

# Spotting a path

## Executive summary

- Sophisticated analytical techniques could help treasurers arrive at a sensible, effective and efficient risk management policy for hedging uncertain foreign exchange exposures.

Many companies face uncertain future foreign exchange (FX) exposures due to a wide range of different scenarios, ranging from unconfirmed orders to contracts tendered for but not yet awarded. Many FX risks are significant and so need to be hedged, but it is undesirable to end up with FX positions as a result of ultimately unnecessary hedges. This article lays out an approach to the problem, offering an example that incorporates uncertainty in the number of orders and when they will occur, and exposure to two correlated exchange rates.

**AN EXAMPLE OF UNCERTAINTY** A US company is tendering to do work for a European-based company in Britain, so the base currency is dollars, costs will be incurred in dollars and sterling, and payment will be in euros. The US company is bidding for four sequential contracts and wants to avoid holding a balance in any currency besides dollars at all times.

The chance of getting the first contract is 80%. The chance of getting the next rises by 5% if the previous contract was won, but falls by 5% if it was not. This means that the chance of clinching the last contract varies between 65% (through failure to win any of the first three) and 95% (through winning all previous three).

Each contract lasts 12 weeks and is worth €20m, paid at the end of the contract. Costs incurred for each contract are \$0.5m each week (total \$6m), £6m after six weeks and £3m after 12 weeks.

From starting spot rates of £/\$ 1.7665 and €//\$ 1.2016, each contract has a profit of \$2.1m on costs of \$21.9m – a return of around 10%.

The methodology used takes many possible scenarios and then looks at the results across these scenarios to give an indication of the average and extreme behaviours that may be seen. There are three key inputs to this Monte Carlo-style approach: the possible contract paths, the hedges to be undertaken, and possible future spot paths.

The resultant cashflows and cash balances from these inputs are then used in the analysis to give an indication of the success or otherwise of the hedging programme.

**DUNCAN FARNSWORTH AND CHRIS LEUSCHKE**  
EXAMINE SOME OF THE DIFFERENT TECHNIQUES  
COMPANIES CAN EMPLOY TO HEDGE UNCERTAIN  
FOREIGN EXCHANGE EXPOSURES.

**Possible contract paths** The first stage is to establish a set of possible contract paths and the probability of each path. Our example has 16 possible paths. The most likely path (58% probability) is for all four contracts to be won. The least likely path (0.5% probability) is where no contract is won. These paths also include information on when a hedge is no longer required and should be closed out because a contract has not been won.

*Figure 1* shows the expected profit and loss (P&L) profile from these 16 orders if spot follows the forward curve and no hedges are put in place. Spot moving along the forward curve has an effect on the expected P&L – it now averages \$2.4m per contract. When analysing the results we will consider this the expected P&L.

**Proposed hedges** Given a set of order paths, it must then be decided how to hedge these paths. A single set of hedges is applied for each run in this methodology. The hedge approaches used were:

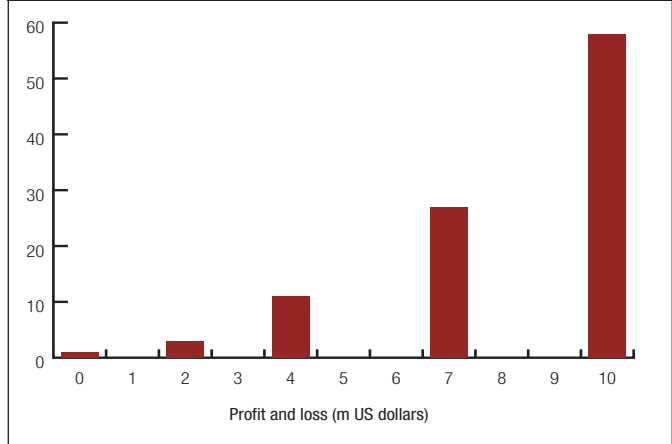
- Forward trades matching each contract;
- Vanilla options with at-the-money forward strikes for each contract;
- Vanilla options with out-of-the-money strikes for each contract. Strikes were set 4% away from the forward, which equates to around 15 delta for a 12-week expiry (payment point for first contract) and 28 delta for a 48-week expiry (payment point for the last contract);
- Vanilla options with in-the-money strikes for each contract. These provide an intermediate case between forwards and at-the-money options and are similar to a number of structures in the market; and
- Spot trades for each cashflow date. This is the minimum that can be done, given the criterion never to hold a non-dollar balance. If spot always followed the forward curve, this would produce the profile seen in *Figure 1*.

If a contract was not won, the relevant hedges were closed out at the prevailing market rates as soon as this was known.

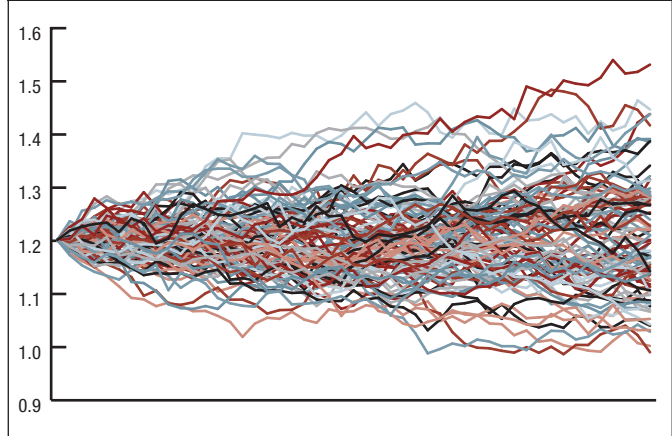
For options the relevant premium was calculated using an indicative volatility. If an option expired out of the money, a spot trade with the equivalent face value was done at the prevailing market rates to ensure there was never a non-dollar balance. Any



**Figure 1. Possible Profit and Loss**



**Figure 2. €//\$ Spot Paths**



hedge that is a combination of forwards, vanillas and barrier options can be tested for any set of face amounts.

**Future spot paths** The key to analysing the effect of the hedges is to look at how spot may move in the future. Future spot paths for £/\$ and €//\$ were generated using RBS's Monte Carlo pricing engine, which uses current market volatilities and correlations.

The first 100 spot paths used for €//\$ are shown in *Figure 2*. For this analysis 10,000 spot paths covering both €//\$ and £/\$ were used.

**160,000 scenarios** For each hedge case, each of the 10,000 spot paths was analysed for each of the 16 contract paths, producing 160,000 scenarios for each hedge case. For each scenario, cashflows and cumulative positions were calculated for every day to produce a final valuation of the position in each currency, along with the final, maximum, minimum and average cash balances in each currency.

The results from all the scenarios were then converted to give percentile measures and a distribution to show the pattern of the results. This analysis assumes there is no correlation between order path and spot path.

*Figures 3 and 4* show the final profit and loss seen for the various hedging cases. Both show the spot case (effectively unhedged). *Figure 3* also shows the forward and in-the-money cases while *Figure 4* shows the at-the-money and out-of-the-money cases.

**ANALYSIS OF THE RESULTS** The average P&L matches across all hedges, validating the methodology and the pricing of the options.

- The 10%-90% difference provides some indication of certainty. The spot result has the greatest uncertainty and the forward case the least, although the forward case has the lowest worst case.
- Use of options allows participation in any upside from favourable spot moves. But this is generally balanced by more downside risk.
- For the forward case where all four orders happen, an exact match with *Figure 1* can be seen. However, the peak corresponding to three

orders is significantly reduced and spread out in the forward case due to close-out of positions.

- For the in-the-money case, the peak corresponding to winning all four contracts is shifted to the left due to the cost of the time value of the options used, although this is offset by the longer tail above the peak than in the forward case. As the options used become more and more in the money and the time value decreases, the peak converges onto the forward case.
- The at-the-money and out-of-the-money option cases do not show the peaks because the ability for options to allow participation in the upside creates a much wider range of P&L.
- The more out of the money the hedge is, the wider the distribution becomes. The spot case is the asymptotic case where the options are so out of the money they are never exercised and a spot trade is always executed.
- The worst-case scenario for the forward is very poor compared with the others. It occurs when there are no orders and the market makes closing out the forwards very expensive. The options perform much better in these cases as just the premium is lost.
- Even given a 10% margin and only a 0.5% chance of getting no

**CASE STUDY: Hedging a 50%-chance M&A Exposure**

In this example, doing spot in five weeks if required (in other words, not hedging) is compared with using a forward and an at-the-money forward option (\$2.3m premium cost). These are tested over a large number of possible future US/Canadian dollar spot paths.

**OVERALL RESULTS** Figure 5 charts the probability for the overall cost of the acquisition (in millions of US dollars) across all possible paths. The two distinct areas visible correspond to the deal happening and not happening.

The average cost across all strategies is -\$130m, confirming the underlying data and modelling. This also matches the theoretical value obtained from (\$300m CAD/Forward (1.1535)) x Probability (50%).

**SCENARIO: DEAL GOES AHEAD** The scenario if the M&A deal goes ahead can be seen on the left-hand side of Figure 5.

*Probability of Final Cost Ending Up Between Two Levels:* The total probability for each row in Table 1 is 50% – the total chance of this scenario happening.

Doing spot gives the greatest uncertainty. 90% of the values in this scenario lie between -\$269.7m and -\$250.7m.

Hedging with a forward leads to absolute certainty in the cost of -\$260m.

The option limits the downside while allowing participation in the upside. In this scenario, 90% of the values lie between -\$262.4m and -\$253.0m.

**SCENARIO: DEAL DOES NOT GO AHEAD** The scenario if the M&A deal does not go ahead can be seen on the right-hand side of Figure 5.

*Probability of Final Cost Ending Up Between Two Levels:* The total probability for each row in Table 2 is 50% – the total chance of this scenario happening.

Doing spot gives absolute certainty in the cost as, of course, nothing will be done.

Hedging with a forward leads to uncertainty because of the close-out, with 90% of values for this scenario being between -\$9.4m and +\$9.7m.

The downside of the option is limited to the premium of \$2.3m. 90% of values for the option hedge lie between -\$2.3m and +\$7.4m.

**HEDGE PERFORMANCE SUMMARY** Over a large number of simulations the average for each hedging strategy is the same. Therefore, the decision comes down to the form of risk that a company wishes to hold. In summary the risks are:

**Doing spot as required**

- If the purchase goes ahead, this introduces an uncertainty of around \$19m to the final cost.
- If the deal does not go ahead, this introduces no costs.

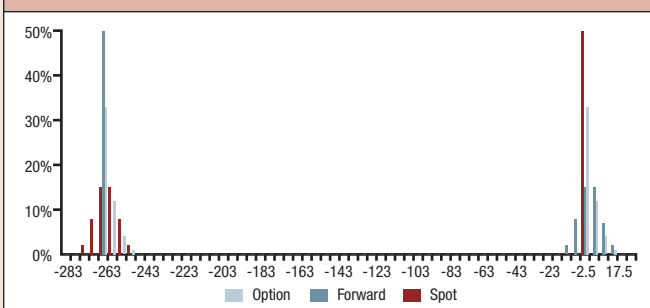
**Doing a forward**

- If the purchase goes ahead, this gives absolute certainty in the final cost.
- If the deal does not go ahead, this introduces around \$19m of uncertainty.

**Doing an at-the-money forward option**

- If the purchase goes ahead, this limits the maximum cost with participation in any upside.
- If the deal does not go ahead, the maximum cost is the option premium (\$2.3m) with the possibility of making money on the option.

**Figure 5. All Results**



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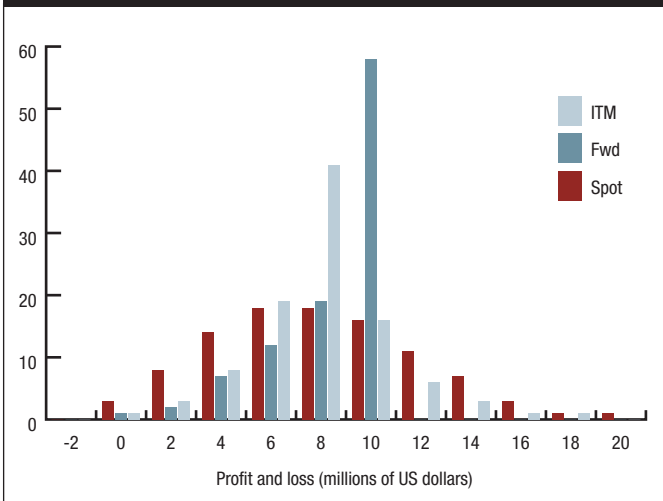
**Table 1. The Deal Goes Ahead**

Minimum	-285	-280	-275	-270	-265	-260	-255	-250	-245	-240	-235
Maximum	-280	-275	-270	-265	-260	-255	-250	-245	-240	-235	-230
Spot	0%	0%	2%	8%	15%	15%	8%	2%	0%	0%	0%
Forward	0%	0%	0%	0%	50%	0%	0%	0%	0%	0%	0%
Option	0%	0%	0%	0%	33%	12%	4%	1%	0%	0%	0%

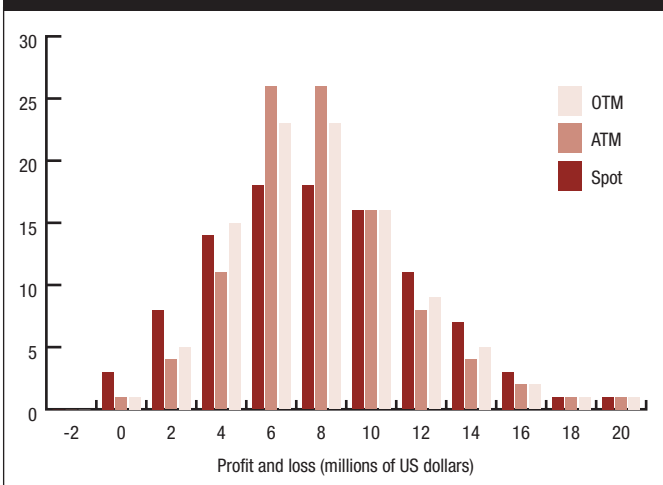
**Table 2. The Deal Does Not Go Ahead**

Minimum	-30	-25	-20	-15	-10	-5	0	5	10	15	20
Maximum	-25	-20	-15	-10	-5	0	5	10	15	20	25
Spot	0%	0%	0%	0%	0%	50%	0%	0%	0%	0%	0%
Forward	0%	0%	0%	2%	8%	15%	15%	7%	2%	0%	0%
Option	0%	0%	0%	0%	0%	33%	12%	4%	1%	0%	0%

**Figure 3. Forward and In-the-Money Cases**



**Figure 4. At-the-Money and Out-of-the-Money Cases**



orders, there is still a 1.4% chance that money will be lost if you ignore the FX risk (see Table 3).

The variety of results allows different success criteria to be set – for example, accepting a positive non-dollar balance within certain limits. This methodology allows it to be seen how well the criteria are met. Also, the underlying calculation of spot balances for every day for every scenario easily enables new output measures to be generated.

**A VARIETY OF SCENARIOS**

Most actual cases will be much simpler than the example in this feature. Applicable scenarios for this methodology include:

- **Merger and acquisition uncertainty:** The possible requirement to fund an acquisition at some point in the future.
- **Asset auction:** Hedging of the income from an auction where the final amount paid is inherently uncertain.
- **Dual asset exposure:** Quantifying possible risks where the exposure is to two assets – for example, oil and the sterling/dollar rate.
- **Bid-to-award risk:** Hedging where a contract has been bid for but not yet won.
- **Order timing:** Uncertainty surrounding the timing of a future order.
- **Product exposure:** Uncertain risks resulting from a specific product – for example, a convertible bond issued in a foreign currency.

**INFORMED CHOICE OF HEDGES** These results allow an informed choice of hedge to be made for this example case. They demonstrate that just trading spot carries the greatest risk, while trading forwards produces the greatest certainty but also the greatest loss.

The results shed light on a number of issues. There are clear trade-offs between the risks faced by not hedging versus the risk of having to close out a hedge that was not needed. These trade-offs need to be considered when a company decides its hedge. For example, it may decide that the 10% profit level cannot be less than \$4m, helping focus the choice of hedge. For this analysis, each hedge approach was treated individually, but a combination may prove better – for example, doing 50% forward and leaving 50% to be done at spot.

The results could also be used to assess the possible cost of tendering for these contracts. If you fail to win any, by hedging using out-of-the-money options you only risk losing around \$1.6m, but if hedging using forwards you risk losing around \$10.8m. Compared with an expected return of \$9.6m this may guide your choice.

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**Table 3. Important P&L Statistics (in millions of US Dollars) for Each Hedge Case**

	Spot	Forward	In the Money	At the Money	Out the Money
<b>Average</b>	8.0	8.0	8.0	8.0	8.0
<b>Worst case</b>	-6.1	-10.8	-5.3	-3.3	-1.6
<b>10% of results less than</b>	2.8	5.0	4.6	4.2	3.7
<b>90% of results less than</b>	13.5	9.4	11.3	12.3	12.8
<b>10%-90% difference</b>	10.7	4.4	6.7	8.1	9.1
<b>Best case</b>	26.8	12.7	32.2	33.8	33.7
<b>Times when money was lost</b>	1.4%	0.7%	0.5%	0.4%	0.3%