

# Citi's Online Academy for Financial Institutions: Meeting the currency Challenge

## Optimal Currency Hedging Benchmarks for a EUR Based Bond and Equity Investor

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and

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23 September

# Introduction

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- This presentation investigates the passive hedge benchmarks for international bond and equity exposures for a EUR based investor.
- Our studies focus on the optimal hedge benchmark, optimal hedge rebalancing frequency and proxy hedging. For simplicity, we look at three international asset indices:
  - The Citi World Government Bond Index AAA/AA (WGBI);
  - The MSCI World Equity Index (MSCI);
  - The MSCI Emerging Markets Free Equity Index (MSCI EM).
- Our results suggest that the **optimal hedge benchmark for international bond exposures is 80-100%, major international equities 50% and emerging market equities 0% (no proxy hedging) or 50% (proxy hedged via G10)**:
  - The volatility of fixed income exposures is low relative to currencies and the underlying portfolio does not benefit from currency risk;
  - International equity exposures have higher volatilities than currencies – currency risk can benefit the portfolio without jeopardising total returns. For an investor without directional currency views we recommend the 50% ‘least regret’ hedge benchmark;
  - There is rarely value in hedging emerging market equity exposures directly. Without proxy hedging we recommend a 0% hedge ratio. We also show that some major currencies like the USD and SGD have worked well in the past as a proxy hedges for emerging market currencies.
- Finally, we show that the tracking error of the hedge can be reduced by introducing an intra-month rebalancing trigger, depending on the long-term historical volatility of the underlying asset.

# Optimal Hedge Benchmark

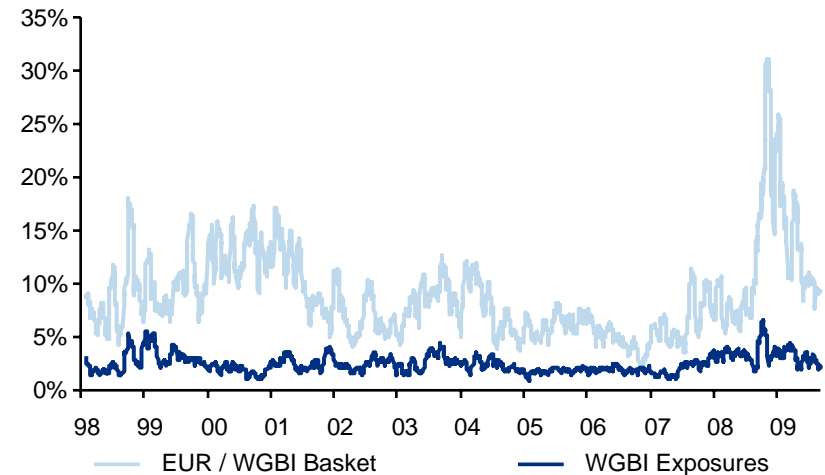
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- Choosing the optimal level of currency risk is the most important decision in terms of the impact on total return.
- We recommend splitting the choice of the hedge ratio in two parts:
- 1) **Passive**: choose the hedge benchmark.
  - When choosing the hedge benchmark one has to take into account relative asset and currency volatility and the cost of hedging in terms of forward points and bid-offer spread.
  - Expected **currency direction should not enter into the decision making process** for the passive hedge.
- 2) **Active**: choose the strategic hedge ratio.
  - The strategic hedge ratio is **chosen on the basis of expected currency direction** either vs the basket of exposures or individually by currencies.
  - The active hedge ratio can be chosen either on the basis of macroeconomic views (long-term strategic hedge), model-based signals or a combination of the two.
  - The active hedge ratio should be reviewed on a medium term basis (e.g. quarterly, semi-annually).
- The benefit of splitting the active and passive hedge is **transparency** – the quality of active hedge management can be easily measured vs. the passive benchmark.
- **This presentation focuses on the suitable choice for a passive hedge benchmark.** Further information on active currency management or alpha generation techniques is available on request.

# Optimal Hedge Benchmark – Relative Asset and Currency Volatilities

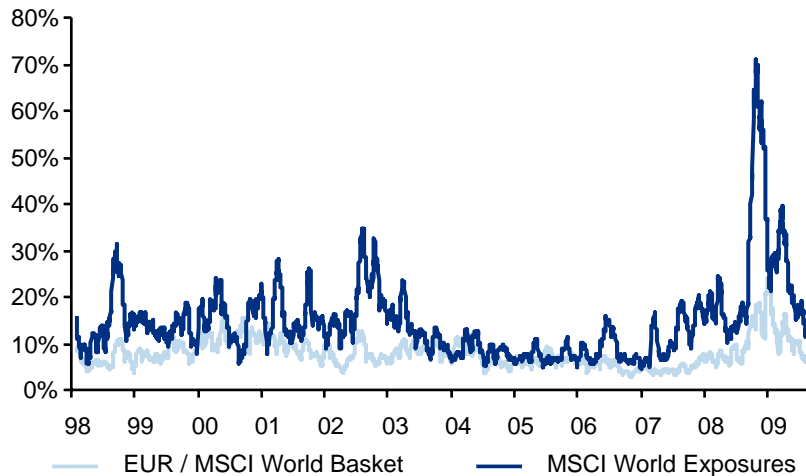
- To illustrate the importance of hedging for bonds and equities we compare historical volatilities of the EUR exchange rate baskets<sup>(1)</sup> and underlying assets.
- The volatility of the EUR WGBI basket has been on average 7.1% points higher than that of the fixed income portfolio. The opposite has been true for the MSCI equity exposures.
- The cost of error from an incorrect choice of hedge ratio is significantly higher for fixed income portfolios than equities.

WGBI: 1M Rolling Historic Volatilities (Annualised)



Source: Citi and Bloomberg. Sample: Jan-98–Sep-09.

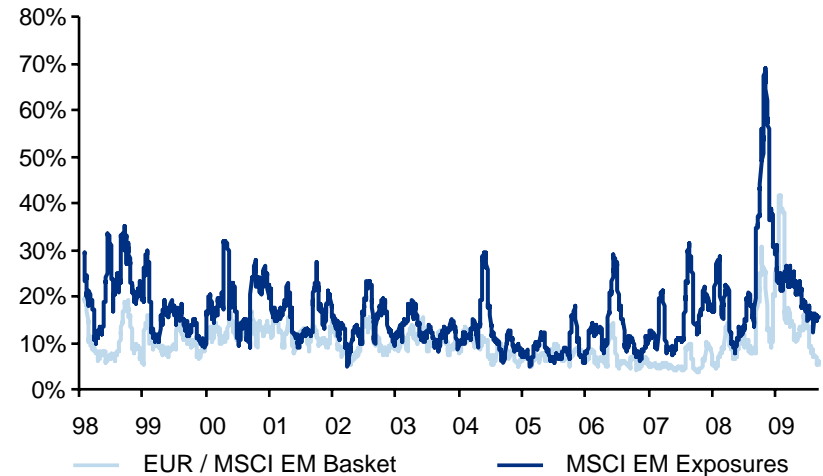
MSCI World: 1M Rolling Historic Volatilities (Annualised)



Source: Citi and Bloomberg. Sample: Jan-98–Sep-09.

Note: (1) The basket of EUR crosses in the respective MSCI World, WGBI or MSCI Emerging Market index proportions.

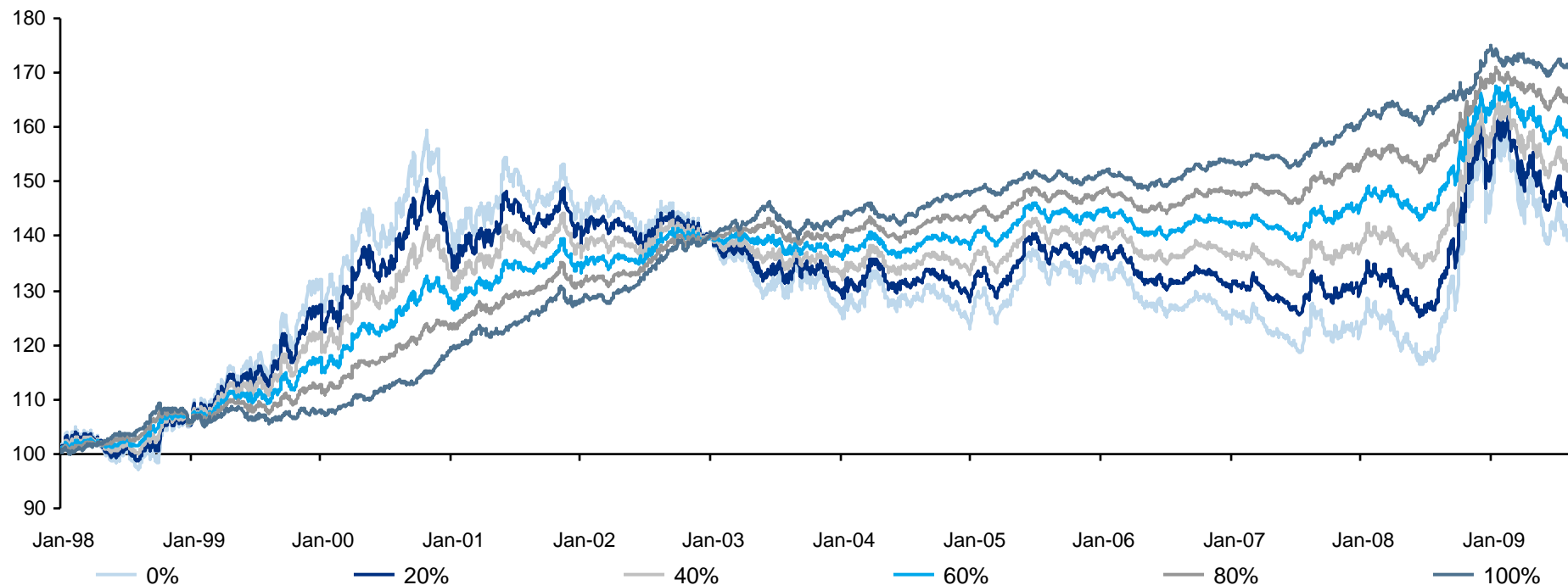
MSCI EM: 1M Rolling Historic Volatilities (Annualised)



Source: Citi and Bloomberg. Sample: Jan-98–Sep-09.

# WGBI: Historical Performance With Various Hedge Ratios<sup>(1)</sup>

## Portfolio Performance for Various Hedge Ratios



Source: Citi and Bloomberg. Sample: Jan-98–Sep-09.

### WGBI total return for various hedge ratios

Jan-98 - Sep-09	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
<b>Annual average return</b>	3.54%	3.80%	4.07%	4.34%	4.60%	4.87%	5.14%	5.40%	5.67%	5.94%	6.20%
<b>Annualised standard deviation</b>	13.49%	12.23%	10.99%	9.77%	8.57%	7.41%	6.31%	5.30%	4.46%	3.88%	3.69%
<b>Information ratio</b>	<b>0.26</b>	<b>0.31</b>	<b>0.37</b>	<b>0.44</b>	<b>0.54</b>	<b>0.66</b>	<b>0.81</b>	<b>1.02</b>	<b>1.27</b>	<b>1.53</b>	<b>1.68</b>
<b>Forward point gain/loss</b>	0.00%	0.14%	0.28%	0.43%	0.57%	0.71%	0.85%	1.00%	1.14%	1.28%	1.42%
<b>Maximum drawdown</b>	-42.76%	-33.94%	-25.11%	-17.31%	-13.81%	-12.06%	-10.37%	-9.02%	-7.65%	-6.28%	-6.87%

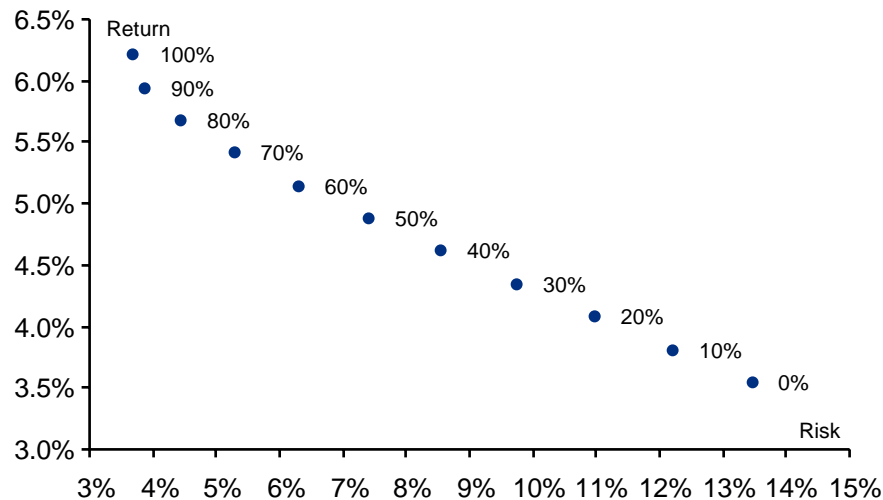
Source: Citi and Bloomberg. Sample: Jan-98–Sep-09.

(1) Monthly rebalancing, no proxy hedging, traded in quarterly forwards. Performance index in EUR: 1 January 1998 =100. All statistics % starting notional.

# WGBI: Optimal Hedge Benchmark

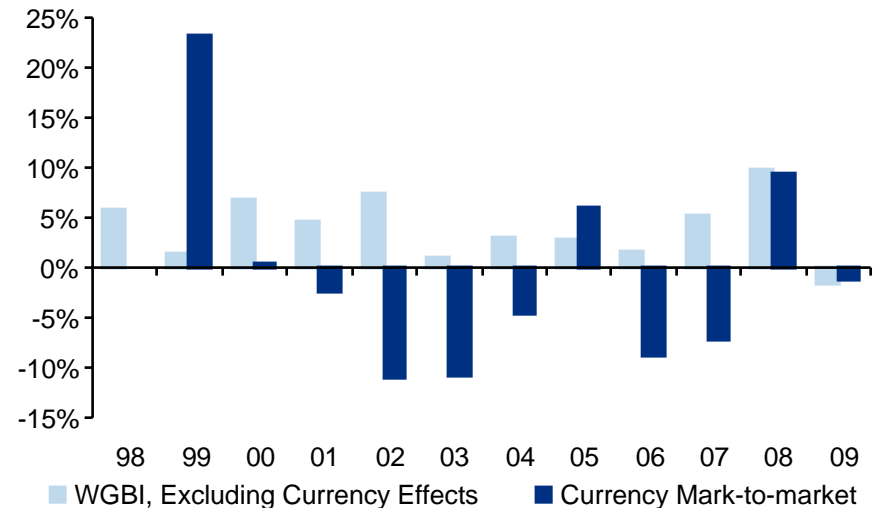
- We recommend a high hedge benchmark of 80-100% for international bond exposures:
  - In our 10-year sample the 100% hedge ratio would have delivered higher returns than the unhedged portfolios. However, this is highly dependent on the choice of sample. Hedging clearly reduces drawdowns and volatility in the long term.
- The potential 'cost' of FX risk in fixed income is high – for example, currency losses would have wiped out all gains in the unhedged WGBI ex-Euro-Zone between 2002 and 2007.
- The currency effect on an unhedged WGBI bond portfolio typically exceeds that of the underlying assets portfolio. Currency risk in the WGBI portfolio is disproportionately large relative to the asset volatility and should therefore be largely hedged away.

WGBI: Total Return and Risk as Function of Hedge Ratio (98–09)



Source: Citi. Sample: Jan-98 Sep-09.

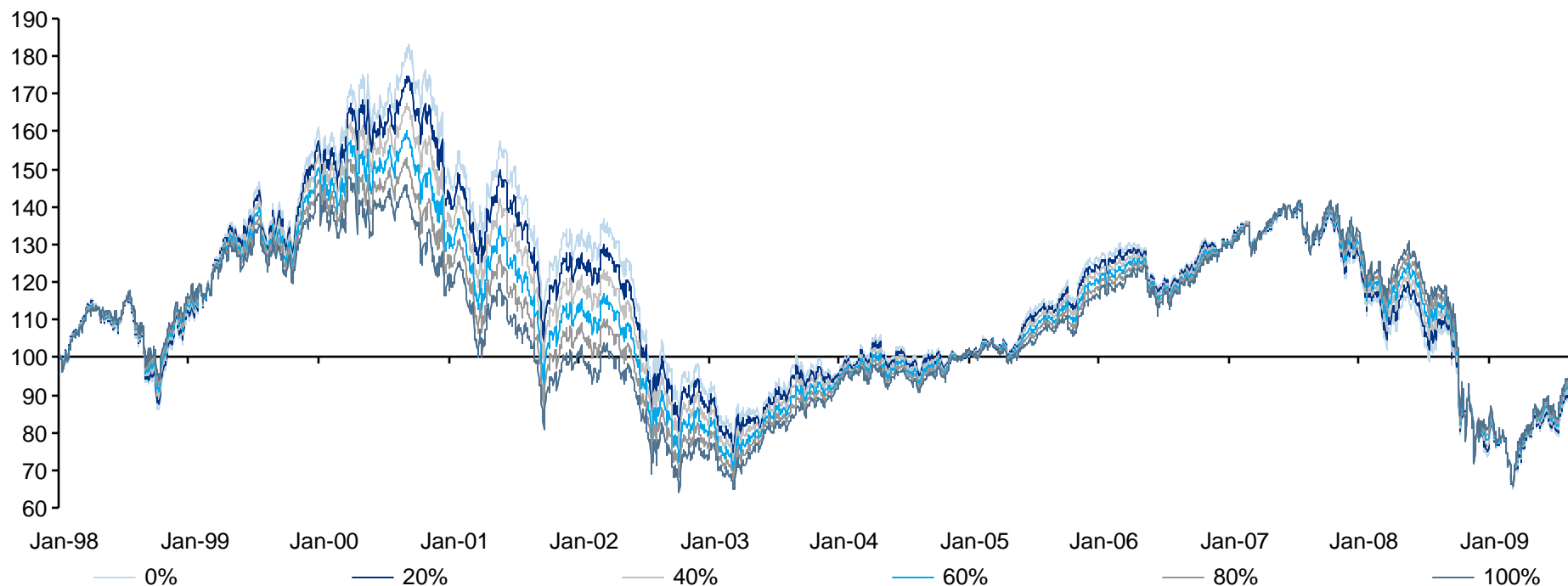
Breakdown of Annual Total Returns: 0% Hedge



Source: Citi. Sample: Jan-98 Sep-09.

# MSCI World: Historical Performance with Various Hedge Ratios<sup>(1)</sup>

## Portfolio Performance for Various Hedge Ratios



Source: Citi and Bloomberg. Sample: Jan-98–Sep-09.

### MSCI World total return for various hedge ratios

Jan-98 - Sep-09	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
<b>Annual average return</b>	-0.83%	-0.78%	-0.73%	-0.68%	-0.63%	-0.57%	-0.52%	-0.47%	-0.42%	-0.37%	-0.32%
<b>Annualised standard deviation</b>	21.88%	21.36%	20.87%	20.43%	20.03%	19.67%	19.37%	19.11%	18.91%	18.76%	18.67%
<b>Information ratio</b>	<b>-0.04</b>	<b>-0.04</b>	<b>-0.03</b>	<b>-0.03</b>	<b>-0.03</b>	<b>-0.03</b>	<b>-0.03</b>	<b>-0.02</b>	<b>-0.02</b>	<b>-0.02</b>	<b>-0.02</b>
<b>Forward point gain/loss</b>	0.00%	-0.04%	-0.08%	-0.12%	-0.16%	-0.20%	-0.24%	-0.27%	-0.31%	-0.35%	-0.39%
<b>Maximum drawdown</b>	-118%	-114%	-110%	-106%	-102%	-98%	-95%	-91%	-87%	-84%	-84%

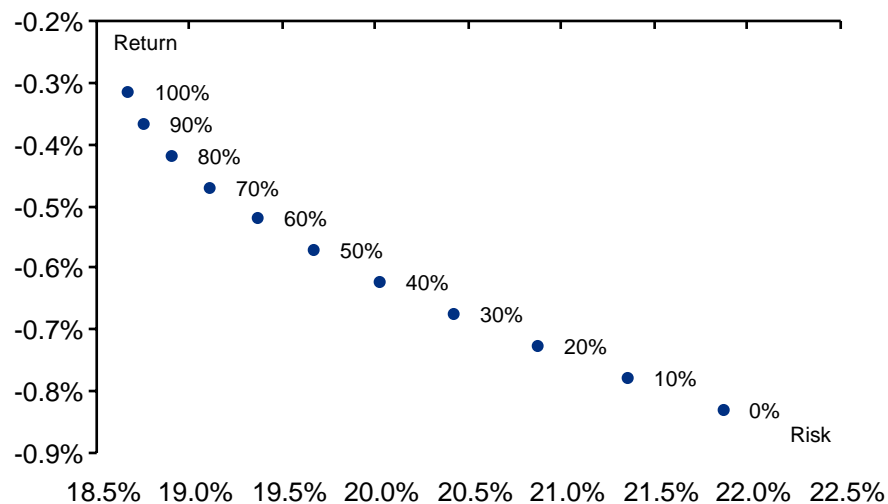
Source: Citi and Bloomberg. Sample: Jan-98–Sep-09.

(1) Monthly rebalancing, no proxy hedging, traded in quarterly forwards. Performance index in EUR: 1 January 1998 =100. All statistics % starting notional.

# MSCI World: Optimal Hedge Benchmark

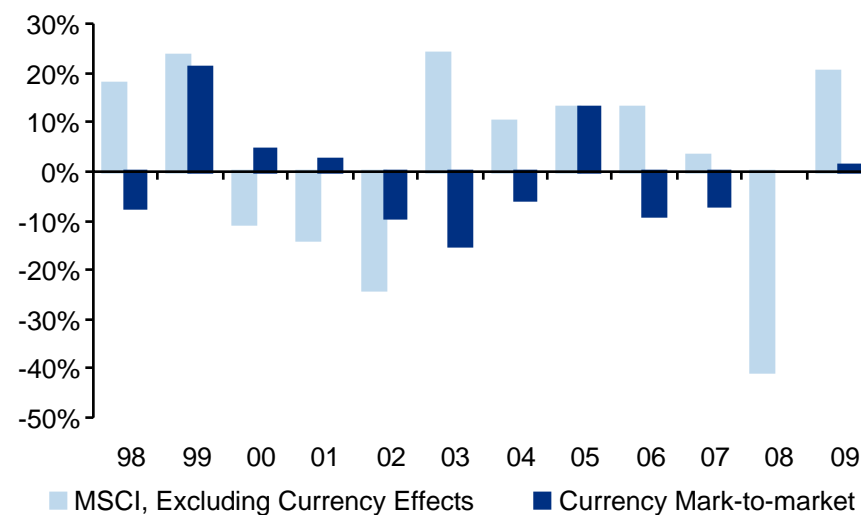
- Unlike for bonds, currency volatility in the MSCI World portfolio has been smaller than that of the underlying asset.
- The marginal impact of the hedge on volatility falls as the hedge ratio increases:
  - For example, increasing the hedge ratio from 0% to 50% has reduced risk by 2.2%, but an increase in the hedge ratio from 50% to 100% has reduced risk only by further 1%.
- Unlike for bonds, there is no unambiguous optimal hedge in equities. While in the long run equities benefit from some hedge against currency risk, the skilful management of the hedge ratio can add value without jeopardising the return from underlying assets.
- For a suitable passive hedge benchmark, we recommend the fully symmetric ‘least regret’ 50% hedge.

MSCI: Total Return and Risk as Function of Hedge Ratio (98–09)



Source: Citi. Sample: Jan-98–Sep-09.

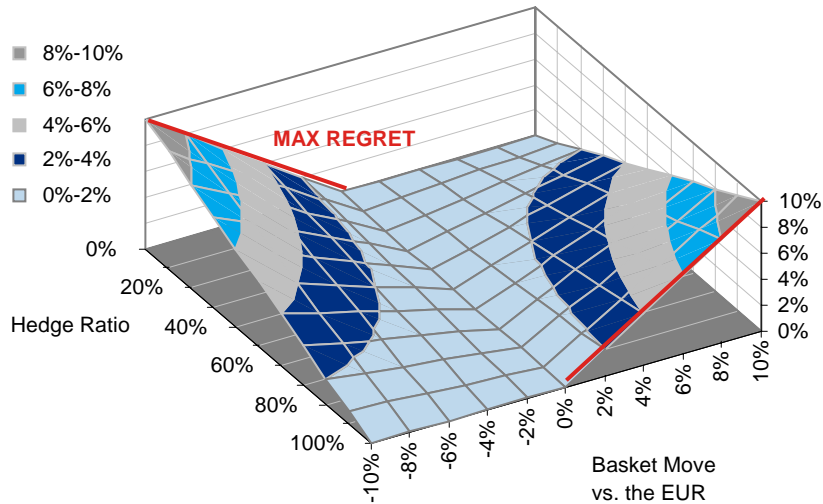
Breakdown of Annual Total Returns: 0% Hedge



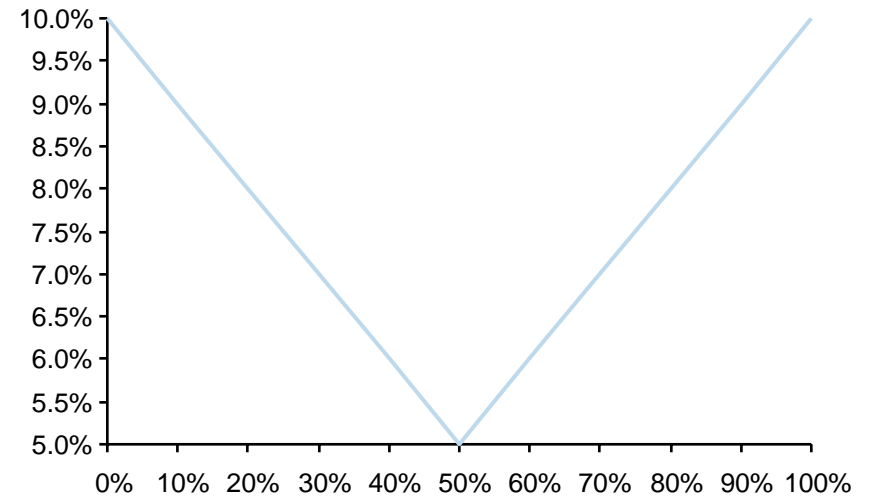
Source: Citi. Sample: Jan-98–Sep-09.

# 'Least Regret'<sup>(1)</sup> – Example

'Regret' as a Function of Basket Move and Hedge Ratio



Maximum Regrets (Alternative Costs) from Incorrect Hedge Ratio



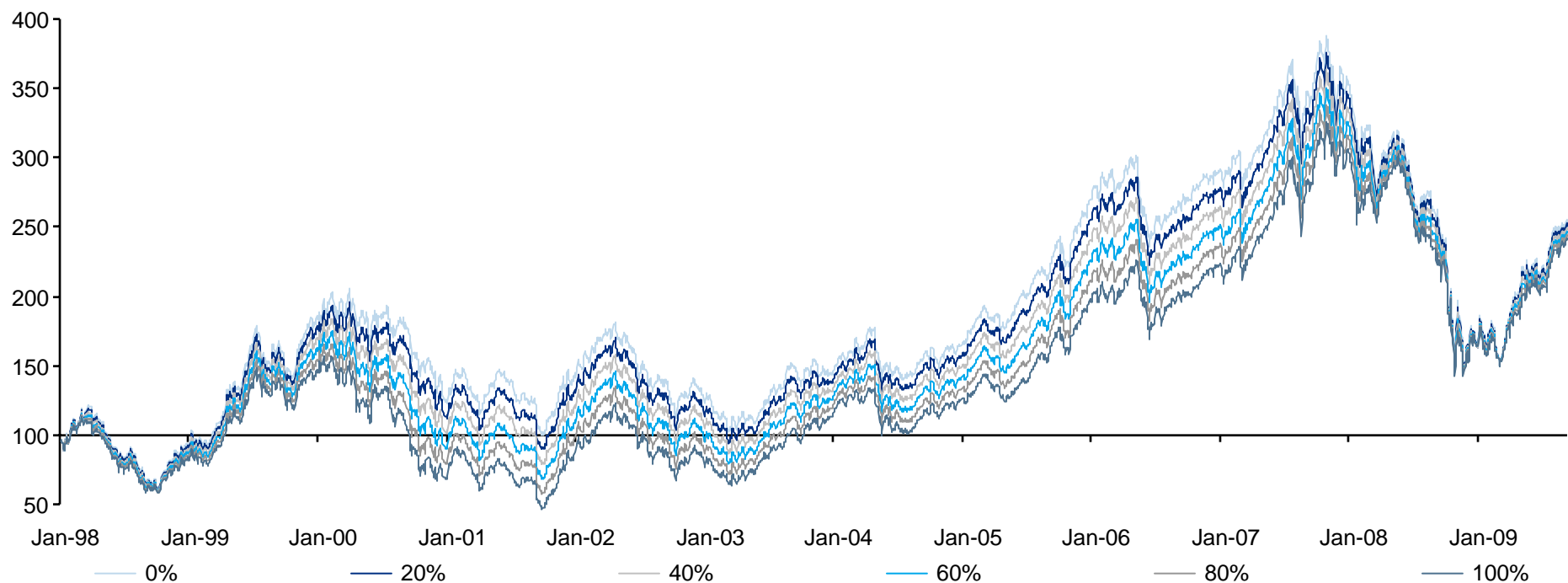
Alternative costs from choosing an incorrect hedge ratio for various hedge ratios and potential basket moves

		Hedge ratio										
		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Basket move vs EUR	-10%	10%	9%	8%	7%	6%	5%	4%	3%	2%	1%	0%
	-8%	8%	7%	6%	6%	5%	4%	3%	2%	2%	1%	0%
	-6%	6%	5%	5%	4%	4%	3%	2%	2%	1%	1%	0%
	-4%	4%	4%	3%	3%	2%	2%	2%	1%	1%	0%	0%
	-2%	2%	2%	2%	1%	1%	1%	1%	1%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	2%	0%	0%	0%	1%	1%	1%	1%	1%	2%	2%	2%
	4%	0%	0%	1%	1%	2%	2%	2%	3%	3%	4%	4%
	6%	0%	1%	1%	2%	2%	3%	4%	4%	5%	5%	6%
	8%	0%	1%	2%	2%	3%	4%	5%	6%	6%	7%	8%
	10%	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
Max regret		10.0%	9.0%	8.0%	7.0%	6.0%	5.0%	6.0%	7.0%	8.0%	9.0%	10.0%

(1) Regret is defined as an alternative cost of the choice of incorrect hedge ratio. For example, if the hedge ratio is 70% and the foreign currency basket appreciates 10% vs the EUR, then the regret is 7%. This is because the 'correct' hedge ratio of 0% would have not lost money on the hedge in that case.

# MSCI EM: Historical Performance With Various Hedge Ratios<sup>(1)</sup>

## Portfolio Performance for Various Hedge Ratios



Source: Citi and Bloomberg. Sample: Jan-98–Sep-09.

### MSCI Emerging Markets total return for various hedge ratios

Jan-98 - Sep-09	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
<b>Annual average return</b>	13.49%	13.38%	13.28%	13.17%	13.06%	12.96%	12.85%	12.74%	12.64%	12.53%	12.42%
<b>Annualised standard deviation</b>	45.47%	44.54%	43.70%	42.95%	42.29%	41.74%	41.28%	40.94%	40.71%	40.59%	40.58%
<b>Information ratio</b>	<b>0.30</b>	<b>0.30</b>	<b>0.30</b>	<b>0.31</b>	<b>0.31</b>	<b>0.31</b>	<b>0.31</b>	<b>0.31</b>	<b>0.31</b>	<b>0.31</b>	<b>0.31</b>
<b>Forward point gain/loss</b>	0.00%	-0.62%	-1.23%	-1.85%	-2.46%	-3.08%	-3.69%	-4.31%	-4.93%	-5.54%	-6.16%
<b>Maximum drawdown</b>	-241%	-236%	-230%	-224%	-218%	-212%	-206%	-200%	-195%	-189%	-183%

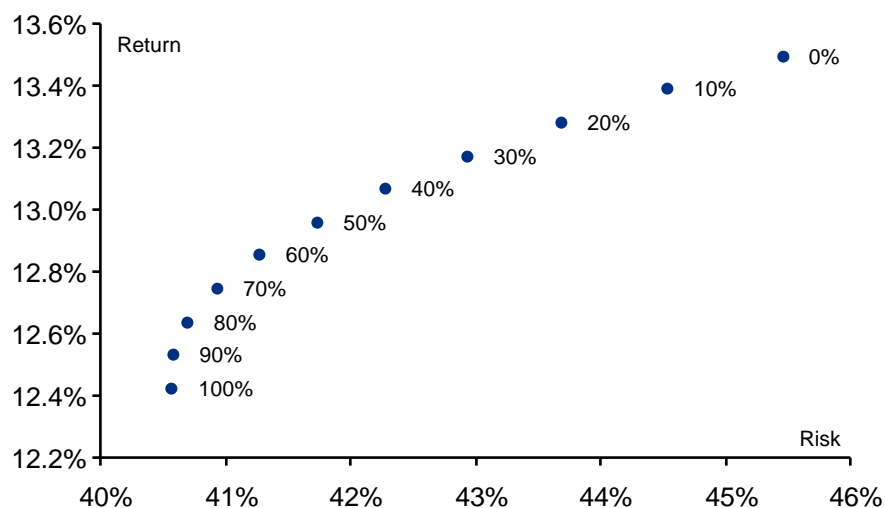
Source: Citi and Bloomberg. Sample: Jan-98–Sep-09.

(1) Monthly rebalancing, no proxy hedging, traded in quarterly forwards. Performance index in EUR: 1 January 1998 =100. All statistics % starting notional.

# MSCI EM: Optimal Hedge Benchmark

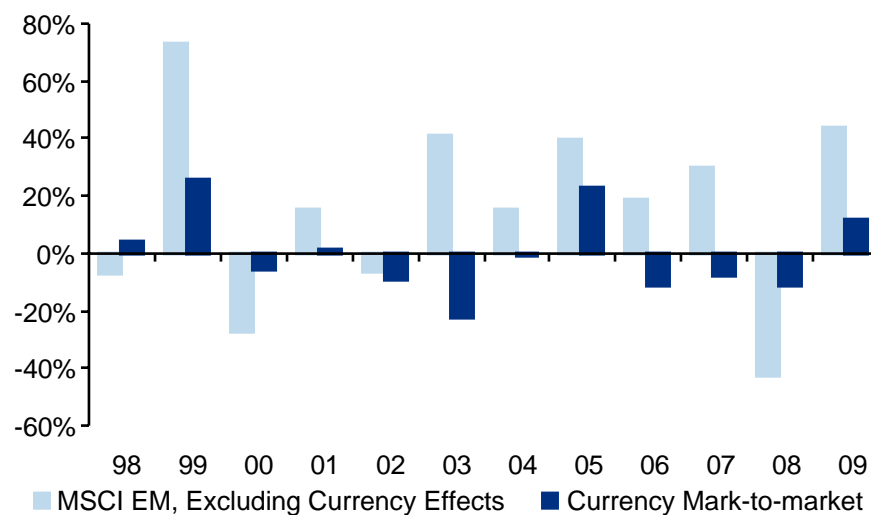
- Without proxy hedging, the optimal hedge ratio for MSCI Emerging Markets has been 0% in the past.
- Direct hedging of the emerging market currency portfolio has been too much of a return drag in the last decade:
  - On average, we find that it has cost 6.2% per year in forward points to hedge MSCI EM directly. This is not practical and in some currency pairs also not possible.
- The MSCI EM basket contains 26 currencies, which offers protection in diversification. Nevertheless, the basket has had double-digit impact on total return in five out of the last ten years.
- Proxy hedging can offer some protection against EUR strength, but it will typically fail to insure against EM specific crises. Basket options or reduced basket proxy hedges can offer temporary protection in periods of high volatility and risk aversion.

MSCI EM: Total Return and Risk as Function of Hedge Ratio (98–09)



Source: Citi. Sample: Jan-98–Sep-09.

Breakdown of Annual Total Returns: 0% Hedge



Source: Citi. Sample: Jan-98–Sep-09.

# MSCI EM: Proxy Hedging – Correlations

Correlations of Daily Log Changes in Spot (Maximum Correlation in Bold)

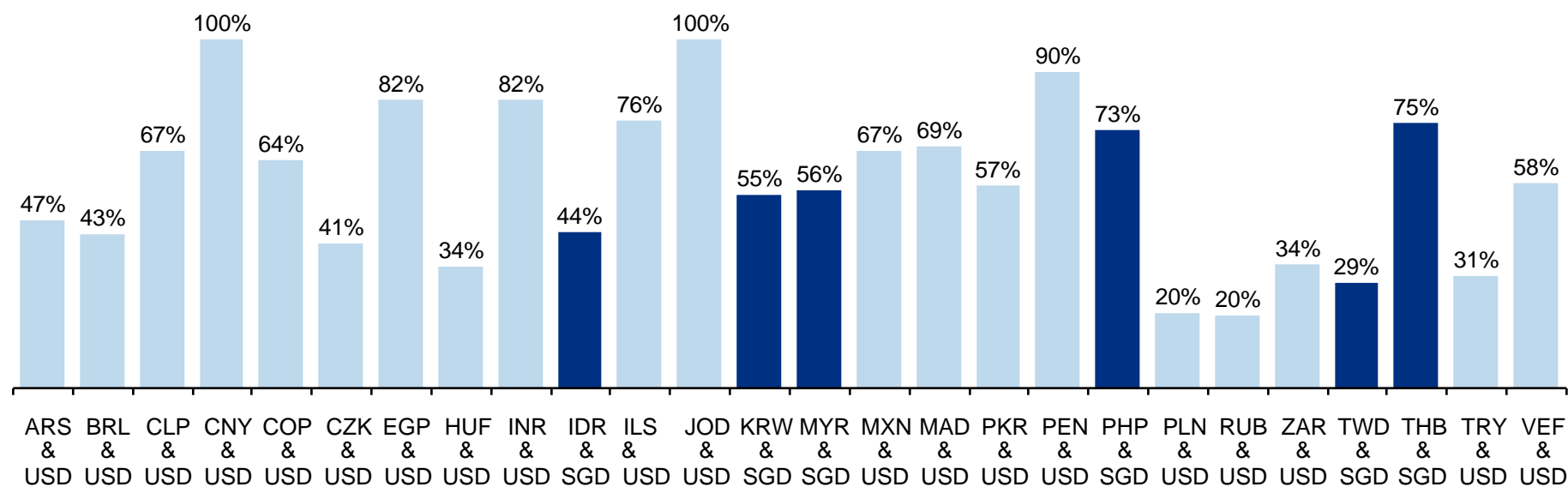
	EURAUD	EURCAD	EURCHF	EURDKK	EURUSD	EURGBP	EURHKD	EURJPY	EURNOK	EURNZD	EURSEK	EURSGD
EURARS	13.5%	29.5%	1.5%	4.0%	<b>47.3%</b>	24.3%	47.3%	23.9%	4.9%	12.9%	4.1%	39.1%
EURBRL	29.7%	37.5%	-12.4%	5.6%	<b>43.3%</b>	28.7%	43.3%	12.6%	16.3%	23.1%	12.9%	43.1%
EURCLP	31.1%	51.5%	-5.4%	7.3%	67.4%	38.5%	<b>67.4%</b>	29.8%	14.0%	26.8%	11.4%	63.6%
EURCNY	24.1%	62.1%	7.0%	9.8%	<b>99.6%</b>	49.2%	99.5%	52.3%	11.3%	22.0%	8.2%	82.8%
EURCOP	28.9%	47.1%	-5.8%	7.9%	<b>64.5%</b>	36.4%	64.4%	27.0%	15.6%	25.1%	13.1%	58.3%
EURCZK	19.7%	33.0%	-6.3%	2.0%	40.6%	25.8%	40.8%	16.7%	16.0%	16.7%	15.8%	<b>49.6%</b>
EUREGP	19.6%	51.6%	6.2%	8.4%	<b>82.0%</b>	40.0%	81.9%	43.6%	10.6%	17.1%	5.5%	68.2%
EURHUF	26.1%	33.1%	-12.8%	2.6%	33.9%	24.1%	34.0%	7.2%	20.8%	22.5%	22.0%	<b>42.9%</b>
EURINR	29.5%	58.0%	-1.8%	8.5%	<b>82.2%</b>	45.9%	82.2%	38.3%	15.4%	27.1%	13.6%	73.0%
EURIDR	21.3%	24.2%	-2.0%	4.6%	29.7%	15.2%	29.8%	23.6%	8.2%	20.8%	7.6%	<b>44.3%</b>
EURILS	27.5%	53.8%	-1.4%	4.3%	75.7%	43.6%	<b>75.8%</b>	35.3%	16.5%	24.9%	13.0%	67.9%
EURJOD	23.5%	61.8%	6.8%	9.4%	<b>99.5%</b>	49.0%	99.5%	52.1%	11.2%	21.4%	7.9%	82.4%
EURKRW	37.6%	45.0%	-8.4%	7.5%	49.8%	35.4%	49.9%	22.3%	16.0%	30.6%	18.7%	<b>54.7%</b>
EURMYR	20.0%	33.3%	4.2%	4.9%	50.9%	24.6%	50.8%	27.4%	6.1%	16.7%	5.4%	<b>55.9%</b>
EURMXN	37.1%	51.4%	-10.6%	5.6%	<b>67.4%</b>	41.5%	67.3%	26.1%	17.4%	30.2%	15.6%	63.7%
EURMAD	22.0%	47.7%	0.3%	6.1%	68.8%	36.4%	<b>68.9%</b>	33.9%	11.7%	18.7%	11.0%	68.7%
EURPKR	15.6%	35.8%	6.3%	16.1%	<b>57.5%</b>	27.6%	57.3%	29.3%	7.5%	14.0%	4.6%	49.0%
EURPEN	25.3%	59.0%	0.9%	9.1%	<b>89.9%</b>	46.2%	89.8%	44.4%	13.2%	21.8%	10.7%	76.0%
EURPHP	31.1%	53.1%	-1.2%	7.6%	<b>73.5%</b>	40.5%	73.5%	42.0%	14.5%	28.8%	12.8%	73.1%
EURPLN	32.1%	<b>34.5%</b>	-21.1%	1.7%	20.5%	26.9%	20.6%	-0.8%	27.8%	27.3%	29.5%	25.8%
EURRUB	8.1%	16.5%	-2.9%	4.7%	19.7%	13.0%	<b>19.8%</b>	5.8%	9.1%	9.2%	8.4%	17.6%
EURZAR	32.1%	34.1%	-11.7%	3.8%	34.4%	27.1%	34.6%	9.1%	20.1%	26.6%	18.8%	<b>41.9%</b>
EURTWD	12.1%	18.8%	-8.2%	3.1%	<b>31.0%</b>	16.0%	31.0%	18.6%	6.9%	11.0%	7.5%	29.5%
EURTHB	25.3%	44.6%	4.9%	5.6%	65.4%	33.4%	65.5%	43.6%	9.2%	23.6%	6.6%	<b>75.2%</b>
EURTRY	20.4%	24.3%	-13.0%	1.5%	31.3%	18.0%	31.1%	5.9%	11.6%	17.0%	13.8%	<b>31.6%</b>
EURVEF	16.2%	37.3%	4.4%	6.8%	<b>57.9%</b>	26.9%	57.8%	29.4%	7.3%	14.9%	5.7%	47.8%

Source: Citi. Sample: Jan-98 – Sep-09

# MSCI EM: Proxy Hedging – Correlations

- Historical correlations of daily spot changes suggest that the USD has acted as a good proxy for most emerging markets.
- The SGD has also been a good regional proxy for IDR, KRW, MYR, PHP, TWD and THB exposures.
- For most CEE currencies it is difficult to find a proxy in EUR crosses. This is because they tend to move more in line with the EUR itself.

Proxy Currencies – Highest G10 Currency Correlation for Each EM Currency EUR Crosses)

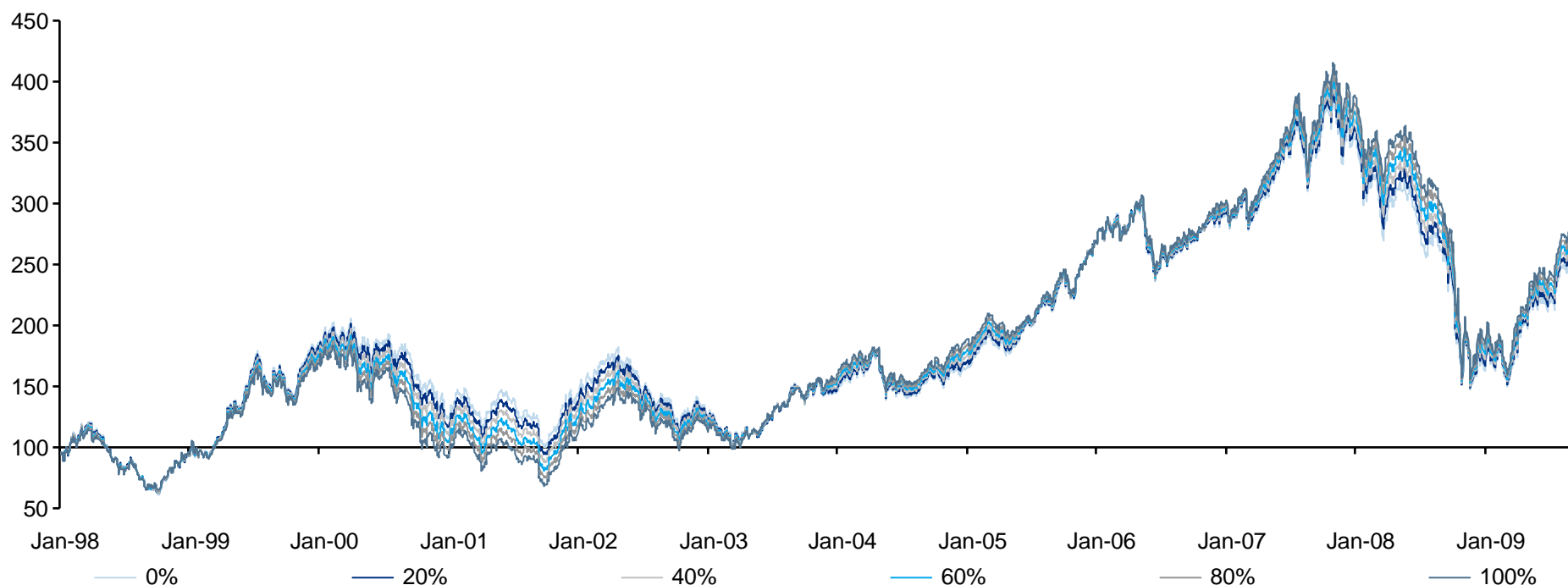


Source: Citi. Sample: Jan-98–Sep-09.

# MSCI EM Proxy: Historical Performance with Various Hedge Ratios<sup>(1)</sup>

- To illustrate the impact of proxy hedging, we show the performance of a strategy, where the IDR, KRW, MYR, PHP, TWD and THB are all hedged via SGD and the rest of the EM MSCI via the USD.

## Portfolio Performance for Various Hedge Ratios



Source: Citi and Bloomberg. Sample: Jan-98–Sep-09.

### MSCI Emerging Markets total return for various hedge ratios, proxy hedged via G10

Jan-98 - Sep-09	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
<b>Annual average return</b>	13.49%	13.74%	13.98%	14.23%	14.47%	14.72%	14.96%	15.21%	15.45%	15.70%	15.94%
<b>Annualised standard deviation</b>	45.47%	44.96%	44.52%	44.15%	43.84%	43.61%	43.45%	43.37%	43.36%	43.43%	43.57%
<b>Information ratio</b>	<b>0.30</b>	<b>0.31</b>	<b>0.31</b>	<b>0.32</b>	<b>0.33</b>	<b>0.34</b>	<b>0.34</b>	<b>0.35</b>	<b>0.36</b>	<b>0.36</b>	<b>0.37</b>
<b>Forward point gain/loss</b>	0.00%	0.05%	0.10%	0.16%	0.21%	0.26%	0.31%	0.37%	0.42%	0.47%	0.52%
<b>Maximum drawdown</b>	-241%	-243%	-245%	-247%	-249%	-250%	-252%	-254%	-256%	-258%	-259%

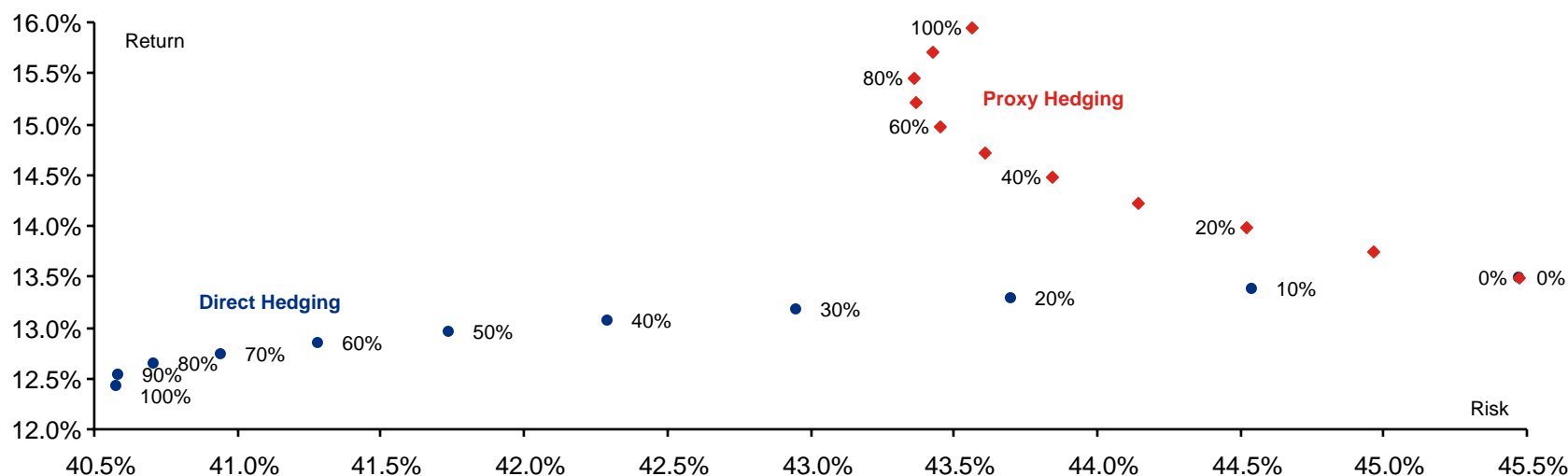
Source: Citi and Bloomberg. Sample: Jan-98–Sep-09.

(1) Monthly rebalancing, proxy hedging, traded in quarterly forwards. Performance index in EUR: 1 January 1998 =100. All statistics % starting notional.

# MSCI EM Proxy Hedging via G10: Optimal Hedge Benchmark

- Contrary to the direct hedge, the proxy hedge basket has been roughly carry neutral in the past (forward point gain +0.52% p.a.).
- But what is the optimal hedge ratio for the proxy?
- From a volatility point of view proxy hedging is not very effective. A 60% proxy hedge for the selected currencies has only reduced volatility by about the same amount as a 25% direct hedge on all currencies (-2%):
  - As usual, the return benefit is highly sample dependent;
  - The diminishing marginal improvement in volatility points to a proxy hedge ratio around 50% for selected currencies. Because of some correlation between the USD and underlying assets, the proxy hedge ratios above 70% have re-introduced risk into the portfolio.
  - Currencies with poor proxies are best hedged directly, occasionally and on a case by case basis.

## MSCI EM: Total Return And Risk as Function of Hedge Ratio (98–09) – Direct vs. Proxy Hedging



Source: Citi and Bloomberg. Sample: Jan-98–Sep-09.

# Hedge Implementation

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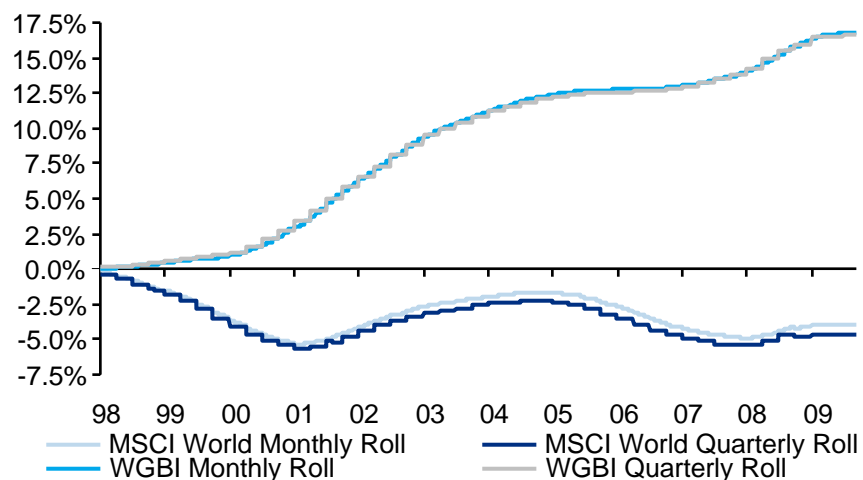
- This presentation has so far dealt with the optimal choice of currency risk.
- Having shown that hedging can reduce the volatility and drawdowns in international bond and equity portfolios, we now proceed to investigate the more [technical questions of hedge implementation](#).
- When hedging via currency forward contracts, the investor is faced with two main questions:
  - Which forwards to use? Is there a difference to hedging in monthly forwards or quarterly forwards?
  - Which maturity dates to choose for the forwards?
  - How to minimise the tracking error relative to the hedge benchmark? What is the optimal trade-off between minimising the error in the hedge ratio and keeping the hedge maintenance costs at reasonable levels?
- In the following section of the presentation we provide the following answers:
  - [Hedging in quarterly forwards](#) is preferred to monthly ones due to lower rolling costs;
  - For large portfolios the maturity dates for the [forwards should be split](#) into two or three;
  - The hedges should be [rebalanced<sup>\(1\)</sup> not less frequently than monthly](#);
  - For ‘protection’, we also recommend adding [an intra-month rebalancing trigger](#) to the hedge program – if the actual hedge ratio deviates from the target by more than the trigger, then the hedges are automatically adjusted;
  - If minimising tracking error is key, then a pure trigger-based strategy with a narrow trigger (and no regular rebalancing) will work well.

(1) Rebalancing means an adjustment of the hedges to the value of the underlying asset exposures.

# Monthly or Quarterly Forward Roll?

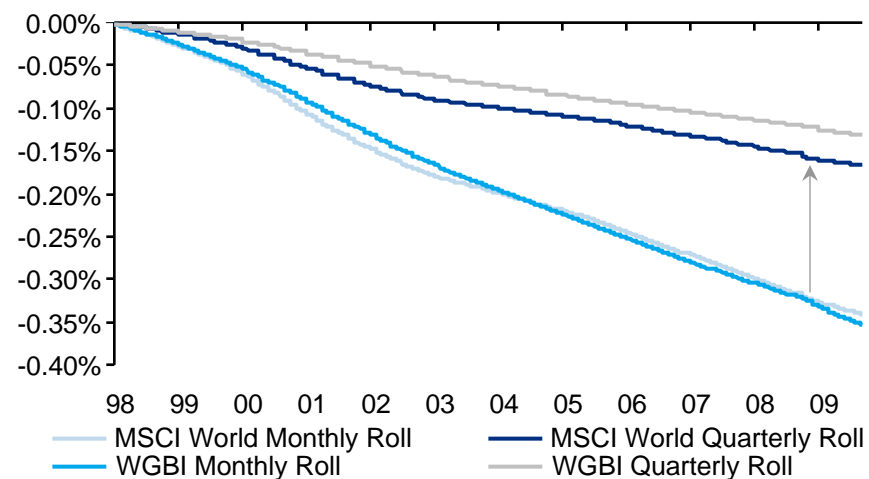
- We recommend using **quarterly forwards with the hedges being split between several roll dates** in order to reduce exposure to liquidity risk:
  - There is little difference between monthly and quarterly forwards in terms of the forward point cost. The only differences arise from mis-pricing of the interest rate path in the short term, but in the long run the difference should be negligible.
  - The quarterly roll is more cost effective – the positions need to be rolled 4x times per year rather than 12x.
  - In order to reduce the risk of rolling the entire hedge under adverse market conditions we recommend splitting the hedge. For example,  $\frac{1}{2}$  traded in quarter-end forwards and another  $\frac{1}{2}$  traded in quarter-end +1 month forwards. The hedge adjustments (rebalancing trades) are traded into straight quarter-end dates.

Cumulative Forward Point Gain on Monthly vs. Quarterly Roll  
(100% Hedge with Monthly Rebalancing)



Source: Citi. Sample: Jan-98–Sep-09.  
(1) 100% hedge with monthly rebalancing of the hedge ratio.

Cumulative Trading Cost of Monthly vs. Quarterly Roll  
(100% Hedge with Monthly Rebalancing)

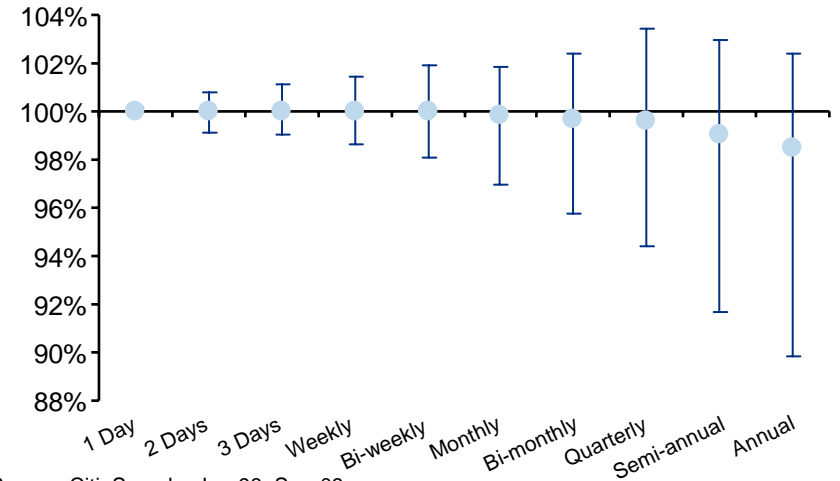


Source: Citi. Sample: Jan-98–Sep-09.

# WGBI: Rebalancing Frequency<sup>(1)</sup> at a Glance

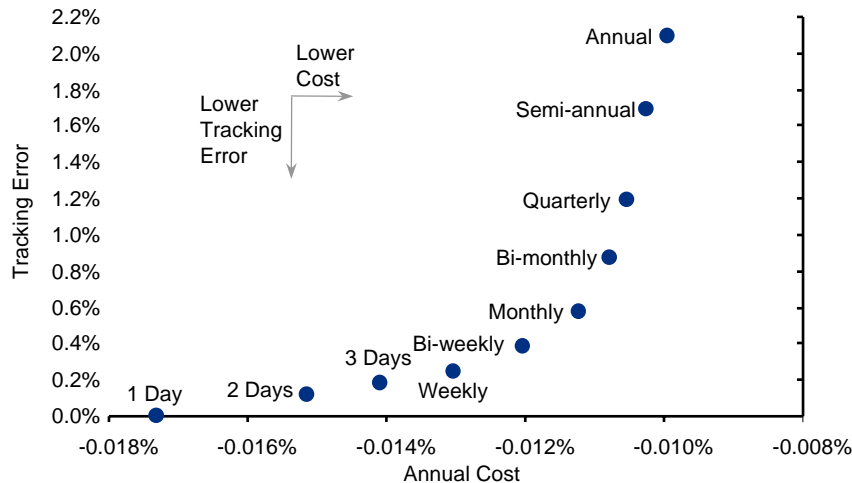
- There is a non-linear trade-off between the tracking error<sup>(2)</sup> and rebalancing costs/volumes:
  - The smallest tracking error of 0% would have been achieved with daily hedge rebalancing. At the same time, this strategy has on average created 0.59x foreign portfolio notional rebalancing volume every year, resulting in high trading costs.
  - The most cost effective option would have been annual rebalancing, with a small spread cost, but a large tracking error of 2.1%.

Max, Min & Average Hedge Ratios For Rebalancing Frequencies



Source: Citi. Sample: Jan-98–Sep-09.

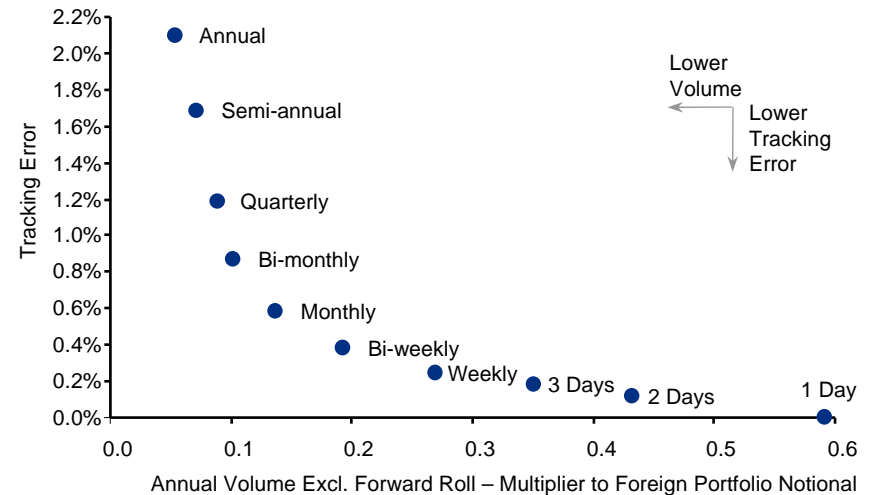
Tracking Error vs. Annual Trading Cost



Source: Citi. Sample: Jan-98–Sep-09.

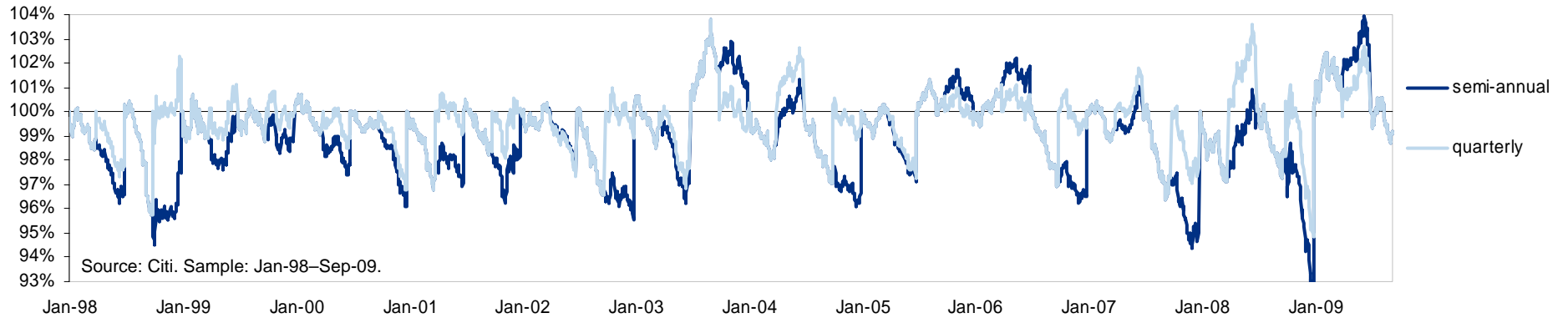
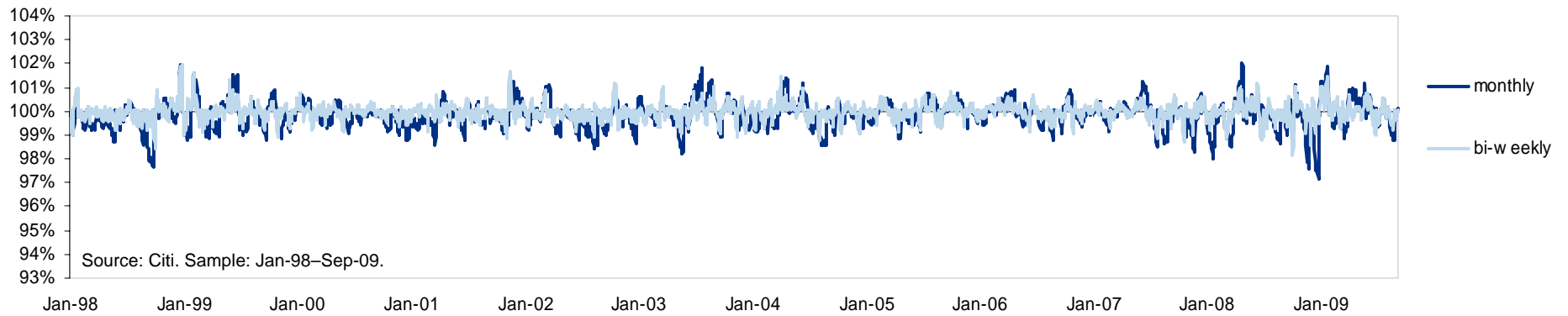
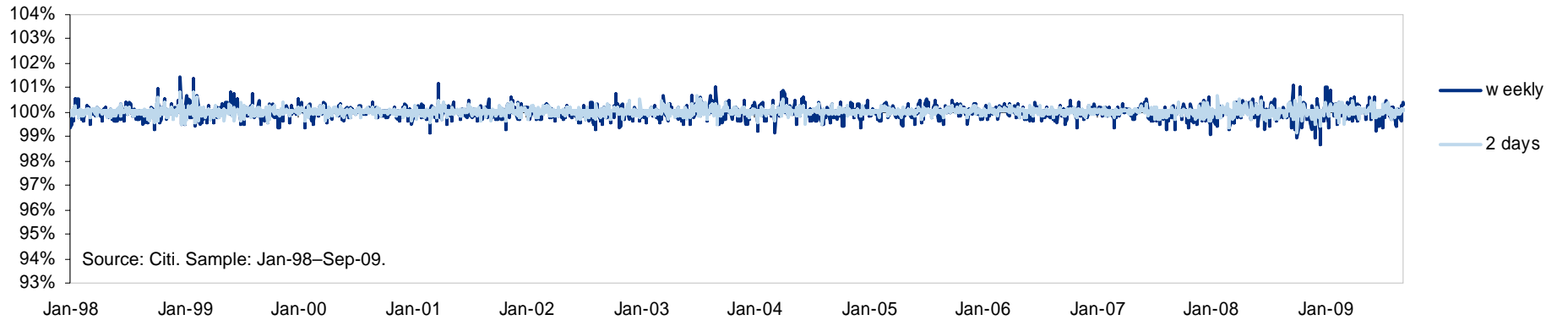
(1) 100% hedge ratio, no proxy hedging. Costs are shown in spread to mid terms only, excluding forward point cost.  
 (2) The tracking error is the standard deviation of daily differences between the actual portfolio hedge and the benchmark.

Tracking Error vs. Annual Rebalancing Volume



Source: Citi. Sample: Jan-98–Sep-09.

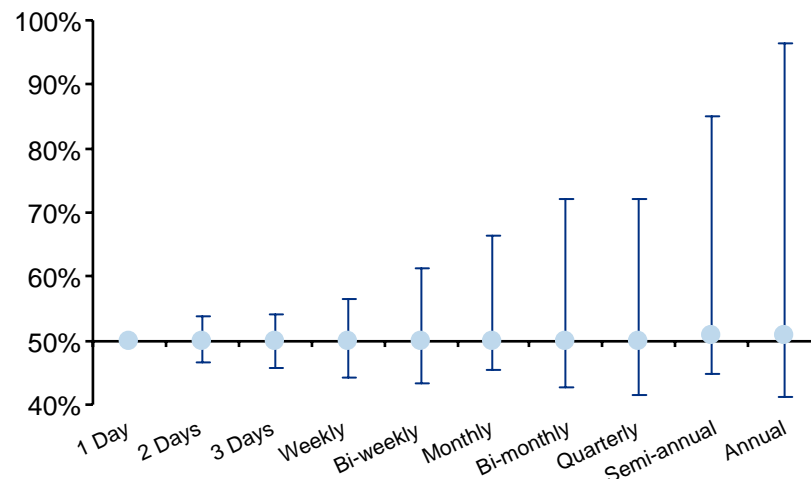
# WGBI: Hedge Ratios for Various Rebalancing Frequencies



# MSCI World: Rebalancing Frequency<sup>(1)</sup> at a Glance

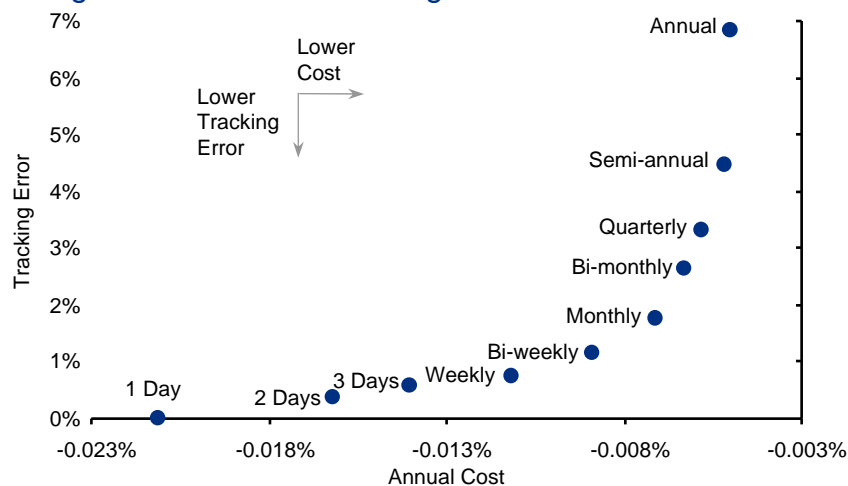
- We test the optimal rebalancing frequency on a 50% hedged MSCI World portfolio.
- Equities are volatile and create larger trading volumes:
  - With 50% hedge ratio the monthly equity rebalancing volume has been 0.26x portfolio notional. This compares to 0.14x for the 100% hedged WGBI.
- Note the bigger downside volatility in equities, which creates an asymmetrical risk of going over-hedged. In fixed income the risks are skewed towards going under-hedged.

## Max, Min & Average Hedge Ratios for Rebalancing Frequencies



Source: Citi. Sample: Jan-98–Sep-09.

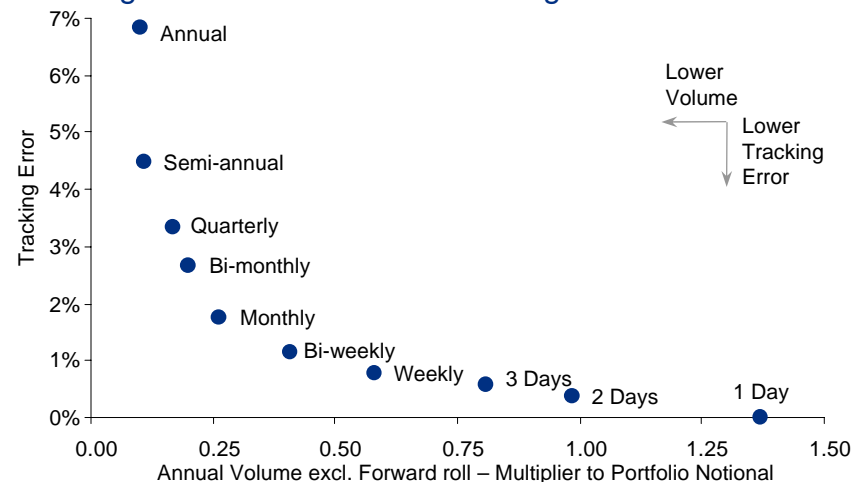
## Tracking Error vs. Annual Trading Cost



Source: Citi. Sample: Jan-98–Sep-09.

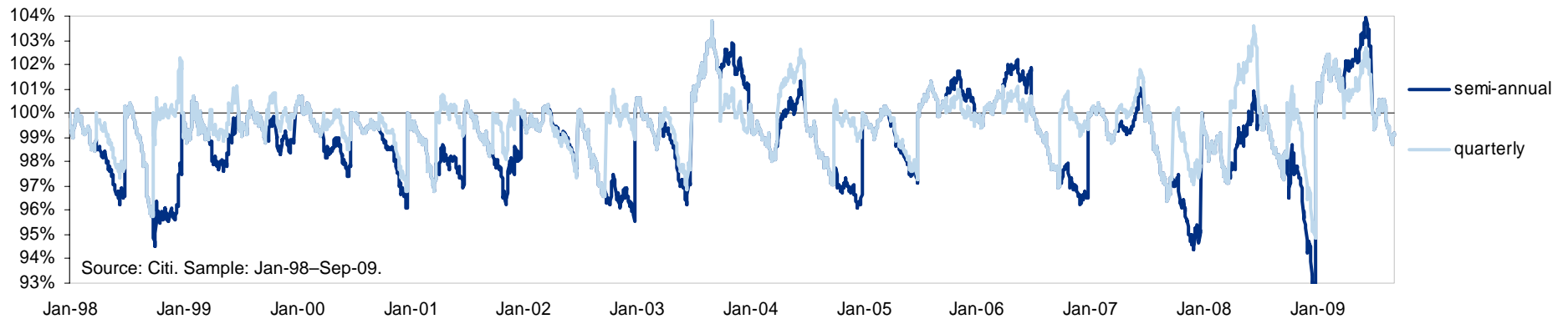
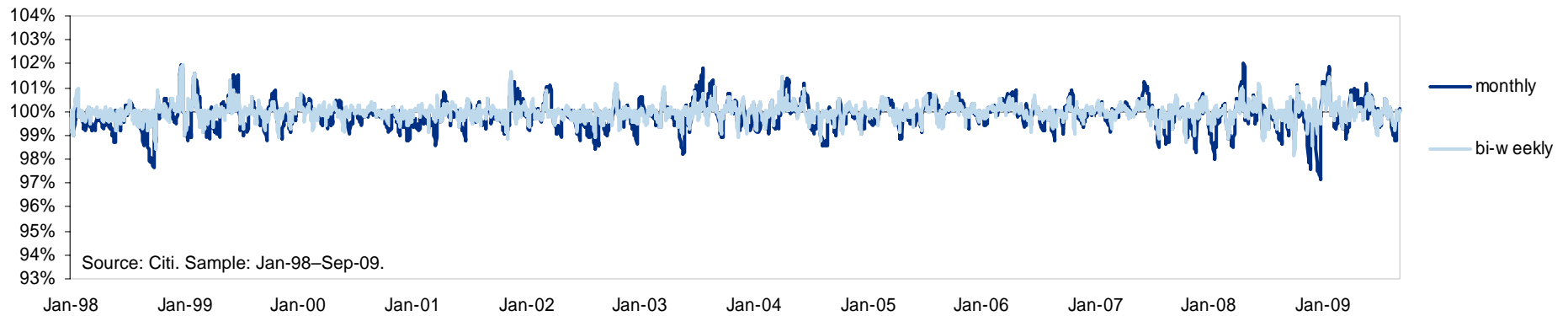
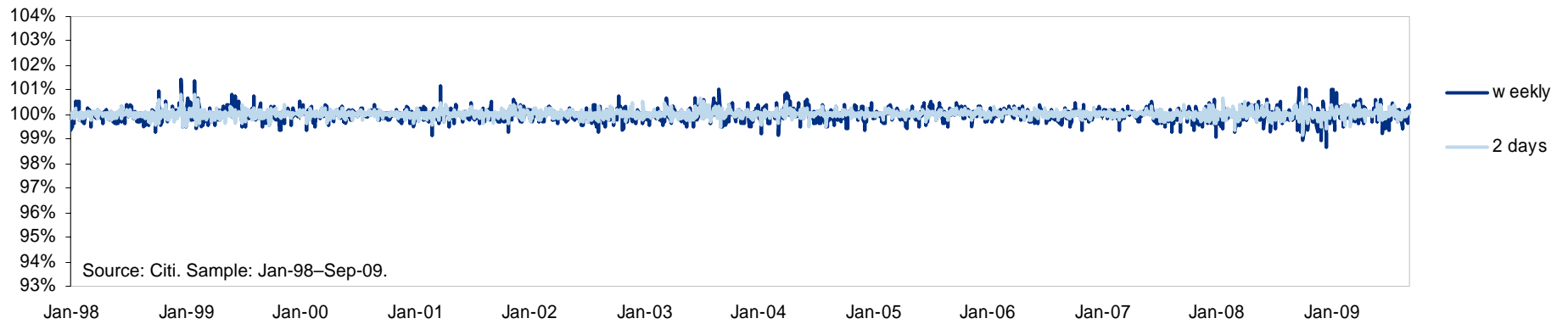
(1) 50% hedge ratio, no proxy hedging. Costs are shown in spread to mid terms only, excluding forward point cost.

## Tracking Error vs. Annual Rebalancing Volume



Source: Citi. Sample: Jan-98–Sep-09.

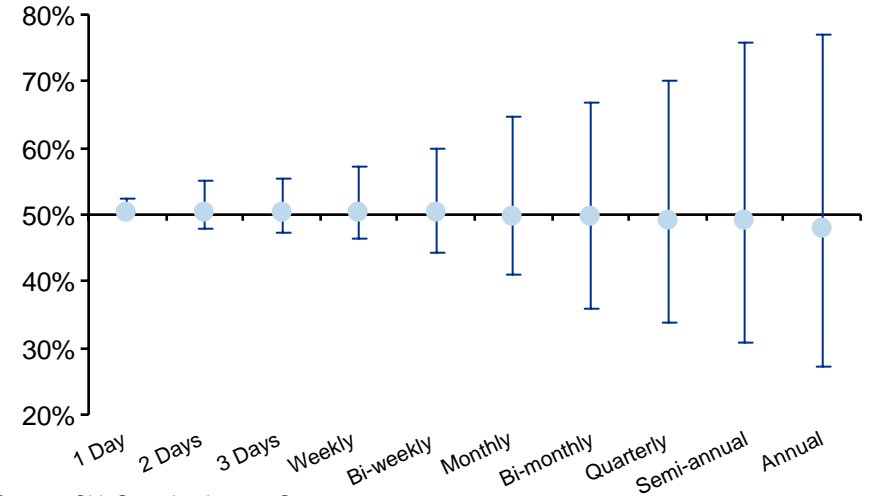
# MSCI World: Hedge Ratios for Various Rebalancing Frequencies



# MSCI EM: Rebalancing Frequency<sup>(1)</sup> at a Glance

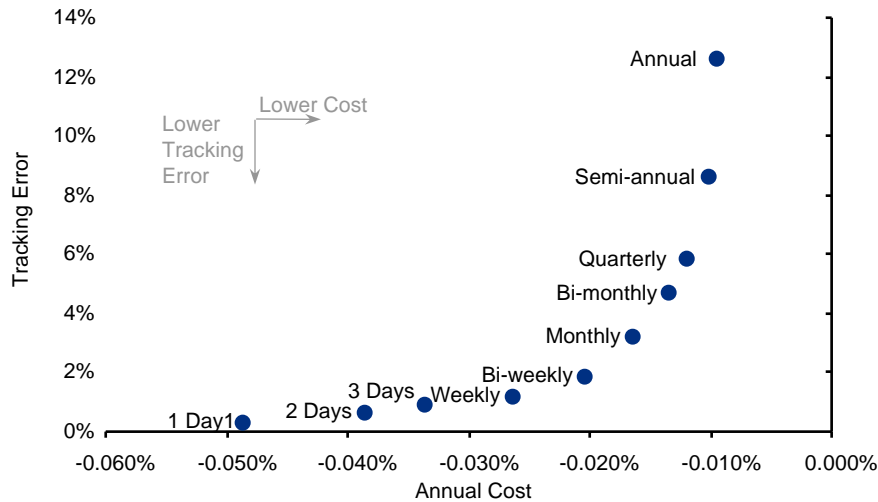
- There is an increase in trading costs and tracking error in hedging emerging market equities relative to G10 equities and bonds (even with proxy hedging).
- The tracking error is larger than in G10.
- Monthly rebalancing has historically given a 3.16% hedge error.
- Due to the higher volatility of EM equities, monthly rebalancing would have created 0.86x portfolio notional p.a. (0.26x for G10 equities).

Max, Min & Average Hedge Ratios for Rebalancing Frequencies



Source: Citi. Sample: Jan-98–Sep-09.

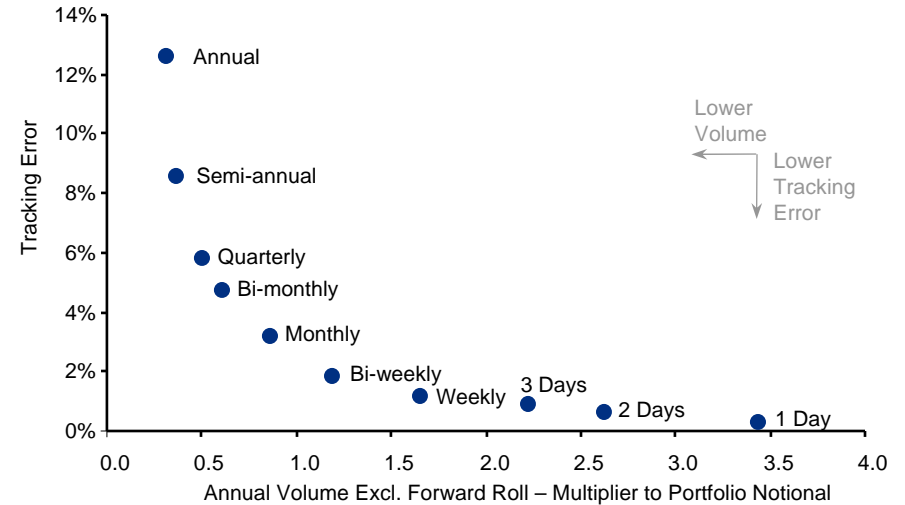
Tracking Error vs. Annual Trading Cost



Source: Citi. Sample: Jan-98–Sep-09.

(1) 50% hedge ratio, proxy hedging via USD and SGD. Costs are shown in spread to mid terms only, excluding forward point cost.

Tracking Error vs. Annual Rebalancing Volume



Source: Citi. Sample: Jan-98–Sep-09.

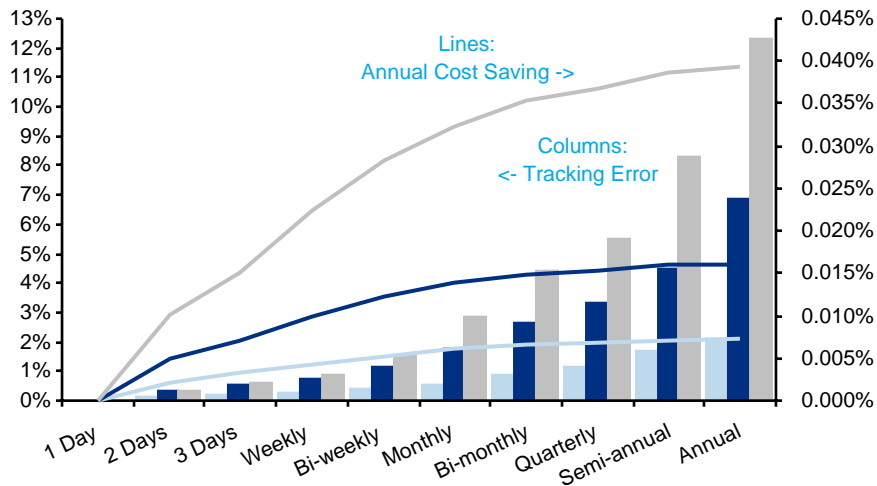
# MSCI EM: Hedge Ratios for Various Rebalancing Frequencies



# Optimal Rebalancing Frequency

- The minimum tracking error can be achieved with daily rebalancing. All other rebalancing frequencies offer a cost saving relative to daily that can also be interpreted as 'profit' from strategy.
- Monthly rebalancing is optimal:
  - Less frequent rebalancing than monthly offers little improvement in costs, but brings large increases in tracking error;
  - Similarly, more frequent rebalancing brings large increases in trading costs and diminishing improvements in tracking error;
  - The smoothest 'profits' in terms of cost saving relative to daily rebalancing have been achieved with rebalancing around monthly frequency. The results are consistent across all three underlying assets.

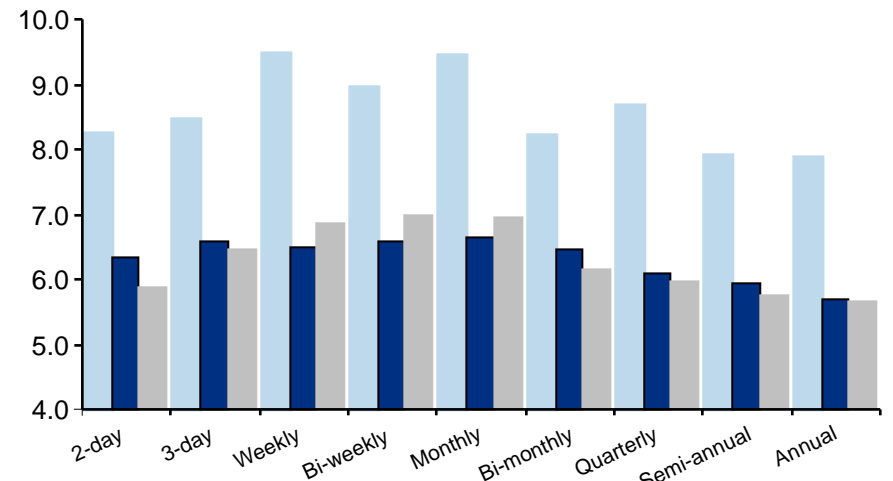
Change in Tracking Error and Costs Relative to Daily Rebalancing



Source: Citi. Sample: Jan-98–Sep-09.

WGBI MSCI World

Information Ratio of the Cost Saving Relative to Daily Rebalancing



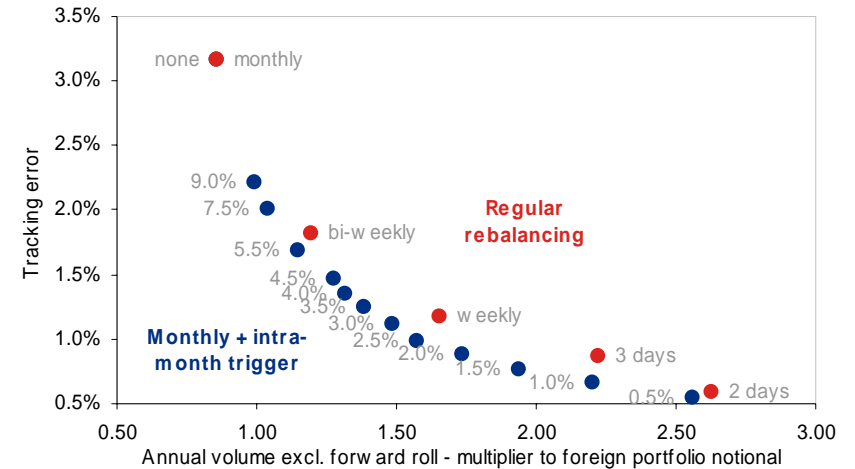
Source: Citi. Sample: Jan-98–Sep-09.

MSCI Emerging Markets

# Intra-month Rebalancing Trigger

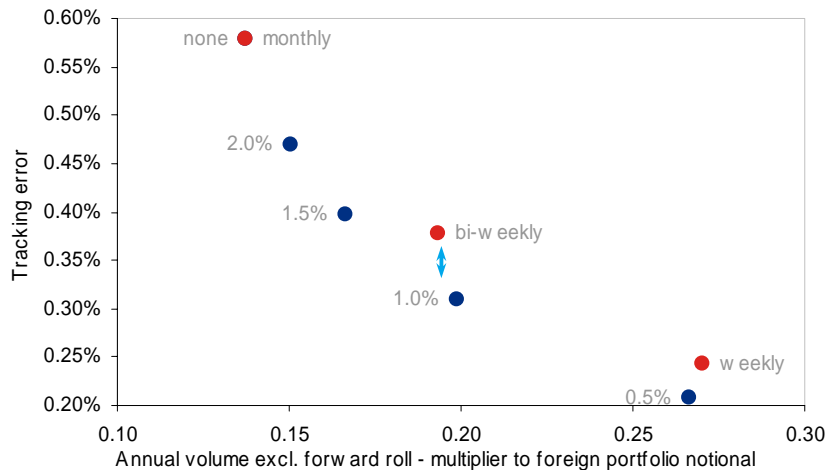
- In order to reduce tracking error, we also recommend an intra-month rebalancing trigger:
  - If the effective portfolio hedge ratio differs from the target by more than the trigger, then the hedges are adjusted on the following day.
- The size of the trigger depends on asset volatility as well as the target hedge ratio<sup>(1)</sup>.
- Monthly rebalancing with a trigger has historically achieved more cost effective tracking error reduction than regular rebalancing at higher frequencies.

MSCI EM: Tracking Error & Trading Cost as Function of Trigger Size



Source: Citi. Sample: Jan-98–Sep-09.

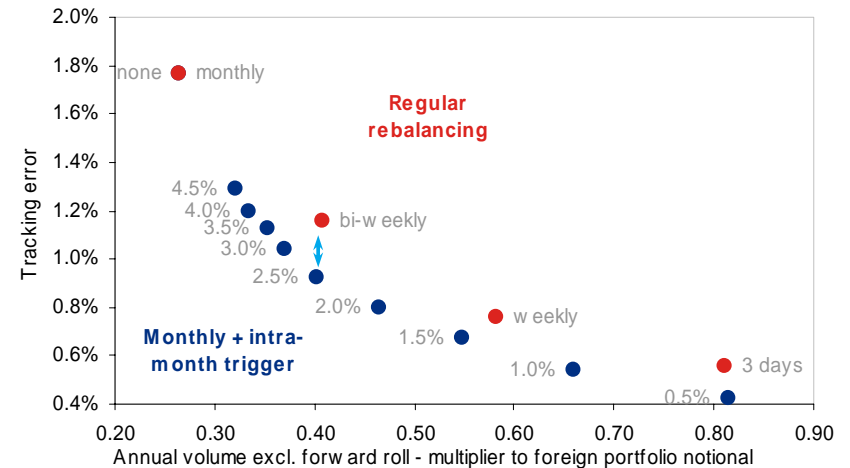
WGBI: Tracking Error & Trading Cost as Function of Trigger Size



Source: Citi. Sample: Jan-98–Sep-09.

(1) The appropriate intra-month trigger depends also on the hedge benchmark, because the tracking error is proportional to the hedge ratio. For example, a drop in asset value from 100 to 90 will result in an effective hedge ratio of 55.6% for a 50% hedge benchmark (T/E 5.55%) and 111% for a 100% benchmark (T/E 11%).

MSCI World: Tracking Error & Trading Cost as Function of Trigger Size

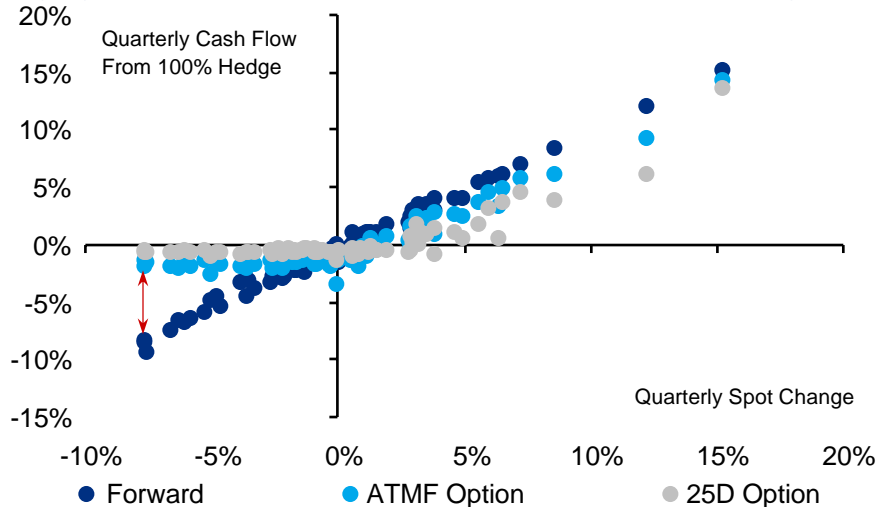


Source: Citi. Sample: Jan-98–Sep-09.

# Managing Hedge Cash Flows

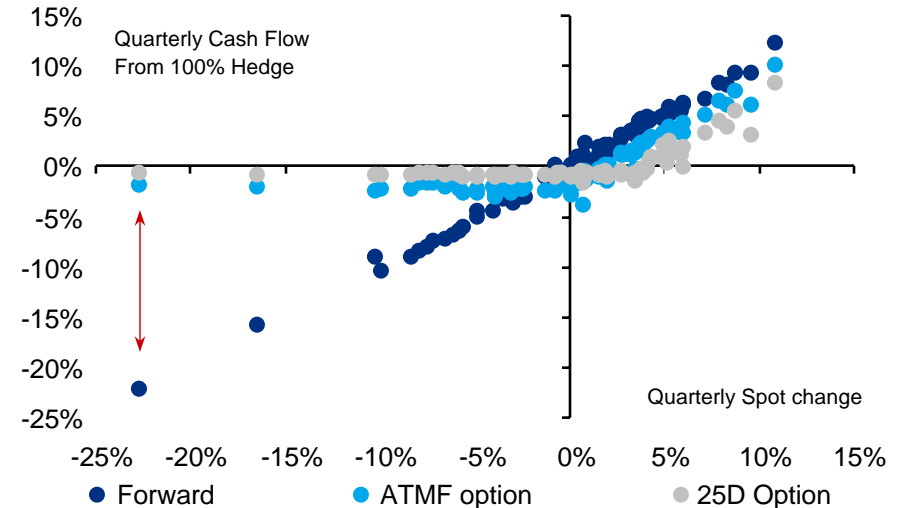
- Currency forwards are a popular choice for hedging, because they are liquid and relatively cheap.
- But forward hedges also have weaknesses:
  - They produce large losses if EUR weakens strongly (e.g. EURJPY);
  - If EUR has lower interest rates than the foreign currency, then forward hedges no longer appear good value (e.g. hedging GBP in the past).
- A tactical switch from a forward hedge into options in periods of EUR weakness can significantly improve the total return of the hedge.

Hedging **GBP** into EUR: Quarterly Cash Flows From Hedges



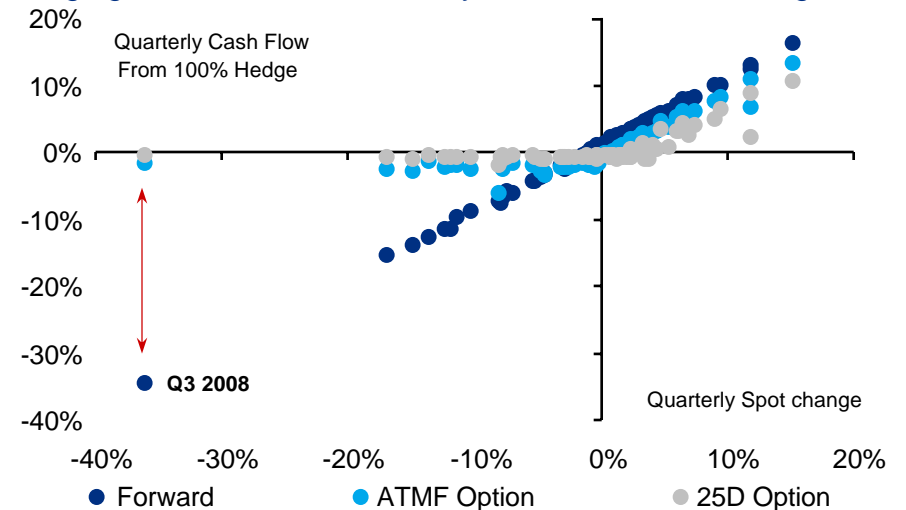
Source: CitiFX, Sample: Jan-90–Jul-09.

Hedging **USD** into EUR: Quarterly Cash Flows from Hedges



Source: CitiFX, Sample: Jan-90–Jul-09.

Hedging **JPY** into EUR: Quarterly Cash Flows from Hedges



Source: CitiFX, Sample: Jan-90–Jul-09.

# Conclusions

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- In this presentation we have investigated optimal hedging strategies for international bond and equity exposures for a EUR based investor.
- We show that a 80-100% hedge ratio would have served well as a benchmark for international bonds. For equities we recommend a symmetric 50% hedge. In the past it hasn't been optimal to hedge emerging market equities with forwards. We recommend basket options or a proxy hedge via G10 crosses (50% benchmark).
- Hedging in quarterly forwards is preferred to monthly ones due to lower rolling costs.
- Tracking error of the hedge can be reduced by introducing an intra-month rebalancing trigger. This trigger may be tied to the long-term historical volatility of the underlying asset.
- For large international portfolios we recommend splitting the hedge between 2 or 3 forward dates (e.g. a quarter-end date, mid-month after quarter-end and the next month-end following the quarter-end date).
- The recent rise in FX volatility demonstrates that foreign currency conversion can be an important part of total return on an international portfolio.
- The recent rise in volatility has shown that hedging currency risk with forward contracts may not always be optimal. While forward hedges are effective in offsetting mark-to-market changes arising from currency conversion, they can produce large negative cash flows.
- We show that hedging short EUR exposure with options tends to generate more stable cash flows than forward hedges, particularly for EURUSD and EURJPY. Three-month options tend to be more cost effective than monthly ones from a total return point of view.

# Citi's Online Academy for Financial Institutions: Meeting the Currency Challenge

## Citi's AutoFX Solutions

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September 2009

Strictly Private and Confidential



# Introduction

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## Citi's AutoFX Solutions

Holistic solutions comprising multiple options for FX execution, based upon the AutoFX model including :

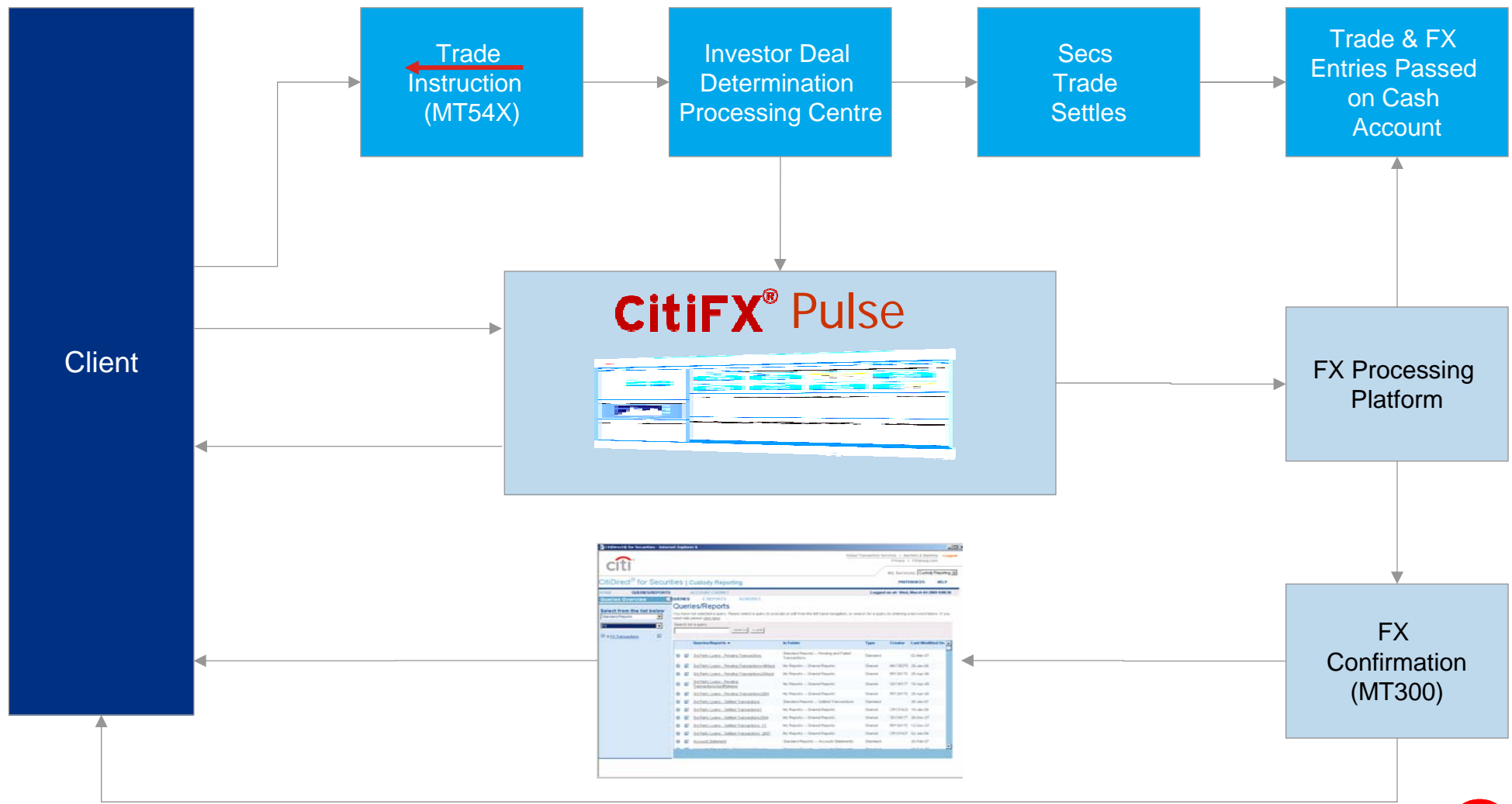
- AutoFX for Settlements
- AutoFX Share Class Hedging
- AutoFX Passive Hedge

Benefits include:

- High quality relationship servicing, backed by Citi's fully integrated service offering
- End-to-end transactions on a global scale that no other financial institution can match
- Reduced operational risk and expense
- Highly flexible solutions
- Transparent pricing
- Flexible reporting options

# AutoFX Processing Model

Seamless integration of Investor and FX systems delivers fully STP solutions.



# Citi's AutoFX for Settlements

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The FX solution delivering transparency and choice in automated transactional FX execution.

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The advantages of AutoFX. AutoFX will simplify and streamline your transactional FX trades, so you gain a number of key advantages, including the following:

- **Flexibility.** AutoFX provides you with passive or active solutions to meet your individual trading profile. The passive solution is enacted through standing instructions, while [SMPG-compliant FX code words are utilized for an active or semi-active solution](#).
  - You choose the standing instructions that meet your investment needs from any combination of the below. For example, select AutoFX for:
    - [Transactions by type](#), e.g. RVP/ DVP/Income/Corporate Actions
    - All trades in a particular currency or multiple currencies
    - Trades up to a [pre-set limit](#)
    - [Contractual settlement](#) date, or on the [actual settlement](#) date for next available value
    - [Fixed or floating](#) spreads
    - [Benchmark rates](#) with more than 20 fixing times each day
    - Single or multiple [fixing times](#) with the benchmark selection option
    - Deal [netting with or without merging](#) or elect no netting
  - In addition, you can use [code words](#) to selectively suppress AutoFX on an individual-trade basis, or use code words on all trades for a completely active solution.
- **Transparency.** Trades can be completed on fixed spreads against a published benchmark mid-point, utilizing CitiFX Benchmark rates.
  - These are published at more than 20 defined "fixing" times throughout the day, and are published within five minutes to [Bloomberg \(FXBE\) and Reuters \(FXBENCH\)](#) pages.
  - The CitiFX Benchmark offers a unique level of accuracy, breadth, independence, convenience and transparency in more than 50 markets, and is [audited by KMPG](#).
- **Risk reduction.** Seamless integration of Custody and FX systems delivers a complete STP solution from trade instruction and payment processing through to reporting via MT300s, online via CitiFX Pulse or through CDS Custody Reporting . [Third-party settlement risk is eliminated, with a full audit trail provided online](#).
  - Operational efficiency. By providing a completely passive solution from trade instruction to reconciliation, AutoFX maximizes efficiency through the use of standing instructions, while eliminating the need to send third-party FX instructions. Reconciliation is simplified utilizing the "no netting" or "netting without merging" options to match settlements to FX transactions on a one-to-one basis. Additionally, [AutoFX automatically differentiates between the requirement for spot and forward FX trades](#), to maximize cash management.

# Citi's AutoFX Share Class Hedging

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A highly flexible and transparent currency-hedging solution that reduces the currency risk associated with international investments in non fund base currency Share Classes.

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- **Advantages**
  - Citi's **Passive solution** allows the Fund Managers to concentrate on day-to-day portfolio management leaving the share class hedging process to be undertaken by Citi as the fund administrator.
  - The solution includes **hedging individual fund share classes** in isolation to eliminate FX movements from base currency performance in a multi currency fund share class. Citi's AutoFX Share Class Hedging solution uses pre-agreed parameters to execute forward FX contracts based upon the **Net Asset Value (NAV) of your fund share class**.
  - **Currency risk**. By locking in the future FX price of the fund share class, you can reduce the currency risk associated with fund share classes in non-base currencies
- **Operational efficiency and risk reduction:** The seamless integration of Citi's Fund Accounting and FX systems delivers a complete STP solution, from capture of Transfer Agent (TA) activity and exposure to share class currency, to execution of FX and payment processing, through to confirmation reporting via MT300s, online via CitiFX Pulse or through CDS Custody Reporting. This passive solution maximises efficiency through an automated calculation of your FX requirement based upon a pre-agreed hedging strategy, with third-party settlement risk eliminated.
  - **Core processes in the deal determination and execution solution** include:
    - FX **spot** transactions arising from TA activity (**subscriptions / redemptions**)
    - FX **hedging** transactions arising from **TA activity and NAV movements**
    - Periodic **rollover of fund share class**
- **Flexibility.** Citi's AutoFX Share Class Hedging solution is highly flexible and can be tailored to meet your specific requirements including:
  - Setting a pre-agreed target **hedge ratio** / benchmark
  - Adding a **trigger threshold**
  - Setting a **minimum deal size** threshold
  - Tenor as determined by you
  - Fixed or floating rate spreads
  - **Transparent** CitiFX® Benchmark rates
  - **Online reporting** via CDS Custody FX reporting or CitiFX Pulse, or through SWIFT MT300 messages
  - **Hedging settlement date selection** i.e. last business day of month, last business day of the quarter or to any specific calendar day of the month.

# Citi's AutoFX Passive Hedge

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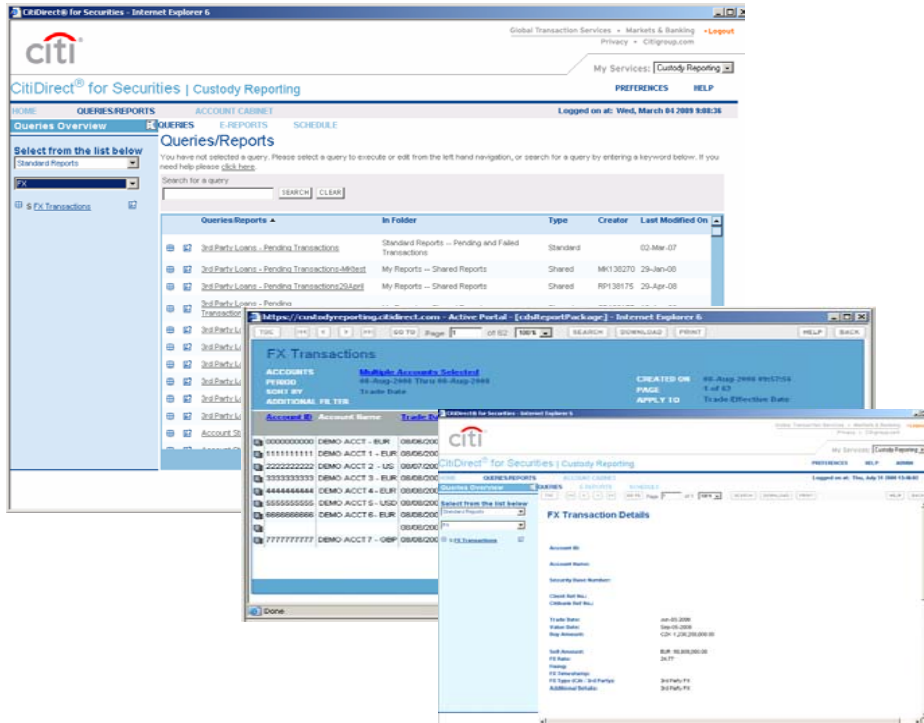
A highly flexible and transparent currency-hedging solution that reduces the currency risk associated with international investments in today's volatile markets.

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- **Advantages**
  - **Passive solution.** To smooth out fluctuations in currency valuations, Citi AutoFX Passive Hedge uses a pre-agreed standing instruction to execute forward FX contracts based on a portfolio's assets under custody (AUC).
  - **Currency risk.** By locking in the future FX price of the portfolio, you can reduce the currency risk associated with your international investment strategy.
- **Operational efficiency and risk reduction**
  - The seamless integration of Citi's Custody and FX systems delivers a complete **STP solution**, from FX execution and payment processing, through to confirmation reporting via MT300s, online via CitiFX Pulse or through CDS Custody Reporting. This passive solution maximizes efficiency through an automated calculation of your FX requirement based upon a pre-agreed hedging strategy, with third-party settlement risk eliminated and a full audit trail is provided online.
- **Flexibility.** Citi AutoFX Passive Hedge can be tailored to meet a specific hedging strategy. For example, you can set:
  - Asset type, including equities, fixed income or both
  - **Hedging ratio** to meet your risk strategy (0–100 per cent of AUC)
  - Hedging ratio can be **set at asset-type** level
  - Booked on **traded** or **settled** AUC valuations
  - **Trigger functionality** – set a threshold to trigger additional hedges to ensure your hedge ratio is maintained off-cycle
  - Option to book hedges through either **SPOT and FORWARD** combination or **FX SWAP**
  - All, multiple or individual currencies
  - **Tenor**, from one week to one year
  - Floating or Fixed spreads using **Transparent benchmark** rates, with more than 20 fixing times each day
  - **Online reporting** via CDS Custody FX reporting or CitiFX Pulse, or through SWIFT MT300 messages
  - **Competitive FX rates.** Using fixed or floating spreads, you can gain access to competitive rates sensitive to deal size and volume with the option of using benchmarking for complete transparency.
- **Transparency.** Reducing the performance discrepancy associated with currency-rate movements, Citi AutoFX Passive Hedge gives you transparency in the performance of the underlying investment.
  - **Extensive scope.** Citi AutoFX Passive Hedge is available in over 60 markets with benchmarking available in more than 50

# FX Reporting

## CDS 2.0 FX Transaction Reporting



## Online FX Transaction Reporting

- All FX transactions including restricted markets and 3rd party FX
- Including scheduled downloadable reports

## SWIFT MT300 FX Confirmations

## CitiFX<sup>®</sup> Pulse



## CitiFX Pulse, Meeting the Needs of the Evolving FX Market ...

- A world-class electronic platform
- With access to local pricing and local liquidity
- Multiple reporting options
- Automated deal flow with straight through processing to your back office – giving you efficiency gains

# Conclusion

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Awareness of the part played by currency exposures in potentially shaping investment performance has rarely been higher. The sharp swings in currency markets experienced in the second half of 2008, as investors fled to perceived safe havens, caused major headaches for international bond investors in particular.

But it is not just performance that is pushing this issue up the agenda. Governance pressures, allied to the drive for cost containment, are also encouraging the investment management industry to find ways of managing both their transactional FX and hedging requirements in a more transparent and effective manner.

At Citi, we are playing our part in this process with the extension of our AutoFX services to deliver cost-effective, operationally efficient and above all transparent solutions that meet our clients' requirements.

**Richard Ernesti**

**Managing Director, Global Head of Client and Sales Management for Investor Services  
Global Transaction Services, Citi**



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Thank you for joining our webinar

Questions?

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