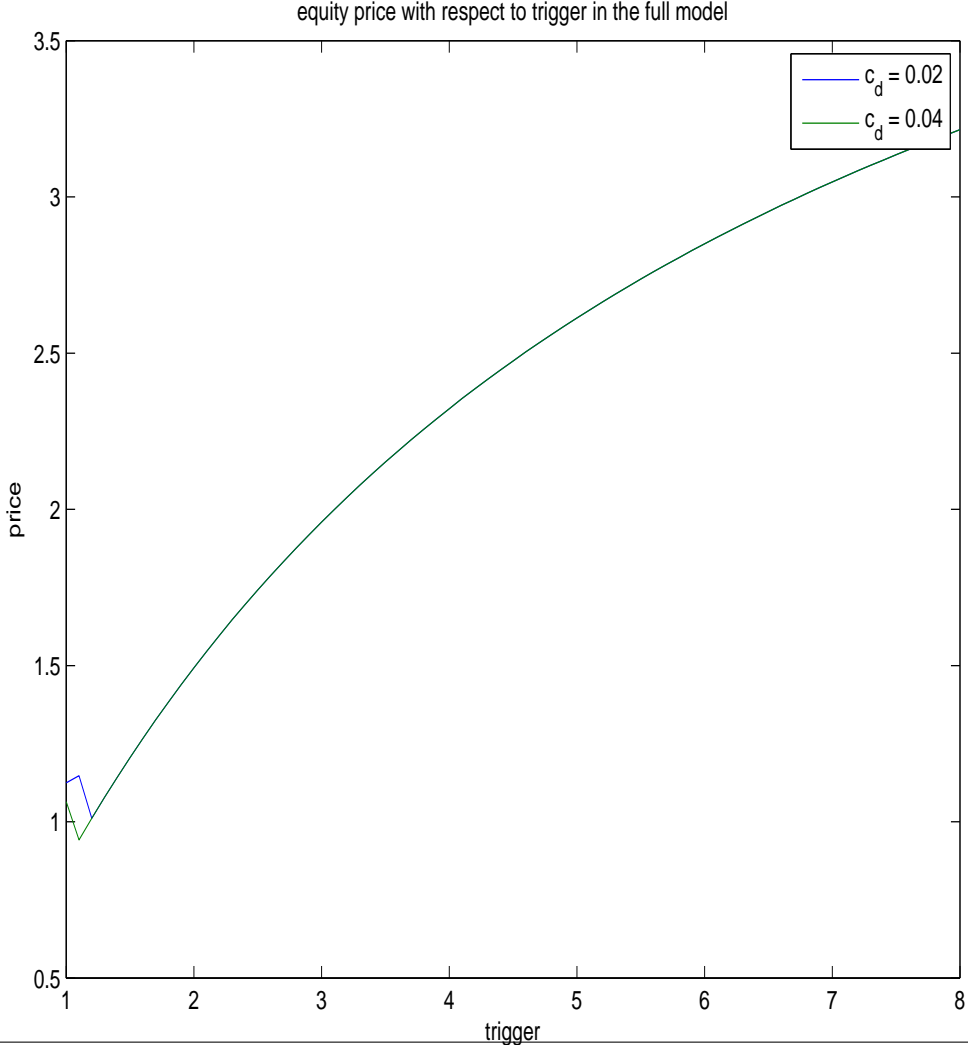
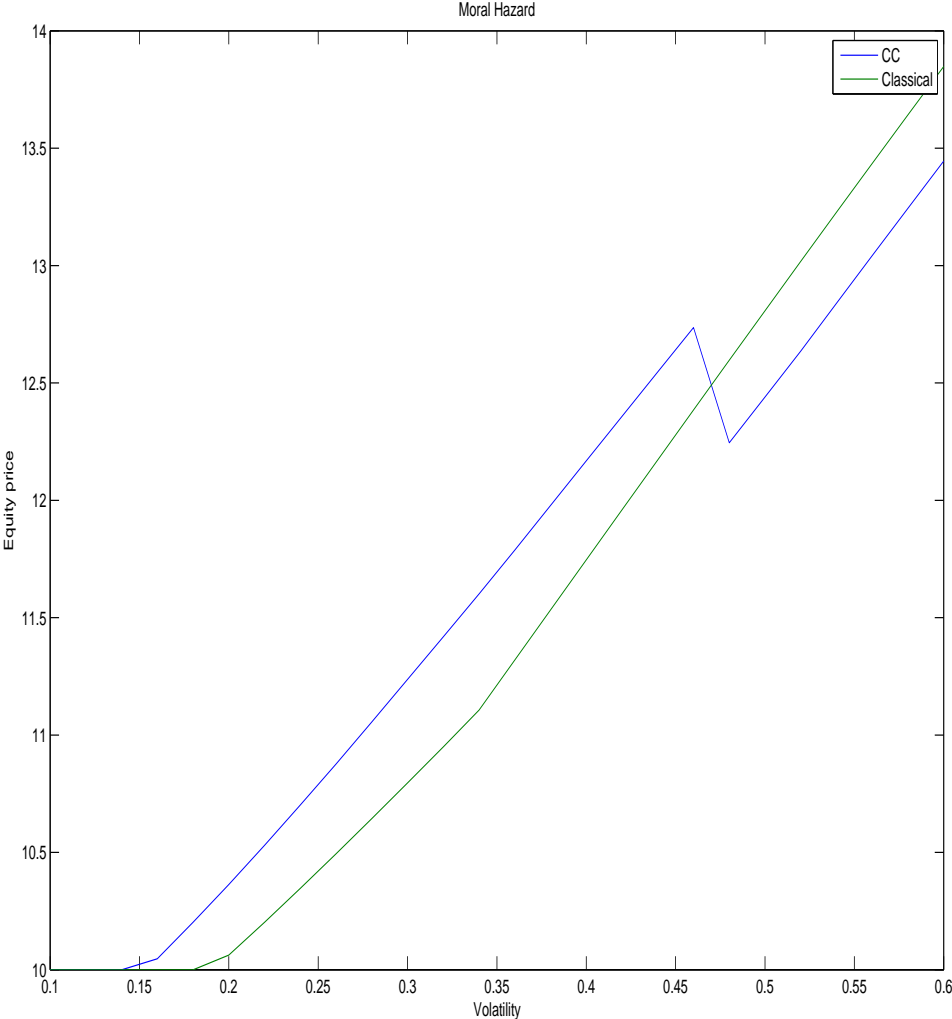


Figure 3: The figure depicts the equity price with respect to the trigger K



Conclusions

This theoretical study

- ▶ solves the design problem;
- ▶ solves the valuation problem, the cost of default, and conversion probability;
- ▶ ensures important implications-regulatory, policy, “too big to fail” etc.