Strategic FX Risk Management

September 2005

Turnhout
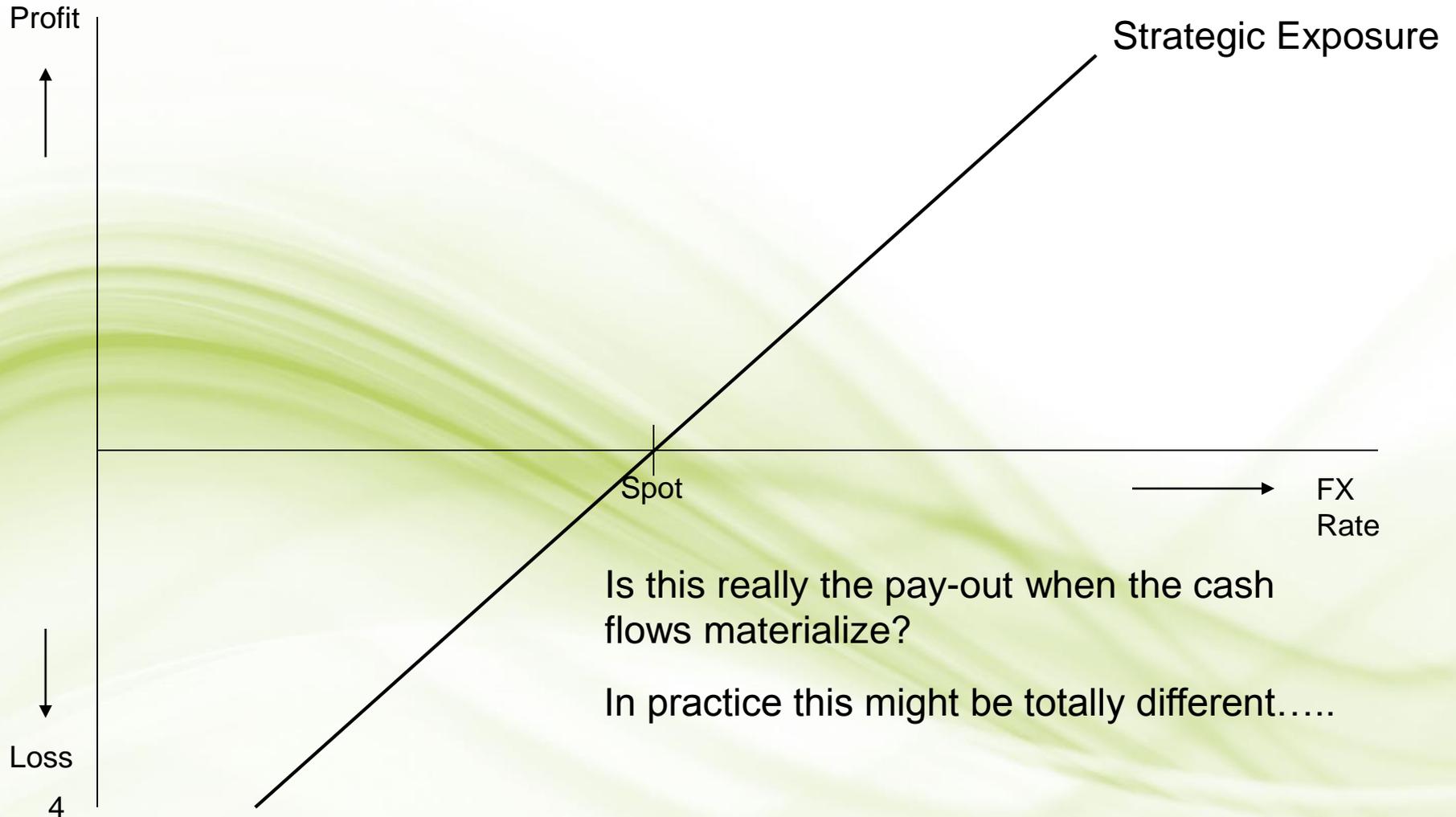
Strategic FX management: introduction

- Definition of Strategic FX Risk

- How does the strategic exposure behave?

- Match the hedging techniques with the risk behavior of the exposure
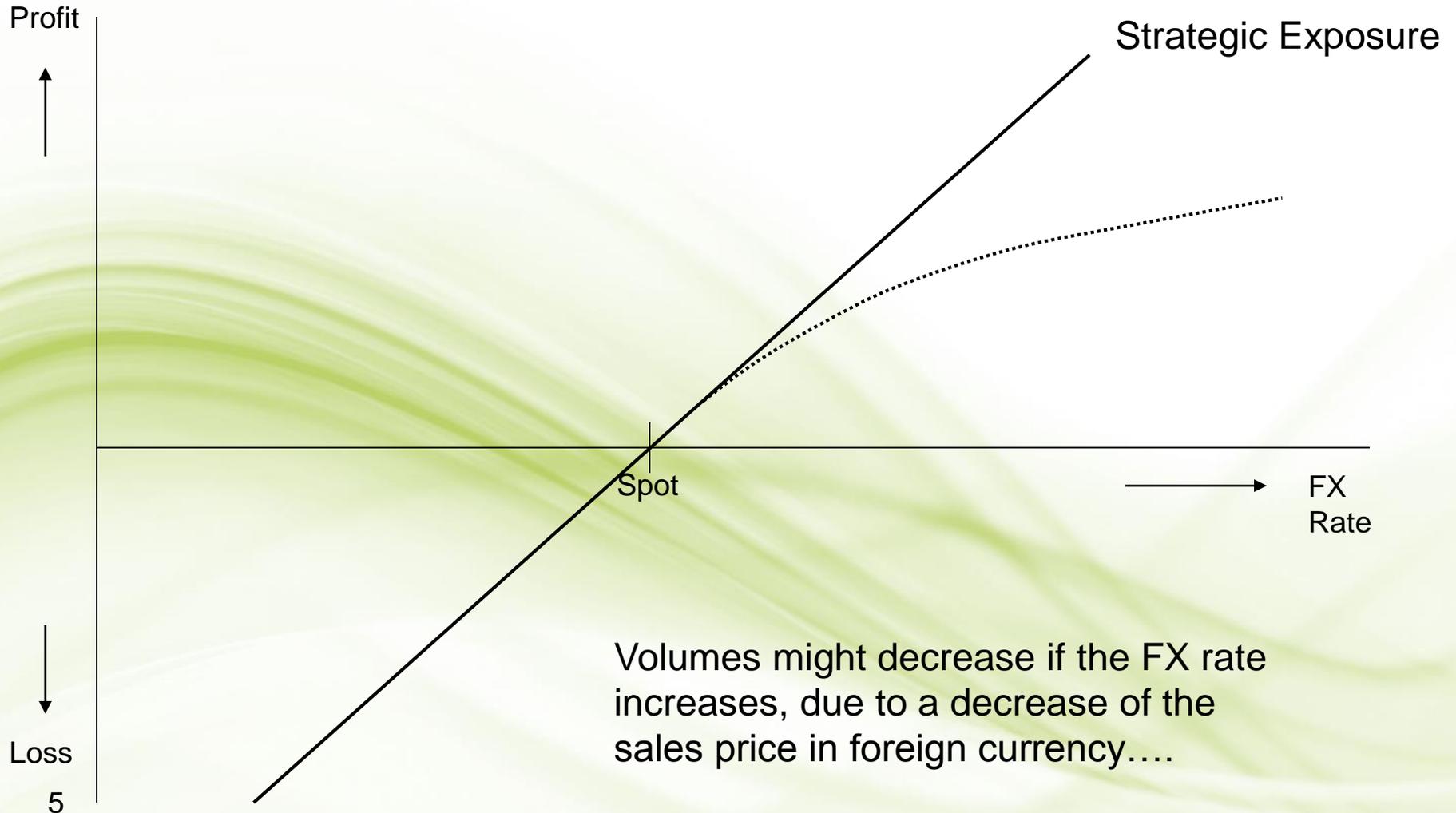
Definition
Strategic FX Risk

- Strategic FX risk consist of:
  - Transactional exposures
  - P & L related translation exposure
- Time Horizon: up to 10 years
- By definition the price elasticity's are the biggest problem to hedge
- This means that the solution should by definition be an option solution, as elasticity's can only be hedged with options

Behavior of strategic exposure (I)

Strategic Exposure

Profit

Spot

FX Rate

Loss

Is this really the pay-out when the cash flows materialize?

In practice this might be totally different.....

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Behavior of strategic exposure (II)

TreasuryServices

Volumes might decrease if the FX rate increases, due to a decrease of the sales price in foreign currency….

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Behavior of strategic exposure (III)

Strategic Exposure

Profit

Spot

FX Rate

Loss

Loss might increase if the FX rate decreases, when you cannot increase the pricing of your product; loss of market share….

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The strategic exposure

Profit

Strategic Exposure

Spot

FX Rate

Loss

Use the characteristics of the exposure to create a hedge

Profit

Strategic Hedge

Strategic Exposure

Spot

FX Rate

Loss

The hedge should have the opposite sensitivities……

Use the characteristics of the exposure to create a hedge

Profit

Strategic Hedge

Strategic Exposure

Spot

FX Rate

Loss

In order to create a no loss no profit situation

The strategic hedge and it's risk behavior (I)

- Since the strategic exposure consists (as we have seen) of anticipated exposures the correct hedge instrument is: Options

- We need to create an option (or set of options) that mirrors the characteristics of the strategic exposure

The strategic hedge and it's risk behavior (II)

- Depending on the company's exposure we need to define:
  - Nominal of the option(s)
  - The strike
  - Time to maturity
- The option(s) should have characteristics (or risk sensitivities) that mirror the exposure.
- Risk sensitivities of options are described by their Greecs: δ, γ, ν and τ

A side step: The "Greeks"

- **Delta (δ)** - the change in the option premium if spot changes (so: first derivative to spot)
- **Gamma (γ)**- the change in the option Delta if spot changes (so: second derivative to spot)
- **Vega (v)** - the change in the option premium if volatility changes
- **Theta (т)** – the change in the option premium if time changes

Some terminology first

- At-the-Money option: strike is equal to the current rate:

  – probability for exercise at maturity = 50%

- Out-of-the-Money option: strike is unfavorable compared to the spot rate:

  – probability for exercise at maturity < 50%

- In-the-Money option: strike is better than the current market:

  – probability for exercise at maturity > 50%

Delta: the change of the option premium if spot changes

- An approximate measure of the probability that the option will finish In-the-Money
- The sensitivity of the value (or premium) of an option with respect to the underlying rate of the currency
- Also called: the Hedge Ratio

Delta sensitivity

- A mathematical calculation and the outcome is expressed on a scale of 0 – 100%
- At-the-Money options: delta approximately 50%
- In-the-Money options: delta > 50%
- Out-of-the-Money options: delta < 50%

An Example explaining delta

- EUR Put / USD Call
- Notional $ 10.000.000
- Strike EUR/USD = 1.3000

- At maturity, if the holder exercises the option, he will have a long USD 10 mln position.
- Exercising the option will only be worthwhile if the option finishes In-the-Money

An Example explaining delta

- If the *current* market rate is 1.2500, then the likelihood that this 1.3000 USD Call option will be exercised is fairly high (Delta > 50%).
- If delta is close to 100% then:
  - The right to own USD is nearly as good as actually having them
  - As a result the long USD Call option position behaves in a similar way to a long USD cash or forward position
- The option becomes more valuable when EUR/USD spot goes down, and less valuable when EUR/USD rises

An Example explaining delta

- If spot is at 1.30 the likelihood that the option will finish In-the-Money is 50% → delta is 50%
- This means that the option will change in value in the same way as a spot contract of $ 10 mln x 50% = $ 5 mln.

- **Delta is the sensitivity of premium (option value) with respect to the underlying currency rate.**
- **It can be used to "translate" an option position into a spot contract**

Delta-neutral positions

- This leads us to the concept of **delta-neutral** positions: i.e. regardless of the change in spot, the value of the position will not change (no risk to the underlying spot rate)

- Professional option hedgers usually wish to be protected from spot risk

- This can be achieved by taking a spot (or forward) position equal and opposite to the delta-position of the option or the portfolio of options

Conclusion

- The Delta of an option can serve to hedge your <u>current</u> exposure.
- As spot moves and time passes, the delta of the position will change. If you want to stay delta-neutral this will require constant monitoring.
- Assume you have an option (portfolio) with a delta that is opposite to the exposure of your company, then:
  - the change of the Fair Value of this option (portfolio) will be opposite to the results of your company's exposure, i.e. hedging the exposure.

Gamma: the change of delta as spot changes

- As we have seen: delta changes when spot changes. This change of delta is referred to as the gamma of an option.

- The consequence is that a spot position being held as an option hedge is only an accurate hedge for relatively small movements in spot.

- A hedger wishing to maintain a delta-neutral position must continually re-balance his portfolio by adjusting his spot position as the spot price moves. This rebalancing is also called gamma trading.

An Example explaining gamma

- **USD Put / EUR Call, USD 10 mln, Strike 1.30, Spot 1.30, 50 delta (Premium 0.0244 USD per EUR).**

- Assume there is no exposure. If this option is bought, USD should be bought as a hedge in order to stay delta-neutral (option has short USD delta).
  - Spot Buy: USD 5 mln at 1.3000

An Example explaining gamma

- If spot rises to 1.3050, the value of the option increases by 0.0025 (50% x 50 bps) to 0.0269.

- But the delta of the option has now increased to 55. This means that the long USD 5 mln spot hedge is no longer keeping you delta-neutral and should therefore be increased to USD 5.5 mln.

- So USD 0.5 mln must be bought at 1.3050.

An Example explaining gamma

- If spot simply falls back to its original level of 1.3000 the value of the option will revert to 0.0244 and the delta goes back to 50. The extra USD 0.5 mln that was bought needs to be reversed to bring the hedge back to USD 5.0 mln.

- So you sell at spot: USD 0.5 mio at 1.3000

An Example explaining gamma

- What happens if spot falls first?
- To follow the logic:
  - the delta would decrease … the USD 5 mln hedge would need to be decreased … sell some USD at high rate …
  - Spot rises again … restore hedge to USD 5 mln by buying USD again … this would be at lower rate …
  - **profit!**

Conclusions of the gamma example

- Long options have positive gamma → gamma trading will by definition result in buying low and selling high → profit!

- Short options have negative gamma → gamma trading will by definition result in buying high and selling low → loss!

Conclusions of the gamma example

- Gamma describes the adjustments necessary to maintain delta-neutral as spot moves.

- Gamma measures the sensitivity of the delta with respect to spot movement; it is the change of the delta.

- Gamma makes profits on long options and costs money on short options. Against this is the premium paid / received.

Preliminary conclusions for the Strategic Hedge

- The delta of the Strategic Hedge portfolio should be equal to your current anticipated exposure. A change in spot brings an equal profit on your hedge as the loss created by your exposure and vice versa.

- The gamma of the Strategic Hedge portfolio can be used to hedge the change of delta or in other words your <u>elasticity's</u>.

Vega: sensitivity of premium to a change in volatility

- One of the variables that determines the price of an option is the volatility of the market.

- Volatility reflects the market's perception of how spot will jump around during the option's life.

- If the market expects big movements volatility is high, when small movements are expected volatility is low.

Vega: sensitivity of premium to a change in volatility

- When volatility is high, the potential range of spot movement is wider and therefore the scope for upside opportunity profits is higher.
- You pay for this upside opportunity profit through a high option premium.
- If volatility is low, option premiums are low

Example of Vega sensitivity

USD Call / EUR Put option, strike At-the-money (Premiums in % of USD face amount)			
Maturity	**Premium at 5% Vol**	**Premium at 6% Vol**	**Premium change (Vega)**
1 – week	0.275	0.330	0.055
3 – months	0.990	1.185	0.195
6 – months	1.380	1.655	0.275

Conclusions on Vega

- Options with long tenors are more sensitive to changes in volatility and thus have more Vega than options with a short tenor.

- Vega is fairly constant– the change in Vega if volatility changes from 5% to 6% is about the same as the change in Vega if volatility changes from 10% to 11%.

Preliminary conclusions for the Strategic Hedge

- Delta can be used to hedge your current anticipated exposure

- Gamma can be used to hedge your elasticity's (the change of the delta) and should be positive

- Vega can be used to hedge your exposure against the risk of an <u>increased market turbulence</u> (volatility)

Theta: the loss of option premium over time

- Theta describes this change of value over time, or "Time Decay". It is answering the question "By how much will the option premium be reduced tomorrow?".

- A trader running options positions must always balance his desire to make gamma profits, which means being long options, against the cost of time decay.

- The rate of time decay accelerates as the expiration date approaches, as each passing day becomes a greater proportion of time remaining.

Conclusions on the Greeks for the Strategic Hedge

- Delta: used to hedge the <u>current anticipated</u> exposure

- Gamma: used to hedge <u>elasticity's</u> and should be positive

- Vega: used to hedge an exposure against the risk of increased market <u>turbulence</u> (volatility)

- Theta: the ideal hedge structure does <u>not loose time value</u> if spot does not move

The Strategic hedge

1. Research: what elasticity's does your business have?
   - What is the DNA-structure of your FX risk?
2. Create the initial Hedge
3. Manage the initial Hedge
   - Reduce loss of time value in case spot does not move (i.e. reduce theta to '0' if possible)
   - Protect the profits in the hedge if it moves In-the-Money, by putting a hedge on the hedge
   - Improve the long-term hedge rate if spot moves in favor of the business

Create the initial Hedge

- Determine the strike of the long dated option:
  - This will be the hedge rate for the long term
- Determine the Notional of the option:
  - I.e. 10 mln exposure per year; 5 year time horizon will give 50 mln.
- Create the desired Delta
  - Delta should be equal to this year's exposure (10 mln)
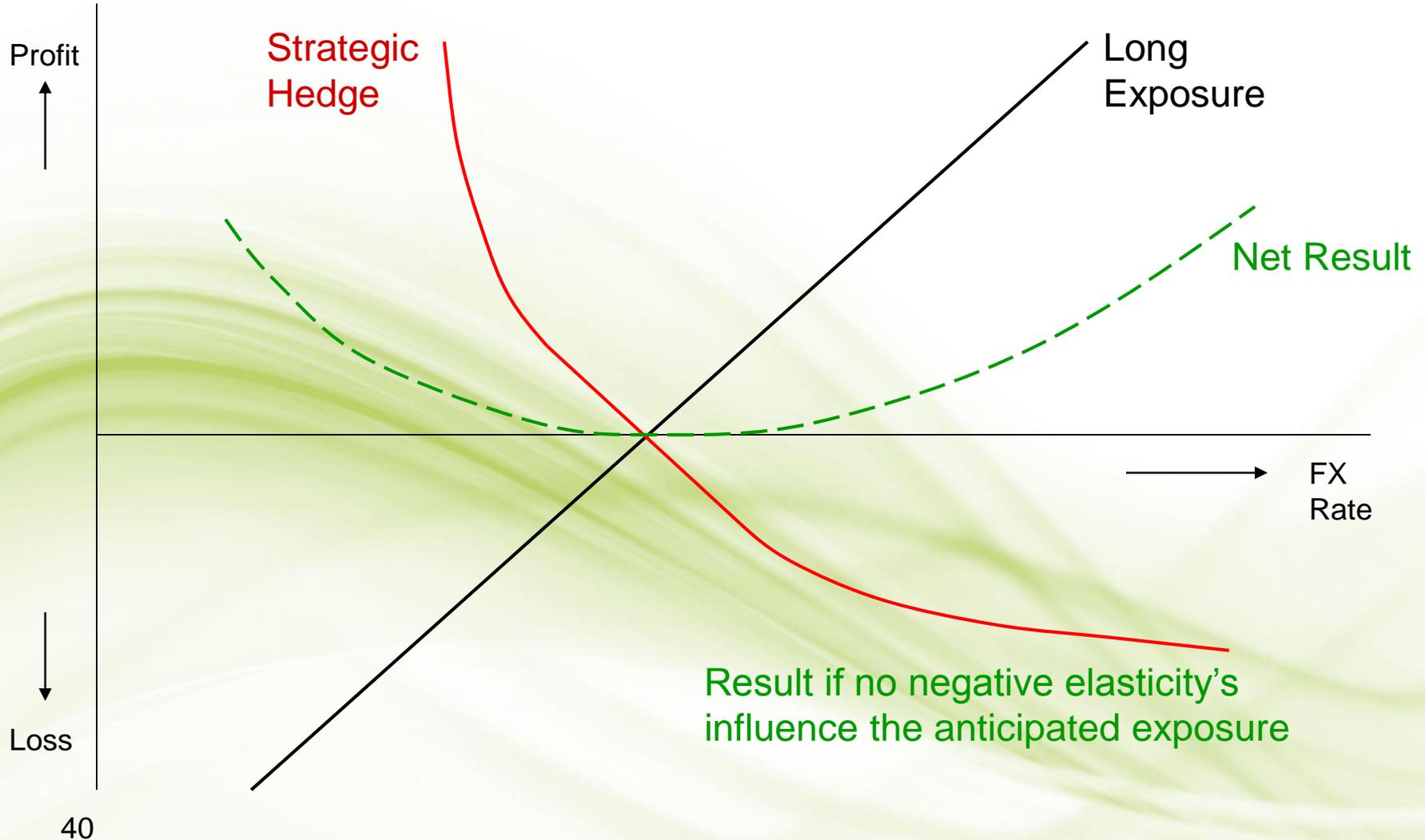 - Instruments: FX contracts / Options

Create the initial Hedge

- Run what-if scenario's to calculate the Greek sensitivities
  - Spot and volatility movements, passage of time
  - Calculate Delta, Gamma, Theta and Vega
- Fine tune the Greek sensitivities
  - Scenario Analysis
  - Delta should hedge your current exposure;
    Gamma should hedge your elasticity's;
    Theta should be zero if spot does not move;
    Vega should hedge your volatility risk
  - Instruments: Options

Characteristics initial hedge

	Long Foreign Currency in FCF	Short Foreign Currency in FCF
Foreign Currency Depreciates	▪ Delta Short and growing ▪ Gamma Long and increasing ▪ Vega Long ▪ Loss time value minimized	NO PROBLEM
Foreign Currency Appreciates	NO PROBLEM	▪ Delta Long and growing ▪ Gamma Long and increasing ▪ Vega Long ▪ Loss time value minimized

Characteristics hedge

Profit

Strategic Hedge

Long Exposure

Net Result

FX Rate

Loss

Result if no negative elasticity's influence the anticipated exposure

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Characteristics hedge

Profit

Strategic Hedge

Long Exposure

Worse or worst case net Result

FX Rate

Loss

Result if elasticity's turn against you

41
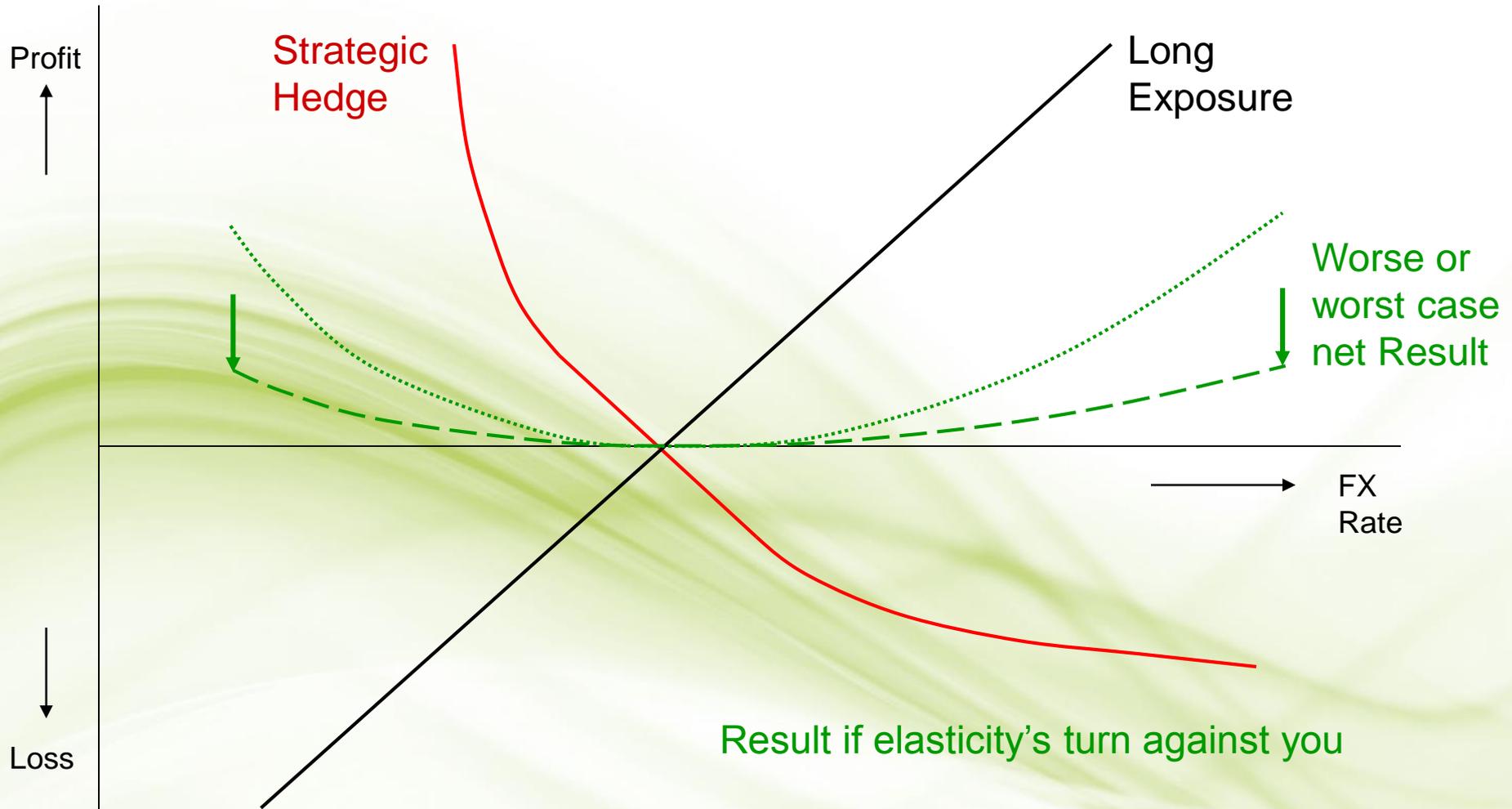
Example

- You have a P & L related translation Exposure
- You anticipate to be Long $ 10 mln per year
- You want to hedge a 5 year's time horizon
- Current spot is at 1,30
- Strike of the long dated USD Put is at 1,44

Goals and Objectives

- **Delta** of the strategic hedge should be short USD 10 mln, as my anticipated annual exposure is long USD 10 mln.
  - If USD appreciates, delta should decrease, as my elasticity's may move against me
  - If USD depreciates, delta should increase, as my elasticity's may move against me
- This means that **Gamma** should be positive.
- But I do not want to loose premium if spot does not move, thus **Theta** should be '0' or positive if spot does not move.
- If volatility moves up, the hedge should start generating additional profit, because your business does not like an increased volatility → **Vega** should be positive.

The Greeks at inception of the initial hedge

Delta CC2	Spot						
	-5%	-3%	-1%	0%	1%	3%	5%
-2%	-8,428,696	-9,469,636	-10,005,623	-10,226,176	-10,574,267	-12,026,747	-14,569,867
-1%	-9,577,412	-10,602,985	-11,258,786	-11,563,662	-11,959,801	-13,286,574	-15,446,876
0%	-10,610,240	-11,612,577	-12,340,333	-12,693,428	-13,113,971	-14,345,281	-16,219,525
1%	-11,532,711	-12,509,752	-13,279,583	-13,660,090	-14,091,828	-15,248,301	-16,906,977
2%	-12,356,940	-13,309,031	-14,102,205	-14,497,786	-14,933,202	-16,029,401	-17,523,245

Volatility (row label)

Note: the Delta moves in favor if spot moves!

What does this mean?

- Delta = - USD 12 mln: the Fair Value of the total structure behaves in the same way for spot movements as being short USD 12 mio in spot.
- Delta will change if spot changes, when time passes and when the volatility moves.
- Explanation why Delta is currently higher than USD 10 mln will follow.

Result of exposure year 1 + long term hedge

Result Exposure + Hedge at inception

| | 1.2352 | 1.2612 | 1.2872 | 1.3003 | 1.3133 | 1.3393 | 1.3653 |
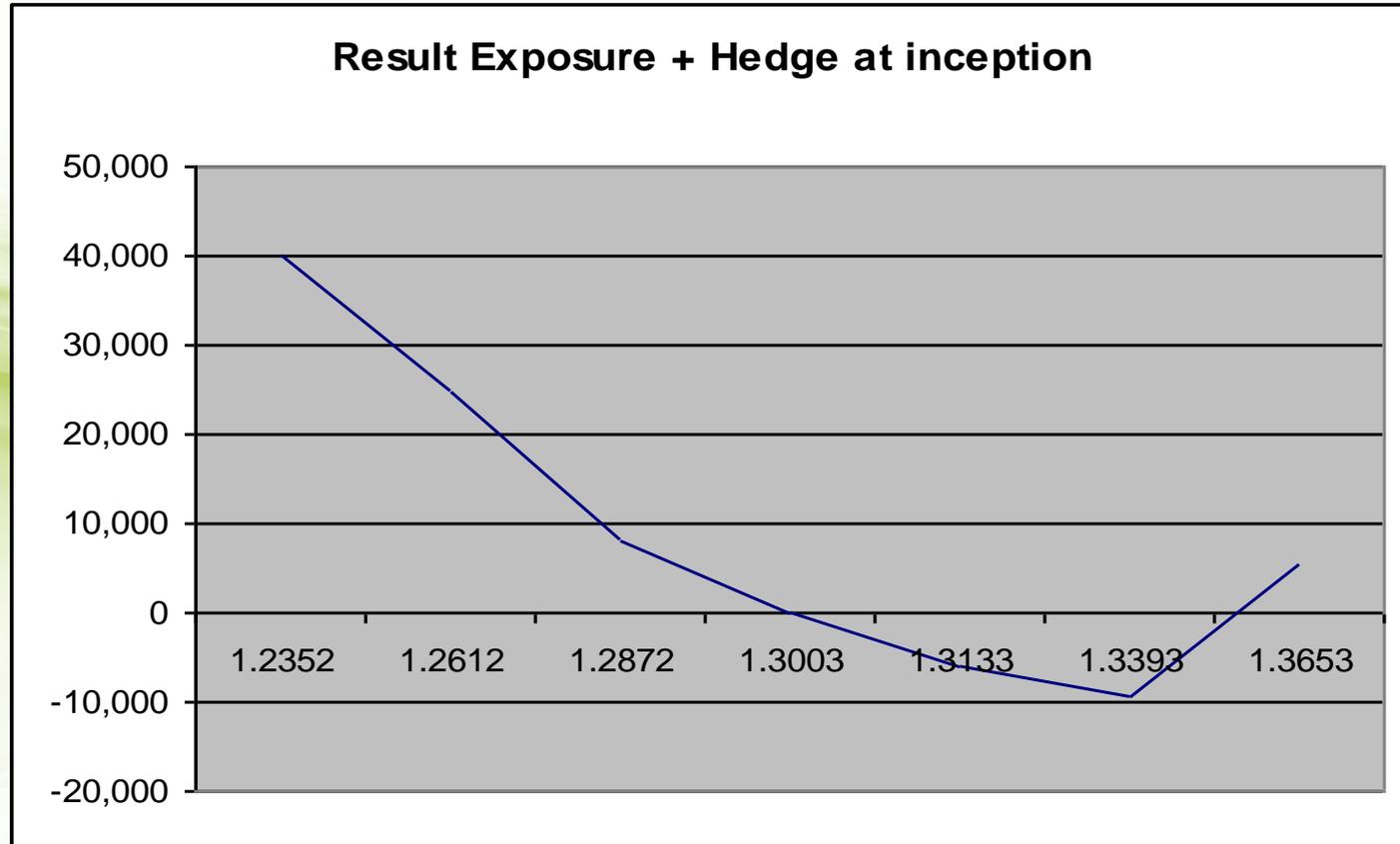
The hedge has to be managed continuously

- The graph of payouts will change:
  - If market rates change;
  - If time passes by;

- Let's see how the payout looks like in 2 month time

In 2 months time the Greeks look like

spot move	-10%	-5%	-1%	0%	1%	5%	10%
Premium (€)	-183,532	203,879	605,850	709,560	781,117	1,101,426	1,663,058
Delta ($)	-6,874,768	-10,722,447	-14,980,178	-12,211,357	-9,741,674	-15,121,156	-22,602,886
Gamma ($)	396,829	646,257	274,374	-4,432,586	444,606	1,004,753	1,005,888
Vega (€)	69,461	113,121	145,761	151,570	159,006	175,872	176,070
Theta (€)	-2,710	-4,027	-2,890	15,861	-2,761	-5,306	-5,650

If spot does not move there is no time decay: Theta is positive!   As a result the option value is increasing if spot does not move.

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Having a positive theta implies by definition that gamma is negative.

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the Greeks look like

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A negative gamma means that for these spot movements delta is
moving against you. This is the reason why the initial hedge has a delta
> USD 10mln

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For bigger movements in spot gamma becomes positive, hedging your elasticity's

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the Greeks look like

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When gamma is positive delta will move in your favor.
If EUR/USD spot moves up with more than 1%, delta is increasing up to
USD 50mln. So your hedged amount is increasing when spot moves
against you.

In 2 months time the Greeks look like

spot move	-10%	-5%	-1%	0%	1%	5%	10%
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When gamma is positive delta will move in your favor.
If EUR/USD spot moves down with more than 1%, delta is decreasing, reducing your hedged amount. So your business profits from the increasing USD rate.

Result of exposure
year 1 + long term hedge


Result Exposure + Hedge in time
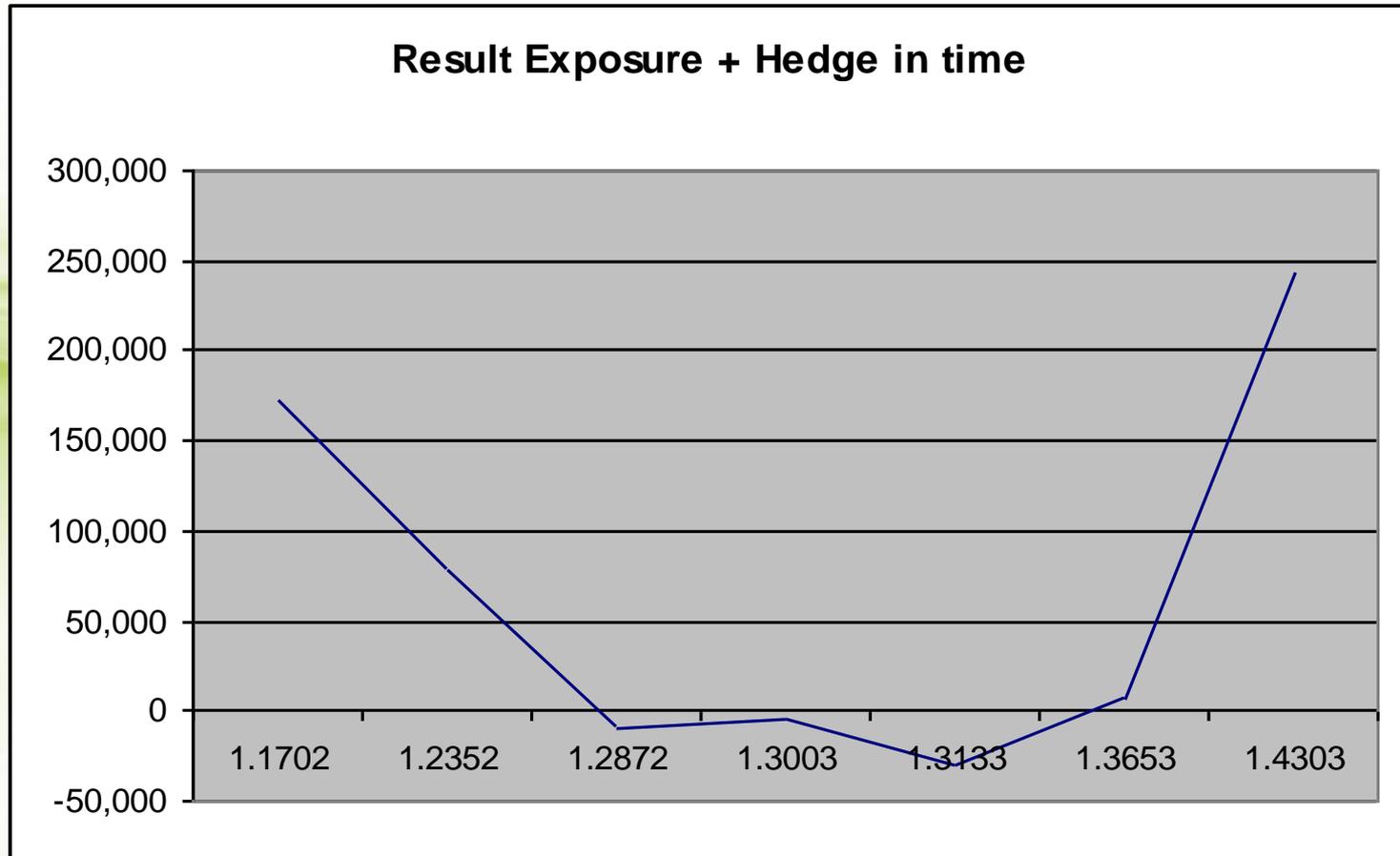
Managing the Strategic hedge

- If spot doesn't move, the net loss in time value (Theta) is close to zero after 2 months (compared to a loss of EUR 100,000 with a plain vanilla option)

- If spot moves up, we will start to protect the profit of the hedge, by putting a hedge on the strategic hedge.

- If spot moves down, the long term hedge rate will improve ("Click characteristic").

- The worst case scenario occurs if EUR/USD moves by 1% (total result however is still better than with a plain vanilla option)

If USD moves up (= EUR/USD down)

Profit

After Adjustment

Initial hedge

EUR/FC

Loss
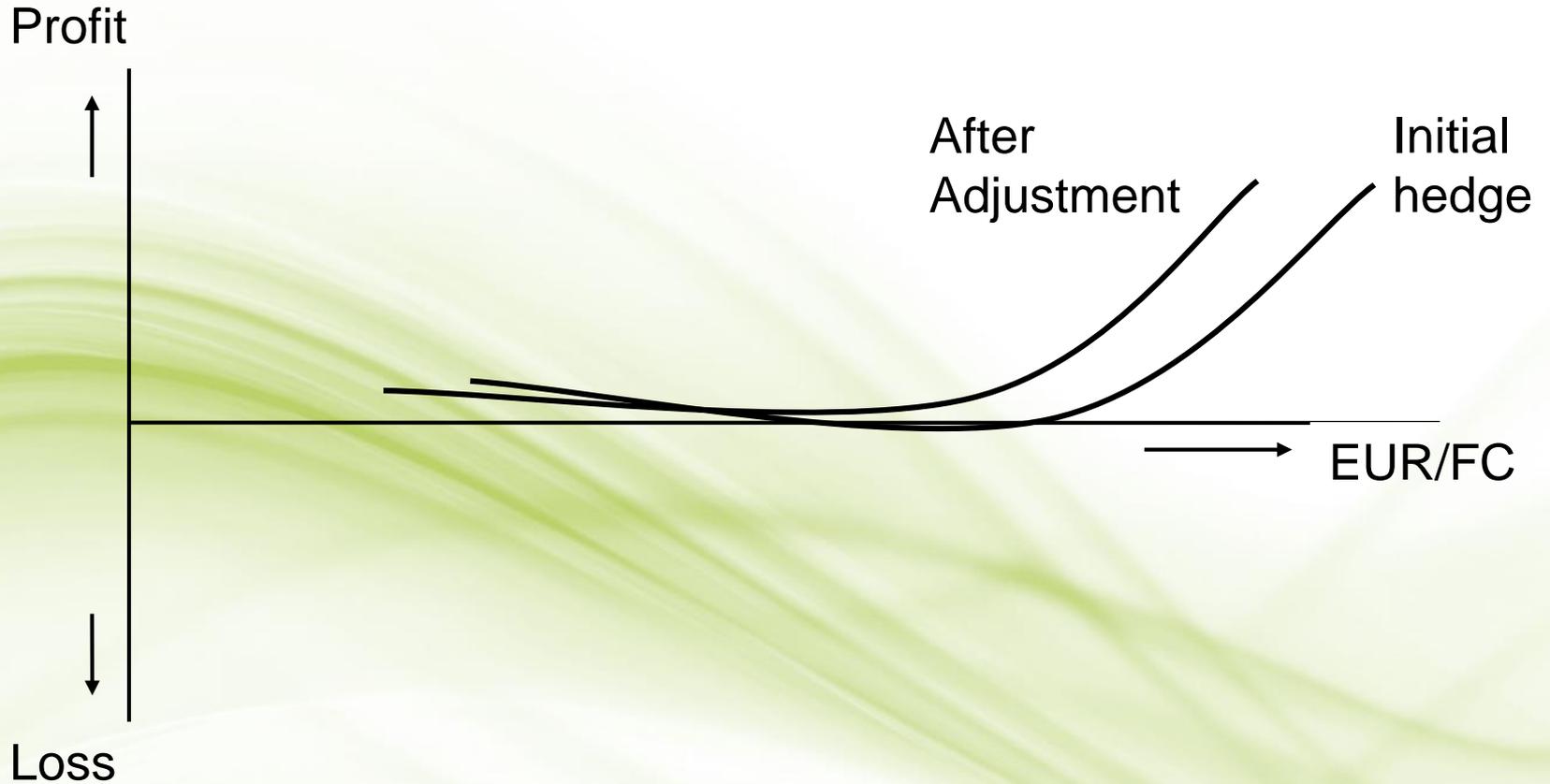
If USD moves down (= EUR/USD up)
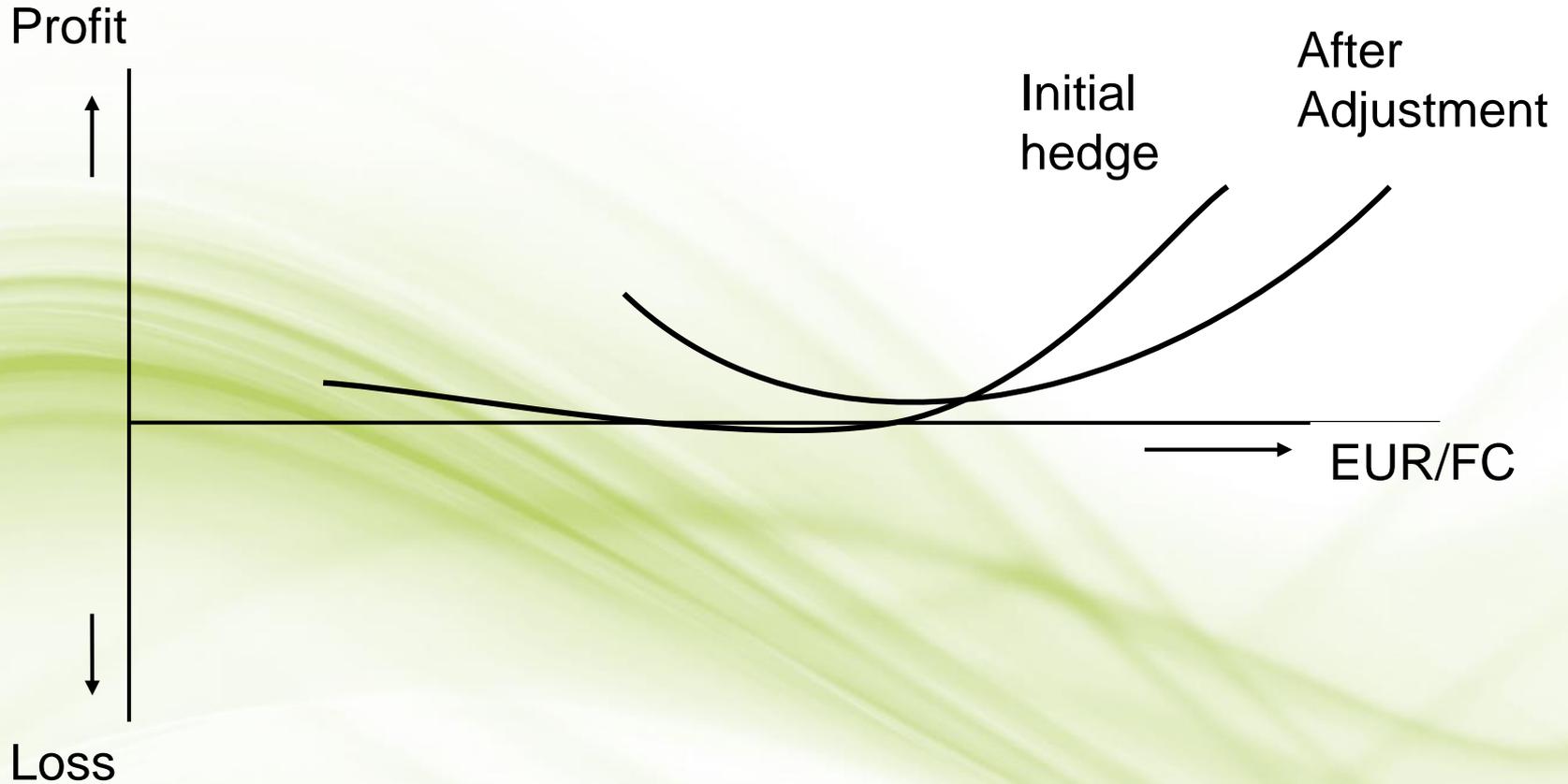
Managing the Strategic hedge

- This process will be continued, with the result:
  - This year's risk is hedged
  - The hedged amount will increase if spot moves against the business
  - The hedged amount will decrease if spot moves in favor of the business
  - Long term hedged rate will "Click" if spot moves in favor of the business.
    - This requires an extra premium investment equal to the profit generated on the first year's exposures
    - This improves the hedged rate for the entire strategic hedge horizon!

Conclusions

- You are hedged for a long term time horizon of your choice
- An unfavorable move is hedged
- You are profiting from a favorable move ("Click" characteristic)
- The premium investment is less than half compared to a classic option
- Loss in time value is minimized if spot does not move:
  - The hedge is an investment in option premium that will maintain its value through the management of the structure
  - You can always sell the hedge and recuperate the premium investment

A Total Solution

- Policy Concepts: tailor the solution into your organization; explain to management, control, auditors and shareholders what you are doing.

- IFRS Issues: to avoid accounting problems

- Dedicated Course: to explain it in detail to your people, so that you become in control

- Mathematical Models: to support the hedging process

- Software: to automate all issues, so that organization costs are eliminated and so that you are fully in control