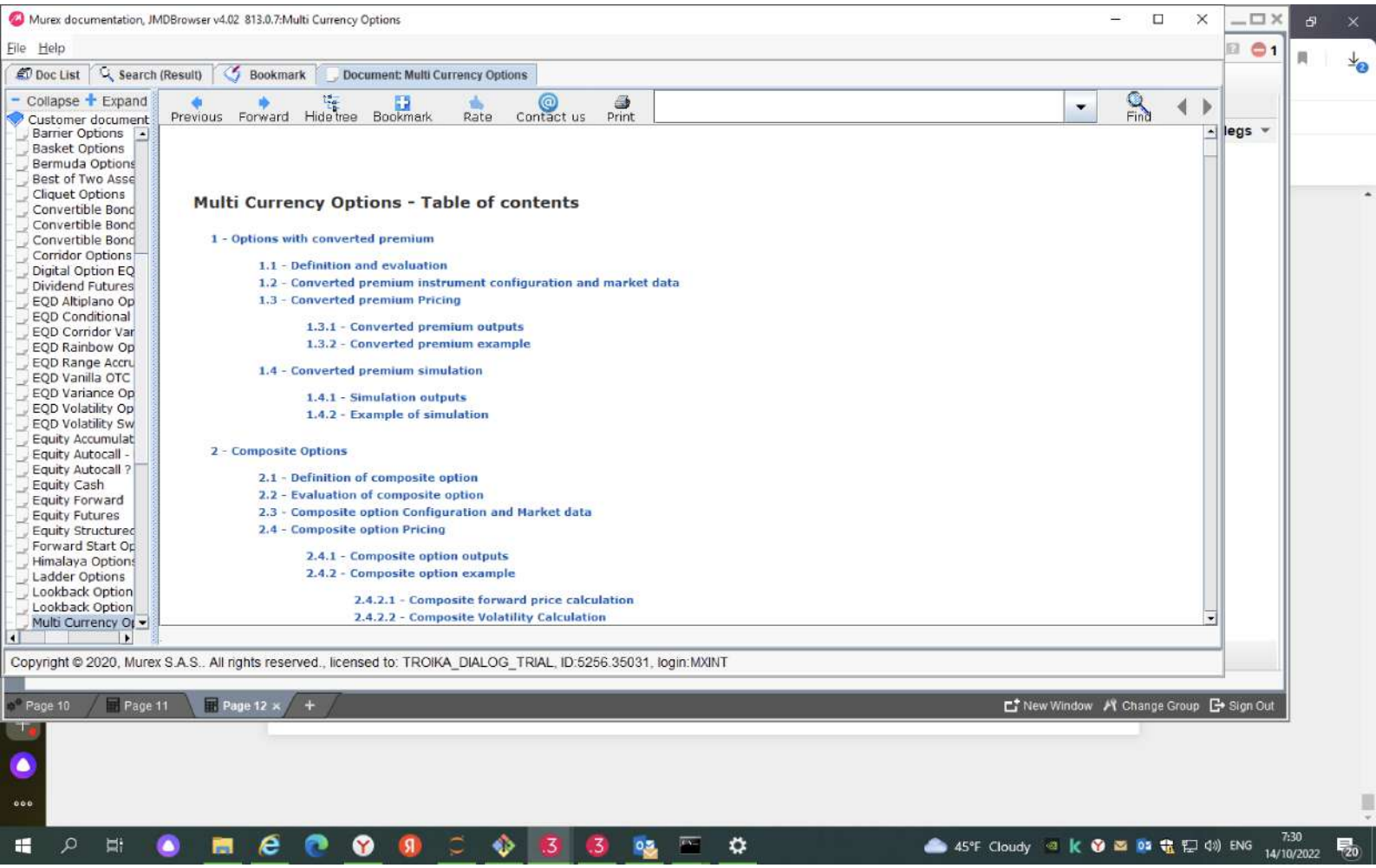
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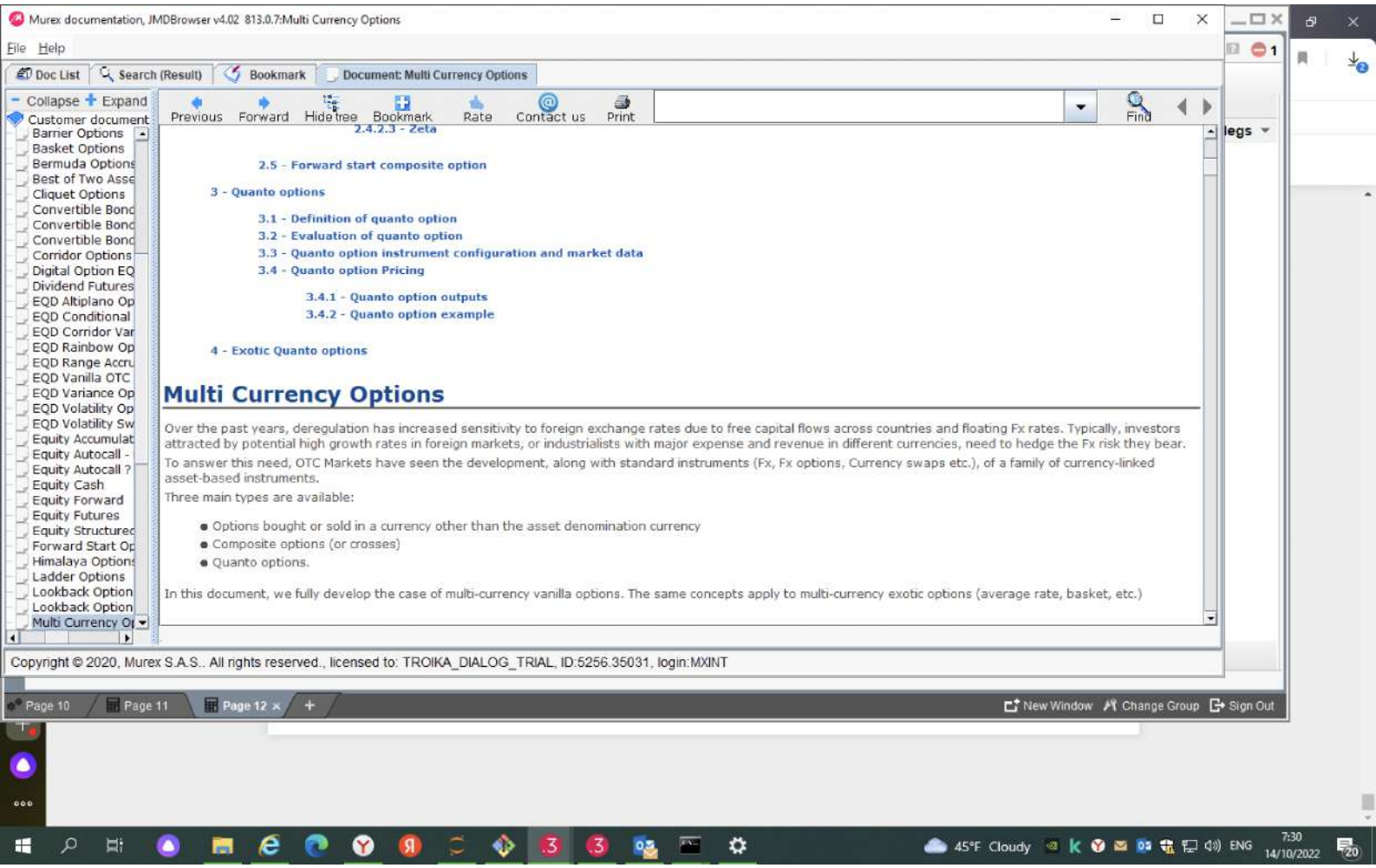
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Multi Currency Options
Over the past years, deregulation has increased sensitivity to foreign exchange rates due to free capital flows across countries and floating Fx rates. Typically, investors attracted by potential high growth rates in foreign markets, or industrialists with major expense and revenue in different currencies, need to hedge the Fx risk they bear.
To answer this need, OTC Markets have seen the development, along with standard instruments (Fx, Fx options, Currency swaps etc.), of a family of currency-linked asset-based instruments.
Three main types are available:
Options bought or sold in a currency other than the asset denomination currency
Composite options (or crosses)
Quanto options.
In this document, we fully develop the case of multi-currency vanilla options. The same concepts apply to multi-currency exotic options (average rate, basket, etc.)
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1 - Options with converted premium

1.1 - Definition and evaluation

These are options traded in a currency different from their underlying asset currency. They can be replicated with an option on the standard asset, and an Fx spot transaction converting the option's market value into the foreign currency at current market Fx spot at revaluation date. The option premium and its market value are paid/expressed in this conversion currency.

Notations and general conventions:

S : the underlying asset spot price at maturity

K : the option strike denominated in the underlying asset currency

F_x : the foreign exchange spot rate at revaluation date between the underlying asset currency and the conversion currency (i.e. premium payment currency)

$V_{foreign}$: the volatility of the underlying asset

MV_{local} : the market value of the converted instrument

$MV_{foreign}$: the market value of the underlying asset

The payoff at maturity of a regular European call option on this asset is : $Payoff = Max(S-K, 0)$

The payoff at maturity of a "converted option" is : $Payoff = Max(S-K, 0) \times Fx$

The option premium is the conversion of the original premium (i.e. option revaluation in asset currency) into the conversion currency using the Fx spot rate :

$MV_{local} = MV_{foreign} \times Fx$

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$$MV_{local} = MV_{foreign} \times Fx$$

;

Considering that $MV_{foreign}$ and Fx are independent, we compute derivatives as follows:

$$option\ delta = \frac{\partial MV_{foreign}}{\partial S}$$

$$option\ gamma = \frac{\partial Option\ delta}{\partial S}$$

$$vega_{local} = \frac{\partial MV_{local}}{\partial V_{foreign}} = \frac{\partial MV_{foreign} \times Fx}{\partial V_{foreign}} = Vega_{foreign} \times Fx$$

Therefore, sensitivities to the underlying asset parameters are equal to sensitivities of the corresponding unconverted option, but they can be expressed in the conversion currency via current Fx spot on revaluation date.

$$FxDelta_{local} = \frac{\partial MV_{local}}{\partial Fx} = \frac{\partial MV_{foreign} \times Fx}{\partial Fx} = MV_{foreign}$$

Thus the buyer bears an Fx risk equal to the market value in the underlying asset currency.

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1.2 - Converted premium instrument configuration and market data

For listed or OTC options, no specific configuration at option contract level is needed. However, for Warrants, select *(S-K)X* in the **Fx rule** flag in Warrant definition screen (under ***Configuration / Securities / Warrants***). Exotic pricing should be used.

Parameters involved are security price, security volatility, Fx spot, and the rate curves of both currencies.

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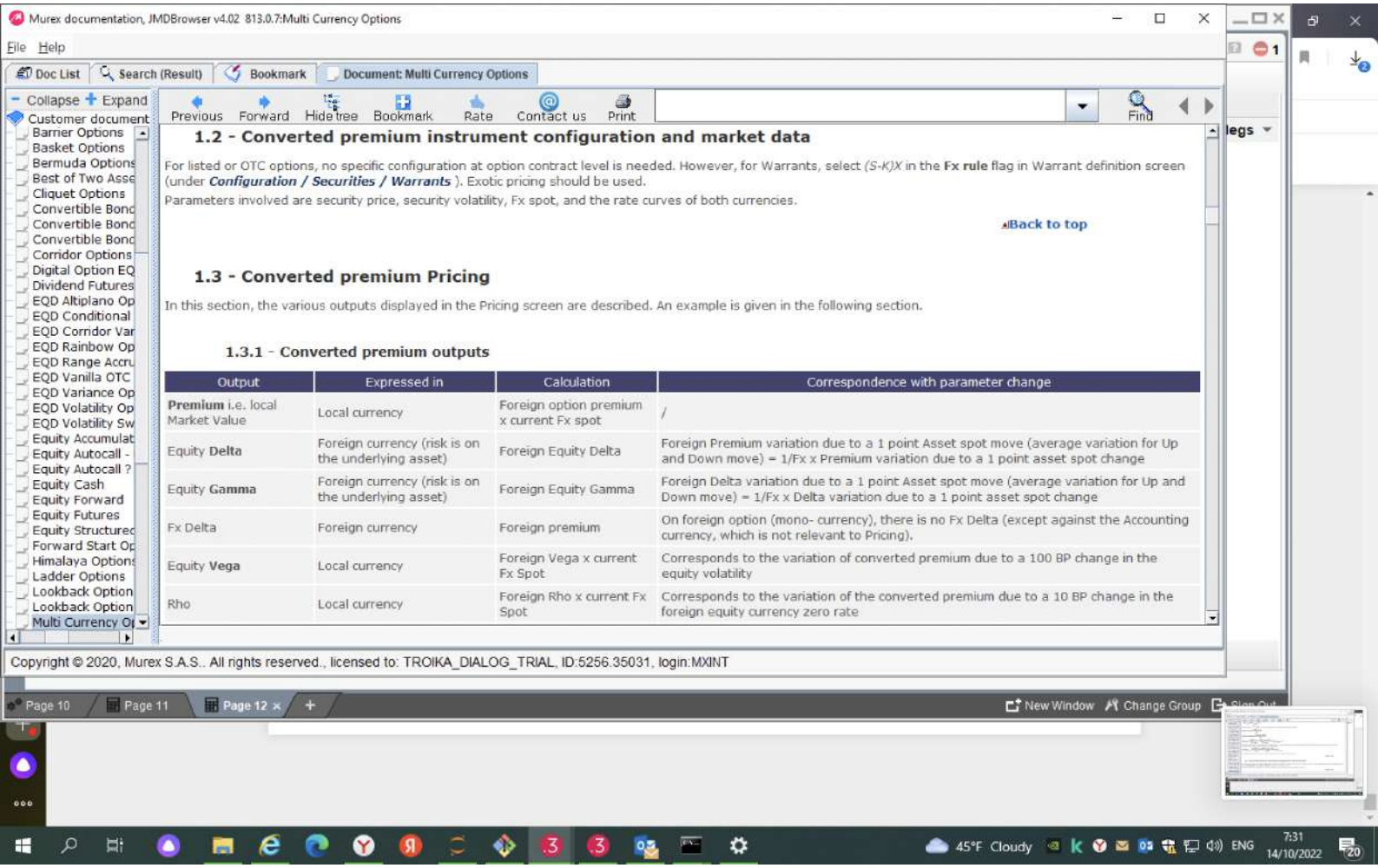
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1.2 - Converted premium instrument configuration and market data
For listed or OTC options, no specific configuration at option contract level is needed. However, for Warrants, select (S-K)X in the Fx rule flag in Warrant definition screen (under Configuration / Securities / Warrants). Exotic pricing should be used.
Parameters involved are security price, security volatility, Fx spot, and the rate curves of both currencies.
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1.3 - Converted premium Pricing
In this section, the various outputs displayed in the Pricing screen are described. An example is given in the following section.
1.3.1 - Converted premium outputs
Output
Expressed in
Calculation
Correspondence with parameter change
Premium i.e. local Market Value
Local currency
Foreign option premium x current Fx spot
/
Equity Delta
Foreign currency (risk is on the underlying asset)
Foreign Equity Delta
Foreign Premium variation due to a 1 point Asset spot move (average variation for Up and Down move) = 1/Fx x Premium variation due to a 1 point asset spot change
Equity Gamma
Foreign currency (risk is on the underlying asset)
Foreign Equity Gamma
Foreign Delta variation due to a 1 point Asset spot move (average variation for Up and Down move) = 1/Fx x Delta variation due to a 1 point asset spot change
Fx Delta
Foreign currency
Foreign premium
On foreign option (mono- currency), there is no Fx Delta (except against the Accounting currency, which is not relevant to Pricing).
Equity Vega
Local currency
Foreign Vega x current Fx Spot
Corresponds to the variation of converted premium due to a 100 BP change in the equity volatility
Rho
Local currency
Foreign Rho x current Fx Spot
Corresponds to the variation of the converted premium due to a 10 BP change in the foreign equity currency zero rate
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		Spot	foreign equity currency zero rate
Theta	Local currency	Foreign Theta x current Fx Spot	Corresponds to the converted premium change for a 1 day horizon change

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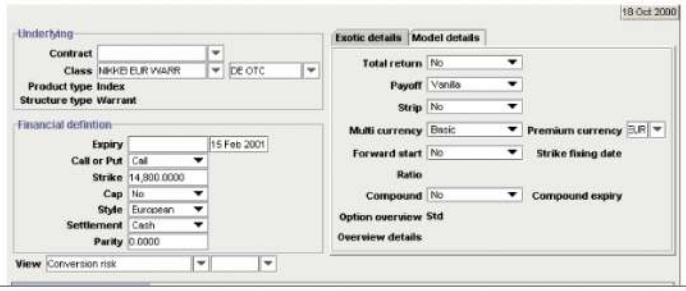
1.3.2 - Converted premium example

A warrant on the Nikkei sold in EUR to a German investor:

- Nikkei 225 Spot = 14872
- EUR/JPY Spot = 91.31654

In the Exotic Pricing screen (menu ***Pricing / Equities / Exotic equity option***), set the **Multi currency** flag to *Basic* and the **Premium currency** flag to *EUR* (for warrants, select the warrant under File/Load warrant).



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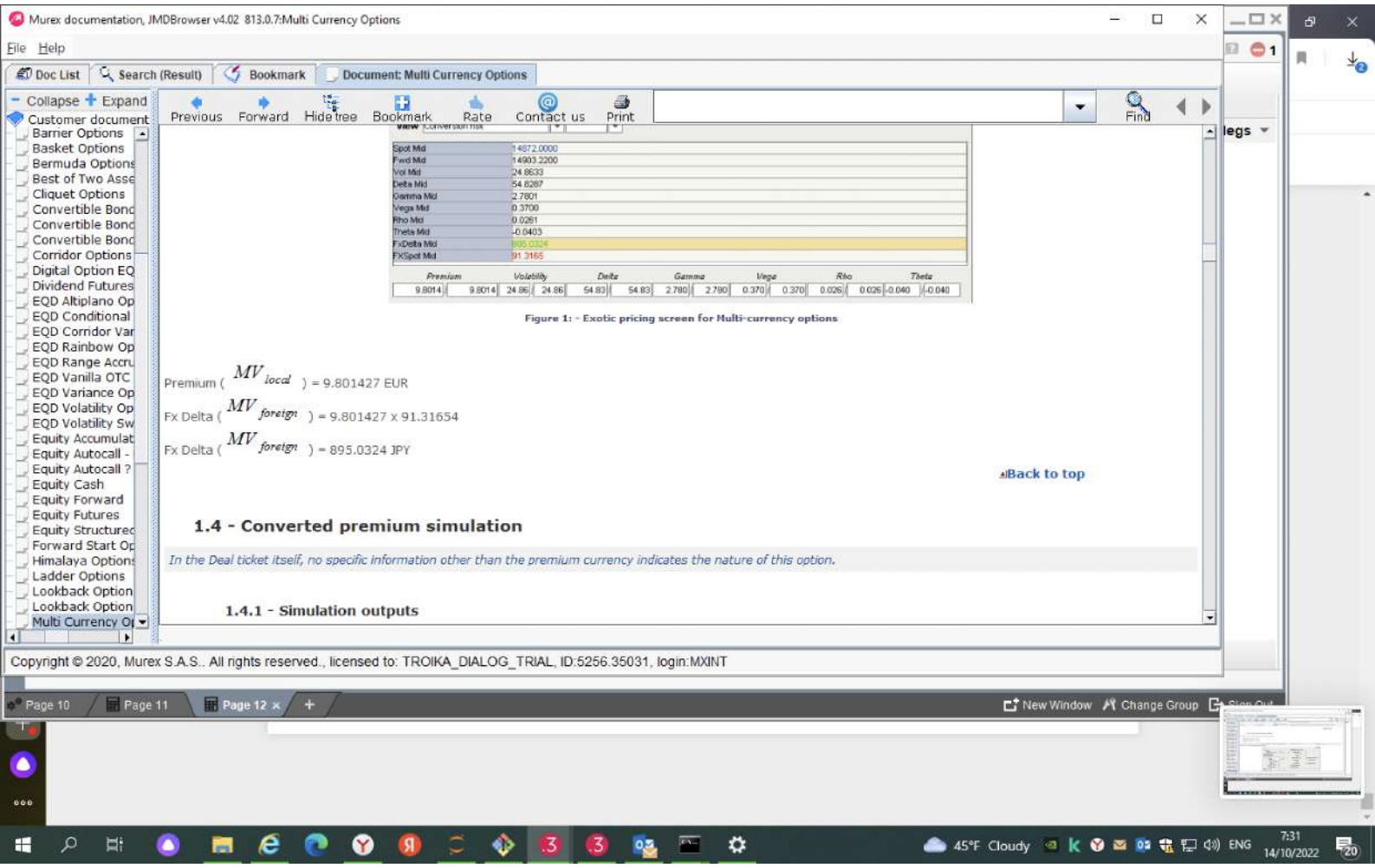
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Spot Mid 14872.0000
Fwd Mid 14903.2200
Vol Mid 24.8633
Delta Mid 54.8287
Gamma Mid 2.7801
Vega Mid 0.3700
Rho Mid 0.0261
Theta Mid -0.0403
FxDelta Mid 895.0324
FXSpot Mid 91.3165
Premium Volatility Delta Gamma Vega Rho Theta
9.8014 9.8014 24.86 24.86 54.83 54.83 2.780 2.780 0.370 0.370 0.026 0.026 -0.040 -0.040
Figure 1: - Exotic pricing screen for Multi-currency options
Premium (MV local) = 9.801427 EUR
Fx Delta (MV foreign) = 9.801427 x 91.31654
Fx Delta (MV foreign) = 895.0324 JPY
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1.4 - Converted premium simulation
In the Deal ticket itself, no specific information other than the premium currency indicates the nature of this option.
1.4.1 - Simulation outputs
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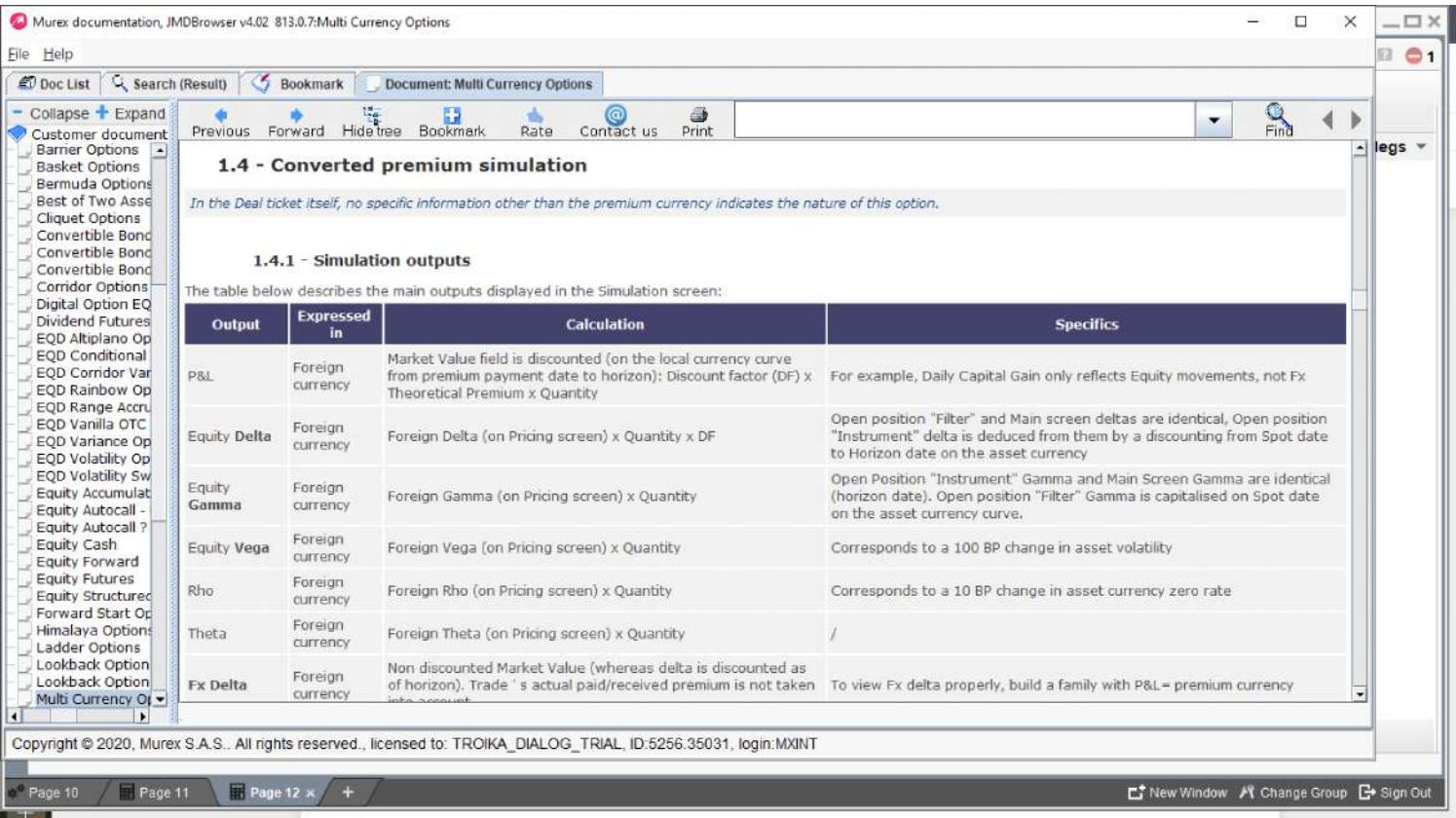
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1.4 - Converted premium simulation
In the Deal ticket itself, no specific information other than the premium currency indicates the nature of this option.
1.4.1 - Simulation outputs
The table below describes the main outputs displayed in the Simulation screen:
Output
Expressed in
Calculation
Specifics
P&L
Foreign currency
Market Value field is discounted (on the local currency curve from premium payment date to horizon): Discount factor (DF) x Theoretical Premium x Quantity
For example, Daily Capital Gain only reflects Equity movements, not Fx
Equity Delta
Foreign currency
Foreign Delta (on Pricing screen) x Quantity x DF
Open position "Filter" and Main screen deltas are identical, Open position "Instrument" delta is deduced from them by a discounting from Spot date to Horizon date on the asset currency
Equity Gamma
Foreign currency
Foreign Gamma (on Pricing screen) x Quantity
Open Position "Instrument" Gamma and Main Screen Gamma are identical (horizon date). Open position "Filter" Gamma is capitalised on Spot date on the asset currency curve.
Equity Vega
Foreign currency
Foreign Vega (on Pricing screen) x Quantity
Corresponds to a 100 BP change in asset volatility
Rho
Foreign currency
Foreign Rho (on Pricing screen) x Quantity
Corresponds to a 10 BP change in asset currency zero rate
Theta
Foreign currency
Foreign Theta (on Pricing screen) x Quantity
/
Fx Delta
Foreign currency
Non discounted Market Value (whereas delta is discounted as of horizon). Trade ' s actual paid/received premium is not taken
To view Fx delta properly, build a family with P&L= premium currency
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Fx Delta	Foreign currency	Non discounted Market Value (whereas delta is discounted as of horizon). Trade ' s actual paid/received premium is not taken into account.	To view Fx delta properly, build a family with P&L= premium currency

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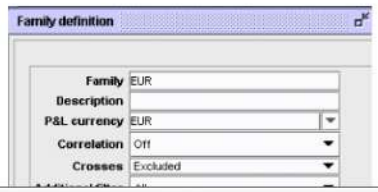
1.4.2 - Example of simulation

In the ***Simulation / Portfolio simulation / Securities*** s creen (with P&L expressed per currency), the **Market_Value** (discounted) is expressed in foreign currency (here, JPY). The discount is done on the local currency (here, EUR) revaluation curve.

Figure 2: - Securities simulation screen



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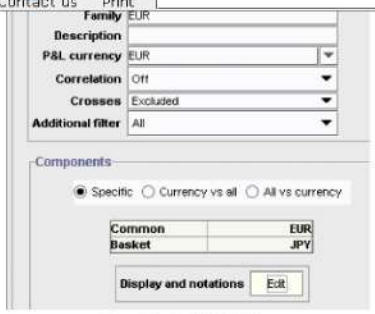

Figure 3: - Family definition

To view the risk on the foreign currency (i.e. JPY) with respect to the local currency (i.e. EUR), family configurations of currency pairs should be built. To do this, click on the Fx tab (see figure 2), select menu option Edit/Insert family, and build the family as shown in figure 3 .

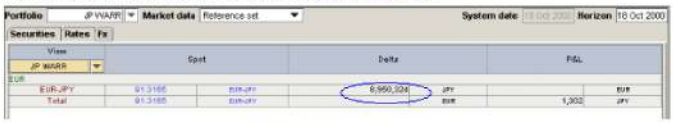

Figure 4: - Fx view on portfolio

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Figure 4: - Fx view on portfolio

In the Fx tab (figure 4), this family view shows the foreign currency risk (here, JPY) with regard to the local currency (EUR).
In our example, for the German investor, the implied Fx risk is high: he may realise capital gains in JPY, which could be wiped out by a fall of JPY against EUR. This Fx risk represented by the EUR/JPY delta changes continuously and is equal to the JPY market value of the warrant.

Indeed, for the German investor, who paid a premium P (EUR), the P&L in EUR is: $PL = MV_{JPY} \times S_{EUR.JPY} - P_{EUR}$

The EUR/JPY delta is therefore MV JPY, the market value in JPY.

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2 - Composite Options

2.1 - Definition of composite option

Composite options are options with a strike price guaranteed in a currency different from their underlying asset currency. They protect against adverse moves of both underlying asset price at maturity and Fx rate.

Notations:

S : the underlying asset spot price in foreign currency

K : the option strike denominated in local currency

F_x : the foreign exchange spot rate at revaluation date between the local and foreign currencies

$r_{foreign}$: the foreign currency interest rate

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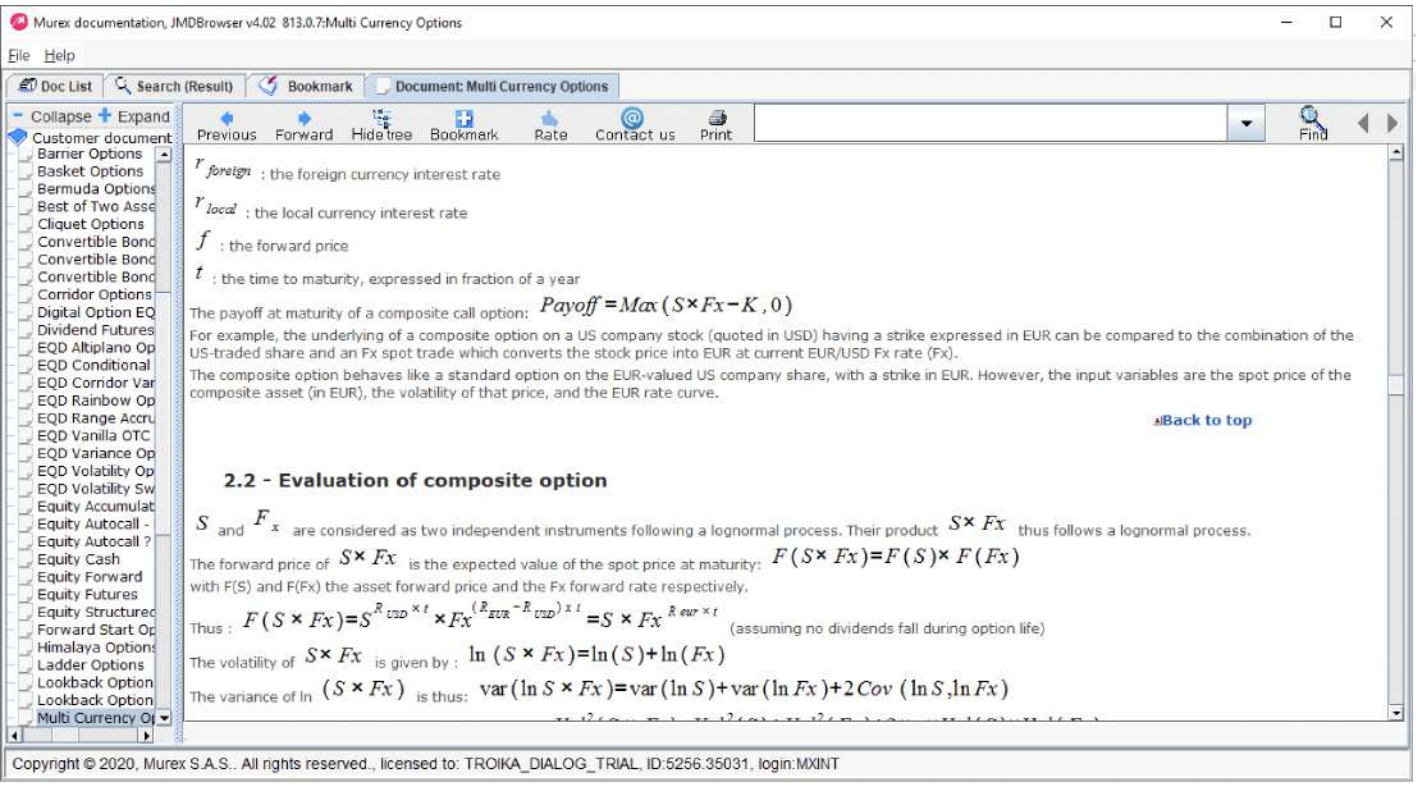

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The volatility of $(S \times Fx)$ is given by :

The variance of ln $(S \times Fx)$ is thus: $\text{var}(\ln S \times Fx) = \text{var}(\ln S) + \text{var}(\ln Fx) + 2\,Cov(\ln S, \ln Fx)$

With the volatilities and the correlation coefficient : $Vol^2(S \times Fx) = Vol^2(S) + Vol^2(Fx) + 2 \times \rho \times Vol(S) \times Vol(Fx)$

These parameters are the input parameters for standard models used to price a composite option.

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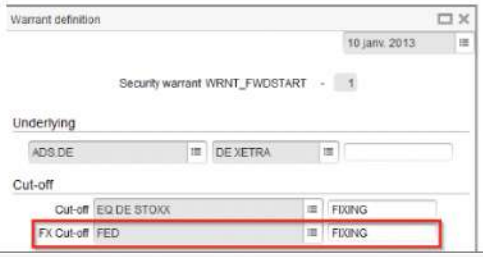
2.3 - Composite option Configuration and Market data

For listed or OTC options, there is no specific configuration at option contract level. At trade ticket level, the fx archiving group and fixing time should be defined to have the fx cutoff considered in the calculation of settlement flux when exercising the option.

For composite option on basket, the volatility type of the basket should be set to *Global* . The volatility types " *by asset* " and " *by asset & smile* " are not compatible with the FX rule " *Composite* " in MX.

For Warrants, select *(SX-K)* in the **Fx rule** flag in the Warrant definition screen (in ***Configuration / Securities / Warrants***). Once the FX rule is set to (SX-K), two fields will be displayed in the bloc Cut-off to define **FX Cut-off** .



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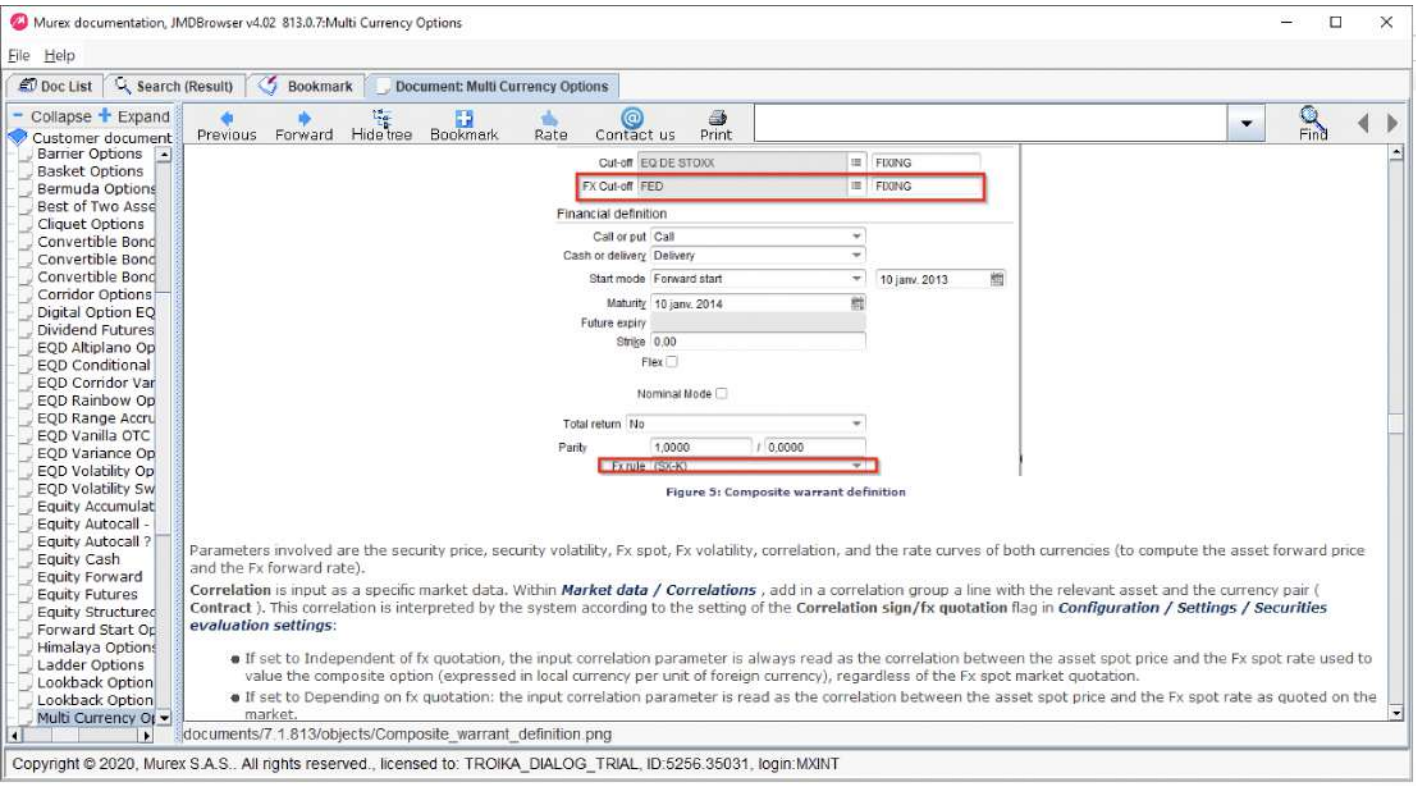
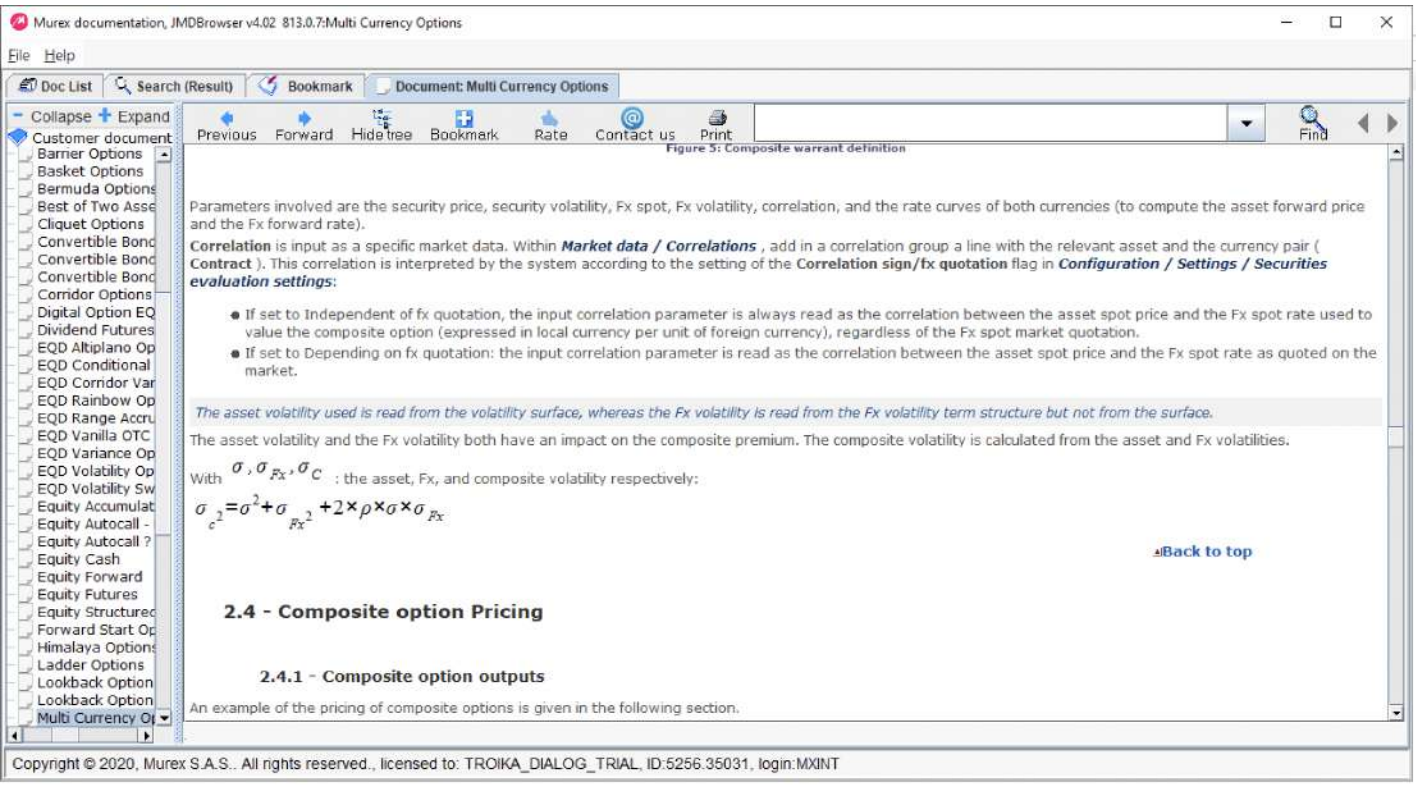


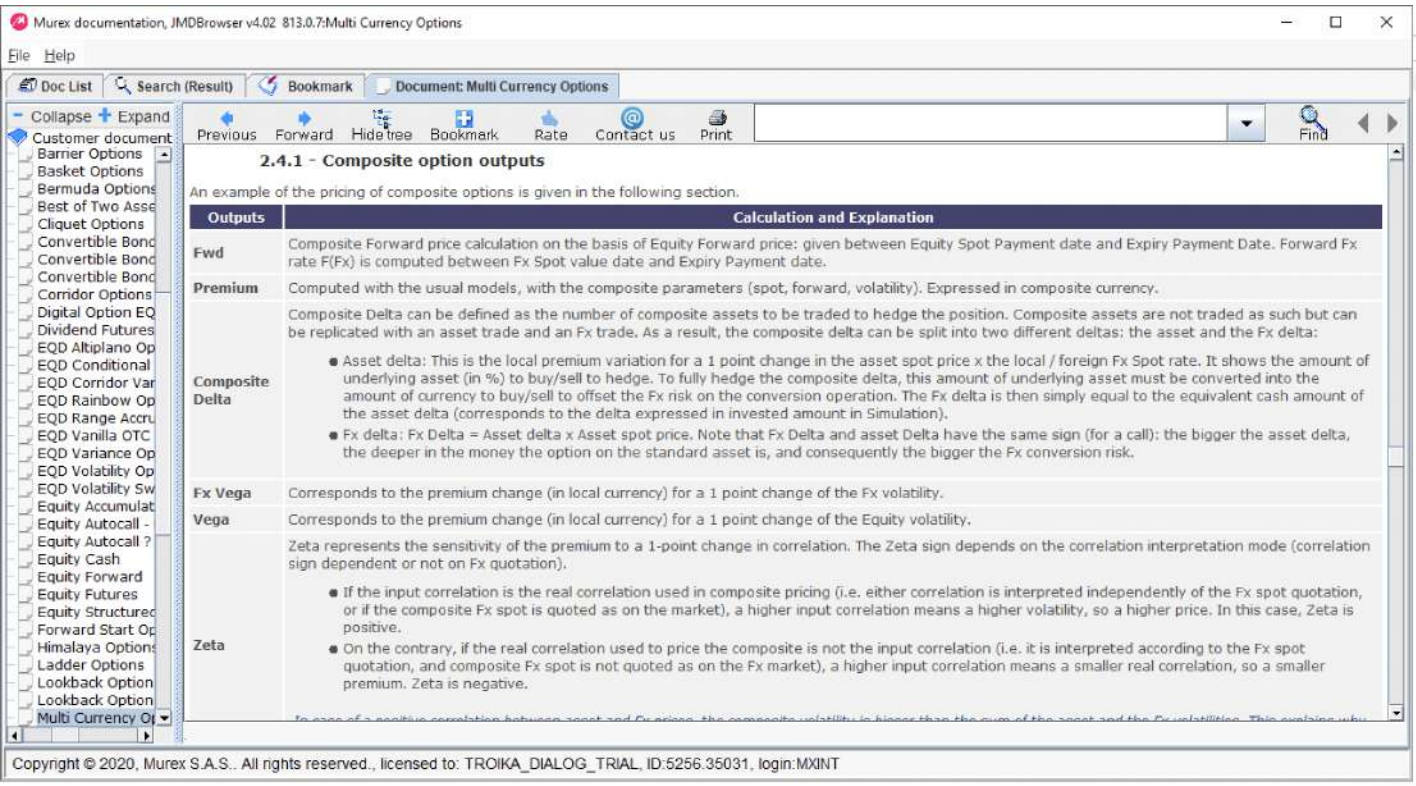
Figure 5: Composite warrant definition

Parameters involved are the security price, security volatility, Fx spot, Fx volatility, correlation, and the rate curves of both currencies (to compute the asset forward price and the Fx forward rate).

Correlation is input as a specific market data. Within ***Market data / Correlations*** , add in a correlation group a line with the relevant asset and the currency pair (**Contract**). This correlation is interpreted by the system according to the setting of the **Correlation sign/fx quotation** flag in ***Configuration / Settings / Securities evaluation settings***:

- If set to Independent of fx quotation, the input correlation parameter is always read as the correlation between the asset spot price and the Fx spot rate used to value the composite option (expressed in local currency per unit of foreign currency), regardless of the Fx spot market quotation.
- If set to Depending on fx quotation: the input correlation parameter is read as the correlation between the asset spot price and the Fx spot rate as quoted on the market.

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2.4.1 - Composite option outputs
An example of the pricing of composite options is given in the following section.
Outputs
Calculation and Explanation
Fwd
Composite Forward price calculation on the basis of Equity Forward price: given between Equity Spot Payment date and Expiry Payment Date. Forward Fx rate F(Fx) is computed between Fx Spot value date and Expiry Payment date.
Premium
Computed with the usual models, with the composite parameters (spot, forward, volatility). Expressed in composite currency.
Composite Delta
Composite Delta can be defined as the number of composite assets to be traded to hedge the position. Composite assets are not traded as such but can be replicated with an asset trade and an Fx trade. As a result, the composite delta can be split into two different deltas: the asset and the Fx delta:
Asset delta: This is the local premium variation for a 1 point change in the asset spot price x the local / foreign Fx Spot rate. It shows the amount of underlying asset (in %) to buy/sell to hedge. To fully hedge the composite delta, this amount of underlying asset must be converted into the amount of currency to buy/sell to offset the Fx risk on the conversion operation. The Fx delta is then simply equal to the equivalent cash amount of the asset delta (corresponds to the delta expressed in invested amount in Simulation).
Fx delta: Fx Delta = Asset delta x Asset spot price. Note that Fx Delta and asset Delta have the same sign (for a call): the bigger the asset delta, the deeper in the money the option on the standard asset is, and consequently the bigger the Fx conversion risk.
Fx Vega
Corresponds to the premium change (in local currency) for a 1 point change of the Fx volatility.
Vega
Corresponds to the premium change (in local currency) for a 1 point change of the Equity volatility.
Zeta
Zeta represents the sensitivity of the premium to a 1-point change in correlation. The Zeta sign depends on the correlation interpretation mode (correlation sign dependent or not on Fx quotation).
If the input correlation is the real correlation used in composite pricing (i.e. either correlation is interpreted independently of the Fx spot quotation, or if the composite Fx spot is quoted as on the market), a higher input correlation means a higher volatility, so a higher price. In this case, Zeta is positive.
On the contrary, if the real correlation used to price the composite is not the input correlation (i.e. it is interpreted according to the Fx spot quotation, and composite Fx spot is not quoted as on the Fx market), a higher input correlation means a smaller real correlation, so a smaller premium. Zeta is negative.
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quotation, and composite Fx spot is not quoted as on the Fx market), a higher input correlation means a smaller real correlation, so a smaller premium. Zeta is negative.

In case of a positive correlation between asset and Fx prices, the composite volatility is bigger than the sum of the asset and the Fx volatilities. This explains why the composite option premium can be largely positive even for quite OTM options.

FxRho

The option premium is discounted on the local currency rate curve, and the composite forward depends only on this curve. Therefore, the composite premium is only sensitive to the local currency rate curve, not to the foreign currency rate curve. Hence $Rho_{foreign}=0$ And Rho_{local} expresses the premium sensitivity to change in the premium currency rate curve.

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2.4.2 - Composite option example

For an option, select *Composite* in the **Multi currency** flag, and select the **Premium currency** .

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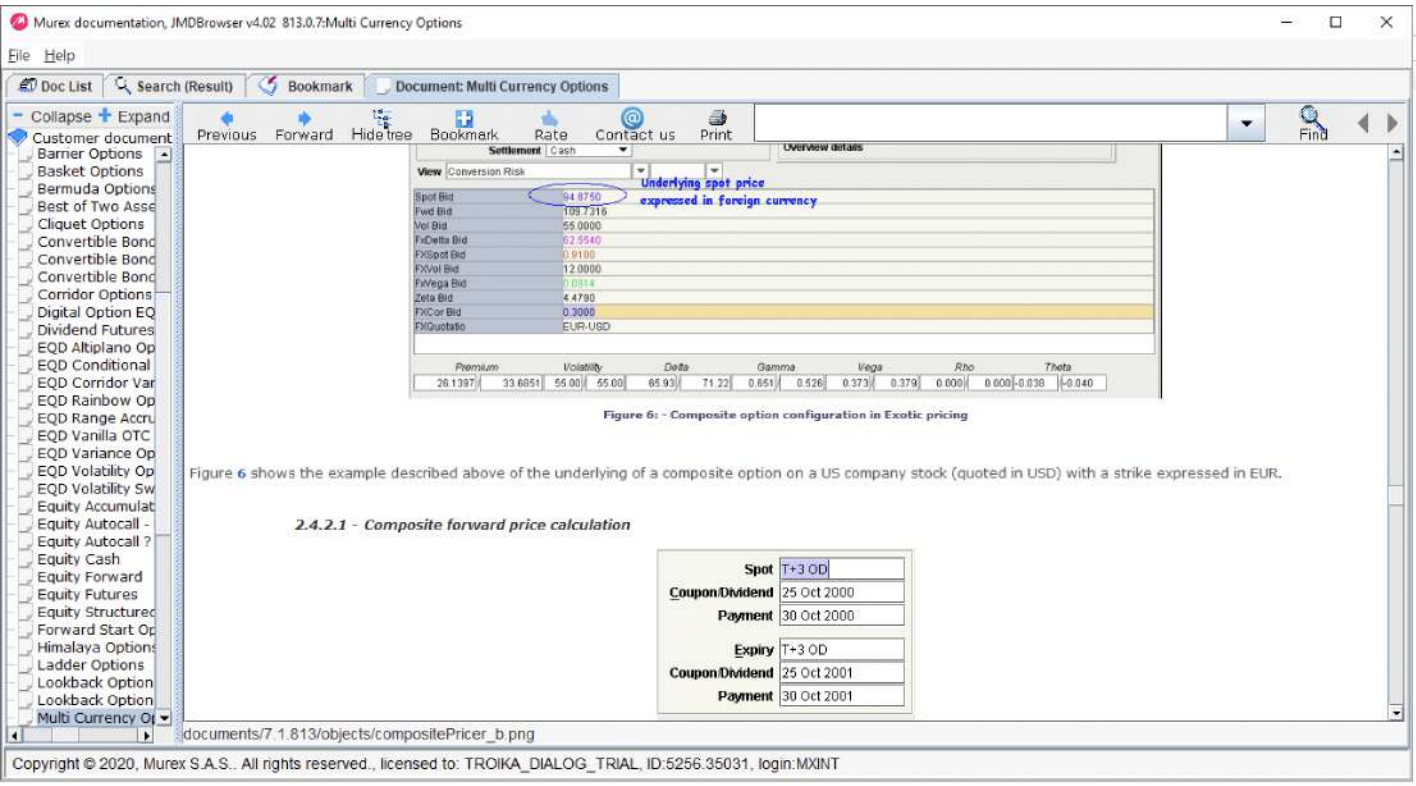

Figure 6: - Composite option configuration in Exotic pricing

Figure 6 shows the example described above of the underlying of a composite option on a US company stock (quoted in USD) with a strike expressed in EUR.

2.4.2.1 - Composite forward price calculation

Spot	T+3 OD
Coupon/Dividend	25 Oct 2000
Payment	30 Oct 2000
Expiry	T+3 OD
Coupon/Dividend	25 Oct 2001
Payment	30 Oct 2001

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Equity Forward price: given between Equity Spot Payment date (30 Oct 2000) and Expiry Payment Date (30 Oct 2001). (To view dates, right click and select Open on **OptDates <Details>** in the parameters list)(figure 7).

- Equity Forward Price F(S) = 101.3389 EUR (Full precision: 101.3388653932).
- Forward Fx rate F(Fx) is computed between Fx Spot value date (27 Oct 2000 in this example) and Expiry Payment date (30 Oct 2001).
- Fx Spot in EUR-USD=0.91
- Compounding factor in USD between 27 Oct 2000 and 30 Oct 2001: 1.068708733
- Compounding factor in EUR between 27 Oct 2000 and 30 Oct 2001: 1.053067619
- Fx Forward price quoted in EUR-USD is given by: 0.91 x 1.068708733 / 1.053067619 = 0.923516144
- Composite forward as of Expiry Payment date is then given by: F (Composite) = 101.3389 / 0.923516144= 109.7315581

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2.4.2.2 - Composite Volatility Calculation

This volatility corresponds to the theoretical volatility used to price the US company share denominated in EUR.

This is a theoretical intermediate parameter, it cannot be displayed on screen.

$$Vol_{composite} = \sqrt{Vol_{equity}^2 + Vol_{FX}^2 + 2 \times \rho \times Vol_{equity} \times Vol_{FX}}$$

$$Vol_{composite} = \sqrt{55^2 + 12^2 + 2 \times 0.3 \times 55 \times 12} = 59.7076$$

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2.4.2.3 - Zeta

In the example shown in Figure 7 , real correlation (FxCorBid) is positive: 0.3 is the correlation between the US company asset and USD-EUR prices. The Fx spot rate used in the composite pricing is quoted in USD-EUR (in EUR for units of USD), so inversely from the market spot (quoted in EUR-USD). But correlation is independent of the

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$$Vol_{composite} = \sqrt{55^2 + 12^2 + 2 \times 0.3 \times 55 \times 12} = 59.7076$$

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2.5 - Forward start composite option

Forward start composite option are options that start at some time in the future, with a strike determined at forward start date and expressed in a currency different from the underlying currency.

Before the forward start date, the strike is estimated by adjusting the equity forward by the FX forward

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Forward start composite option are options that start at some time in the future, with a strike determined at forward start date and expressed in a currency different from the underlying currency.

Before the forward start date, the strike is estimated by adjusting the equity forward by the FX forward.

$F_{fwd\,start}$: Equity forward price at forward start date

$FX_{fwd\,start}$: FX forward at forward start date

$K\%$: option strike in percentage

$K = F_{fwd\,start} * FX_{fwd\,start} * K\%$

At the foward start date, the strike price is set. The fixing procedure needs to be performed to determine the acutal strike of the forward start option.

S_{fixing} : equity fixing value

FX_{cutoff} : FX cutoff at forward start date

$K\%$: option strike in percentage

$K = S_{fixing} * FX_{cutoff} * K\%$

If the FX cutoff is not available at forward start date, the FX spot is used to determine the strike. Once the strike is set, the option is valued in the same way as a vanilla composite option.

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3.1 - Definition of quanto option

Quanto options are options whose payoff is paid in a currency other than the underlying asset currency, at a pre-arranged Fx rate. The purpose is to eliminate the Fx risk. The Fx rate on the final payoff is guaranteed, whereas the underlying asset price is not.

The call quanto option payoff is : $Payoff = Max(S \times 1 - K, 0)$, where S is the underlying asset price (in foreign currency) and 1 the fixed Fx rate. K and $S \times 1$ are expressed in local currency.

Notations used:

F_A : Forward asset price

F_Q : Forward quanto price

T : number of days between evaluation date and expiry date (fraction of year)

The widespread convention, for simplicity's sake, is to fix the Fx rate to 1 . The quanto asset price is then equal to underlying traded asset price but quoted in another currency.

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3.2 - Evaluation of quanto option

The quanto asset is converted at a pre-arranged fixed rate, which is equivalent to an asset quoted in another currency. This asset is a fictitious asset, not traded on the market. The quanto forward (adjusted forward) is estimated through the management cost of the quanto asset. The quanto option on the foreign denominated asset is equal to a standard option on the quanto asset quoted in local currency.

The adjusted forward evaluation is calculated as follows:

Assume we sell a quanto forward on one GBP stock (BritCo) quoted in EUR. To hedge the position, we need to buy one BritCo quoted in EUR.

$$\frac{1}{FX_{EUR/GBP}}$$

Such an asset does not exist on the market, but we can buy BritCo units. If BritCo goes up by 1 GBP, the quanto BritCo PL change is 1 EUR. Our 1/Fx

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The adjusted forward evaluation is calculated as follows:

Assume we sell a quanto forward on one GBP stock (BritCo) quoted in EUR. To hedge the position, we need to buy one BritCo quoted in EUR.

Such an asset does not exist on the market, but we can buy $\frac{1}{FX_{EUR/GBP}}$ BritCo units. If BritCo goes up by 1 GBP, the quanto BritCo PL change is 1 EUR. Our 1/Fx BritCo goes up by 1/Fx x 1 GBP = 1 EUR. The quanto forward position is thus hedged.

If Delta is the number of BritCo to hedge the quanto forward: Delta=1/Fx:

- If Fx goes up, delta goes down. Therefore, we need to sell BritCo. If BritCo price has gone up, we make a profit. If BritCo price has gone down, we make a loss.
- If Fx goes down, delta goes up. Therefore, we need to buy BritCo. If BritCo price has gone up, we make a loss. If BritCo price has gone down, we make a profit.

Therefore, if BritCo price and Fx rate move in the same direction, we make a profit when re-hedging; if they move in opposite directions, we make a loss when re-hedging. The bigger the BritCo or the Fx variation, the greater the gain or loss when re-hedging.

Conclusion: the quanto forward price being equal to the hedge price, the quanto forward price depends on:

- the correlation between the Fx rate and the asset price (the quanto forward value decreasing with the increasing correlation)
- the volatility of the Fx rate and of the asset, their effect being combined with the correlation.

Finally, the quanto forward price is equal to the asset forward price, adjusted by a management cost which is the profit or loss made when re-hedging. If the correlation is positive (resp. negative), the quanto forward price is lower (resp. higher) than the standard forward asset price.

$F_Q = F_A \times e^{(-\rho \times \sigma_A \times \sigma_{FX} \times T)}$, where:

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$F_Q = F_A \times e^{(-\rho \times \sigma_A \times \sigma_{Fx} \times T)}$, where:

- ρ is the correlation between the asset price and the Fx rate, quoted in asset-quanto (i.e. in units of quanto local currency per unit of asset foreign currency).
- Security volatility σ_A is interpolated inside the smile surface using an adjusted strike and the maturity. The adjusted strike is computed as the ratio of the deal strike and the Fixed FX rate. $Adjusted\ Strike = \frac{deal\ Strike}{Fixed\ FX\ Rate}$

The quanto option is an option on this instrument. Standard models (Forward B&S for Vanilla) can then be applied. All expected flows being in the local currency, discounting is done with this currency rate curve. The quanto volatility is the underlying asset volatility, because asset price and quanto asset (asset price x Fx_Q) vary similarly.

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3.3 - Quanto option instrument configuration and market data

For listed or OTC options, there is no specific configuration required at option contract level. For Warrants, select *(S.1-K)* in the **Fx rule** flag. Parameters involved are the security price, security volatility, Fx spot, Fx volatility, correlation, and both currencies ' rates curves (to compute the asset forward price and the Fx forward rate, and for discounting). Dividends also affect the asset forward calculation. All flows and premium being in the local currency, they are discounted on the local currency curve.

Correlation is input as a specific market data. Within Market data/Equities/Correlations, add in a correlation group a line with the relevant asset and the currency pair (**Contract**). This correlation will be interpreted by the system according to the setting of the **Correlation sign/Fx quotation** flag in ***Configuration/Settings/Securities evaluation settings*** :

- If set to Independent of fx quotation, the input correlation parameter is always read as the correlation between the asset spot price and the Fx spot rate used to value the option (expressed in local currency per unit of foreign currency), regardless of the Fx spot market quotation.
- If set to Depending on fx quotation: the input correlation parameter is read as the correlation between the asset spot price and the Fx spot rate as quoted on the market.

The equity volatility used to compute the quanto forward can be either the ATM volatility or the smile volatility. The choice depends on the settings **Quanto drift volatility**

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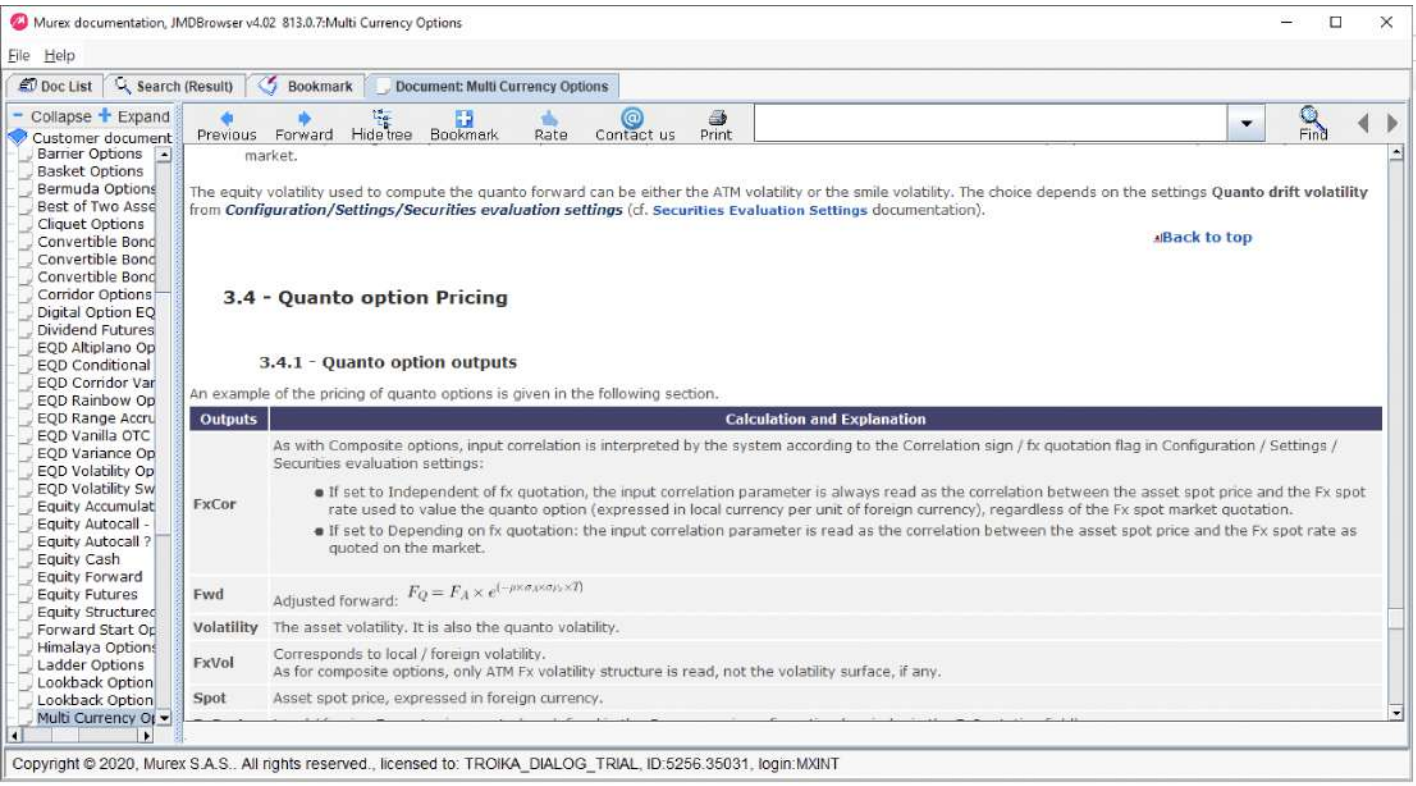
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market.
The equity volatility used to compute the quanto forward can be either the ATM volatility or the smile volatility. The choice depends on the settings Quanto drift volatility from Configuration/Settings/Securities evaluation settings (cf. Securities Evaluation Settings documentation).
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3.4 - Quanto option Pricing
3.4.1 - Quanto option outputs
An example of the pricing of quanto options is given in the following section.
Outputs
Calculation and Explanation
FxCor
As with Composite options, input correlation is interpreted by the system according to the Correlation sign / fx quotation flag in Configuration / Settings / Securities evaluation settings:
If set to Independent of fx quotation, the input correlation parameter is always read as the correlation between the asset spot price and the Fx spot rate used to value the quanto option (expressed in local currency per unit of foreign currency), regardless of the Fx spot market quotation.
If set to Depending on fx quotation: the input correlation parameter is read as the correlation between the asset spot price and the Fx spot rate as quoted on the market.
Fwd
Adjusted forward: $F_Q = F_A \times e^{(-\rho \times \sigma_A \times \sigma_{fx} \times T)}$
Volatility
The asset volatility. It is also the quanto volatility.
FxVol
Corresponds to local / foreign volatility.
As for composite options, only ATM Fx volatility structure is read, not the volatility surface, if any.
Spot
Asset spot price, expressed in foreign currency.
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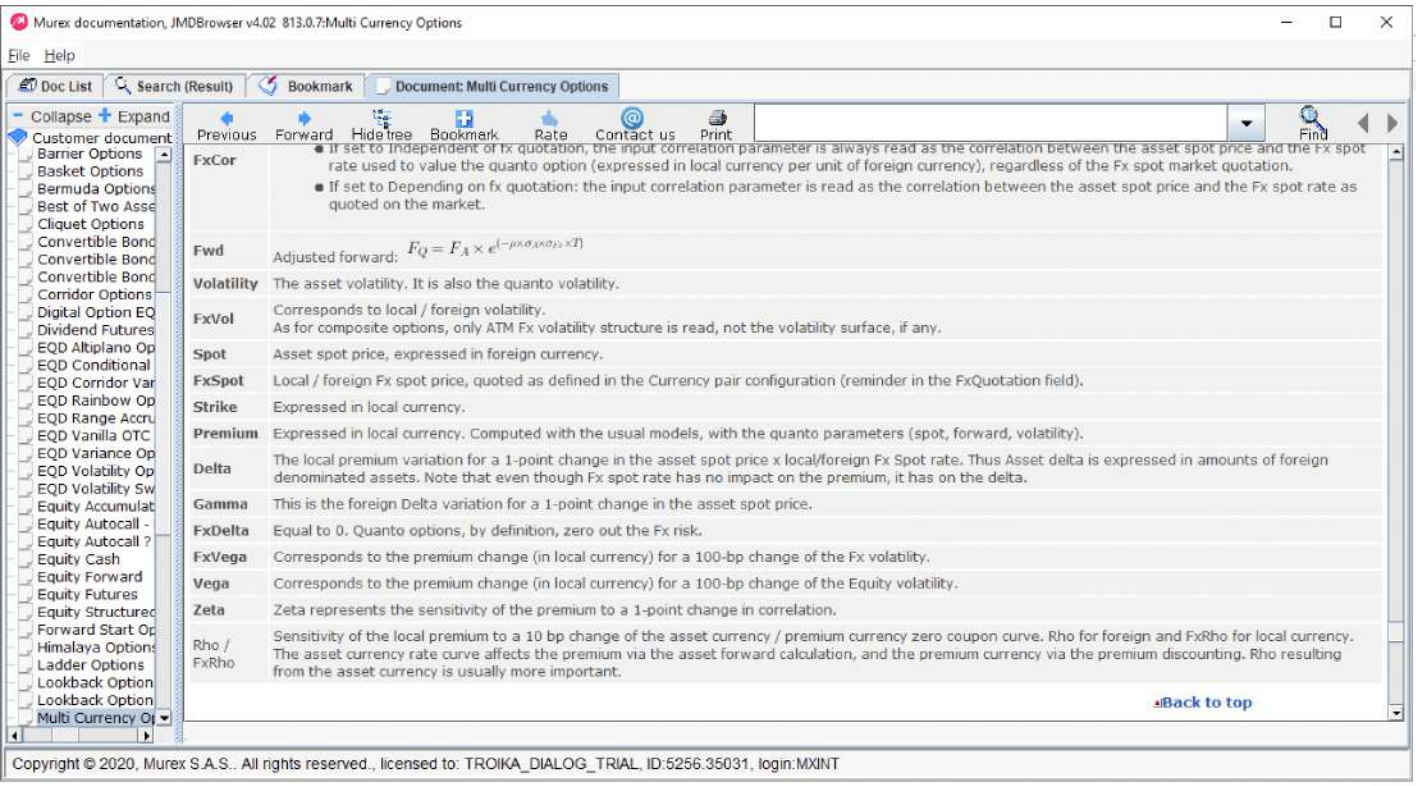
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FxCor
If set to Independent of fx quotation, the input correlation parameter is always read as the correlation between the asset spot price and the Fx spot rate used to value the quanto option (expressed in local currency per unit of foreign currency), regardless of the Fx spot market quotation.
If set to Depending on fx quotation: the input correlation parameter is read as the correlation between the asset spot price and the Fx spot rate as quoted on the market.
Fwd
Adjusted forward: $F_Q = F_A \times e^{(-\rho \times \sigma_A \times \sigma_{FX} \times T)}$
Volatility
The asset volatility. It is also the quanto volatility.
FxVol
Corresponds to local / foreign volatility.
As for composite options, only ATM Fx volatility structure is read, not the volatility surface, if any.
Spot
Asset spot price, expressed in foreign currency.
FxSpot
Local / foreign Fx spot price, quoted as defined in the Currency pair configuration (reminder in the FxQuotation field).
Strike
Expressed in local currency.
Premium
Expressed in local currency. Computed with the usual models, with the quanto parameters (spot, forward, volatility).
Delta
The local premium variation for a 1-point change in the asset spot price x local/foreign Fx Spot rate. Thus Asset delta is expressed in amounts of foreign denominated assets. Note that even though Fx spot rate has no impact on the premium, it has on the delta.
Gamma
This is the foreign Delta variation for a 1-point change in the asset spot price.
FxDelta
Equal to 0. Quanto options, by definition, zero out the Fx risk.
FxVega
Corresponds to the premium change (in local currency) for a 100-bp change of the Fx volatility.
Vega
Corresponds to the premium change (in local currency) for a 100-bp change of the Equity volatility.
Zeta
Zeta represents the sensitivity of the premium to a 1-point change in correlation.
Rho / FxRho
Sensitivity of the local premium to a 10 bp change of the asset currency / premium currency zero coupon curve. Rho for foreign and FxRho for local currency. The asset currency rate curve affects the premium via the asset forward calculation, and the premium currency via the premium discounting. Rho resulting from the asset currency is usually more important.
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from the asset currency is usually more important.

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3.4.2 - Quanto option example

For an option, select *Quanto* in the **Multi currency** flag, and select the **Premium currency .**

By default, the Fixed Fx rate is equal to 1.

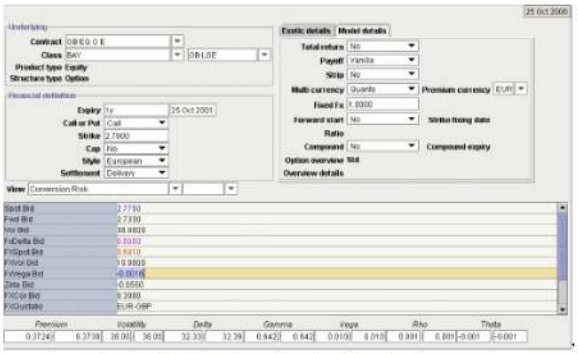

Figure 8: - Quanto option configuration of exotic option screen

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Figure 8: - Quanto option configuration of exotic option screen

Figure 9: - Option date details

To view date details of the option, right click and select **Open <Details>** in **OptDates** line (figure **9**).
In the example in figures **8** and **9** , the adjusted forward (Fwd) price is calculated as follows:

Reminder of general formula : $F_Q = F_A \times e^{(-\rho \times \sigma_A \times \sigma_{Fx} \times T)}$

F_A = Asset forward = 2.7643366906 GBP

ρ = 0.3 = correlation between the asset price and the Fx price actually used to price the option (correlation Independent of fx quotation in this example).

ρ_A = 0.38

ρ_{Fx} = 0.10

T

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ρ_{Fx} = 0.10

T = number of days between evaluation date (25 Oct 2000) and expiry date (25 Oct 2001), as a fraction of year = 365/365 = 1

Hence $F_Q = 2.7643366906^{(0.3 \times 0.38 \times 0.10 \times 1)}$.

F_Q = 2.7330 (Full precision: 2.733002198)

- Spot is the Asset spot price, expressed in foreign currency (GBP)
- Fx Spot Price is EUR/GBP Fx spot price.
- Strike is expressed in EUR (local currency).
- Premium is expressed in EUR (local currency).

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4 - Exotic Quanto options

- Asian: forward quanto for each fixing, Volatility term structure.
- Forward start.
- Quanto basket: same with several underlying currencies.
- B = Somme (Ni x Si) so we take the option on basket model, with quanto inputs: quanto forward of each component, volatility of each component and correlation. In the basket configuration, set the multi currency rule. The Pricing screen shows each component.

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