THE ACADEMY OF ECONOMIC STUDIES, BUCHAREST
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Banks' self-insurance using bail-in measures: Contingent Convertible Bonds

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Introduction

- As a result of the financial crisis in 2008 and 2009, regulatory authorities have placed stricter capital requirements on banks (Basel III)

- One way to acquire the extra capital is through contingent convertible capital bonds. Contingent convertibles (CoCos) are hybrid subordinated bonds that have properties of both bonds and equity, that converts to equity when a bank gets in trouble:

  - A built-in mechanism to increase capital when it is most needed and most difficult to raise

  - With a credible mechanism in place in advance, a government bail-out becomes less likely

- This thesis investigates the effects of BRD – GROUPE SOCIÉTÉ GÉNÉRALE issuing contingent capital.

- Initial I present a structural model that assumes a bank's asset evolves as a Geometric Brownian Motion with drift. In the classic Black and Scholes settings I obtain a closed form pricing expression of contingent convertible bonds and evaluate BRD – GROUPE SOCIÉTÉ GÉNÉRALE shares price, default probabilities and shareholders risk shifting incentives.

Methodology

Bank Capital Structure

- Deposit – face value F_D
- Contingent Convertible debt (face value - F_C and market value – C) or subordinated debt (face value F_B and market value B)
- Equity - E

Value of the bank's assets: : $V = E + F_D + C$ (or B) .

- Default threshold: $K^D = F^D(1-\gamma)$, *where* $0 \leq \gamma \leq 1$
- Conversion threshold: $K^C = (1 + \beta)(F^C + F^D)$, *where* $\beta \geq 0$

❖ View a firm's assets (factories, patents, or loan portfolio for a bank) as the "underlying" and value debt and equity as options on these assets.

❖ This was the original problem of Black-Scholes (1973) and Merton (1974).

❖ Black and Cox (1976): The firm defaults when asset value hits a barrier.

Valuation

Capital structure includes Contingent Convertible Bonds

- Deposits can be expressed as:

$$D = E^Q\left[e^{-rT}\left(F^D 1_{\{V_T>F^D\}} + V_T 1_{\{F^D>V_T\}}\right)1_{\{\tau_d>T\}} + e^{-r\tau_d}F^D(1-\gamma)1_{\{\tau_d<T\}}\right]$$

$$D = F^D\left(DB^{dout}\left(K^d\right) + DB^{din}\left(K^d\right)\right) - PB^{dout}\left(K^d, F^D\right)$$

- Cocos value:

$$C = E^Q\left[e^{-rT}\left(F^C 1_{\{\tau_c>T\}} + \alpha\left(V_T - F^D\right)1_{\{\tau_c<T<\tau_d, V_T>F^D\}}\right)\right]$$

$$C = F^C DB^{dout}(K^c) + \alpha\left(CB^{din}\left(K^c, F^D\right) - CB^{din}\left(K^d, F^D\right)\right)$$

- Equity value:

$$E = E^Q\left[e^{-rT}\left(\left(V_T - F^D - F^C\right)1_{\{\tau_c>T\}} + (1-\alpha)\left(V_T - F^D\right)1_{\{\tau_c<T<\tau_d, V_T>F^D\}}\right)\right]$$

$$E = F^C CB^{dout}\left(K^c, F^D + F^C\right) + (1-\alpha)\left(CB^{din}\left(K^c, F^D\right) - CB^{din}\left(K^d, F^D\right)\right)$$

Capital structure includes Subordinated Debt

- Deposits value:

$$D = F^D\left(DB^{dout}\left(K^d\right) + DB^{din}\left(K^d\right)\right) - PB^{dout}\left(K^d, F^D\right)$$

- Subordinated debt value:

$$B = e^{-rT}E^Q\left[\left(F^B 1_{\{\tau_d > T, V_T \geq (F^B + F^D)\}} + max\left(V_T - F^D, 0\right)\right)\right] 1_{\left\{\tau_d > T, (F^B + F^D) > V_T \geq F^D\right\}}$$

$$B = CB^{dout}\left(K^d, F^D\right) - CB^{dout}\left(K^d, F^D + F^B\right)$$

- Equity value:

$$E = e^{-rT}E^Q\left[max\left(V_T - F^D - F^B, 0\right)\right] 1_{\{\tau_d > T\}}$$

$$E = CB^{dout}\left(K^d, F^D + F^B\right)$$

Determination of implied asset values and volatility

- Based on the boundary condition by Merton (1974), the asset volatility can be expressed by the historical variance of market capitalization E and total book value of liabilities ($F^D + F^B$).

$$\frac{\partial E}{\partial V} \cdot \sigma_V = \sigma_E \frac{E_0}{V_0} = \sigma_E \frac{E_0}{E_0 + F^D + F^B}$$

- Equity value:

$$E = CB^{dout}\left(K^d, F^D + F^B\right)$$

Default probability

Contingent capital vs. subordinated debt

- *The probability of default of a bank with a capital structure that includes CoCos :*

$$PD(C) = Pr(\tau_d < T) + Pr\left(V_T < F^D \middle| \tau_d > T\right)$$

- *The probability of default of a bank with a capital structure that includes subordinated debt :*

$$PD(B) = Pr(\tau_d < T) + Pr\left(V_T < \left(F^D + F^B\right) \middle| \tau_d > T\right)$$

Risk neutral default probability for CoCo

$$PD(C) = 1 - N\left(\frac{\ln\left(\frac{V_T}{F^D}\right) + \left(r - \frac{1}{2}\sigma^2\right)(T-t)}{\sigma\sqrt{(T-t)}}\right) + \left(\frac{K^D}{V_T}\right)^{\frac{2r}{\sigma^2}-1} \cdot N\left(\frac{\ln\left(\frac{{K^D}^2}{F^D V_T}\right) + \left(r - \frac{1}{2}\sigma^2\right)(T-t)}{\sigma\sqrt{(T-t)}}\right)$$

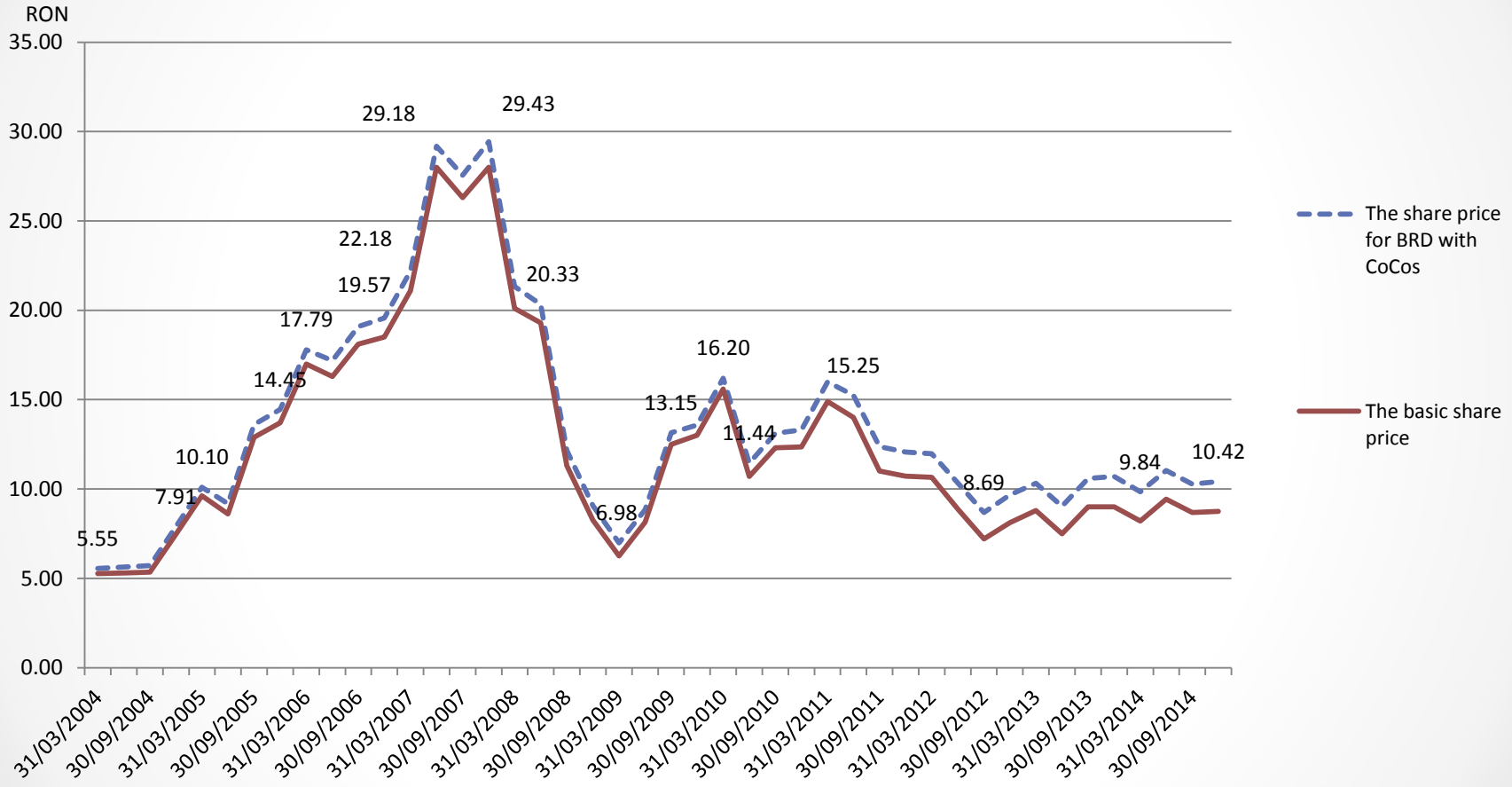
Risk neutral default probability for Subordinated Debt

$$PD(B) = 1 - N\left(\frac{\ln\left(\frac{V_T}{F^D + F^B}\right) + \left(r - \frac{1}{2}\sigma^2\right)(T-t)}{\sigma\sqrt{(T-t)}}\right) + \left(\frac{K^D}{V_T}\right)^{\frac{2r}{\sigma^2}-1} \cdot N\left(\frac{\ln\left(\frac{{K^D}^2}{(F^D + F^B)V_T}\right) + \left(r - \frac{1}{2}\sigma^2\right)(T-t)}{\sigma\sqrt{(T-t)}}\right)$$

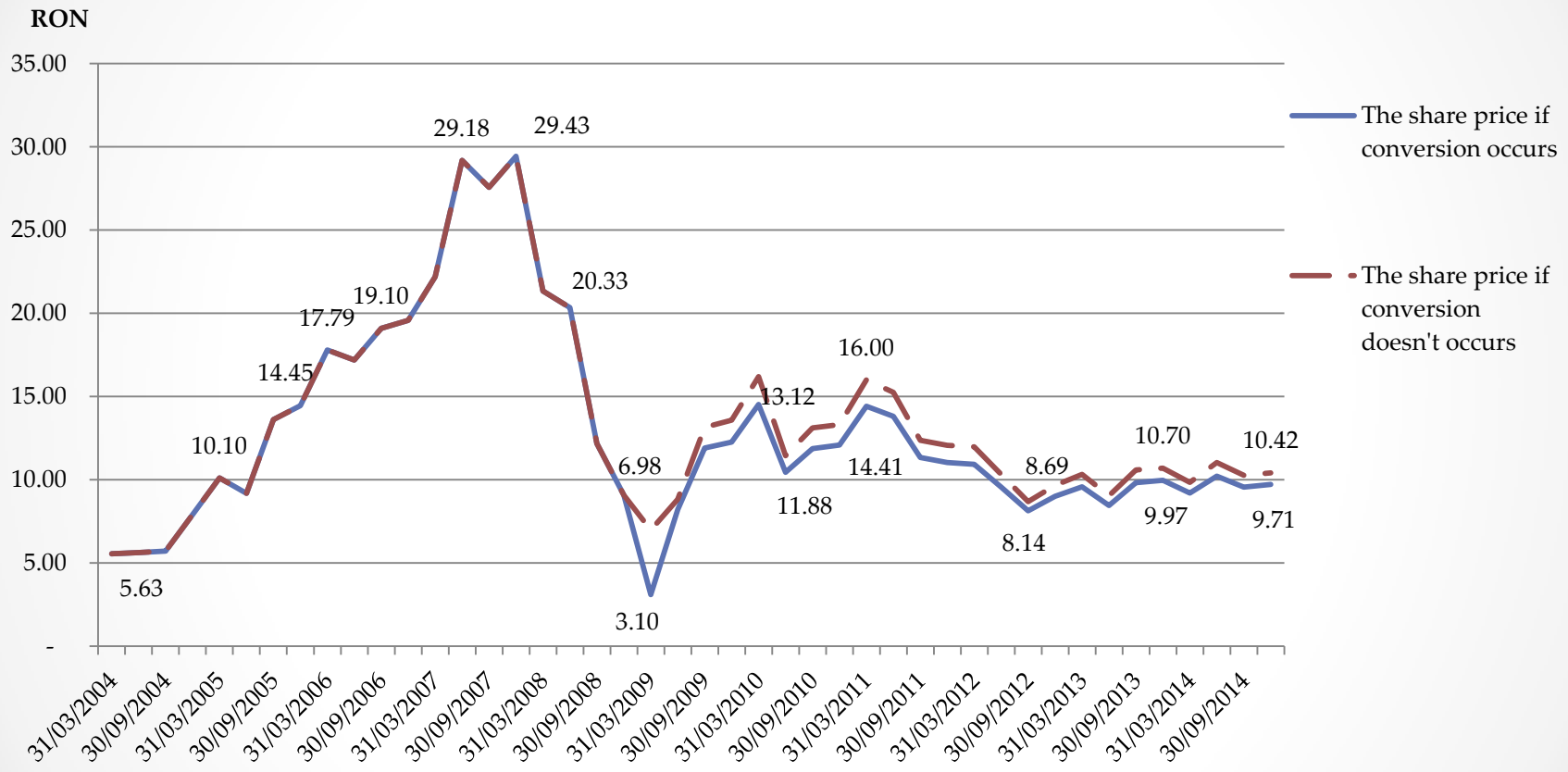
Input data

- **Financial data of BRD - Groupe Société Génér**ale : share price, number of shares, value of total deposits, value of subordinated debt .
- **Analyzed period**: 2004 Q1 – 2014 Q4
- **Source of data**: Reuters and Financial statements of BRD-GSG
- **Market value of equity**= share price x number of shares
- **Equity volatility**, σ_E, = annual volatility of share price, $\sigma\sqrt{t}$, where σ is the daily volatility of share and t=252
- **Initial value of assets**: V = E + F_D+F_B and the **initial value of asset risk** σ_V = 20%
- **Maturity** (T): 1 year
- **Leverage ratio** (LR) : $LR = \frac{F \cdot e^{-rT}}{V_0}$
- **Interest rate** (r): A continuous constant rate of 6,26%
- **Cotingent capital principal** (F_C): 2 % of the deposit face value
- **Conversion ratio** (α): 0.5
- **Conversion threshold** (β): 1% above the total face value of debt
- **Regulatory seizing policy** (γ): 3% below the face value of the deposits

Results: The effect on the share price of convertible contingent bonds I

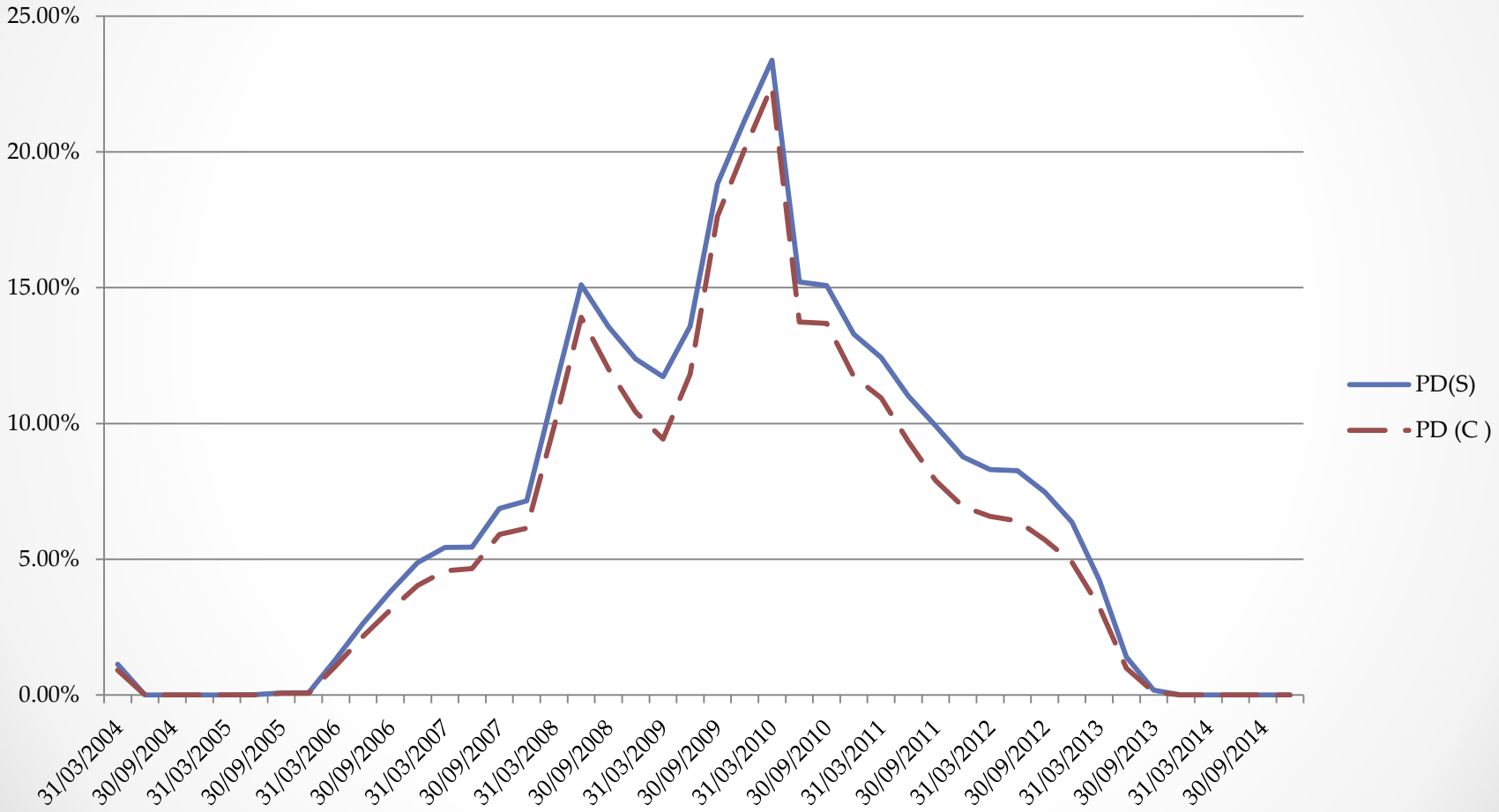


Results: The effect on the share price of convertible contingent bonds II

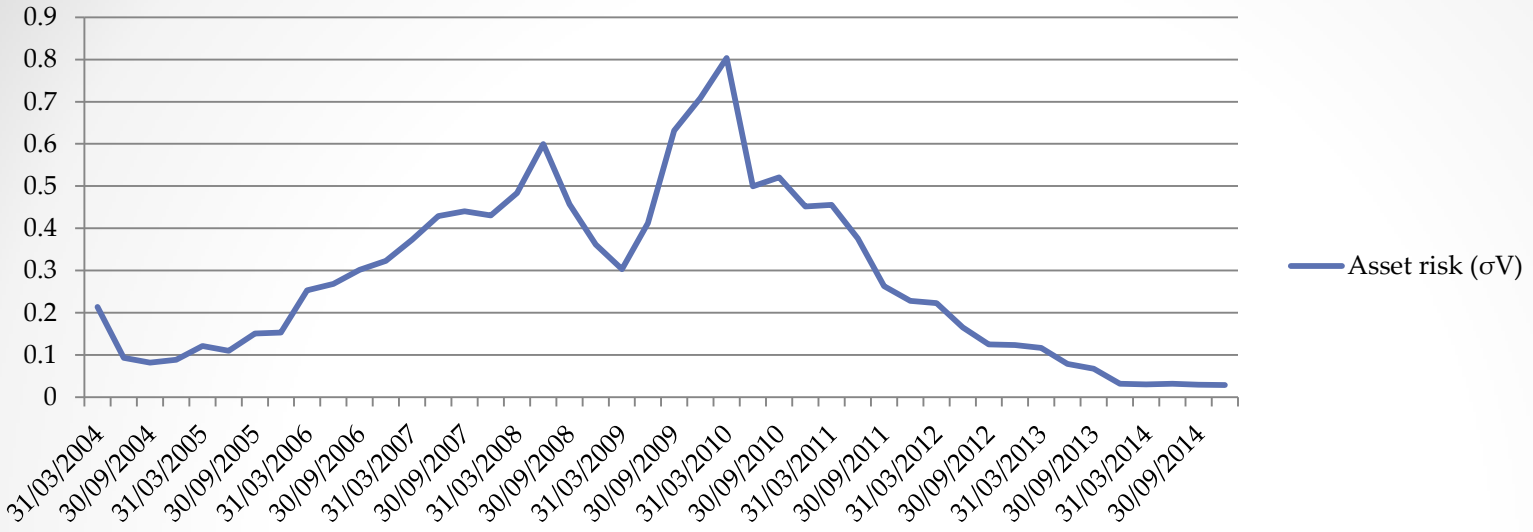


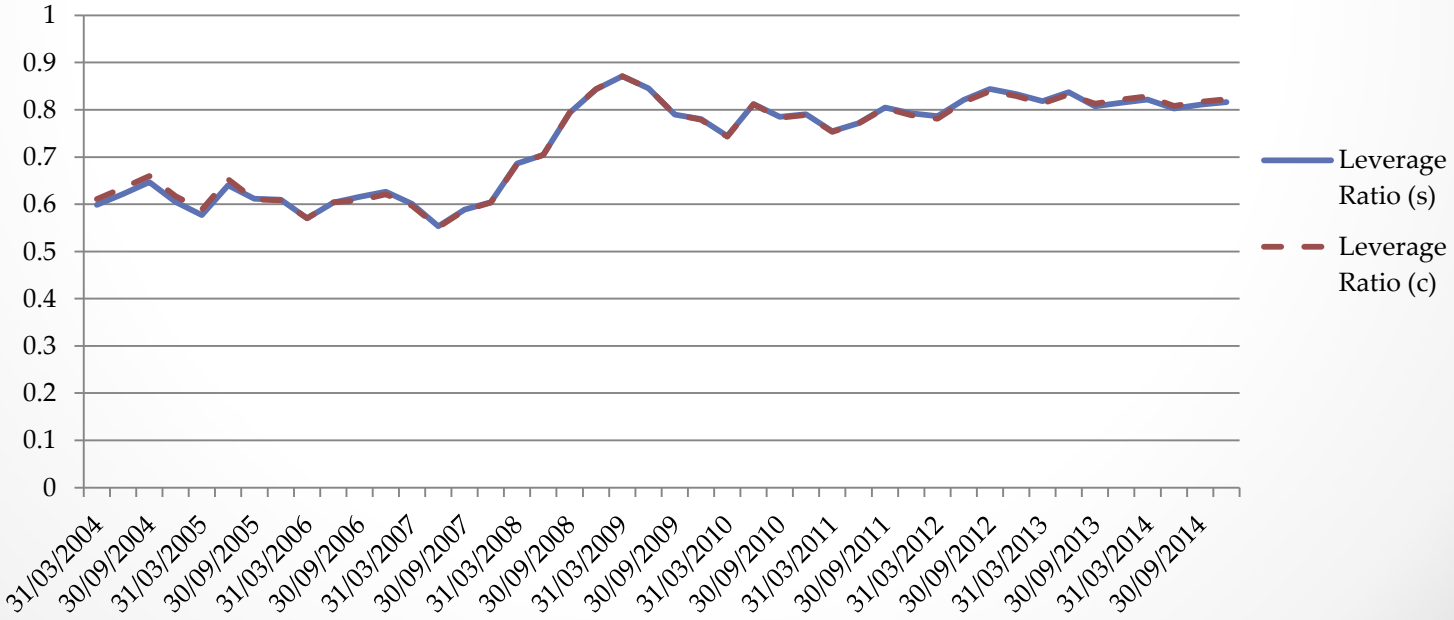
Results: Probability of Default I

Probability of default for BRD in the case of subordinated debt – PD (S) and Probability of default for BRD in the case of CoCos

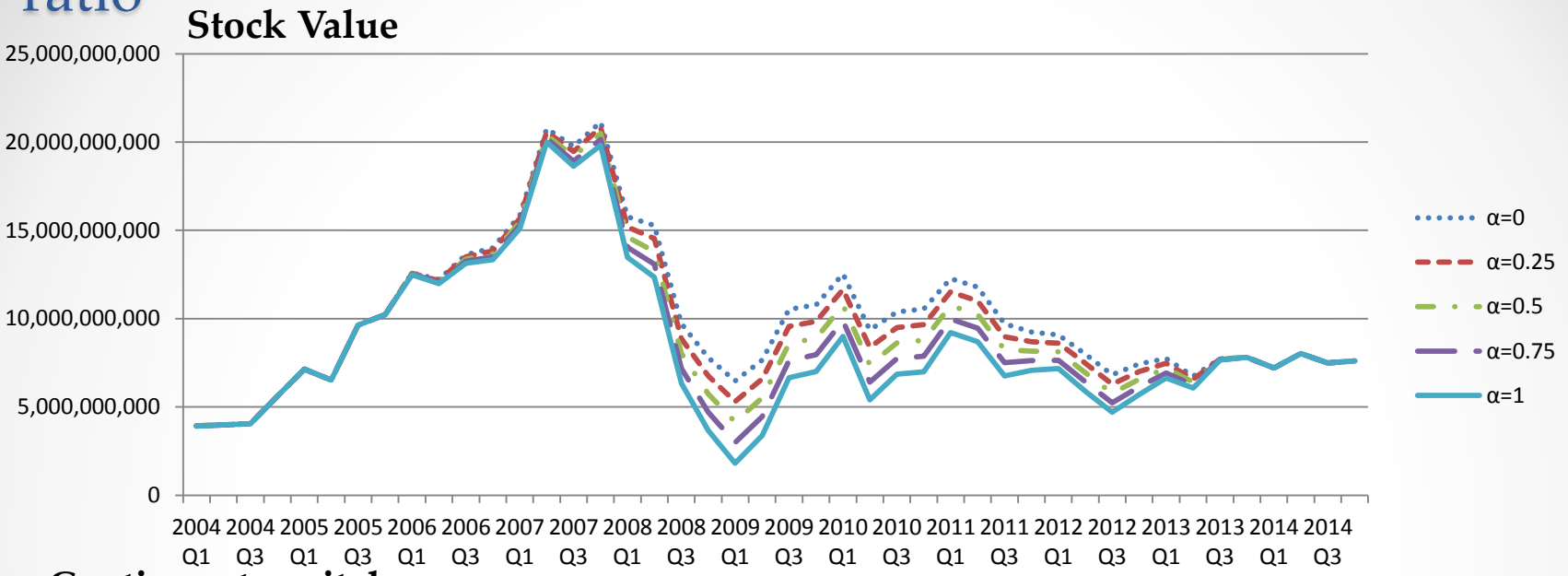


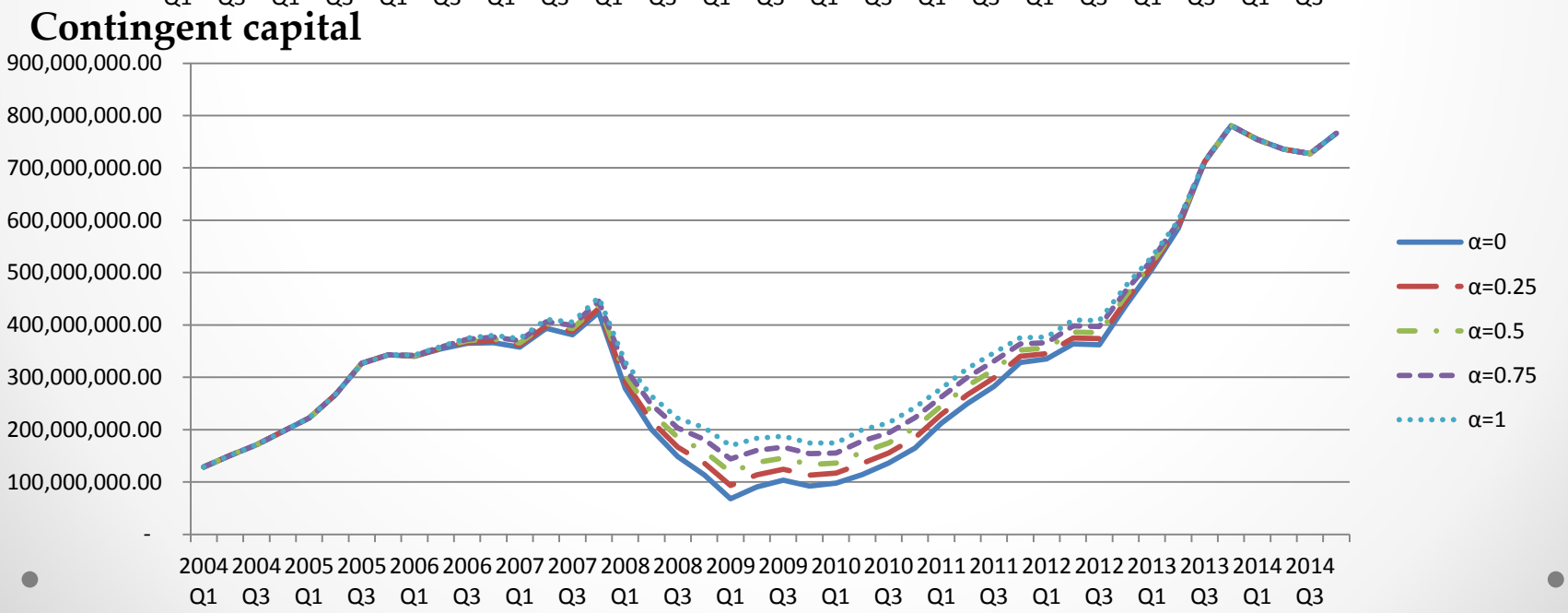
Results: Probability of Default II





Results: Risk taking incentives - Varying the conversion ratio





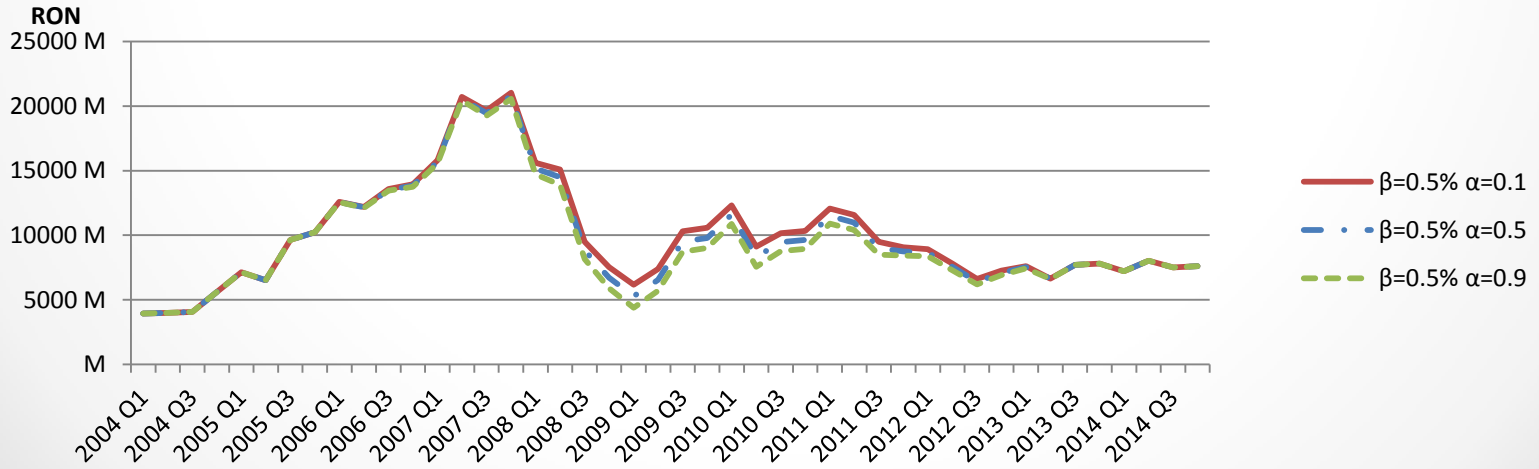
Results: Risk taking incentives - Conversion threshold

α=0.1	β=0.5%	β=1.5%	β=2.5%
2009 Q1	6,157,198,446.82	6,128,904,544.60	6,097,752,689.64
2009 Q2	7,386,092,023.46	7,355,351,684.20	7,322,771,499.83
2009 Q3	10,300,690,740.78	10,268,689,655.86	10,235,713,598.73
2009 Q4	10,565,944,311.14	10,533,967,437.51	10,501,191,896.44

Stock value for different beta values in the case of a high, low, and intermediate conversion ratio.

α=0.5	β=0.5%	β=1.5%	β=2.5%
2009 Q1	5,270,359,000.14	5,042,027,467.11	4,799,417,596.20
2009 Q2	6,536,721,896.52	6,326,172,170.52	6,106,813,865.14
2009 Q3	9,506,240,777.03	9,315,430,728.22	9,120,105,499.58
2009 Q4	9,790,235,759.43	9,605,087,507.96	9,416,268,570.68

α=0.9	β=0.5%	β=1.5%	β=2.5%
2009 Q1	4,383,519,553.47	3,955,150,389.62	3,501,082,502.76
2009 Q2	5,687,351,769.58	5,296,992,656.83	4,890,856,230.44
2009 Q3	8,711,790,813.28	8,362,171,800.58	8,004,497,400.44
2009 Q4	9,014,527,207.72	8,676,207,578.42	8,331,345,244.93



Conclusions

- Contingent capital may be effective in stabilizing the banking sector.
- Properly designed CoCos can induce risk reduction.
- Contingent capital design (in particular the conversion ratio, the fraction of post-conversion common equity that contingent capital holders receive) has an important impact on risk-taking motivation.
- Because equity holders capture some of the benefit of reduced bankruptcy costs, they often have a positive incentive to issue CoCos.
- My calibration suggest that CoCos could have a significant impact on BRD – Groupe Société Générale in the lead up to the financial crisis.

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