



FX Forward Product Specification

Vector Risk Pty Ltd

May 11, 2017

Version 8.0.8095

Contents

List of Figures	3
List of Tables	4
1 FX Forward	5
1.1 Instrument Properties	5
1.2 Definitions	5
1.3 Representations	5
1.4 Cashflow Generation	7
1.5 Examples	8
2 No Interest Cashflow	10
2.1 Properties of Cashflow	10
2.2 Definitions	10
2.3 Cashflow Inputs	10
2.4 Formula	11
2.5 Examples	12
3 Fixed Cashflow	13
3.1 Properties of Cashflow	13
3.2 Definitions	13
3.3 Cashflow Inputs	13
3.4 Formula	15
3.5 Examples	15
Glossary	17

List of Figures

1.1	FX forward	5
2.1	No interest cahflow	10
3.1	Fixed cahflow	13

List of Tables

1.1	Mandatory trade fields for the Default representation of the FX Forward	6
1.2	Optional trade fields for the Default representation of the FX Forward	6
1.3	Trade field restrictions for the Default representation of the FX Forward	6
1.4	Mandatory trade fields for the Strike representation of the FX Forward	7
1.5	Optional trade fields for the Strike representation of the FX Forward	7
1.6	Trade field restrictions for the Strike representation of the FX Forward	7
1.7	Optional trade field for Cashflows representation of the FX Forward	7
1.8	Cashflow generation for FX Forward	8
1.9	Representation reduction for the Strike representation of the FX Forward	8
2.1	Mandatory fields for No Interest Cashflow	10
2.2	Optional field for No Interest Cashflow	11
2.3	Field restrictions for No Interest Cashflow	11
3.1	Mandatory fields for Fixed Cashflow	14
3.2	Optional field for Fixed Cashflow	14
3.3	Field restrictions for Fixed Cashflow	14

Chapter 1

FX Forward

1.1 Instrument Properties

An FX forward is an agreement to purchase a predetermined amount of one currency, the **receive currency** against another currency, the **pay currency** at an agreed fixed exchange rate, the **strike rate** on the **maturity date** (MD).

Figure 1.1 illustrates an FX forward that swaps \$100,000 AUD for \$60,000 GBP.

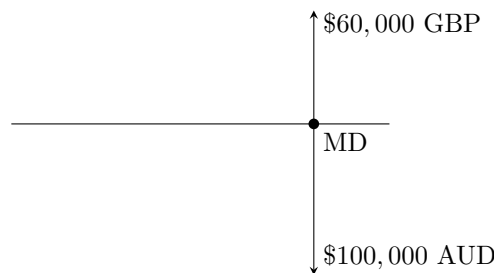


Figure 1.1: FX forward

1.2 Definitions

In this section, we define terms that are specific to FX forwards.

maturity date is the date the contract expires.

pay currency is the currency one agreed to sell.

receive currency is the currency one agreed to purchase.

strike rate is the agreed exchange rate between **pay currency** and **receive currency**.

1.3 Representations

In the Risk Engine, products are specified by *representations*. In this section, we provide the representations of FX forwards.

1.3.1 Default Representation

The *Default* representation consists of the mandatory trade fields in Table 1.1, the optional trade fields in Table 1.2, with their restrictions in Table 1.3.

<i>Field</i>	<i>Description</i>	<i>Data Type</i>	<i>Symbol</i>
PayCurrency	The pay currency	string	p
RecCurrency	The receive currency	string	r
PayAmount	The amount to be paid in <i>PayCurrency</i>	double	N_p
RecAmount	The amount to be received in <i>RecCurrency</i>	double	N_r
MaturityDate	The maturity date	date	MD

Table 1.1: Mandatory trade fields for the Default representation of the FX Forward

<i>Field</i>	<i>Description</i>	<i>Data Type</i>	<i>Symbol</i>	<i>Default Value</i>
BreakDate	Date of the right to break	date	BD	MD
PayCurrencyDiscountReference	Alternative discounting curve for pay leg	string		
RecCurrencyDiscountReference	Alternative discounting curve for receive leg	string		

Table 1.2: Optional trade fields for the Default representation of the FX Forward

<i>Field</i>	<i>Restriction</i>
RecCurrency	$r \neq p$
PayAmount	$N_p > 0$
RecAmount	$N_r > 0$

Table 1.3: Trade field restrictions for the Default representation of the FX Forward

1.3.1.1 Required Curves

The following curves are required by an FX forward:

- *PayCurrency FX spot curve*: FX Spot Curve — (FX.PRICE.PayCurrency.BaseCurrency),
- *ReceiveCurrency FX spot curve*: FX Spot Curve — (FX.PRICE.ReceiveCurrency.BaseCurrency),
- *PayCurrency discounting curve*: FX Zero Curve — (FX.ZERO.PayCurrency.ReserveCurrency), and
- *ReceiveCurrency discounting curve*: FX Zero Curve — (FX.ZERO.ReceiveCurrency.ReserveCurrency).

When the optional field PayCurrencyDiscountReference or RecCurrencyDiscountReference is provided, the reference curve is used as the PayCurrency discounting curve or the RecCurrency discounting curve respectively.

1.3.2 Strike Representation

The *Strike* representation consists of the mandatory trade fields in Table 1.4, the optional trade fields in Table 1.5, with their restrictions in Table 1.6.

1.3.2.1 Required Curves

The following curves are required by an FX forward:

- *Currency FX spot curve*: FX Spot Curve — (FX.PRICE.Currency.BaseCurrency),
- *CrossCurrency FX spot curve*: FX Spot Curve — (FX.PRICE.CrossCurrency.BaseCurrency),
- *Currency discounting curve*: FX Zero Curve — (FX.ZERO.Currency.ReserveCurrency), and
- *CrossCurrency discounting curve*: FX Zero Curve — (FX.ZERO.CrossCurrency.ReserveCurrency).

When the optional field CurrencyDiscountReference or CrossCurrencyDiscountReference is provided, the reference curve is used as the Currency discounting curve or the CrossCurrency discounting curve respectively.

<i>Field</i>	<i>Description</i>	<i>Data Type</i>	<i>Symbol</i>
Currency	The primary currency	string	p
CrossCurrency	The cross currency	string	c
CrossCurrencyAmount	The deal amount in <i>CrossCurrency</i>	double	N_c
Strike	The strike rate as <i>Currency / CrossCurrency</i>	double	X
MaturityDate	The maturity date	date	MD
Direction	Pay and receive direction	string	direction

Table 1.4: Mandatory trade fields for the Strike representation of the FX Forward

<i>Field</i>	<i>Description</i>	<i>Data Type</i>	<i>Symbol</i>	<i>Default Value</i>
BreakDate	Date of the right to break	date	BD	MD
CurrencyDiscountReference	Alternative discounting curve for currency leg	string		
CrossCurrencyDiscountReference	Alternative discounting curve for cross currency leg	string		

Table 1.5: Optional trade fields for the Strike representation of the FX Forward

<i>Field</i>	<i>Restriction</i>
CrossCurrency	$c \neq p$
CrossCurrencyAmount	$N_c > 0$
Strike	$X > 0$
Direction	PayCurrencyReceiveCrossCurrency, ReceiveCurrencyPayCrossCurrency

Table 1.6: Trade field restrictions for the Strike representation of the FX Forward

1.3.3 Cashflows Representation

The *Cashflows* representation consists of the optional trade field in Table 1.7 and the accepted cashflows are

- no interest flow (NoInterest)¹, and
- fixed flow (Fixed)².

<i>Field</i>	<i>Description</i>	<i>Data Type</i>	<i>Symbol</i>	<i>Default Value</i>
BreakDate	Date of the right to break	date	BD	

Table 1.7: Optional trade field for Cashflows representation of the FX Forward

1.4 Cashflow Generation

For an FX forward, two cashflows are generated:

- 1) a no interest flow in the pay direction, and
- 2) a no interest flow in the receive direction,

as illustrated in Table 1.8.

¹See No Interest Cashflow for details (p.10 of this document).

²See Fixed Cashflow for details (p.13 of this document).

<i>Field</i>	<i>Pay Side</i>	<i>Receive Side</i>
FlowType	NoInterest	NoInterest
PayReceive	Pay	Receive
Currency	p	r
FlowDate	MD	MD
Amount	N_p	N_r

Table 1.8: Cashflow generation for FX Forward

1.4.1 Representation Reduction

The cashflow generation algorithm described in Table 1.8 is only defined for the Default representation. If the trade is specified by other representations, we need to reduce it to the Default representation.

1.4.1.1 Strike Representation

For the Strike representation, the trade fields are set according to the trade field Direction, as illustrated in Table 1.9, with the trade fields in column 1 take the values in either column 2 or 3, depending on the trade field Direction.

<i>Direction</i>	<i>PayCurrencyReceiveCrossCurrency</i>	<i>ReceiveCurrencyPayCrossCurrency</i>
PayCurrency	Currency	CrossCurrency
RecCurrency	CrossCurrency	Currency
PayAmount	Strike \times CrossCurrencyAmount	CrossCurrencyAmount
RecAmount	CrossCurrencyAmount	Strike \times CrossCurrencyAmount
PayCurrencyDiscountReference	CurrencyDiscountReference	CrossCurrencyDiscountReference
RecCurrencyDiscountReference	CrossCurrencyDiscountReference	CurrencyDiscountReference

Table 1.9: Representation reduction for the Strike representation of the FX Forward

1.5 Examples

This section provides some deal examples of FX forward.

Example 1.1. An FX forward in Default representation:

- PayCurrency: AUD
- ReceiveCurrency: GBP
- PayAmount: 100,000,000
- ReceiveAmount: 60,000,000
- MaturityDate: 2013-11-15

On 2013-11-15, one receives \$60,000,000 GBP and pays \$100,000,000 AUD.

Example 1.2. An FX forward in Strike representation:

- Currency: AUD
- CrossCurrency: USD
- CrossCurrencyAmount: 100,000,000
- Strike: 1.0500
- MaturityDate: 2013-11-15
- Direction: PayCurrencyReceiveCrossCurrency

The deal amount in Currency is

$$N_p = X \times N_c = 1.05 \times 100,000,000 = 105,000,000.$$

Given the holder of the FX forward pays AUD and receives USD, on 2013-11-15, one receives \$100,000,000 USD and pays \$105,000,000 AUD.

Example 1.3. An FX forward in Strike representation:

- Currency: JPY
- CrossCurrency: AUD
- CrossCurrencyAmount: 100,000,000
- Strike: 98.1528
- MaturityDate: 2013-11-15
- Direction: ReceiveCurrencyPayCrossCurrency

The deal amount in Currency is

$$N_p = X \times N_c = 98.1528 \times 100,000,000 = 9,815,280,000.$$

Given the holder of the FX forward pays AUD and receives JPY, on 2013-11-15, one receives \$9,815,280,000 JPY and pays \$100,000,000 AUD.

Chapter 2

No Interest Cashflow

2.1 Properties of Cashflow

A no interest cashflow is a transfer of the **amount** of N in **currency** on the **flow date** (FD), as illustrated in Figure 2.1. Principal repayment of a loan is an example of no interest cashflow.



Figure 2.1: No interest cashflow

2.2 Definitions

In this section, we define terms that are specific to no interest cashflow.

amount is the amount in **currency** that one has to transfer on the **flow date**.

currency is the currency that the transfer is in.

flow date is the date that the cashflow transfer occurs.

2.3 Cashflow Inputs

A no interest cashflow is specified by the mandatory fields in Table 2.1, the optional field in Table 2.2, with their restrictions in Table 2.3.

<i>Field</i>	<i>Description</i>	<i>Data Type</i>	<i>Symbol</i>
PayReceive	The pay/receive direction of the cashflow	string	direction
Currency	The currency	string	ccy
FlowDate	The date of the cashflow payment, i.e. the flow date	date	FD
Amount	The amount of the transfer	double	N

Table 2.1: Mandatory fields for No Interest Cashflow

<i>Field</i>	<i>Description</i>	<i>Data Type</i>	<i>Symbol</i>	<i>Default Value</i>
DiscountReference	Alternative discounting curve	string		
LegID	The identifier of the leg	string		
Description	The description of the flow	string		

Table 2.2: Optional field for No Interest Cashflow

<i>Field</i>	<i>Restriction</i>
PayReceive Amount	Pay, Receive, P, R $N > 0$

Table 2.3: Field restrictions for No Interest Cashflow

2.3.1 Required Curves

The following curves are required by a no interest cashflow:

- *Currency FX spot curve*: FX Spot Curve — (FX.PRICE.Currency.BaseCurrency), and
- *Currency discounting curve*: Money Market Zero Curve: (MM.ZERO.SWAP.Currency) ¹.

When the optional field DiscountReference is provided, the reference curve is used as the Currency discounting curve.

2.4 Formula

A no interest cashflow gives a transfer of N in **currency** on the **flow date**.

If the Valuation Date is less than or equal to the **flow date**, the value of a no interest cashflow in Base Currency is

$$N \times E_{\text{ccy}} \times \mathbb{I}_{\text{pr}} \times Df_t,$$

where

- N is the **amount** of the transfer in **currency**,
- E_{ccy} is the spot exchange rate in units of Base Currency per **currency**, from the Currency FX spot curve,
- the discount factor from Valuation Date to **flow date** is

$$Df_t = e^{-r_{\text{ccy}} t},$$

- r_{ccy} is the continuous zero rate of **currency** from Valuation Date to **flow date** in Actual/365 (Fixed) day count convention, from the Currency discounting curve,
- t is the time in years from Valuation Date to **flow date** in Actual/365 (Fixed) day count convention, and
- the indicator for pay or receive direction is

$$\mathbb{I}_{\text{pr}} = \begin{cases} 1, & \text{if direction is 'R'}, \\ -1, & \text{if direction is 'P'}. \end{cases}$$

If the Valuation Date is greater than the **flow date**, then the no interest flow has expired and thus has a value of zero.

¹For certain products, e.g. FX Forward or Cross Currency Swap, FX ZERO curve is used for discounting.

2.5 Examples

This section provides some deal examples of no interest cashflow.

Example 2.1. A no interest cashflow:

- PayReceive: Pay
- Currency: GBP
- FlowDate: 2013-11-15
- Amount: 60,000,000

On 2013-11-15, there is a payment of \$60,000,000 GBP.

Example 2.2. A no interest cashflow:

- PayReceive: Receive
- Currency: AUD
- FlowDate: 2013-11-15
- Amount: 100,000,000

On 2013-11-15, one receives \$100,000,000 AUD.

Chapter 3

Fixed Cashflow

3.1 Properties of Cashflow

A fixed cashflow is a transfer of the interest component of a transfer schedule on the **flow date** (FD) where the interest payment is determined by a **fixed rate** R on an **amount** of N in **currency** for the **accrual period**. The **accrual period** is specified by **accrual start date** (ASD) and **accrual end date** (AED). An example of fixed cashflow is illustrated in Figure 3.1. The coupon payment of bond where the coupon rate is fixed is an example of fixed cashflows.

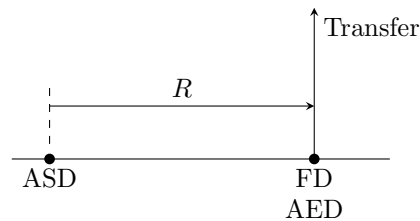


Figure 3.1: Fixed cashflow

3.2 Definitions

In this section, we define terms that are specific to fixed cashflow.

accrual day count fraction is the day count fraction of the **accrual period**.

accrual end date is the end date of the **accrual period**.

accrual period is the tenor period over which the **fixed rate** applies.

accrual start date is the start date of the **accrual period**.

amount is the notional amount in **currency** of the cashflow.

currency is currency that the transfer is in.

fixed rate is the per annum fixed interest rate that applies to the cashflow.

flow date is the date that the cashflow transfer occurs.

3.3 Cashflow Inputs

A fixed cashflow is specified by the mandatory fields in Table 3.1, the optional field in Table 3.2, with their restrictions in Table 3.3.

<i>Field</i>	<i>Description</i>	<i>Data Type</i>	<i>Symbol</i>
PayReceive	The pay/receive direction of the cashflow	string	direction
Currency	The currency	string	ccy
InterestStyle	The interest style of the cashflow	string	style
AccrualDayCount	The day count convention for the accrual period	string	dcc
FlowDate	The date of the cashflow payment, i.e. the flow date	date	FD
Amount	The notional amount	double	N
FixedRate	The fixed interest rate, i.e. the fixed rate	double	R
AccrualStartDate	The accrual start date	date	ASD
AccrualEndDate	The accrual end date	date	AED

Table 3.1: Mandatory fields for Fixed Cashflow

<i>Field</i>	<i>Description</i>	<i>Data Type</i>	<i>Symbol</i>	<i>Default Value</i>
DiscountReference	Alternative discounting curve	string		
DiscountRate	For Discount flow, standard discounting method applies. This specifies the discount rate. If not specified, the flow will be discounted with the fixed rate .	string	D	R
DiscountRateDayCount	For Discount flow, standard discounting method applies. This specifies the day count convention for the discount rate. If not specified, it takes the value of the accrual day count fraction .	string	dcc _D	dcc
LegID	The identifier of the leg	string		
Description	The description of the flow	string		

Table 3.2: Optional field for Fixed Cashflow

<i>Field</i>	<i>Restriction</i>
PayReceive	Pay, Receive, P, R
InterestStyle	Simple, Discount
Amount	$N > 0$
AccrualEndDate	AED > ASD

Table 3.3: Field restrictions for Fixed Cashflow

3.3.1 Required Curves

The following curves are required by a fixed cashflow:

- *Currency FX spot curve*: FX Spot Curve — (FX.PRICE.Currency.BaseCurrency), and
- *Currency discounting curve*: Money Market Zero Curve: (MM.ZERO.SWAP.Currency) ¹.

In the case of the optional field DiscountReference is provided, the reference curve is used as the Currency discounting curve instead.

¹For certain products, e.g. FX Forward or Cross Currency Swap, FX ZERO curve is used for discounting.

3.4 Formula

The transfer in **currency** on the **flow date** of a fixed cashflow is

$$\begin{cases} N \times \mathbb{I}_{\text{pr}} \times R\tau, & \text{if style is 'Simple',} \\ N \times \mathbb{I}_{\text{pr}} \times \frac{R\tau}{1 + D\tau_D}, & \text{if style is 'Discount',} \end{cases} \quad (3.1)$$

where

- N is the notional **amount** in **currency**,
- R is the **fixed rate**,
- τ is the **accrual day count fraction**, from **accrual start date** to **accrual end date**, according to the day count convention for the **accrual period** (dcc),
- D is the discount rate,
- τ_D is the day count fraction from **accrual start date** to **accrual end date**, according to the discount day count convention (dcc_D), and
- the indicator for pay or receive direction is

$$\mathbb{I}_{\text{pr}} = \begin{cases} 1, & \text{if direction is 'R',} \\ -1, & \text{if direction is 'P'.} \end{cases}$$

3.5 Examples

This section provides some deal examples of fixed cashflow.

Example 3.1 (Simple interest). A fixed cashflow:

- PayReceive: Pay
- Currency: GBP
- InterestStyle: Simple
- AccrualDayCount: ACT365(FIXED)
- FlowDate: 2013-11-15
- Amount: 60,000,000
- FixedRate: 0.0315
- AccrualStartDate: 2013-08-15
- AccrualEndDate: 2013-11-15

There are 92 days from the **accrual start date** (2013-08-15) to the **accrual end date** (2013-11-15). The **accrual day count fraction** of the cashflow is calculated using the Actual/365 (Fixed) day count convention to give

$$\tau = \frac{92}{365}.$$

Using (3.1), on 2013-11-15, there is a payment of

$$N \times R\tau = 60,000,000 \times 0.0315 \times \frac{92}{365} = \$476,383.56 \text{ GBP.}$$

Example 3.2 (Discount interest). A fixed cashflow:

- PayReceive: Receive
- Currency: USD
- InterestStyle: Discount
- AccrualDayCount: 30360
- FlowDate: 2013-11-15
- Amount: 100,000,000
- FixedRate: 0.0145
- AccrualStartDate: 2013-08-15
- AccrualEndDate: 2013-11-15

Using 30/360 day count convention, there are 90 days from the **accrual start date** (2013-08-15) to the **accrual end date** (2013-11-15). The **accrual day count fraction** of the cashflow is

$$\tau = \frac{90}{360} = 0.25.$$

Using (3.1), on 2013-11-15, one receives

$$N \times \frac{R\tau}{1 + D\tau_D} = 100,000,000 \times \frac{0.0145 \times 0.25}{1 + 0.0145 \times 0.25} = \$361,190.68 \text{ USD.}$$

Example 3.3 (Discount interest with discount rate provided). A fixed cashflow:

- PayReceive: Receive
- Currency: USD
- InterestStyle: Discount
- AccrualDayCount: 30360
- FlowDate: 2013-11-15
- Amount: 100,000,000
- FixedRate: 0.0145
- AccrualStartDate: 2013-08-15
- AccrualEndDate: 2013-11-15
- DiscountRate: 0.0125
- DiscountRateDayCount: ACT360

Using 30/360 day count convention, there are 90 days from the **accrual start date** (2013-08-15) to the **accrual end date** (2013-11-15). The **accrual day count fraction** of the cashflow is

$$\tau = \frac{90}{360} = 0.25.$$

There are 92 days from the **accrual start date** (2013-08-15) to the **accrual end date** (2013-11-15). The discount rate day count fraction of the cashflow is calculated using the Actual/360 (Fixed) day count convention to give

$$\tau_D = \frac{92}{360}.$$

Using (3.1), on 2013-11-15, one receives

$$N \times \frac{R\tau}{1 + D\tau_D} = 100,000,000 \times \frac{0.0145 \times 0.25}{1 + 0.0125 \times \frac{92}{365}} = \$361,361.46 \text{ USD.}$$

Glossary

Base Currency The currency that the risk engine is configured to return values in.

Reserve Currency The currency that all cross currency basis is benchmarked against.

Risk Engine The Vector Risk market risk and credit risk system.

Valuation Date The date that we value the trades as.