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PAPER

Panda bonds: opportunity or threat for Europe?

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Abstract We analyse the effect of panda bonds on indebted firms default probability. The theoretical default probability as a function of debt is evaluated in the Black, Scholes (1973) and Merton (1974) framework for various set of parameters values. We consider as benchmark the prevailing default rates for speculative-grade corporate companies based on the last reports by S&P (2019) and Moody's (2018).

Keywords: Capital structure; Credit risk; Bond markets; Chinese internationalization.

JEL Classification; G15; G33

1. Introduction

In 2005 the International Finance Corporation and Asian Development Bank issued the first panda bonds. The two panda bonds were renmbinbi-denominated and their values were 1.13 and 1 billion renminbi respectively (about 133 and 118 million dollars at the exchange rate in 2005). Both bonds had a 10-years maturity and annual returns of 3.4% and 3.34%. It was the first time that foreign issuers were entitled to sell bonds in Chinese financial market. At the beginning, funds collected through Panda bond were restricted to be used in China only. This rule was too binding for foreign companies interested in issuing panda bonds. In 2010 this rule was cancelled and this created a strong appetite towards panda bonds. The first corporate panda issuer was Deutsche Daimler in 2014: the face value was 500 million renmbinbi (about 83 million $ at the time), maturity 1 year and coupon 5.2%. Daimler often repeated the deal (about 14 times, with short-term maturities, usually 1 or three years).

In 2016 Polish Finance Ministry signed an agreement with Bank of China and Poland became the first European Government to issue panda bonds. Now, there are many countries (Governments or governmental financial institutions or single companies) all over the world involved in panda bond project. Recently (march 2019) Italian Cassa Depositi e Prestiti (CDP) and Bank of China planned a panda bond issue with face value equal to 5 billion renminbi (about 750 million $) together with a co-

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financing plan for Italian firms investing in China with value equal to 4 billion renminbi (about 606 million $).

The total deal volume of panda bonds was about 125 billion renminbi at the end of 2017 (Schipke et al, IMF 2019). The outstanding volume in the last year (June 2018-May 2019) was about 24 billion renminbi (source GlobalCapital 2019).

In general, panda bonds issues have maturity from 1 to 10 years and annual coupons from about 3% to about 6% (GlobalCapital 2019).

Panda bonds are important in the development of China's credit bond market and in the process of reforming and opening up Chinese economy. They make part of the Belt and Road Initiative and contribute to the process of Chinese internationalization (Schipke et al, IMF 2019).

From the point of view of issuers, the main purpose is the growth of foreign entrepreneurial projects in China. Many financial analysis state, on one hand, that panda bonds will give relevant advantages in the short term: in particular China will increase liquidity of counterparty governments (or counterparty financial intermediaries, usually governmental institutions).

On the other hand, in the medium or long term there are serious risks. First of all there is the risk of counterparty sovereignty reduction, due to the future influence of Chinese monetary policy on bonds returns and therefore on the issuer value of debt, influenced also by the exchange rate evolution. Another kind of risk is the inducement for non-Chinese firms to reinforce their activities in China and to reduce them in the country of origin.

In this paper we provide an analysis focused on companies that directly issue panda bonds or on firms that borrow money through panda bonds, both with the aim of financing their activities in China. From their point of view, if indebtedness is too much high and the firm is not able to repay debt, China should acquire the control of the firm itself: it is, in some sense, another risk of "sovereignty reduction". In the worst situation, if the firm goes bankruptcy, China could become the owner of the firm. In this paper we focus on the risk of default of indebted firm and therefore on the possibility of Chinese final ownership. From a quantitative point of view the main factors affecting the default probability for indebted firms are debt ratios, the maturity of debt, the coupon (cost of debt), the risk free rate in the country of origin, the volatility of the value of the firm. Another important factor is the foreign exchange rate. We evaluate the default probability ignoring this last factor in the Black, Scholes and Merton framework (Section 2), for various set of values of the main factors. The results are described in Section 3.

In Section 4 we analyze the ex-post annual default rates for corporate non-financial rated companies presented in reports by S&P (2019) and Moody's (2018).

The conclusions outlined in Section 5 discuss the comparison between the theoretical default probabilities and the real ex-post default probabilities reported by S&P and Moody's.

2. Black, Scholes and Merton (BSM) structural approach

This section describes the Black, Scholes (1973) and Merton (1974) structural approach. Merton considers a firm with a simple capital structure, that is the value of the firms' assets Vt is given by the value of equity Et and the value of risky debt v(t,T) corresponding to the present value of a zero-coupon bond with a face value D and maturity T subject to the firm's risk of default:

$$Vt=Et+v(t,T)$$

At maturity *T*, if the value of the firm's assets *VT* is greater than the amount owed to the debt holders (the face amount *D*) then the equity holders repay the bondholders and retain the firm. If the value of the firm's assets is less than the face value, the firm goes bankruptcy. In this case, if there are no costs associated with default, bondholders take over the firm and the value of equity becomes zero, assuming limited liability. In this simple framework, if *Vt* and *Et* follow a geometric brownian motion, using Black, Scholes arguments in presence of a risk free rate *r*, Merton shows that the value of equity is the value *ct* of a European call option on the firm value *Vt* with strike price the face value of debt *D*:

$$E_t = c\,[V_t, D, t, T, r, \sigma] = c_t$$

where σ represents the volatility of the firm.
In the Black, Scholes model the call value, that is the equity value is given by the well-known formula:

$$c_t = E_t = V_t N(d_1) - D_e^{-r(T-t)} N(d_2)$$

with *N(x)* equal to the standard normal cumulative distribution function evaluated at *x* and:

$$d_1 = \frac{\ln\left(\frac{V_t}{D}\right) + \left(r + \frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}};\; d_2 = d_1 - \sqrt{T-t}$$

It can be shown that the value at time *t* of the probability that the call will be in the money at time *T* is equal to *N(d2)*; in the Merton structural model this means that the firm survival probability is:

$$Prob(V_t > D) = N(d_2)$$

then the probability of default is given by:

$$PD_t = Prob(V_t \leq D) = 1 - N(d_2) = N(-d_2)$$

3. BSM applied to panda bonds

The assumption is that panda bonds can have three final maturities (3, 5 and 10 years). We let 100 the firm initial value and we consider different levels of debt, from 0 to 200. This means that the debt ratio goes from 0 to 200%. We suppose that the risk free return is equal to zero, 1%, 2% or 3%. The firm volatility is fixed to 20%, 25% or 30%. The analysis has been repeated for two level of panda bond coupon (the firm cost of indebtedness), approximately corresponding to the minimum and maximum value applied until now, that is 3.5% and 6%. We discuss the results in two separate sub-

sections.The results show the strong impact of maturity and of the risk free rate on cumulative PD as a function of initial debt. Paradoxically, the volatility seems to have less effect on cumulative PD. In any case, when the debt ratio is greater than 1, the cumulative PD is usually above 80% and it increases over 90% for debt ratio more than 1.5. However, the analysis of annual default probabilities seems to be more valuable. First of all, they are comparable whatever the maturity and they can be compared with the values reported by S&P and Moody's (see Section 4).

3.1 Panda bond coupon equal to 3.5%

The following Figures 1, 2 and 3 show some static comparative analysis using annual PD as a function of initial debt.

Figure 1. Ann. PD: r=0, σ=25%, maturity changes

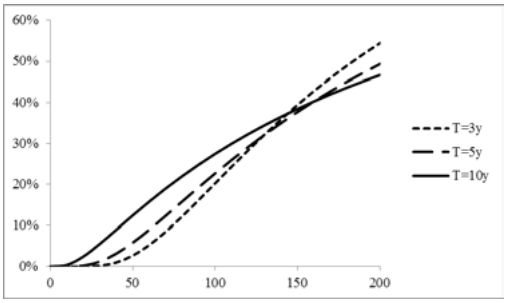

Figure 2. Ann. PD: T=10y, σ=25%, r changes

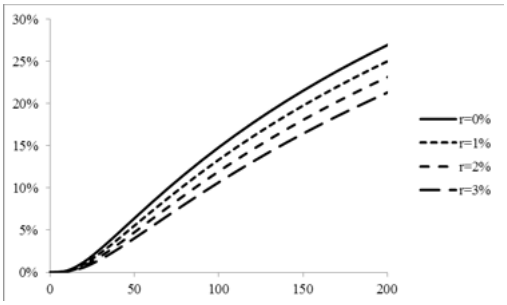

Figure 3. Ann. PD: r=0, T=10y, volatility changes

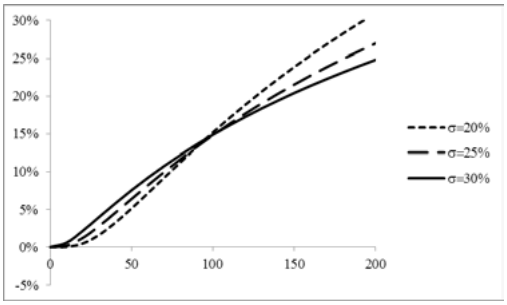

Figure 1 shows the effects of maturity for a fixed level of risk free rate and of volatility. In this case, the annual default probability is 2.7%, 5.8% and 12.4% for T=3, 5, 10 years respectively, with a 50% debt ratio. With debt ratio equal to 100%, the probabilities become 20.2%, 22.7% and 27.5% for T=3, 5, 10 years. The situation changes for debt ratio greater than about 150%: e.g. with a 200% debt ratio, the shorter maturity presents the worst default probability (73%), T=5y and T=10y have, respectively, a 49.3% and a 27% probability. This is due to the effect of the logarithmic component (d1 and d2) in the BSM formula. The combined effect of low volatility and high risk free rate, gives 4.4%, 5.8% and 6.4% default probabilities for the three maturities with 50% debt ratio, 31.4%, 22.7% and 14.8% with 100% debt ratio and 56.6%, 37.7% and 21.5% with 200% debt

ratio. Intuitively, even if a debt ratio between 50% and 150% is considered "normal" (it depends on the kind of firm, sometimes it can reach values greater than 1.5), in our Black, Scholes, Merton application debt ratios greater than 1 give rise to dangerous situations for the indebted firm. This is confirmed also varying the other parameters in the analysis. For example, looking at Figure 2, in the most favorable situation (r=3%) the default probability is 4%, 10.7% and 22% with debt ratio 50%, 100% and 200%.
At the end, changing volatility (Figure 3) for various fixed sets of the other parameters , paradoxically seem to have less impact on the default probability levels.

The following Table 1 shows the results corresponding to some sets of parameters used in the analysis. In particular, it gives evidence of dangerous annualized default probability in case of debt ratios greater than 50%.

Table 1

Firm initial value = 100		r=0%						r=2%					
		σ=20%		σ=25%		σ=30%		σ=20%		σ=25%		σ=30%	
Final debt	Initial	Default probability						Default probability					
maturity (years)	debt	cumulative	annualized	cumulative	annualized	cumulative	annualized	cumulative	annualized	cumulative	annualized	cumulative	annualized
3	20	0.00%	0.00%	0.06%	0.02%	0.42%	0.14%	0.00%	0.00%	0.03%	0.01%	0.30%	0.10%
	30	0.14%	0.05%	1.01%	0.34%	3.18%	1.07%	0.08%	0.03%	0.69%	0.23%	2.44%	0.82%
	40	1.50%	0.50%	4.88%	1.65%	9.65%	3.33%	0.96%	0.32%	3.63%	1.22%	7.82%	2.68%
	50	6.37%	2.17%	12.68%	4.42%	19.16%	6.84%	4.48%	1.52%	10.02%	3.46%	16.17%	5.71%
	60	15.91%	5.61%	23.55%	8.56%	30.11%	11.26%	12.07%	4.20%	19.51%	6.98%	26.22%	9.64%
5	20	0.14%	0.03%	1.11%	0.22%	3.57%	0.72%	0.07%	0.01%	0.68%	0.14%	2.55%	0.52%
	30	1.89%	0.38%	5.92%	1.21%	11.54%	2.42%	1.07%	0.21%	4.09%	0.83%	8.89%	1.84%
	40	7.58%	1.56%	14.77%	3.15%	22.08%	4.87%	4.87%	0.99%	11.02%	2.31%	17.91%	3.87%
	50	17.49%	3.77%	25.87%	5.81%	33.11%	7.73%	12.33%	2.60%	20.43%	4.47%	27.89%	6.33%
	60	29.90%	6.86%	37.40%	8.94%	43.44%	10.77%	22.63%	5.00%	30.85%	7.11%	37.67%	9.02%
10	20	4.70%	0.48%	11.55%	1.22%	19.68%	2.17%	2.32%	0.23%	7.34%	0.76%	14.37%	1.54%
	30	15.06%	1.62%	24.67%	2.79%	33.51%	4.00%	8.85%	0.92%	17.41%	1.89%	26.22%	3.00%
	40	28.12%	3.25%	37.41%	4.58%	45.12%	5.82%	18.53%	2.03%	28.30%	3.27%	36.94%	4.51%
	50	41.05%	5.15%	48.45%	6.41%	54.48%	7.57%	29.37%	3.42%	38.52%	4.75%	46.09%	5.99%
	60	52.47%	7.17%	57.61%	8.22%	61.97%	9.22%	39.96%	4.97%	47.56%	6.25%	53.74%	7.42%

3.2 Panda bond coupon equal to 6%

The new level of coupon rate has obviously a negative impact on default probabilities: they considerably increase. This effect is heightened with medium and long term maturities: in this situations in order to obtain annual PD less than 3% it is necessary to restrict indebtedness below 40%. The following Table 2 replicate Table 1 with the new coupon rate and it allows to compare the two cases.

Table 2

Firm initial value = 100		r=0%						r=2%					
		σ=20%		σ=25%		σ=30%		σ=20%		σ=25%		σ=30%	
Final debt	Initial	Default probability						Default probability					
maturity (years)	debt	cumulative	annualized	cumulative	annualized	cumulative	annualized	cumulative	annualized	cumulative	annualized	cumulative	annualized
3	20	0.00%	0.00%	0.10%	0.03%	0.64%	0.21%	0.00%	0.00%	0.06%	0.02%	0.46%	0.15%
	30	0.27%	0.09%	1.58%	0.53%	4.36%	1.47%	0.16%	0.05%	1.11%	0.37%	3.39%	1.14%
	40	2.55%	0.86%	6.89%	2.35%	12.36%	4.30%	1.68%	0.56%	5.24%	1.78%	10.16%	3.51%
	50	9.54%	3.29%	16.64%	5.89%	23.34%	8.48%	6.93%	2.37%	13.41%	4.69%	19.96%	7.15%
	60	21.72%	7.84%	29.20%	10.87%	35.31%	13.51%	16.98%	6.01%	24.63%	8.99%	31.12%	11.69%
5	20	0.34%	0.07%	1.96%	0.40%	5.30%	1.08%	0.17%	0.03%	1.25%	0.25%	3.87%	0.79%
	30	3.61%	0.73%	9.05%	1.88%	15.57%	3.33%	2.16%	0.44%	6.47%	1.33%	12.28%	2.59%
	40	12.42%	2.62%	20.53%	4.49%	27.98%	6.35%	8.41%	1.74%	15.82%	3.39%	23.20%	5.14%
	50	25.61%	5.75%	33.59%	7.86%	40.10%	9.74%	18.97%	4.12%	27.34%	6.19%	34.47%	8.11%
	60	40.21%	9.78%	46.11%	11.63%	50.84%	13.24%	31.87%	7.39%	39.11%	9.45%	44.91%	11.24%

Firm initial value = 100		r=0%						r=2%					
		σ=20%		σ=25%		σ=30%		σ=20%		σ=25%		σ=30%	
Final debt maturity (years)	Initial debt	Default probability						Default probability					
		cumulative	annualized	cumulative	annualized	cumulative	annualized	cumulative	annualized	cumulative	annualized	cumulative	annualized
10	20	10.03%	1.05%	18.90%	2.07%	27.77%	3.20%	5.52%	0.57%	12.83%	1.36%	21.17%	2.35%
	30	26.15%	2.99%	35.62%	4.31%	43.55%	5.56%	16.98%	1.84%	26.71%	3.06%	35.45%	4.28%
	40	42.71%	5.42%	49.81%	6.66%	55.60%	7.80%	30.85%	3.62%	39.83%	4.95%	47.21%	6.19%
	50	56.71%	8.03%	60.93%	8.97%	64.66%	9.88%	44.15%	5.66%	50.98%	6.88%	56.57%	8.00%
	60	67.62%	10.66%	69.43%	11.18%	71.51%	11.80%	55.61%	7.80%	60.07%	8.77%	63.96%	9.70%

4. Ex-post default probabilities for rated companies

The aim of the analysis shown in this Section is to find effective default rates comparable with the theoretical annual default rate previously described.

In 2019 S&P publishes the last annual report on global corporate default and rating transition. In the introduction, S&P distinguishes rated companies in two main classes: investment and speculative grade. S&P depicts the annual default rates evolution of the two classes and of overall since 1981. Focusing on years from 2006 and on the two classes, S&P shows that at the beginning the investment grade companies default rates are near to zero while speculative are around 1%. In 2008-2009 the rates rise, respectively, to 0.5% and 10%. There are new peaks in 2012 (2.6%) and 2016 (4.2%) only for speculative grade while investment grade default rates remain around 0.1% since 2010 nowadays.

S&P assessed that "*the global speculative-grade corporate default rate fell to 2.1% in 2018 from 2.5% at the end of 2017 … Despite greater market volatility and political uncertainty in 2018".*

Moody's (2018) analyzes the evolution of corporate default rates in the period 1920-2017, showing that in the last years they decreased and fell below historical average. Moody's states that speculative-grade corporate companies has a default rate equal to 2.9% in 2017, while the overall rate is 1.4%.

Even though data refer to companies rated by S&P and Moody's, the estimated default rates can be considered representative of a wide set of corporate companies all over the world.

If we let the entrepreneurial projects of international firms investing in China comparable to speculative-grade corporate companies, we can refer to annual default rate in the range 2.5%-2.9% (S&P, Moody's) and 2.1% in 2018 (S&P). This can be considered a "worst case" estimation of the expected future default rates, keeping into account that both S&P and Moody's forecast a further decline in default rates.

Otherwise, we can consider the average over the last years, excluding peaks if we don't expect new crises or, vice versa, including peaks. Using S&P data and considering, substantially, the last decade, the average over the period 2010-2018 is about 2.6% while that over 2008-2018 is about 3.3%.

5. Conclusions

We analyze the effect of firms financing through panda bonds on firms default probability. We make use of a static comparative analysis varying, in particular, the bond maturity

and the volatility level. The theoretical default probability as a function of debt is evaluated in the Black, Scholes (1973) and Merton (1974) framework. We provide also an analysis of the recent prevailing default rates for speculative-grade corporate companies based on the last report by S&P (2019) and Moody's (2018): it emerges that last default rates are in the range 2.1%-2.9%, while the average on the last decade gives values in the range 2.6%-3.3%.

If S&P and Moody's default rates are considered as a benchmark level, the analysis of the theoretical probabilities suggest that indebtedness levels greater than 50% combined with long panda bonds maturity gives rise to annual default probabilities greater than 6%: this is about two times the default rate of speculative-grade corporate. This situation gets worse when panda bond coupon rate rises from 3.5% to 6% and the precautionary level of debt ratio should be less than 40%. Volatility seems to have a minor impact with respect to maturity, nevertheless it represents another key factor.

Panda bonds can be considered a good financing source if the debt ratio is limited to low levels (40%-50%) and if the bond maturity is short (3 years). At the same time, a careful monitoring of volatility is necessary. We omit the effect of Chinese monetary policies and of exchange rates, but obviously this could have an important effect on firms solvency capacity.

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