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Pricing partially guaranteed bonds

Valuation of bonds benefiting from a World Bank partial guarantee

On October 7, 2015, after a hiatus of almost 15 years, the World Bank reentered the debt capital markets with a guarantee instrument that supported the issuance of a US$1 billion bond by the Republic of Ghana. Pricing a partially guaranteed bond proved to be challenging for investors due to limited familiarity with the instrument. To help future investors familiarize with World Bank guarantees, this paper presents four ways to assess the value of bonds benefiting from such guarantees.

The absence of sovereign bond issuances with World Bank guarantee support for almost 15 years and the customized application of the WB guarantee instrument led potential investors in the Ghana bond to ponder the best way to value the instrument. This paper provides guidance on this subject by presenting four ways to assess the value of a World Bank guarantee for debt capital market issues. The methodologies presented are: nominal weighted average yield; rolling nominal weighted average yield; discounted cash flow; and recovery analysis.

The paper presents the methodologies by applying them to a fictional bond issuance by the government of Emergistan, a fictional low income country. Background information on the country and bond issuance have been kept to the minimum as the sole purpose of this example is to illustrate the results of each of the methodologies.

It should be noted that World Bank guarantees can be structured in a number of ways depending on the issuer's objectives as well as country and market circumstances. For instance, guarantees could cover interest and/or principal payments of bonds. Coverage could be on a first loss or back-ended basis. Therefore, the most appropriate valuation method would depend on the specific features of the guarantee being considered.

The World Bank is comprised of two entities, the International Development Association (IDA) and the International Bank for Reconstruction and Development (IBRD) for low and middle income countries respectively. Since IDA does not have any outstanding bonds, it has been assumed that IBRD would be used as a proxy for the risk of both IDA and IBRD.

The case of Emergistan

Emergistan is an emerging country rated in the B/BB category by credit rating agencies with several USD denominated Eurobonds already outstanding. Table 1 illustrates the fictional yield curves of US Treasuries, IBRD and Emergistan.

Table 1

	US	IBRD	Emergistan	Spread vs US
1 year	0.20%	0.50%	7.00%	680bps
3 years	1.00%	1.20%	7.82%	682bps
5 years	1.29%	1.49%	8.44%	716bps
7 years	1.57%	1.77%	9.07%	750bps
10 years	2.00%	2.20%	10.00%	800bps
15 years	2.50%	2.70%	11.00%	850bps

Fictional yield curves

Emergistan intends to raise a 15-year, US$1 billion bond in the debt capital markets with the support of a US$400 million World Bank guarantee. To smoothen out the repayment profile of Emergistan's debt, it has been decided that the bond would have a soft-bullet feature, amortizing in three equal installments in the last three years of its life. The World Bank guarantee has been structured as a first loss arrangement until its maturity date.

Mechanics of a World Bank First Loss Guarantee

The first loss feature means that, from the first day of the bond's issuance, US$400 million of cover is made available by the World Bank for any missed payment by Emergistan. If Emergistan fails to make any debt service payment under this particular bond, the World Bank is obliged to pay instead of Emergistan. After each coupon/principal payment date, the remaining balance of the guarantee (US$400 million less any previous guarantee payments) is then made available for the next scheduled payment of interest and/or principal. Figure 1 illustrates the profile of first loss coverage over the life of the bond.

Figure 1

One important feature of this guarantee structure is that the guarantee amount does not reduce as the bond amortizes, i.e. the full balance of the guarantee (US$400 million less any prior payments) remains available as long as the bond is outstanding. Therefore, if Emergistan does not default on its payment obligations, over time an increasingly larger share of the remaining debt service is guaranteed by the World Bank. In the current case, the soft-bullet amortization feature allows the World Bank to cover the last three installments sequentially in full. Figures 2 and 3 show these increased shares of the debt service covered in Years 8 and 14 when there is no payment default.

Figure 2

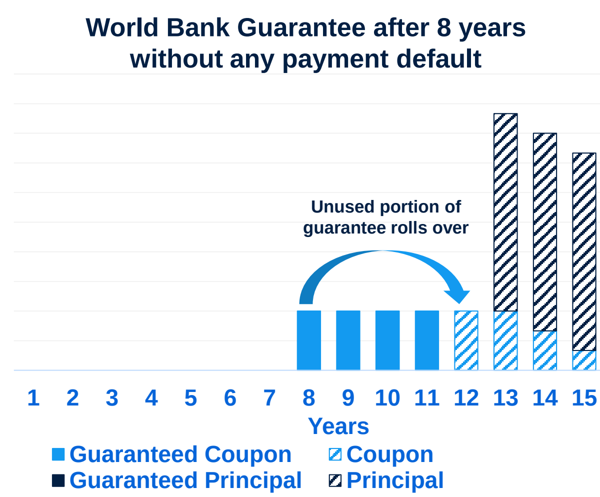


Figure 3

The World Bank guarantee supporting Emergistan's bond issuance is non-accelerable. This means that even if bondholders decide to accelerate the partially guaranteed bond following an event of default, the World Bank guarantee does not accelerate and the World Bank pays out according to the original payment schedule. As a general rule, World Bank guarantees are non-accelerable but IBRD may provide accelerable guarantees in exceptional circumstances.

Before embarking on a deeper assessment of the methodologies presented in this paper, please note:

- The calculations do not take into account any premiums the market may demand (such as for new issue); and
- The calculations used to develop this note are contained in a financial model that can be downloaded from the World Bank Guarantees website. This model could help readers assess other planned bond issues that could benefit from a World Bank partial guarantee.

Methodology #1
Nominal weighted average yield

The first methodology consists of calculating a weighted average yield based on the weights of the total guaranteed cash flows and the total uncovered cash flows. For the purpose of this paper, it has been assumed that the reference 14-year (average life of the bond) IBRD and Emergistan yields are 2.60% and 10.80% respectively.

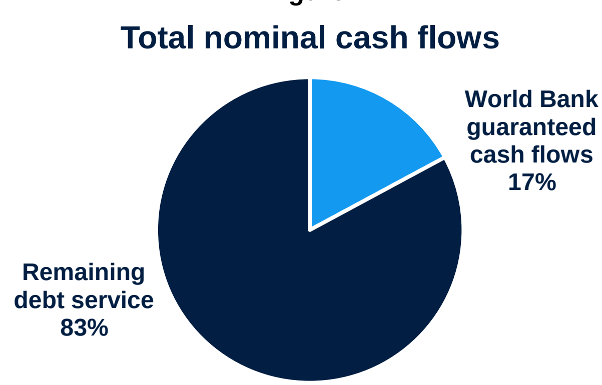
For the first iteration, Emergistan's uncovered bond yield is used to simulate a series of bond cash flows. The total nominal debt service over the life of such a bond is US$2,512 million. The weight of the guaranteed cash flows is therefore 400/2,512 = 15.9%. Using this number, the weighted average yield is:

15.9% x 2.60% + 84.1% x 10.80% = 9.49%

Using 9.49% as the yield of the guaranteed bond for a second iteration, the new total debt service is US$2,329 million and the new weight of the guaranteed cash flows is 400/2,329 = 17.2%. Through this second iteration, the weighted average yield can be refined to:

17.2% x 2.60% + 82.8% x 10.80% = 9.39%

Figure 4



As the impact of additional iterations is limited to 1 or 2bps, two iterations are usually sufficient to provide an estimate of the blended yield of a bond partially guaranteed by the World Bank.

This methodology is the most basic one. However, it has two major drawbacks. First, it does not capture the rolling feature of the guarantee (i.e. as long as Emergistan does not default on its payment obligation the share of remaining debt service guaranteed by the World Bank increases). Second, it does not account for the time value of money. As a result, it produces the lowest estimate of the value of the World Bank guarantee support.

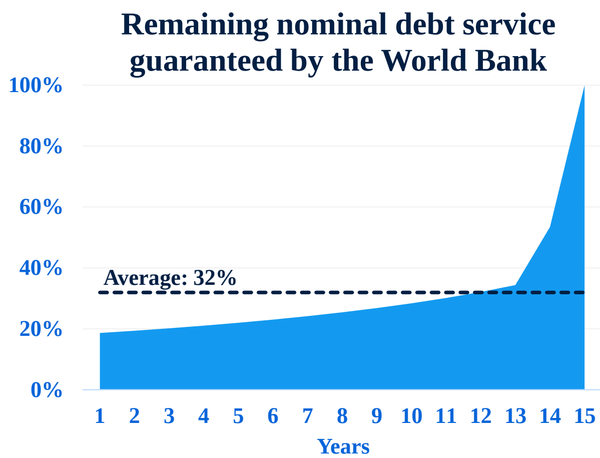
Table 2

Features captured by methodology	**#1**
Blending of WB and EM yields	✓
Rolling feature	✗
Time value of money	✗
Bond Yield	9.4%
Implied value of World Bank guarantee	142bps

Methodology #2
Rolling nominal weighted average yield

One of the key features of a first loss World Bank Guarantee is that after each interest/principal payment date, the unused portion of the guarantee rolls over to the next scheduled payment of principal and interest. The previous methodology can thus be improved by calculating the percentage of the remaining cash flows guaranteed by the World Bank at any point in time during the life of the bond (instead of just once at the time of issuance).

Figure 5



The first series of cash flows is simulated using the yield of an uncovered Emergistan bond in a similar fashion to Methodology #1. The weights of the remaining guaranteed cash flows and the uncovered guaranteed cash flows are then calculated 15 times (once every year until bond maturity). The corresponding nominal weighted average yields for each year are then calculated and then used to subsequently calculate the average of all these yields. This number is used to run additional iterations until the yield converges. In the present example, the average percentage of cash flows guaranteed by the World Bank over the life of the bond is 32% and the resulting rolling nominal weighted average yield is 8.18%.

While this methodology still does not account for the time value of money, it captures the rolling feature of the guarantee as it accounts for the fact that, over time, an increasingly larger share of the remaining cash flows are guaranteed by the World Bank.

Table 3

Features captured by methodology	**#2**
Blending of WB and EM yields	✓
Rolling feature	✓
Time value of money	✗
Bond Yield	8.2%
Implied value of World Bank guarantee	262bps

Methodology #3
Discounted Cash Flow

This methodology consists in breaking down the bond cash flows into two separate streams and using two different discount rates (IBRD's and Emergistan's) to calculate their present value. The resulting bond yield is subsequently adjusted so that the sum of the two present values is equal to the face value of the bond.

One limitation of this methodology is that it does not capture the rolling feature of the guarantee. This is because a predetermined US$400 million cash flow stream needs to be isolated and discounted at IBRD's discount rate, while the rest of the debt service is discounted at Emergistan's yield.

A pessimistic scenario is to assume that Emergistan defaults in Year 1 by discounting the first US$400 million at IBRD's discount rate and the rest of the cash flows at Emergistan's yield. Another scenario is to assume that the guarantee rolls over until maturity of the bond and the last US$400 million due by Emergistan are therefore guaranteed by the World Bank.

The yield derived from equalizing the cash flows' present value to the face value of the bond is driven by whether the cash flows guaranteed by the World Bank are assumed to occur at the beginning, the middle or the end of the bond's life. The more distant in time the guaranteed cash flows, the lower the yield. Figures 6 and 7 illustrate how cash flows are discounted using different discount rates.

Figure 6

First $400 million discounted at IBRD's yield

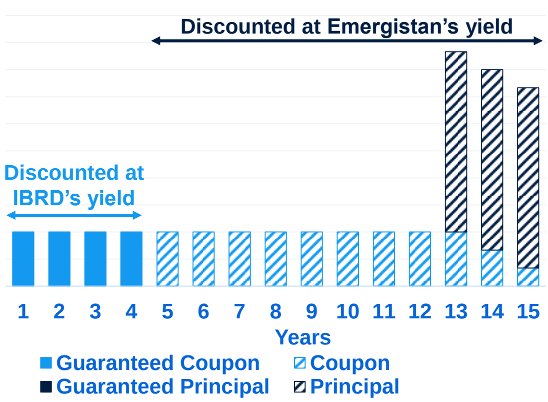
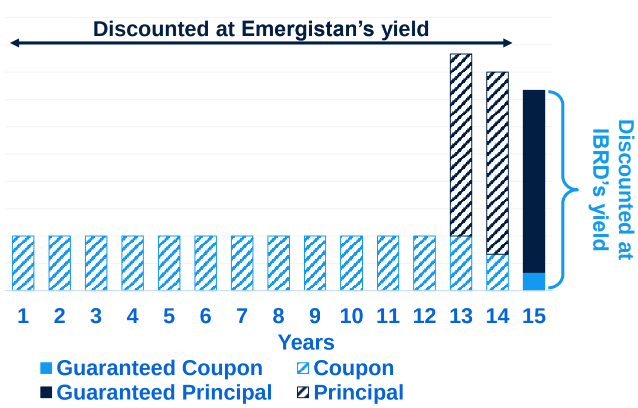


Figure 7

Last $400 million discounted at IBRD's yield



This methodology results in yields ranging from 8.16% to 9.89%.

Even though this methodology captures the time value of money component that was missing from the previous methodologies, it still does not capture the full value of the guarantee as the rolling feature is not taken into account. The ability to call on the guarantee for any missed payment during the life of the bond is indeed not captured by this methodology.

Table 4

Features captured by methodology	#3
Blending of WB and EM yields	✓
Rolling feature	✗
Time value of money	✓
Bond Yield	8.2% - 9.9%
Implied value of World Bank guarantee	91 - 264bps

Methodology #4
Recovery analysis

A more rigorous way to capture the value of the World Bank guarantee, and especially its rolling feature, is to run a detailed recovery analysis.

The first step of this methodology consists in extracting the implied annual probability of default from the current trading levels of Emergistan's bonds. To do so, the World Bank model assumes that, once adjusted for the probability of default and proceeds received from recovery, an Emergistan bond should have a yield to maturity similar to that of a similar maturity, risk-free bond (the risk-adjusted yields of the two bonds being equal) adjusted by any liquidity premium currently priced by the market.

The probability of default is calculated such that:

$(1 + YTM_{EM}) \times (1 - Pd_{EM}) + R_{EM} \times Pd_{EM} = 1 + R_f + L$,

where YTM_{EM} is the Yield of Emergistan, Pd_{EM} is the annual probability of default of Emergistan, R_{EM} is the recovery rate from Emergistan, R_f is the risk free rate and L the implied liquidity premium embedded in Emergistan's spread over UST.

The following scenario analysis assumes that if Emergistan were to default on its bonds, investors would recover 25% of the outstanding principal at the time of default, following exhaustion of the World Bank guarantee. It has also been assumed that the probability of Emergistan defaulting on a partially guaranteed bond and non-guaranteed bonds are equal, that the US Treasury has a probability of default of 0% and that the implied liquidity premium for Emergistan bonds is 100bps.

Figures 8 and 9 illustrate the mechanics of the World Bank guarantee in the cases of events of default in Year 6 and in Year 14.

Figure 8

Event of default in Year 6

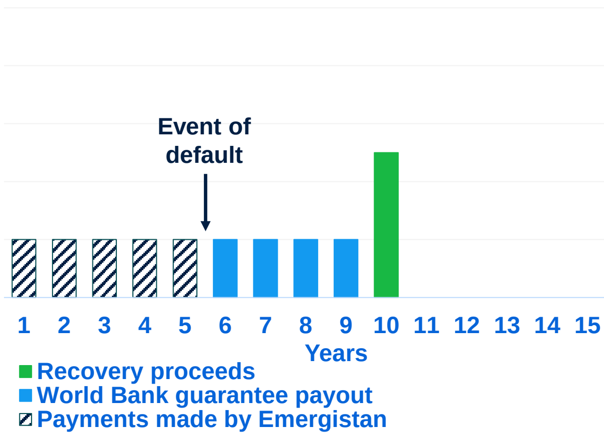
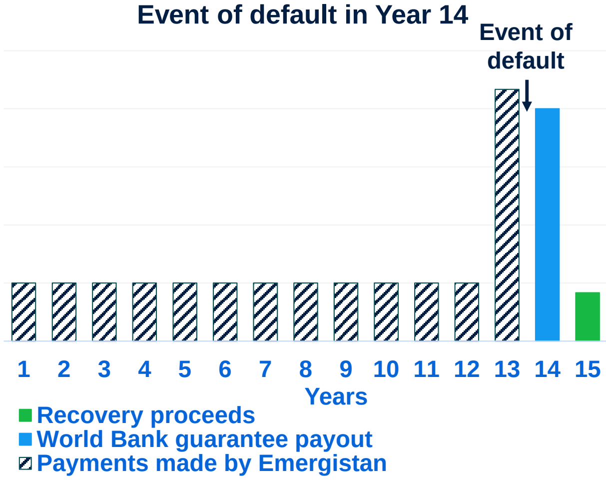


Figure 9

Event of default in Year 14

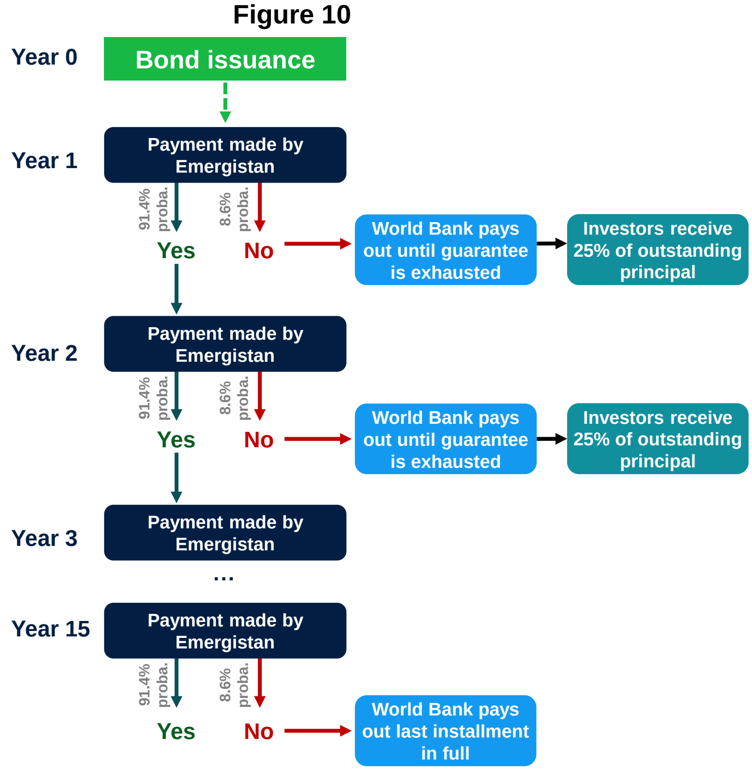


On the basis of above, the implied annual probability of default of Emergistan is calculated at 8.6%. Therefore, in Year 1 Emergistan has a probability of default of 8.6%, in Year 2 this probability is 7.9% (8.6% x (1-8.6%)) and for any subsequent years, the probability of Emergistan defaulting in a particular Year Y is Pd_i=8.6% x $(1\text{-}8.6\%)^{Y-1}$ (this methodology assumes that if Emergistan has not defaulted in the first N-1 years of the life of the bond, the probability of default in Year N is 8.6%).

Once the implied annual probability of default for Emergistan bonds has been calculated, the next step is to simulate the behavior of the World Bank guarantee and recoveries from Emergistan for each year as per the assumptions described previously. From the moment Emergistan misses one coupon and/or principal payment, the World Bank guarantee is assumed to be drawn on each payment date until the full US$400 million has been exhausted. Subsequently, investors accelerate the bond and recover 25% of the outstanding principal of the bond. Figure 8 illustrates the steps of the recovery analysis.

This methodology leads to the simulation of 16 probabilistic scenarios (one event of default for each of the 15 years and one scenario assuming no default).

Figure 10



The last step of this methodology consists in finding the yield of the bond such that once adjusted for the probability of default and the payments received from the World Bank guarantee, the risk-adjusted yield of the bond is equal to that of a US Treasury bond (plus the implied liquidity premium) with a similar maturity.

In the present example, this methodology results in a partially guaranteed bond yield of 7.59% and an implied guarantee value of 321bps.

A sensitivity analysis assuming different levels of liquidity premium embedded in the current spread of Emergistan vs US Treasuries shows the potential dispersion of results.

Table 5

Liquidity premium	0bps	100bps	200bps
Partially guaranteed bond yield	6.97%	7.59%	8.10%
Yield reduction vs naked bond	383bps	321bps	270bps

This methodology adequately captures all the features of a World Bank guarantee and thus results in lower yields, and higher implied value of the World Bank guarantee.

Table 6

Features captured by methodology	#4
Blending of WB and EM yields	✓
Rolling feature	✓
Time value of money	✓
Bond Yield	7.0% - 8.1%
Implied value of World Bank guarantee	270 - 383bps

Conclusion

The World Bank recently guaranteed a Sovereign bond issue that was difficult for some investors to value. This paper will help future investors in World Bank guaranteed bonds by explaining four ways to value ways to value these types of instruments. A hypothetical US$1 billion, 15-year, soft-bullet maturity bond issued by the government of fictional Emergistan, all supported by a US$400 million World Bank non-accelerable first loss guarantee, was used to analyze each method.

The first technique considered was the nominal weighted average yield method, which is a simple approach but does not capture the rolling aspect of a guarantee or account for the time value of money. The rolling nominal weighted average yield method, as the second method, is more accurate, accounts for a guarantee's rolling nature but does not account for the time value of money. The discounted cash flow approach, as a third method, assesses time value but does not include the rolling feature of the guarantee. None of these methods therefore fully values a World Bank guarantee.

Recovery analysis is a more comprehensive and more complex way to value a World Bank guarantee. This involves calculating the implied annual probability of default, simulating the behavior of the World Bank guarantee and recoveries from Emergistan and then calculating the yield of the bond after the probability of default and payments received under the World Bank guarantee are included. The implied value of the guarantee in the study case is 270 – 383 basis points, which is greater than the other methods because it fully captures time value and the value of a rolling guarantee.

The structure considered in this note is only one of many possibilities as the guarantee instrument offered by the World Bank is highly flexible. Investors should therefore carry out their own analysis to determine the methodology they believe to be the most relevant to price a particular security.

The Financial Solutions team is available to help guide its clients, their advisors and investors in developing new financing solutions.

Case study summary

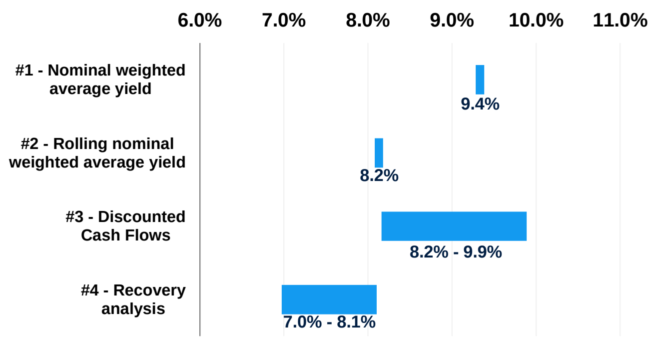
Table 7 and figures 11 and 12 summarize the results of the four methodologies in the case of Emergistan.

Table 7

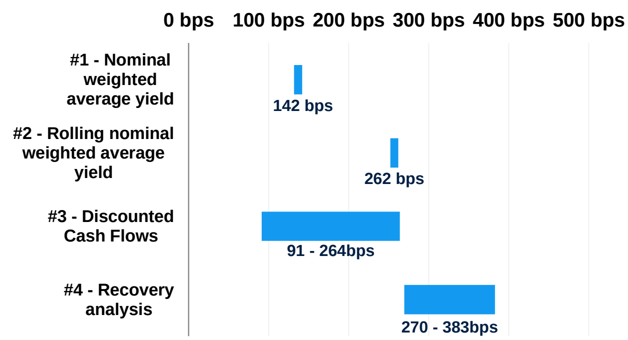
Features captured by methodology	Methodologies #1	#2	#3	#4
Blending of WB and EM yields	✓	✓	✓	✓
Rolling feature	✗	✓	✗	✓
Time value of money	✗	✗	✓	✓
Bond Yield	9.4%	8.2%	8.2% - 9.9%	7.0% - 8.1%
Implied value of World Bank guarantee	142bps	262bps	91 - 264bps	270 - 383bps

Figures 11 & 12

Summary of valuation methodologies



Implied World Bank guarantee value



Summary of methodologies

Nominal weighted average yield

$$YTM = \frac{\sum GCF}{\sum Total\ Bond\ Cash\ Flows} \times YTM_{WB} + \left(1 - \frac{\sum GCF}{\sum Total\ Bond\ Cash\ Flows}\right) \times YTM_{EM}$$

Rolling nominal weighted average yield

Through several iterations, the yield is calculated as follows:

$$YTM = \frac{\sum_{i=1}^{T} \frac{\sum_i^T GCF}{\sum_i^N Remaining\ Bond\ Cash\ Flows} \times YTM_{WB} + \left(1 - \frac{\sum_i^T GCF}{\sum_i^T Remaining\ Bond\ Cash\ Flows}\right) \times YTM_{EM}}{N}$$

Discounted Cash Flows

Yield to Maturity of a partially guaranteed is bond determined such that:

$$\sum_i \frac{GCF_i}{(1 + YTM_{WB})^i} + \sum_y \frac{NGCF_y}{(1 + YTM_{EM})^y} = FV$$

Where:
YTM_{WB} = World Bank (IBRD) Yield to Maturity
YTM_{EM} = Emergistan estimated Yield to Maturity
FV = Face Value of the bond[1]
GCF = Guaranteed Cash Flows (equal to guarantee amount)
NGCF = Non-Guaranteed Cash Flows (total bond cash flows less GCF)
N = Number of installments covered by the World Bank Guarantee
T= Number of payment periods

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[1] *assuming the bond has not been issued yet and that the face value is equal to the present value of the bond cash flows*

Recovery analysis

First step: *extract the annual implied probability of default from outstanding bonds (annual probability of default found such that the risk-adjusted YTM is equal to the risk free rate, in this case the US Treasury yield, plus any liquidity premium currently priced by the market)*

The formula used to calculate the implied annual probability of default is the following:

$$(1 + YTM_{EM}) \times (1 - Pd_{EM}) + R_{EM} \times Pd_{EM} = 1 + Rf + L$$

$$\Leftrightarrow (R_{EM} - 1 - YTM_{EM}) \times Pd_{EM} = Rf + L - YTM_{EM}$$

$$\Leftrightarrow Pd_{EM} = \frac{YTM_{EM} - Rf - L}{1 + YTM_{EM} - R_{EM}}$$

Where:
YTM_{EM} is the Yield of Emergistan
Pd_{EM} is the probability of default of Emergistan
R_{EM} is the estimated recovery rate following an event of default of Emergistan
Rf is the risk free rate (US Treasury)
L is the liquidity premium embedded in Emergistan's yield (accounts for the fact that Emergistan's spread over UST is not credit risk only)

First step: *check that the risk-adjusted YTM of the Emergistan bond is equal to the risk free rate + liquidity premium*

Scenario probability	Cumulative probability	Default year	Years 1	2	3	4	5	6	7	8	9	10	11	12	13	14
8.6%	8.6%	1	250.0	-	-	-	-	-	-	-	-	-	-	-	-	-
7.9%	16.5%	2	108.0	250.0	-	-	-	-	-	-	-	-	-	-	-	-
7.2%	23.7%	3	108.0	108.0	250.0	-	-	-	-	-	-	-	-	-	-	-
6.6%	30.3%	4	108.0	108.0	108.0	250.0	-	-	-	-	-	-	-	-	-	-
6.0%	36.3%	5	108.0	108.0	108.0	108.0	250.0	-	-	-	-	-	-	-	-	-
5.5%	41.8%	6	108.0	108.0	108.0	108.0	108.0	250.0	-	-	-	-	-	-	-	-
5.0%	46.8%	7	108.0	108.0	108.0	108.0	108.0	108.0	250.0	-	-	-	-	-	-	-
4.6%	51.4%	8	108.0	108.0	108.0	108.0	108.0	108.0	108.0	250.0	-	-	-	-	-	-
4.2%	55.6%	9	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	250.0	-	-	-	-	-
3.8%	59.4%	10	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	250.0	-	-	-	-
3.5%	62.9%	11	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	250.0	-	-	-
3.2%	66.1%	12	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	250.0	-	-
2.9%	69.0%	13	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	250.0	-
2.7%	71.7%	14	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	250.0
-	71.7%	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28.3%	**100.0%**	**No default**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**1,108.0**
	Probability weighted sc.		120.2	109.9	100.4	91.7	83.8	76.6	70.0	64.0	58.4	53.4	48.8	44.6	40.7	320.1

Probability weighted YTM	**3.4%**
Difference with UST + Liquidity premium	*0 bps*

Second step: *Simulate bond cash flows received from Emergistan*

Scenario probability	Cumulative probability	Default year	Years 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8.6%	8.6%	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7.9%	16.5%	2	75.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7.2%	23.7%	3	75.9	75.9	-	-	-	-	-	-	-	-	-	-	-	-	-
6.6%	30.3%	4	75.9	75.9	75.9	-	-	-	-	-	-	-	-	-	-	-	-
6.0%	36.3%	5	75.9	75.9	75.9	75.9	-	-	-	-	-	-	-	-	-	-	-
5.5%	41.8%	6	75.9	75.9	75.9	75.9	75.9	-	-	-	-	-	-	-	-	-	-
5.0%	46.8%	7	75.9	75.9	75.9	75.9	75.9	75.9	-	-	-	-	-	-	-	-	-
4.6%	51.4%	8	75.9	75.9	75.9	75.9	75.9	75.9	75.9	-	-	-	-	-	-	-	-
4.2%	55.6%	9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	-	-	-	-	-	-	-
3.8%	59.4%	10	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	-	-	-	-	-	-
3.5%	62.9%	11	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	-	-	-	-	-
3.2%	66.1%	12	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	-	-	-	-
2.9%	69.0%	13	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	-	-	-
2.7%	71.7%	14	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	409.3	-	-
2.4%	74.2%	15	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	409.3	384.0	-
25.8%	**100.0%**	**No default**	**75.9**	**75.9**	**75.9**	**75.9**	**75.9**	**75.9**	**75.9**	**75.9**	**75.9**	**75.9**	**75.9**	**75.9**	**409.3**	**384.0**	**358.6**

Third step: *Simulate the World Bank Guarantee payout*

Scenario probability	Cumulative probability	Default year	Years 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8.6%	8.6%	1	75.9	75.9	75.9	75.9	75.9	20.3	-	-	-	-	-	-	-	-	-
7.9%	16.5%	2	-	75.9	75.9	75.9	75.9	75.9	20.3	-	-	-	-	-	-	-	-
7.2%	23.7%	3	-	-	75.9	75.9	75.9	75.9	75.9	20.3	-	-	-	-	-	-	-
6.6%	30.3%	4	-	-	-	75.9	75.9	75.9	75.9	75.9	20.3	-	-	-	-	-	-
6.0%	36.3%	5	-	-	-	-	75.9	75.9	75.9	75.9	75.9	20.3	-	-	-	-	-
5.5%	41.8%	6	-	-	-	-	-	75.9	75.9	75.9	75.9	75.9	20.3	-	-	-	-
5.0%	46.8%	7	-	-	-	-	-	-	75.9	75.9	75.9	75.9	75.9	20.3	-	-	-
4.6%	51.4%	8	-	-	-	-	-	-	-	75.9	75.9	75.9	75.9	75.9	20.3	-	-
4.2%	55.6%	9	-	-	-	-	-	-	-	-	75.9	75.9	75.9	75.9	96.2	-	-
3.8%	59.4%	10	-	-	-	-	-	-	-	-	-	75.9	75.9	75.9	172.2	-	-
3.5%	62.9%	11	-	-	-	-	-	-	-	-	-	-	75.9	75.9	248.1	-	-
3.2%	66.1%	12	-	-	-	-	-	-	-	-	-	-	-	75.9	324.1	-	-
2.9%	69.0%	13	-	-	-	-	-	-	-	-	-	-	-	-	400.0	-	-
2.7%	71.7%	14	-	-	-	-	-	-	-	-	-	-	-	-	-	384.0	16.0
2.4%	74.2%	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	358.6
25.8%	**100.0%**	**No default**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Fourth step: *Simulate recovery proceeds*

Scenario probability	Cumulative probability	Default year	Years 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8.6%	8.6%	1	-	-	-	-	-	250.0	-	-	-	-	-	-	-	-	-
7.9%	16.5%	2	-	-	-	-	-	-	250.0	-	-	-	-	-	-	-	-
7.2%	23.7%	3	-	-	-	-	-	-	-	250.0	-	-	-	-	-	-	-
6.6%	30.3%	4	-	-	-	-	-	-	-	-	250.0	-	-	-	-	-	-
6.0%	36.3%	5	-	-	-	-	-	-	-	-	-	250.0	-	-	-	-	-
5.5%	41.8%	6	-	-	-	-	-	-	-	-	-	-	250.0	-	-	-	-
5.0%	46.8%	7	-	-	-	-	-	-	-	-	-	-	-	250.0	-	-	-
4.6%	51.4%	8	-	-	-	-	-	-	-	-	-	-	-	-	250.0	-	-
4.2%	55.6%	9	-	-	-	-	-	-	-	-	-	-	-	-	244.9	-	-
3.8%	59.4%	10	-	-	-	-	-	-	-	-	-	-	-	-	225.9	-	-
3.5%	62.9%	11	-	-	-	-	-	-	-	-	-	-	-	-	207.0	-	-
3.2%	66.1%	12	-	-	-	-	-	-	-	-	-	-	-	-	188.0	-	-
2.9%	69.0%	13	-	-	-	-	-	-	-	-	-	-	-	-	169.0	-	-
2.7%	71.7%	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	83.3
2.4%	74.2%	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25.8%	**100.0%**	**No default**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Final step: *Combine all cash flows and solve coupon such that the risk adjusted YTM is equal to that of the US Treasury yield plus any liquidity premium currently priced by the market*

Scenario probability	Cumulative probability	Default year	Years 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8.6%	8.6%	1	75.9	75.9	75.9	75.9	75.9	270.3	-	-	-	-	-	-	-	-	-
7.9%	16.5%	2	75.9	75.9	75.9	75.9	75.9	75.9	270.3	-	-	-	-	-	-	-	-
7.2%	23.7%	3	75.9	75.9	75.9	75.9	75.9	75.9	75.9	270.3	-	-	-	-	-	-	-
6.6%	30.3%	4	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	270.3	-	-	-	-	-	-
6.0%	36.3%	5	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	270.3	-	-	-	-	-
5.5%	41.8%	6	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	270.3	-	-	-	-
5.0%	46.8%	7	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	270.3	-	-	-
4.6%	51.4%	8	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	270.3	-	-
4.2%	55.6%	9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	341.1	-	-
3.8%	59.4%	10	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	398.1	-	-
3.5%	62.9%	11	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	455.1	-	-
3.2%	66.1%	12	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	512.0	-	-
2.9%	69.0%	13	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	569.0	-	-
2.7%	71.7%	14	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	409.3	384.0	99.4
2.4%	74.2%	15	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	409.3	384.0	358.6
25.8%	**100.0%**	**No default**	**75.9**	**75.9**	**75.9**	**75.9**	**75.9**	**75.9**	**75.9**	**75.9**	**75.9**	**75.9**	**75.9**	**75.9**	**409.3**	**384.0**	**358.6**
Probability weighted cash flow			75.9	75.9	75.9	75.9	75.9	92.7	84.7	77.4	70.7	64.6	59.1	54.0	217.6	118.9	104.1

Probability weighted YTM	**3.4%**
Difference with UST + Liquidity premium	*0 bps*

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