

**credit
derivatives**



$Q_{\mu} \cdot \alpha(\eta) \cdot \tau^Z$

Welcome

to the Quantz credit derivatives pricing toolkit. This is a great tool for:

- **Traders** running a credit derivatives book.
- **Quants** pricing vanilla or custom credit structures.
- **Risk Managers** needing to verify p&l and ascertain the risk on credit portfolios.
- **Funds and Corporate holders** of credit derivatives wanting to re-value their holdings.

Instruments

The toolkit provides analytic pricing of the key credit derivatives:

- **Credit Default Swaps** (vanilla, digital and forward start).
- **Total Return Swaps** (vanilla and forward start, with both appreciation at maturity and appreciation on reset dates).
- **Credit Default Baskets** (vanilla and forward start, with both first to default and second to default baskets).
- **Spread Forwards and Spread Options** (vanilla and digital, default contingent or non-contingent, using normal or lognormal models - for spreads between a risky and a risk free asset or between two risky assets).

In addition, a number of asset swap, bond calculation, curve handling and default probability calculation functions are provided to give a comprehensive pricing toolkit for custom credit structures - for example, credit linked and principal protected notes.

features



Models

The package uses the standard Jarrow and Turnbull model of default probabilities and for spread futures and options uses either a normal or lognormal Black style model for spreads. The package is 'quant and trader orientated' rather than 'academic model orientated'. It requires a minimum of difficult-to-obtain data as possible. For example, only one default correlation factor is required for default baskets instead of a theoretical matrix, since this factor is very difficult to estimate.

Platforms

This brochure describes the Excel add-in version of the toolkit. The toolkit is also available as a C++ library, an OCX, and as a COM or CORBA component.

Innovations

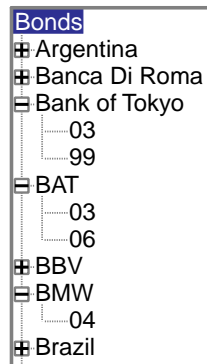
A number of innovative ease of use features are incorporated in the package:

A **reference assets database** is provided along with a maintenance application so that common underlying reference assets can be used immediately.

Curves and instruments are defined with **unique names** to reduce the number of parameters required when requesting analytics.

Both **specific and relative dates** can be entered whenever a date is expected. The relative dates are taken relative to the relevant benchmark date given the context. For instance, it is possible to enter '12-Dec-99' or '18m' for a maturity date.

All parameters have **sensible defaults** whenever possible. This means we can determine the premium of a new credit default swap with just a risky curve name, a maturity, and an assumed recovery rate. On the other hand, we can specify a forward start default swap, or value one that was started some time ago by specifying more of the 12 possible parameters.



features



Capabilities

This version of the toolkit comes as a C++ Excel add-in, with example spreadsheets and a comprehensive manual and help system. There are examples of:

- **Fair Market Value** calculations for pricing current or forward start trades.
- **Valuation and risk analysis** of existing trades.
- Calculation of **expected future value** and **counterparty exposure**.
- Analysis of the **market implied levels** of default probabilities, hazard rates / default intensities and recovery rates.
- **Portfolio** valuation and risk analysis.

Pricing a Default Swap

Here is an example of the steps required to price a default swap from bond prices. We are going to price a 5 year credit default swap on the GMAC 05 5.4% bond - which has 7 years remaining life at the valuation date. We will use bond prices to define the risky curve, and may hedge some part of the risk with one of the issuer's bonds. Note that we could have used a risky curve defined from default swap quotes if this was more appropriate.

Creating a risk free curve

In this example, let's assume we obtain the 'risk free' Libor curve from our swaps desk. This curve might be obtained as discount factors, zero rates, or (less likely) bond yields. Note that if we have zero rates or yields, we will need to know what compounding frequency they are stated for. This curve will be named 'Libor'. We define a risk free curve like this:

Create a risk free curve						
valuation date	23-Sep-98					
6m	1	2	3	5	7	
5.573%	5.358%	5.232%	5.287%	5.462%	5.600%	
Define Zero Rate Curve				USD - Libor		

At this point we can retrieve any rates from this curve that we like (discount factors, zero rates, forward rates, yields etc).

examples



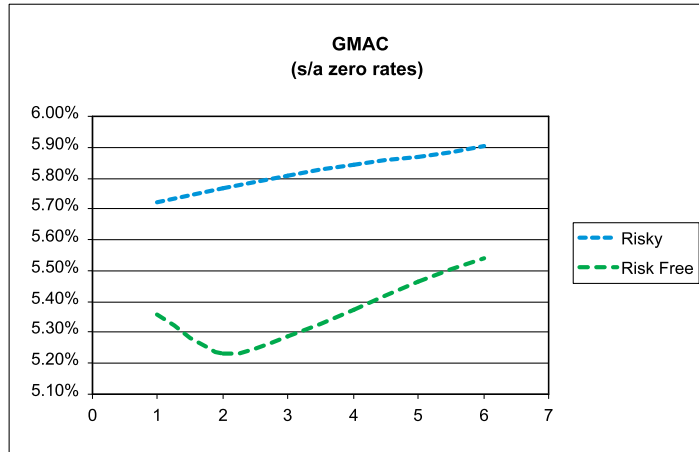
Creating a risky curve

In this case the issuer is GMAC, and we will select the 99, 03 and 05 bonds as being representative of the issuer's credit risk.

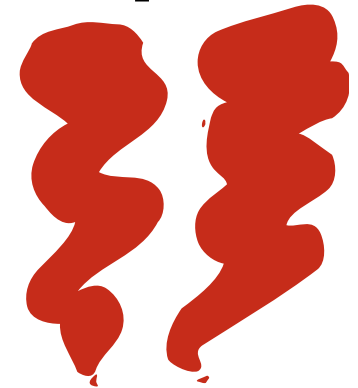
We define the risky curve like this:

Create a risky curve						
valuation date	23-Sep-98					
	GMAC 99	GMAC 03	GMAC 05			
	99.7223%	97.9219%	100.500%			
Define Bond Price Curve			USD - GMAC			

Here are the curves shown as semi-annual zero rates:



examples



Defining an instrument

Once the curves have been built, defining the instrument is easy. Since we just want a vanilla default swap, we can define only those parameters we are interested in – the bond, risky curve, maturity and assumed recovery rate. We use the `DefineCreditDefaultSwap` function and leave many of the parameters blank:

Create a default swap			
	bond		GMAC 05
	risky curve		USD - GMAC
	recovery rate		30%
	maturity		5
	premium frequency		
	accrual method		
	Define Default Swap		GMAC 05 CDS

Calculating analytics

Again this step is easy. First, we can calculate the premium and retrieve the premium cash flows using the `GetPremium` and `GetPremiumCashflows` functions.

Calculate fair market premium				
	Premium		0.407%	

Here are the semi-annual premium cash flows:

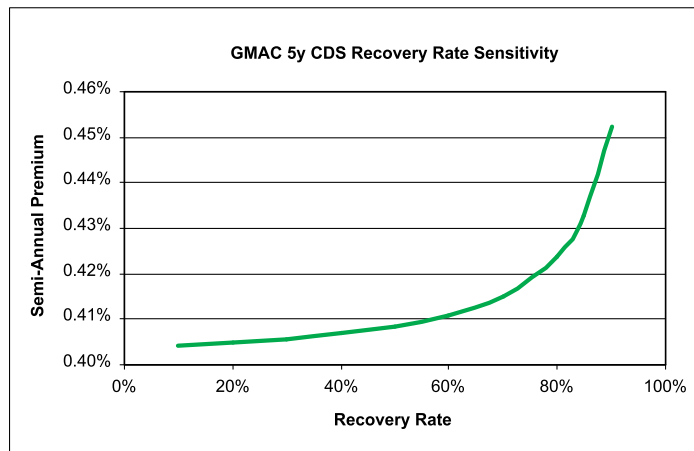
Calculate premium cash flows			
	day	date	amount
	Tue	23-Mar-99	0.2034%
	Thu	23-Sep-99	0.2034%
	Thu	23-Mar-00	0.2034%
	Mon	25-Sep-00	0.2057%
	Fri	23-Mar-01	0.2011%
	Mon	24-Sep-01	0.2045%
	Mon	25-Mar-02	0.2045%
	Mon	23-Sep-02	0.2011%
	Mon	24-Mar-03	0.2045%
	Tue	23-Sep-03	0.2023%
	#N/A	#N/A	#N/A

examples



Performing sensitivity analysis

Then, by specifying a strip of default swaps with different recovery rates, we can see the sensitivity of the premium to our recovery rate assumption:



We note that there is a sharp rise in premiums once our recovery rate assumption rises over 60%.

In Summary

This example detailed some of the common operations when valuing a credit derivative trade. In particular the following complex operations are performed very easily:

- Deriving a **risky curve from bond prices or default swap quotes**.
- Calculating the **fair market premium** level.
- Performing a **sensitivity analysis** on recovery rate.

We could go on to:

- Price and calculate **sensitivities** for new **Total Return Swaps, Default Baskets, Spread Forwards** or **Spread Options** - or value **existing** or **forward start** trades.
- Design and price a **custom credit structure** - perhaps a **credit linked** or **principal protected** note.
- Calculate **implied hazard rates / default intensities** or **recovery rates** from market data.
- **Re-value** and **calculate the risk** on a **credit portfolio**.

Instrument Definition Functions

DefineBond(name, currency, start, maturity, coupon, frequency, accrual method)

DefineParAssetSwap(name, bond, bond price, risk free curve, spread, start date, frequency, accrual method, previous fixing, valuation date, roll method, end-of-month method)

DefineMarketAssetSwap(name, bond, bond price, risk free curve, spread, start date, frequency, accrual method, previous fixing, valuation date, roll method, end-of-month method)

DefineCreditDefaultSwap(name, bond, risky curve, recovery rate, start date, maturity, premium, frequency, accrual method, first premium, valuation date, roll method, end-of-month method)

DefineCreditDefaultDigital(name, bond, risky curve, recovery rate, start date, maturity, premium, frequency, accrual method, first premium, valuation date, roll method, end-of-month method)

DefineFirstToDefaultBasket(name, bonds, nominals, risky curves, recovery rates, start date, maturity, premium, frequency, accrual method, correlation, first premium, valuation date, roll method, end-of-month method)

DefineSecondToDefaultBasket(name, bonds, nominals, risky curves, recovery rates, start date, maturity, premium, frequency, accrual method, correlation, first premium, valuation date, roll method, end-of-month method)

DefineTotalReturnSwap(name, bond, bond price, risk free curve, spread, recovery rate, start date, frequency, recovery rate, accrual method, return on resets?, previous fixing, previous bond price, valuation date, roll method, end-of-month method)

DefineSpreadForward(name, risky curve, start, maturity, initial spread, strike spread, recovery rate, contingent?, maximum spread)

DefineSpreadOption(name, risky curve, call/put, start, maturity, initial spread, strike spread, spread volatility, american?, normal?, recovery rate, contingent?, maximum spread)

DefineSpreadDigital(name, risky curve, call/put, start, maturity, initial spread, strike spread, spread volatility, american?, normal?, recovery rate, contingent?, maximum spread)

Cashflow Calculation Functions

GetCashflows(name, **spread/premium/curve**)

GetFloatingCashflows(name, **spread/curve**)

GetFixedCashflows(name)

GetPremiumCashflows(name, **premium**)

GetAppreciationCashflows(name)

GetNoOfPayments(name)

functions



Analytic Calculation Functions

GetValue(name, **spread/premium**)

GetSpread(name)

GetPremium(name)

GetImpliedRecoveryRate(name, premium)

GetDelta(name)

GetImpliedVolatility(name, value)

GetDiversificationEffect(name)

GetCorrelationEffect(name)

GetDefaultEffect(name)

GetAccrualMethod(name)

Instrument Utility Functions

GetStart(name)

GetMaturity(name)

GetCoupon(name)

GetFrequency(name)

GetTenor(name)

GetRemainingTenor(name, date)

GetBondType(name)

GetCurrency(name)

Curve Building Functions

DefineYieldCurve(currency, curve name, start date, maturities, yields, frequency, **accrual method**)
DefineYieldSpreadCurve(reference curve, curve name, maturities, spreads, frequency, **accrual method**)
DefineDiscountFactorCurve(currency, curve name, start date, maturities, discount factors)
DefineZeroCurve(currency, curve name, start date, maturities, zero rates, frequency)
DefineZeroSpreadCurve(reference curve, curve name, maturities, spreads, frequency)
DefineForwardSpreadCurve(reference curve, curve name, spread, frequency)
DefineBondPriceCurve(risk free curve, curve name, start date, bonds, bond prices)
DefineDefaultSwapCurve(risk free curve, curve name, maturities, premiums, recovery rate)

Curve Use Functions

d(curve, t1, t2) - (discount factor)
f(curve, t1, t2, frequency) - (forward rate)
z(curve, t1, frequency) - (zero rate)
y(curve, t1, frequency, **accrual method**) - (yield)
fy(curve, t1, t2, frequency, **accrual method**) - (forward yield)
fs(curve, t1, t2, frequency) - (forward rate spread)
zs(curve, t1, frequency) - (zero rate spread)
ys(curve, t1, frequency, **accrual method**) - (yield spread)
fys(curve, t1, t2, frequency, **accrual method**) - (forward yield spread)
GetPoints(curve)

Implied Default Probability Functions

pd(curve, recovery rate, t1) - (cumulative probability of default)
h(curve, recovery rate, t1, t2) - (conditional hazard rate or default intensity)
hu(curve, recovery rate, t1, t2) - (unconditional hazard rate or default intensity)
l(curve, recovery rate, t1, t2) - (loss rate)
s(curve, recovery rate, t1, t2) - (survival probability)

Reference Assets Database Functions

GetBonds(issuer)
GetDetails(bond)
GetFixings(bond)
ReReadAssetsDatabase(no parameters)

functions



Bond Functions

GetYieldFromPrice(bond, date, price)
GetPriceFromYield(bond, date, yield)
GetPriceFromCurve(bond, curve, spread, date)
GetSpreadFromCurve(bond, curve, price, date)
GetAccrued(bond, date)
GetAccrualFraction(accrual method, from date, to date, **coupon date**, frequency)

Date and Rate Functions

DateAdd(date, increment, **roll method**, **end-of-month method**)
DoW(date)
Roll(date, **roll method**)
ConvertRate(rate, from frequency, to frequency)

Utility Functions

GetVersionInfo(no parameters)
ReReadIniFile(no parameters)



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www.quantz.com
info@quantz.com
telephone +44 (0)171-232-0296
fax +44 (0)171-231-3738