# Introduction to Foreign Exchange

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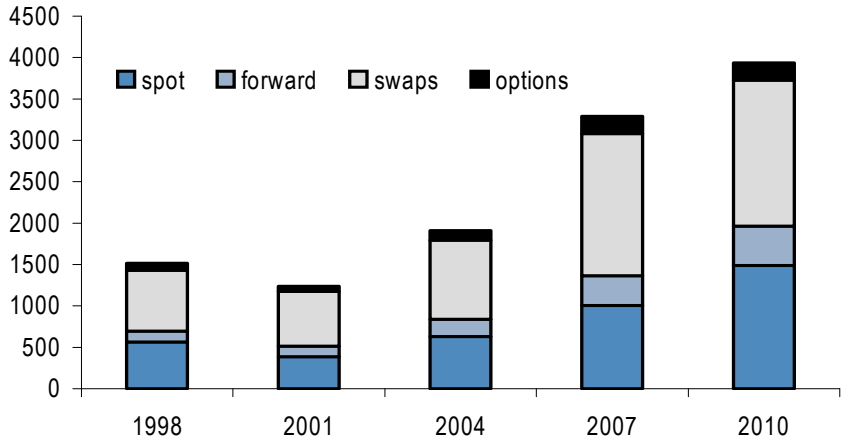
# Agenda

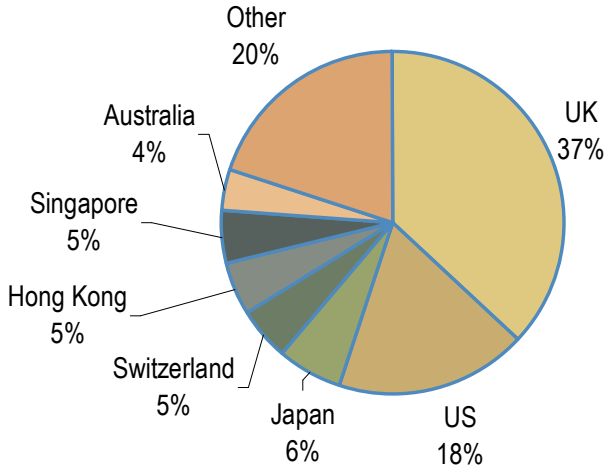
# Size and structure of global forex markets



**Average daily turnover in FX spot, forwards, swaps and options**
$bn, based on *BIS Triennial Central Bank Survey*




**Geographic distribution of global forex turnover**
% total turnover in each center, based on BIS survey

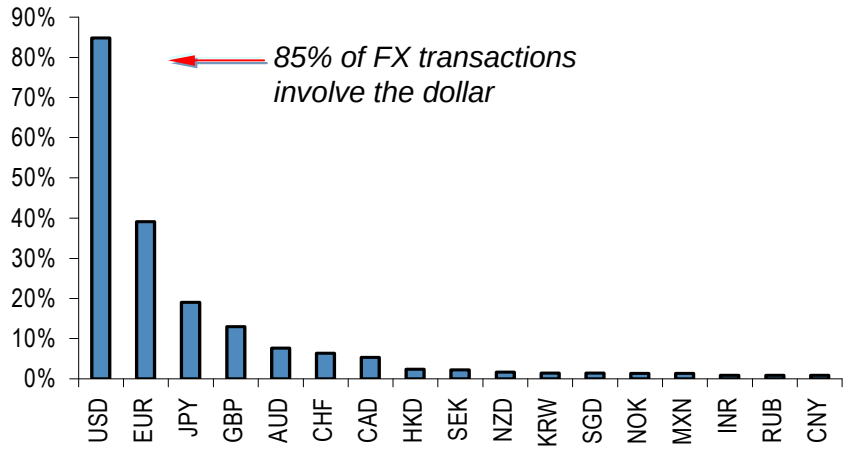



- **Forex markets are unique from four perspectives**
  - **Liquidity:** deepest market in the world
  - **Trading hours:** continuously from Sunday evening (Auckland) to Friday night (New York)
  - **Structure**: largely over-the-counter
  - **Government intervention**: frequent, but more in emerging markets FX than in major currencies
- **$4 trillion in average daily turnover across all products,** but dominated by **spot** (37% of total) and **swaps** (44%). **Forwards** and **options** comprise 12% and 6 % of turnover, respectively.
  - **FX is the most liquid market in the world.** For comparison, daily turnover in equities (cash and futures) averages $150bn for the S&P500, $ 20bn for Nasdaq, $40bn for Dax, $16bn for FTSE and $13bn for Nikkei.
- **London accounts for 37% of turnover,** or twice the US's volume. Other centres account for 5% or less of global volume.

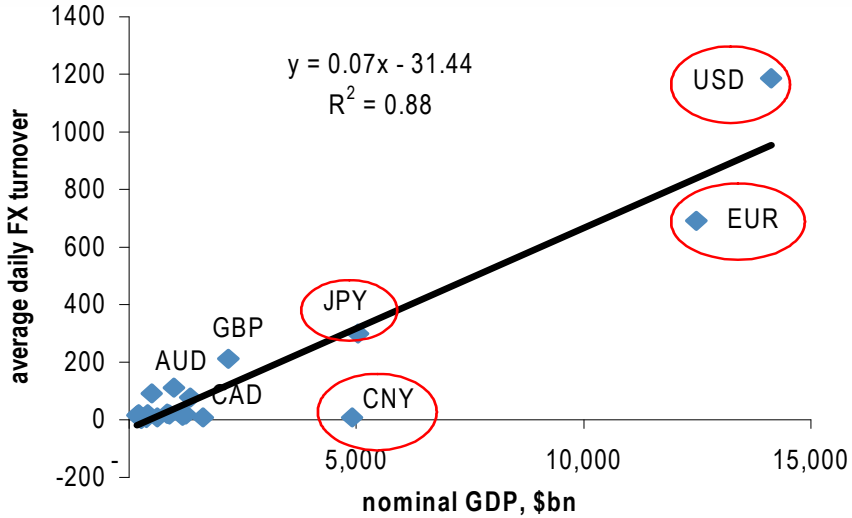
# Forex markets are disproportionately dollar-centric…



**Currency distribution of global turnover**
Percentage share of average daily turnover

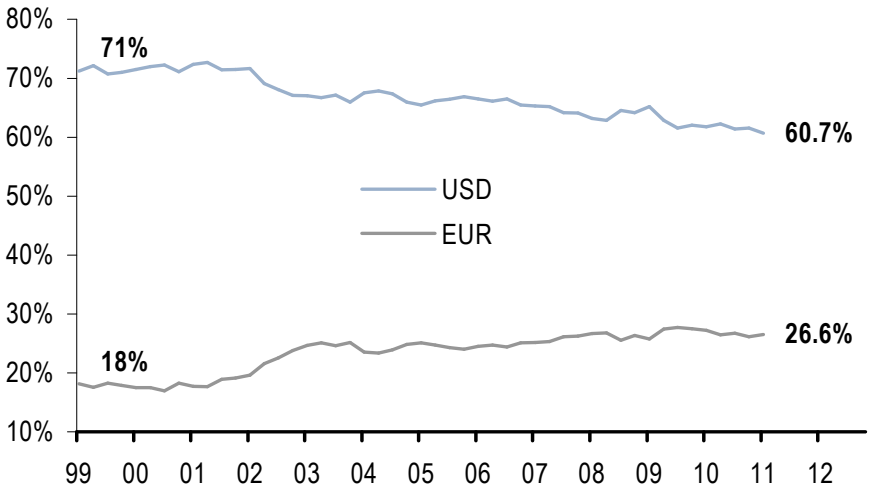



**Daily turnover versus nominal GDP**
Average daily turnover for specified currency versus all other currencies



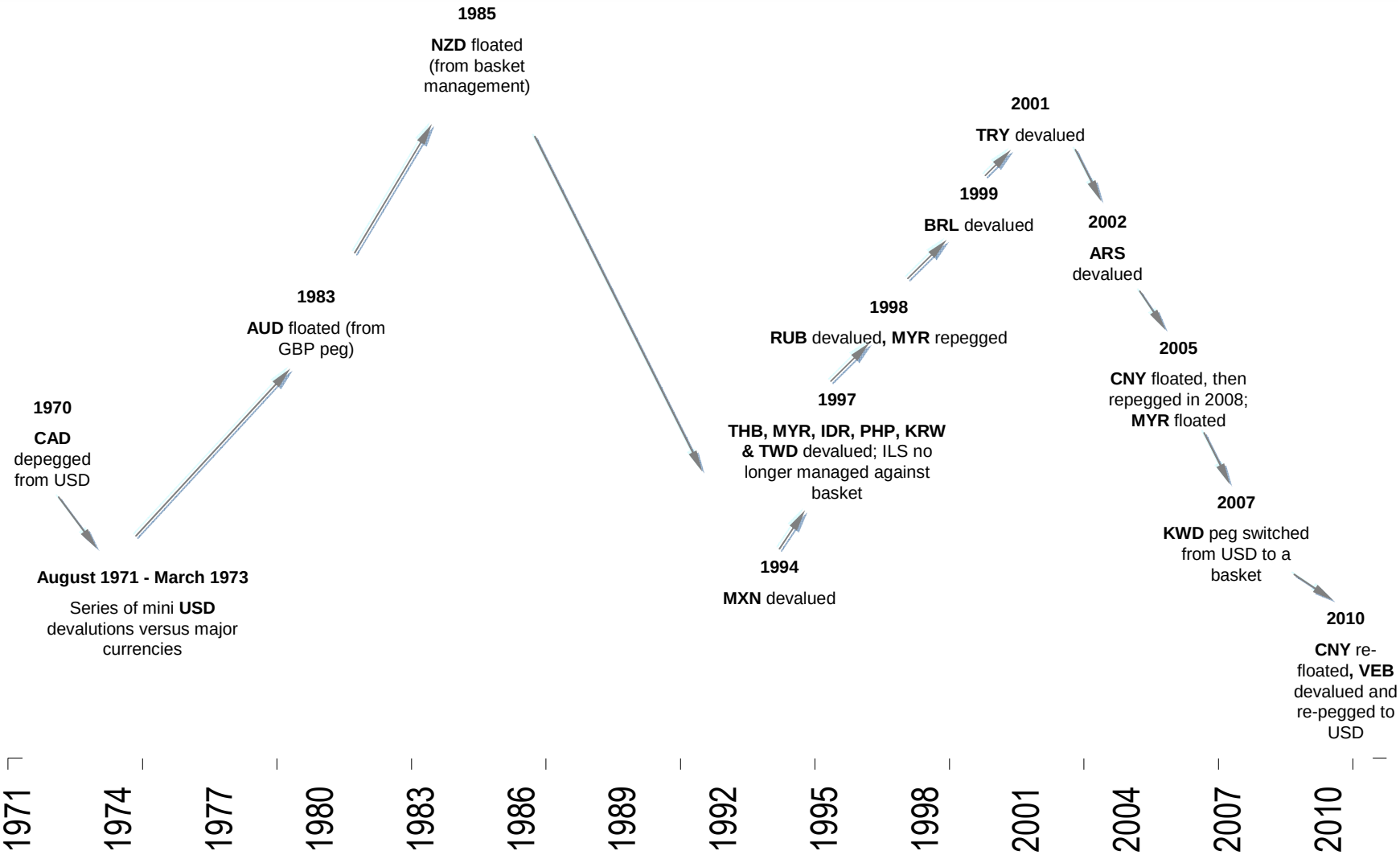

- **Currency markets are disproportionately USD-centric**
  - **USD is used in 85% of forex transactions** even though US constitutes only 25% of the global economy. This figure has fallen only 5 points (from 90%) since 2001
  - **60% of central bank reserves are still held in USD,** though this share is down from over 70% in 1999.
- **Chinese renminbi is grossly underrepresented in** global markets relative to the Chinese economy's size.

**Currency allocation of global central bank reserves**
as % of total, according to IMF COFER report



# …despite 40 years of floating currencies and more diversified trade patterns

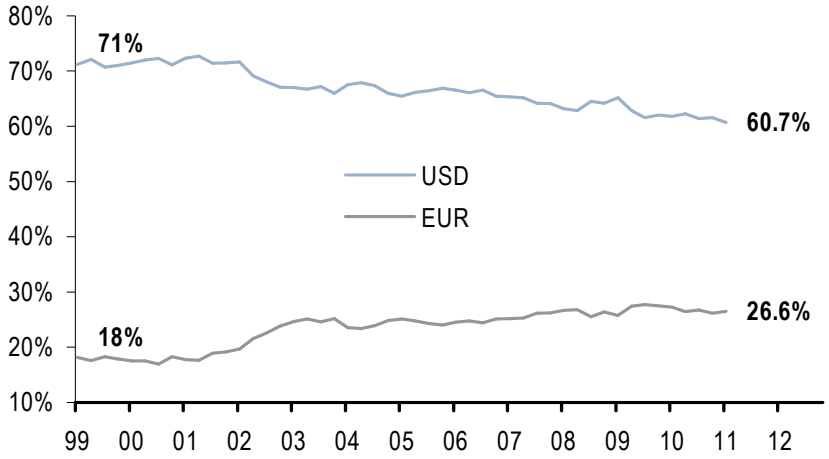
**Timeline for moving from fixed or managed to floating exchange rates**
Trajectory roughly approximates the trade-weighted USD's performance since 1971



# The dollar's dominance has been declining for a decade, but only glacially

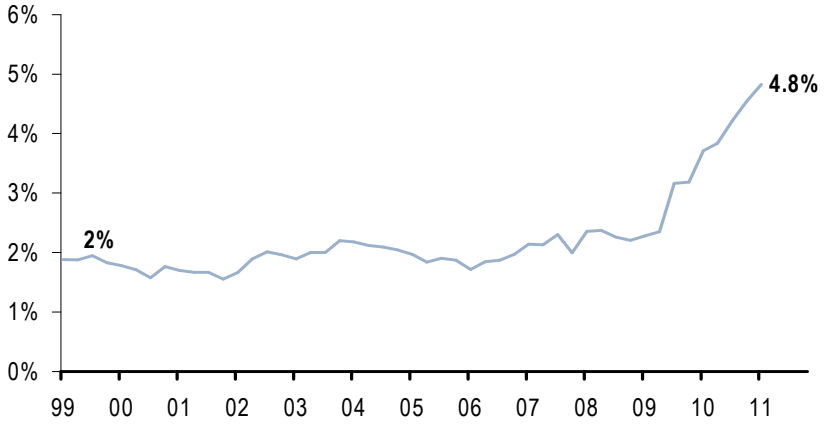


**Currency allocation of global central bank reserves**
as % of total, according to IMF COFER report

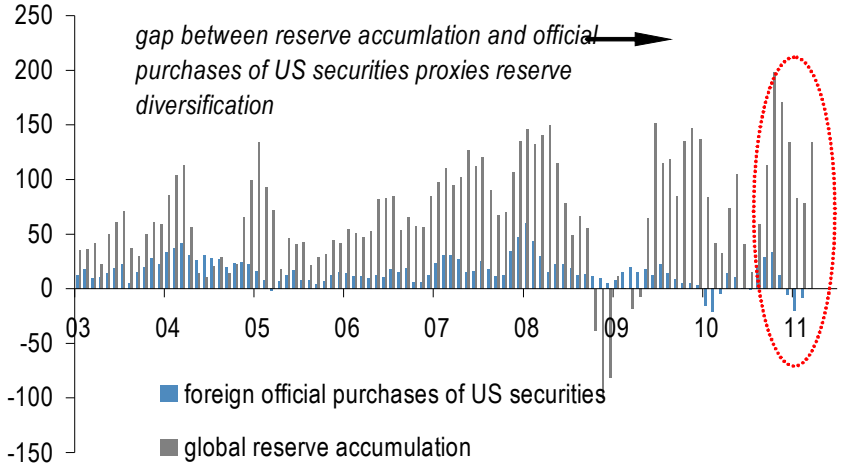



- Any currency can serve as a **reserve asset** if it is **liquid, convertible and stable.**
- USD's dominance has been declining for a decade, but only glacially
  - **Transaction demand**: USD was involved in 90% of forex transactions in 2001, compared to 85% in 2010
  - **Reserve demand**: USD accounted for 71% of global reserves in 1999, compared to 61% in 2011
    - EUR and minor currencies (commodity FX, Scandis) have gained market share

**Currency allocation of global central bank reserves to currencies other than USD, EUR, GBP and JPY**
as % of total, according to IMF COFER report



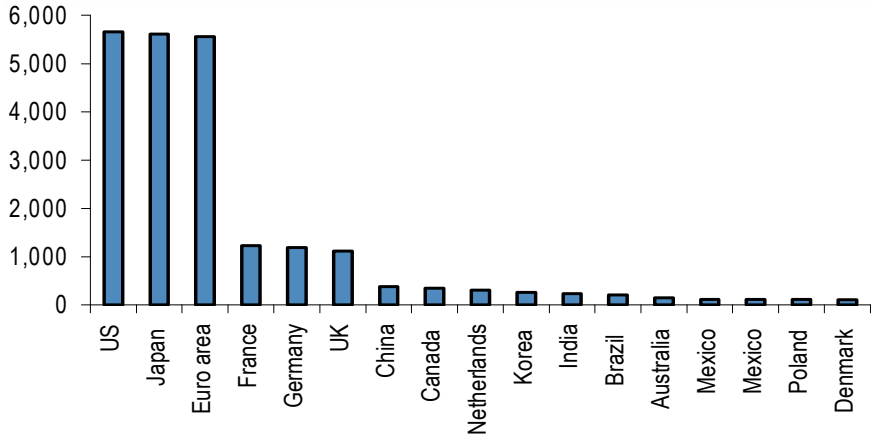

**Reserve diversification accelerating**
Central bank reserve accumulation versus foreign official purchases of US securities. USD bn, 3-month moving average.



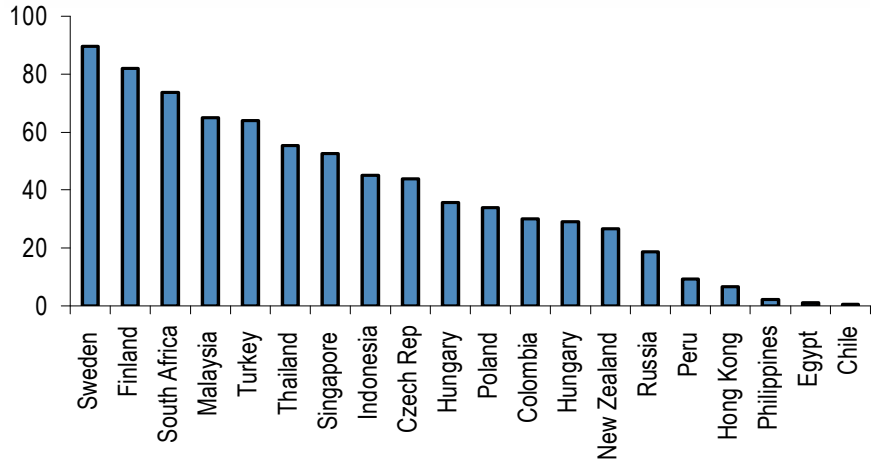
# Making more reserve currencies



**Government bond markets with more than $100bn of outstanding debt**
Government bonds outstanding with maturity above 12mos

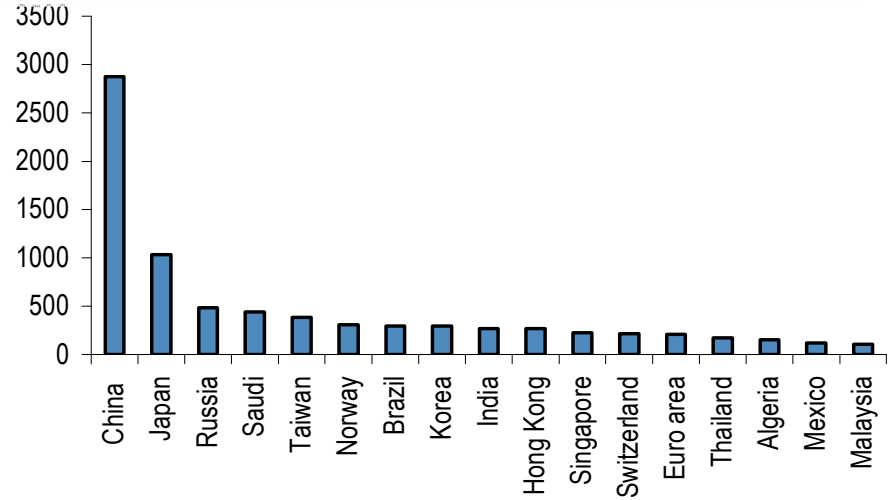



**Government bond markets with less than $100bn of outstanding debt**
Government bonds outstanding with maturity above 12mos




- **Reserve currencies must be liquid, convertible and stable**
  - Many currencies retain value, but few will every offer sufficient liquidity and convertibility to the world's largest asset managers and sovereign wealth funds
    - Only four bond markets offer bond outstandings >$1trn, and only four have outstandings > $250bn
    - **Liquidity, diversification and AAA credit quality are irreconcilable** in an era of high G-10 deficits

**World's largest holders of forex reserves**
FX reserves in $bn



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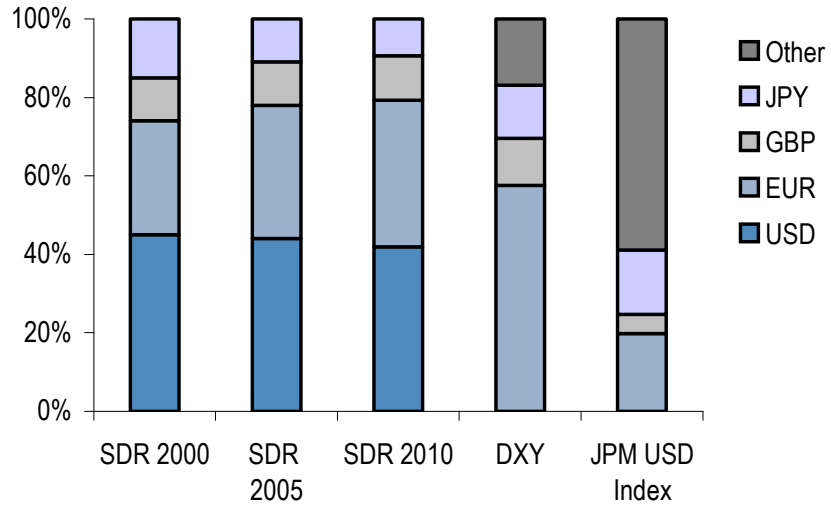
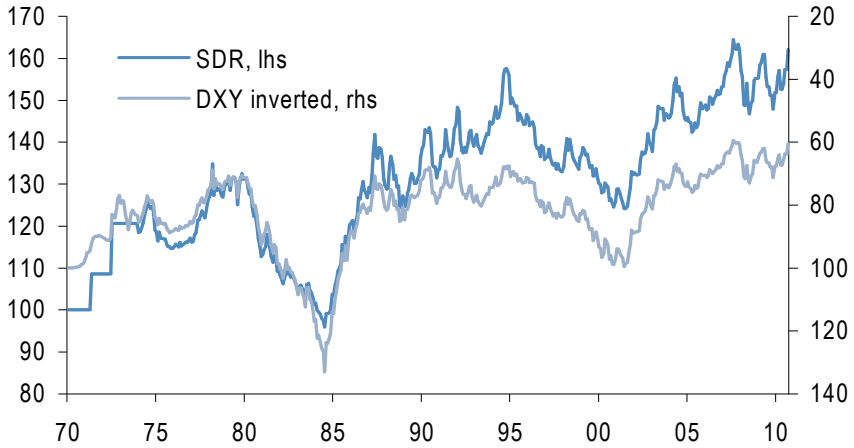
# The SDR is not an alternative world currency



**Weightings of the IMF's Special Drawing Rights (SDR) vs other USD indices**




**SDR's value tracks DXY closely**
SDR vs DXY indexed to 100 in 1970

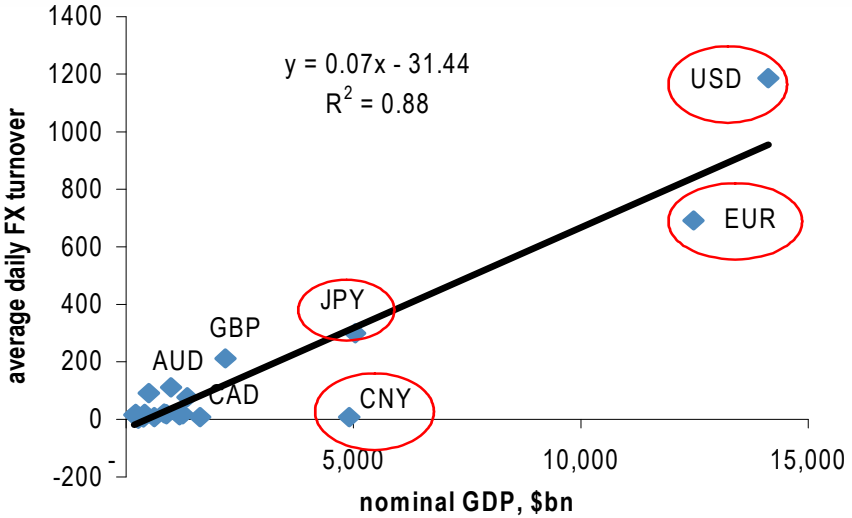



- The IMF's **Special Drawing Rights (SDR)** has been proposed as an alternative reserve asset
  - **SDR isn't a currency**. It is a **potential claim** on the freely usable currencies of IMF members.
  - Value is based on weighted average of **USD** (41.9%), **EUR** (37.4%), **GBP** (11.3%) and **JPY** (9.4%). Unsurprisingly, performance mirrors DXY.
  - CNY excluded because it isn't fully convertible.
- **Practicalities of expanding the SDRs role**
  - **Easy**: Any investor could replicate the SDR or hold an expanded version of it. There is no need to await the IMF's imprimatur.
  - **Hard**: IMF could issue bonds payable in SDR to fund its lending, but issuance would be limited compared to sovereigns.

# China as a reserve currency: rivaling the yen in a decade, and the euro in two

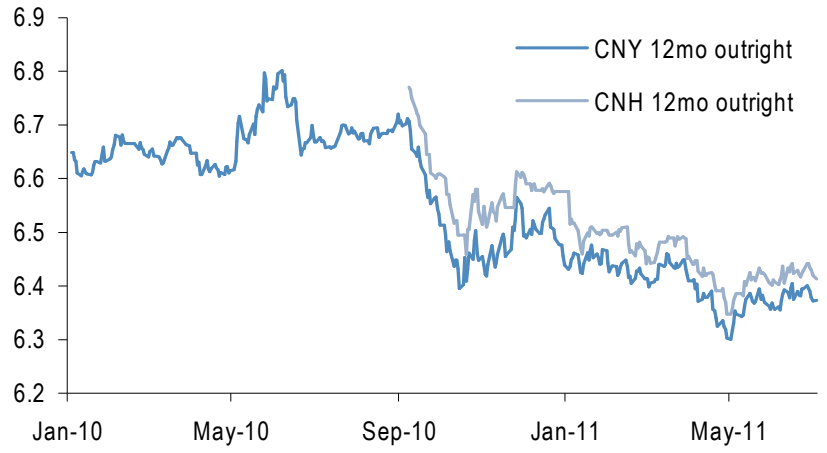


**Daily turnover versus nominal GDP**
Average daily turnover for specified currency versus all currencies

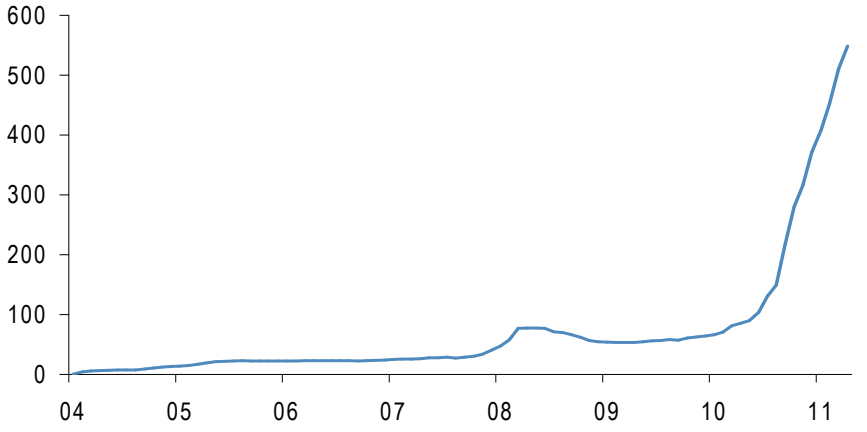



- **The renminbi** is grossly underrepresented in global forex markets in terms of transaction demand and reserve allocation
- **The main limitation is exchange controls**
- The **renminbi could rival the yen in 10 years** as turnover rises to the level predicted by the size of China's economy.
- The renminbi couldn't rival the euro for at least two decades given China's relatively small debt market.

**USD/CNY vs USD/CNH 12-mo forward outright rate**




**Renminbi deposits with Hong Kong Banks**
CNY billion

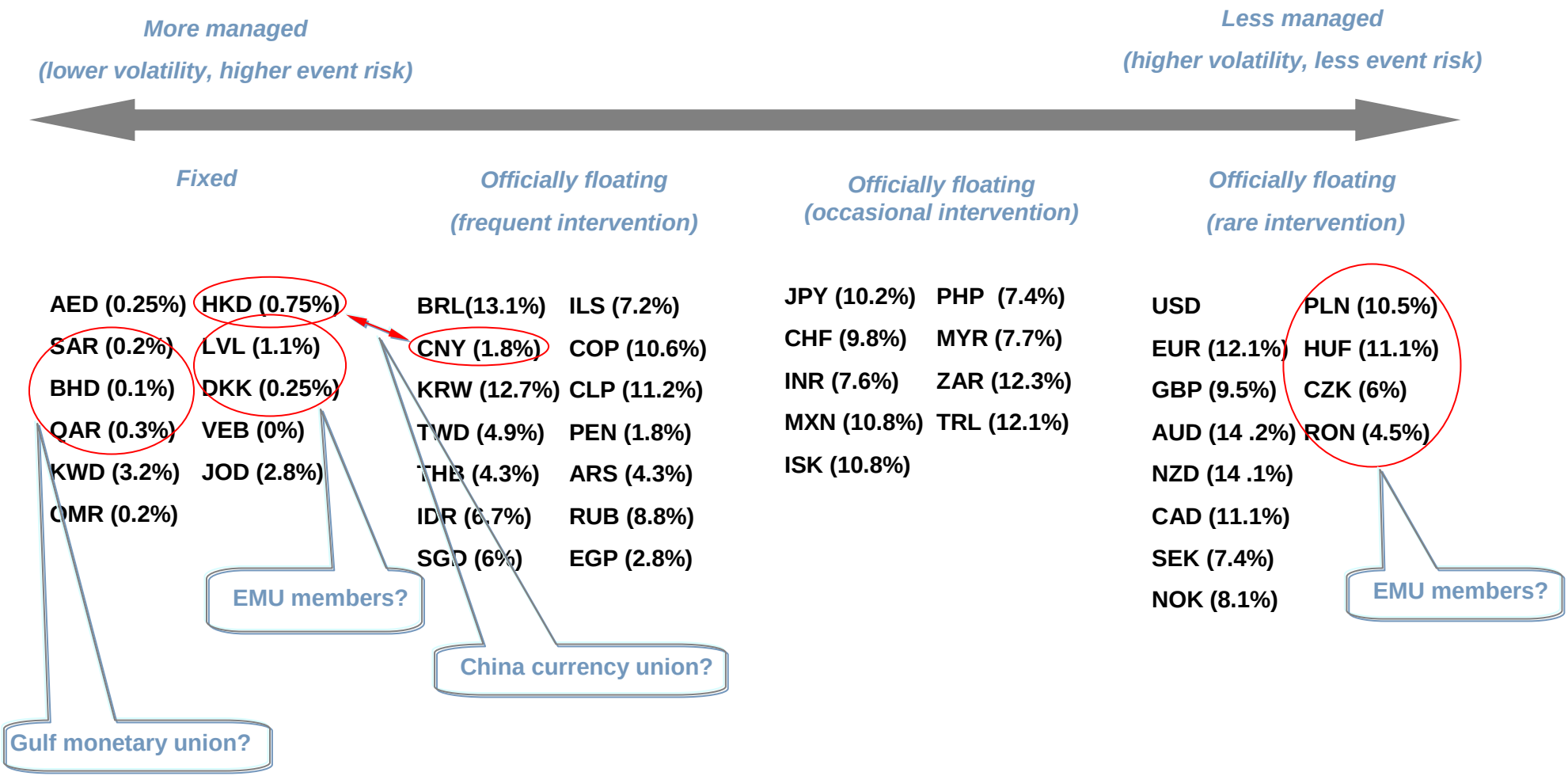


# Advantages and disadvantages of reserve currency status

- **Advantages**
  - **Lower interest rates** due to substantial foreign demand for country's government bonds.
    - Probably worth 50bp in the US
    - More important for debtor countries like the US than surplus countries such as China.
  - **Higher sovereign credit rating** due to financing flexibility from a dedicated investor base.
    - Ratings agencies fail to see the circularity of this issue but nonetheless cite the dollar's reserve currency dominance as justifying a high rating.
  - **Less exchange rate risk for corporates** since international trade is invoiced in their home currency.
- **Disadvantages**
  - **Stronger currency** than what otherwise would prevail.
    - More important for open economies like Switzerland and China than relatively closed ones like the US
- The **winners** from a loss of the dollar's reserve status will be European and Chinese corporates
- The **losers** will be US borrowers (government and corporaets) and US pegged to the dollar or viewed Treasuries as the only liquid and risk-free reserve assert.

# Currency regimes by 2020 – more fixed or floating?

**Currency regimes and implied volatility**
Annualised daily volatility over the past year in parentheses for specified currency versus USD for all currencies but GBP, SEK, NOK, CHF, DKK and CEEMEA, which are quoted versus EUR





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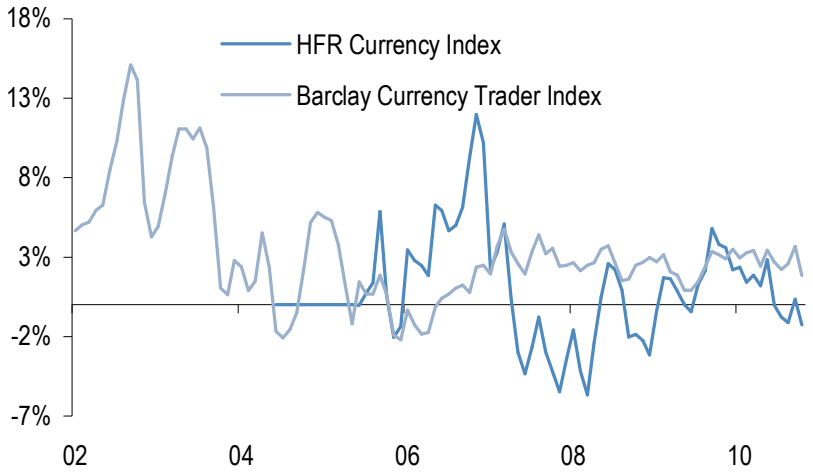
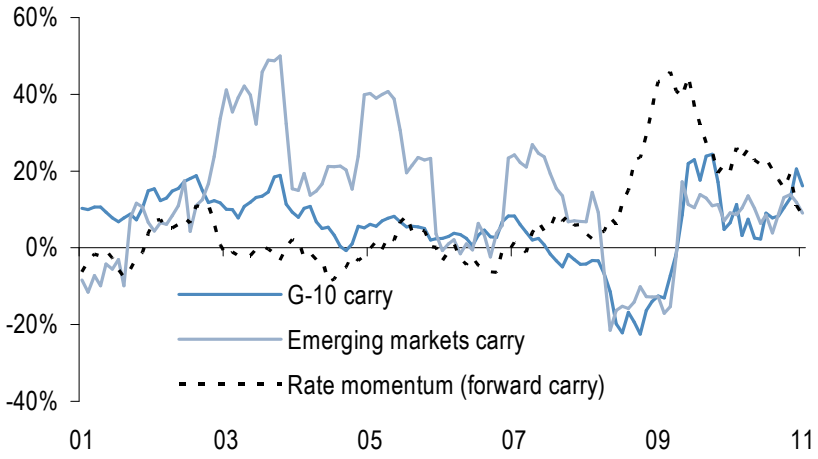
# Agenda

# What drives markets? More consternation in currencies than in core asset classes

**Annual returns by currency managers**
Rolling 12-mo returns for currency managers



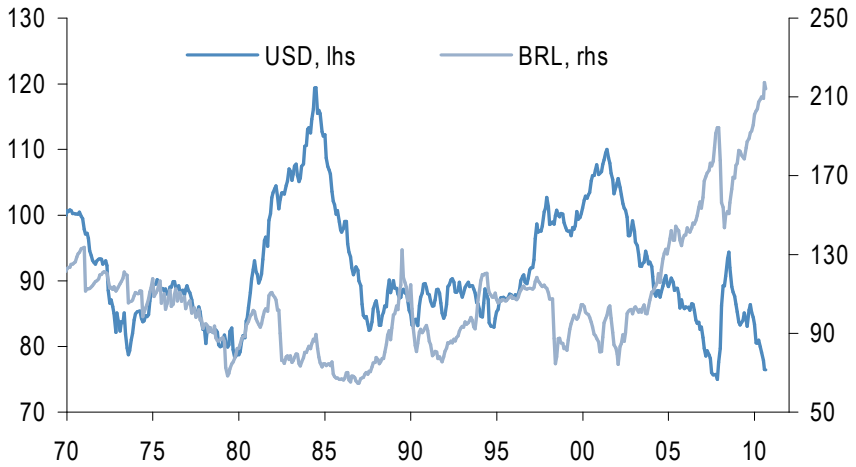

**Performance of J.P. Morgan model-based strategies**
Rolling 12-mo returns




- **Common perception**
  - Currency movements are random. They can be explained ex post but cannot be predicted.
  - Implications: For investors, currencies present no profit opportunity. For hedgers, currencies present volatility with no apparent trend. Those with mark-to-market constraints should hedge. Those without should ignore currency risk, since prices will mean revert eventually.
- **Common frameworks**
  - More **complementary than competing.**
  - Currencies have **monetary** and **non-monetary** drivers.
  - Some more appropriate for **long** than **short term**.
    - **Monetary approach**
    - **Balance of payments approach**
    - **Asset market approach**
    - **Overlay: central bank intervention**
- Regardless of framework, remember the key distinction between FX and other markets: **FX is driven by relative fundamentals, not absolute ones.** By definition FX is a relative value market.

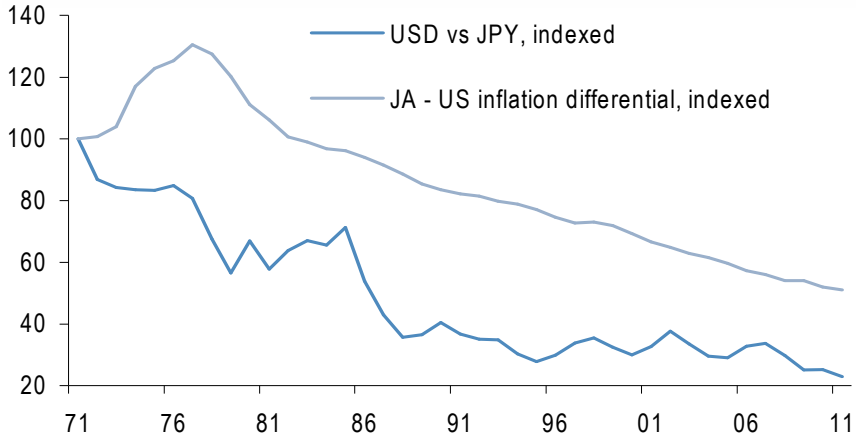
# Monetary approach (purchasing power parity): currencies respond to inflation differentials

**Drift in real exchange rates undermines PPP theory**
J.P.Morgan real effective exchange rate indices for USD & BRL

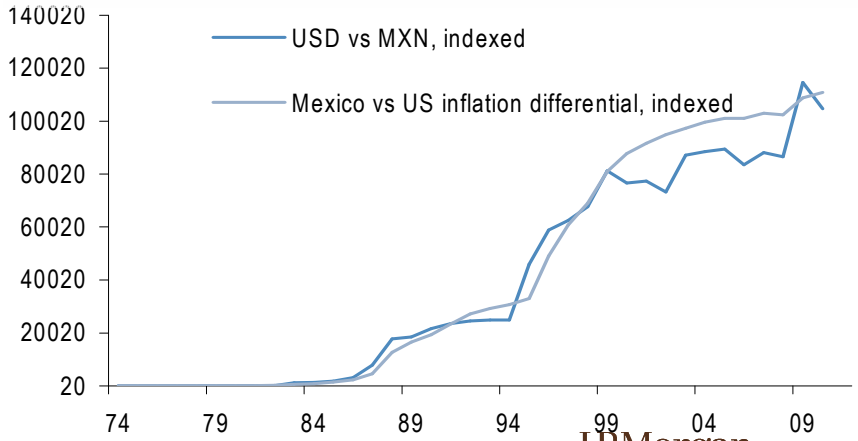



- **Purchasing power parity**
  - **Theory:** high-inflation currencies should depreciate relative to lower-inflation ones through the impact on trade balances
  - **Empirical evidence:** very poor over the short term. Only useful over the short term for a few currencies, particularly hyper-inflation ones.

**USD/JPY has fallen vs JPY twice as much as inflation differentials imply**
USD/JPY versus cumulative Japan – US inflation differential. Both series indexed to 100 in 1971




**USD/MXN has risen by multiples of what inflation differentials imply**
USD/MXN vs cumulative Mexico – US inflation differential. Both series indexed to 100 in 1974.



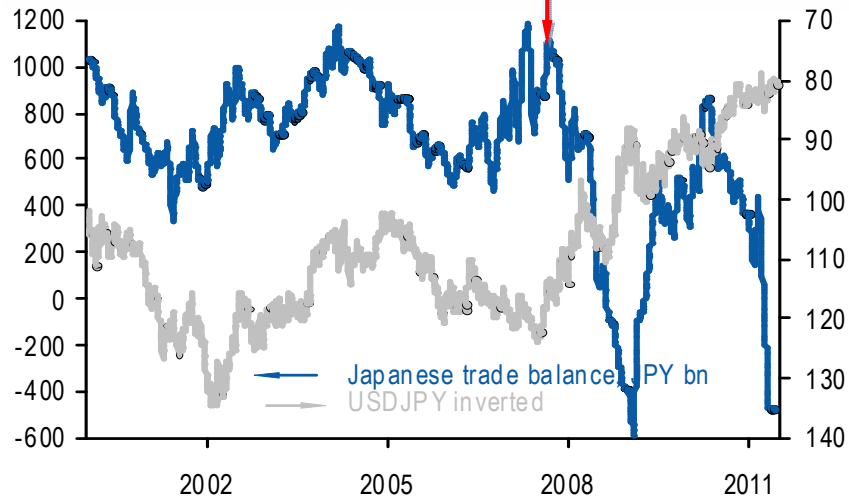
# Balance of payments approach: focus on particular current and capital account components

**Balance of payments for 2010**
All figures in billions of USD

| | US | Euro area | Japan | Australia | Brazil |
|---|---|---|---|---|---|
| **Current account** | -472 | -48 | 18 | -48 | -47 |
| Trade balance | -646 | 27 | 7 | -3 | 20 |
| Services balance | 145 | 54 | -1 | -1 | -31 |
| Income | 165 | 2 | 13 | -45 | -40 |
| Transfers | -136 | -133 | -1 | 0 | 3 |
| | | | | 0 | 0 |
| **Capital account** | 451 | 59 | -11 | 45 | 111 |
| Portfolio investment | 552 | 190 | -8 | 63 | 63 |
| Financial derivatives | 13.7 | 11 | 1 | -8 | 0 |
| Direct investment | -115 | -104 | -6 | 19 | 48 |
| Other investment | NA | -37 | 2 | -29 | NA |
| **Change in reserves*** | -1.8 | -14 | -6 | 5 | -49 |

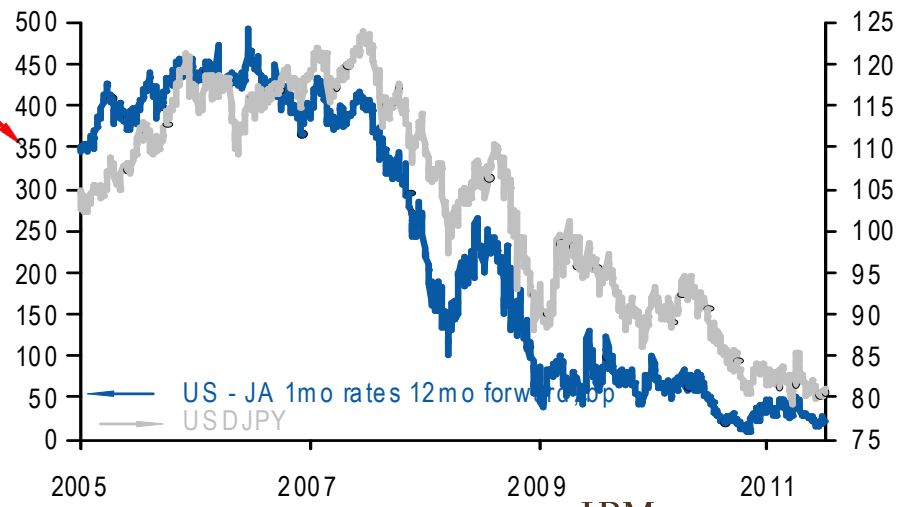
* negative value indicates an increase in reserve assets

**USD/JPY vs Japanese trade balance**




- **Balance of payments approach**
  - **Theory:** currencies driven by a range of trade and capital flows. Trade/current account positions determine structural bias, and capital account components the shorter-term fluctuations. Challenge is to identify key components, which vary by currency and over time.
  - **Empirical evidence:** more descriptive than predictive; currencies are much more variable than underlying balance of payments flows would suggest

**USD/JPY vs US – Japan rate differential**



# Asset markets approach: currencies respond to current and future fundamentals

**Balance of payments for 2010 in USD bn**

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|---|---|---|---|---|---|
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| | | | | | |
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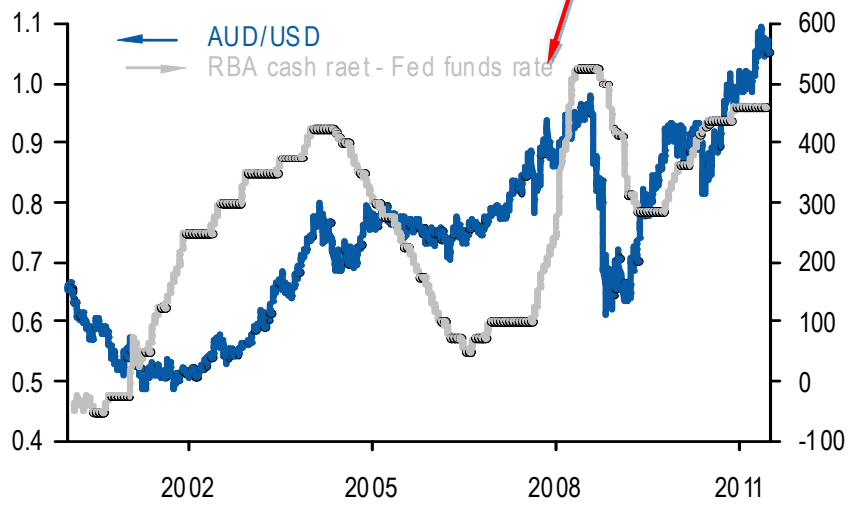
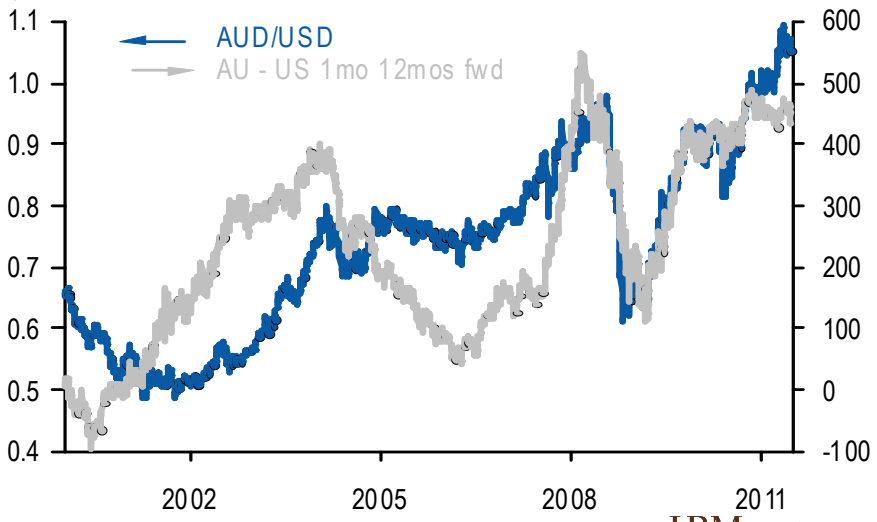
## Asset markets approach

- **Theory:** Currencies aren't just relative prices. They are also assets, so follow the same principles which drive asset markets (price = PV of future cash flows, prices adjust instantaneously to new information about fundamentals). Current and future fundamentals matter.
- **Empirical evidence:** very strong. Currencies show clear correlation with current conditions and changes in expectations. These relationships can be exploited through systemic trading rules.

**AUD/USD vs AU – US policy rate spread**
RBA cash rate minus Fed funds rate




**AUD/USD vs AU – US rate expectations**
Rate expectations are 1mo rates 12mos forward

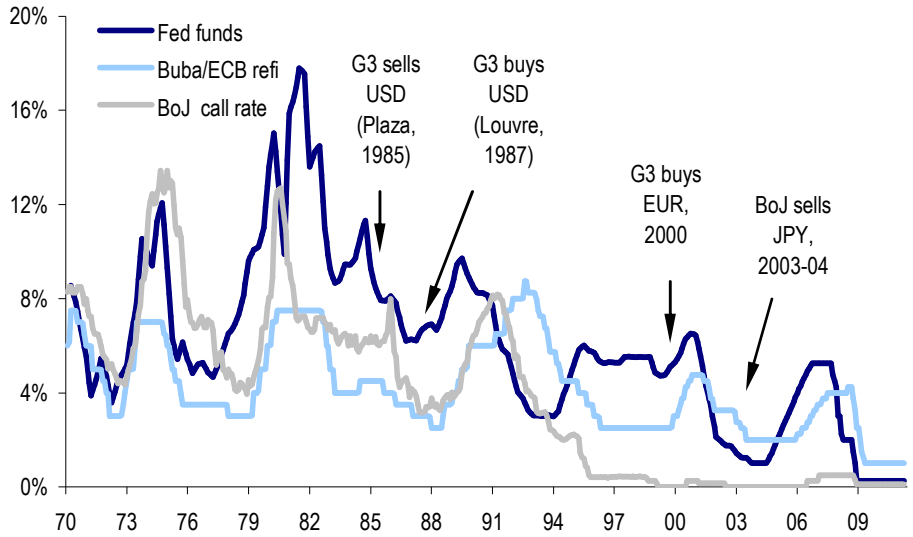


# Intervention: an overlay to fundamentals

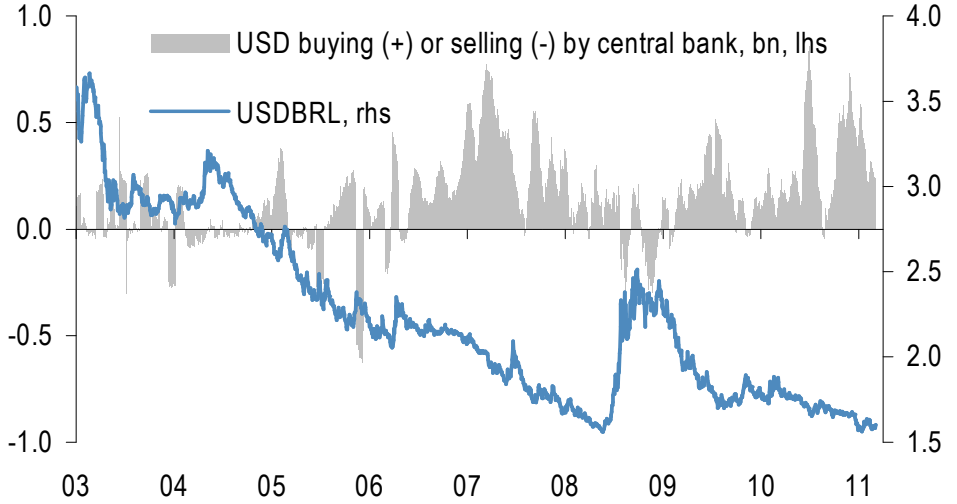
- **Central banks intervene for three reasons**
  - **Correct a misalignment**
    - Central bank considers the FX rate to be far from equilibrium, and the misalignment may adversely affect its objectives for growth, inflation or financial stability. It will therefore intervene to influence the exchange rate's *level*.
      - **Example:** Bank of Japan in September 2010
  - **Reduce volatility**
    - Disorderly FX movements can destabilise other asset markets. During crises, FX moves have bankrupted corporates. Central bank intervention can contain this volatility, improve liquidity and prevent a market from becoming one-way.
      - **Example**: numerous EM central banks during the Lehman crisis
  - **Build reserves**
    - Intervention by selling the domestic currency/buying the foreign currency allows a country to accumulate reserve assets. These can be used to fund investment (a sovereign wealth fund), to insure against a future liquidity crisis or to support the domestic currency if it should weaken excessively.
      - **Example**: $300bn of China's $3trn of forex reserves are allocated to its sovereign wealth fund
- Intervention can be **unilateral or coordinated,** and **sterilised or unsterilised**

# Only effective if backed by changes in policy or cyclical conditions

**Interventions start currency trends when reinforced by changes in policy rates**
Fed funds rate, Buba/ECB refi rate and BoJ call rate since 1970, with major coordinated and unilateral interventions noted




**USD/BRL versus Central Bank of Brazil daily intervention**
Intervention in USD bn, where positive (negative) value indicates USD purchases (sales)

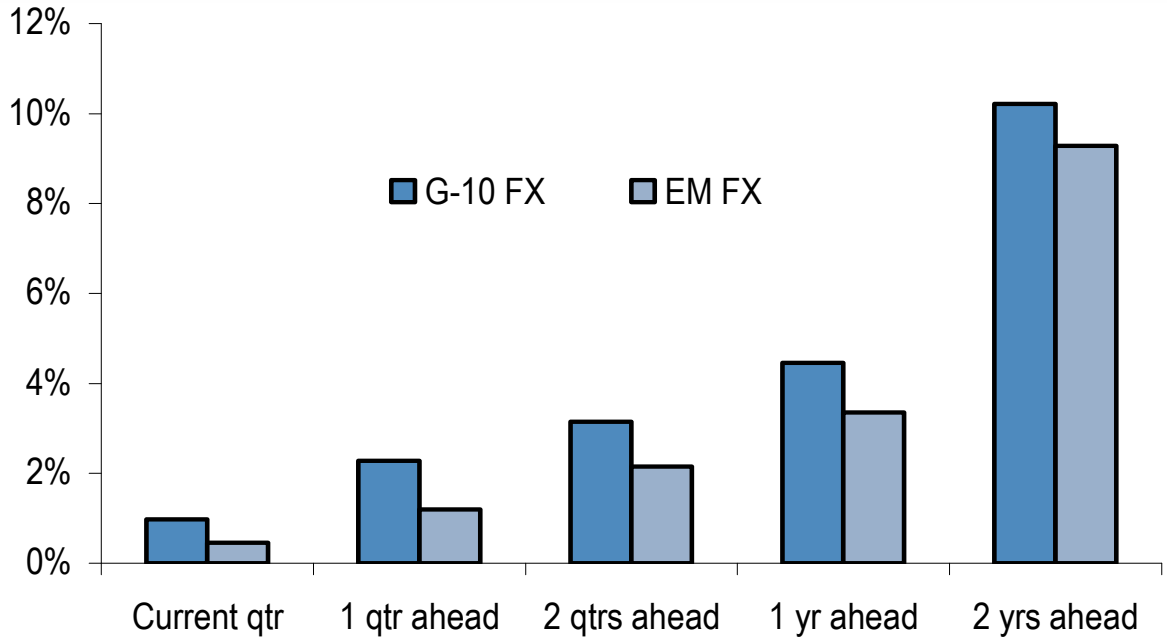



- **Successful if unsterilised or backed by a shift in monetary policy.**
  - Plaza Accord weakened the dollar because the Fed began easing in 1985 while the Bundesbank, and the BoJ were on hold. Louvre Accord lifted the dollar because the Fed began tightening as the Buba eased and the BoJ lifted rates only modestly.
- **Otherwise intervention only arrests a trend briefly (intra-week).**
  - Bank of Japan intervention in 2003-04 and in 2011 didn't not reverse yen strength. Neither has Central Bank of Brazil intervention since 2003.

# Agenda

# Can FX rates be forecast?

**Forecast errors: the consensus has been too conservative in forecasting USD weakness since 2000**
Consensus error on G-10 and emerging market FX forecasts vs USD, where error is calculated as difference between actual rate and forecast r ate over horizons of one quarter to two years. A positive (negative) value indicates that the consensus underestimated (overestimated) foreign currency strength vs USD.




- FX forecasters have been better at calling **direction** than **magnitude**
- **Forecast error** = realised FX rate ($t_1$) vs consensus forecasts ($t_0$)
  - Positive (negative) error indicates that consensus underestimated foreign currency strength (weakness) vs USD
  - Zero error indicates perfect foresight
- **Since 2000, error has ranged from 1% over one quarter to 10% over two years.**
  - Consensus was correct in forecasting the dollar's decline but was too conservative on the magnitude.

# Different models for different purposes

| Frequency / Inputs | Low (quarterly) | Intermediate (monthly) | High (daily) |
|---|---|---|---|
| **Fundamental** | **Fundamental equilibrium exchange rate models (structural variables)**<br>▪ terms of trade<br>▪ productivity<br>▪ government debt<br>▪ net investment income<br><br>**JPM model**: long-term fair value model | **Purchasing Power Parity**<br>▪inflation differentials<br><br>**JPM indicator**: real effective exchange rate indicators | **Daily fair value regressions (cyclical variables)**<br>▪ Rate expectations<br>▪ Sovereign spreads<br>▪ Equity volatility<br>▪ Commodity prices<br><br>**JPM models:** Fair value regression chartpack |
| **Technical** | **Momentum**<br>▪Long-term (+10yr) price trend<br><br>**JPM models**: NA | **Carry**<br>▪ Cash rate/libor differentials<br><br>**JPM models**: IncomeFX for G-10 carry, Income EM for emerging markets carry | **Momentum**<br>▪ Rate trends<br>▪ Price trends<br><br>**JPM models**: Forward Carry, Price momentum |

Models vary by **input** (fundamental, technical) and **frequency** (high, intermediate, low)

# Long-term models: PPP versus fundamental exchange rate models

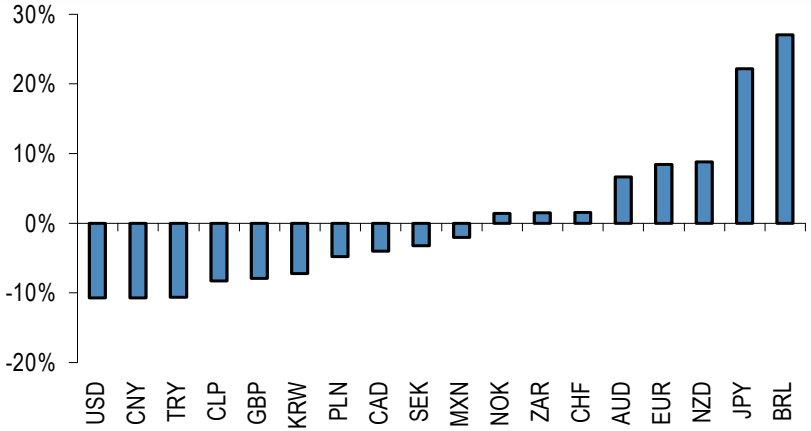
| Approach | Theory | Advantages | Disadvantages |
|---|---|---|---|
| **Purchasing Power Parity (PPP)** | **Inflation differentials** drive the bulk of exchange rate swings. Real exchange rates are constant, or at least mean revert, over time. | **Simple** to explain, model and implement (sell/buy currencies which are very expensive/cheap versus PPP value). | In practice real exchange rates for most currencies **trend** rather than mean revert. The choice of base year against which to benchmark misalignment is arbitrary. Only relevant for bilateral exchange rates and ignores multilateral interactions. |
| **Fundamental equilibrium exchange rate (FEER)** | FEER vary systematically with **macroeconomic fundamentals**. Equilibrium is a multilateral not a bilateral concept. | Accommodates the intuitively-appealing notion that **factors other than relative prices** drive exchange rates. Allows simulation for how changes in fundamentals (other than inflation) alter a currency's long-run equilibrium level. | More **cumbersome** to estimate, and to transform multilateral misalignments into bilateral fair values. |

# Estimating a long-term econometric model…

**Components and interpretation of J.P.Morgan REER model**

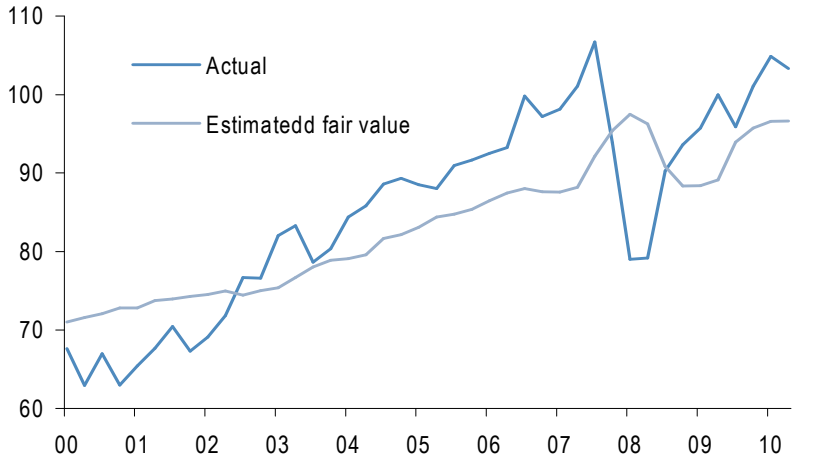
| Variable | Coefficient | Interpretation |
|---|---|---|
| **Terms of trade** | 0.34 | A 1% increase in terms of trade increases REER by 0.34% |
| **Productivity** | 0.58 | A 1% increase in productivity increases REER by 0.58% |
| **Gross gov'to debt/GDP** | -0.21 | A 1 percentage point increase to Debt/GDP decreases REER by 0.21% |
| **Net investment income/trade** | 0.2 | A 1 percentage point increase to NII/trade increases REER by 0.20% |

**Real trade-weighted deviations from fair value (%)**
Positive (negative) value indicates over (under) valuation



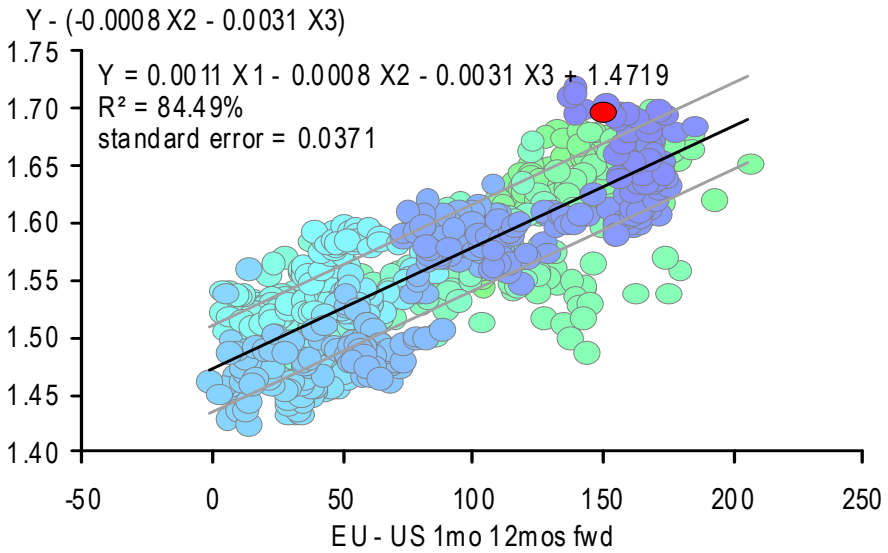

- J.P.Morgan's REER model uses **terms of trade**, **productivity, government debt and net investment income**. Panel regression for 19 currencies over 2000-10 sample.
- **On a real effective basis** the most overvalued are JPY, NZD, EUR, AUD; most undervalued are USD and GBP.
- **On a nominal basis relative to USD, the most** overvalued currencies are JPY, NZD, EUR; the most undervalued is USD relative to all other currencies.
- **Caveats:** (1) fair value is more a range than a point; (2) valuation requires a catalyst to force mean reversion

**AUD REER model versus actual**

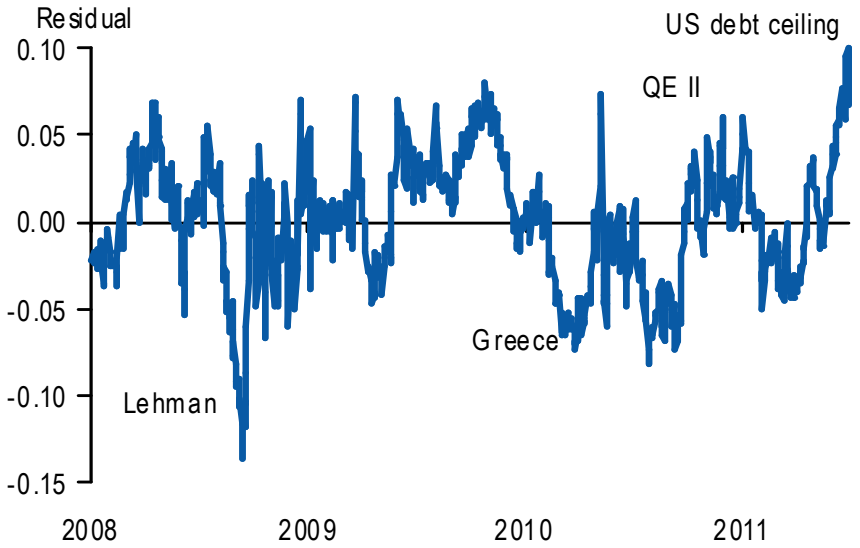


# ….versus a short-term one

**EUR/USD high-frequency cyclical model**
EUR/USD regressed on Euro – US rate spreads (1-mo rates 12mos forward), sovereign spreads (5-yr Spain vs. Germany) and equity volatility (VIX). Positive (negative) value indicates EUR/USD over (under) valuation. Daily data since 2008.




**Deviations from fair value using high-frequency model**
Residual in cents from EUR/USD regression in chart 1. Positive (negative) value indicates EUR/USD over (under) valuation.




- Similar to the **long-term** regressions which focus on **structural** factors (productivity, government debt), **short-term** models focus on **cyclical** factors such as rate expectations, sovereign risk, commodity prices or equity performance which can be measured daily
- If these cyclical variables well explain movements in the currency, then **extreme deviations** from predicted fair value identify turning points for short-term corrections.

# Rule-based trading models versus discretion

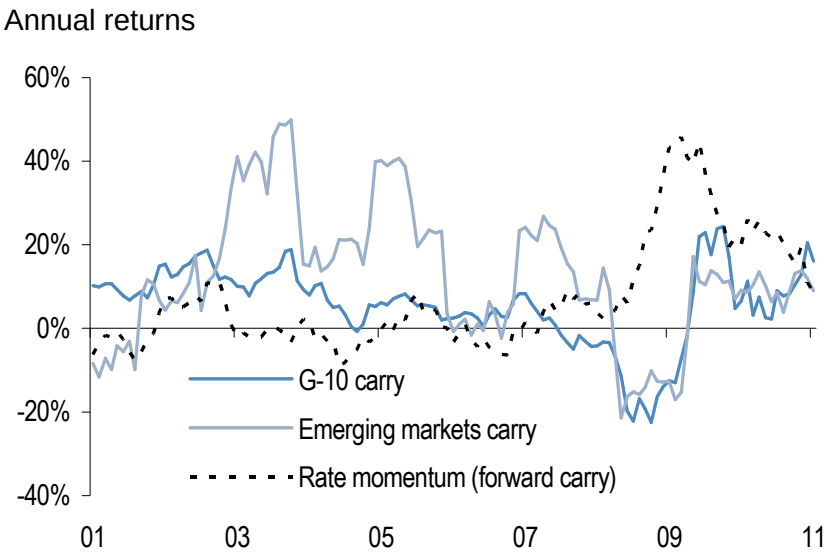
- Rule-based investing employs fixed rules to decide which assets to buy and sell.
  - **Momentum**: Buy (sell) asset because it has performed well (poorly) in the past
    - Exploits positive serial correlation in returns
  - **Value**: Buy (sell) asset because it is cheap (expensive)
    - Exploits negative serial correlation in returns

- Why rules & models?
  - Investing requires systematic thinking
    - World is complex and requires quantitative balancing of many driving forces
  - Trading rules perform better (though in-sample) than actual managers
    - Models identify low-hanging fruit, thus allowing managers to focus on the more complex issues. This division of labor is more efficient.
  - For asset managers, rules create discipline, admittedly at the price of flexibility
  - For investors, RBI-structured products create cheap sources of alpha

- Why discretion & judgement?
  - Markets are relatively efficient. Any systematic mispricing will be arbitraged away, thus eliminating once profitable trading rules
  - Models cannot capture full complexity of the world or structural changes.
  - Making models more complex is self defeating, as it creates parameter drift

# A few guidelines for model-based strategies

**Returns on JPM FX currency models**




- **Much J.P. Morgan Research is hybrid**
  - Some strategists use models for baseline view, but final recommendation has discretionary overlay
  - J.P. Morgan approach combines pure algorithmic recommendations with discretionary ones
  - **Model-informed** vs model-driven
  - Quantitative and discretionary approaches are **complementary**, not opposing
- Guidelines for quantitative models
  - **Occam's razor**: minimize number of parameters
  - **Robustness** to alternative specifications
  - Trading **rules rather than econometrics**
  - Strong **conceptual rationale** for why the inefficiency exists and should persist
  - Absence of a large following

# Rule-based trading models: Carry

## Top FX carry trades: Absolute carry vs carry-to-risk

| Pair | Absolute carry | Pair | Carry-to-risk ratio |
|---|---|---|---|
| Long INR vs JPY | 8.2% | Long IDR vs USD | 2.1 |
| Long IDR vs JPY | 7.4% | Long INR vs USD | 1.7 |
| Long TRY vs USD | 6.6% | Long TWD vs USD | 0.8 |
| Long ZAR vs USD | 5.6% | Long PHP vs USD | 0.8 |
| Long AUD vs USD | 5.1% | Long AUD vs USD | 0.5 |
| Long NZD vs USD | 2.7% | Long NZD vs USD | 0.3 |
| Long NOK vs USD | 2.3% | Long NOK vs USD | 0.2 |

## Returns: Absolute carry vs carry-to-risk strategy

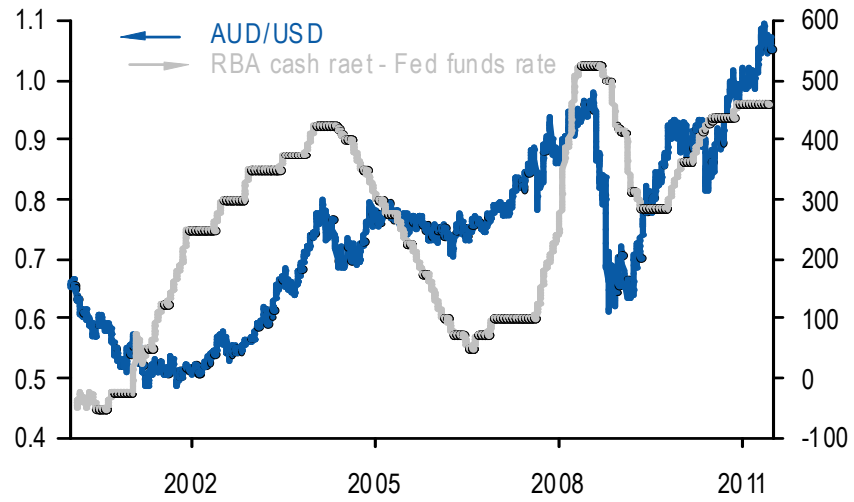
information ratio on basket of top pairs based on absolute carry and carry-to-risk

| | 2000-10 | | 2006-2010 | |
|---|---|---|---|---|
| | Absolute carry | Carry-to-risk ratio | Absolute carry | Carry-to-risk ratio |
| Top pair | 1.09 | 0.94 | 0.58 | 0.45 |
| Top 2 pairs | 1.20 | 0.94 | 0.72 | 0.13 |
| Top 3 pairs | 1.32 | 1.45 | 0.58 | 0.91 |
| Top 4 pairs | 1.33 | 1.48 | 0.57 | 0.84 |

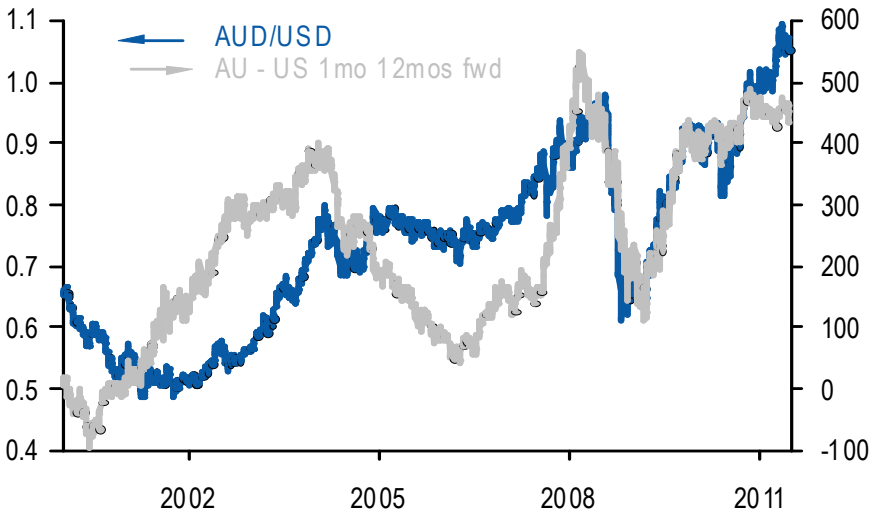
- **Intuition**
  - High interest rates are associated with strong economies so attract foreign capital, thus appreciating currencies.
  - Investors are more motivated by risk-adjusted yield differentials than absolute ones
- **Trading rule**
  - Buy basket of currencies offering the highest risk-adjusted carry each month (1-mo libor spread/realised spot vol)
- **Performance since 2000**
  - **G-10 basket**: annual returns of 5.2%, volatility of 8.3% and IR of 0.6.
  - **EM basket**: annual returns of 11.2%, volatility of 13.2% and IR of 0.8.
  - Risk-adjusted carry tends to outperform absolute carry
  - Basket of top currencies outperforms top pair

# Rule-based models: Interest rate momentum (Forward Carry)

**AUD/USD vs AU – US policy rate spread**
RBA cash rate minus Fed funds rate

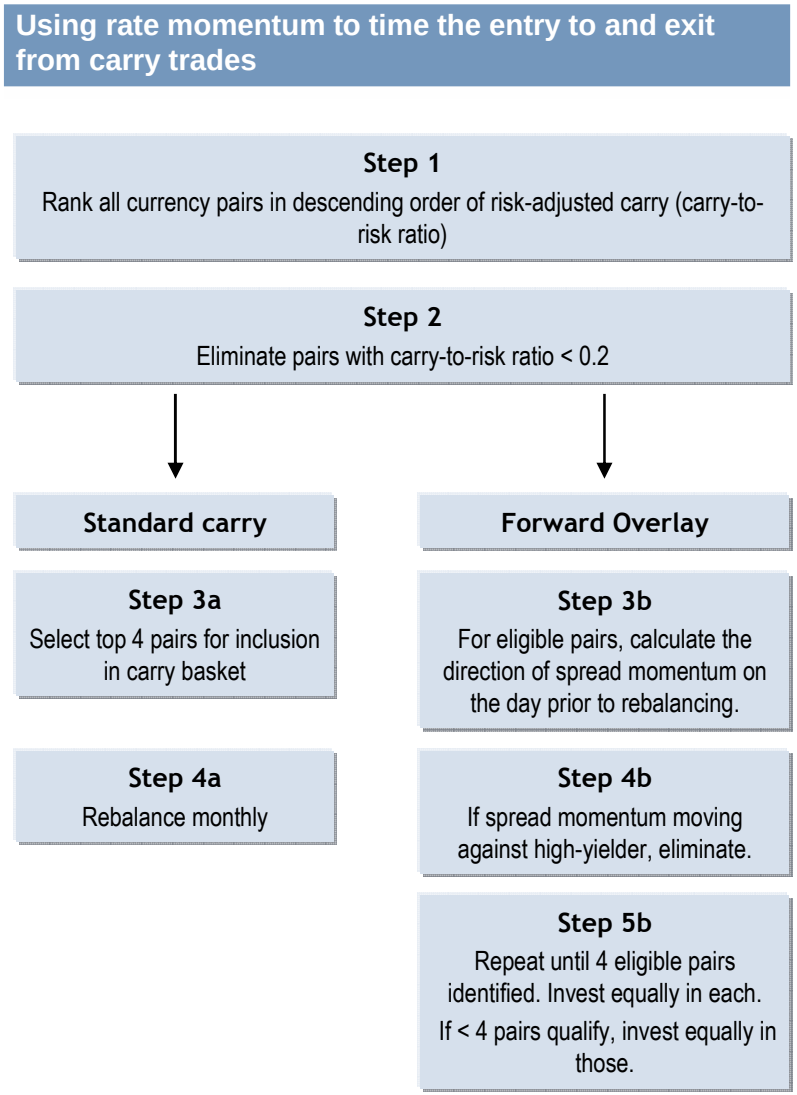



**AUD/USD vs AU – US rate expectations**
Rate expectations are 1mo rates 12mos forward




- **Intuition**
  - Currencies respond to changes in rate spreads as much as to static rate spreads (carry)
    - Most currencies appreciate (depreciate) against others when rate rise (fall) relative to others, regardless of a currency's initial yield.
    - These moves reflect shifting cyclical momentum and/or monetary policy.
    - Referred to as **forward carry**, since FX reflects expected carry levels in future.
- **Trading rule**
  - Buy (sell) currencies in whose favor yields have moved recently.
- **Parameters:** (1) reference interest rate; (2) lookback period for measuring change (3) rebalancing frequency (daily, weekly, monthly)
- **Performance since 2000**
  - Annual returns of 6.5%, volatility of 6.7% and IR of 1.

# Rule-based models: Carry with rate momentum overlay




- **Intuition**
  - If currencies respond to static spreads (carry) and changes in rate expectations (forward carry), the **strongest** currencies should be high-yielders where rates are rising. The **most vulnerable** are low-yielders where rates are falling.
- **Trading rule**
  - Only hold carry where spreads are also widening in favor of the high-yielder
  - Forward carry functions as a cyclical overlay to a carry strategy, an approach which is conceptually more appealing that the endogenous risk-appetite filters common in the market
- **Performance since 2000**
  - Annual returns of 6.6%, volatility of 8.3% and IR of 1, which improves on the standard carry strategy.

# Rule-based models: Price momentum

**Conditional probability of consensus forecast changes on US growth and inflation since 2000**
Probability of forecast change in time t+1 given change in period t

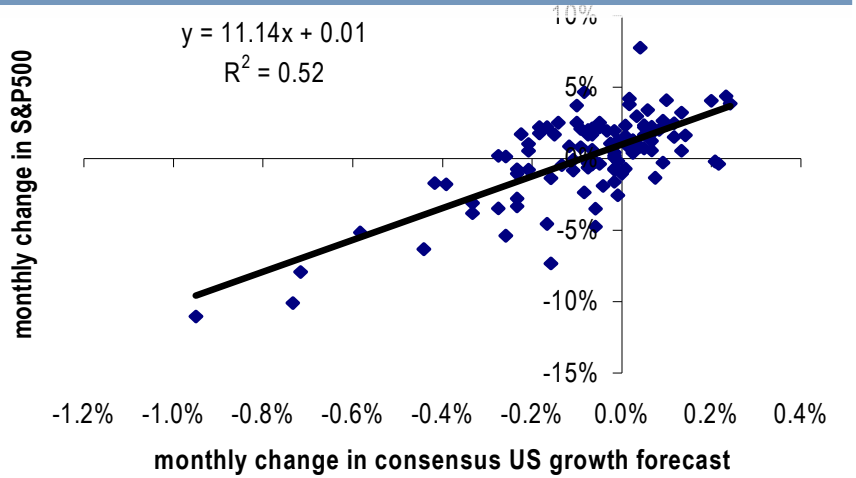
**Growth**

| *Period t* | *Period t+1* Up | Down |
|---|---|---|
| Up | **0.67** | 0.33 |
| Down | 0.31 | **0.69** |

**Inflation**

| *Period t* | *Period t+1* Up | Down |
|---|---|---|
| Up | **0.65** | 0.35 |
| Down | 0.17 | **0.83** |

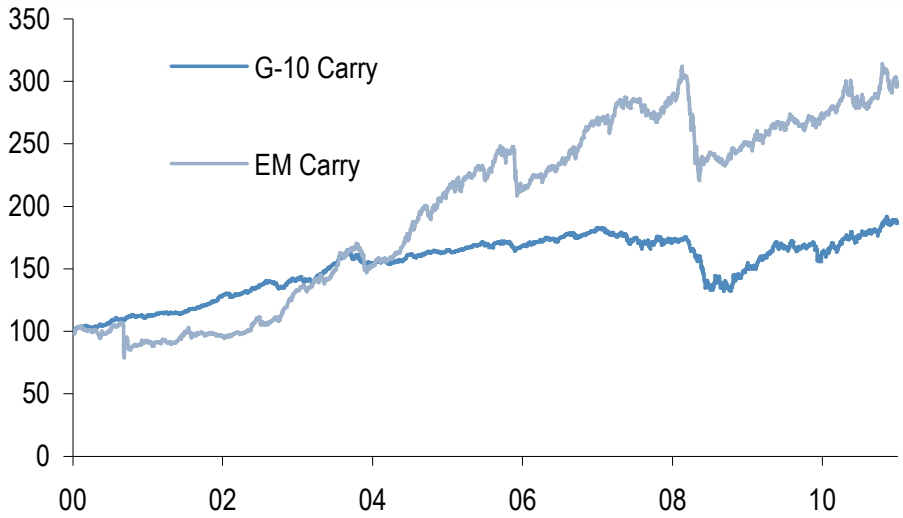
**Revisions to consensus forecasts on US growth vs S&P500 returns**
Consensus forecasts based on monthly *Blue Chip* survey



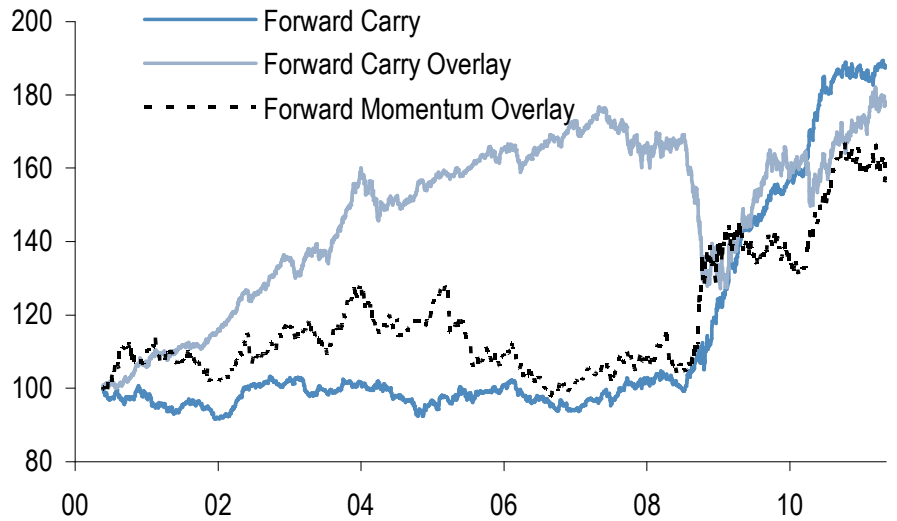

- **Intuition**
  - Markets exhibit momentum due to the behavioural biases of **under** and **over reaction**
    - Investors under-react to information and adjust position incrementally, thus creating trends
- **Trading rule**
  - Buy (sell) currencies which have appreciated (depreciated) recently
    - Overlay rate momentum (forward carry) as an additional filter. Buy currencies which have appreciated over past year and where rates have risen over the past month.
- **Parameters:** (1) momentum measure (simple or exponential change in price); (2) lookback period (intra-day, daily, weekly, monthly); and (3) rebalancing frequency (daily, weekly, monthly).
- **Performance since 2000**
  - Annual returns of 3.7%, volatility of 8.9% and IR of 0.41

# Rule-based strategies: a summary

**Returns on G-10 and emerging markets carry strategies**
index levels




**Returns on G-10 momentum strategies**
index levels




- **G-10 and emerging markets carry** strategies select four currencies with highest ratio of carry (1-mo rate differential) to volatility (annualized spot vol over past 30 days).
- **Forward Carry** buys the currency in whose favor rate expectations have moved over the past month. Expectations are based on 1mo rates 3mos forward.
- **Forward Carry Overlay** only buys high yield currencies if rate expectations are also moving in that currency's favor, so combines standard carry and Forward Carry concepts.
- **Forward Momentum Overlay** only buys currencies which have appreciated in spot terms over the past year and are experiencing rising rate expectations relative to another currency over the past month. Thus it combines the standard price momentum framework with Forward Carry.
- All **strategies are described in *Alternatives to Standard Carry and Momentum in FX* (Normand, August 8, 2008).**

# Performance: comparable to currency managers but lower than hedge funds

## Long-term performance of FX rule-based strategies compared to performance of fund managers

| | | | | | | Currency manager performance | | | | Hedge fund performance | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | G-10 carry (unlevered) | Emerging Markets carry (IncomeEM) | Rates momentum (9 USD pairs) | G-10 carry with Forward Carry overlay | Price momentum Overlay (9 USD pairs) | Barclay Currency Traders Index* | Barclay Group BTOP FX** | Parker Blacktree CMI** | HFR currency index* | HFR global macro hedge funds** | HFR global macro hedge funds* | HFR emerging market hedge funds* |
| **2011 YTD** | | | | | | | | | | | | |
| **1H11 return** | 10.7% | 9.4% | 1.1% | 7.2% | -5.3% | 2.1% | -3.2% | -5.3% | -1.7% | -4.3% | -4.3% | -0.2% |
| **Std dev** | 8.5% | 10.1% | 4.9% | 8.4% | 10.6% | 3.6% | 5.2% | 3.6% | 6.5% | 6.0% | 5.8% | 4.3% |
| **IR** | 1.3 | 0.9 | 0.1 | 0.9 | -0.5 | 0.6 | -0.6 | -1.5 | -0.3 | -0.7 | -0.7 | -0.1 |
| **2010** | | | | | | | | | | | | |
| **Avg annual return** | 8.5% | 8.2% | 20.2% | 6.1% | 22.0% | 2.6% | 7.5% | 0.7% | -1.3% | -1.7% | 8.1% | 11.4% |
| **Std dev** | 10.8% | 9.1% | 6.9% | 8.2% | 9.5% | 3.1% | 4.1% | 3.3% | 5.1% | 0.5% | 6.9% | 9.9% |
| **IR** | 0.8 | 0.9 | 2.9 | 0.8 | 2.3 | 0.8 | 1.8 | 0.2 | -0.3 | -3.5 | 1.2 | 1.2 |
| **2006-2010 (5 years)** | | | | | | | | | | | | |
| **Avg annual return** | 1.9% | 5.8% | 13.0% | 5.9% | 10.3% | 0.2% | 1.6% | 2.7% | 1.2% | 0.2% | 6.8% | 4.5% |
| **Std dev** | 10.4% | 11.3% | 8.1% | 10.2% | 11.5% | 2.2% | 4.3% | 3.0% | 5.1% | 0.3% | 5.7% | 14.2% |
| **IR** | 0.2 | 0.5 | 1.6 | 0.6 | 0.9 | 0.1 | 0.4 | 0.9 | 0.2 | 0.7 | 1.2 | 0.3 |
| **2001-2010 (10 years)** | | | | | | | | | | | | |
| **Avg annual return** | 5.2% | 11.2% | 6.5% | 6.6% | 5.4% | 3.7% | NA | NA | NA | NA | 11.6% | 24.8% |
| **Std dev** | 8.3% | 13.2% | 6.7% | 8.3% | 10.1% | 5.0% | NA | NA | NA | NA | 5.7% | 12.3% |
| **IR** | 0.6 | 0.8 | 1.0 | 0.8 | 0.5 | 0.7 | NA | NA | NA | NA | 2.1 | 2.0 |

* monthly return composites
** daily return composites

# Agenda



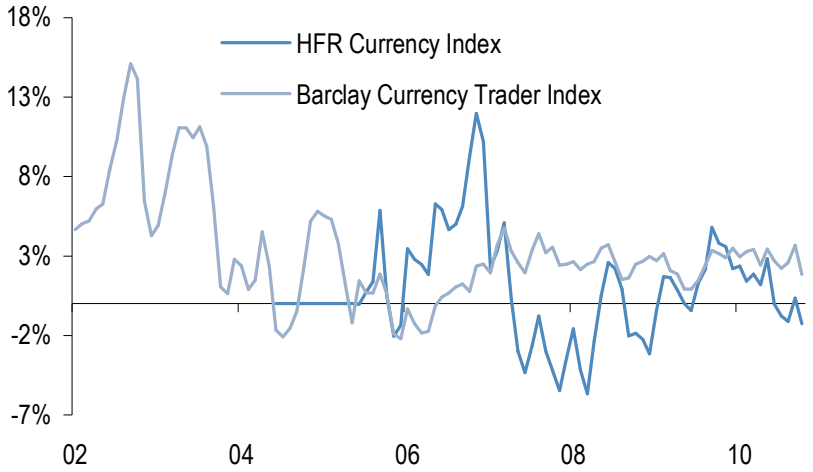


J.P.Morgan

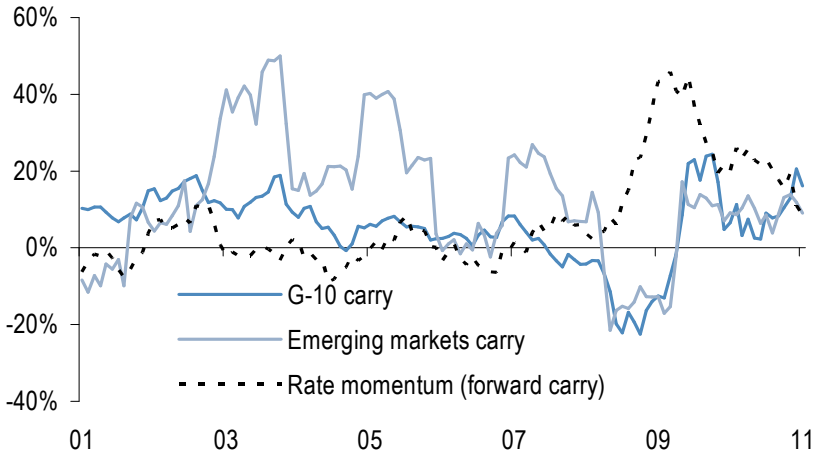
# Is trading FX profitable? Yes by several measures



**Annual returns by currency managers**
Rolling 12-mo returns on three composites of dedicated currency managers

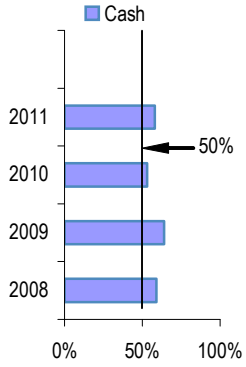


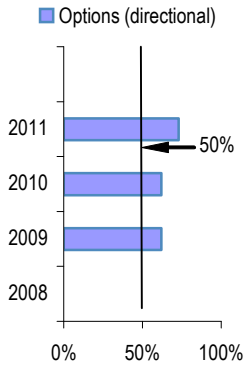

**Performance of J.P. Morgan model-based strategies**
Rolling 12-mo returns

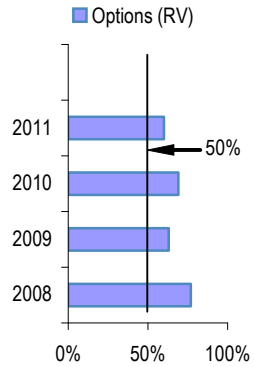



**J.P. Morgan *FX Markets Weekly* model portfolio**
**Success rates and average return per trade by type of position.**
Average return in % for cash and directional options position, and vol points for options relative value.

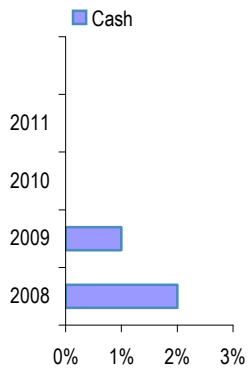
**Success rates**

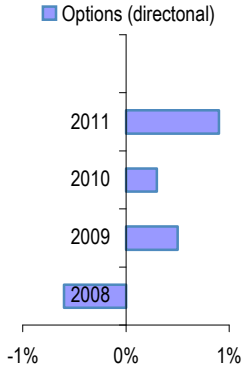


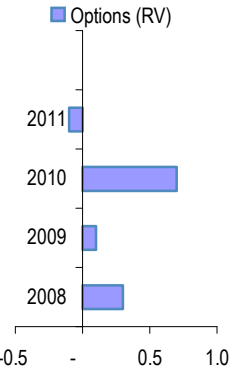




**Average return per trade**

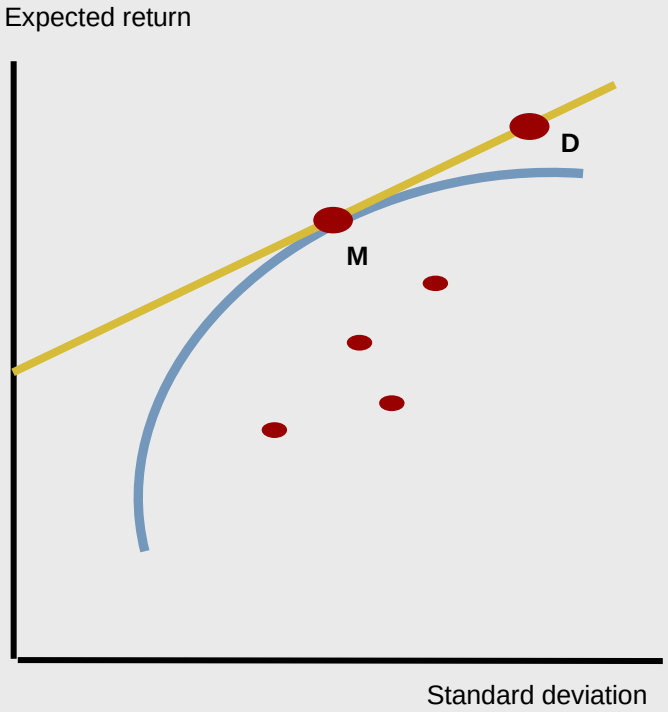


# Portfolio construction: *FX Markets Weekly* approach vs Markowitz optimization

**Efficient frontier**




- Requires thinking like a statistician
  - requires a view on expected returns and covariance for every asset/trade, which in turn increases **estimation risk**
  - the alternative – relying on historical returns and vol – has a **backward-looking bias**
- Difficult to translate views into this language
  - **garbage in, garbage out**
  - model results frequently require discretionary adjustment due to skewed results

# A top-down alternative: think in themes, convert to trades

| Global themes (qualitative) | Strategy (directional, relative value) | Trades (cash, options) |
|---|---|---|
| ■ Global expansion | ■ Across asset classes, overweight risky versus safe markets.<br>■ Across currencies, overweight cyclical versus defensive currencies | ■ Long equities vs bonds<br>■ Long commodity FX vs USD or JPY |
| ■ Sovereign risk | ■ Underweight bonds, currencies of countries with poor fiscal positions | ■ Sell 10-yr Italy vs Germany, sell EUR vs CHF |

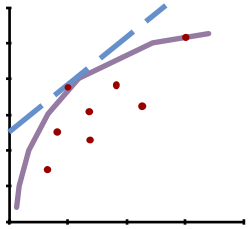
**You can get far without point forecasts**

# The complete process

## Markowitz mean-variance optimization

1. Forecast FX rates for relevant investment horison

2. Forecast variance/covariance matrix



3. Optimise for capital allocation to each trade

4. Adjust position sizes to control for liquidity risk

VS

## *FX Markets Weekly* approach

1. Identify independent global macro themes

2. Identify trades to express each theme

Macro (fundamental) portfolio

Technical portfolio

Directional | Relative value | Directional | Relative value

Cash | Options | Cash | Options | Cash

3. Size trades by conviction

4. Set stops technically (levels) and fundamentally (data/policy triggers)

5. Rebalance weekly on Fridays

# Directional trades: high conviction and large move in spot

Higher leverage

Lower leverage

| Strategy | Example | Rationale/Appropriateness |
|---|---|---|
| One-touch | At spot reference 1.05 on **USD/CAD**, buy a 3-mo one-touch put with 0.96 strike at cost of 18%. | Best executed when vols are low. Optimal pairs given by assuming a 10% premium to be paid and filtering for currencies where the distance from spot to barrier is smallest in standardised terms (sigmas of recent realised vol). In this instance, **maximum payout is more than 5:1** if the strike is hit, since payout is 100% of notional for 18% up-front premium. |
| At-expiry digital | At spot reference 1.40 on **EUR/CHF**, buy a 12-mo 1.25 at-expiry digital. | Similar to the one-touch but with **more leverage** (higher return relative to premium) since EUR/CHF must be at or below the strike at expiry. |
| Risk reversal (buy a call/put and sell a put/call on same currency) | At spot reference 8544 on **USD/IDR**, sell a 1-mo risk reversal consisting of buying an 8475 USD/IDR put and selling a 8700 USD/IDR call. | Useful as **protective overlay** on cash, particularly on high-yield currencies. The hedger buys a USD call/Ccy put and sells a USD put/Ccy call while holding a short USD/Ccy cash FX trade. This trade floors the downside at the cost of capping the upside. Can be structured as a zero-cost strategy depending on the strikes. Best executed when skews are elevated relative to the level of vols. |
| Sell calls or puts | After G-7 announced co-ordinated intervention in March 2011, sell **USD/JPY** puts struck at 78. | Intervention lows odds of a USD/JPY move below a threshold level, so selling USD/JPY puts **earns premium**. |

# Directional trades: lower conviction and modest move in spot

Higher leverage

Lower leverage

| Strategy | Example | Rationale/Appropriateness |
|---|---|---|
| Calls (puts) with reverse knock-outs (RKOs) | At spot reference 0.92 in **USD/CHF**, buy a 3-mo USD/CHF put struck at 0.90 with RKO at 0.85. | Cheapens the vanilla option by selling OTM strike. If the view if too correct, barrier is hit and option is worthless. **Benefits from modest move in spot**. Savings generally aren't symmetric between puts and calls, since high-yield currencies typically are skewed for currency downside. |
| Calls (puts) with reverse knock-ins (RKIs) | At spot reference 1.21 on **EUR/CHF**, buy a 2-mo 1.18/1.15 EUR/CHF put with RKI on lower strike at 1.11 | Adding an RKI increases the cost relative to the vanilla option but provides **additional leverage** (exposure to EUR/CHF downside) if the lower strike is hit prior to expiry. |
| Call (put) spread | With spot reference 0.9440 on **AUD/CHF**, buy a 2-mo 0.91/0.88 out spread for 60bp. | AUD/CHF is expected to fall about 5%, resulting in a 2:1 payout ratio (expected return vs cost). The put spread **cheapens the structure** by selling downside beyond the lower strike. Generally target a payout ratio of 2 or 3 to 1. |
| Ratio call (put) spread | At spot reference 1.42 on **EUR/USD**, buy a 2-mo 1x2 ratio call spread struck at 1.45 and 1.50. | Like a vanilla call/put spread, the ratio structure **cheapens the position** by selling up/downside. Selling twice as much upside achieves greater savings than a 1x1, but is only appropriate if the buyer has high conviction that the rally will be limited. |
| Seagull | At spot reference 3.07, buy 1-yr **USD/MYR** 3.00/2.90 put spread and sell a 1-yr 3.35 USD/MYR call for zero cost | Cheapens a vanilla call (put) spread by selling a put (call). Appropriate when expecting a **limited move**. Best executed when vols are high and skews elevated, which maximises the premium savings from selling an option against the underlying call or put spread. |

# Range trades

Low leverage

High leverage

| Strategy | Example | Rationale/Appropriateness |
|---|---|---|
| Carry trade with cash | Buy basket of four currencies offering highest risk-adjusted carry (**INR, IDR, AUD, NZD**) funded in lowest-yielding currencies (**USD, JPY**). | Ideal when vols are high or expected to decline. |
| Carry trade with options | Buy ATMF – ATMS call spread in high-yield currencies. At spot reference 1.75 on **USD/BRL**, buy a 1-mo ATMF (1.7603) USD/BRL put and sell a 1-mo ATMS (1.7500) USD/BRL put. | Preferred when vols are high and vol curve steep. Downside on the trade is floored at the option premium, unlike the cash trade executed with forwards where the downside is unlimited. |
| Range binary (double no-touch) | At a spot reference of 1.42, by a 2-mo **EUR/USD** double no-touch with 1.3850/1.4850 barriers. | A method of earning carry in a range-bound market if the spot rate realises a tighter range than the barriers selected by buying two barrier options above ad below spot. Similar to a carry trade in that it accrues gains from the passage of time (theta). Strategy is best executed when vols are high, and in 1-yr tenors on steep vol curves to achieve a wider barrier and therefore avoid the gap risk inherent in these structures. |

# Relative value trades

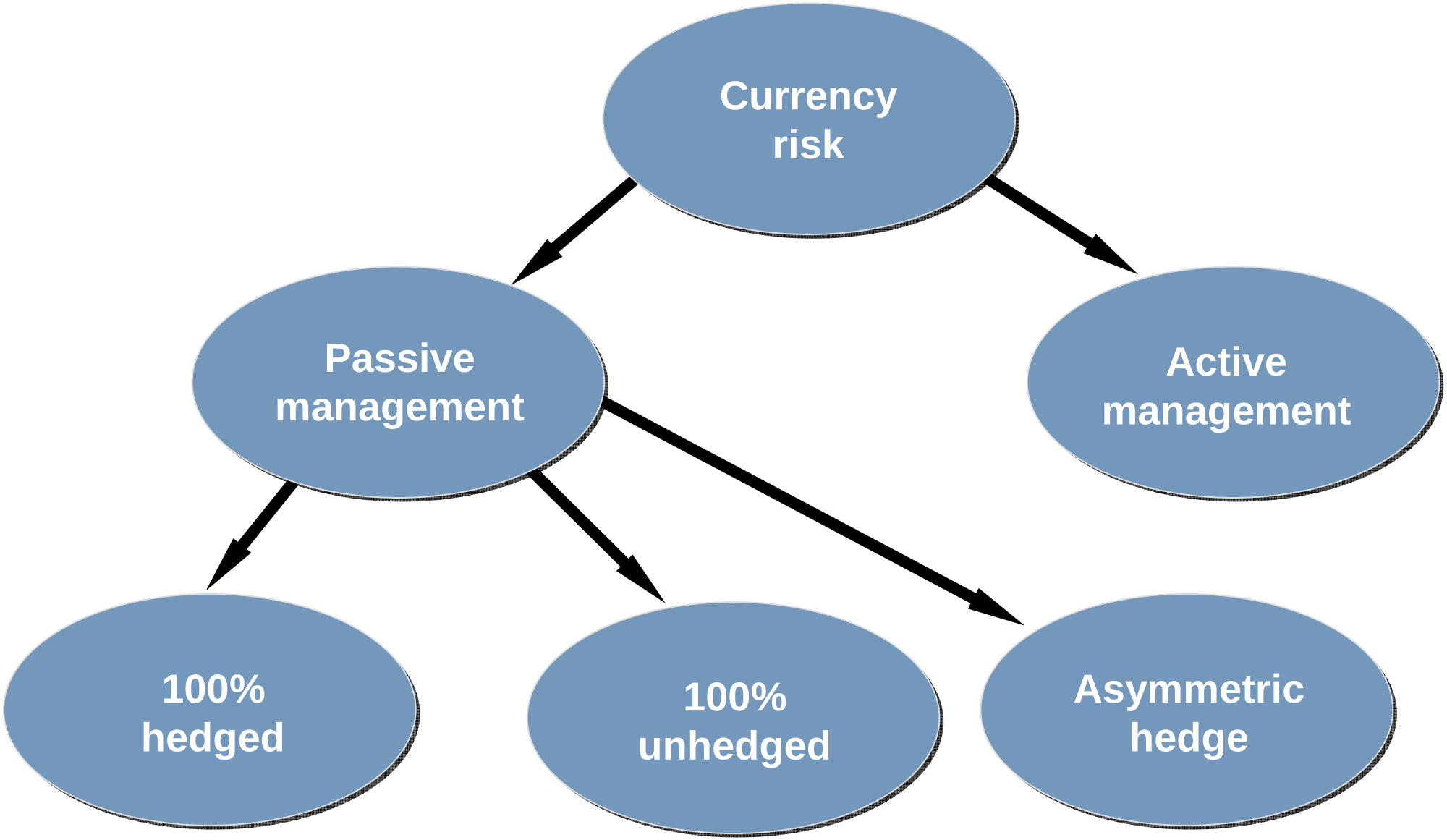
| Strategy | Example | Rationale/Appropriateness |
|---|---|---|
| **Basket options (worst of)** | Buy a basket of **3-mo worst-of USD puts** versus NZD, BRL and TRY | Correlation amongst basket components is low so basket option achieves a discount relative to the strip of vanillas. If correlation rises, the worst performer will track best one closely, resulting in a high payout ratio on the trade. |
| **Correlation swaps** | Sell 6-mo **USD/CAD vs USD/NZD correlation** via correlation swap | Correlations are bounded between +1 and 1, and are mean-reverting. The ideal sell occurs when (1) implied correlation is near a historic high (low); and (2) realised correlation is below (above) implied. |

# Case study: constructing a model portfolio

- **Investable markets**
  - All regions
  - All currencies
  - All instruments (cash, derivatives)
- **Inputs to the view**
  - Economics/Fundamentals
    - *Global Data Watch* (JPM view on cyclical and policy outlook)
    - Valuation models and position measures for currencies
- **Three tasks**
  - Identify 2 – 3 global macro themes which should influence currencies over the next three months
  - Propose two trades for each theme in cash or options. For options trades, explain why a particular structure is appropriate for the view.
  - Specify stops for the trade in terms of currency levels and fundamental triggers.

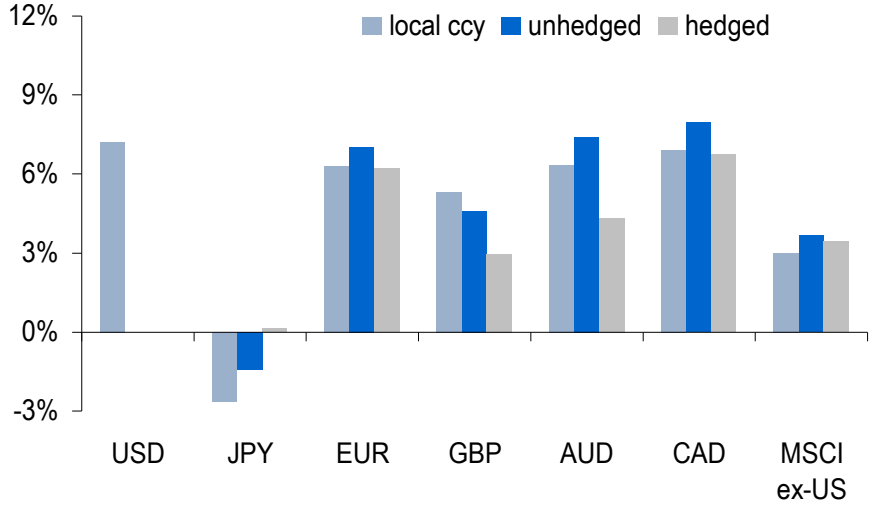
# Agenda

# A decision tree for FX hedge ratios

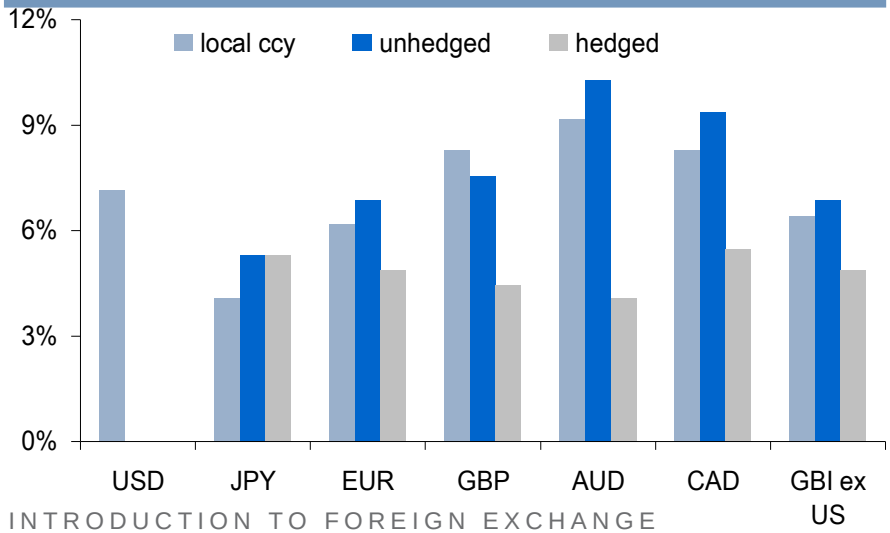


# Conventional wisdom on currency exposure: all risk, no return

**Equity market returns, 1988-2009**
annual %, USD terms



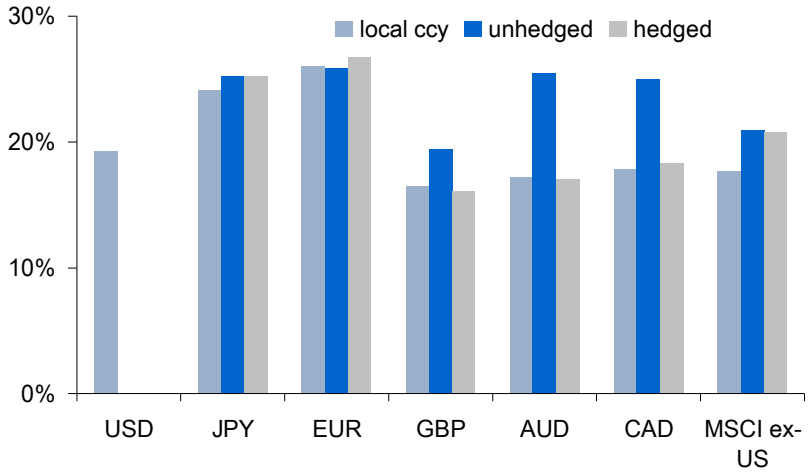

**Bond market returns, 1988-2009**
annual %, USD terms



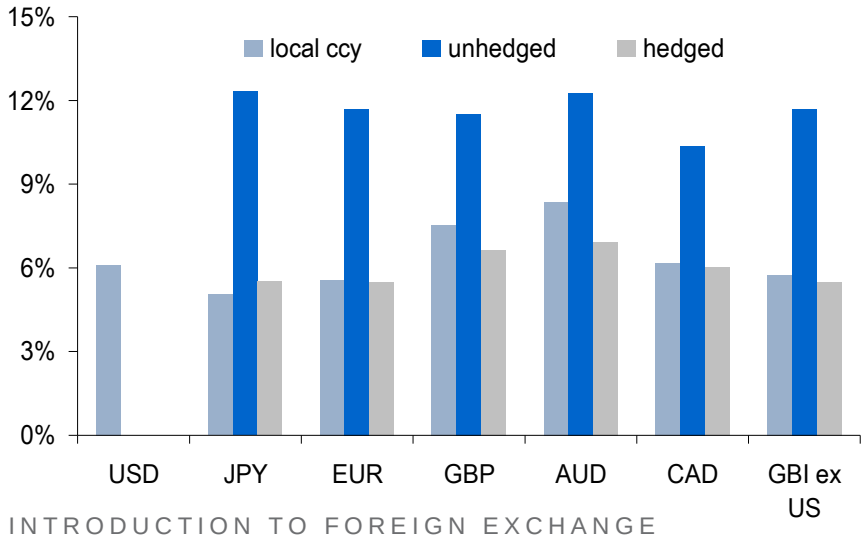

- **Conventional wisdom claims that** FX exposure delivers more risk than return, since currencies are mean-reverting over the long run
- **A simple test:** compare returns, volatility and risk-adjusted returns in hedged and unhedged terms inefficiencies
- **For USD-based investors, the long-term return differential from currency exposure has been modest**
  - Unhedged currency exposure has raised equity and bond returns by about 1.0% per annum on Euro area, Japanese, Australian and Canadian assets, but lowered returns on UK exposure.

# FX exposure can raise volatility more than returns

**Equity market volatility, 1988–2009**
annual %, USD terms




**Bond market volatility, 1988–2009**
annual %, USD terms

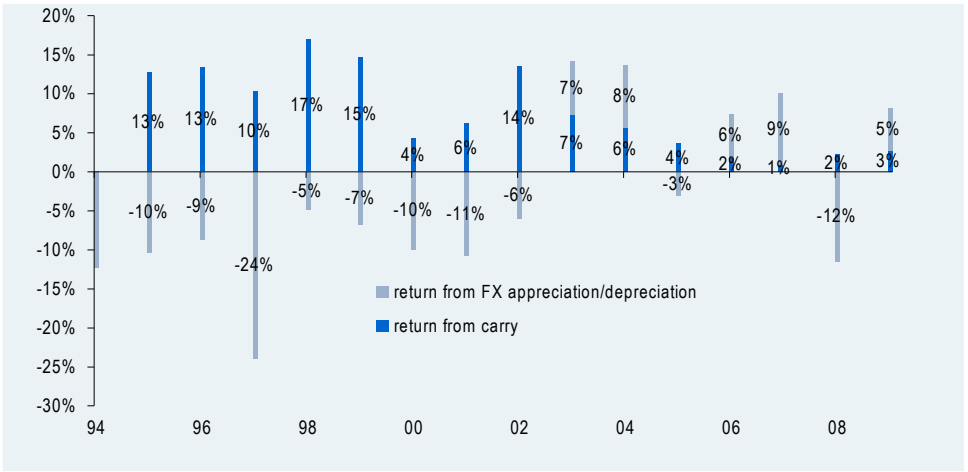



- **Volatility impact can be more significant**
- **For equities**
  - Unhedged Canadian and Australian exposures have been 7-8 percentage points more volatile
  - Unhedged UK returns are 3 percentage points more volatile than local currency returns
  - Unhedged Euro area and Japanese equities are similarly volatile, regardless of hedging
- **For bonds**
  - Unhedged bonds are close to twice as volatile as hedged exposure

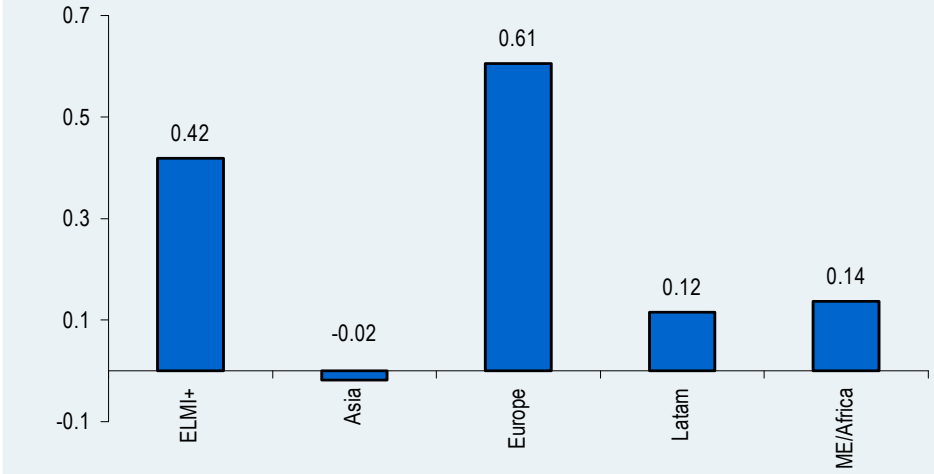
# Exception 1: With emerging markets FX exposure, strategic hedging does not pay



**EM FX returns: spot versus carry, 1994-2009**
based on returns from J.P. Morgan ELMI+ index




**Emerging markets FX Sharpe ratios, 1994-2009**
based on returns from J.P. Morgan ELMI+ index



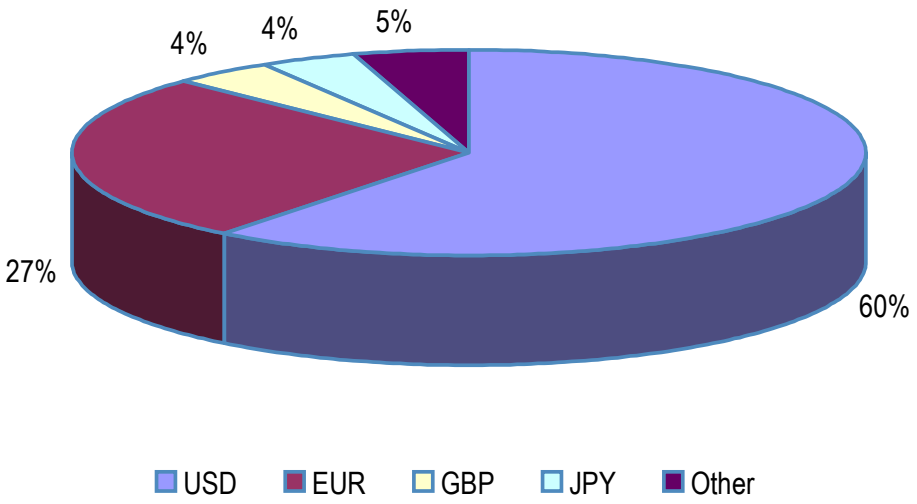

- **Unlike G-10 FX which tends to mean-revert, emerging market currencies tend to trend.**
  - Spot appreciation stems from (1) higher return on capital in stronger-growth, higher interest rate economies; (2) current account surpluses in commodity exporters.
- Carry is on average positive and about twice the level of G-10 rate differentials.
- For G-10 based corporates and investors, strategic hedging results in losses over the long term.



J.P.Morgan

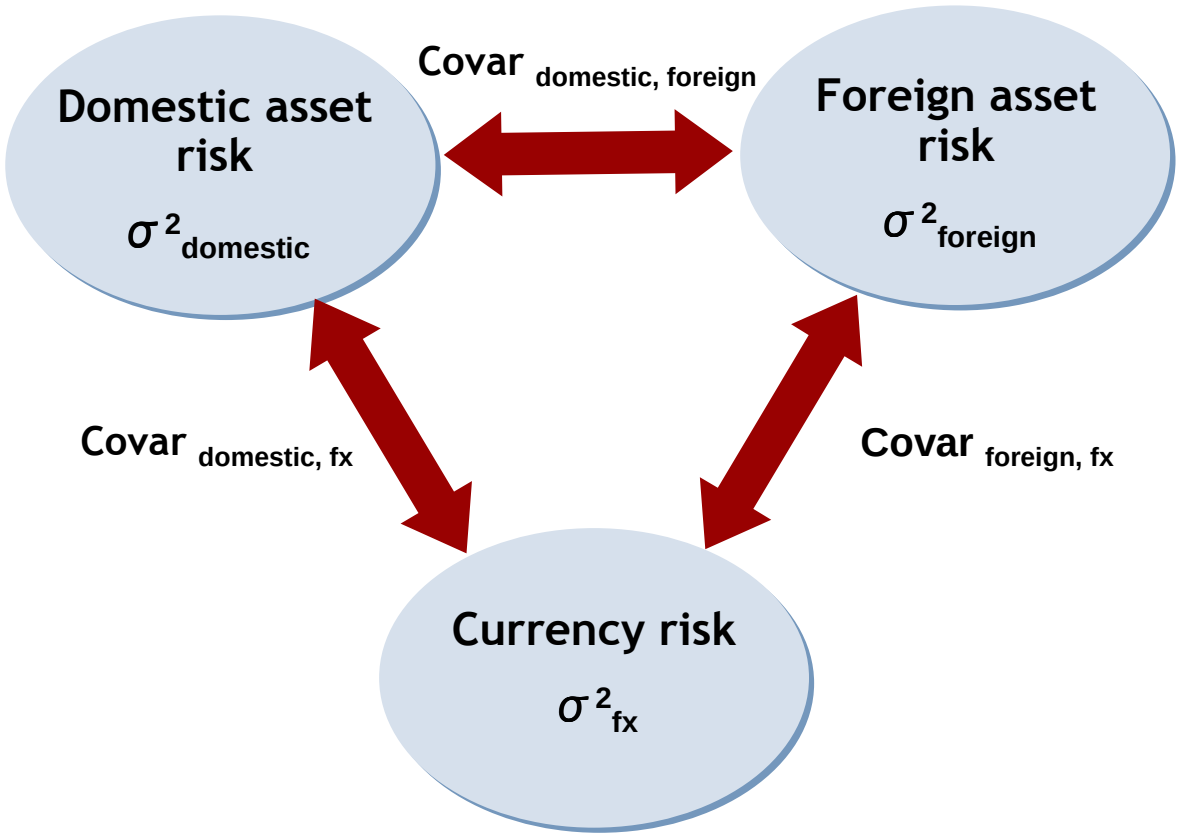
# Exception 2: Risk insurance and Asset/Liability matching

**Currency composition of central bank reserves, 2011**
As percentage of global total




- Domestic event risks can justify unhedged foreign exposure
  - Japanese insurance companies have USD holdings (earthquake insurance)
  - Investors from emerging markets hold unhedged foreign assets
- Central banks match foreign liabilities with foreign assets

# Exception 3: Risk diversification from FX




- **Portfolio σ a function of**
  - domestic asset's σ
  - foreign asset's σ
  - currency's σ
  - covariance between domestic and foreign assets
  - covariance between domestic/foreign assets and currency

# Conditions for lowering portfolio volatility through FX exposure

$$\sigma^2_{unhedged} < \sigma^2_{hedged} \text{ when}$$

$$w^2_{foreign}\ \sigma^2_{fx} + 2\, w_{foreign}\,(w_{domestic}\,\sigma_{domestic,\,fx} + w_{foreign}\,\sigma_{foreign,\,fx}) < 0$$

Foreign exposure

FX vol

Domestic asset covar with FX

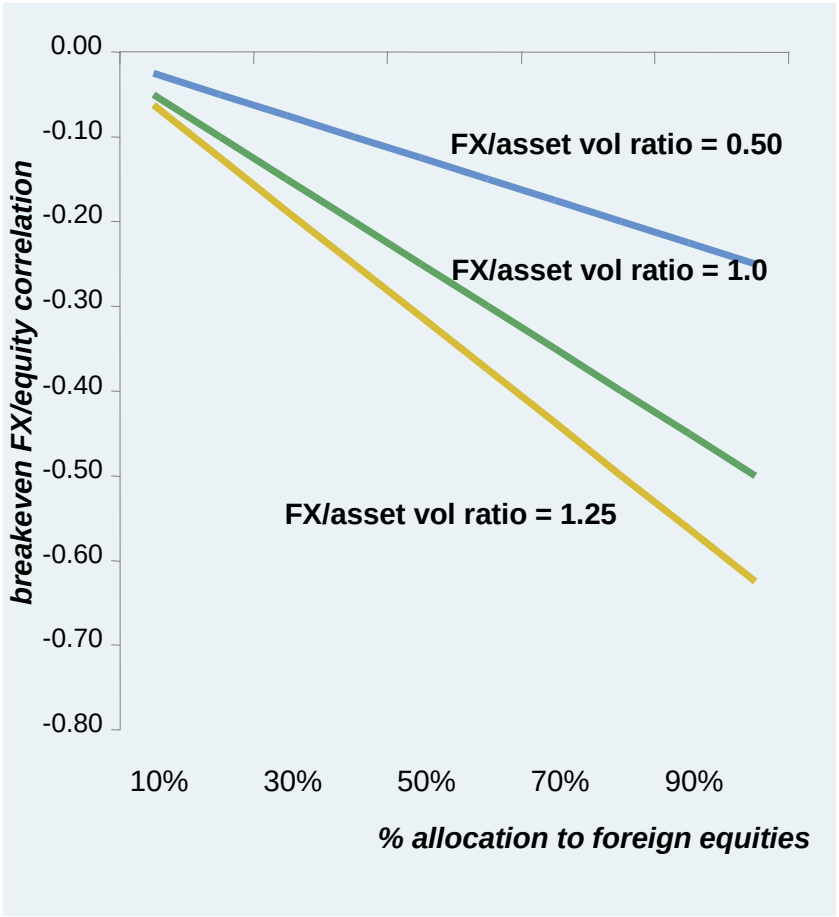
Foreign asset covar with FX

- Positive correlation between FX and assets increases portfolio vol
- Negative correlation can reduce portfolio vol, if sufficiently large
- Covariance between assets and FX must be large and negative

# An example of required breakeven correlations



**Breakeven correlations**

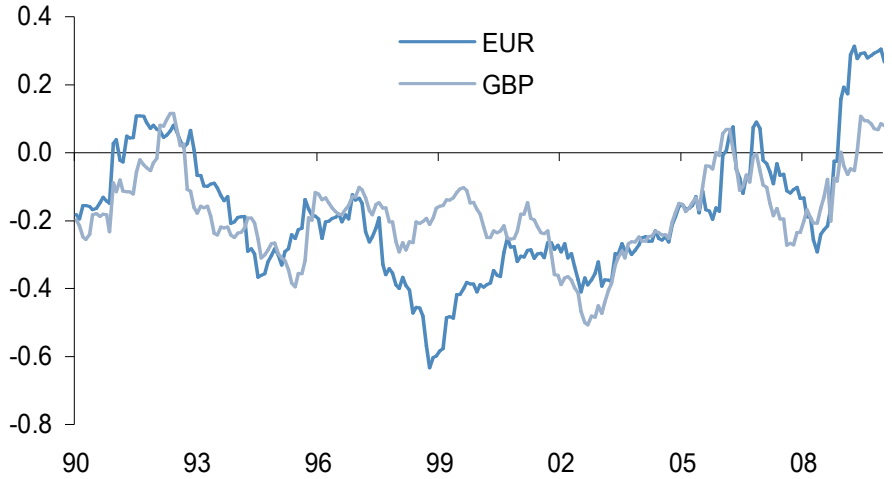



- **How negative must the correlation be to reduce portfolio volatility?**
  - For simplicity, assume
    - US and foreign equity markets are equally volatile
    - US and foreign equities are equally correlated with FX
  - Input various vols for assets and FX, and solve for breakeven correlation which reduces portfolio volatility
  - If FX is half as volatile as assets and foreign allocation is 50% of portfolio, FX/asset correlation must be at least -0.12
  - If FX is as volatile as assets, correlation must be at least -0.25

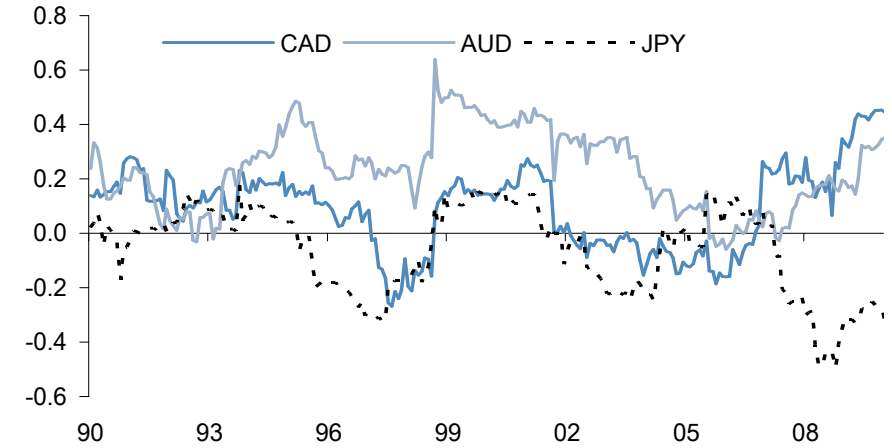
# US investor's perspective: Equity/bond and FX correlations insufficiently negative



**Correlation* of foreign stocks and FX, 1990-2009**
monthly returns, 3 year rolling periods, USD terms

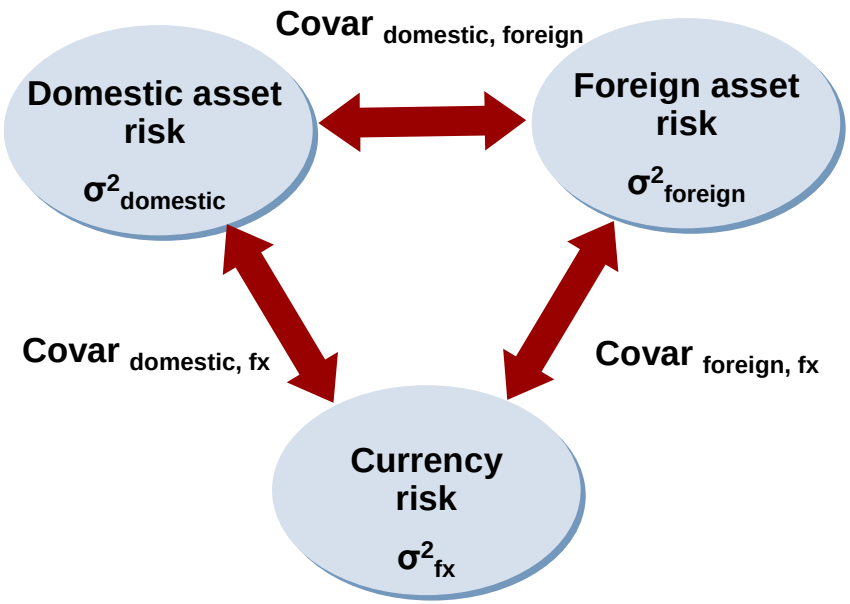



**Correlation* of foreign bonds and FX, 1990-2009**




*negative correlation indicates that ccy depreciates vs USD when equities or bonds rally

# Choosing the optimal hedge ratios: one size never fits all

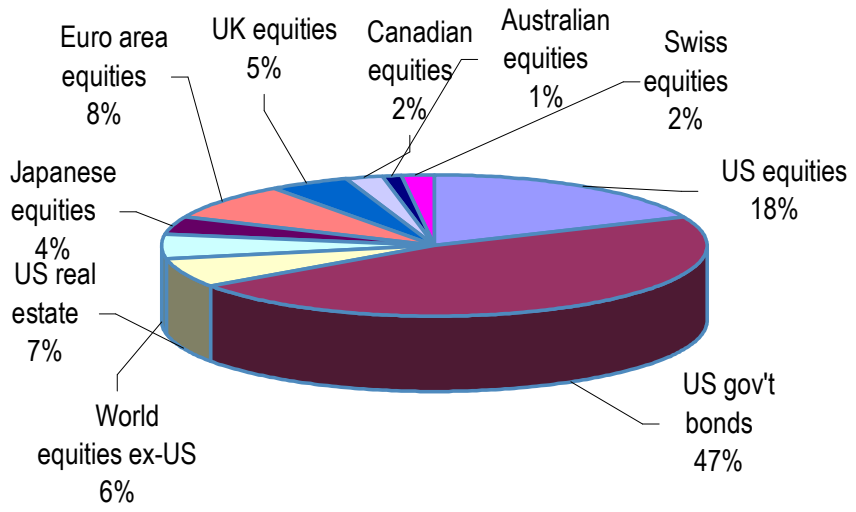



- **The optimal hedge ratio is percentage of foreign currency exposure which should be hedged to**
  - raise the portfolio's risk-adjusted returns (Sharpe ratio); or
  - minimise the portfolio's volatility (σ).
- **Given the number of variables affecting portfolio vol, optimal hedge ratio depends on**
  - allocation between domestic and international assets
  - the currency allocation of foreign assets
  - consistency of historical volatilities and correlations in the future
  - investor's risk preference
- **Optimal hedge ratio therefore will vary by investor and over time.**

# Example: US investor with 70% US, 30% non-US exposure



## Current portfolio allocation, %




## Portfolio performance, 1987 - 2010

| | Returns | Vol | IR | Client allocation |
|---|---|---|---|---|
| **US equities** | 9.9% | 14.9% | 0.66 | 18.3% |
| **US gov't bonds** | 7.1% | 4.7% | 1.51 | 47.0% |
| **US real estate** | 10.1% | 18.1% | 0.56 | 6.7% |
| **EM equities** | 3.4% | 18.3% | 0.18 | 0.0% |
| **World equities ex-US** | 6.6% | 17.3% | 0.38 | 5.6% |
| **Global gov't bonds ex US** | 6.7% | 9.1% | 0.74 | 0.0% |
| **Japanese equities** | 0.8% | 22.1% | 0.04 | 4.1% |
| **Euro area equities** | 8.5% | 23.0% | 0.37 | 8.2% |
| **UK equities** | 5.7% | 14.9% | 0.39 | 4.8% |
| **Canadian equities** | 9.2% | 19.6% | 0.47 | 2.3% |
| **Australian equities** | 8.3% | 20.7% | 0.40 | 1.1% |
| **Swiss equities** | 10.1% | 17.4% | 0.58 | 1.9% |
| **Unhedged portfolio** | **7.7%** | **7.9%** | **0.98** | |

- Portfolio of 70% US assets/30% foreign assets has returned 7.7% annually since 1987 with annualised vol of 7.9%, for risk-adjusted returns (information ratio) of 0.98.
  - Note: EM assets categorised as World equities ex-US given smaller data history on EM hedged indices (only since 1999)

# Optimisation results



## Optimal hedge ratios to maximise IR or minimise volatility

| | Criterion: maximise IR | Criterion: minimise vol |
|---|---|---|
| World equities ex-US | 0% | 100% |
| Japanese equities | 100% | 50% |
| Euro area equities | 100% | 100% |
| UK equities | 0% | 50% |
| Canadian equities | 100% | 100% |
| Australian equities | 100% | 100% |
| Swiss equities | 75% | 0% |

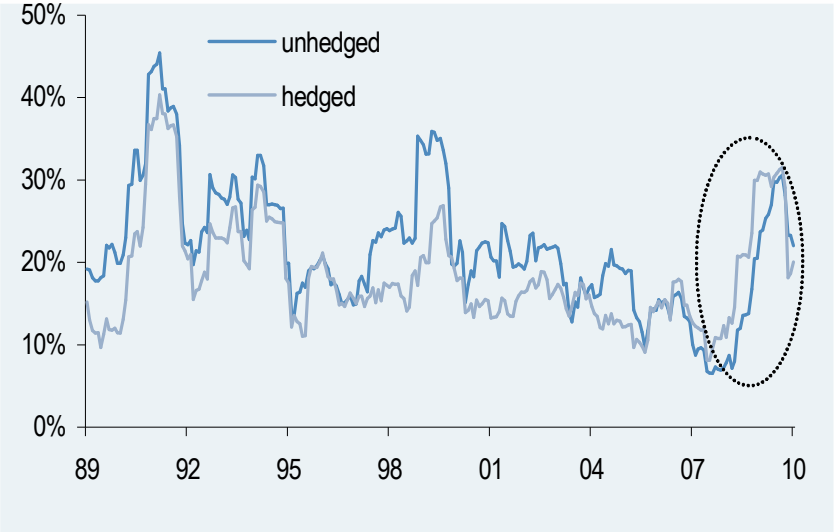
## Performance statistics for hedged and unhedged portfolios

| | Annual returns | Annual vol | IR |
|---|---|---|---|
| Unhedged portfolio | 7.7% | 7.9% | 0.98 |
| Maximum IR portfolio | 7.6% | 7.5% | 1.02 |
| Minimum volatility portfolio | 7.4% | 7.5% | 1.00 |

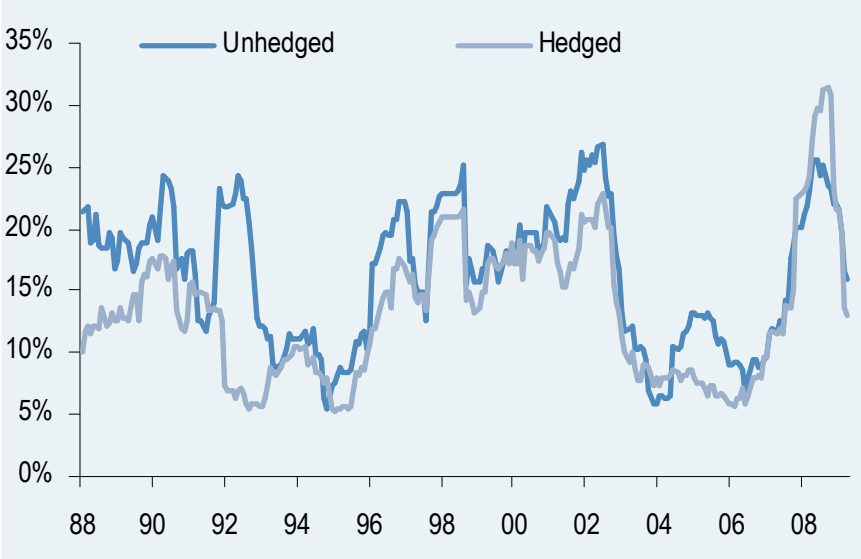
- **Optimisation process**
  - Percentage allocation to non-US assets is fixed by the investor. Only the FX hedge ratio can vary, to be either 0%, 25 %, 50%, 75% or 100%.
  - Optimiser solves for the combination of hedge ratios which (1) maximises the portfolio's risk-adjusted returns (information ratio) or (2) minimises the portfolio's volatility.
- **Results**
  - **To maximise IR**: hedge equities in Japan, Euro area, Canada and Australia 100%; hedged Swiss equities 75%. Leave all other non-US asset unhedged.
  - IR improves slightly from 0.98 to 1.02 due to modest decline in vol (from 7.9% to 7.5%).
  - Small improvement in IR due to (1) size of international exposure; (2) small negative correlation between stocks and FX and (3) comparable vol between hedged and unhedged equities
  - **To minimise vol:** hedge equities in Euro area, Canada and Australia 100%. Hedge UK and Japan 50%.
- **Caveats**
  - Results assume historical returns, correlations and volatilities are stable going forward.

# An additional wrinkle: cash flow consequences of fully hedged portfolios

**Japanese equities: volatility of hedged vs unhedged returns, 1988–2009**
12mo-mo rolling vol, USD as base currency




**US equities: hedged and un-hedged into GBP**
**volatility of hedged vs unhedged returns, 1988–2010**

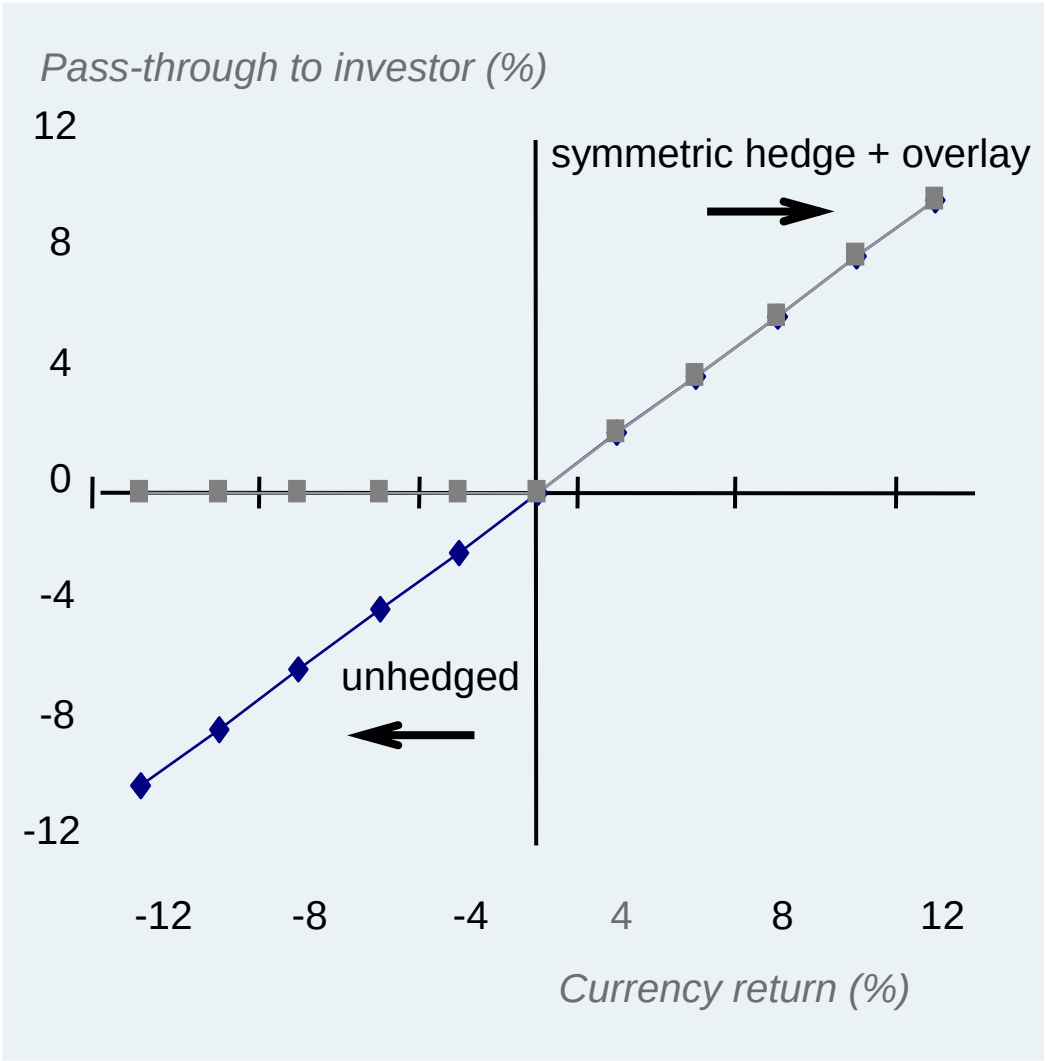



- **During the credit crisis, unhedged equity market returns became more volatile than hedged ones in cases where the foreign investor was short a currency which was strengthening.**
  - US investors in the Nikkei were short JPY as it strengthened.
  - European and Australian investors in US equities were short USD as it strengthened.
- **Cash flows implications were significant,** sometimes obliging investors to liquidate underlying assets to generate sufficient funds to rebalance FX hedges.

# Symmetric vs asymmetric benchmarks: 50% hedging is option of least regret



**Performance with and without overlay**

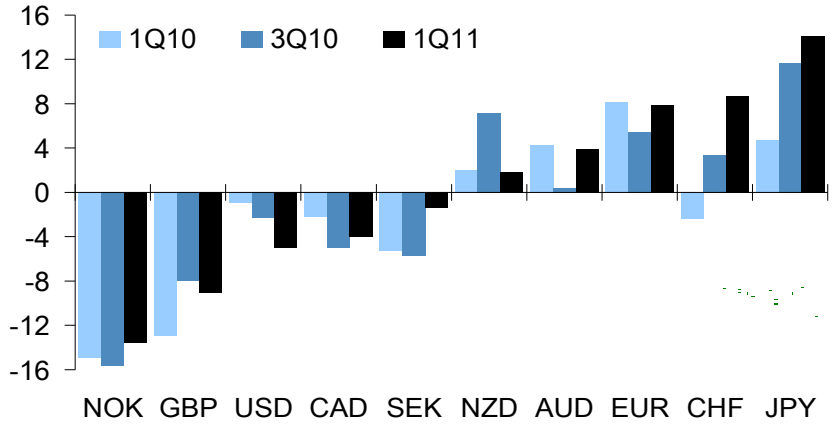



- **Asymmetric/polar benchmarks**
  - 100% hedged or unhedged
  - allows manager to profit in only one environment
- **Symmetric benchmarks**
  - 50% hedged/unhedged (or some variant)
  - allows manager to profit regardless of currency's direction
  - similar to call option

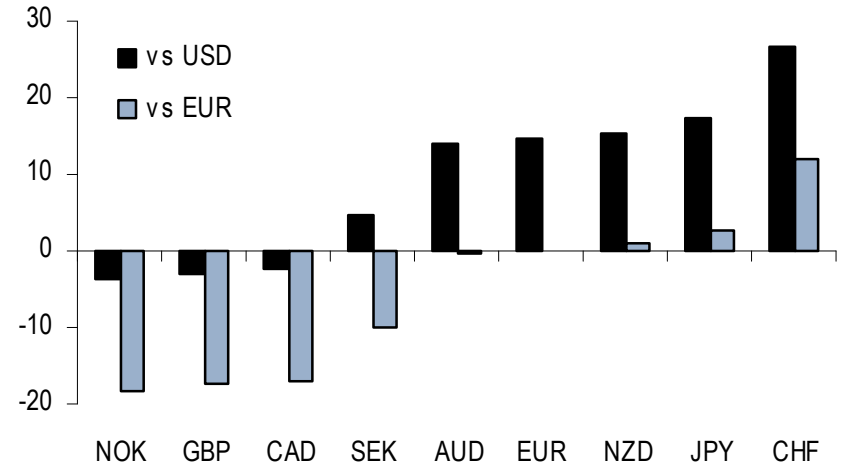
# Using long-term fair value models to focus strategic hedge ratios



**G10 real trade-weighted FX deviations from long-term fair value (%), 2010 Q1 – 2011 Q1**




**G-10 exchange rate deviations from 2011 Q1 fair value (%)**
Misalignments measured as average spot rate Jun 24-30 vs Q1 fair value estimate. A negative (positive) value indicates under (over) valuation of the foreign currency vs USD or EUR.




- **Model:** real effective exchange rate modelled as function of terms of trade (+ impact), current account balance (-), international investment income balance (+), government debt (-) and inflation (-).
- **Hedging rule:** sell (buy) currencies which are over (under) valued by at least 10%. Hold hedge for 6 to 12-months to capture mean reversion.
- **Current signals**
  - In real effective (trade-weighted terms), the cheapest currencies are NOK, GBP, and USD, and the most expensive are JPY, CHF, and EUR.
  - In bilateral terms, the currencies breaching 10% misalignment are:
    - USD-based hedgers: CHF, JPY, NZD, EUR, and AUD are too expensive vs USD, so are sells.
    - EUR-based hedgers: NOK, GBP, CAD, USD, and SEK are cheap vs EUR, so are buys; CHF is expensive vs EUR so is a sell.

# Using alpha models to adjust tactical hedge ratios



**Current signals from rate momentum model (forward carry)**
Signals based on changes in 1-month rates 3-months forward over the past month

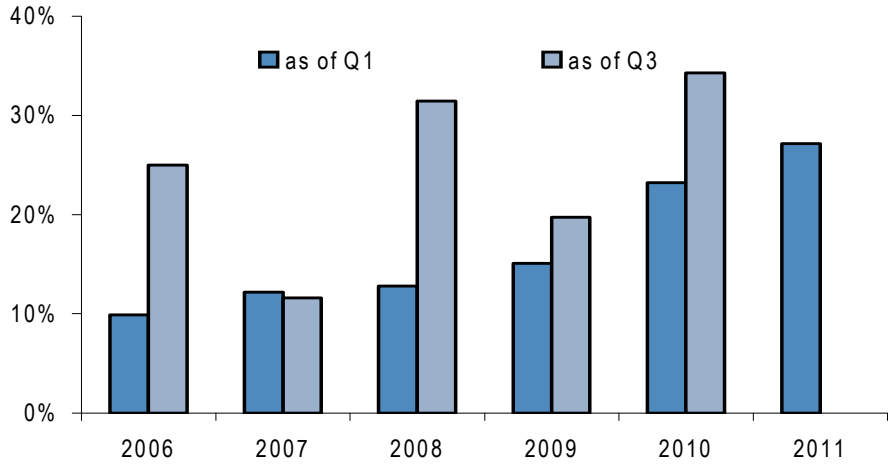
| | USD | JPY | EUR | GBP | CHF | NOK | SEK | CAD | AUD | NZD |
|---|---|---|---|---|---|---|---|---|---|---|
| **USD-based hedgers** | | | | | | | | | | |
| Current signal (column ccy vs.USD) | NA | Sell | Buy | Sell | Sell | Buy | Buy | Sell | Sell | Sell |
| Change in spreads over past month (bp, column ccy minus US) | NA | -4.0 | 11.4 | -3.0 | -6.3 | 14.1 | 2.9 | -3.1 | -28.0 | -4.9 |
| Signal returns over past 6mos | NA | 3.0% | 0.7% | 1.7% | -1.5% | 12.0% | 3.2% | 4.8% | -13.4% | 1.5% |
| **EUR-based hedgers** | | | | | | | | | | |
| Current signal (column ccy vs.EUR) | Sell | Sell | NA | Sell | Sell | Buy | Sell | Sell | Sell | Sell |
| Change in spreads over past month (bp, column ccy minus Euro) | -11.4 | -15.4 | NA | -14.4 | -17.7 | 2.7 | -8.5 | -14.5 | -39.4 | -16.3 |
| Signal returns over past 6mos | 0.7% | 2.3% | NA | 0.8% | -10.6% | -4.0% | -3.8% | 5.6% | 3.7% | -5.2% |
| **GBP-based hedgers** | | | | | | | | | | |
| Current signal (column ccy vs.GBP) | Buy | Sell | Buy | NA | Sell | Buy | Buy | Sell | Sell | Sell |
| Change in spreads over past month (bp, column ccy minus UK) | 3.0 | -1.0 | 14.4 | NA | -3.3 | 17.0 | 5.9 | -0.2 | -25.0 | -1.9 |
| Signal returns over past 6mos | 1.7% | 8.4% | 0.8% | NA | -1.8% | -5.8% | -1.2% | -2.2% | -7.8% | 4.3% |

- **Model**
  - Rate expectations drive short-term currency trends by signalling shifts in cyclical momentum, relative monetary policy and eventually carry. Thus we use the term **forward carry** to describe a signal based on changes in rate expectations between two countries.
  - Hedging rule is to sell (buy) currencies in whose favor interest rate expectations have moved over past month.
- **Current signals**
  - **USD-based hedgers**: Buy USD vs JPY, GBP, CHF, CAD, AUD and NZD and sell USD vs all other currencies.
  - **EUR-based hedgers:** Buy EUR vs USD, JPY, GBP, CHF, SEK, CAD, AUD, NZD and sell EUR vs. NOK.

# Corporate hedging policy: six key issues



**Percentage of year-ahead revenues that G-3 corporates hedged by Q1 and Q3 of each year**
Based on J.P. Morgan Corporate Hedging Survey conducted each quarter




- **1. Coverage: Balance sheet versus cash flow hedging**
  - Most corporates would not hedge balance sheet exposure if they plan to be invested in the country for a very long time. The cost could also be substantial given the size of foreign exposure. Private equity firms are most likely to hedge the investment since they intend to dispose within a few years. Corporates tend to hedge cash flows only, on a rolling basis.
- **2. Hedge ratio: Full versus partial hedging**
  - **Optimal hedge ratios are not uniform** across corporates. Depends on **predictability of cash flows**, **tightness of margins**, **natural currency diversification** of the firm's business and treasury's **ability to forecast exchange rates**. In J.P.Morgan's quarterly *Corporate Hedging Survey*, corporates on average hedge 75% of quarter-ahead cash flows and 25% of year-ahead cash flows.
- **3. Management: Centralised versus local**
  - Centralised hedging takes portfolio approach to the firm's exposure, so benefits from netting. In many EM currencies (Asia), however, **exchange controls** could require the local subsidiary to hedge onshore. Most corporates centralise hedging unless exchange controls are prohibitive.

# Corporate hedging policy: forwards versus options



**Option-based hedges (ATM puts or risk reversals) have outperformed forwards**
Benchmark hedge is a 50% short foreign currency forward. Option hedges are sized to provide the same hedge ratio as the benchmark forward hedge at inception. No transaction costs

| Local Currency | Strategy | Average Return | Volatility | IR |
|---|---|---|---|---|
| AUD | Unhedged | -6.5% | 15.2% | -0.43 |
| | Hedged via Forward | -1.8% | 6.3% | -0.28 |
| | Hedged via Option | 0.1% | 7.8% | 0.01 |
| | Hedged via 40dRiskReversal | -1.5% | 5.9% | -0.26 |
| | Hedged via 25dRiskReversal | -1.7% | 5.8% | -0.29 |
| | Hedged via 10dRiskReversal | -6.4% | 13.4% | -0.48 |
| | Hedged via Signal (option and fwd) | -0.6% | 8.2% | -0.08 |
| | Hedged via Signal (25d rr and fwd) | -1.8% | 5.9% | -0.30 |
| EUR | Unhedged | -3.1% | 10.1% | -0.31 |
| | Hedged via Forward | -1.6% | 4.6% | -0.35 |
| | Hedged via Option | -1.5% | 5.5% | -0.28 |
| | Hedged via 40dRiskReversal | -1.4% | 4.6% | -0.30 |
| | Hedged via 25dRiskReversal | -1.2% | 4.8% | -0.24 |
| | Hedged via 10dRiskReversal | -2.6% | 6.7% | -0.38 |
| | Hedged via Signal (option and fwd) | -1.5% | 5.6% | -0.28 |
| | Hedged via Signal (25d rr and fwd) | -1.6% | 4.8% | -0.33 |
| GBP | Unhedged | 0.7% | 10.5% | 0.07 |
| | Hedged via Forward | 0.9% | 5.0% | 0.18 |
| | Hedged via Option | 1.0% | 6.2% | 0.15 |
| | Hedged via 40dRiskReversal | 1.0% | 5.1% | 0.19 |
| | Hedged via 25dRiskReversal | 1.0% | 5.6% | 0.18 |
| | Hedged via 10dRiskReversal | 0.5% | 8.6% | 0.06 |
| | Hedged via Signal (option and fwd) | 0.8% | 5.9% | 0.13 |
| | Hedged via Signal (25d rr and fwd) | 1.1% | 5.5% | 0.19 |

- **4. Instruments: Forwards versus options**
  - Forwards are considered simpler, less-risky instruments because they guarantee a conversion rate for future cash flows. Still, many corporates are reluctant to hedge when foreign rates are above domestic ones, thus entailing a negative carry hedge.
  - The conventional wisdom on forwards understates their limitations. Options such as vanilla currency puts have the advantage of entailing a defined downside (premium paid) and can be structured as zero-cost instruments (risk reversals/collars).
- **5. Timing: Fixed hedging schedule versus opportunistic hedging**
  - Fixed hedging every month, quarter or year should be done when the objective is to minimise cash flow volatility and the corporate has no view on currency direction. Opportunistic hedging is more cost-effective when the corporate has some success in identifying the currencies most vulnerable to a large move. The treasurer could control for forecast error by hedging less than 100%.

# Proxy hedging: sensible under certain conditions

**Beta matrix: EM Asian currencies**
Beta from regressing row currency on column currency over past 12mos; based on weekly changes

| | SGD | MYR | THB | TWD | KRW | INR | IDR | PHP | CNY | HKD |
|---|---|---|---|---|---|---|---|---|---|---|
| **SGD** | NA | 0.53 | 0.58 | 0.64 | 0.29 | 0.61 | 0.79 | 0.55 | 1.22 | 4.00 |
| **MYR** | 0.81 | NA | 0.29 | 0.86 | 0.42 | 0.70 | 1.33 | 0.75 | 1.23 | 4.17 |
| **THB** | 0.30 | 0.10 | NA | 0.24 | 0.07 | 0.24 | 0.12 | 0.19 | 0.57 | 1.07 |
| **TWD** | 0.48 | 0.42 | 0.35 | NA | 0.25 | 0.47 | 0.53 | 0.38 | 1.10 | 3.08 |
| **KRW** | 1.70 | 1.61 | 0.80 | 2.00 | NA | 1.56 | 2.43 | 1.56 | 1.82 | 11.48 |
| **INR** | 1.02 | 0.76 | 0.76 | 1.04 | 0.44 | NA | 1.29 | 0.78 | 1.69 | 5.41 |
| **IDR** | 0.44 | 0.49 | 0.12 | 0.40 | 0.23 | 0.43 | NA | 0.43 | 0.47 | 2.55 |
| **PHP** | 0.99 | 0.89 | 0.65 | 0.93 | 0.48 | 0.85 | 1.40 | NA | 0.82 | 5.27 |
| **CNY** | 0.11 | 0.08 | 0.10 | 0.14 | 0.03 | 0.09 | 0.08 | 0.04 | NA | 0.24 |
| **HKD** | 0.09 | 0.06 | 0.04 | 0.09 | 0.04 | 0.07 | 0.10 | 0.06 | 0.06 | NA |

- **6. Proxy hedging:** depends on four variables
  - **Beta** between underlying exposure (asset/earnings stream) and proxy variable
  - **Liquidity** of underlying versus proxy
  - **Cost** of underlying versus proxy
  - **Size** of underlying exposure relative to total portfolio/corporate exposure
- **Proxy hedging is sensible where** the exposure is meaningful, the beta high, the liquidity deeper elsewhere and the cost cheaper
- **Example**
  - TWD exposure well hedged with CNY but not with MYR or KRW
  - KRW exposure not well hedged with other currencies, thus highlighting the idiosyncratic risk

# Agenda

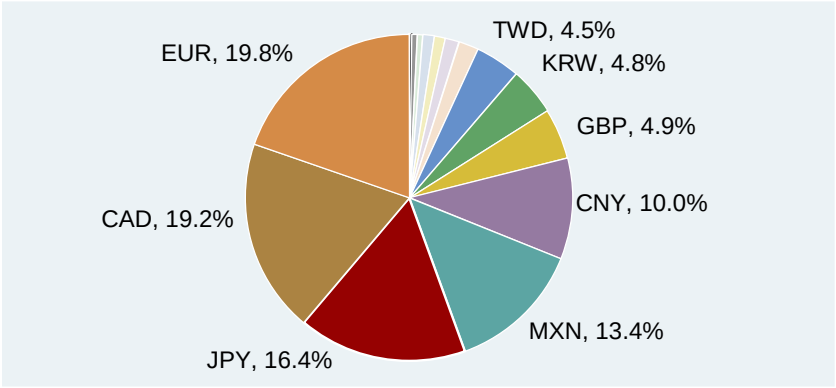




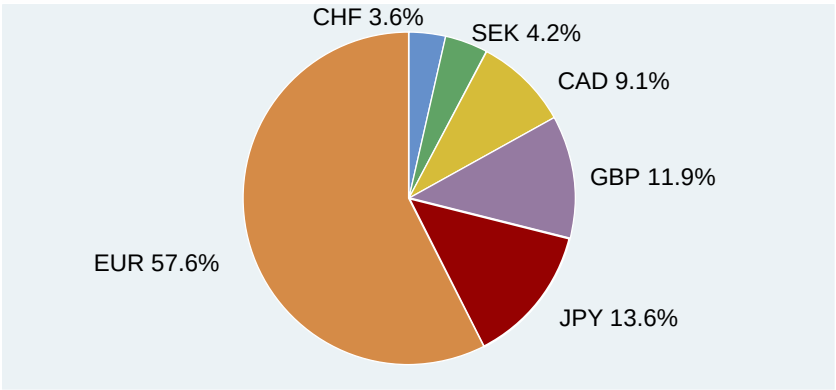
J.P.Morgan

# J.P. Morgan nominal effective exchange rate indices

**J.P. Morgan US Dollar TCI weights**
Based on 2000 trade weights



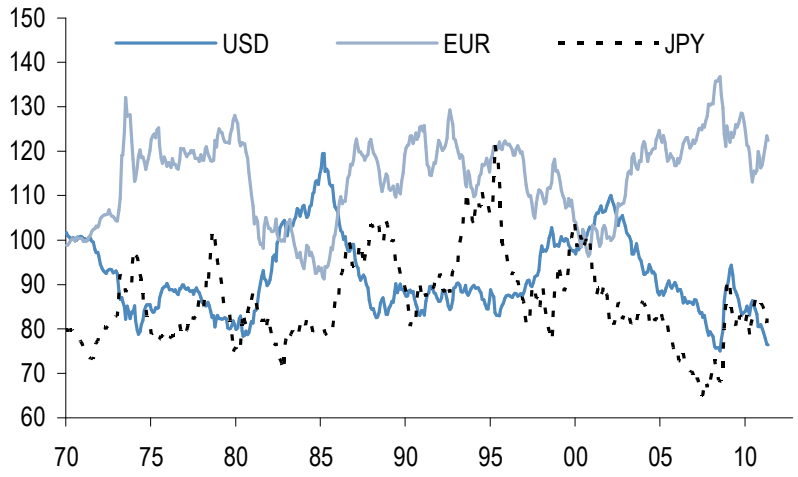

**DXY weights**




- Tradeable Currency Indices (TCIs) are investable versions of nominal trade-weighted indices produced by J.P. Morgan Economic Research since the 1970s
- TCIs currently are available for 17 countries in the G-10 and emerging markets. Intra-day indications and daily fixings are posted on Bloomberg <ALLX JPMQ>
- TCIs offer three advantages over existing products: more representative weights, a mechanism for regular reweighting and broader country coverage
- TCIs can be used for several medium-term investment strategies such as macro hedges, lower-volatility carry trades and cheaper long-term valuation trades
- J.P. Morgan offers forwards and options on the indices
- See *J.P. Morgan Tradeable Currency Indices (TCIs),* J. Normand, Jul 2, 2007

# J.P. Morgan real effective exchange rate indices

**J.P. Morgan REER for USD, EUR and JPY**
Index value




**J.P. Morgan real effective exchange rate indices on www.morganmarkets.com/GlobalFXStrategy**

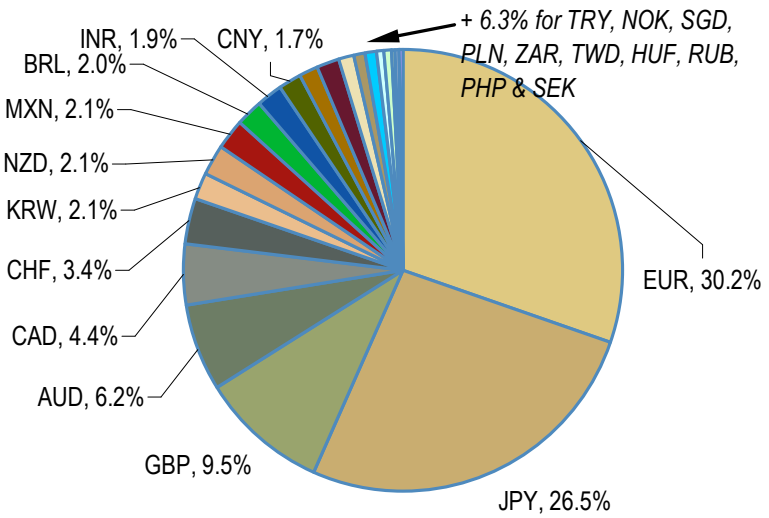
Tools

| Tool Name | Contact | Info |
|---|---|---|
| DataQuery | MorganMarkets@jpmorgan.com | ? |
| FX Volatility Center | FXOCom Support | ? |
| Correlation Analyzer | Arindam Sandilya and Talis Bauer | |
| Chart-O-Rama | FXOCom Support | ? |
| J.P. Morgan Real Effective Exchange Rate Indices | Carlton Strong | ? |
| Empire | Victor Dituro | |

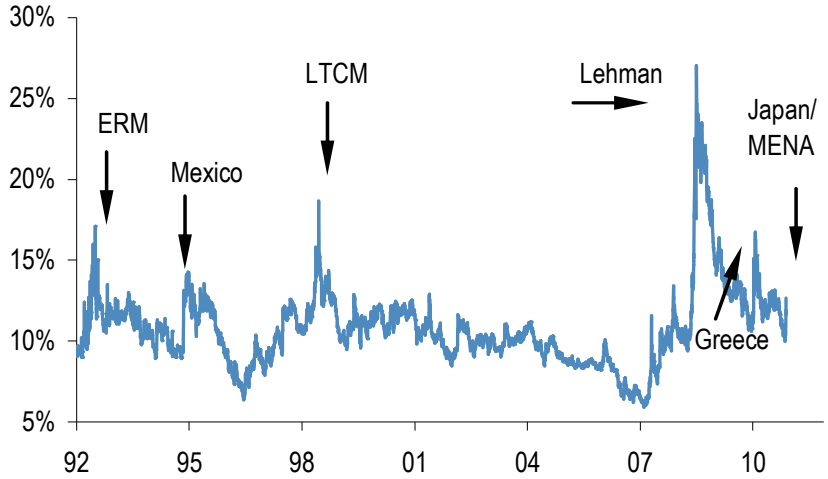
- J.P. Morgan has been publishing real effective exchange rate indices since the early 1970s.
- Monthly levels on real trade-weighted indices constructed by J.P.Morgan and covering 45 countries. Data are available since the 1970s for G-10 countries, and since the 1980s for most other markets.
- Available on Bloomberg with tickers "JBXR" plus the currency code (e.g. JBXRUSD for the dollar's real effective exchange rate).
- See *J.P. Morgan effective exchange rates: revised and modernized,* D. Hargreaves and C Strong, May 30, 2003

# J.P. Morgan VXY Global ™ index of global FX implied volatility

**J.P. Morgan VXY Global™ weights, 2010**
Based on BIS-reported options market turnover



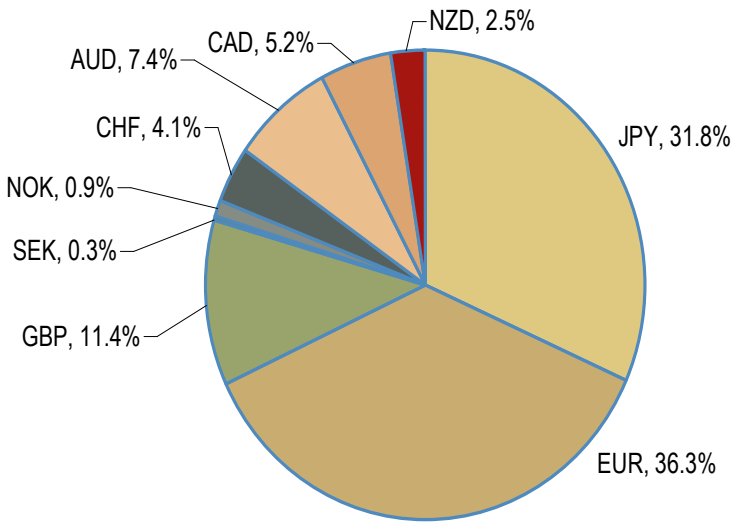

**J.P. Morgan VXY Global™ level (%)**




- In 2006 J.P. Morgan launched **VXY** and EM-**VXY** as the first benchmarks for aggregate FX implied volatility for G-10 and emerging markets.
- **VXY Global** was launched in 2011 to produce the world's first global index for currency vol.
- The indices are based on 3-month at-the-money-forward options weighted by market turnover
- VXY™ is priced continuously and intra-day updates are reported on Bloomberg through the tickers JPMVXYGL <Index>
- See *Rebalancing VXY™ and Introducing VXY Global™*, J Normand and A. Sandilya, March 25, 2011.

# J.P. Morgan VXY™ index of G-10 FX implied volatility

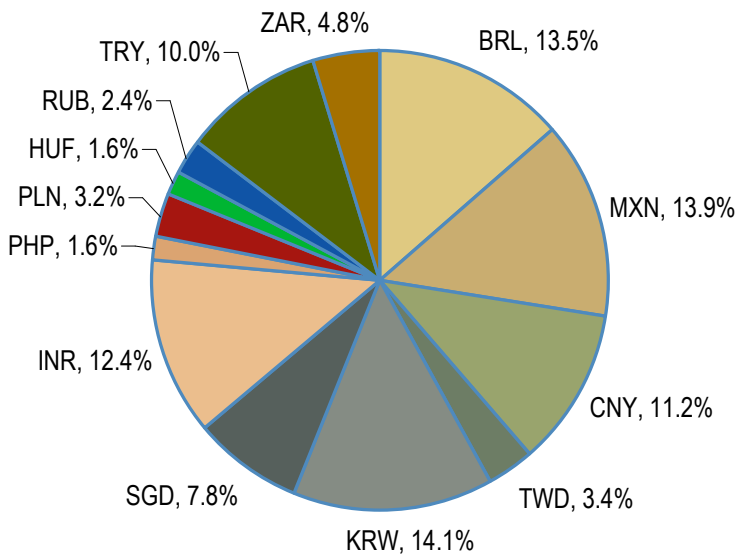
**J.P. Morgan VXY™ weights, 2010**
Based on BIS-reported options market turnover




- In 2006 J.P. Morgan launched VXY™ and EM-VXY™ as the first benchmarks for aggregate FX implied volatility
- The indices are based on 3-month at-the-money-forward options weighted by market turnover
- VXY™ and EM-VXY™ can be used to measure aggregate risk premia in currency markets, calibrate trading strategies and express views on volatility as an asset class
- VXY™ is priced continuously and intra-day updates are reported on Bloomberg through the tickers JPMVXYG7 <Index>
- J.P. Morgan offers access through forward contracts that will settle with reference to a fixing level
- See *Introducing the J.P. Morgan VXY™ & EM-VXY™*, J. Normand and A. Sandilya, Dec 11, 2006.

# J.P. Morgan EM-VXY™ index of emerging markets FX implied volatility

**J.P. Morgan EM-VXY™ weights, 2010**
Based on BIS-reported options market turnover




- EM-VXY™ is the first benchmark for implied volatility in emerging markets currencies
- The indices are based on 3-month at-the-money-forward options weighted by market turnover
- EM-VXY™ is priced continuously and intra-day updates are reported on Bloomberg through the ticker JPMVXYEM <Index>
- J.P. Morgan offers access to the index through forward contracts that will settle with reference to a fixing level
- See *Introducing the J.P. Morgan VXY™ & EM-VXY™*, J. Normand and A. Sandilya, Dec 11, 2006

# Appendix table 1: Global FX turnover, 2001-10: spot markets

**Global FX turnover in spot markets, 2001 to 2010**
All figures in $ billion, based on BIS *Triennial Central Bank Survey*

| | 2010 | | | 2007 | | | 2004 | | | 2001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | vs all currencies | vs USD | vs EUR | vs all currencies | vs USD | vs EUR | vs all currencies | vs USD | vs EUR | vs all currencies | vs USD | vs EUR |
| **USD** | 1187 | NA | 469 | 790 | NA | 265 | 528 | NA | 195 | 327 | NA | 116 |
| **JPY** | 300 | 183 | 73 | 206 | 140 | 44 | 130 | 104 | 24 | 101 | 81 | 18 |
| **EUR** | 691 | 469 | NA | 420 | 265 | NA | 273 | 195 | NA | 166 | 116 | NA |
| **GBP** | 212 | 139 | 50 | 150 | 103 | 30 | 83 | 61 | 18 | 42 | 28 | 12 |
| **SEK** | 19 | 5 | 11 | 18 | 6 | 10 | 10 | NA | NA | 6 | NA | NA |
| **NOK** | 12 | NA | NA | 12 | NA | NA | 5 | NA | NA | 3 | NA | NA |
| **DKK** | 5 | NA | NA | 6 | NA | NA | 3 | NA | NA | 3 | NA | NA |
| **CHF** | 92 | 51 | 35 | 88 | 49 | 33 | 41 | 22 | 17 | 27 | 18 | 9 |
| **AUD** | 111 | 84 | 5 | 53 | 39 | 3 | 29 | 25 | 0.9 | 14 | 13 | 0.5 |
| **CAD** | 78 | 65 | 5 | 38 | 33 | 2 | 24 | 23 | 0.7 | 16 | 15 | 0.3 |
| **NZD** | 22 | NA | NA | 17 | NA | NA | 4 | NA | NA | 1 | NA | NA |
| **BRL** | 9 | 8 | NA | 6 | NA | NA | 3 | NA | NA | 4 | NA | NA |
| **MXN** | 18 | NA | NA | 15 | NA | NA | 11 | NA | NA | 5 | NA | NA |
| **CNY** | 8 | 6 | NA | 9 | NA | NA | 0.9 | NA | NA | 0.04 | NA | NA |
| **HKD** | 19 | 13 | NA | 16 | NA | NA | 7 | NA | NA | 6 | NA | NA |
| **TWD** | 6 | NA | NA | 5 | NA | NA | 4 | NA | NA | 2 | NA | NA |
| **KRW** | 21 | 20 | NA | 15 | NA | NA | 11 | NA | NA | 6 | NA | NA |
| **SGD** | 16 | NA | NA | 8 | NA | NA | 5 | NA | NA | 3 | NA | NA |
| **THB** | 3 | NA | NA | 1.2 | NA | NA | 1.3 | NA | NA | 0.5 | NA | NA |
| **IDR** | 2 | NA | NA | 1.4 | NA | NA | 0.8 | NA | NA | 0.3 | NA | NA |
| **INR** | 14 | 13 | NA | 9 | NA | NA | 3 | NA | NA | 1 | NA | NA |
| **PHP** | 2 | NA | NA | 1.3 | NA | NA | 0 | NA | NA | 0 | NA | NA |
| **CZK** | 1.3 | NA | NA | 2 | NA | NA | 0.7 | NA | NA | 0.7 | NA | NA |
| **PLN** | 7 | NA | NA | 5 | NA | NA | 2 | NA | NA | 2 | NA | NA |
| **HUF** | 4 | NA | NA | 3 | NA | NA | 0.8 | NA | NA | 0.2 | NA | NA |
| **RUB** | 18 | NA | NA | 18 | NA | NA | 10 | NA | NA | 4 | NA | NA |
| **TRY** | 8 | NA | NA | 3 | NA | NA | 0.8 | NA | NA | 0.3 | NA | NA |
| **ZAR** | 9 | 7 | NA | 6 | NA | NA | 2 | NA | NA | 2 | NA | NA |

Source: J.P. Morgan and BIS Triennial Central Bank Survey

# Appendix table 2: Global FX turnover, 2001-10: options markets

**Global FX turnover in options markets, 2001 to 2010**
All figures in $ billion, based on BIS *Triennial Central Bank Survey*

| | 2010 | | | 2007 | | | 2004 | | | 2001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | vs all currencies | vs USD | vs EUR | vs all currencies | vs USD | vs EUR | vs all currencies | vs USD | vs EUR | vs all currencies | vs USD | vs EUR |
| **USD** | 160 | NA | 51 | 158 | 43 | 43 | 92 | NA | 31 | 48 | NA | 16 |
| **JPY** | 54 | 44 | 6 | 60 | 38 | 16 | 37 | 27 | 10 | 24 | 17 | 6 |
| **EUR** | 87 | 51 | NA | 81 | 43 | NA | 51 | 31 | NA | 26 | 16 | NA |
| **GBP** | 20 | 10 | 7 | 28 | 19 | 4 | 12 | 9 | 3 | 5 | 3 | 2 |
| **SEK** | 2.95 | 0.28 | 2 | 3 | 0.4 | 2 | 1.65 | NA | NA | 0.680 | NA | NA |
| **NOK** | 1.90 | NA | NA | 3 | NA | NA | 0.86 | NA | NA | 0.318 | NA | NA |
| **DKK** | 0.20 | NA | NA | 0.18 | NA | NA | 0.26 | NA | NA | 0.059 | NA | NA |
| **CHF** | 13.40 | 4 | 8 | 16 | 6 | 8 | 7 | 3 | 4 | 2.903 | 2 | 1 |
| **AUD** | 15.33 | 10 | 1 | 13 | 9 | 0.71 | 9 | 7 | 0.7 | 3.421 | 3 | 0.1 |
| **CAD** | 6.10 | 4 | 1 | 10 | 9 | 0.35 | 6 | 6 | 0.2 | 2.978 | 3 | 0.007 |
| **NZD** | 2.79 | NA | NA | 3.81 | NA | NA | 0.81 | NA | NA | 0.054 | NA | NA |
| **BRL** | 4.66 | 4 | NA | 1.68 | NA | NA | 0.42 | NA | NA | 0.250 | NA | NA |
| **MXN** | 2.32 | NA | NA | 4.19 | NA | NA | 0.71 | NA | NA | 0.135 | NA | NA |
| **CNY** | 5.00 | 5 | NA | 0.24 | NA | NA | 0.14 | NA | NA | 0.001 | NA | NA |
| **HKD** | 1.69 | 1 | NA | 3.86 | NA | NA | 0.37 | NA | NA | 0.075 | NA | NA |
| **TWD** | 1.27 | NA | NA | 0.34 | NA | NA | 0.72 | NA | NA | 0.144 | NA | NA |
| **KRW** | 3.56 | 3 | NA | 3.08 | NA | NA | 0.58 | NA | NA | 0.159 | NA | NA |
| **SGD** | 2.68 | NA | NA | 0.99 | NA | NA | 0.27 | NA | NA | 0.161 | NA | NA |
| **THB** | 0.10 | NA | NA | 0.06 | NA | NA | 0.13 | NA | NA | 0.004 | NA | NA |
| **IDR** | 0.16 | NA | NA | 0.23 | NA | NA | 0.01 | NA | NA | 0.000 | NA | NA |
| **INR** | 3.75 | 3 | NA | 2.08 | NA | NA | 0.10 | NA | NA | 0.000 | NA | NA |
| **PHP** | 0.69 | NA | NA | 0.04 | NA | NA | 0.01 | NA | NA | 0.001 | NA | NA |
| **CZK** | 0.22 | NA | NA | 0.23 | NA | NA | 0.10 | NA | NA | 0.058 | NA | NA |
| **PLN** | 2.08 | NA | NA | 0.94 | NA | NA | 0.26 | NA | NA | 0.103 | NA | NA |
| **HUF** | 1.24 | NA | NA | 0.27 | NA | NA | 0.07 | NA | NA | 0.002 | NA | NA |
| **RUB** | 1.05 | NA | NA | 0.09 | NA | NA | 0.01 | NA | NA | 0.001 | NA | NA |
| **TRY** | 3.76 | NA | NA | 0.91 | NA | NA | 0.05 | NA | NA | 0.001 | NA | NA |
| **ZAR** | 1.04 | 1 | NA | 1.23 | NA | NA | 0.28 | NA | NA | 0.317 | NA | NA |

Source: J.P. Morgan and BIS Triennial Central Bank Survey

# Appendix table 3: Global central bank FX reserves

**Central bank FX reserves, 2000 to 2011**
All figures in $ billion

| | 2011 | 2010 | 2009 | 2008 | 2007 | 2006 | 2005 | 2004 | 2003 | 2002 | 2001 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| China | 3045 | 2847 | 2399 | 1946 | 1528 | 1066 | 819 | 610 | 403 | 286 | 212 | 166 |
| Japan | 1062 | 1036 | 997 | 1003 | 948 | 875 | 829 | 824 | 653 | 451 | 388 | 347 |
| Russia | 524 | 479 | 438 | 438 | 454 | 281 | 165 | 114 | 65 | 44 | 33 | 24 |
| Saudi Arabia | 482 | 443 | 397 | 440 | 304 | 224 | 153 | 23 | 18 | 17 | 15 | 18 |
| Taiwan | 399 | 382 | 348 | 292 | 270 | 266 | 253 | 242 | 207 | 162 | 122 | 107 |
| Norway | 305 | 307 | 282 | 357 | 330 | 354 | 318 | 268 | 251 | 225 | 211 | 246 |
| Brazil | 330 | 289 | 239 | 194 | 180 | 86 | 54 | 53 | 49 | 38 | 36 | 33 |
| Korea | 304 | 292 | 270 | 201 | 262 | 239 | 210 | 199 | 155 | 121 | 103 | 96 |
| India | 277 | 268 | 259 | 246 | 267 | 170 | 131 | 125 | 97 | 67 | 45 | 37 |
| Hong Kong | 273 | 269 | 256 | 183 | 153 | 133 | 124 | 124 | 118 | 112 | 111 | 108 |
| Singapore | 240 | 226 | 188 | 174 | 163 | 136 | 116 | 113 | 96 | 82 | 76 | 80 |
| Switzerland | 230 | 217 | 92 | 44 | 44 | 37 | 35 | 54 | 46 | 38 | 30 | 31 |
| Euro area | 214 | 207 | 194 | 202 | 203 | 184 | 167 | 181 | 188 | 216 | 208 | 219 |
| Thailand | 184 | 172 | 138 | 111 | 87 | 67 | 52 | 50 | 42 | 39 | 33 | 33 |
| Algeria | 174 | 157 | 147 | 143 | 110 | 78 | 56 | 43 | 33 | 23 | 18 | 12 |
| Mexico | 130 | 114 | 91 | 85 | 78 | 68 | 69 | 61 | 56 | 46 | 40 | 34 |
| Malaysia | 133 | 106 | 97 | 91 | 101 | 82 | 70 | 67 | 45 | 35 | 31 | 30 |
| Libya | 101 | 99 | 96 | 91 | 78 | 58 | 38 | 24 | 18 | 13 | 14 | 11 |
| Indonesia | 118 | 96 | 66 | 52 | 57 | 43 | 35 | 36 | 36 | 32 | 28 | 29 |
| Poland | 93 | 81 | 70 | 57 | 55 | 45 | 39 | 35 | 32 | 27 | 24 | 25 |
| Turkey | 93 | 81 | 70 | 70 | 71 | 61 | 51 | 36 | 34 | 27 | 19 | 20 |
| Denmark | 89 | 77 | 76 | 40 | 33 | 30 | 33 | 40 | 38 | 27 | 17 | 15 |
| Israel | 77 | 71 | 61 | 42 | 28 | 29 | 28 | 27 | 26 | 24 | 23 | 23 |
| Philippies | 69 | 62 | 44 | 37 | 34 | 23 | 18 | 17 | 17 | 16 | 16 | 15 |

Source: J.P. Morgan and national central banks/finance ministries

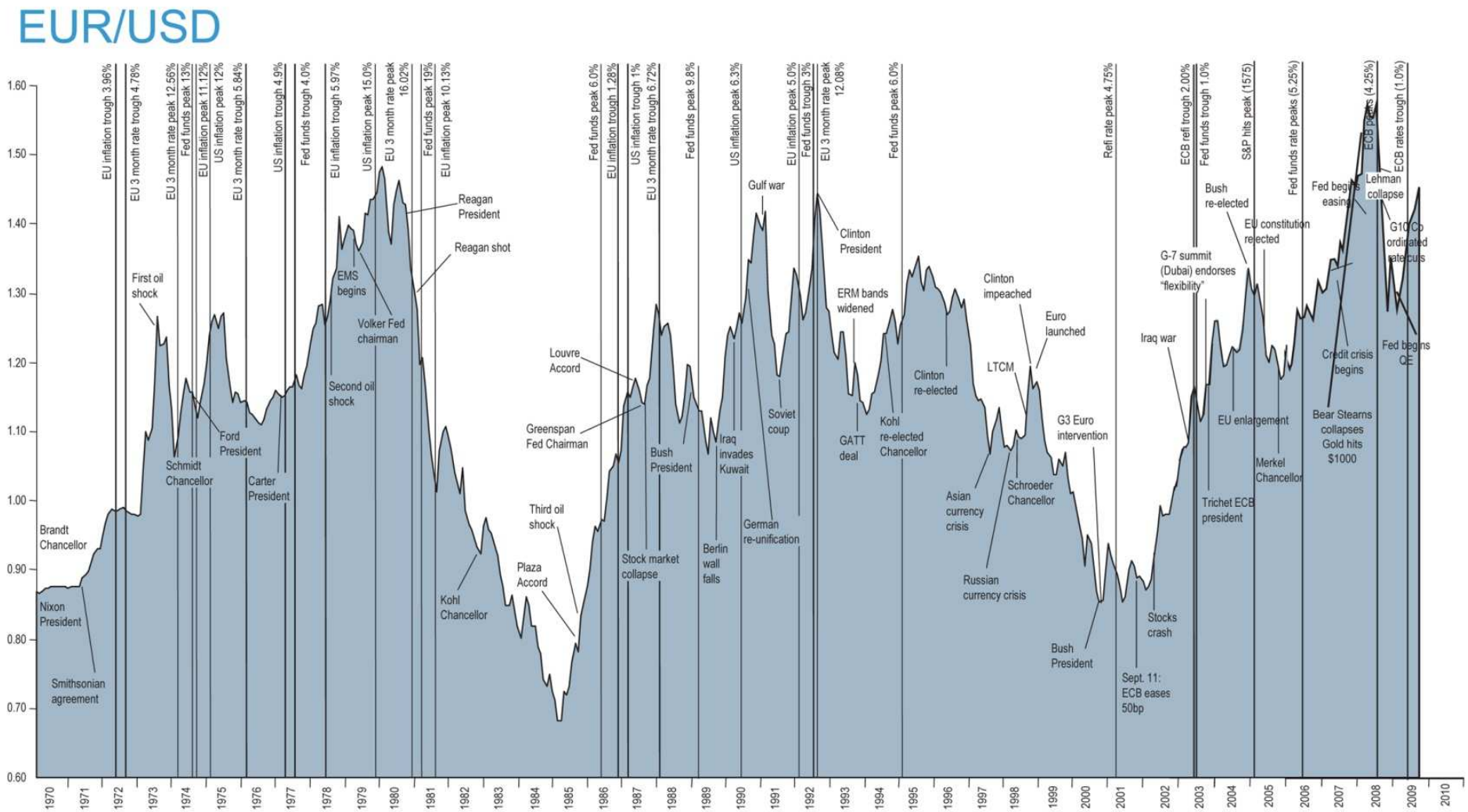
# Appendix table 3: Global central bank FX reserves

**Central bank FX reserves, 2000 to 2011**
All figures in $ billion

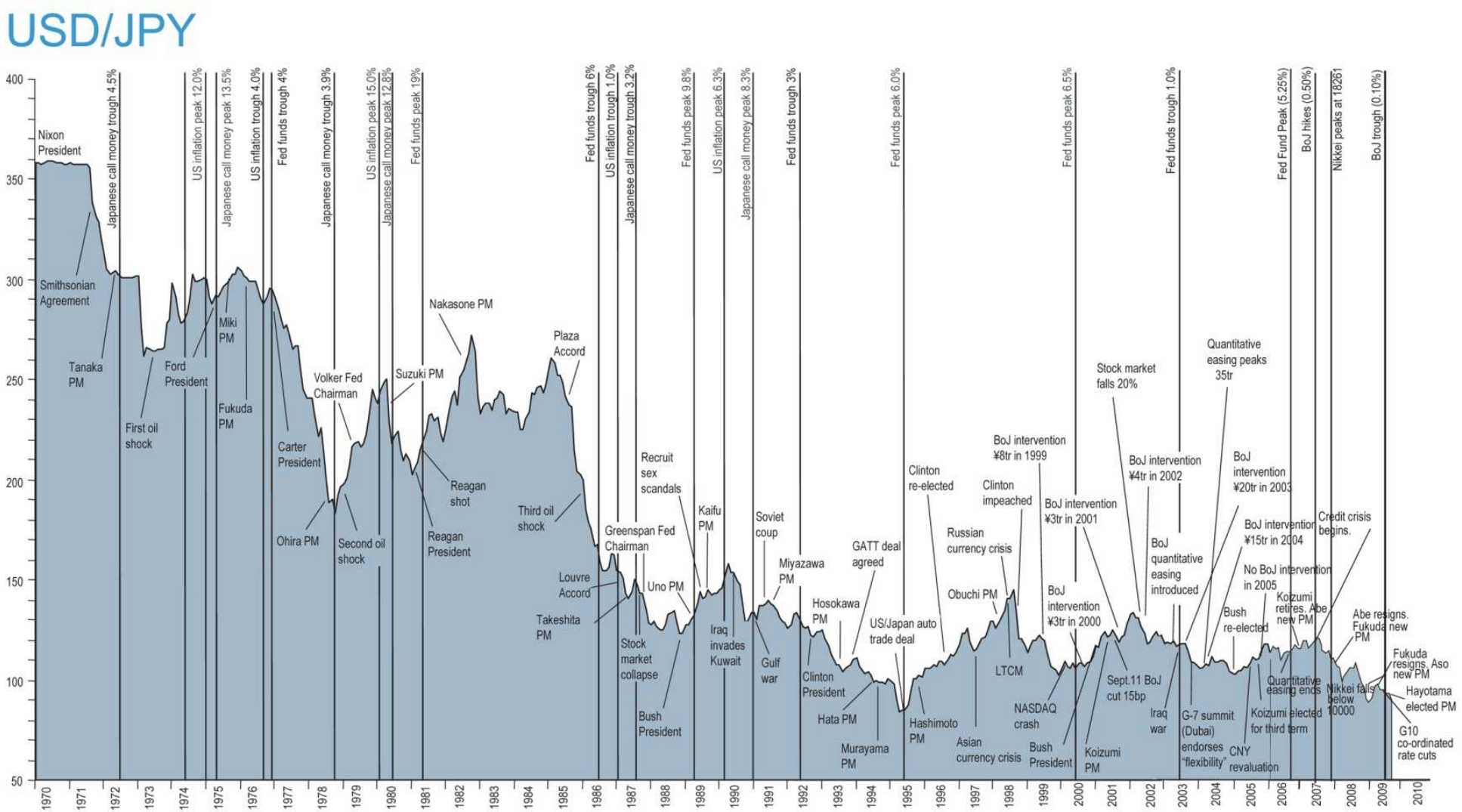
| | 2011 | 2010 | 2009 | 2008 | 2007 | 2006 | 2005 | 2004 | 2003 | 2002 | 2001 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Argentina** | 52 | 52 | 48 | 46 | 46 | 32 | 28 | 20 | 14 | 10 | 20 | 34 |
| **UK** | 56 | 49 | 38 | 42 | 47 | 39 | 36 | 34 | 29 | 31 | 29 | 34 |
| **USA** | 48 | 47 | 46 | 42 | 45 | 41 | 38 | 43 | 40 | 34 | 29 | 31 |
| **Canada** | 51 | 45 | 43 | 42 | 39 | 33 | 31 | 30 | 32 | 33 | 30 | 29 |
| **Peru** | 47 | 44 | 33 | 31 | 28 | 17 | 14 | 13 | 10 | 10 | 9 | 9 |
| **Hungary** | 49 | 43 | 41 | 33 | 23 | 21 | 18 | 15 | 12 | 10 | 10 | 11 |
| **Czech Republic** | 43 | 43 | 42 | 37 | 35 | 32 | 30 | 28 | 27 | 24 | 15 | 13 |
| **Sweden** | 41 | 41 | 40 | 40 | 39 | 39 | 39 | 38 | 38 | 38 | 37 | 37 |
| **South Africa** | 41 | 35 | 32 | 31 | 30 | 23 | 19 | 13 | 6 | 6 | 6 | 6 |
| **Egypt** | 27 | 36 | 34 | 34 | 32 | 26 | 22 | 15 | 13 | 13 | 13 | 13 |
| **Romania** | 34 | 32 | 28 | 26 | 25 | 21 | 17 | 10 | 8 | 6 | 4 | 2 |
| **Australia** | 32 | 33 | 33 | 29 | 24 | 53 | 41 | 34 | 30 | 18 | 16 | 17 |
| **Qatar** | 31 | 30 | 18 | 10 | 9 | 5 | 4 | 3 | 3 | 1 | 1 | 1 |
| **Colombia** | 30 | 27 | 25 | 24 | 21 | 15 | 15 | 14 | 11 | 11 | 10 | 9 |
| **Chile** | 33 | 28 | 25 | 23 | 17 | 19 | 17 | 16 | 16 | 15 | 14 | 15 |
| **Kazakhstan** | 32 | 25 | 20 | 18 | 16 | 18 | 6 | 8 | 4 | 3 | 2 | 2 |
| | | | | | | | | | | | | |
| **Developed markets** | 2128 | 2061 | 1840 | 1841 | 1754 | 1684 | 1567 | 1547 | 1343 | 1111 | 996 | 1006 |
| **Emerging markets** | 7465 | 6930 | 6019 | 5206 | 4563 | 3386 | 2672 | 2152 | 1672 | 1321 | 1102 | 1015 |
| **EM Asia ex China** | 1997 | 1873 | 1666 | 1386 | 1394 | 1160 | 1011 | 972 | 814 | 666 | 565 | 535 |
| **Latam** | 592 | 526 | 436 | 380 | 349 | 222 | 182 | 163 | 146 | 119 | 119 | 124 |
| **CEEMEA** | 1683 | 1550 | 1400 | 1397 | 1212 | 870 | 599 | 355 | 267 | 208 | 167 | 152 |

Source: J.P. Morgan and national central banks/finance ministries

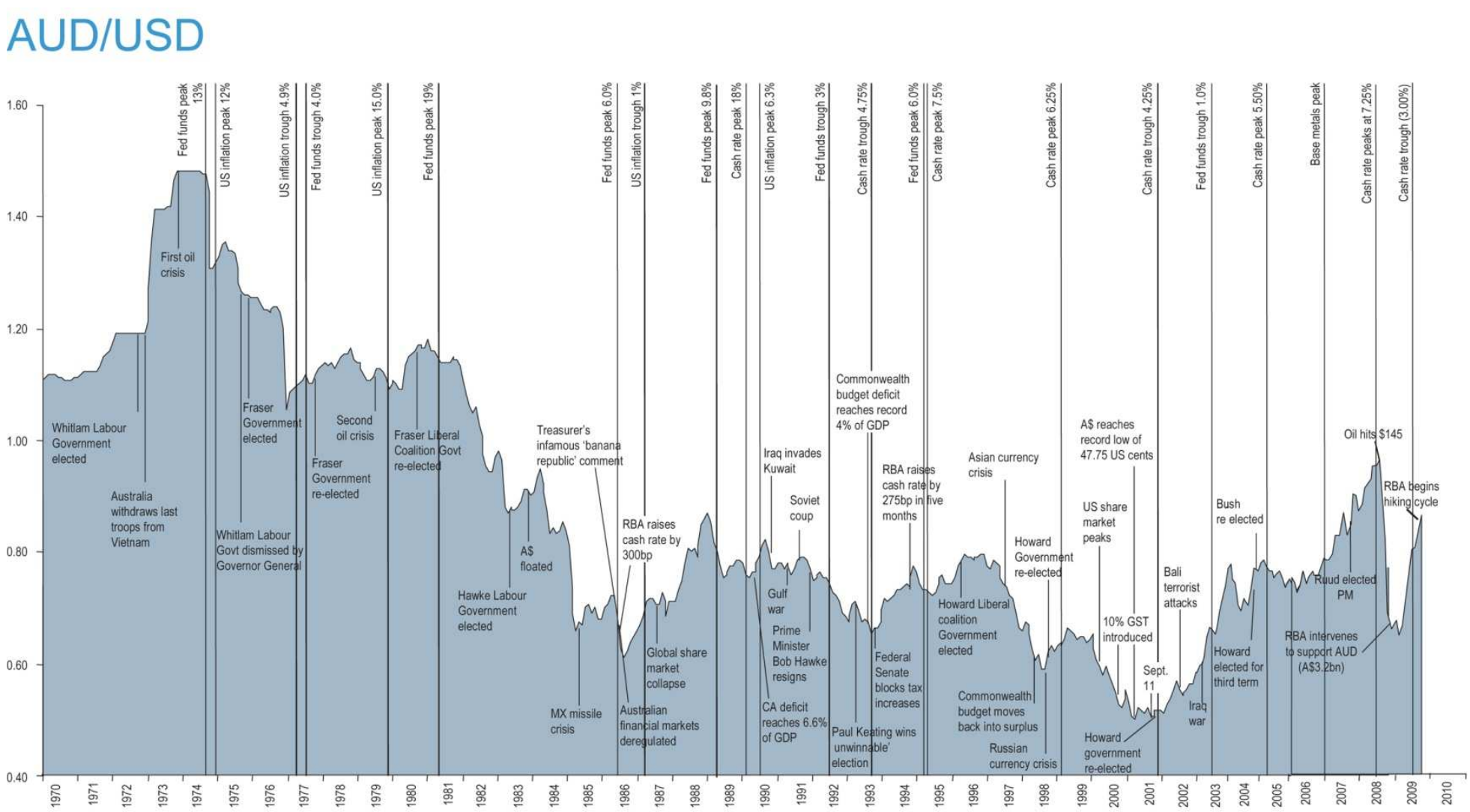
# EUR/USD since 1970 (synthetic euro pre-1999)



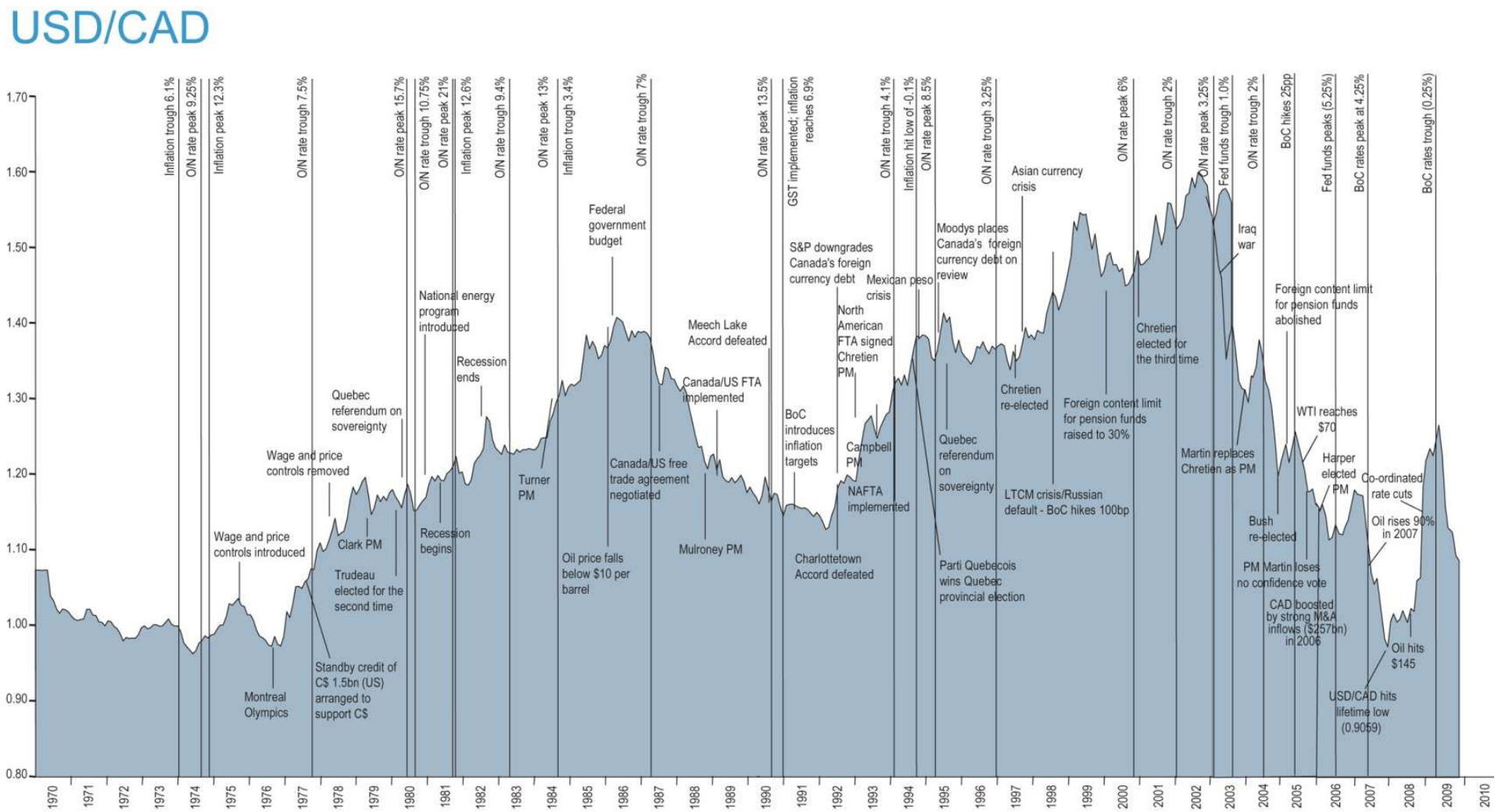
# USD/JPY since 1970



# AUD/USD since 1970



# USD/CAD since 1970



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