Balance Sheet Model

The balance sheet model is used to determine the risks of various assets, liabilities and balance sheet items. Primarily, the model calculates the interest rate risk profile of these instruments.

The model involves defining an underlying interest rate process, valuation models for all the instruments that depends on the interest rates, and various scenarios for the interest rates in order to compute “risk profiles”.

The instruments on (and off) the balance sheet are split into various subaccounts, and these subaccounts are mapped to accounts. It is at the subaccount level that many of the instrument characteristics are defined, including cash flows, behavioral assumptions and valuation models.

Most of the subaccounts are simple, and simply project cash flows for the instruments that are not rate dependent. Therefore, most are simple discounted cash flow models. The only subaccount that was dynamic (i.e. the cash flows depended on the interest rates) were the cashable GICs.

The cashable GIC is essentially a GIC that is redeemable, and this redemption is modeled with a rate dependent function. We define the current coupon as the coupon that would be offered on a brand new Cashable GIC as Cc, and customer coupon of the (aged) GIC to be C. In the model, the current coupon is modelled using the 1 month spot rate (money market compounding, act/365 daycount) as

$$C = \max(0.966r - 0.704, 0.0001),$$

where r is the one month spot rate. Furthermore, the maximum coupon experienced by the GIC is denoted by C_{max}. The current refinancing incentive is the difference between the customer coupon and the current coupon, or

$$R = C_c - C,$$

and the maximum refinance is

$$R_{max} = C_{max} - C. \quad (3)$$

We define the “baseline” redemption rate by

$$T = 0.025 + bWAM,$$

where WAM is the weighted average maturity of the GIC pool. As usual, this is defined as the average number of months remaining until the GIC matures. With this, the function is defined by

- If $R > 0.1$ and $R > R_{max}$ and $WAM >= 2$ then

  $$SMM = \min\left[T + cR_{max} + d(R - R_{max}), 0.9\right]$$

- Else if $R < -0.1$ then

  $$SMM = T\exp[e(R + 0.1)]$$

- Else $SMM = T$

In the model, the current coupon is modelled by the 1 month spot rate. Since the cashflows depend on the interest rates (through the SMM) a Monte Carlo valuation model is used.

The cashflows for these instruments depend on whether their payment frequency and the day count convention used. Denoting the amount redeemed in a given month i by

Wi, this is simply given by

Wi = Pi−1SMM

where Pi−1 is the principal of the previous period and the principal at the end of month i is given by Pi = Pi−1 −Wi.

If the payment frequency is monthly, then the interest paid at month i is given by

$$I_i = P_{i-1}\Delta_i \mathrm{WAC}$$

where WAC is the weighted average coupon and _i is the day count fraction for that month. This is defined as $\Delta_i = \frac{t_i - t_{i-1}}{365}$, where ti − ti−1 is the number of days between the current and the last coupon period. The total cashflows used to value the GIC include the redeemed principal payments Wi as well as the principal payment PT−1 for the last month, so that Ci = Ii + Wi for all months other than maturity and CT = IT + PT−1 at maturity.

The cashflows are different if the payment frequency is “At Maturity”. In this case, the monthly interest Ii is given by

$$I_i^{AM} = W_i\Delta_i^0 \mathrm{WAC}$$

where Δi is the fraction of the total number of days from the current payment period to the start date of the GIC divided by 365. This is because the interest is paid on the GIC for as long as the GIC is not redeemed. Using the same notation as before, the cashflows should be Ci = Ii + Wi for all months other than maturity. At maturity, there is a additional interest payment on the remaining principal, as well as the principal itself:

$$C_T = P_{i-1}(1 + \Delta_T^0 \mathrm{WAC}).$$

Reference:

https://finpricing.com/lib/EqBarrier.html