



INTRODUCTION TO THE FX MARKET

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Agenda

- Market characteristics
- Basic theories and models
- Investment strategies
- The currency basket of NBIM



MARKET CHARACTERISTICS



Basic terms and concepts

- Bilateral versus effective exchange rates: EURNOK (E = EURNOK) versus NOK I-44
- ISO-codes: NOK, SEK, EUR, BRL, IDR, CNY, TRY
- Quotes: EURNOK = 8.40 USDBRL = 2.52 AUDUSD = 0.88
- Bid-ask spread: 8.3961 – 8.3980

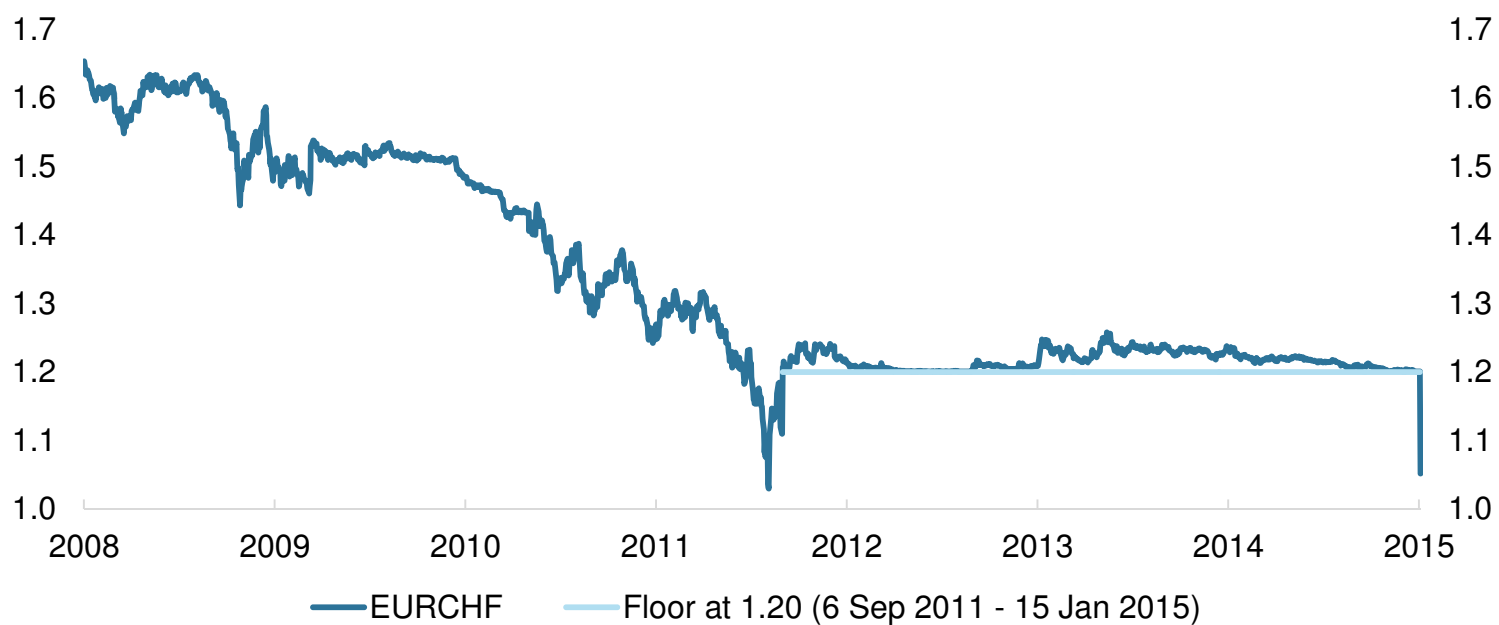


Basic terms and concepts (cont'd)

- Real exchange rate: $\varepsilon = EP^*/P$
- Depreciation ($E \uparrow$) / appreciation ($E \downarrow$) (nominal and real)
- Exchange rate regimes: Fixed/float
- FX interventions: Central bank buys/sell own currency to strengthen or weaken it

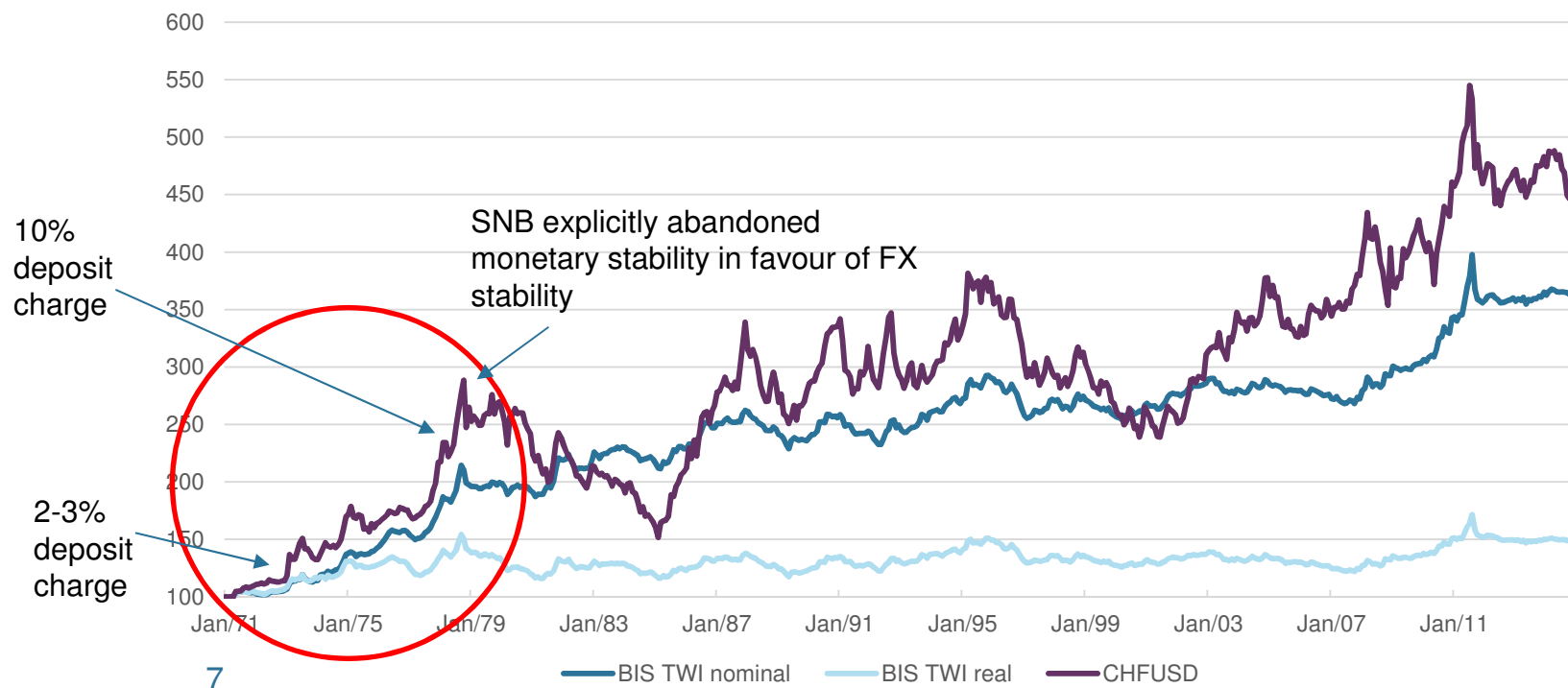


EURCHF: SNB letting go the 1.20 floor



CHF: Negative rates from 1972-78

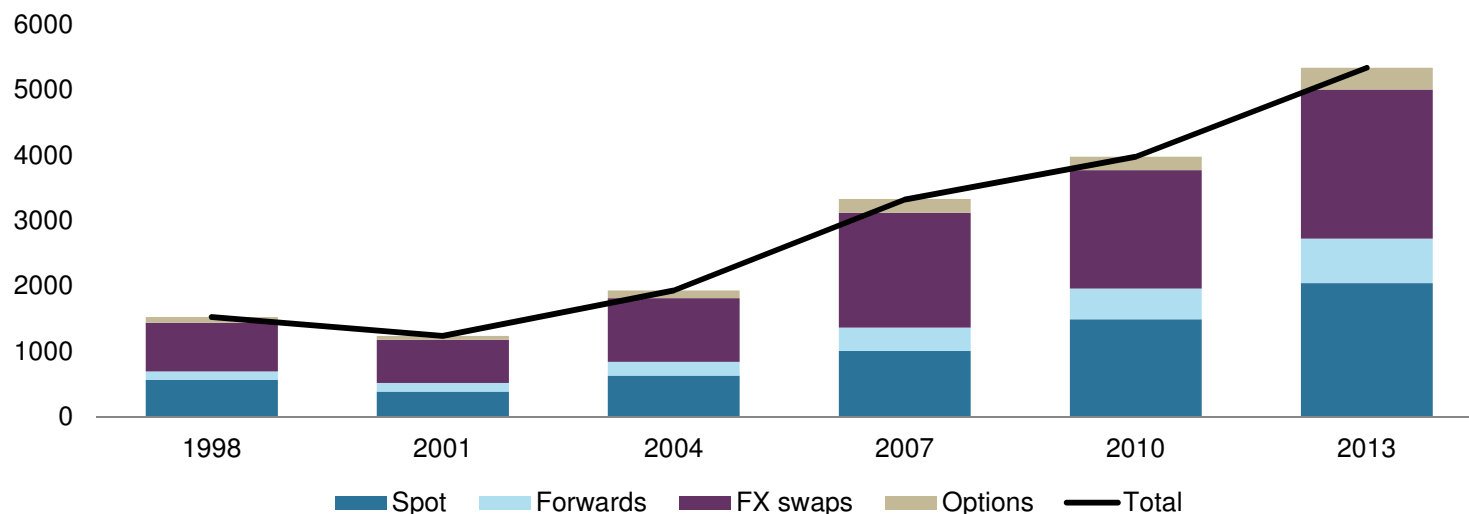
Trade weighted CHF appreciated by 100 per cent



The world's largest financial market

Average daily turnover 5.3 trillion USD (+35% from 2010)

Global FX market turnover Billion USD, daily average



Used in international trade, financial transactions, borrowing, investment and speculation.

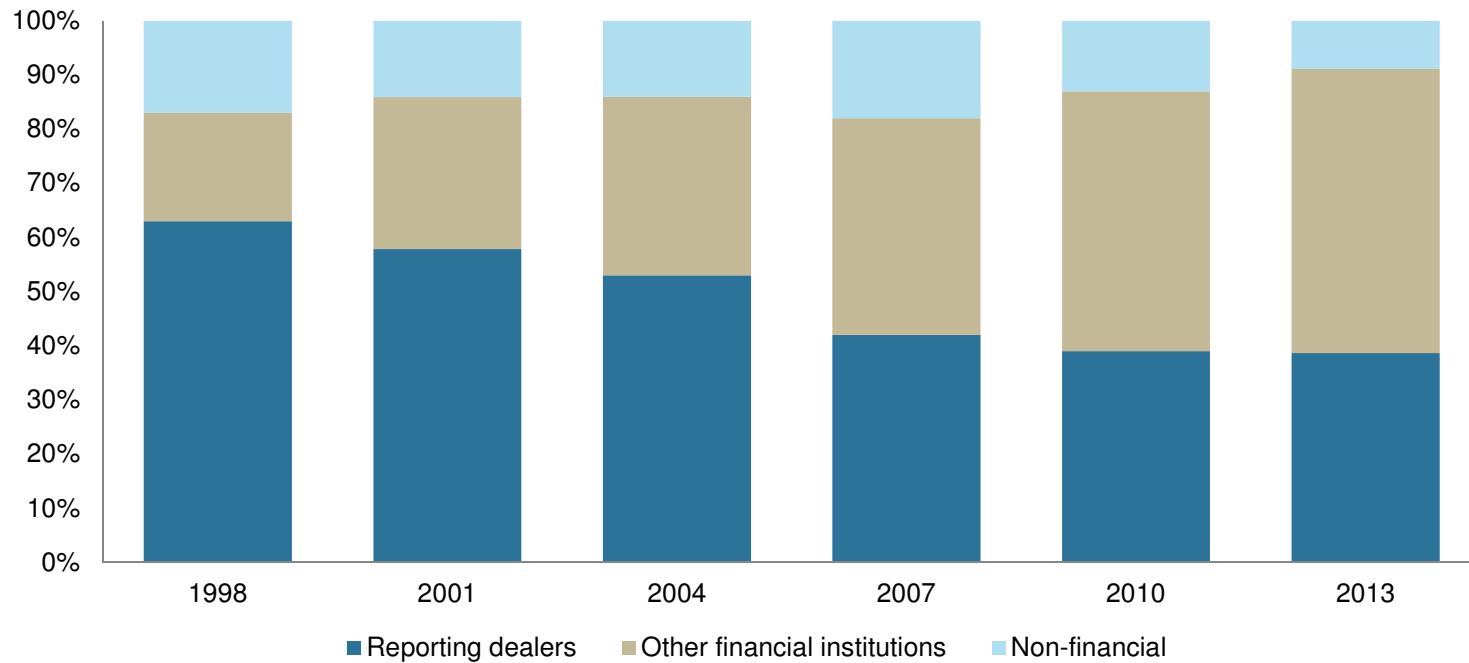


Transaction types – Definitions

- **Spot:** An agreement to buy or sell foreign currency with immediate delivery (two banking days after the transaction).
- **Forward:** An agreement to purchase or sell foreign currency for future delivery. The amount, price and delivery date agreed upon signing the contract and can not be changed during the contract period (some modifications). A forward contract involves an obligation to deliver or receive currency.
- **FX swap:** Agreement to purchase (sell) foreign currency with immediate delivery, while entering into agreement to sell back (repurchase) at a specified future date at a price determined today. A swap thus consists of a spot transaction and a forward transaction.
- **Options:** Agreement that gives the holder the right but not the obligation to buy (call option) or sell (put option) a certain quantity of an underlying object at a given price.

Turnover by counterparty

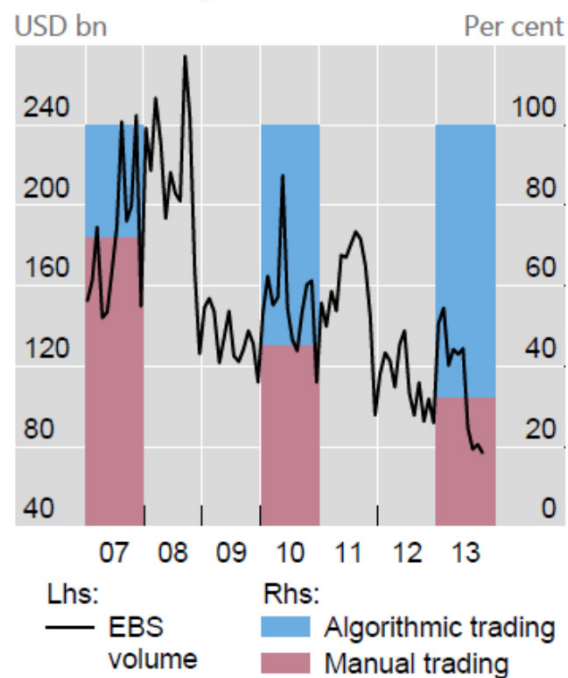
Institutions like NBIM are becoming more and more dominant



Electronic trading changed the market

BIS survey 2013

EBS trading volume,
manual vs algorithmic



Execution method by counterparty in 2013 (percentage shares)¹

Net-net basis, daily averages in April 2013

Table 3

	Voice			Electronic						Total	
	Direct ²	Indirect ³	Total	Direct ²			Indirect ³				
				Single-bank platforms ⁴	Other ⁵	Total	Reuters/EBS	Other ECNs ⁶	Other		Total
Reporting dealers	22	19	41	14	15	29	16	9	3	27	56
Other financials	30	14	43	10	20	31	14	9	2	25	55
Non-financials	37	4	42	18	10	28	3	9	12	24	52



High frequency trading (HFT)

Table 1: Similarities and differences between HFT and AT

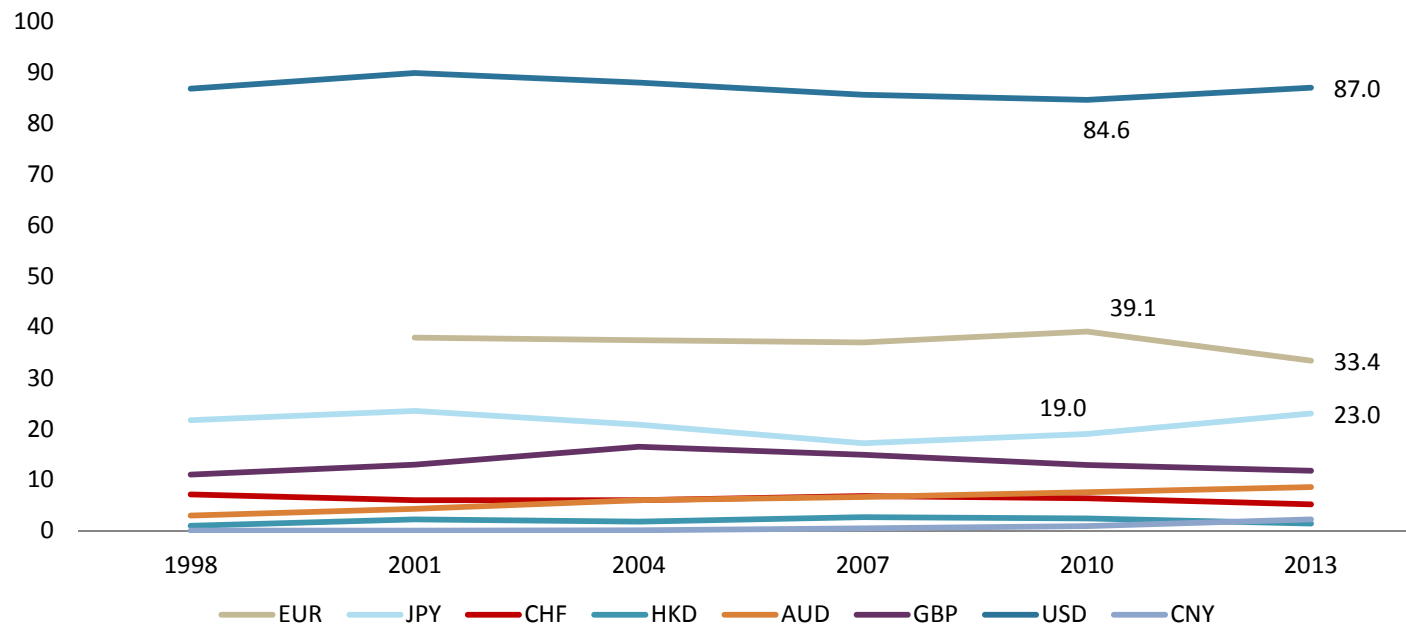
	Characteristic Type	HFT	AT	Comment
Similarities	Real-time market data	Yes	Yes	
	Automated order management and submission	Yes	Yes	
	Direct market access/ Sponsored access	Yes	Yes	
Differences	Trading objective	Proprietary	Agent	For AT, goal is to minimize market impact (for large orders) referenced to a particular benchmark (e.g. Implementation shortfall, VWAP, etc). For HFT, profit is generated by transacting as intermediaries
	Order frequency	Very high	Varies depending on trade urgency and other factors	HFTs have very high number of orders with rapid order cancellation
	Holding period	Seconds, depending on strategy type	Days, weeks or months, depending on trade size	HFTs do not hold significant overnight risk
	Latency sensitivity	Extremely high	Varies, depending on trade urgency	HFTs typically use co-location/ proximity services and individual data feeds to gain faster access to market data. Most brokers which provide algorithmic trading services for clients also use co-location
	Investment universe	Focus on highly liquid instruments	Instruments across majority of liquidity spectrum, depending on trade profile	

*http://www.nbim.no/globalassets/documents/discussion-paper/2013/discussionnote_1-13.pdf



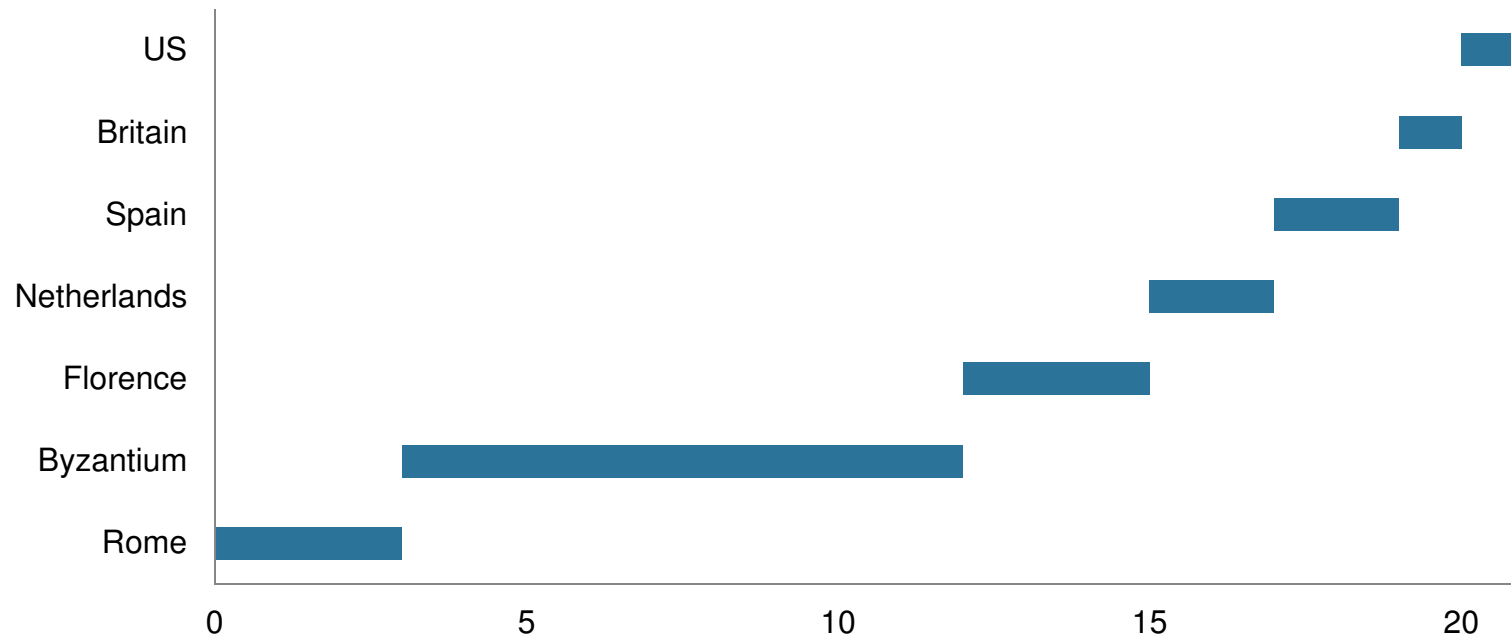
USD – the one and only

Global currency composition, per cent of global turnover (200%)



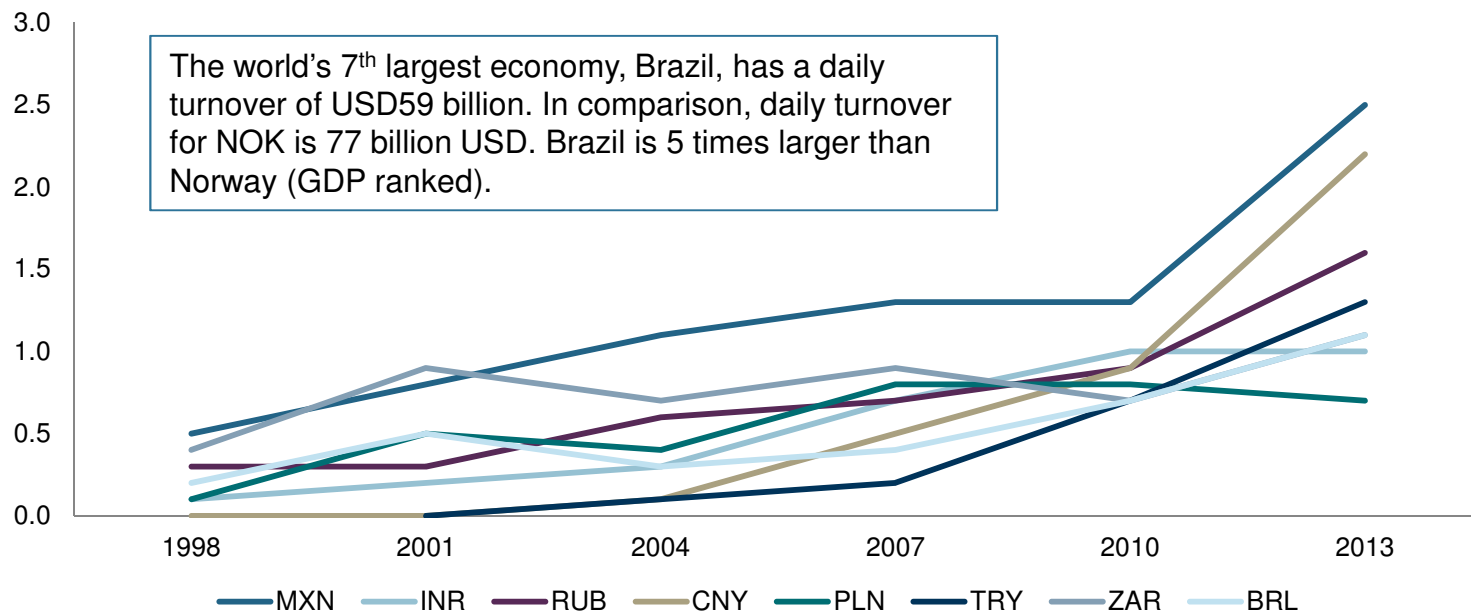
Reserve currencies in the past

X-axis: Centuries. Y-axis: Leading economic power and currency



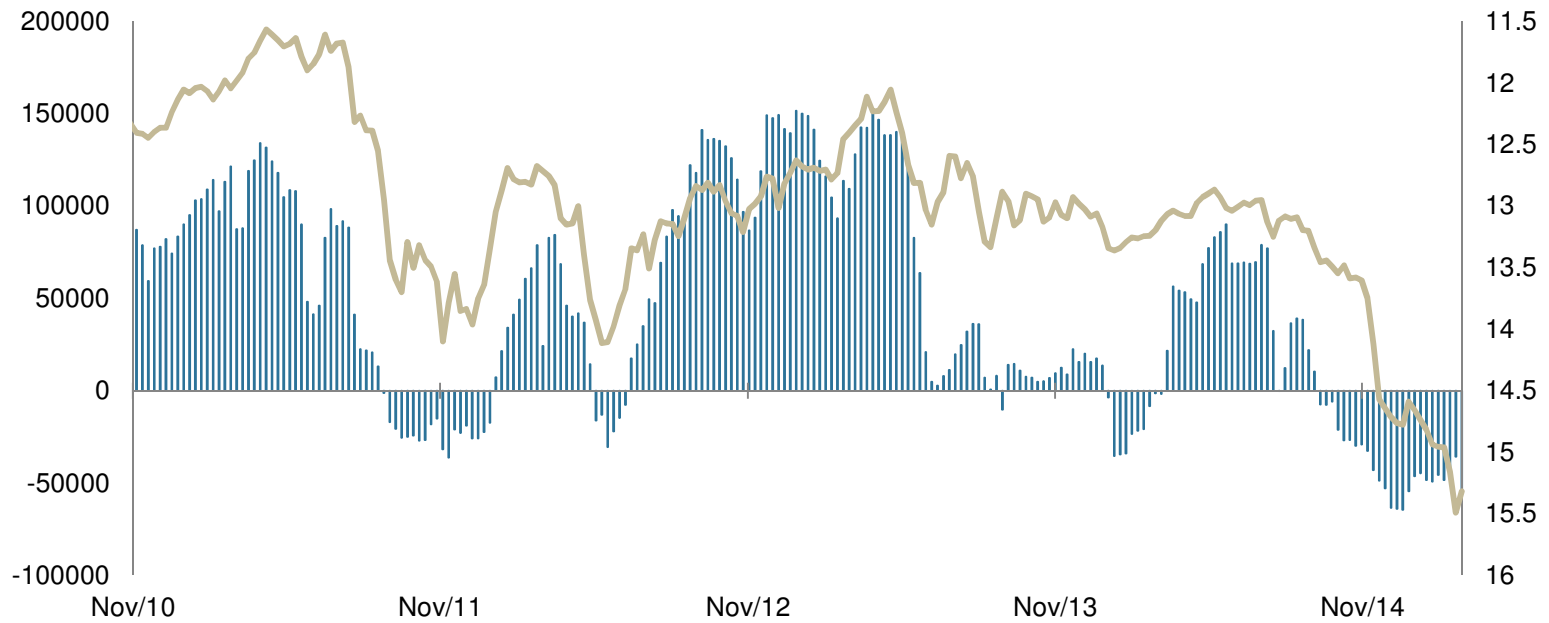
EM currencies are growing

But from a low base. Per cent of global turnover



Mexican peso used to hedge EM FX risk

USDMXN - net CTFC inflows (speculative)



THEORIES AND MODELS



Basic models and theories

- Covered interest rate parity (CIP)
 - Uncovered interest rate parity (UIP)
 - Purchasing Power Parity (PPP)
 - Fundamental Equilibrium Exchange rate (FEER) – external balance
 - Behavioural Equilibrium Exchange rate (BEER) – internal balance
-
- For FX analysis we have to look at different models, since no single model has proven to work for all currencies over all horizons.
-
- Foreign exchange markets will over- and undershoot in the short term (we are investing for infinity).



Covered interest rate parity (CIP)

No arbitrage opportunities keep exchange rates and FX rates together

- Two strategies:

1. To put 100 NOK in the local bank at the domestic risk-free rate at time t . Total wealth at time $t+1$:

$$W_{t+1} = NOK100 \times (1 + R_{t,t+1}^{NOK})$$

2. To convert 100 NOK into foreign currency, for example SEK, using the exchange rate $S_t^{SEK/NOK}$, earn the Swedish risk free rate and decide to convert the total amount back to NOK at time $t+1$ using a forward contract:

$$W_{t+1} = (NOK100 \times S_t^{\frac{SEK}{NOK}} \times (1 + R_{t,t+1}^{SEK})) \div F_{t,t+1}^{SEK/NOK}$$

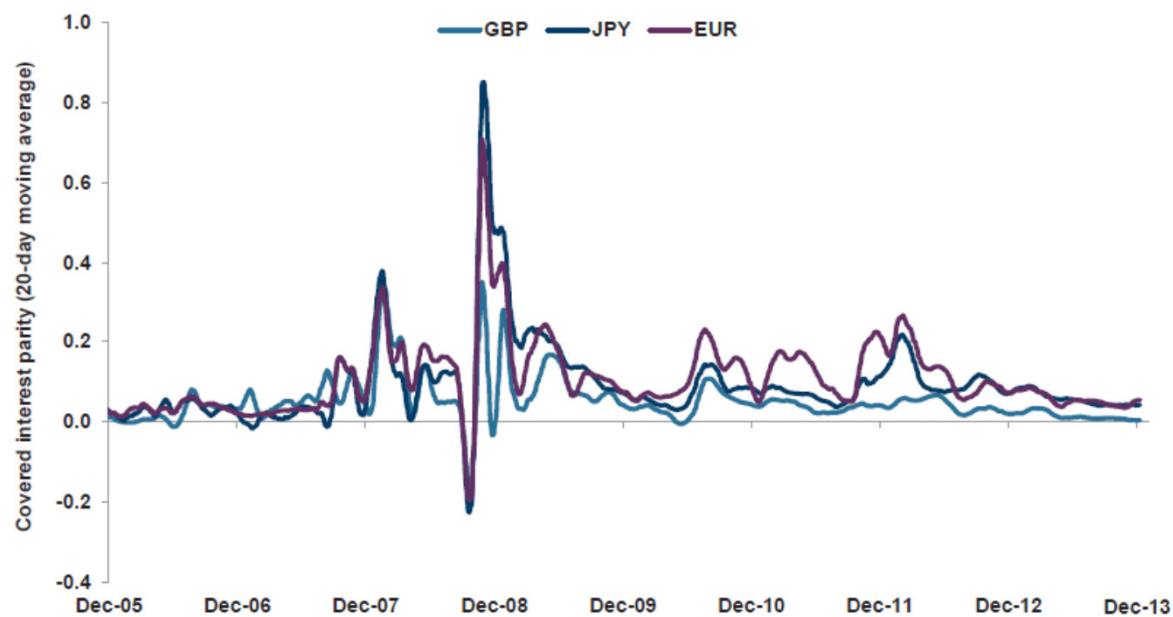
$$\rightarrow \text{CIP: } F_{t,t+1}^{SEK/NOK} = S_t^{\frac{SEK}{NOK}} \times \frac{(1 + R_{t,t+1}^{SEK})}{(1 + R_{t,t+1}^{NOK})}$$



CIP holds most of the time

Exception: Periods with extreme financial stress

Figure 1: Covered interest parity (20-day moving average), 2005-2013



Source: NBIM, Factset, WM Reuters

- Akram, Rime and Sarno (2008) conclude that there are some arbitrage opportunities, but they are short-lived and cannot be detected unless using data a daily or lower frequency.



Uncovered interest rate parity (UIP)

Based on no-arbitrage, but more a trading strategy/value model

- The uncovered interest rate parity (UIP) hypothesis is often a critical building block in theoretical FX models.
- UIP states that the interest rate differential is, on average, equal to the expected exchange rate change.

$$\frac{(1 + i_t)}{(1 + i^*_t)} = \frac{E_t(S_{t+\Delta})}{S_t}$$

- Countries with high interest rates should have depreciating currencies (eliminating arbitrage opportunities).



Purchasing Power Parity (PPP)

- Absolute PPP:
 - Price of a standardized consumption basket in different countries should be the same (Law of one Price).
 - Exchange rate changes eliminate goods market arbitrage.
- Relative PPP:
 - Exchange rate changes should offset bilateral inflation differentials. A standardized basket is no longer required.

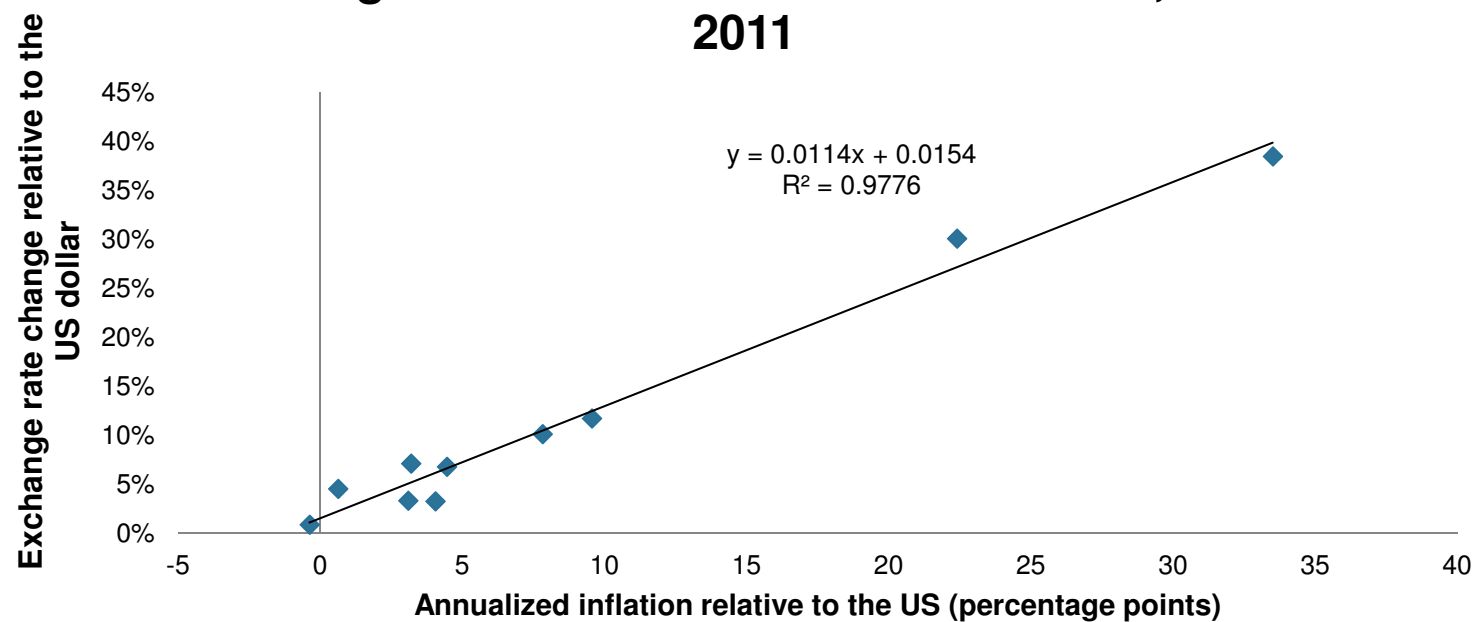
$$\frac{E_t}{E_{t-1}} = \frac{P_t}{P_{t-1}} \bigg/ \frac{P_t^*}{P_{t-1}^*}$$

- Empirical evidence:
 - Consensus is that PPP holds fairly good on a long horizon.
 - Often large deviation from PPP short term, due to rigid prices. The half-life of PPP deviations is three to five years, or roughly 15 per cent per year.



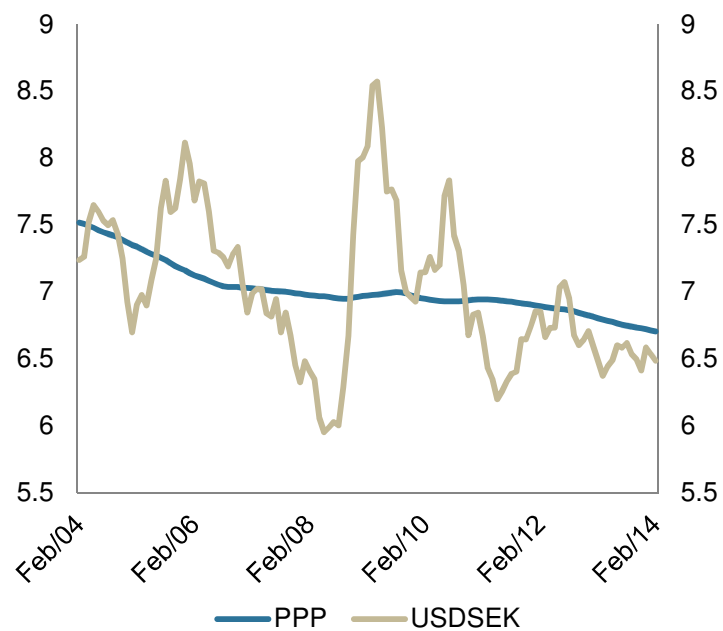
PPP – Holds fairly good long-term

Exchange rates and inflation EM countries, 1992-2011

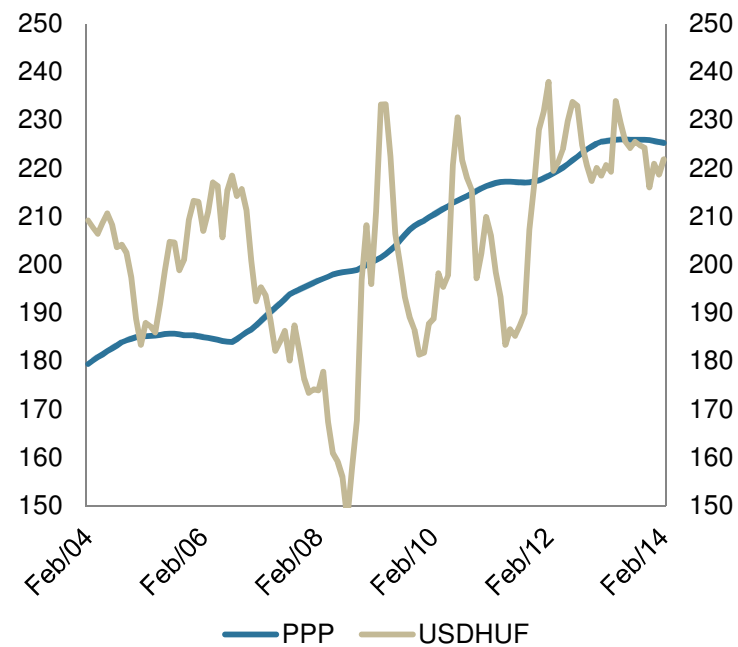


PPP – large deviations short-term

PPP USDSEK



PPP USDHUF



The best “model” is random-walk

Meese and Rogoff (1983)

Model:		Random walk	Forward rate	Univariate autoregression	Vector autoregression	Frenkel-Bilson ^b	Dornbusch-Frankel ^b	Hooper-Morton ^b
Exchange rate	Horizon							
\$/mark	1 month	3.72	3.20	3.51	5.40	3.17	3.65	3.50
	6 months	8.71	9.03	12.40	11.83	9.64	12.03	9.95
	12 months	12.98	12.60	22.53	15.06	16.12	18.87	15.69
\$/yen	1 month	3.68	3.72	4.46	7.76	4.11	4.40	4.20
	6 months	11.58	11.93	22.04	18.90	13.38	13.94	11.94
	12 months	18.31	18.95	52.18	22.98	18.55	20.41	19.20
\$/pound	1 month	2.56	2.67	2.79	5.56	2.82	2.90	3.03
	6 months	6.45	7.23	7.27	12.97	8.90	8.88	9.08
	12 months	9.96	11.62	13.35	21.28	14.62	13.66	14.57
Trade-weighted dollar	1 month	1.99	N.A.	2.72	4.10	2.40	2.50	2.74
	6 months	6.09	N.A.	6.82	8.91	7.07	6.49	7.11
	12 months	8.65	14.24	11.14	10.96	11.40	9.80	10.35

^aApproximately in percentage terms.
^bThe three structural models are estimated using Fair's instrumental variable technique to correct for first-order serial correlation.



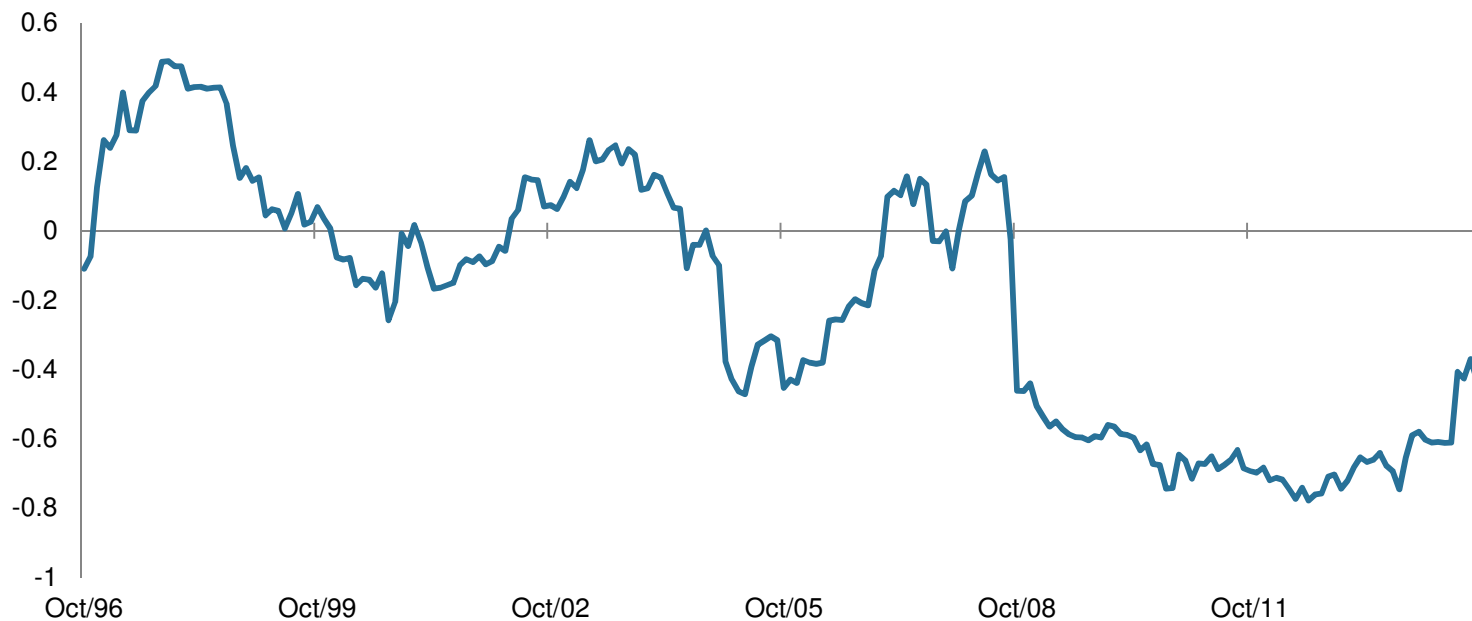
Why are FX rates so difficult to predict

- Bilateral FX rates are affected by relative macro development, relative monetary/fiscal policy, micro, investor's behaviour and expectations, market sentiment, FX market characteristics and more.
- Macro drivers
 - News, inflation, GDP, trade balances
- Policy drivers
 - Austerity, interest rate decisions, QE, tapering
- Market sentiment/ investor's behaviour
 - Risk on/off, safe haven currencies, carry trade sentiment (return chasing, results in overvaluation and overcrowding)
- FX market characteristics
 - Currency turnover, liquidity (bid-ask spread), electronic trading possibilities, interventions
- Flows



Why are FX rates so difficult to predict

2y rolling correlation S&P500 and trade weighted USD index



INVESTMENT STRATEGIES



Carry, value and momentum strategies

- **The currency carry trade:** A strategy that involves investment in a high-yielding currency, funded by borrowing in a low-yielding currency
- **Momentum:** Investment based on trend following
- **Value strategy:** Investment based on discrepancy between the fundamental value and price



The currency carry trade

Empirical research: Infrequent large drawdowns, persistent gains

Table 1: Overview of some of the empirical literature on the currency carry trade

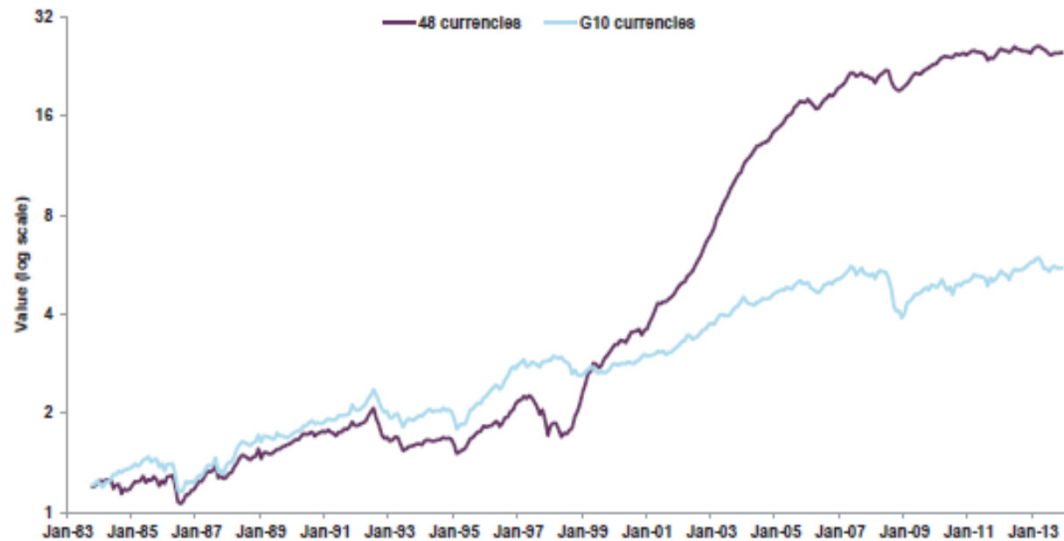
Authors	Publication	Period	Interest	Currencies	Return	Volatility
Brunnermeier, Nagel and Pedersen	NBER 2008	1986–2006	3-month	9	6.4%	10.2%
Burnside, Eichenbaum and Rebelo	JEEA 2008	1976–2007	-	23	5.4%	6.5%
Burnside, Eichenbaum, Kleshchelski and Rebelo	RFS 2011	1976–2009	1-month	21	4.8%	5.3%
Christiansen, Rinaldo and Söderlind	JFQA 2011	1995–2008	1-day	10	4.6%	-
Darvas	JBF 2009	1976–2008	1-month	11	4.1%	4.6%
Della Corte, Riddiough and Sarno	WP 2012	1983–2011	1-month	60	5.4%	8.9%
Koijen, Moskowitz, Pedersen and Vrugt	WP 2012	1983–2012	1-month	20	5.3%	7.8%
Lustig, Roussanov and Verdelhan	RFS 2011	1983–2009	1-month	35	8.5%	9.0%
Barroso and Santa-Clara	JFQA 2013	1996–2011	1-month	27	21.4%	24.3%
Menkhoff, Sarno, Schmeling and Schrimpf	JF 2012a	1983–2009	1-month	48	7.2%	9.8%
Rafferty	WP 2011	1976–2011	1-month	37	7.0%	8.3%
Jurek	JFE 2013	1990–2012	1-month	10	4.5%	9.5%
<i>Our results</i>	<i>DN 2014</i>	<i>1983–2013</i>	<i>1-month</i>	<i>10</i>	<i>5.5%</i>	<i>9.1%</i>



The currency carry trade

Empirical research: Infrequent large drawdowns, persistent gains

Figure 6: Cumulative returns on the currency carry trade, 1983-2013



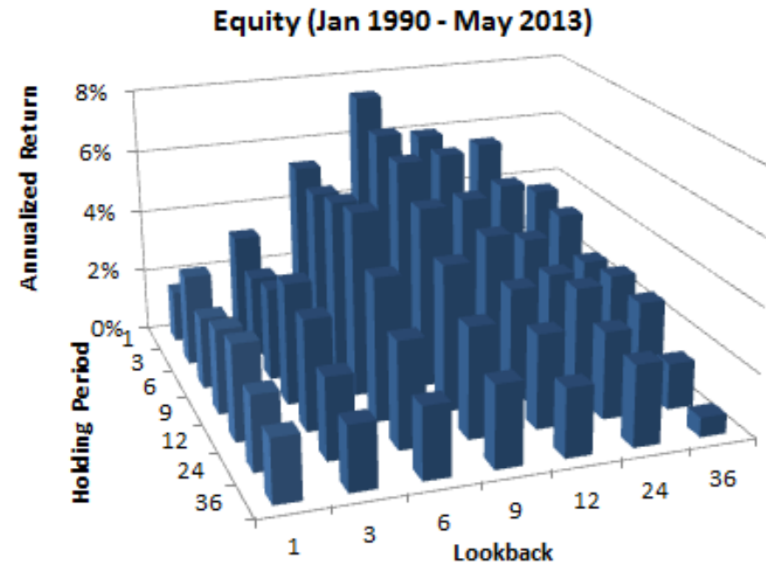
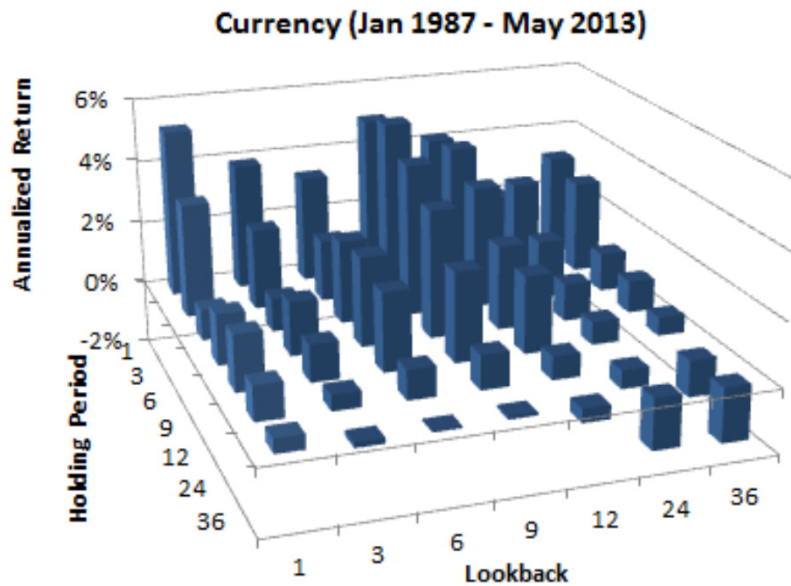
Source: NBIM, Factset, Thomson Reuters, WM Reuters

- **Why does it work?**
 - Liquidity risk?
 - Crash risk?
 - Volatility risk?
 - Behavioral explanations?
- No agreement in academic literature



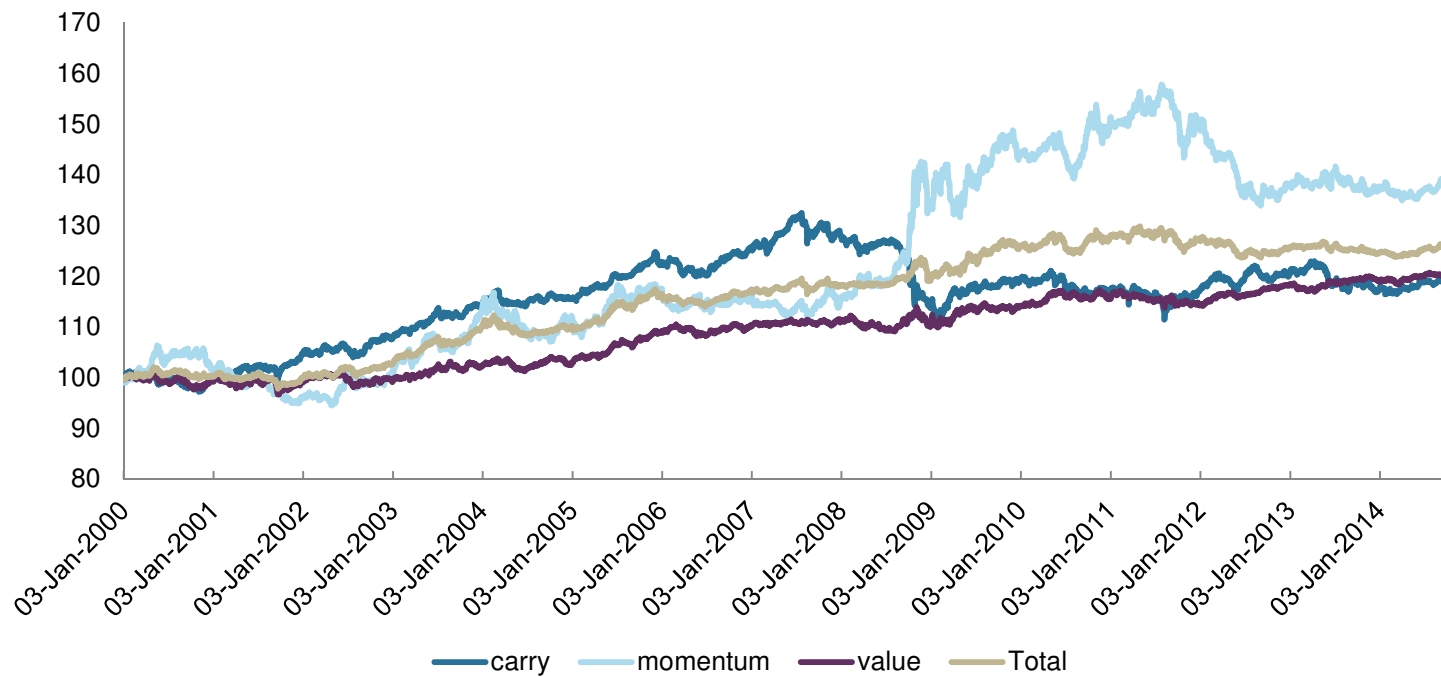
Momentum strategy

Empirical research: Significant return persistence in the first 12 mths



Value strategy

Jan-2000 = 100. Monthly rebalancing. Value = absolute PPP.



THE FUND'S CURRENCY BASKET



Premises

- Fund objective
“Maximise international purchasing power of the Fund at moderate risk”
- Fund (net foreign assets) is to finance future imports
- Current measurement of returns
*“Measured in the currency composition of the [...] benchmark index” –
no/very little measured currency risk*



Currency weights under alternatives

Currency	Index weights	Import weights*	GDP weights	SDR weights	Market weights
USD	34	5	22	43	35
EUR	23	31	17	37	22
GBP	11	6	3	11	11
JPY	8	2	7	8	11
CHF	4	1	1	0	4
CAD	3	3	2	0	2
AUD	2	0	2	0	2
SEK	2	14	1	0	2
KRW	2	1	2	0	1
MXN	1	0	2	0	0
CNY	1	9	12	0	2
BRL	1	2	3	0	1
INR	0	1	2	0	1
Other	8	24	25	0	6



Criteria – in order of importance

1. Measures international purchasing power
2. Has economic interpretability
3. Is interpretable with regard to currency risk exposure
4. Is tradable and convertible
5. Is easy to calculate and transparent



Evaluation of reference currency baskets

Reference currency → Criterion ↓	Importance	Index weight	Import weight	GDP weight	SDR weight	Market weight	NOK weight
International purchasing power	50%	2	3	4	2	2	1
Economic interpretation	20%	3	5	5	2	2	5
Interpretation of currency risk exposure	10%	4	3	3	2	3	1
Tradable and convertible	10%	4	4	3	5	3	1
Transparency of calculation	10%	5	4	4	4	2	5
Overall Score		2.9	3.6	4	2.5	2.2	2.2



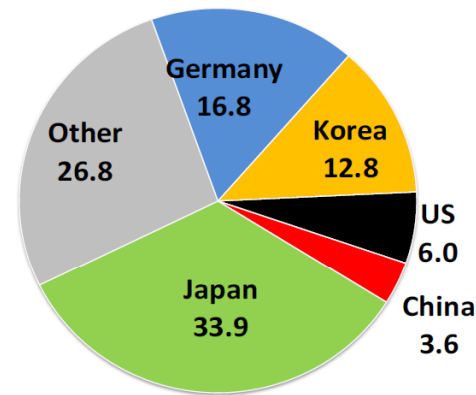
The famous iPhone example

Value chain of an iPhone 3G

Table 1 . Apple iPhone 3G's Major Components and Cost Drivers

Manufacturer	Component	Cost (USD)
Toshiba (Japan)	Flash Memory	\$24.00
	Display Module	\$19.25
	Touch Screen	\$16.00
Samsung (Korea)	Application Processor	\$14.46
	SDRAM-Mobile DDR	\$8.50
Infineon (Germany)	Baseband	\$13.00
	Camera Module	\$9.55
	RF Transceiver	\$2.80
	GPS Receiver	\$2.25
	Power IC RF Function	\$1.25
Broadcom (USA)	Bluetooth/FM/WLAN	\$5.95
Numonyx (USA)	Memory MCP	\$3.65
Murata (Japan)	FEM	\$1.35
Dialog Semiconductor (Germany)	Power IC Application Processor Function	\$1.30
Cirrus Logic (USA)	Audio Codec	\$1.15
Rest of Bill of Materials		\$48.00
Total Bill of Materials		\$172.46
Manufacturing costs		\$6.50
Grand Total		\$178.96

iPhone Manufacturing Cost Distribution by County (%)



Source: Xing and Detert (2010)



TAKK FOR MEG!