



# Seðlabanki Íslands

## The recent turmoil in the Icelandic foreign exchange market

The Icelandic carry trade and Wile E. Coyote moments

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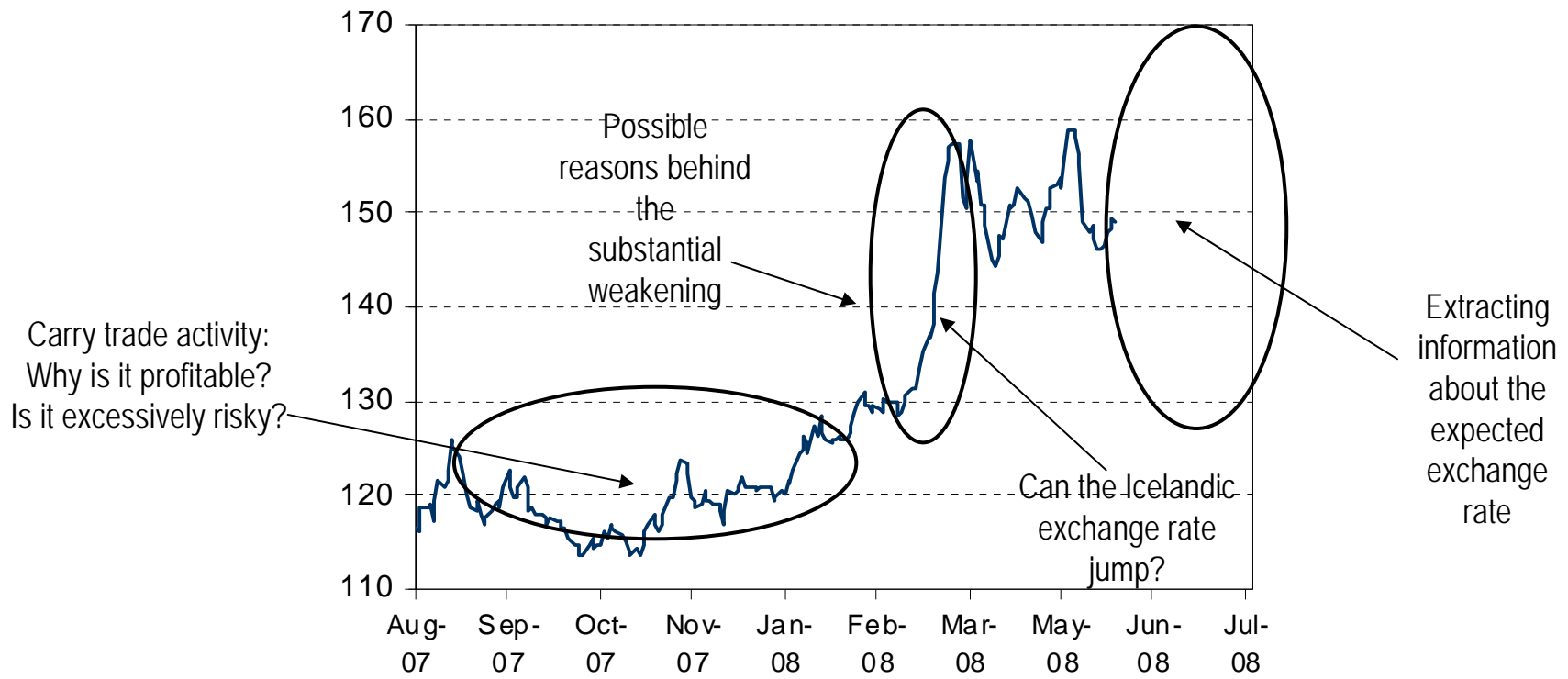
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# Motivation



## Icelandic exchange rate index

Daily data, August 2007 - March 2008



Source: Bloomberg.



# 1. What is a currency carry trade?

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- A currency carry trade:
  - Usually defined as a leveraged position where borrowing at a low interest rate in one currency and buying a higher-yielding asset in another
- Other related strategies:
  - Retail investors purchasing higher-yielding assets in foreign currency
  - Icelandic households borrowing in lower-yielding currencies (mortgages, etc.)

[Focus is often on leveraged positions since they are more likely to be unwound quickly when market turbulence occurs]

## Factors underpinning carry trades:

- large interest rate spreads
- low exchange rate volatility (since large changes in FX are not expected)
- global risk appetite (related to low volatility)

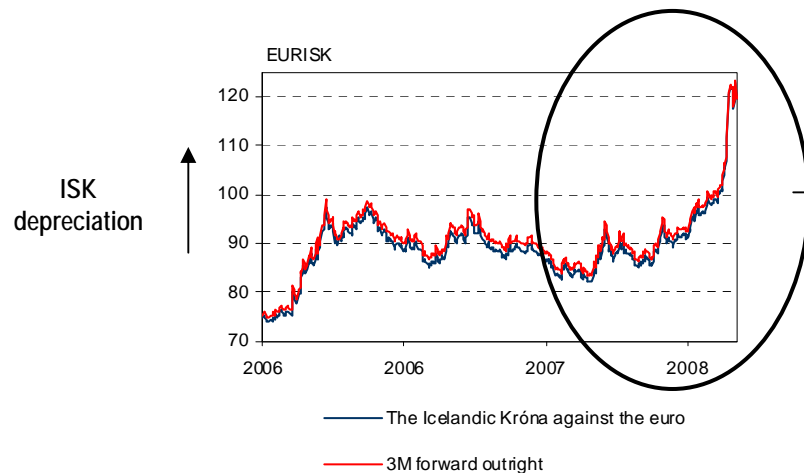
- A few technicalities ...

- The **covered interest rate parity** follows from an assumption of no-arbitrage condition (in absence of capital controls and asymmetric default risks):

$$I^{EUR} = I^{ISK} + ([1/F_{0,1}] - [1/S_0]) / [1/S_0]$$

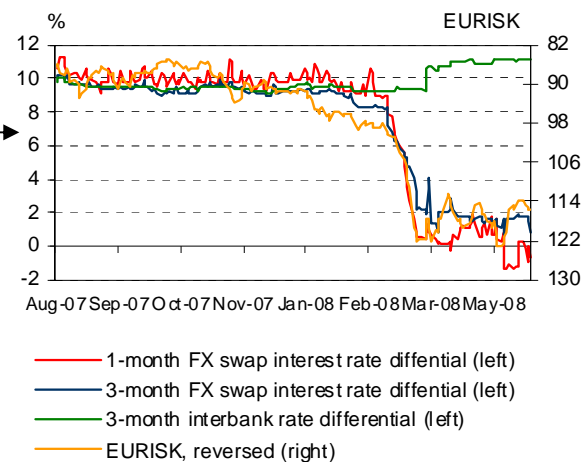
- S is the spot price of ISK per EUR and F is the forward exchange rate. Hence, high-yielding currencies trade at a discount ( $F > S$ ) whereas low yielding currencies trade at a premium ( $F < S$ )
  - $I^{EUR}$  money market rates are not available to Icelanders
  - $I^{ISK}$  money market rates are not available risk-free to foreigners

Spot and three-month forward exchange rate  
Daily data, January 2006 - March 2008



Source:s Bloomberg and local sources.

FX swap-implied ISK rates minus EUR Libor and the Icelandic króna  
Daily data, August 2007 - March 2008



Sources: Bloomberg, Central Bank of Iceland.



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- The **uncovered interest rate parity** (UIP) states that the expected return should be equal on two different currencies' interest rates, expressed in terms of a common currency (but not covered for the exchange rate risk on the forward market)

$$r^{EUR} = r^{ISK} + ([1/E(S_1)] - [1/S_0]) / [1/S_0]$$

- According to UIP high-yielding currencies should depreciate against low-yielding currencies. **Empirical evidence** suggests a **failure of this parity**.
- Higher-yielding currencies tend to appreciate (and not depreciate) on average, and the carry trade has been very popular



## 2. Is the carry trade profitable?

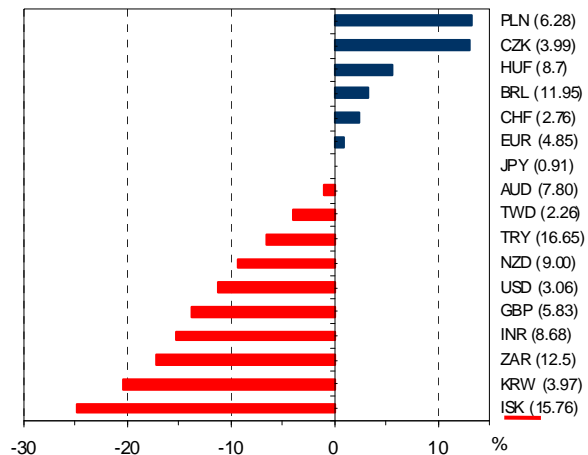
- Ex-ante total return:
  - Expect the return on the interest-rate differential to be larger than an unfavourable exchange rate movement. Hence, the UIP is not expected to hold
- Ex-post total return:
  1. Borrow in low-yielding currencies ... inconvenient (the traditional carry trade)
    - $\text{Return} = I^{\text{ISK}} - I^{\text{EUR}} + ([1/S_1] - [1/S_0])/[1/S_0]$
    - The interest rate differential plus the appreciation of the ISK in terms of the EUR
  2. Positions through currency forward contracts (the derivatives carry trade)
    - The investor is selling forward currencies that trades at a forward premium and buying forward currencies that are trading at a forward discount. It function like a short position in the EUR and long position in ISK.
    - $\text{Return} = ([1/S_1] - [1/F_{0,1}])/[1/S_0]$

The returns from the two different strategies are equal if the covered interest rate parity holds



## Spot return:

Spot return (per JPY)<sup>1</sup>  
August 2007 - May 2008

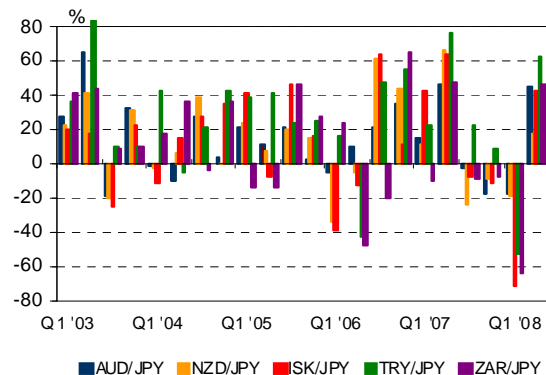


1. 3-month interbank rates in parentheses  
Source: Bloomberg.

## The total carry return:

### Carry trades: ex post returns

Annualised average daily returns, in per cent

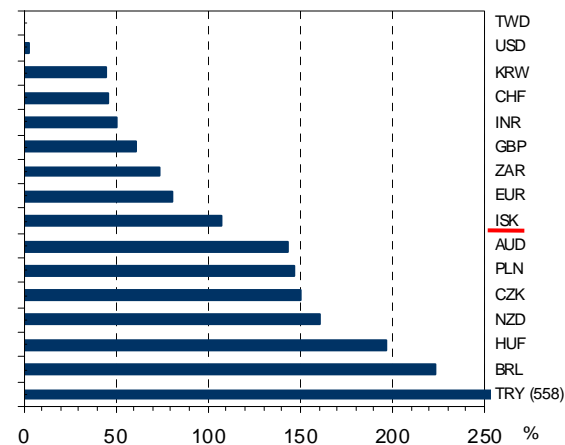


Calculated as the sum of interest rate differentials and the percentage change in the target currency's bilateral exchange rate against the Japanese yen.

Sources: Bloomberg and author's calculations

### Carry return (spot + interest rate differential)

April 2001 - May 2008



Source: Bloomberg.

# 3. Liquidity risk and skewness

- Two concepts of liquidity risk<sup>1</sup>

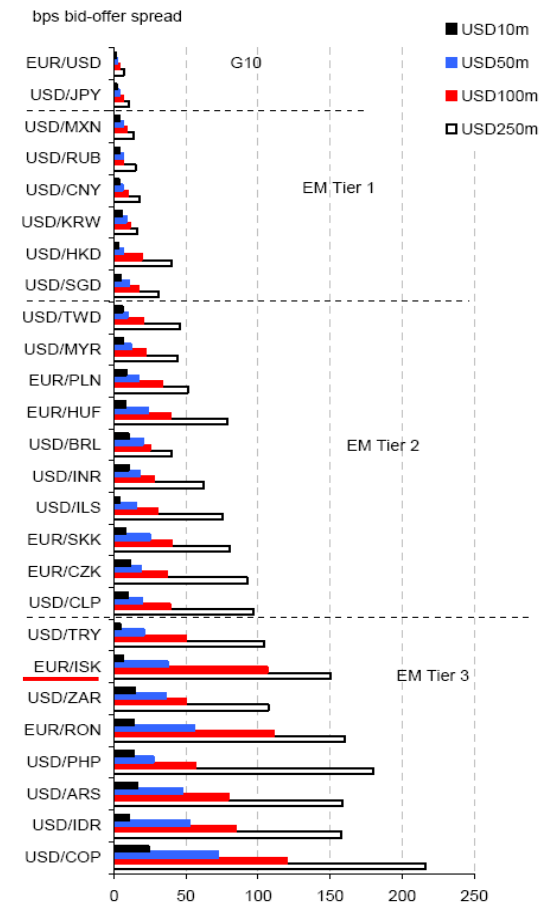
### Market liquidity risk

- The ease with which one can raise money by selling an asset
  - a) Bid-ask spread
  - b) Market depth
  - c) Market resiliency

### Funding liquidity risk

- The ease with which one can raise money by borrowing using an asset as collateral
  - When funding liquidity is tight, traders become reluctant to take positions

Indicative best spreads and EM liquidity tiering



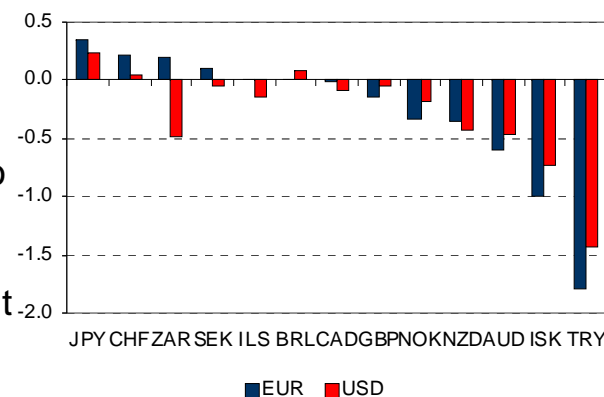
Source: Deutsche Bank

1. Source: Brunnermeier (2008)



- Carry trade:  
In case of adverse price movements, (leveraged) investor may be forced to be unwound a derivatives position (it leads to pro-cyclical market dynamics). This is not the case with favourable price movements.
- It means that the historical distribution is expected to be skewed towards depreciation of high-yielding currencies appreciation of low-yielding currencies.
- The asymmetry in the return distribution is consistent with carry trades

Foreign exchange skewness<sup>1</sup>  
Based on daily returns over the whole period  
April 2001 - March 2008



Sources: Bloomberg and author's calculations.

- The **build-up of** carry positions results in strengthening target currencies and weakening funding currencies
- Changes in interest rate expectations or volatility lead to an **abrupt unwinding of carry trades** and target currencies tend to depreciate and funding currencies to appreciate sharply.
- **Up by the stairs and down by the elevator**

# 4. The Icelandic Wile E. Coyote moment

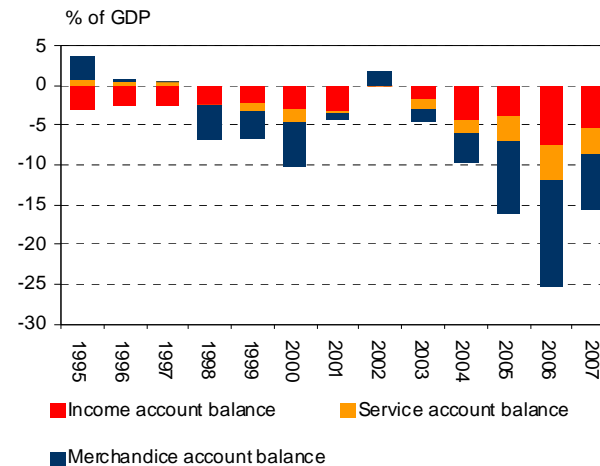
- An economy can live with macroeconomic imbalances for years if by chance nothing triggers a crisis. But given these vulnerabilities, there are many possible crisis triggers.
- Vulnerabilities according the CBol's Financial Stability report 2007

Table 1 Main vulnerabilities

Risk	Explanation
Exchange rate development	Macroeconomic imbalances are pronounced. The current account deficit poses the risk of a depreciation of the króna. Shifts in carry trades and other exposures could catalyse a sudden turnaround. The FX market relies on three market makers and is still relatively thin. Some borrowers from the commercial banks have little or no hedge against exchange rate movements.
Global interest rates and premia	In recent years, interest rates and premia have been at a historical low. Interest rates have begun to climb and sooner or later premia will rise again, increasing corporate financing costs.
Asset quality of commercial banks	Rapid credit growth often eventually leads to poorer loan quality. Loans with equities as collateral are substantial. Prices of equities and real estate are buoyant. Although arrears and impairment are at a low, they are unlikely to remain so over the next few years.
International market funding	High dependence on market funding and deposits on call makes credit ratings and global market conditions crucial for the commercial banks. Experience shows that credit assessment can shift suddenly.

Current account balance components<sup>1</sup>

Annual data 1995 - 2007



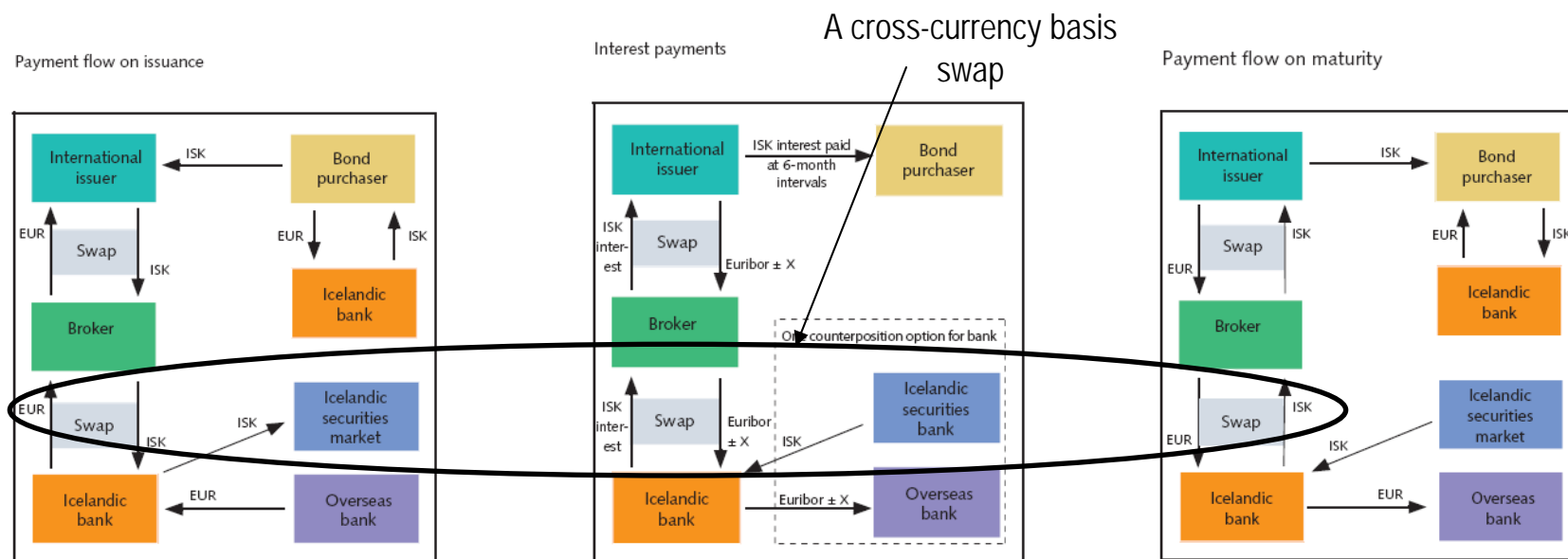
1. Net current transfer is included in balance on income.  
Sources: Statistics Iceland, Central Bank of Iceland.

- The Icelandic 2008 trigger: A sudden re-evaluation of risks associated with the three commercial banks amid the global credit crisis



## • The Icelandic currency swap and Eurobond market ...

- Issuers of Eurobonds receive EUR (at issuance) and pay Euribor through a **broker**, who normally hedge his risk using a cross-currency basis swap
- However, brokers decided to roll-over their future obligations on a short-term basis betting on
  - A more less negative cross-currency basis spreads in the future
  - Policy rate hikes by the central bank
  - A liquidity FX swap market
- Icelandic market makers became reluctant to give away their EUR, and thus priced themselves out of the market. They stopped market making in cross-currency basis-swaps in March 08'. As a result carry on the ISK evaporated



Source: Central Bank of Iceland.

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- Because the FX swap market has been the principal channel for the ISK carry trade, a narrowing FX swap rate differential reduced position-taking in the króna

Krugman (2007):

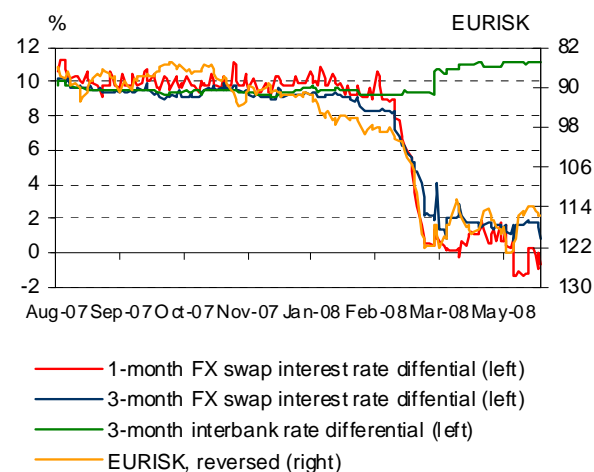
- *"If markets are failing to take the required future fall of the [exchange rate] into account, they will eventually have a Wile E. Coyote moment, when they look down and realize that nothing is supporting the currency. At that point the [exchange rate] will plunge."*

Road Runner cartoons: Wile E. Coyote run off a cliff



FX swap-implied ISK rates minus EUR Libor and the Icelandic króna

Daily data, August 2007 - March 2008

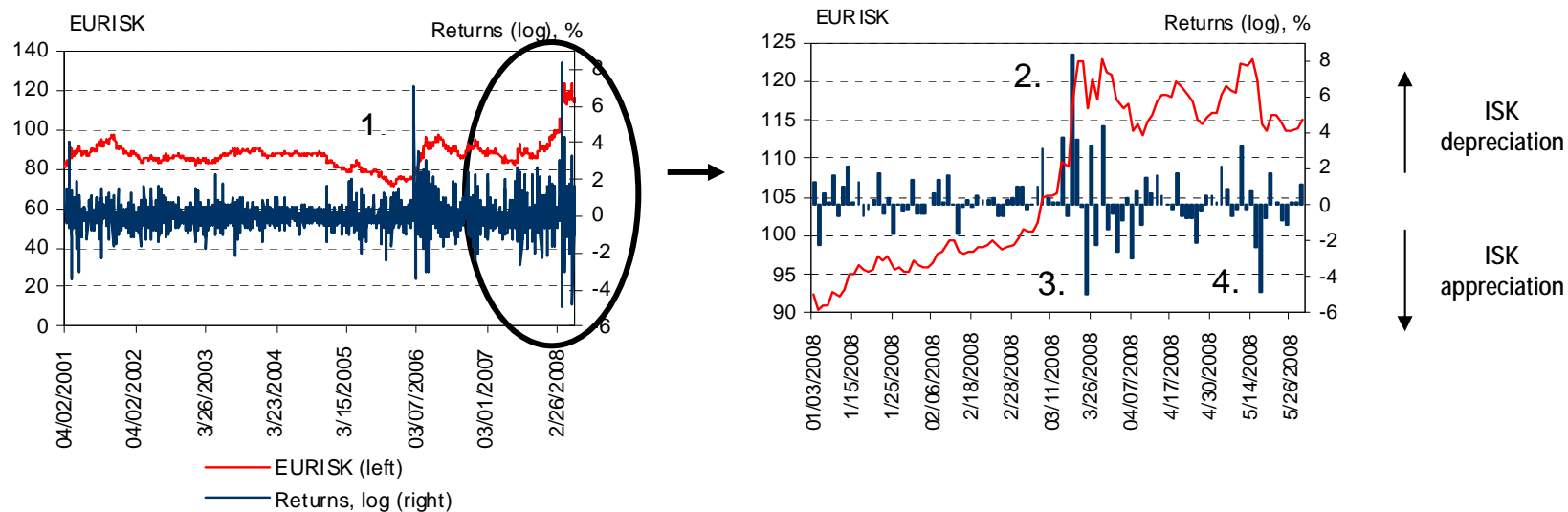


# 5. Can the Icelandic exchange rate jump?



- Four (in)famous abrupt changes in the ISK (daily data):

The Icelandic króna against the euro  
April 2001 - May 2008, level and daily returns

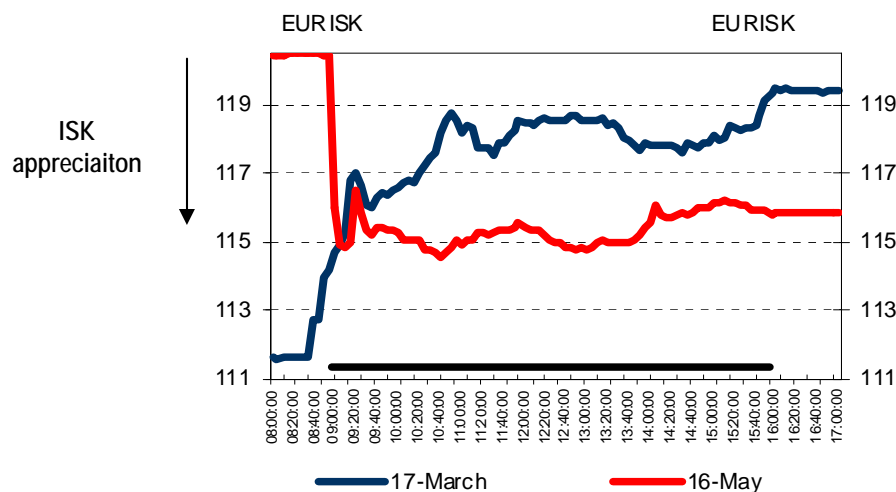


Source: The Central Bank of Iceland.

- No 1. The Fitch 2006 report (21/22 February, 2006)
- No 2. The ISK-EUR FX swap rate differential is close to zero (17 March, 2008)
- No 3. The Central Bank of Iceland raises the policy rate by 125bp (25 March, 2008)
- No 4. The CBoI concludes Nordic swap facility arrangements (16 May, 2008)

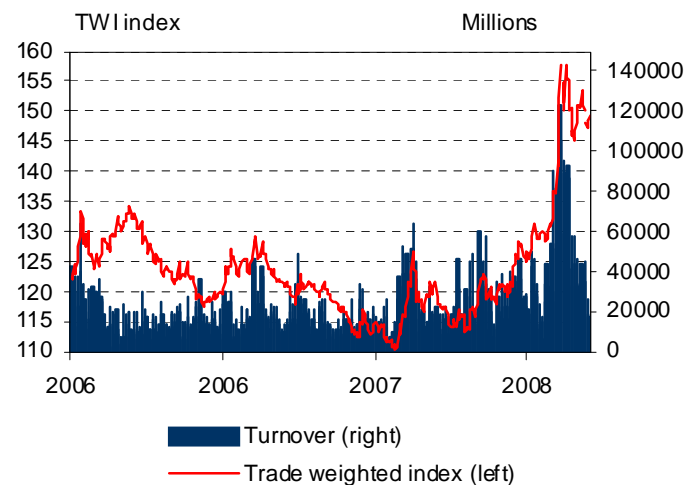
- When sentiment changes sharply, it seems to have a greater impact on the Icelandic króna than in more liquid foreign exchange markets. It may result in something that resembles a jump in daily data (also close to being the case intra-day)

Intra-day exchange rate movement (2008)  
Five minutes intervals



Sources: Bloomberg

Daily turnover in the Icelandic interbank FX market  
Daily data, April 2006 - April 2008



Source: Central Bank of Iceland.



# 6. How do investors assess currency risk?

- Return relative risk: Ex post (realised) measures

- Carry return sharpe ratio is the average annual excess return divided by the annualised standard deviation
- Carry return sortino ratio
- Carry return calmar ratio is the annualised excess return relative to the drawdown (downside) risk, which is the largest difference between a high and a low of the exchange rate.

- **Currency-specific carry trades**

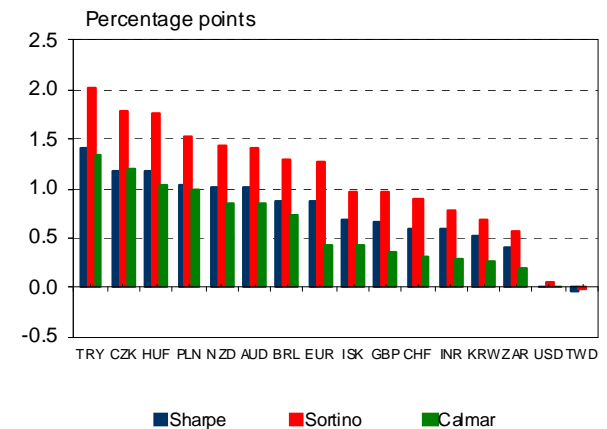
- The payoffs are very volatile... and negative for extended periods
- Strategy known as “picking up peenies in front of a truck”

- **Diversification of the carry strategy**

- There are large gains from diversifying the carry trade across currencies - large increase in the sharpe ratio
- A diversified carry trade can be seen as maximizing the returns on a portfolio given a tolerance for risk

Risk ratios

Daily data, April 2001 - May 2008



Source: Bloomberg.

	AUDJPY	NZDJPY	ISKJPY	TRYJPY	ZARJPY	PORTJPY*
Average Annual Excess Return:	13.2%	14.2%	10.6%	30.0%	8.0%	15.7%
Annualized Standard Deviation:	12.6%	13.9%	15.0%	20.7%	19.6%	12.6%
Sharpe Ratio:	1.05	1.02	0.71	1.45	0.41	1.24
Annualized Downside Deviation:	9.2%	10.1%	10.8%	14.7%	14.3%	9.1%
Sortino Ratio:	1.43	1.42	0.98	2.03	0.56	1.72
Maximum Drawdown:	15.7%	19.2%	32.9%	22.2%	30.6%	20.8%
Calmar Ratio:	0.84	0.74	0.32	1.35	0.26	0.75

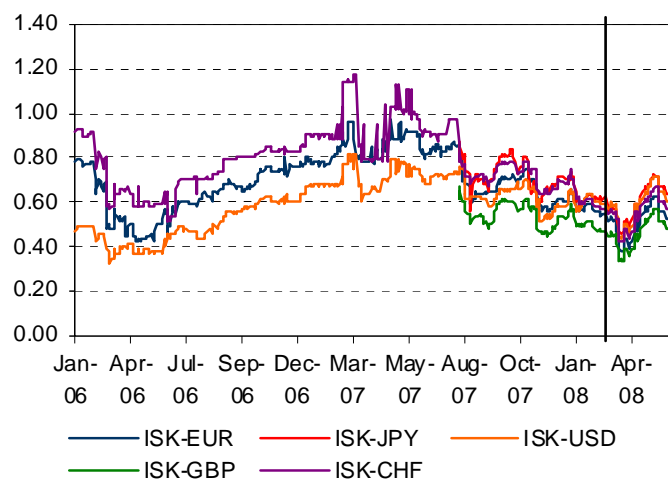
\* Long the AUD, NZD, ISK, TRY and ZAR (equally weighted) against the JPY

## – Ex ante measures

- Carry-to-risk ratios: e.g. 3-month interest rate differential divided by the 3-month implied volatility
- Risk reversals: Foreign exchange option traders use risk reversals to reflect the expected skewness in the distribution. Market participants are willing to pay more for protection against an ISK depreciation than an appreciation

### Carry-to-risk ratios

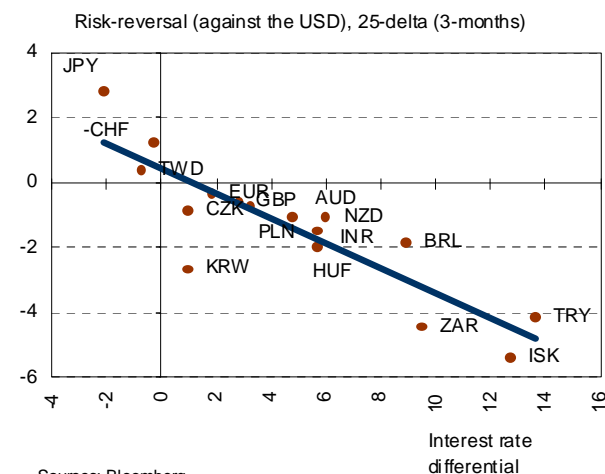
January 2006 - May 2008 (indicative prices)



Sources: Bloomberg, Investment banks.

### Risk-reversals and interest rate differential

30 May 2008



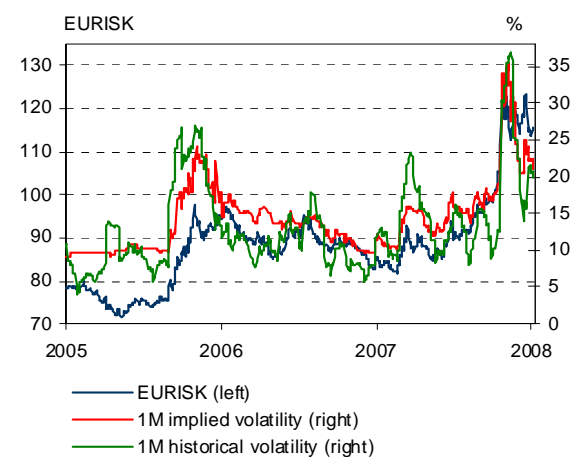


## • Implied volatility

- One-month (at-the-money) implied volatility is the market's estimate for realised one-month volatility in one month's time
- The depreciation of the Icelandic króna in 2008 resulted in a spike in volatility; one-month implied volatility reached 35% and bid-ask spreads widened significantly
- Implied volatilities tend to follow historical volatilities
- A depreciation of the Icelandic króna is correlated with a rise in implied volatility (and vice versa)

EURISK implied volatility

Daily data, July 2005 - March 2008



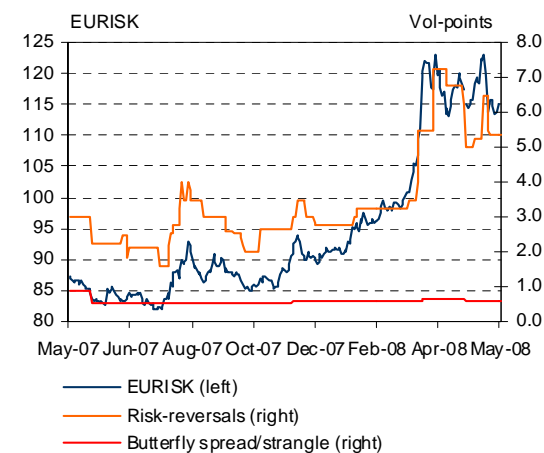
Source: Bloomberg.

## • Risk-reversals and carry trades

- Market perception is tilted towards a depreciation of the ISK
- The price of risk-reversals (crash insurance) increases with interest rate differential and past losses. It suggests carry traders are afraid of these losses

Risk-reversals and strangles (1M, 25-delta)

Daily data, May 2007 - May 2008

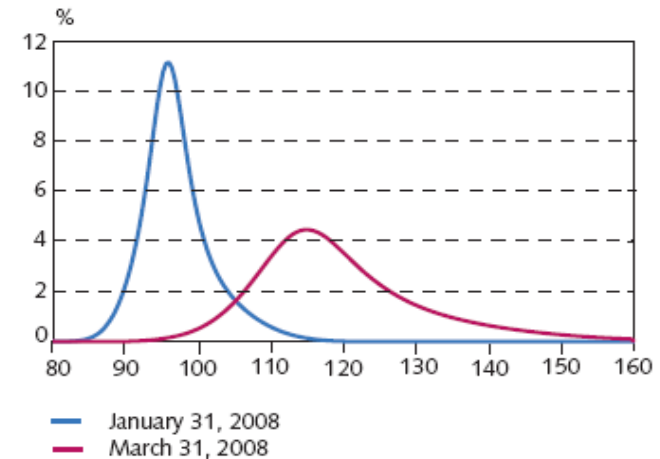


Sources: Bloomberg and investments banks.

# 7. The expected future exchange rate ...

- Option quotes can be used to extract a risk-neutral probability distribution for the one-month ahead exchange rate
  - Implied volatilities provide a measure of the standard deviation of the distribution.
  - Risk-reversals are a measure of the skewness.
- The accuracy of the PDF depends on the quality of the quoted option prices

1M EURISK risk-neutral probability functions<sup>1</sup>



1. 25-delta risk reversal: 3.25 (7.25), 25-delta butterfly spread: 0.60 (0.65)  
 at-the-money implied volatility (mid): 16.50 (33.5), forward rate: 97.87  
 (119.8), Interest rate: 14.088 (15.36). Volatility smile fitted according to  
 Malz (1997).

Sources: Bloomberg, Investment banks, author's calculations.

# 8. When the music stops ...

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## Carry trades, flight-to-safety and the children's game of musical chairs

- *"Those who stand aside face a loss of market share, perhaps lasting for a protracted period, before they can be proved right. In the words of Charles Prince (UBS), if the music is playing, they more or less have to dance."*

Caballero et al. (2008):

- *"... when the music stops, only one child will be left without a seat. However if the children are confused about the rules and each is convinced that he will be the one left without a seat, chaos may erupt. Kids may start grabbing on to chairs, running backwards, etc... The [subprime shock] at the end of the day is a small shock; it is only the actions of panicked investors that have made it large. The standard recipe in such a flight-to-quality scenario is for central banks to convincingly promise large liquidity injections in the event of a meltdown"*
- The Eurobond market became too large to handle when access to cheap foreign liquidity dried up
- The exchange rate is likely to remain volatile unless high-yielding "low-risk" assets are made available:
  - CDs and government bonds
  - The FX swap market is kick-started
    - The Icelandic banks secure enough foreign liquidity
    - The Central Bank acts as a liquidity provider of foreign currency

# Literature

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