

# Evaluations of the Perpetual Bond in Chinese Inter-Bank Bond Market

## An Empirical Research from 2013 to 2021

Bei Liu<sup>1</sup>    Zhiwei Hu<sup>2</sup>

<sup>1</sup>Business School  
Beijing Language and Culture University

<sup>2</sup>Department of Mathematics, Physical Science Division  
The University of Chicago

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# Introduction: Subject

Perpetual Bond (PB): a hybrid capital

- ▶ **Equity**: in general, it is a fixed income security which has no maturity date, or where the agreed-upon period over which interest will be paid is forever (in perpetuity).
- ▶ **Bond**: most perpetual bonds do have a call feature, thereby allowing the issuer to redeem it according to a fixed schedule.

# Introduction: Subject

Table: A PB Example of [102100864.IB]

| Year                       | Coupon Rate if NOT Redeemed by the Issuer        |
|----------------------------|--|
| First 3 Years (2021-2024)  | 4.5%   |
| Second 3 Years (2024-2027) | $4.5\% + 300\text{BPs} = 7.5\%$                  |
| Third 3 Years (2027-2030)  | $4.5\% + 300\text{BPs} + 300\text{BPs} = 10.5\%$ |
| ...                        | $4.5\% + 300\text{BPs} + \dots + 300\text{BPs}$  |

- ▶ The above is issued by Shanghai Infrastructure Construction and Development Co., with the size of 600 Million yuan.
- ▶ Has a term of '3+N' callable schedule. It means at the end of every three years after its issuance (in 2021), the issuer has the option to extend the bond.
- ▶ Although a PB can be extended forever, each extension may be penalized with a certain degree's coupon rate booster, in the example above, the booster is **300BPs**.

# Introduction: Main Results

- ▶ Given the 'T' years to maturity equal, the value of the call option for a 'T+N' type PB is the difference in coupon rate between the PB and the regular coupon bond issued by the same debtor.
- ▶ Our estimations are slightly higher than the real value in the prospectus. We have proved that the true value is **undervalued and it is increasing**.
- ▶ We also find that a PB is both a substitute and a complement of a regular coupon bond. And both affect its option value. These effects are significant and may be used for adjusting the coupon rate of a PB.



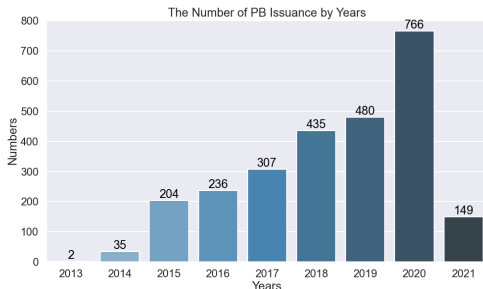
# Introduction: PB in China

PB has been introduced to China in 2010s.

- ▶ In 2013, Wuhan Subway Co. issued the first PB '13Wu[124999.SH]' in the nation with a term of '5+N' callable schedule.
- ▶ PB '14 PB Shouchuang Group 01[1480549.IB]' is the first been called '3+N' type of PB on September 2017, but it has been redeemed at the end of the second term on November 2020.

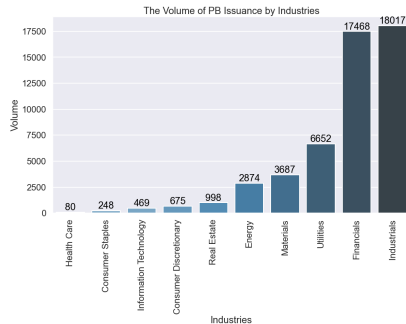
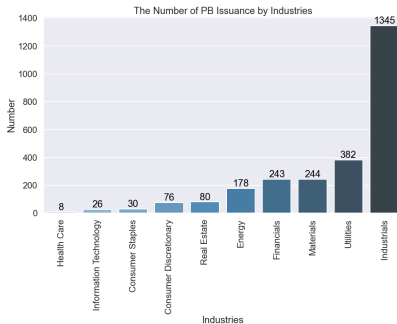
## Introduction: PB in China

- ▶ Since 2013, PB is generally becoming popular. Especially at the end of 2018, after being allowed as secondary capital for commercial banks to meet sufficiency requirements.
- ▶ In 2021, government continues to stabilize macro leverage ratio to rein in risks, PB issuance has firstly decreased.



# Introduction: PB in China

- ▶ **Industrial** sector has the greatest number of PBs.
- ▶ **Financial** sector usually issues PBs with much larger size.



# Introduction: PB in China

## A Win-Win Game:

- ▶ For issuers, a PB is issued as a regular credit bond, but categorized as issuers' equity. It has advantage in legal procedures over IPO, convertible bonds, or preferred stock.
- ▶ For investors, a PB pays higher coupon rate than a regular coupon bond because of the premium brought by the callable feature.

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## Issuance of A PB: The $T(T+N)$ Schedule

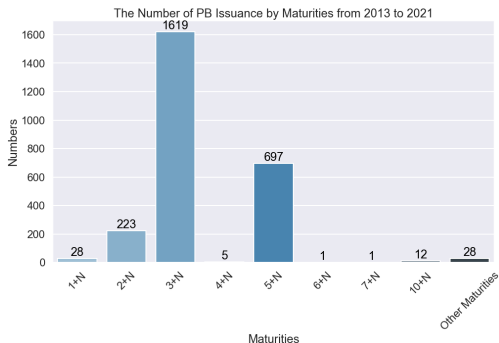
- ▶ A term of ' $T+N$ ' callable schedule PB is written as ' $T(T+N)$ ': ' $T$ -year' is a repricing cycle. At the end of each repricing cycle, the issuer will have the right to redeem or extend the PB. If a ' $T(T+N)$ ' type of PB is extended, it will be still categorized as a  $T$ -year bond, but written as ' $T(T+T+N)$ '.
- ▶ A PB can also be categorized as ' $T(T+T+\dots+N)$ ' schedule at its first issue date. In this scenario, the PB is assumed to be extended for  $(n-1)$  times, mostly because there's no coupon rate booster applied to the first  $(n-1)*T$  years.

### Therefore

A PB's schedule should be dealt **case by case** according to its prospectus.

# Issuance of A PB: The $T(T+N)$ Schedule

- For the format ' $T(T+N)$ ': ' $T$ ' can be any number theoretically; and it has value from 1 to 10 in China presently. But  $2+N$ ,  $3+N$  and  $5+N$  are the most favored.



# Issuance of A PB: Breakdown of The Coupon Rate

## Firstly

A PB builds on a regular coupon bond. The coupon rate should be related with the rate of a regular coupon bond with the same issuer and the same maturity.

## Therefore

The coupon rate = spot rate of the benchmark interest rate + initial difference in coupon rate

- ▶ where the **'difference in coupon rate'** is determined by issuer, and we believe it reflects the difference between a PB with its corresponding coupon bond, we called **'the target bond'** in our case.



# Issuance of A PB: Breakdown of The Coupon Rate

## In Addition

A PB is indented with a callable option, which allows the issuer to extend the PB at the end of every Tth year. It also comes with a price.

## Therefore

The coupon rate = spot rate of the benchmark interest rate + initial difference in coupon rate + **interest rate booster**

- ▶ Generally, the interest rate booster is agreed at the issue date, and it is expensive. The value of it can be 100bps, 300bps, 400bps or 600bps, and the general value is 300bps.
- ▶ A PB may have multiple interest rate boosters. These usages are stated in the bond prospectus as well.

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# Literature Reviews

## Literature related with hybrid capital and option

For an issuer, the right to decide whether to extend or redeem a PB, can be seen as a European call option.

- ▶ Black and Cox (1976) first valued the effects of safety covenants “time to default”, subordination arrangements, and restrictions on the financing of interest and dividend payments for corporate securities.
- ▶ Akesl and Svein-Arne (2004, 2005, 2007) evaluated perpetual bond—callable bonds with European embedded option. The value of the call option is tied with issuer’ possibility to default and the value of the default. Therefore, the value of such European call option shows both issuers’ financial statue and their rationality faced to default.

# Literature Reviews

## Literature related with hybrid capital and option

- ▶ Wu and Li (2010) use BS Model, Binomial tree Model, and OAS Model to price the “a+b” type of option-embedded bonds in China. although the examination and conclusion were limited, they agreed that pricing hybrid securities should be estimated by pricing bond and pricing option separately.
- ▶ Wang and Nie (2019) examine six extended perpetual bonds and also conclude that the value of perpetual bond includes both the value of bond and the value of option. To price the value of the extension part, they believe that without a certain date for redeeming, the value of the option for a PB can be estimated by n steps' binomial tree model.

# Literature Reviews

## Literature related with bond interest rate

The coupon rate of a general credit bond is affected from a various source such as yield levels from the primary market, trading levels of similar bonds in the secondary market, benchmarks (such as ratings, generic sector, state-specific, and so on) (Fabozzi, 2005).

- ▶ For an option-embedded bond, investors evaluate the call risk by comparing it with a comparable without option-embedded bond before their purchase. The evaluation methods have yield to maturity (YTM), yield to call (YTC), and yield to worst (YTW);
- ▶ YTW is calculated as 'YTW=risk free rate +credit risk premium', which is familiar to the expression of the coupon rate of a PB in its bond prospectus.

# Literature Reviews

To sum up,

We believe the coupon rate of a PB represents the worst earning for the investors, and the difference in the interest rate values the credit risk premium for investors as the value of the call.

# The Model

## Our Hypothesis is:

The coupon rate = spot rate of benchmark interest rate + initial difference in coupon rate + interest rate booster

in which,

- ▶ 'spot rate of benchmark interest rate' = the coupon rate of its target bond
- ▶ 'initial difference in coupon rate' = value of the call (price for extension)

# The Model

## The Replication is:

The Value of PB = the value of a general coupon bond ( $PV_B$ ) + the values of all future call ( $C_1, C_2, C_3, \dots, C_n$ ) options

$$PV = \sum_{K=0}^n C_k + PV_B \quad (1)$$



# The Model: To Price the Call Option

## The Binomial Trees Approach

Suppose the initial coupon rate of a “T+N” PB is fixed as  $R_{T0}$  in the first pricing period of T. Near the end of Year T, the issuer can have a probability  $p$  to use  $uR_{T0}$  ( $u > 1$ ) to keep financing, and have a probability  $1 - p$  to use  $dR_{T0}$  ( $1 > d > 0$ ) to buy back a PB.

Which is,

$$C_{1u} = \max[u * R_0 - R_{T0}, 0] \quad \text{for} \quad (u > 1) \quad (2)$$

$$C_{1d} = \max[d * R_0 - R_{T0}, 0] \quad \text{for} \quad (0 < d < 1) \quad (3)$$

# The Model: To Price the Call Option

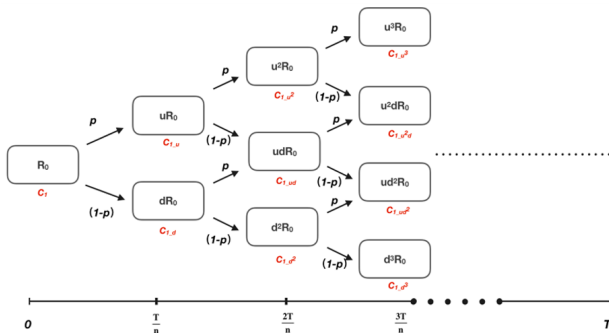


Figure: Binomial Trees

# The Model: To Price the Call Option

Under the risk-free conditions we have:

$$R_{T0} = \mathbb{E}[S_T] = u * R_{T0} * p + d * R_{T0} * (1 - p) \quad (4)$$

And,

$$\begin{aligned} C_1 &= \left( C_{1u} * p + C_{1d} * (1 - p) * e^{-rT} \right) \\ &= \left( \frac{C_{1u} * (e^{rT} - d) + C_{1d} * (u - 2d - e^{rT})}{(u - d)} \right) * e^{-rT} \end{aligned} \quad (5)$$

# The Model: To Price the Call Option

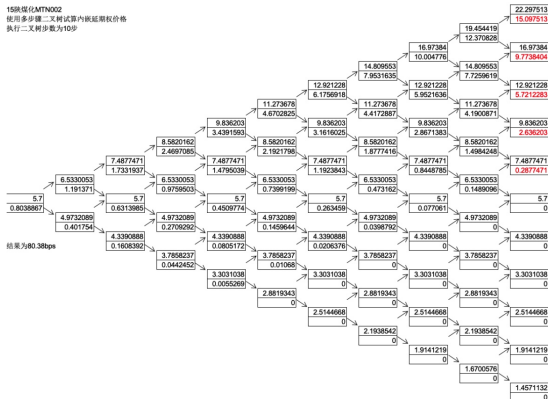
Take N Steps of Binomial Trees

$$C_1 = e^{-nr\Delta t} * \sum_{k=0}^n \frac{n!}{k!(n-k)!} * p^k * (1-p)^{(n-k)} C_{1_{u^k - kd^k}}, \quad k \in N \quad (6)$$

# The Model: To Price the Call Option

## Examples

Take PB '15 ShanMeiHua MTN002' As an example:



# The Model: To Price the Call Option

## Black-Scholes-Merton Approach

$$\mathbb{E}(C_T) = \mathbb{E}[\max(R_{T+1} - R^*, 0)] \quad (7-1)$$

$$C = p * e^{-rT} * (\mathbb{E}[R_{T+1} | R_{T+1} > R^*] - R^*) \quad (7-2)$$

Where  $p$  is,

$$p = \text{Prob}[R_{T+1} > R^*] = \text{Prob}[\text{return} > \ln(\frac{R_{T+1}}{R^*})] \quad (8)$$

# The Model: To Price the Call Option

Under lognormal distribution and the risk neutral condition:

$$p = N * \frac{\ln \frac{R^*}{R_{T+1}} + (r - \frac{\sigma^2}{2}) * t}{\sigma * \sqrt{t}} \quad (9)$$

$$\begin{aligned} C &= p * e^{-rt} * (\mathbb{E}[R_{T+1} | R_{T+1} > R^*] - R^*) \\ &= N(d_2) * e^{-rt} * \left( R_{T_0} e^{rt} \frac{N(d_1)}{N(d_2)} - R^* \right) \end{aligned} \quad (10)$$

Which is equal to

$$C = R_{T_0} N(d_1) - R^* e^{-rt} N(d_2) \quad (11)$$

# The Model: To Price the Call Option

## Monte Carlo Approach

Followed with Weiner Process

$$dR = \mu R dt + \sigma R dz \quad (12)$$

Then the coupon rate develops as

$$R_{T+\Delta t} = R_T * e^{\left(r - \frac{\sigma^2}{2}\right) * t + \sigma * \epsilon \sqrt{\Delta t}} \quad (13)$$

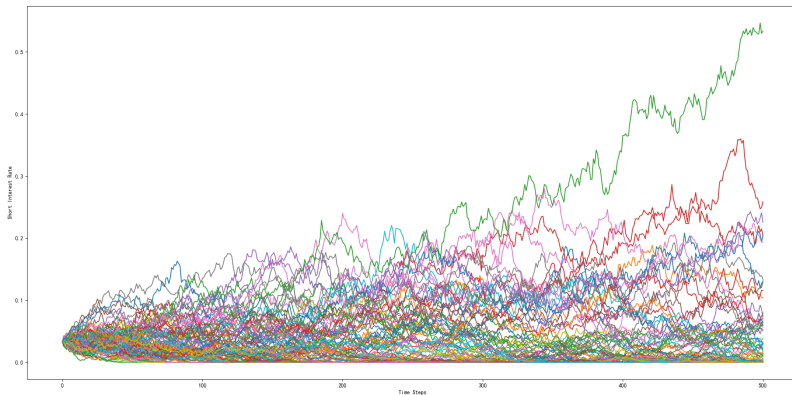
We simulate the rate with Eq (13) for N times, and take the value of the call option as the average of generated rates.



# The Model: To Price the Call Option

## Examples

Take PB '15 ShanMeiHua MTN002' As an example:



# The Model: To Price the Regular Coupon Bond

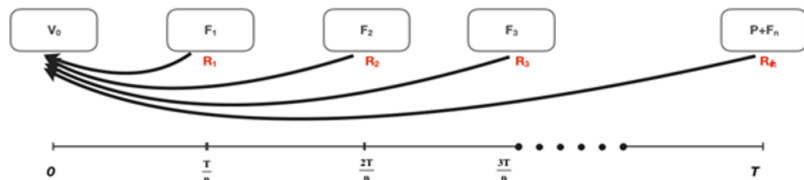


Figure: Discounted Cashflow Using YTM

the YTM we use it is the arithmetic mean of the government bond interest rate (which has the same time to maturity) provided by CCDC (China Central Depository & Clearing Co., Ltd.)

## Data: Selecting the Data

- ▶ These PBs are most traded between 2013 and 2020. Higher trading volume yields more accurate volatility.
- ▶ Issuers of PBs are not commercial banks but enterprises, as they have more possibility to meet financial difficulties and may have more motivations to exercise the option.
- ▶ For each selected PB, it needs a regular coupon bond (we call it **‘the target bond’** of the PB) issued by the same issuer, has a same time  $T$  to expire, and is issued not far from the date that the PB is issued. These target bonds can help us find the quoted difference in coupon rate to compare with the value of the call option that we estimated.
- ▶ The term of the perpetual period is a regular “ $T+N$ ” type.

# Data: Selecting the Data

| Bond Code    | PB Name                | Issuer   | Issue Size<br>(¥ 100 million) | Issue Date | 'T+N'<br>Term | Coupon<br>Rate% | Implied<br>Rating | Trade Size<br>(¥ 100 million) |
|--------------|------------------------|--|-------------------------------|------------|---------------|-----------------|-------------------|-------------------------------|
| 101555017.IB | 15ShanMeiHua MTN002    | Shaanxi Coal & Chemical Industry               | 50.0                          | 2015-8-18  | 5+N           | 6.20%           | AAA               | 2,837.061                     |
| 101560005.IB | 15 HuanNanKuang MTN001 | Huaihe Energy Group Co Ltd                     | 20.0                          | 2015-03-09 | 3+N           | 6.94%           | AAA               | 1,065.600                     |
| 101560065.IB | 15 ZhongLv MTN003      | Aluminum Corporation of China                  | 20.0                          | 2015-10-27 | 5+N           | 5.50%           | AAA               | 973.988                       |
| 101580017.IB | 15 LinYe MTN003        | China Forestry Group Corporation               | 20.0                          | 2015-12-11 | 3+N           | 5.49%           | AA                | 805.646                       |
| 101560004.IB | 15 ChuanTieTou MTN001  | China Railway Investment Co Ltd                | 35.0                          | 2015-03-05 | 3+N           | 6.18%           | AA+               | 695.720                       |
| 101478003.IB | 14 ZhongLvYe MTN002    | Aluminum Corporation of China                  | 50.0                          | 2014-12-18 | 5+N           | 6.35%           | AAA               | 659.600                       |
| 101552032.IB | 15 JinJiaoMei MTN004   | Shanxi Coking Coal Group                       | 30                            | 2015-9-10  | 5+N           | 6.30%           | AAA               | 466.460                       |
| 101559056.IB | 15 ZhongHuaGong MTN003 | China National Chemical Corporation Ltd        | 25                            | 2015-11-23 | 5+N           | 5.30%           | AAA               | 225.24                        |
| 101574003.IB | 15 JianCaiJi MTN002    | China National Building Material Group Co. Ltd | 50                            | 2015-6-11  | 5+N           | 5.46%           | AAA               | 207.56                        |
| 101653005.IB | 16 HuaNengJi MTN001B   | China Huaneng Group                            | 50                            | 2016-01-14 | 5+N           | 3.60%           | AAA               | 182.00                        |

Figure: Selected Top-10 Traded Bonds

# Data: Selecting the Data

| Bond Code    | Target Bond Name          | Issuer  | Issue Size<br>(¥100 million) | Issue Date | Maturity | Coupon<br>Rate% | Difference in Coupon<br>Rate in bps |
|--------------|---------------------------|---|------------------------------|------------|----------|-----------------|-------------------------------------|
| 101572001.IB | 15 ShanHuaMei<br>MTN001   | Shaanxi Coal & Chemical<br>Industry               | 30                           | 2015-10-26 | 5        | 5.70%           | -50bps                              |
| 101466014.IB | 14 HuaNanKuang<br>MTN001  | Huaihe Energy Group Co Ltd                        | 3                            | 2014-12-26 | 5        | 6.45%           | -49bps                              |
| 101552030.IB | 15 ZhongLv MTN002         | Aluminum Corporation of<br>China                  | 15                           | 2015-8-26  | 3        | 4.68%           | -82bps                              |
| 101569014.IB | 15 LinYe MTN001           | China Forestry Group<br>Corporation               | 5                            | 2015-6-8   | 5        | 5.28%           | -21bps                              |
| 031562033.IB | 15 ChuanTieTou<br>PPN003  | China Railway Investment<br>Co Ltd                | 10                           | 2015-9-21  | 3        | 5.30%           | -88bps                              |
| 101468005.IB | 14 ZhongLvYe MTN001       | Aluminum Corporation of<br>China                  | 40                           | 2014-9-3   | 5        | 5.99%           | -36bp                               |
| 101553013.IB | 15 JinJiaoMei MTN001      | Shanxi Coking Coal Group                          | 30                           | 2015-6-12  | 5        | 5.60%           | -70bps                              |
| 101554074.IB | 15 ZhongHuaGong<br>MTN002 | China National Chemical<br>Corporation Ltd        | 30                           | 2015-11-05 | 5        | 4.08%           | -122bps                             |
| 101554007.IB | 15 JianCaiJi MTN001       | China National Building<br>Material Group Co. Ltd | 4                            | 2015-2-12  | 5        | 4.69%           | -77bps                              |
| 101654086.IB | 16 HuaNeng Ji<br>MTN005   | China Huaneng Group                               | 40                           | 2016-09-23 | 5        | 3.14%           | -46bps                              |

Figure: Target Bonds for Selected Top-10 Traded Bonds

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# Main Estimation

| Bond Code        | PB Name                | PB CR% | "T+N" Term | Target Bond CR% | Real Difference in CR% | Interest Booster | $\sigma$ Volatility | Risk- Free Rate* | 500 Step Binomial Trees | 100 thousands Monte Carlo | B-S Model  |
|------------------|------------------------|--------|------------|-----------------|------------------------|------------------|---------------------|------------------|-------------------------|---------------------------|------------|
| 10155501<br>7.IB | 15ShanMeiHua MTN002    | 6.20%  | 5+N        | 5.70%           | 50bps                  | 100bps           | 0.1929              | 3.26%            | 81.43 bps               | 81.98 bps                 | 81.36 bps  |
| 10156000<br>5.IB | 15 HuanNanKuang MTN001 | 6.94%  | 3+N        | 6.45%           | 49bps                  | 300bps           | 0.2818              | 3.26%            | 53.72 bps               | 54.36 bps                 | 53.57 bps  |
| 10156006<br>5.IB | 15 ZhongLv MTN003      | 5.50%  | 5+N        | 4.68%           | 82bps                  | 300bps           | 0.2559              | 3.33%            | 42.31 bps               | 43.12 bps                 | 42.39 bps  |
| 10158001<br>7.IB | 15 LinYe MTN003        | 5.49%  | 3+N        | 5.28%           | 21bps                  | 300bps           | 0.3221              | 2.71%            | 49.69 bps               | 50.47 bps                 | 49.65 bps  |
| 10156000<br>4.IB | 15 ChuanTieTou MTN001  | 6.18%  | 3+N        | 5.30%           | 88bps                  | 300bps           | 0.3531              | 3.20%            | 52.88 bps               | 53.66 bps                 | 52.71 bps  |
| 10147800<br>3.IB | 14 ZhongLvYe MTN002    | 6.35%  | 5+N        | 5.99%           | 36bps                  | 300bps           | 0.4398              | 3.62%            | 178.15 bps              | 177.98 bps                | 181.04 bps |
| 10155203<br>2.IB | 15 JinJiaoMei MTN004   | 6.30%  | 5+N        | 5.60%           | 70bps                  | 300bps           | 0.3261              | 3.35%            | 97.88 bps               | 99.10 bps                 | 97.63 bps  |
| 10155905<br>6.IB | 15 ZhongHuaGong MTN003 | 5.30%  | 5+N        | 4.08%           | 122 bps                | 300bps           | 0.3349              | 3.00%            | 51.12 bps               | 52.13 bps                 | 51.11 bps  |
| 10157400<br>3.IB | 15 JianCaJi MTN002     | 5.46%  | 5+N        | 4.69%           | 77bps                  | 300bps           | 0.4439              | 3.29%            | 119.27 bps              | 122.17bps                 | 119.76 bps |
| 10165300<br>3.IB | 16 HuaNengJi MTN001B   | 3.60%  | 5+N        | 3.14%           | 46bps                  | 300bps           | 0.3230              | 2.61%            | 32.58 bps               | 33.39 bps                 | 32.70 bps  |

Figure: Test Result for The Selected Top-10 Traded Bonds

# Analysis on extreme values

Two extreme values: PB '15ZhongHuaGong MTN003' (underestimated) and the PB '14ZhongLvYe MTN002' (overestimated) . Factors for an option value estimation:

- ▶ time to maturity
- ▶ the volatility
- ▶ the initial rate or/and the strike rate



## Analysis on extreme values

- ▶ The volatility of these PBs might be low due to low liquidity; however the most estimations are reliable.
- ▶ According to Eq (10) in Section 3, the relationship between the call value and the volatility is positive; then for the bigger volatility by PB '15 ZhongHuaGong MTN003' should have a bigger call value while the smaller volatility by PB '14 ZhongLvYe MTN002' should have a smaller call value. However, in fact their real quoted values are objective by our estimation.

## Analysis on extreme values

- ▶ We re-estimate another two PBs (PB' 15ZhongDianTou MTN001' and PB' 15ZhongxinGuoanMTN001') with even higher volatility than PB '14ZhongLvYe MTN002'

| Bond Code    | PB Name               | PB CR% | "T+N" Term | Target Bond CR% | Premium by PB | Real Difference in CR% | Interest Booster | Volatility | Risk- Free Rate* | Premium by Issuer | 500 Step Binomial Trees | 100 thousands Monte Carlo | B-S Model  |
|--------------|-----------------------|--------|------------|-----------------|---------------|------------------------|------------------|------------|------------------|-------------------|-------------------------|---------------------------|------------|
| 101478003.IB | 14ZhongLvYeMTN002     | 6.35%  | 5+N        | 5.99%           | 6.01%         | 36bps                  | 300bps           | 0.4398     | 3.62%            | 65.47%            | 178.15 bps              | 177.98 bps                | 181.04 bps |
| 101566001.IB | 15ZhongDianTouMTN001  | 5.75%  | 5+N        | 4.32%           | 33.10%        | 143 bps                | 300bps           | 0.5435     | 3.41%            | 26.69%            | 135.69 bps              | 139.56 bps                | 136 bps    |
| 101576001.IB | 15ZhongxinGuoanMTN001 | 6.50%  | 5+N        | 4.38%           | 48.40%        | 212 bps                | 300bps           | 0.6804*    | 3.26%            | 34.36%            | 181 bps                 | 187.94bps                 | 181.51 bps |

Figure: Re-estimate of PBs with higher Volatility

## Analysis on extreme values

According to the B-S formula applied on our case, the call value is positively related with the spot price and negatively with the strike price. In our case, the coupon rate of a PB is confirmed based on its target bond according to a PB's features. Then the relationship between a PB with its target bond is both **substitutional** and **complementary**.

## Analysis on extreme values

- ▶ The premium by PB evaluates issuer's motivations to issue a PB over a regular bond which shows the substitutional effect. If the issuer is eager to issue a PB, he may increase further coupon rate (premium by PB). **Higher the premium on PB, higher the initial coupon rate; thus, the premium increases the positive relationship between the initial rate and the option value.**
- ▶ The premium by issuers represents the ability of getting financed which shows the complementary effect. If the issuer has difficulty to issue a regular bond, increasing the coupon rate (premium by issuer) is a rational choice. **Higher the coupon rate of a target bond, higher the value of the strike price; thus, the premium increases the negative relationship between the strike rate and the option value.**

## Analysis on extreme values

We found PB '14ZhongLvYe MTN002' has a significant small premium coupon rate by PB, while PB '15 ZhongHuaGong MTN003' has a significant big premium coupon rate by PB and a relatively lower premium by issuer as well.

| Bond Code        | PB Name                | PB CR% | "T+N" Term | Target Bond CR% | Premium by PB | Real Difference in CR% | Interest Booster | Volatility | Risk- Free Rate* | Premium by Issuer | 500 Step Binomial Trees | 100 thousands Monte Carlo | B-S Model  |
|------------------|------------------------|--------|------------|-----------------|---------------|------------------------|------------------|------------|------------------|-------------------|-------------------------|---------------------------|------------|
| 10155501<br>7.1B | 15ShanMeiHua MTN002    | 6.20%  | 5+N        | 5.70%           | 8.77%         | 50bps                  | 100bps           | 0.1929     | 3.26%            | 74.85%            | 81.43 bps               | 81.98 bps                 | 81.36 bps  |
| 10156000<br>5.1B | 15 HuanNanKuang MTN001 | 6.94%  | 3+N        | 6.45%           | 7.60%         | 49bps                  | 300bps           | 0.2818     | 3.26%            | 97.85%            | 53.72 bps               | 54.36 bps                 | 53.57 bps  |
| 10156008<br>5.1B | 15 ZhongLv MTN003      | 5.50%  | 5+N        | 4.68%           | 17.52%        | 82bps                  | 300bps           | 0.2550     | 3.33%            | 40.54%            | 42.31 bps               | 43.12 bps                 | 42.39 bps  |
| 10158001<br>7.1B | 15 LinYe MTN003        | 5.49%  | 3+N        | 5.28%           | 3.98%         | 21bps                  | 300bps           | 0.3221     | 2.71%            | 94.83%            | 49.60 bps               | 50.47 bps                 | 49.65 bps  |
| 10158000<br>4.1B | 15 ChuanTieTou MTN001  | 6.18%  | 3+N        | 5.30%           | 16.60%        | 88bps                  | 300bps           | 0.3531     | 3.20%            | 65.63%            | 52.88 bps               | 53.66 bps                 | 52.71 bps  |
| 1014780<br>03.1B | 14 ZhongLvYe MTN002    | 6.35%  | 5+N        | 5.99%           | 6.01%         | 36bps                  | 300bps           | 0.4398     | 3.62%            | 65.47%            | 178.15 bps              | 177.98 bps                | 181.04 bps |
| 10155203<br>2.1B | 15 JinJiaoMei MTN004   | 6.30%  | 5+N        | 5.60%           | 12.50%        | 70bps                  | 300bps           | 0.3261     | 3.35%            | 67.16%            | 97.88 bps               | 99.10 bps                 | 97.63 bps  |
| 1015590<br>56.1B | 15 ZhongHuaGong MTN003 | 5.30%  | 5+N        | 4.08%           | 29.90%        | 122 bps                | 300bps           | 0.3349     | 3.00%            | 36.00%            | 51.12 bps               | 52.13 bps                 | 51.11 bps  |
| 1015740<br>03.1B | 15 JianCaLi MTN002     | 5.46%  | 5+N        | 4.69%           | 16.42%        | 77bps                  | 300bps           | 0.4439     | 3.29%            | 42.55%            | 119.27 bps              | 122.17bps                 | 119.76 bps |
| 10165300<br>3.1B | 16 HuaNengJi MTN001B   | 3.60%  | 5+N        | 3.14%           | 14.65%        | 46bps                  | 300bps           | 0.323      | 2.61%            | 20.31%            | 32.58 bps               | 33.39 bps                 | 32.70 bps  |

## Analysis on extreme values

In order to check whether substitution and complement effects inflate or deflate the values of call option, we analyze two extreme PBs comprehensively.

- ▶ For PB '14 ZhongLvYe MTN002', we compare it with PB '15 ZhongLvYe MTN003'. Both are issued by Aluminum Corporation of China.
- ▶ According to our calculations, the general premium by PB should be closed to 10% (most '5+N' PBs have above 10% premium) at least. Then 6% premium is unusually low for PB '14 ZhongLvYe MTN002'.
- ▶ We check the prospectus for PB '14 ZhongLvYe MTN002', and it is stated that 30 of the total 50 hundred million yuan is designed to pay back bank loan and to adjust enterprise's finance structure.

## Analysis on extreme values

- ▶ Furthermore, the debtor, Aluminum Corporation of China has high credit rate, and it generally issues numbers of short-term credit bonds which all have high implied rate annually. Therefore, it is a very high possibility that the enterprise issues this PB is not for the fund, but for the equity characters of it; and the debtor has ability to redeem it like a regular bond. Then both the market and investors also treat this PB more like another regular bond which can be redeemed on time.
- ▶ Thus, there's no need for the debtor to increase the cost to issue this PB on purpose. Indeed, this PB was redeemed on time at the date 'T'—Year 2020 to expire (which causes ours overestimation).

## Analysis on extreme values

For PB '15ZhongHuaGong MTN003', its higher premium by PB means that the debtor is eager for this bond. In fact, the enterprise just issued another credit bond (the target bond PB'15ZhongHuaGong MTN002') only 2 weeks ago with the same issue size before the PB. If the enterprise must issue a bond on a date so close to another already issued bond, the possibly rational choice is to increase the coupon rate on this one to re-attract investors' interest.

| Bond Code    | Bond Name                   | Issuer                                  | Issue Size<br>(¥ 100 million) | Issue Date | Maturity | Coupon<br>Rate% | Difference in<br>Coupon Rate in<br>bps |
|--------------|-----------------------------|---|-------------------------------|------------|----------|-----------------|--|
| 101559056.IB | 15 ZhongHuaGong MTN003 (PB) | China National Chemical Corporation Ltd | 25                            | 2015-11-23 | 5+N      | 5.30%           | -122bps                                |
| 101554074.IB | 15 ZhongHuaGong MTN002      | China National Chemical Corporation Ltd | 30                            | 2015-11-05 | 5        | 4.08%           | /                                      |



## Analysis on extreme values

For PB '15ZhongHuaGong MTN003', its higher premium by PB means that the debtor is eager for this bond. In fact, the enterprise just issued another credit bond (the target bond PB'15ZhongHuaGong MTN002') only 2 weeks ago with the same issue size before the PB. If the enterprise must issue a bond on a date so close to another already issued bond, the possibly rational choice is to increase the coupon rate on this one to re-attract investors' interest.

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| 101554074.IB | 15 ZhongHuaGong MTN002      | China National Chemical Corporation Ltd | 30                            | 2015-11-05 | 5        | 4.08%           | /                                      |

## Effect by the PB issuance system

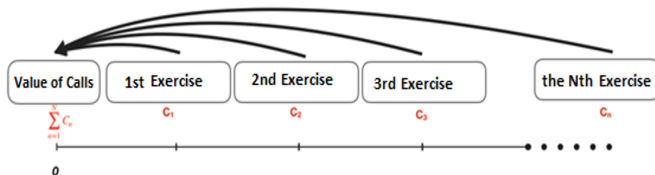
**Recall** the definition of the PB coupon rate if it is extended:

- ▶ **The coupon rate = spot rate of benchmark interest rate + initial difference in coupon rate + interest rate booster**
- ▶ 'the difference in coupon rate'  $\leq 100\text{bps}$ , and we believe it is the value of one call to extend the PB.
- ▶ 'the interest rate booster'  $\approx 300\text{bps}$ , and we believe it is temporary cost for having a PB as an enterprise's equity.

## Effect by the PB issuance system

If a PB can be extended forever without the booster, then the call value should be the accumulative value of all future call options.

$$PV = \sum_{k=0}^n C_K + PV_{Bi} \quad (14)$$



## Effect by the PB issuance system: Multiple Extensions

Take PB '15 ZhongHuaGong MTN003' to evaluate the accumulative call options verse the effect of the interest rate booster (300bps).

- ▶ According to our estimation, the premium by PB would be 251.28bps should the PB be extended for 3 times.
- ▶ The real premium by PB at the issuance was 122bps, but adding up the booster, the CP% will be 14.03%.
- ▶ Thus, the interest rate booster lowers the value of the option, and limits the chance for the debtor to over exercise the right which make the PB still behaves more like a bond.

| PB Code          | PB Name                   | Coupon Rate | Estimated Value of 1 <sup>st</sup> Extension | Estimated Value of 2 <sup>nd</sup> Extension | Estimated Value of 3 <sup>rd</sup> Extension | Accumulative Estimated Values | Real Difference Interest |
|------------------|---------------------------|-------------|--|--|--|-------------------------------|--------------------------|
| 10155905<br>6.IB | 15 ZhongHuaGong<br>MTN003 | 5.3%        | 51.11bps                                     | 84.81bps                                     | 115.36bps                                    | 251.28bps                     | 122bps                   |

## Effect by the PB issuance system: The Booster

The interest rate booster may also be combined with credit ratings, types of the perpetual term, and the experiences for issuing PB; and the value is various for PBs.

- ▶ For example, the interest rate booster for the top traded PB'15 ShanMeiHua MTN002', which is a triple A for both the bond and the debtor, is only 100bps.
- ▶ The booster for '2+2+N' type of PB'18 YangMei MTN004', which is the only PB issued by the debtor and the credit rate had been degraded, is 400bp.

Bigger booster may lower the chance for the debtor to exercise the right; and the effect of the interest rate booster is much bigger than the value of the option which may cause investors under value the option.

# Effect by the PB issuance system: Re-discover the values

The current difference in coupon rate is growing, which means the value of the option is realizing; and differences should be above 60bps is in common by the market.

| Issue Date | PB Code          | PB Name               | Issue Size | CR%   | X+N Term | Target Code      | Target Bond Name     | Issue Size | CR%   | Term | Differences in interest |
|------------|------------------|-----------------------|------------|-------|----------|------------------|----------------------|------------|-------|------|-------------------------|
| 2017       | 10175407<br>7.IB | 17HeGangJiMT<br>N010  | 10         | 5.65% | 3+N      | 101755018.I<br>B | 17HeGangJi<br>MTN011 | 30         | 5.18% | 3    | 27 bps                  |
| 2017       | 10178200<br>8.IB | 17HeGangJiMT<br>N013A | 18         | 5.75% | 3+N      | 101755018.I<br>B | 17HeGangJi<br>MTN011 | 30         | 5.18% | 3    | 76 bps                  |
| 2018       | 10180061<br>5.IB | 18HeGangJiMT<br>N004  | 20         | 5.89% | 3+N      | 101800629.I<br>B | 18HeGangJi<br>MTN005 | 20         | 5.10% | 3    | 79 bps                  |
| 2018       | 10180114<br>3.IB | 18HeGangJiMT<br>N009  | 15         | 5.35% | 3+N      | 101801161.I<br>B | 18HeGangJi<br>MTN010 | 15         | 4.27% | 3    | 108 bps                 |
| 2019       | 10190019<br>3.IB | 19HeGangJiMT<br>N002A | 12         | 4.91% | 3+N      | 101900023.I<br>B | 19HeGangJi<br>MTN001 | 15         | 3.80% | 3    | 111 bps                 |
| 2019       | 10190025<br>6.IB | 19HeGangJiMT<br>N003  | 15         | 5.15% | 3+N      | 101900023.I<br>B | 19HeGangJi<br>MTN001 | 15         | 3.80% | 3    | 135 bps                 |
| 2019       | 10190098<br>2.IB | 19HeGangJiMT<br>N005  | 15         | 4.64% | 3+N      | 101900833.I<br>B | 19HeGangJi<br>MTN004 | 15         | 3.90% | 3    | 74bps                   |
| 2019       | 10190131<br>7.IB | 19HeGangJiMT<br>N006  | 15         | 4.36% | 3+N      | 101900833.I<br>B | 19HeGangJiMTNO<br>04 | 15         | 3.90% | 3    | 64bps                   |

## Effect by the PB issuance system: Further Analysis

- ▶ Our estimations needs to be more reliable.
- ▶ Factor controlling is heavy in sample data.
- ▶ Direct limitation in the true volatility of a PB.
- ▶ Indirect effect by investors' liquidity condition, credit ratings or rating for the PB on the true volatility of a PB.
- ▶ Not every PB can find a target bond to be paired with. How to find a couple for a single PB.
- ▶ Substitution effect by Multi-types of PB.

Thank You for Listening!