Foreign Exchange: Markets, Products, and Pricing

Winter Quarter 2023

Week #2

Bid offer for forward contracts

Review: Bid / Offer for Spot Transaction

Information needed to determine bid or offer:

- Which two currencies are being exchanged? (example: EUR, USD)
- What is the quoting convention, which is the base currency and which is the terms currency? (example: EUR/USD, EUR base, USD terms)
  - A market-maker will buy base currency at the BID, and sell base currency at the OFFER
  - A market-taker will sell base currency at the BID, and buy base currency at the OFFER
- One method to check which is correct: the market-market always has a more advantageous price than the market-taker

Bid offer using forward points

- Example: **Sell** AUD forward (for a market-taker)
  - Outright rate: bid side
  - Spot + Forward points
    - Bid side spot rate
    - Bid side forward points
    - Will equal the bid side forward outright

T	Dates	Points Bid/Ask		Forwards Bid/Ask	
ON	04/07/15	-2.999	-2.351	0.7592788	0.7597507
TN	04/08/15	-0.508	-0.437	0.7590437	0.7594508
SP	04/08/15	0.7590	0.7594	0.7590	0.7594
SN	04/09/15	-0.461	-0.409	0.7589539	0.7593591
1W	04/15/15	-3.09	-2.91	0.758691	0.759109
2W	04/22/15	-6.07	-5.92	0.758393	0.758808

When forward points are known, there is no need to consult deposit rates

The outright forward rates, and swap points can be determined directly

Bid offer using covered interest rate parity

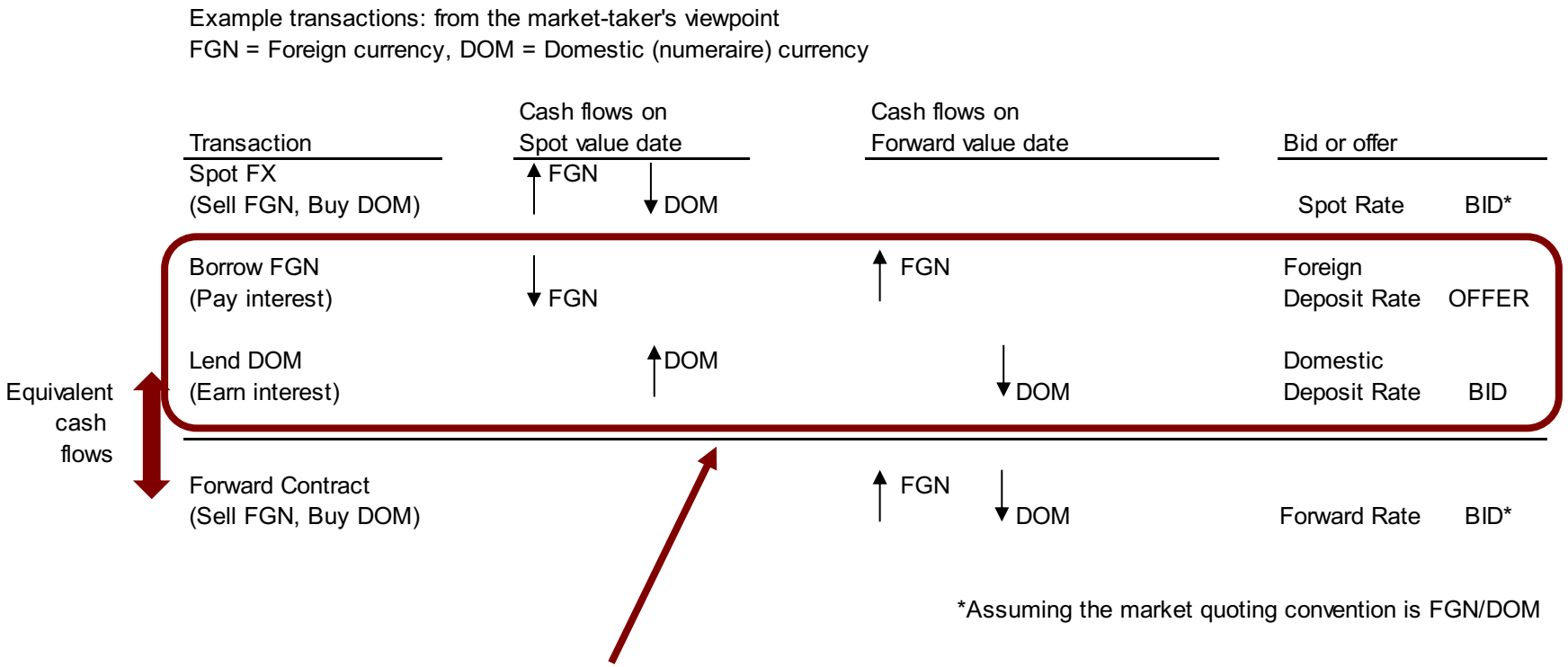
Example transactions: from the market-taker's viewpoint
FGN = Foreign currency, DOM = Domestic (numeraire) currency

Transaction	Cash flows on Spot value date	Cash flows on Forward value date	Bid or offer	
Spot FX (Sell FGN, Buy DOM)	↑ FGN ↓ DOM		Spot Rate	BID*
Borrow FGN (Pay interest)	↓ FGN	↑ FGN	Foreign Deposit Rate	OFFER
Lend DOM (Earn interest)	↑ DOM	↓ DOM	Domestic Deposit Rate	BID
Forward Contract (Sell FGN, Buy DOM)		↑ FGN ↓ DOM	Forward Rate	BID*

Equivalent cash flows

*Assuming the market quoting convention is FGN/DOM

Bid offer using covered interest rate parity



"Borrow Foreign and Lend Domestic" corresponds to bid-side forward points

Note that bid/offer on the spot rate is generated by the initial spot transaction
Bid/offer on forward points is generated by the borrow and lend transaction

Implied Yields

Implied yields

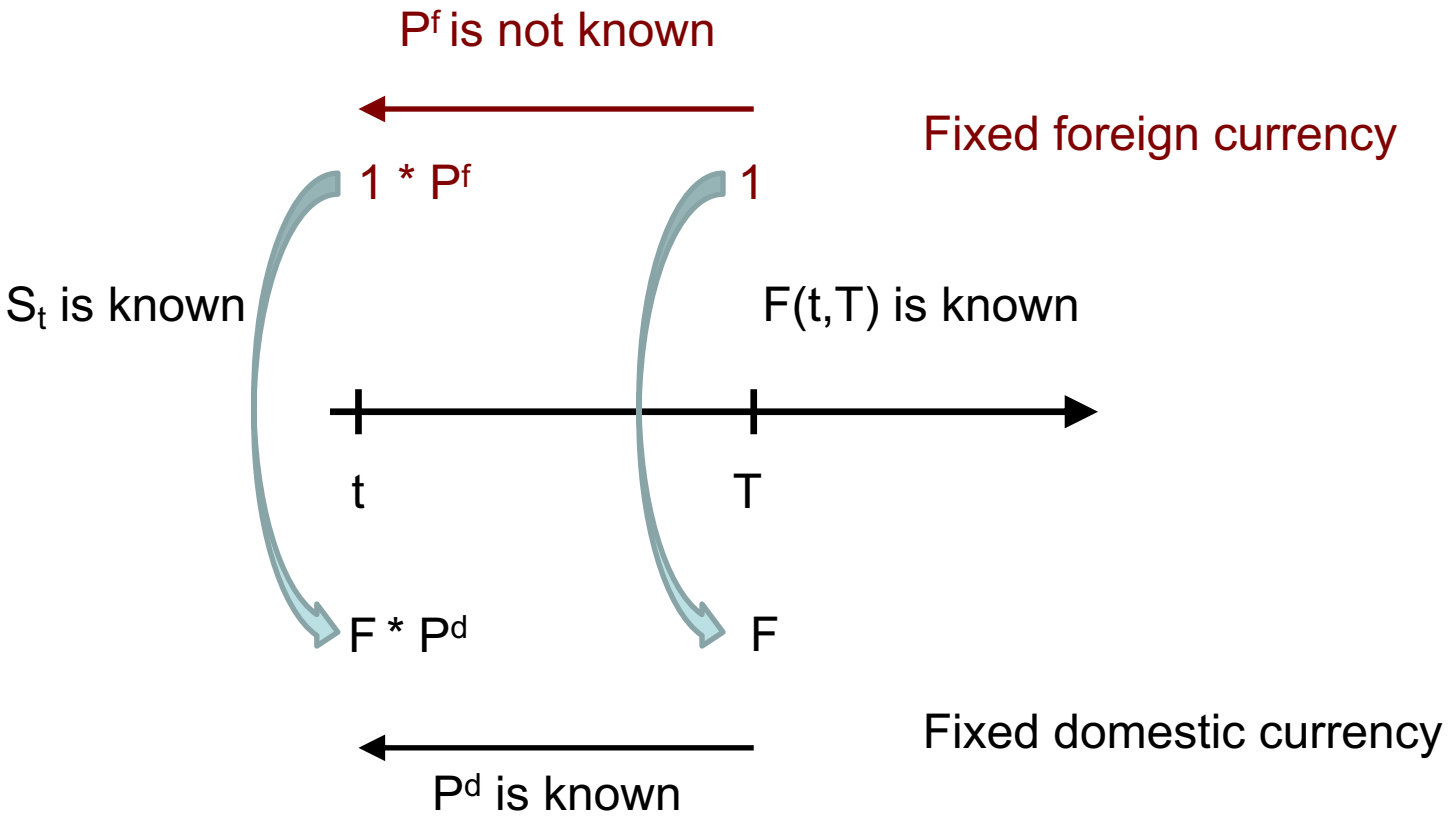
- "Implied yield" – a foreign interest rate implied by the FX forward rate
- If we know the
  - domestic interest rate, and
  - spot and forward rates for a foreign currency
  - then we can imply the foreign interest rate:

    $F = S_t * \mathbf{P^f} / P^d$

    $\mathbf{P^f} = F * P^d / S_t$ where $\mathbf{P^f}$ is not known, and is being implied
  - "Implied yield" is the interest rate, $\mathbf{r^f}$, corresponding to $\mathbf{P^f}$

- The calculation of $\mathbf{r^f}$ will depend on the interest rate quoting convention

Implied yields



Implied yields (continuously compounded)

Implied yield:

$$F = S * \mathbf{P^f} / P^d$$

$\mathbf{P^f} = F * P^d / S$ where $\mathbf{P^f}$ is not known, and is being implied

For zero coupon, continuously compounded rates:

$$\mathbf{P^f} = exp[-\mathbf{r^f}*(T-t)] = P^d * F / S_t = exp[-r^d*(T-t)] * F / S_t$$

$$-\mathbf{r^f}*(T-t) = -r^d*(T-t) + log(F / S_t)$$

$$\mathbf{r^f} = r^d - log(F / S_t) / (T-t)$$

- Notice that when $F < S_t$ then the implied foreign yield is greater than the domestic interest rate

Implied yields (money market rates)

Implied yield:

$F = S * P^f / P^d$

$P^f = F * P^d / S$ where P^f is not known, and is being implied

For money market rates (in this example ACT/360)

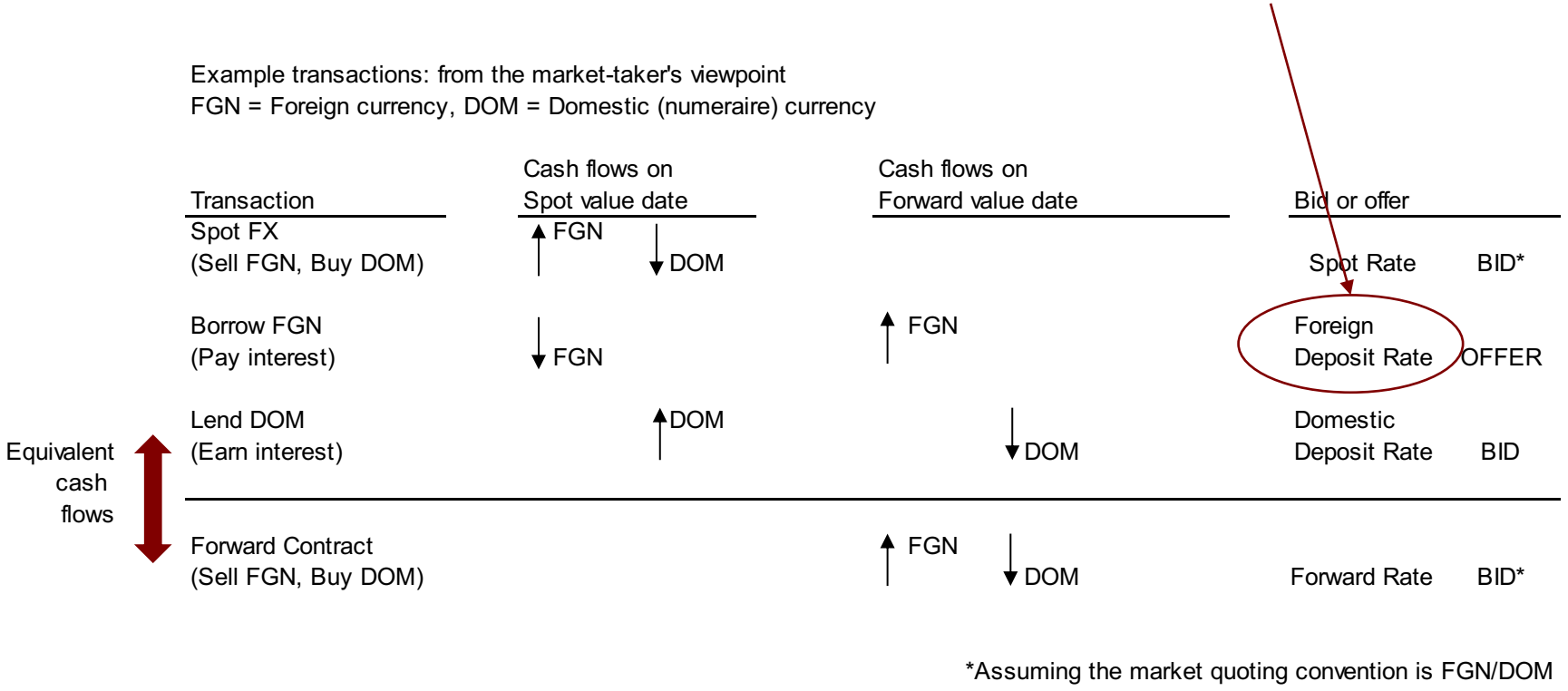
$1/P^f = (S/F) * (1/P^d)$ helpful since it's easier to work with $1/P^f$

$1+R_f*(Days/360) = (S/F) * (1+R_d*(Days/360))$

$R_f = [(S/F) * (1+R_d*(Days/360)) - 1] * (360/Days)$

Implied yields and covered interest rate parity

- *In practice covered interest rate parity using deposit rates does not hold exactly (actual forward points can vary from the interest rate calculation)*
- *This relationship can be made precise if we refer to implied yields.*



*Assuming the market quoting convention is FGN/DOM

Covered interest rate parity is not exact in practice

- Although arbitrage through covered interest rate parity influences the market, it does not fully determine the exact market price

1) Actions | 2) Refresh | 3) Settings | FX-Interest Rate Arbitrage

5) Same Currency | 6) Multi-Currency

Currencies AUD ↔ USD -- via -- Pricing Date 05/08/18

Spot Source BGN

Fwd Source BGN

Imply AUD Yield

31) RFQ 32) CNF

FX Swap to AUD Depo

Auto Refresh

Direct Input

Show Outrights

		7) FX Swap		8) AUD Yield		9) USD Yield (d)		AUD Implied Yield		Spread	
Term	Date	Bid	Ask	Bid	Ask	Bid	Ask	Bid	Ask	Bid	Ask
10) ON	05/09/18	0.745296	0.745414	1.5000	1.5000	2.3691	2.3691	2.3041	2.7938	0.8041	1.2938
11) TN	05/10/18	0.745298	0.745406	1.8784	1.8784	2.3691	2.3691	2.2796	2.6713	0.4012	0.7929
12) SP	05/10/18	0.7453	0.7454								
13) SN	05/11/18	0.745295	0.745401	1.8784	1.8784	2.3620	2.3620	2.3507	2.6446	0.4723	0.7662
14) 1W	05/17/18	0.745283	0.745411	1.8787	1.8787	2.3625	2.3625	2.3183	2.5143	0.4396	0.6356
15) 1M	06/12/18	0.745310	0.745432	1.8800	1.8800	2.3645	2.3645	2.3498	2.3825	0.4698	0.5025
16) 2M	07/10/18	0.745465	0.745605	1.9524	1.9524	2.3667	2.3667	2.2344	2.2666	0.2820	0.3142
17) 3M	08/10/18	0.745665	0.745802	1.9764	1.9765	2.3691	2.3691	2.1869	2.2066	0.2105	0.2301
18) 4M	09/10/18	0.745844	0.746019	1.9466	1.9466	2.3777	2.3777	2.1625	2.1925	0.2159	0.2459
19) 5M	10/10/18	0.746088	0.746237	1.9465	1.9465	2.3989	2.3989	2.1619	2.1777	0.2154	0.2312
20) 6M	11/13/18	0.746390	0.746561	1.9493	1.9493	2.4218	2.4218	2.1481	2.1668	0.1988	0.2175

Non-deliverable forwards (“NDF”)

Non-deliverable currencies

- Non-deliverable currency
  - A currency where exchange is restricted by local regulations
  - Typically, a regulated currency that cannot be transferred outside of the issuing country
  - Restrictions are specific to each country and may include
    - In-country transactions may require official approval,
    - Transactions may be restricted to certain types of institutions
- Examples of non-deliverable currencies:
  - Asia: CNY, IDR, INR, KRW, MYR, PHP, TWD
  - Latin America: ARS, BRL, CLP, COP, PEN, UYU, VEB
  - EMEA: EGP, KZT

Non-deliverable forward contract ("NDF")

Mechanics:

- No physical exchange of currencies. Instead, a net settlement in a deliverable currency (typically USD) occurs at maturity. The net settlement is equal to the contract's mark-to-market value
- Formula for mark-to-market value at maturity:

  $N * (1/R - 1/S_T)$ (for a seller of variable currency)

Where,

N = notional amount (typically the amount of variable currency)

R = NDF contract rate

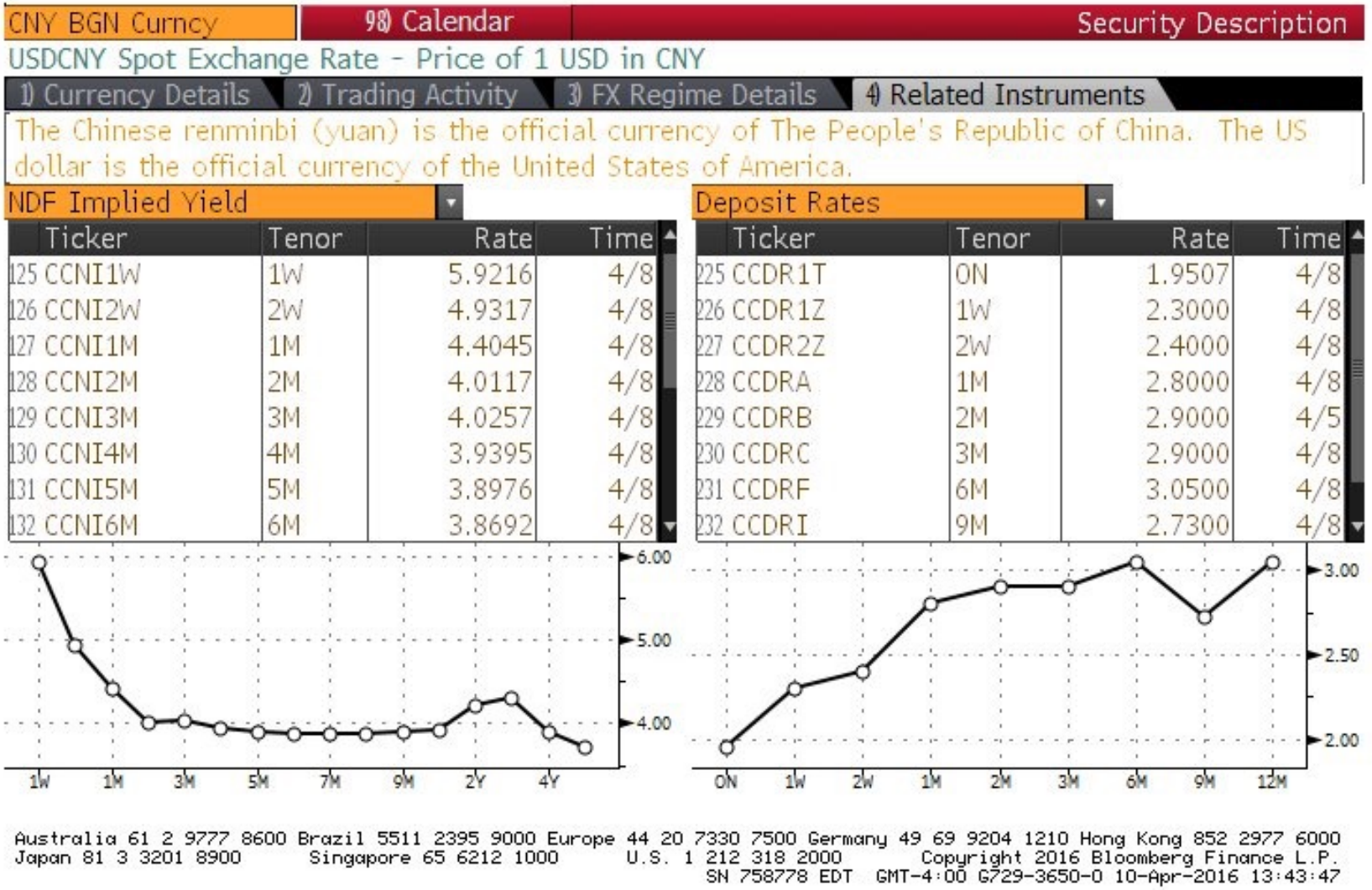
S_T = spot rate at maturity ("fixing rate")

S_T will be based on an observable FX rate (a "fixing rate", usually published by the country's central bank)

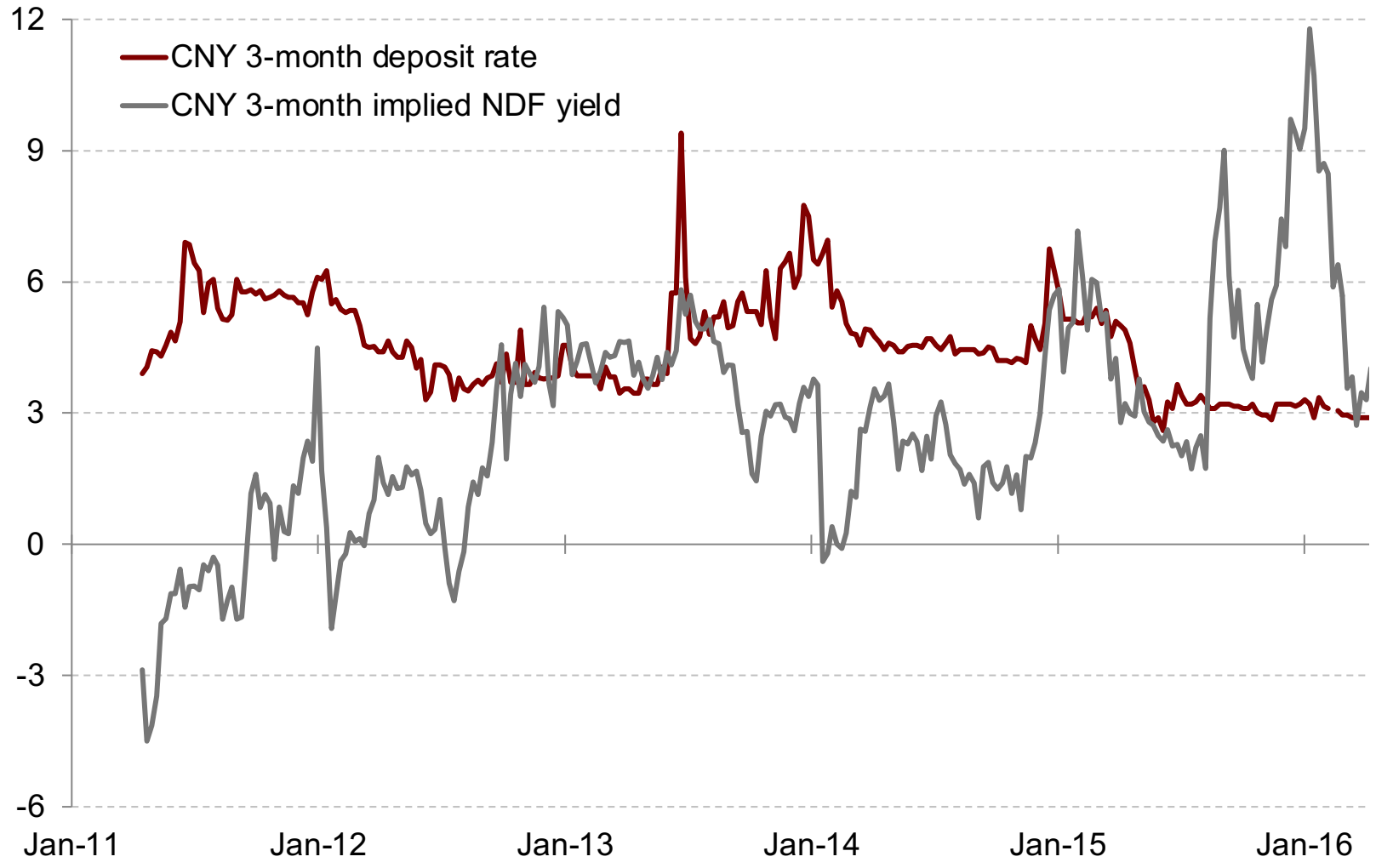
Non-deliverable forwards – pricing

- Covered Interest Rate Parity does not hold since the borrow and lend strategy is not possible
  - Risk neutral pricing theory does not necessarily apply
  - Pricing reflects risk-adjusted expectations
- On a practical note, for certain currencies there may be broad limits to how far NDF pricing can vary from onshore forward pricing

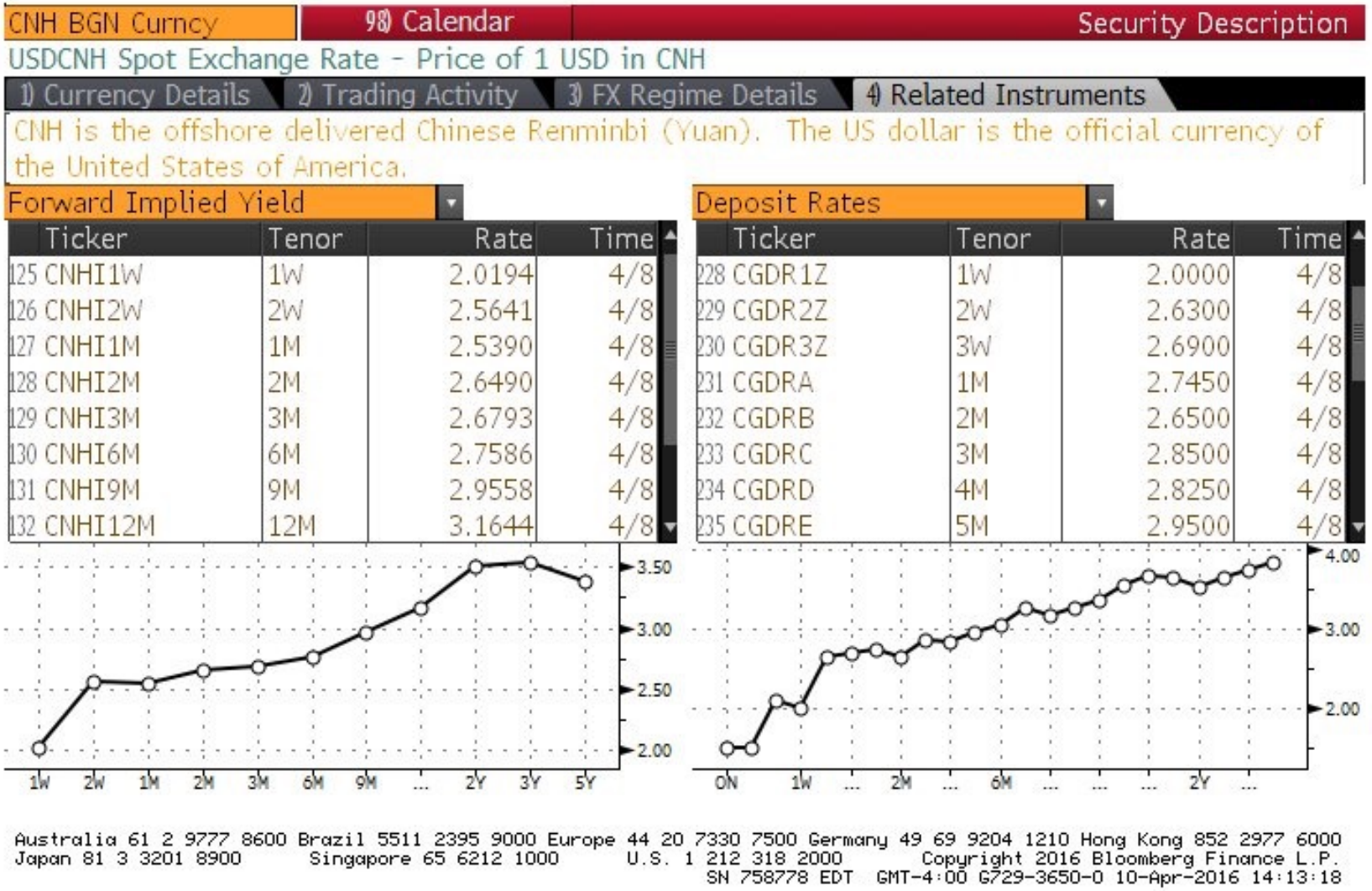
Implied CNY NDF yields versus CNY onshore deposit rates



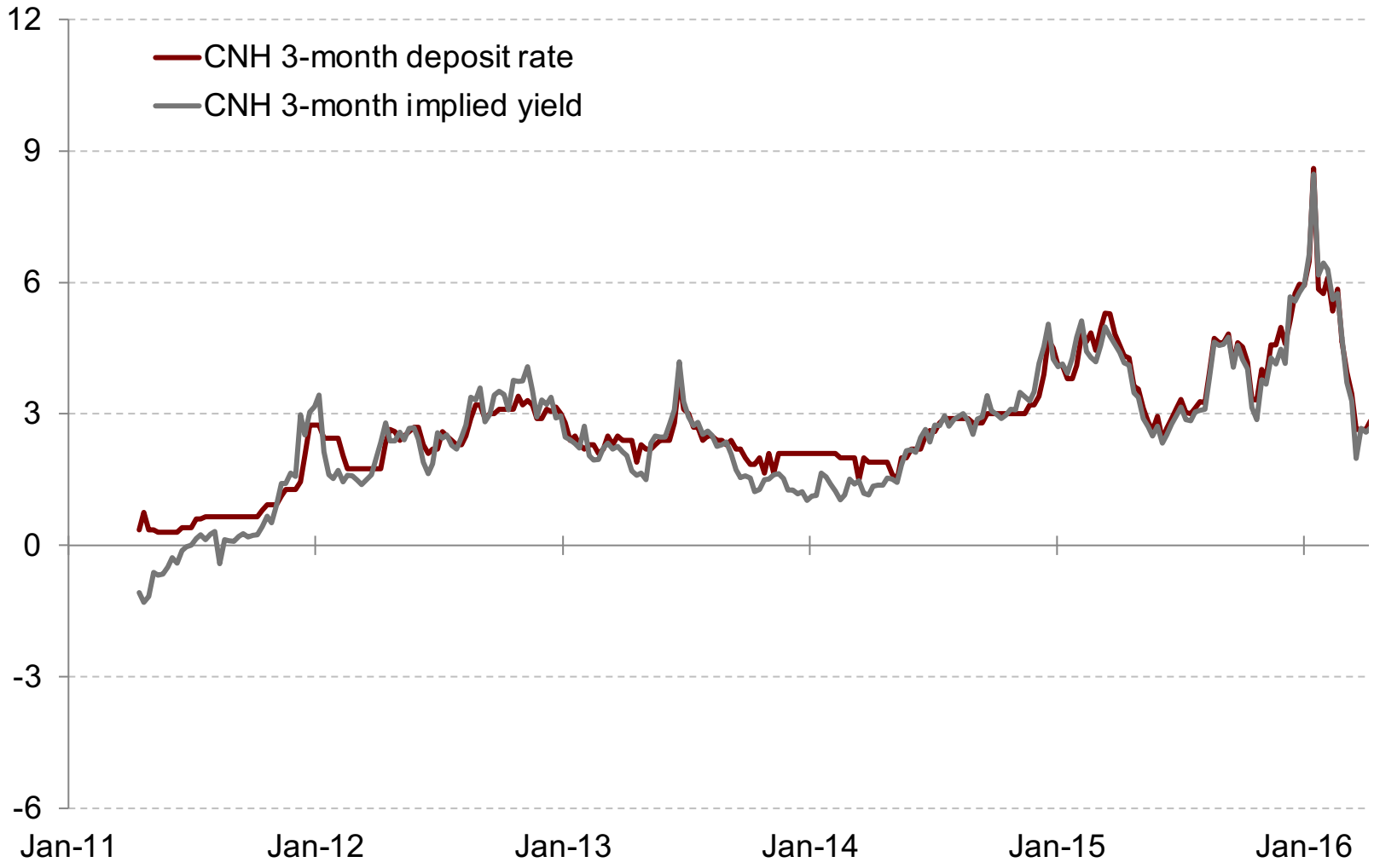
Implied CNY NDF yields versus CNY onshore deposit rates



Implied yields from CNH forwards versus CNH deposit rates



Implied yields from CNH forwards versus CNH deposit rates

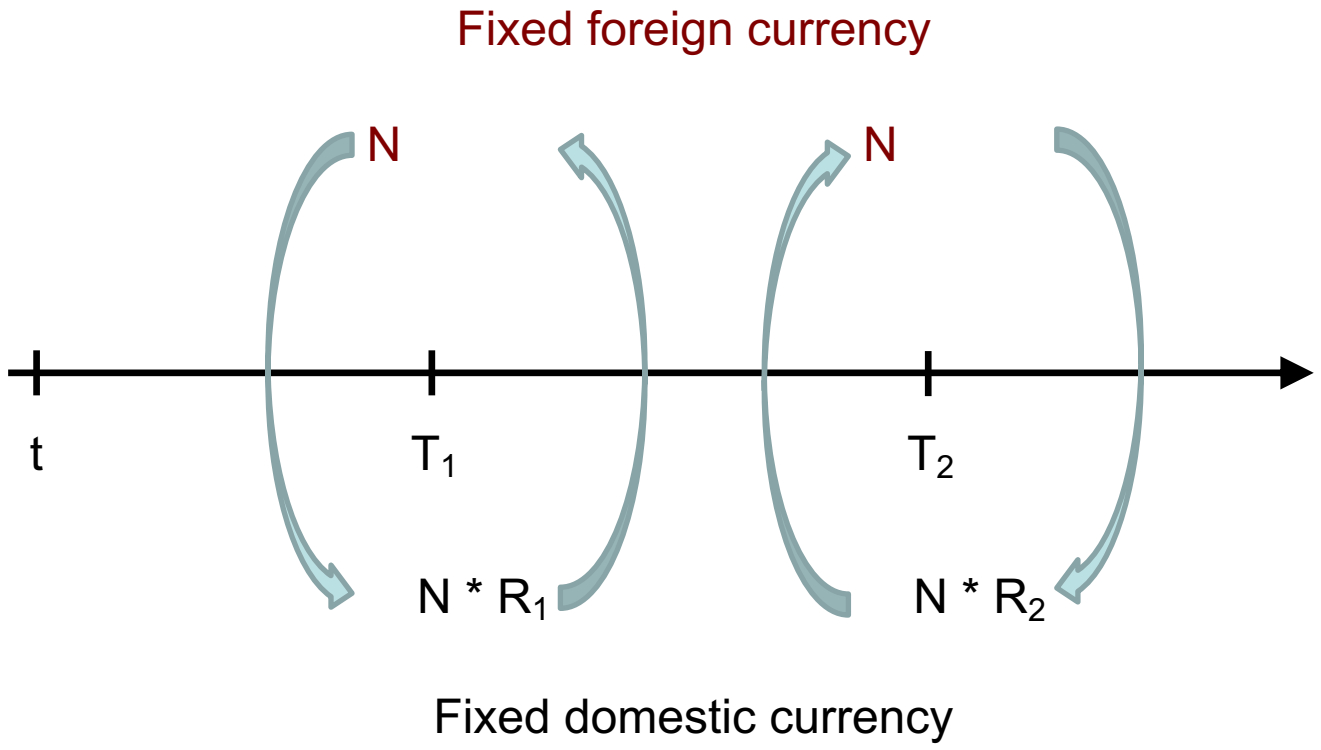


NDF Fixing

- An NDF can be thought of as a standard forward contract plus an agreement to close out at a designated fixing rate
- Considerations:
  - Fixing date and value date
  - Fixing risk

Foreign exchange swaps

FX swaps: Cash flows



What is an FX Swap contract?

- Purpose:
  - To alter the value date on an existing trade by simultaneously executing two forward transactions
- Contract that adjusts the timing of cash flows, from T_1 to T_2
  - Two simultaneously executed FX forward contracts
  - Forward contracts must have opposite buy/sell directions
  - Two forward rates, which correspond to times T_1 and T_2
  - Same notional amounts, N
- Example: "buy/sell" foreign currency

  (1) + N *(of foreign currency)*, - $N * R_1$ *(of domestic)*, *for delivery* T_1

  (2) - N *(of foreign currency)*, + $N * R_2$ *(of domestic)*, *for delivery* T_2

FX swap

Terminology

- "Buy/sell" means to buy the base currency for delivery T_1 and simultaneously sell base currency for delivery T_2
- "Sell/buy" means to sell the base currency for delivery T_1 and simultaneously buy base currency for delivery T_2

Borrow and lend

- ***"You buy/sell EUR"***
  - "Buy/sell" means you "borrow" the base currency (and "lend" the terms currency)
- ***"You sell/buy EUR"***
  - "Sell/buy" means you "lend" the base currency (and "borrow" the terms currency)

FX swaps – Pricing

FX swap – pricing

- "Pricing" for FX swaps means producing two rates:
  - "Near Rate" (corresponding to the "Near Date")
  - "Far Rate" (corresponding to the "Far Date")
- In practice, the Near Rate should be consistent with the current market forward rate (for the Near Date)
- The FX swap should have PV=0
  - So, in practice the Far Rate should also be consistent with the current market forward rate (for the Far Date)
- "Swap points" refer to the difference between near and far rates (in pips)

FX swap contract: “Pricing”

An FX swap contract is composed of two forward contracts

- Example

  (1) + N *(of foreign currency)*, - $N * R_1$ *(of domestic), for delivery* T_1

  (2) - N *(of foreign currency)*, + $N * R_2$ *(of domestic), for delivery* T_2

- Both should have PV = 0, so both should be market forward rates:

  $R_1 = S_t * exp[(r_{d1}-r_{f1})*(T_1-t)]$

  $R_2 = S_t * exp[(r_{d2}-r_{f2})*(T_2-t)]$

FX forward contract: A note about “pricing”

- Notice that the difference between spot and forward rates are roughly proportional to the effective interest rate differential

$$F(t,T) = S_t * \exp[\,(r_d - r_f)*(T-t)\,]$$

$$= S_t * \{\, 1 + (r_d - r_f)*(T-t) + O[((r_d - r_f)(T-t))^2]\,\}$$

So,

$$F(t,T) - S_t \approx S_t*(\, r_d - r_f\,)*(T-t)$$

FX swap contract: A note about "pricing"

- Notice that the difference between swap rates is also roughly proportional to interest rate differentials

$$R_1 = S_t * exp[(r_{d1}-r_{f1})*(T_1-t)] \approx S_t * [\ 1 + (r_{d1}-r_{f1})*(T_1-t)\ ]$$

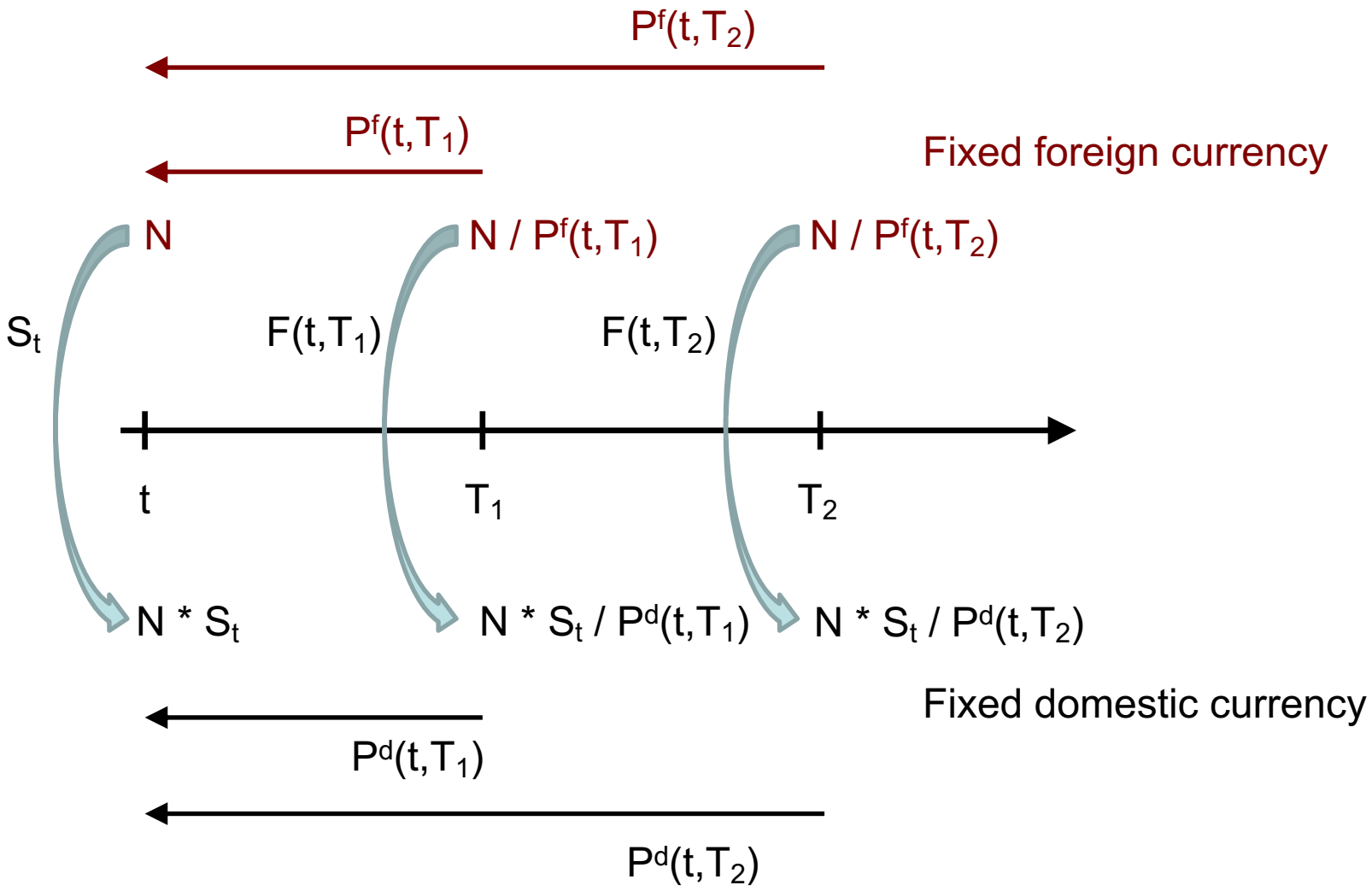
$$R_2 = S_t * exp[(r_{d2}-r_{f2})*(T_2-t)] \approx S_t * [\ 1 + (r_{d2}-r_{f2})*(T_2-t)\ ]$$

So,

$$R_2 - R_1 \approx S_t * [\ (r_{d2}-r_{f2})*(T_2-t) - (r_{d1}-r_{f1})*(T_1-t)\ ]$$

FX swaps – Calculating present value

Spot and forward cash flows



FX swaps: Calculating value

- For example, “buy/sell”

  (1) + N *(of foreign currency)*, - $N * R_1$ *(of domestic)*, *for delivery* T_1

  (2) - N *(of foreign currency)*, + $N * R_2$ *(of domestic)*, *for delivery* T_2

$$PV = N * (S_t * P^{f1} - R_1 * P^{d1} - S_t * P^{f2} + R_2 * P^{d2})$$

$$= N * (S_t * [P^{f1} - P^{f2}] - R_1 * P^{d1} + R_2 * P^{d2})$$

$$= N * \{ S_t * [\exp(-r_{f1}*(T_1-t)) - \exp(-r_{f2}*(T_1-t))]$$

$$- R_1 * \exp(-r_{d1}*(T_1-t)) + R_2 * \exp(-r_{d2}*(T_2-t)) \}$$

FX swaps: A note about calculating value

Notice that the fair value of a swap is fairly insensitive to spot rates

$$PV_S = N * [\, exp(-r_{f1}*(T_1-t)) - exp(-r_{f2}*(T_2-t)) \,]$$

$$\approx N * [\, r_{f2}*(T_2-t) - r_{f1}*(T_1-t) + O(r_f(T_2-t)^2) \,]$$

$$\approx N * r_f(T_2-T_1)$$

- Unlike the fair value of a forward contract

$$PV_S = N * exp(-r_f*(T-t))$$

$$\approx N * [\, 1 - r_f*(T-t) + O(r_f(T-t)^2) \,]$$

$$\approx N$$

Risk characteristics for Spot, Forward, and FX Swaps

	Number of legs	FX risk?	IR spread risk?
Spot	1	Yes	No
All-in forward	1	Yes	Yes
FX swap	2	No	Yes

Spot-starting FX swaps

Swap from the spot date

- An (outright) forward contract can be thought of as two separate transactions:
  - Spot transaction
  - FX swap, where the near date equals the spot date

- Common trading practice:
  - Initiate a spot transaction, typically early in the trading day
  - If the trader wants to maintain the position beyond that day's close of business, "Roll out" the spot transaction to a forward
  - "Swap points" = "Forward points" in this case

Example: Forward points for USDNOK

30) Spot & Forward Rates (FRD)

Mkt type: Regular Source: BGN

	Settle Date	Points Bid	Points Ask	Outright Bid	Outright Ask
31) ON	02/14/14	1.82	2.38	6.104753	6.107448
32) TN	02/18/14	8.70	9.40	6.104991	6.107630
33) SPOT	02/18/14	6.1059	6.1085	6.1059	6.1085
34) SN	02/19/14	2.24	2.41	6.106154	6.108742
35) 1W	02/25/14	15.68	16.82	6.107498	6.110183
36) 1M	03/18/14	63.41	65.59	6.112272	6.115059
37) 3M	05/19/14	207.33	212.67	6.126664	6.129767
38) 6M	08/18/14	408.35	420.65	6.146765	6.150566
39) 12M	02/18/15	798.54	835.46	6.185784	6.192047
40) 18M	08/18/15	1169.72	1230.28	6.222902	6.231528
41) 2Y	02/18/16	1513.70	1614.55	6.257300	6.269956
42) 5Y	02/19/19	1947.19	2213.71	6.300649	6.329872

Forward points indicate the different between forward and spot rates,
So forward points are a specific example of swap points, with the
Near Date equal to the spot date

Spot-starting swaps – example

- ***"You sell/buy USD versus NOK, spot to 1 month"***
- You *borrow* NOK and *lend* USD

Spot position **one exchange executed in the past**		**FX swap** **two new exchanges executed simultaneously**			
Sell NOK	611,000,000	Buy NOK	611,000,000	Sell NOK	611,000,000
Buy USD	100,000,000	Sell USD	99,755,102	Buy USD	99,415,871
Rate	6.1100	Rate*	6.1250	Rate	6.1459
Value date	14-Feb-14	Value date	14-Feb-14	Value date	14-Mar-14

“Forward-Forward” swaps

“Forward-forward” swaps

- Purpose:
  - “Roll” an existing forward transaction to a new value date

Forward-forward swaps – Example

Foward position Executed in the past, now a 1 month forward		FX swap Near date "1 month", far date "1 year"			
Sell EUR	100,000,000	Buy EUR	100,000,000	Sell EUR	100,000,000
Buy USD	129,550,000	Sell USD	133,954,700	Buy USD	134,217,700
Rate	1.2955	Rate (bid)	1.339547	Rate (bid)	1.342177
Value date	22-Mar-13	Value date	22-Mar-13	Value date	24-Feb-14

Forward Points (Swap Points) – Terminology

- Premium, discount
  - Premium means the quoted forward rate is higher than the quoted spot rate (forward points are positive). Discount means it is lower (forward points are negative)
- “Up”, “down” (add or subtract points)
  - Forward points are sometimes quoted as positive numbers for simplicity. The designation “up” or “down” would be used to indicated whether quoted forward points are positive or negative.
- “Earn” or “Pay”
  - “Earn” means the forward points make a forward rate more favorable to a counterparty relative to the spot rate (e.g., a lower forward rate when the counterparty is buying.) “Pay” the forward points means the forward rate is less favorable than the spot rate
  - “Earn” and “pay” are specific to a counterparty’s direction in a transaction, depends on whether the counterparty is buying or selling

“Earn” or “pay” the swap points

FX swap earning the points				Difference
Sell NZD	100,000,000	Buy NZD	100,000,000	
Buy USD	83,070,000	Sell USD	82,000,000	1,070,000
Rate	0.8307	Rate	0.8200	-0.0107
Value date	14-Mar-14	Value date	14-Aug-14	

FX swap paying the points				Difference
Sell JPY	10,000,000,000	Buy JPY	10,000,000,000	
Buy USD	97,560,976	Sell USD	97,837,785	-276,809
Rate	102.5000	Rate	102.2100	-0.2900
Value date	14-Mar-14	Value date	17-Feb-15	

FX swaps – Bid/Offer

Bid/Offer for Swap Points from Spot

- Example: Buy/**Sell** AUD for spot to the 2-week date (for a market-taker)
  - Forward points: bid-side
  - The spot rate is simply a reference – forward points are not sensitive to small movements in the spot rate
  - Convention is to use the bid-side spot rate
    - The bid-side spot rate also corresponds to the FX swap economics

T	Dates	Points Bid/Ask		Forwards Bid/Ask	
ON	04/07/15	-2.999	-2.351	0.7592788	0.7597507
TN	04/08/15	-0.508	-0.437	0.7590437	0.7594508
SP	04/08/15	0.7590	0.7594	0.7590	0.7594
SN	04/09/15	-0.461	-0.409	0.7589539	0.7593591
1W	04/15/15	-3.09	-2.91	0.758691	0.759109
2W	04/22/15	-6.07	-5.92	0.758393	0.758808

Bid/offer for FX swaps (for swap points)

30) Spot & Forward Rates (FRD)

Mkt type: Regular Source: BGN

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42) 5Y	02/19/19	1947.19	2213.71	6.300649	6.329872

Bid/offer is only charged once, meaning if the bid is used for the far date then the bid is also used for the near date.

Bid/Offer for FX swaps and swap points

Example transactions: from the market-taker's viewpoint
FGN = Foreign currency, DOM = Domestic (numeraire) currency

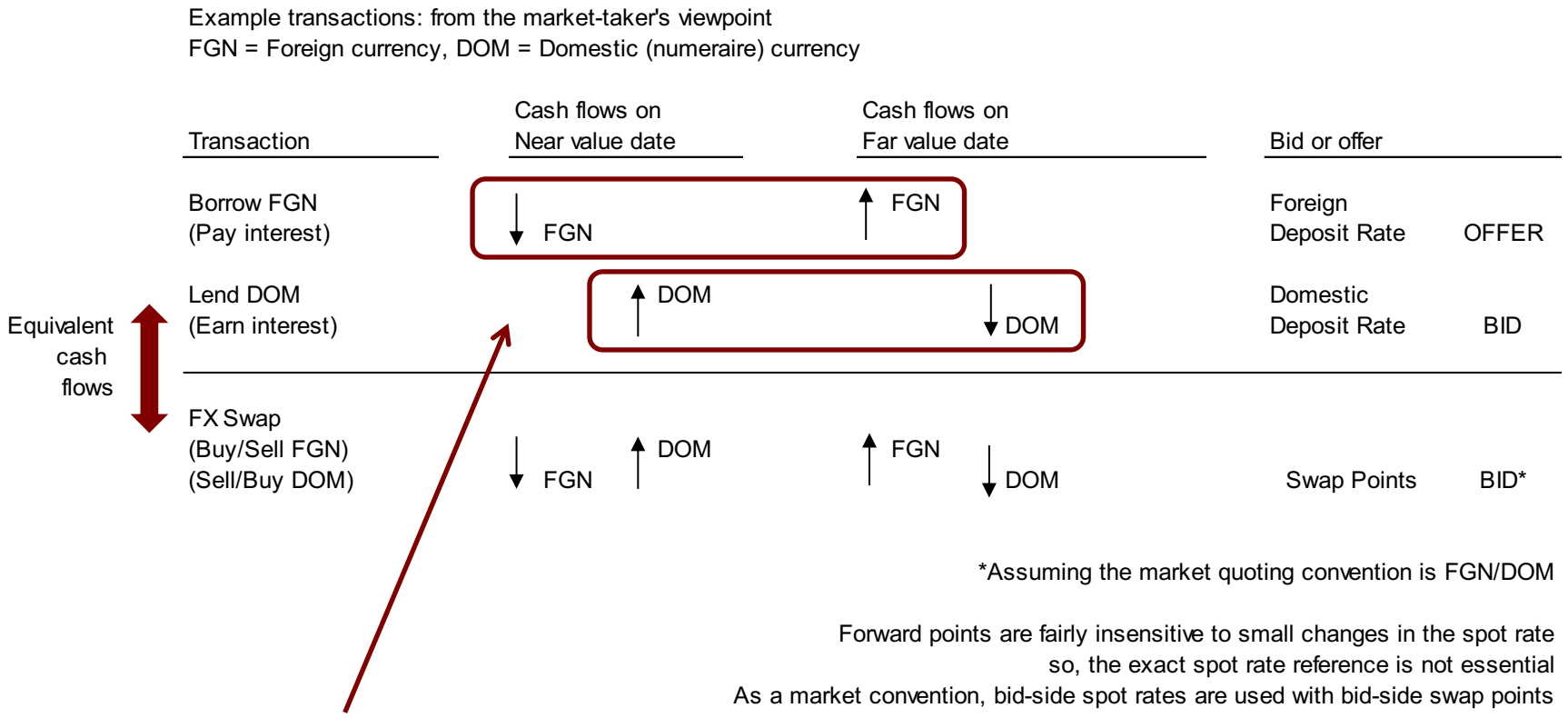
Transaction	Cash flows on Near value date	Cash flows on Far value date	Bid or offer	
Borrow FGN (Pay interest)	↓ FGN	↑ FGN	Foreign Deposit Rate	OFFER
Lend DOM (Earn interest)	↑ DOM	↓ DOM	Domestic Deposit Rate	BID
FX Swap (Buy/Sell FGN) (Sell/Buy DOM)	↓ FGN ↑ DOM	↑ FGN ↓ DOM	Swap Points	BID*

Equivalent cash flows

*Assuming the market quoting convention is FGN/DOM

Forward points are fairly insensitive to small changes in the spot rate
so, the exact spot rate reference is not essential
As a market convention, bid-side spot rates are used with bid-side swap points

Bid/Offer for FX swaps and swap points



These are forward-starting transactions, not spot-starting transactions
The bid/offer spread should only reflect the near-to-far date time period, not the full spot-to-far date time period

O/N and T/N swaps

Side note on O/N and T/N points and forwards

Why do bid and offer appear to be reversed?

T	Dates	Points Bid/Ask		Forwards Bid/Ask	
ON	04/07/15	-2.999	-2.351	0.7592788	0.7597507
TN	04/08/15	-0.508	-0.437	0.7590437	0.7594508
SP	04/08/15	0.7590	0.7594	0.7590	0.7594
SN	04/09/15	-0.461	-0.409	0.7589539	0.7593591
1W	04/15/15	-2.09	-2.91	0.758691	0.759109
2W	04/22/15	-6.07	-5.92	0.758393	0.758808

Dates beyond Spot

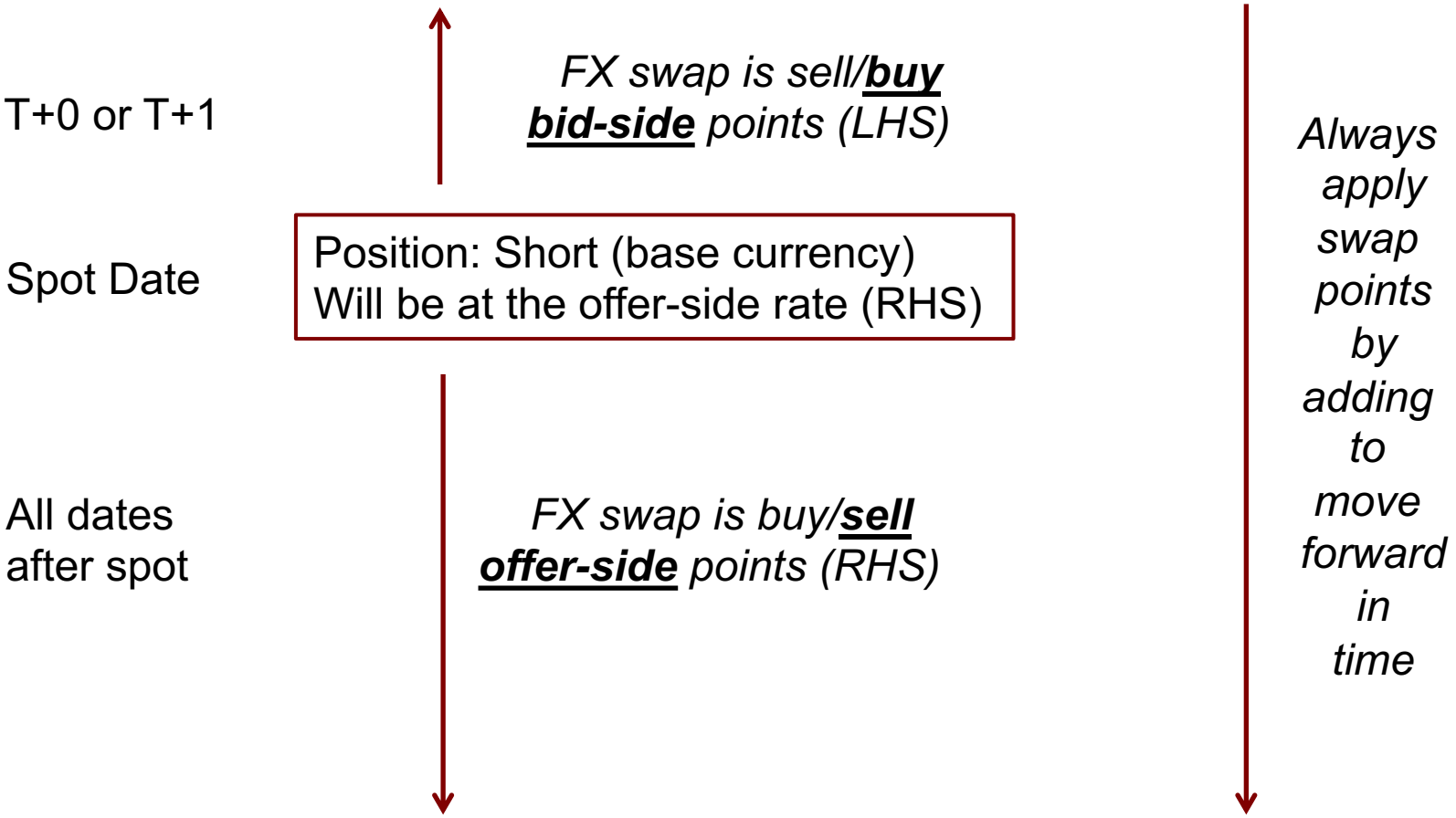
Bid-side points are used to calculate the bid-side forward rate

Dates prior to Spot

Offer-side points are used to calculate the bid-side forward rate

Applying forward points – O/N and T/N

Example: Adjusting a short spot position (market-maker's perspective)



Applying forward points – O/N and T/N

Example: Adjusting a short spot position (market-maker's perspective)

Always apply swap points by adding to move forward in time

T+1 to "Spot" FX swap is a buy/sell transaction

T	Dates	Points Bid/Ask		Forwards Bid/Ask	
ON	04/07/15	-2.999	-2.351	0.7592788	0.7597507
TN	04/08/15	-0.508	-0.437	0.7590437	0.7594508
SP	04/08/15	0.7590	0.7594	0.7590	0.7594
SN	04/09/15	-0.461	-0.409	0.7589539	0.7593591
1W	04/15/15	-3.09	-2.91	0.758691	0.759109
2W	04/22/15	-6.07	-5.92	0.758393	0.758808

"Spot" to "2W" FX swap is a sell/buy transaction