Aalto-yliopisto
Kauppakorkeakoulu

Currency Carry Trades, Momentum and Reversals

by
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13 May 2019

Agenda

- Introduction
- Theories behind carry trade returns
- Hedge funds and currency carry trades
- Momentum and Value
- Conclusion

INTRODUCTION

- Financial Times (January 28, 2008) definition of currency carry trades:

  “the purchase of riskier, higher-yielding assets is funded by selling lower-yielding currencies.”

- UIP Theory: low interest rate currencies will appreciate relative to high interest rate currencies, so the expected returns to carry trades are zero.

INTRODUCTION

But UIP fails and there are positive returns to carry trades:

- Burnside, Eichenbaum, Kleshchelski, and Rebelo (2006), Lustig, Roussanov and Verdelhan (2008).
- Failure of Uncovered Interest Rate Parity, Fama (1984).

Sanford Grossman (AFA Presidential Address in 1995):

- Interest rate differentials across countries do not reflect merely the expected depreciation or appreciation of currencies, but also real rewards to the world for bearing risks related to investments in the respective currencies.

Sample of 11 industrialized countries

Figure 1. Cumulative performance of carry trade strategy.

This figure shows the growth of 100 pounds invested in a carry trade strategy from 1976 through 2007 on a logarithmic scale. *Short* refers to portfolio of short positions in low interest rate currencies, *Long* refers to portfolio of long positions in high interest rate currencies, and Short+*Long* refers to portfolio of short positions in low interest rate currencies and long positions in high interest rate currencies.

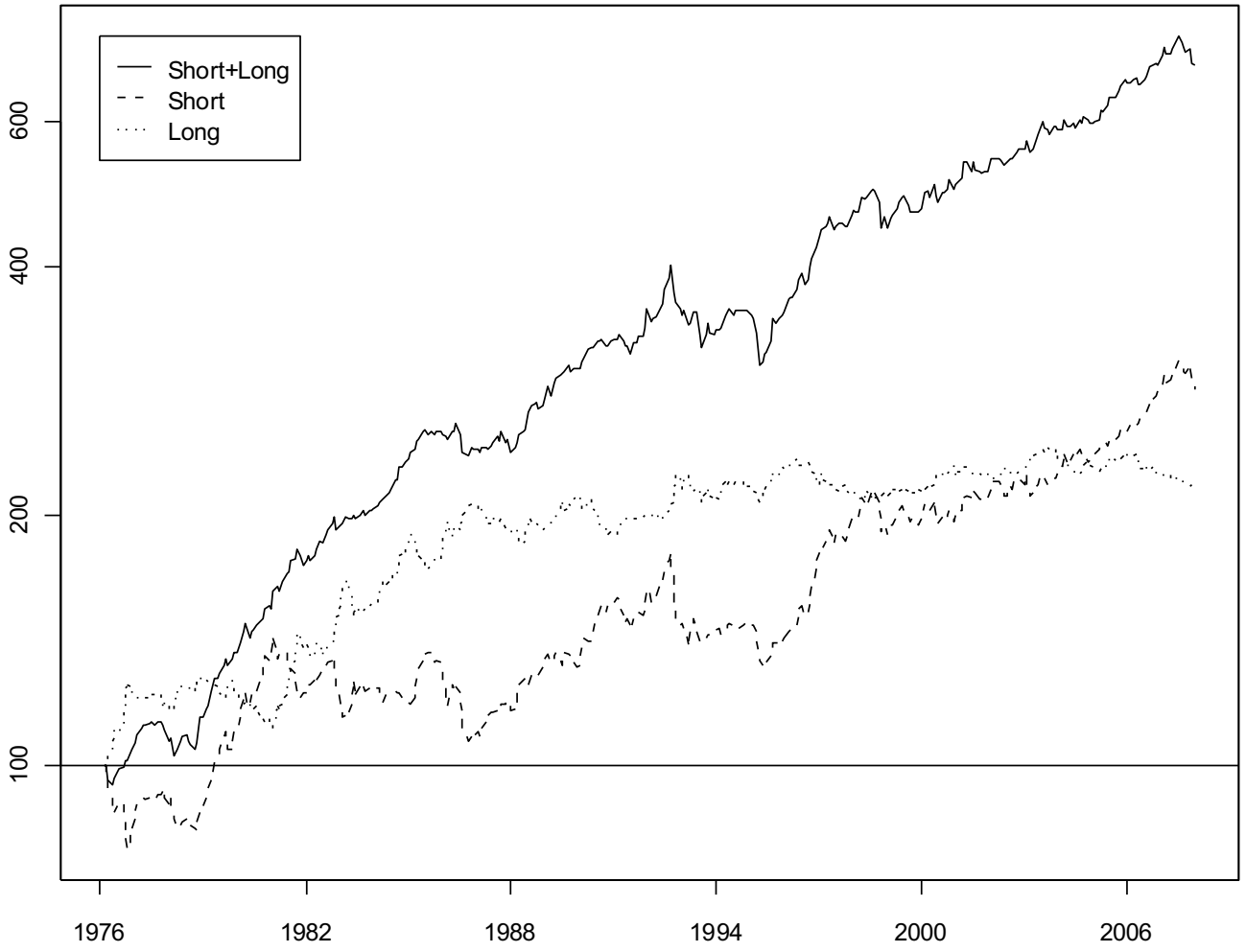

Table 5. Carry trade positions.

This table presents the number of total months a position is in individual currencies over the sample period. Figures in parenthesis show the number of months divided by the length of the sample for the particular currency. *Short* refers to portfolio of short positions in low interest rate currencies, *Long* refers to portfolio of long positions in high interest rate currencies, and *Short+Long* refers to portfolio of short positions in low interest rate currencies and long positions in high interest rate currencies.

	Short+Long		Short		Long	
BEF	73	(26.4%)	8	(2.9%)	65	(23.6%)
CAD	165	(43.0%)	28	(7.3%)	137	(35.7%)
CHF	348	(90.6%)	348	(90.6%)	0	(0.0%)
DEM	175	(63.4%)	168	(60.9%)	7	(2.5%)
EUR	25	(22.9%)	1	(0.9%)	24	(22.0%)
FRF	135	(48.9%)	4	(1.4%)	131	(47.5%)
GBP	293	(76.3%)	1	(0.3%)	292	(76.0%)
ITL	268	(97.1%)	0	(0.0%)	268	(97.1%)
JPY	319	(89.9%)	319	(89.9%)	0	(0.0%)
NLG	108	(39.1%)	99	(35.9%)	9	(3.3%)
USD	177	(46.1%)	67	(17.4%)	110	(28.6%)

Table 2. Descriptive statistics of carry trade returns.

This table presents the basic descriptive statistics of monthly gross returns to carry trade strategy. *Short* refers to portfolio of short positions in low interest rate currencies, *Long* refers to portfolio of long positions in high interest rate currencies, and *Short+Long* refers to portfolio of short positions in low interest rate currencies and long positions in high interest rate currencies. *p*-values are given in parenthesis for selected statistics.

	Short+Long	Short	Long
Mean	0.53%	0.31%	0.22%
	(0.000)	(0.020)	(0.016)
Standard deviation	1.99%	2.57%	1.82%
Sharpe ratio	0.266	0.119	0.123
Skewness	-0.640	-0.661	0.898
Excess kurtosis	2.441	1.674	3.631
Jarque-Bera	123.670	74.135	266.371
	(0.000)	(0.000)	(0.000)
AR(1)	0.045	0.107	0.127
	(0.376)	(0.035)	(0.013)

Table 3. Breakdown of carry trade returns.

This table provides the breakdown of average monthly returns. *Short* refers to portfolio of short positions in low interest rate currencies, *Long* refers to portfolio of long positions in high interest rate currencies, and *Short+Long* refers to portfolio of short positions in low interest rate currencies and long positions in high interest rate currencies. *Interest return* is the return earned from the difference in interest rates between funding and investment currencies, *Currency return* is the return due to the changes in exchange rates, *Gross return* is the total return excluding transaction costs, *Transaction costs* are due to the bid-ask spread, and *Net return* is the total return including transaction costs. Figures are calculated against British pound.

	Short+Long	Short	Long
Interest return	0.55%	0.45%	0.10%
Currency return	-0.02%	-0.14%	0.12%
Gross return	0.53%	0.31%	0.22%
Expenses	-0.32%	-0.23%	-0.09%
Net return	0.21%	0.08%	0.14%

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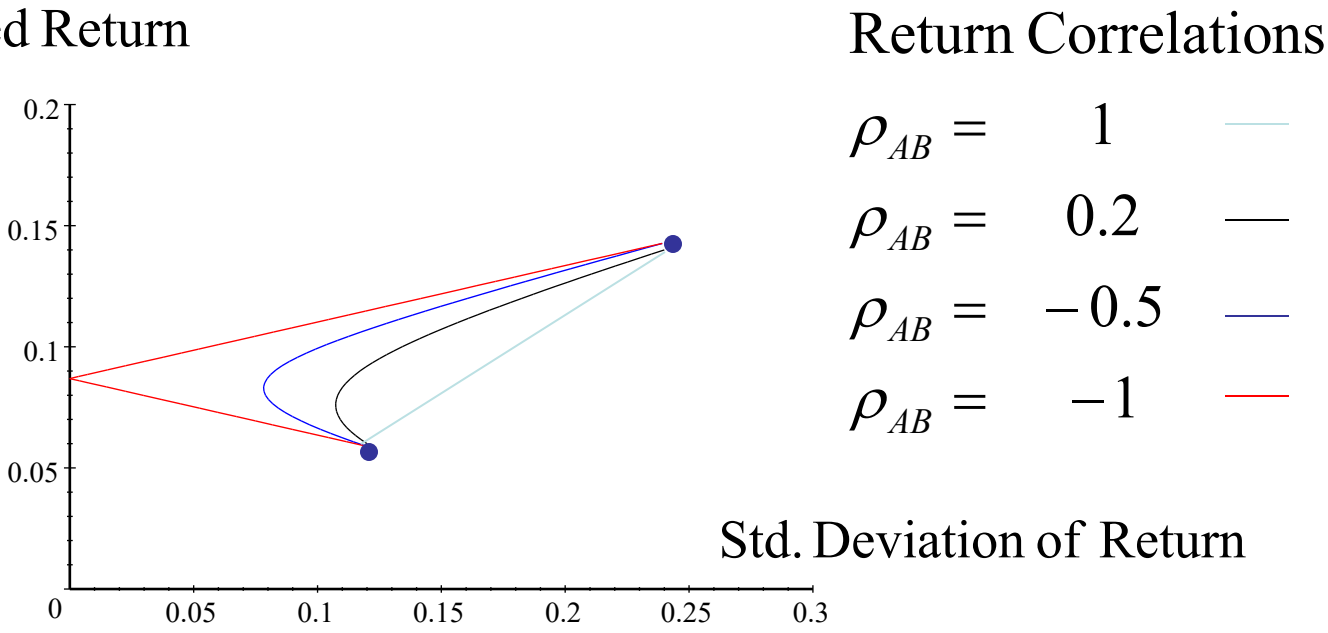
Segmented markets

- Suppose investors invest mainly in domestic fixed income assets
- Yet, there are differences in yields to the fixed income assets across contries as the countries citizen's risk bearing abilities differ
- Yields are compensation to risk: what risk is there in fixed income securities? Inflation risk for domestic investors, currency risk for foreign investors.

Recall portfolio theory: Risk Return possibilities for portfolios – the case of two Risky Assets



- In case of perfect negative correlation we can obtain a riskless portfolio (arbitrage portfolio) by going long in the higher yielding asset and short in the lower yielding asset

- Inflation risks (currency values) across countries can be highly correlated implying that very attractive long-short portfolios can emerge

Jylhä and Suominen, JFE

$$\begin{bmatrix} \tilde{\pi}_{i,t+1} \\ \tilde{\pi}_{j,t+1} \end{bmatrix} \sim N(\mu;\Sigma), \quad where \quad \mu = \begin{bmatrix} E_t\tilde{\pi}_{i,t+1} \\ E_t\tilde{\pi}_{j,t+1} \end{bmatrix} \quad and \quad \Sigma = \begin{bmatrix} \sigma_i^2 & \rho\sigma_i\sigma_j \\ \rho\sigma_i\sigma_j & \sigma_j^2 \end{bmatrix}.$$

CARA utilities for consumption, 2 countries with local investors (x=0) + arbitrageurs (x=∞)

π is inflation, m money holdings, b bond holdings

$$max_{m_{i,t},b_{i,t},b_{j,t}} E_t u(\tilde{c}_{t+1}) = -E_t e^{-a\tilde{c}_{t+1}} \qquad (2)$$

$$st. \quad \begin{cases} \tilde{c}_{t+1} = (w_t - m_{it} + p_{it}m_{it}/\pi_{it}))(1+r_f) + f(m_t) + b_{it}(\tilde{\pi}_{it+1} - p_{it}(1+r_f)) + b_{jt}(\tilde{\pi}_{jt+1} - p_{jt}(1+r_f)) \\ |b_{j,t}| \le x. \end{cases}$$

Jylhä and Suominen, JFE

Per capita supply (fraction k arbitrageurs)

$$M_{i,t}^{d} = \frac{\overline{M}_i - (k_i + k_j) b_{i,t}^{s}}{1 - k_i}.$$

$b_{i,t}^{d} = M_{i,t}^{d}$, we obtain that the price of the zero coupon bond, $p_{i,t}$, in country i at time t is:

$$p_{i,t} = \frac{E_t \tilde{\pi}_{i,t+1} - a\sigma_i^2 M_{i,t}^{d}}{1 + r_f}.$$

$$SR_i = \frac{r_i - r_f}{\sigma_i / p_i} = a M_{i,t}^{d} \sigma_i .$$

Propositions

Proposition 1: *When correlation between inflation shocks is high enough, $\rho > \bar{\rho}$, and the markets are sufficiently segmented, $k_L < \bar{k}_L$, the speculators' portfolio is a "currency hedge fund" with a short position in currency L and a long position in currency H. The expected returns to the speculators' hedge fund are positive. The leverage in the speculators' hedge fund, as defined by $-b_L^{s*}$, approaches infinity when $\rho \to 1$ and $max\{k_i,k_j\} \to 0$. The leverage decreases as the number of speculators increases.*

Propositions

Proposition 2: *Assume* $\rho > \overline{\rho}$ *and* $k_L < \overline{k}_L$. *A reduction in* Φ, *the cost of becoming a speculator, leads to an increase in the number of speculators (which is equivalent to the flow of assets to the hedge fund), the convergence of the Sharpe ratios of the two countries' domestic bonds and a decrease in the expected returns to the speculators' hedge fund. A decrease in* Φ, *through an increase in the number of speculators, leads to a rise in* r_L *and a decrease in* r_H, *a rise in bond price* p_H *and a decrease in bond price* p_L, *and an increase in the exchange rate* $S_{H,L} = \pi_H / \pi_L$. *An increase in the number of speculators in period t affects positively the contemporaneous returns to the period t-1 speculators' hedge fund.*

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Hedge funds "trade carry"

	Correlation with Carry Trade Returns	*p*-value
S&P 500	0.079	0.118
Lehman US Aggregate	-0.090	0.076
Hedge funds	0.258	0.001
Convertible Arbitrage	0.266	0.000
Dedicated Short Bias	-0.024	0.754
Emerging Markets	0.189	0.012
Equity Market Neutral	-0.083	0.271
Event Driven	0.175	0.021
Fixed Income Arbitrage	0.332	0.000
Global Macro	0.252	0.001
Long/Short Equity	0.096	0.203
Managed Futures	-0.027	0.720
Multi-Strategy	0.111	0.144

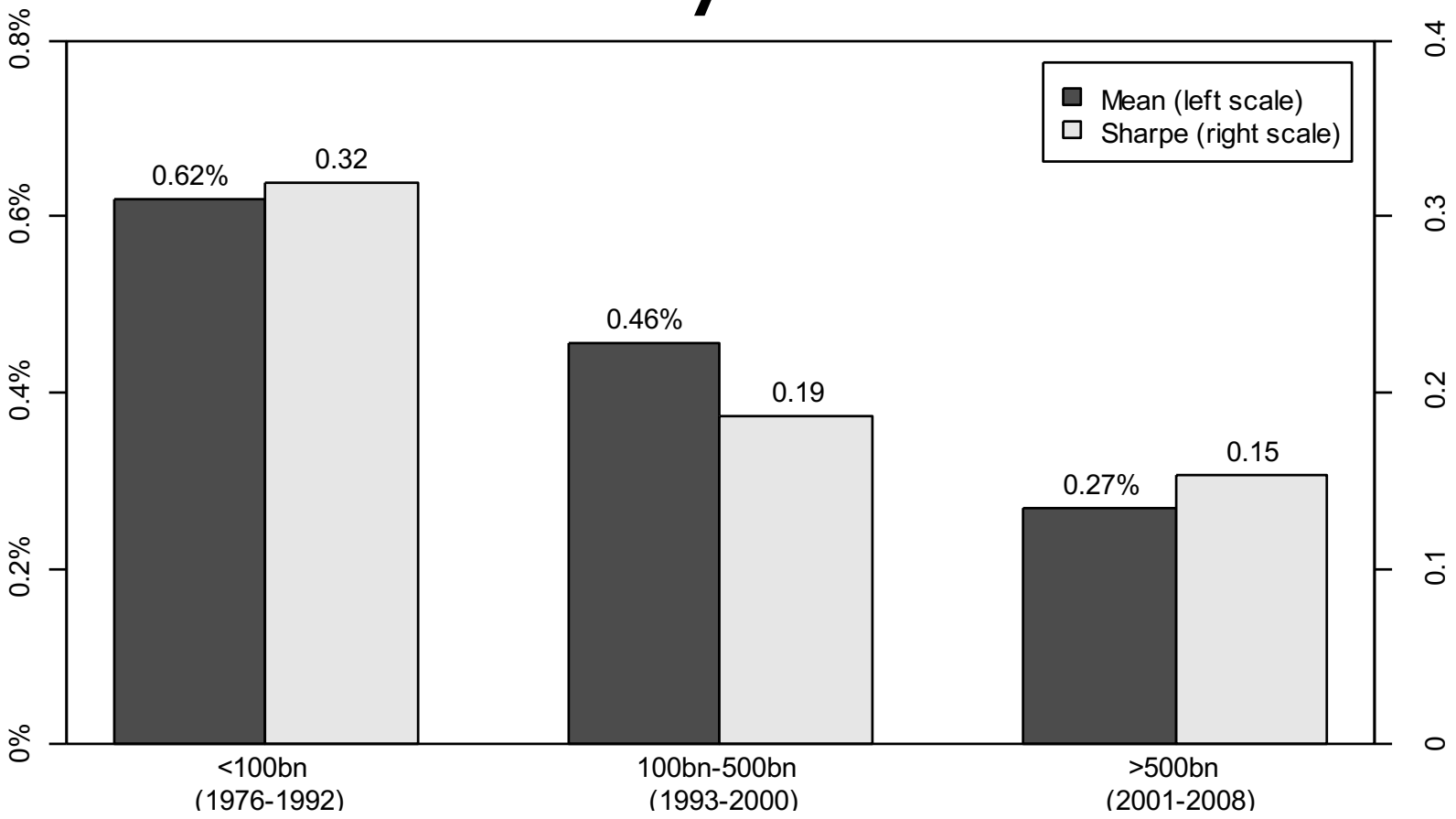
Hedge funds "trade carry"

Fung & Hsieh 7 factors

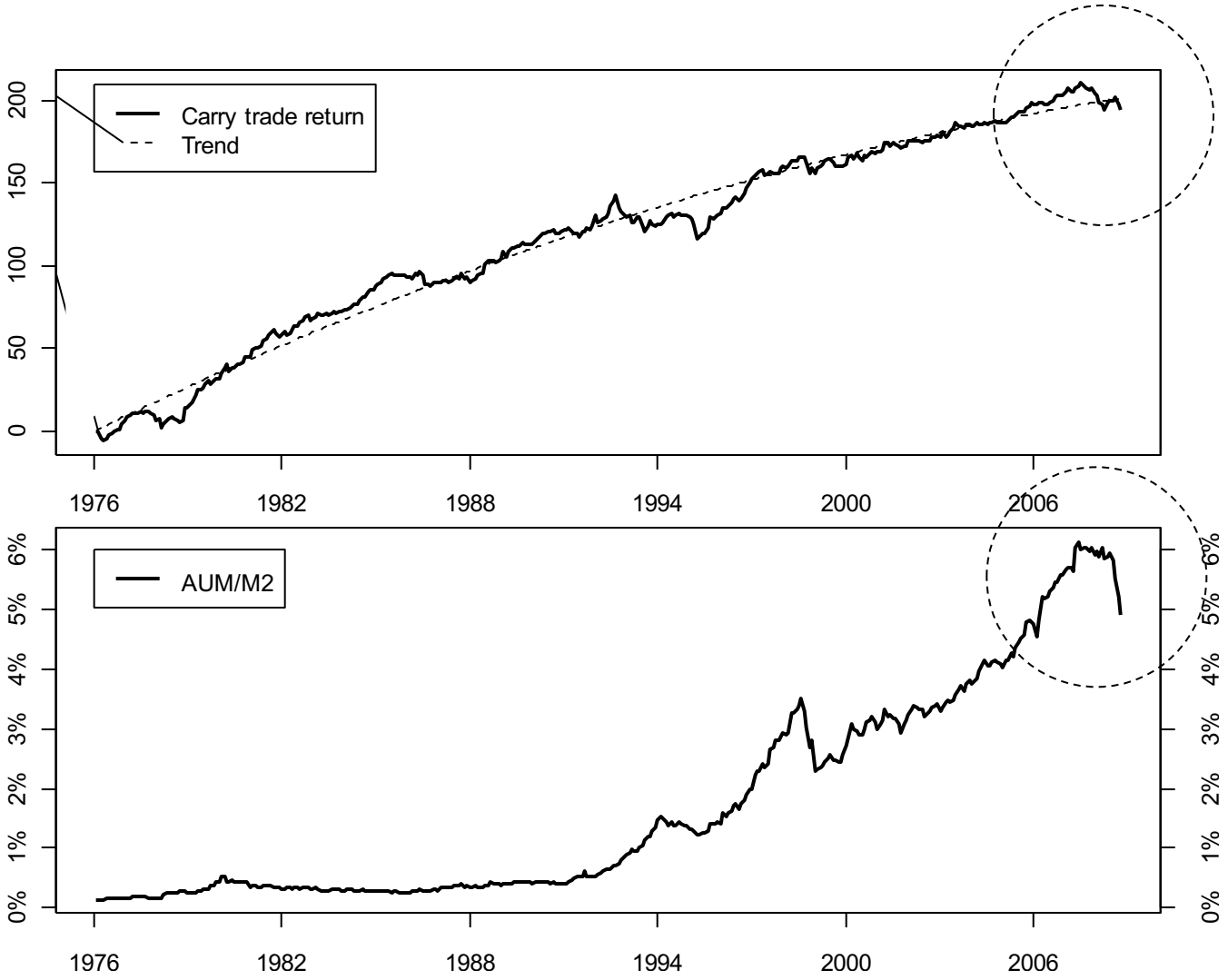
New factor

	Hedge fund		Global macro		Fixed income arbitrage	
Constant	0.0063	0.0049	0.0097	0.0075	0.0049	0.0042
	(5.51)	(4.56)	(5.07)	(3.52)	(5.29)	(4.23)
Bond trend following factor	-0.0254	-0.0243	-0.0283	-0.0263	-0.0116	-0.0111
	(-2.12)	(-1.99)	(-1.68)	(-1.54)	(-1.78)	(-1.64)
Currency trend following factor	0.0123	0.0189	0.0191	0.0301	-0.0069	-0.0038
	(1.68)	(2.61)	(1.32)	(2.18)	(-1.07)	(-0.76)
Commodity trend following factor	0.0240	0.0249	0.0279	0.0295	0.0122	0.0126
	(2.03)	(2.33)	(1.34)	(1.53)	(1.91)	(2.10)
Equity market factor	0.2578	0.2687	0.1500	0.1682	-0.0200	-0.0148
	(5.62)	(7.00)	(1.72)	(2.27)	(-0.63)	(-0.55)
Size spread factor	0.1815	0.1742	0.0647	0.0524	0.0034	-0.0001
	(3.36)	(3.43)	(0.95)	(0.86)	(0.22)	(-0.01)
Bond market factor	-0.0241	-0.0225	-0.0412	-0.0384	-0.0154	-0.0146
	(-3.72)	(-3.56)	(-3.59)	(-3.62)	(-2.61)	(-2.80)
Credit spread factor	-0.0310	-0.0197	-0.0457	-0.0267	-0.0397	-0.0342
	(-2.04)	(-1.58)	(-1.75)	(-1.23)	(-3.07)	(-3.44)
Currency carry trade return		**0.2820**		**0.4733**		**0.1355**
		(3.30)		**(2.63)**		**(2.03)**
Adjusted R-squared	0.425	0.485	0.141	0.228	0.154	0.199

Decreasing returns to carry trade



Has the increase in hedge fund industry AUM caused the decrease in carry trade returns?



Regression analysis: Definition of key variables

- **AUM** = Hedge fund industry's Assets Under Management/M2
- **Flow (t) & Flow (t-1)** = contemporaneous flow of new AUM/M2
- **Position** = $\begin{cases} 1 \text{ Carry long currencies} \\ -1 \text{ Carry short currencies} \\ 0 \text{ otherwise} \end{cases}$
- **TED** = Treasury – Eurodollar spread
  = proxy for the premium hedge funds must pay when borrowing (marginal cost for arbitrageurs)

Arbitrage Capital (Hedge fund industry AUM) affects carry trade returns

Dependent: CARRY TRADE RETURN	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.0065	0.0061	0.0067	0.0061	0.0064	0.0059
	(4.36)	(4.06)	(4.52)	(4.16)	(4.23)	(3.91)
AUM	-0.1395	-0.1332	-0.0962	-0.0917	-0.1270	-0.1207
	(-2.21)	(-2.14)	(-1.70)	(-1.68)	(-2.07)	(-2.00)
Hedge fund flow (t)	1.6820	1.7781			1.9891	2.0569
	(1.20)	(1.31)			(1.44)	(1.53)
Hedge fund flow (t-1)	2.4789	2.2512			2.1805	1.9014
	(1.69)	(1.54)			(1.58)	(1.36)
Δ TED × AUM			-0.2424	-0.2613	-0.2407	-0.2575
			(-2.90)	(-3.10)	(-3.03)	(-3.25)
Δ TED			0.0034	0.0058	0.0033	0.0055
			(1.10)	(1.69)	(1.04)	(1.57)
Mkt-rf		0.0004		0.0005		0.0005
		(1.66)		(2.06)		(1.91)
HML		0.0003		0.0005		0.0004
		(0.63)		(1.30)		(0.87)
SMB		0.0001		0.0003		0.0002
		(0.36)		(0.72)		(0.47)
R-squared	0.017	0.024	0.019	0.029	0.027	0.036

APPENDIX: Inflation risk

To find a proxy for the time varying inflation risk, we estimate the following autoregressive model, that also allows for heteroskedasticity, for the rate of inflation, d_t:

$$d_t = \beta_0 + \sum_{j=1}^{12} \beta_j d_{t-j} + e_t, \qquad e_t \sim N(0, h_t^2)$$

$$h_t^2 = \gamma_0 + \gamma_1 h_{t-1}^2 + \gamma_2 e_{t-1}^2.$$

The model is estimated individually for each country using OECD data on monthly inflation dating back to January 1965 for other countries and January 1990 for euro area. We use the mean equation for d_t to produce inflation forecasts and the time varying variance term, h_t^2, as our proxy for the inflation risk. The approach is similar to those used by *e.g.*, Grier and Perry (1998) and Hwang (2001).

Carry trading affects interest rates

Dependent: INTEREST RATE	(1)	(2)	(3)	(4)
Inflation forecast	0.3117	0.2718	0.2117	0.1874
	(3.63)	(3.53)	(4.23)	(3.68)
Log(inflation risk)	0.0010	0.0009	0.0007	0.0007
	(1.97)	(3.98)	(1.79)	(4.09)
Log(money supply)	0.0018	0.0009	0.0012	0.0003
	(3.70)	(2.18)	(3.32)	(0.92)
Position × AUM		-0.0285		-0.0240
		(-2.25)		(-2.58)
Position × TED			0.0007	0.0006
			(3.19)	(3.43)
Position		0.0019	0.0008	0.0013
		(7.86)	(3.68)	(6.27)
AUM		-0.0801		-0.0762
		(-9.06)		(-10.21)
TED			0.0014	0.0014
			(9.28)	(8.49)
Country effects	Yes	Yes	Yes	Yes

Carry trading and interest rates

Dependent: **INTEREST RATE CHANGE**	(1)	(2)
Δ Inflation forecast	-0.0090	-0.0423
	(-0.79)	(-2.06)
Δ Log(inflation risk)	0.0004	0.0003
	(2.04)	(1.24)
Δ Log(money supply)	0.0051	0.0065
	(3.96)	(4.21)
Position × Hedge fund flow (t)		-0.2595
		(-1.95)
Position × Hedge fund flow (t-1)		-0.4508
		(-2.32)
Position		0.0003
		(3.77)
Hedge fund flow (t)		0.0951
		(1.08)
Hedge fund flow (t-1)		0.0687
		(0.54)
Country effects		Yes

Carry trading affects exchange rates

Dependent: **EXCHANGE RATE CHANGE**	
Forward premium	0.4629
	(1.46)
Position × Hedge fund flow (t)	1.5333
	(7.35)
Position × Hedge fund flow (t-1)	1.3291
	(1.08)
Position	0.0021
	(1.85)
Hedge fund flow (t)	-0.1215
	(-0.25)
Hedge fund flow (t-1)	-0.0072
	(-0.01)
Country Effects	Yes

Summary and Conclusions

- Arbitrage capital has had a price effect on interest and exchange rates
  - Higher arbitrage capital $\Rightarrow$ smaller interest rate differentials
  - An increase in arbitrage capital leads to appreciation (depreciation) of high (low) interest rate currencies
  - Increase in arbitrage capital leads to positive contemporaneous returns but lower future expected returns to carry trades

- According to our results the historically observed clear failure of Uncovered Interest Parity Theory has been partly due to
  - Compensation for the risks taken
  - Low levels of arbitrage capital in the past

Conclusions

Implications for Monetary Economics

- Level of arbitrage capital can be an important factor for monetary policy in both high and low interest rate countries

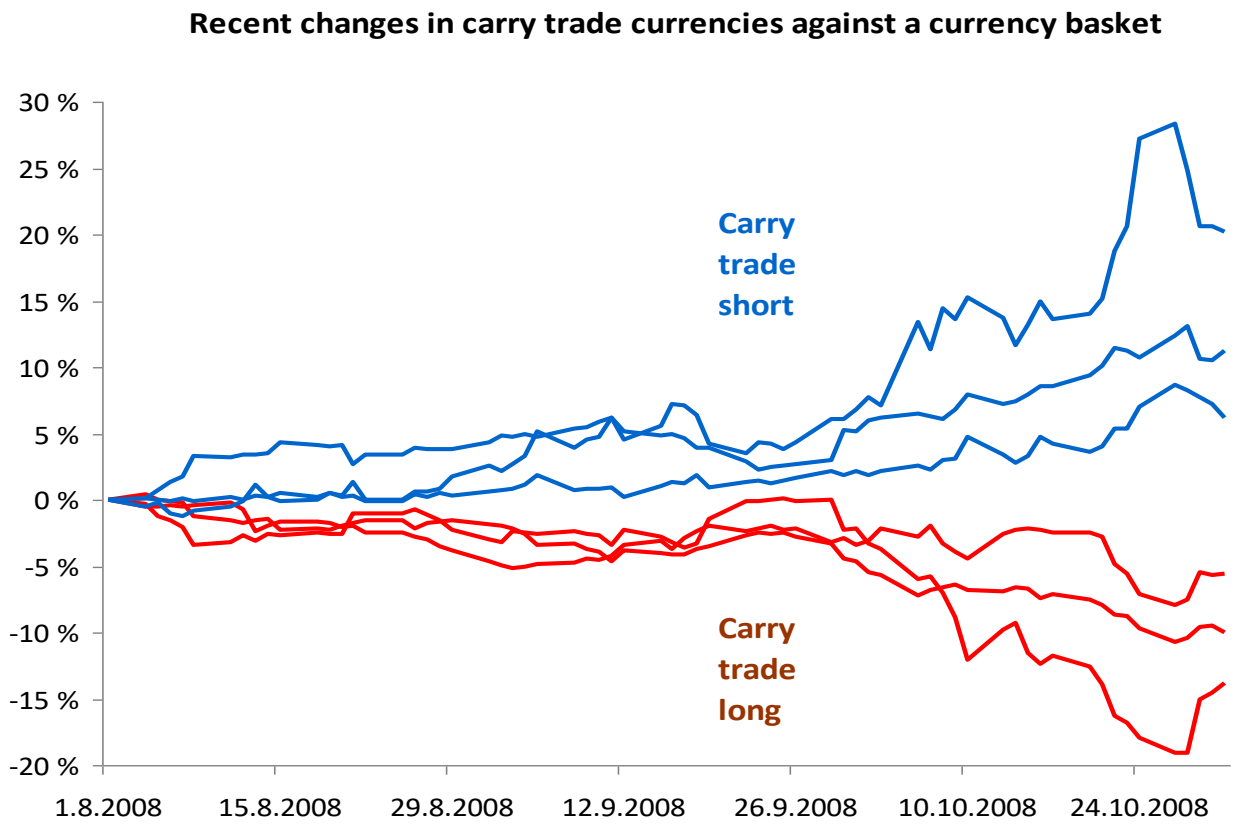
Carry trades, liquidity and recent currency movements

- During the past decade largely Asian savings were channeled through carry trading to the West (including the US and Europe) at an enormous scale. This brought about a huge increase in liquidity to carry trade long countries (US until 2007)

- While the AUM in hedge funds kept increasing, carry trade long currencies appreciated in relation to carry trade short currencies

- In fall 2008, when hedge funds cost of borrowing first increased and later hedge fund AUM started to decline, carry trade positions were drastically reduced and the process was reversed

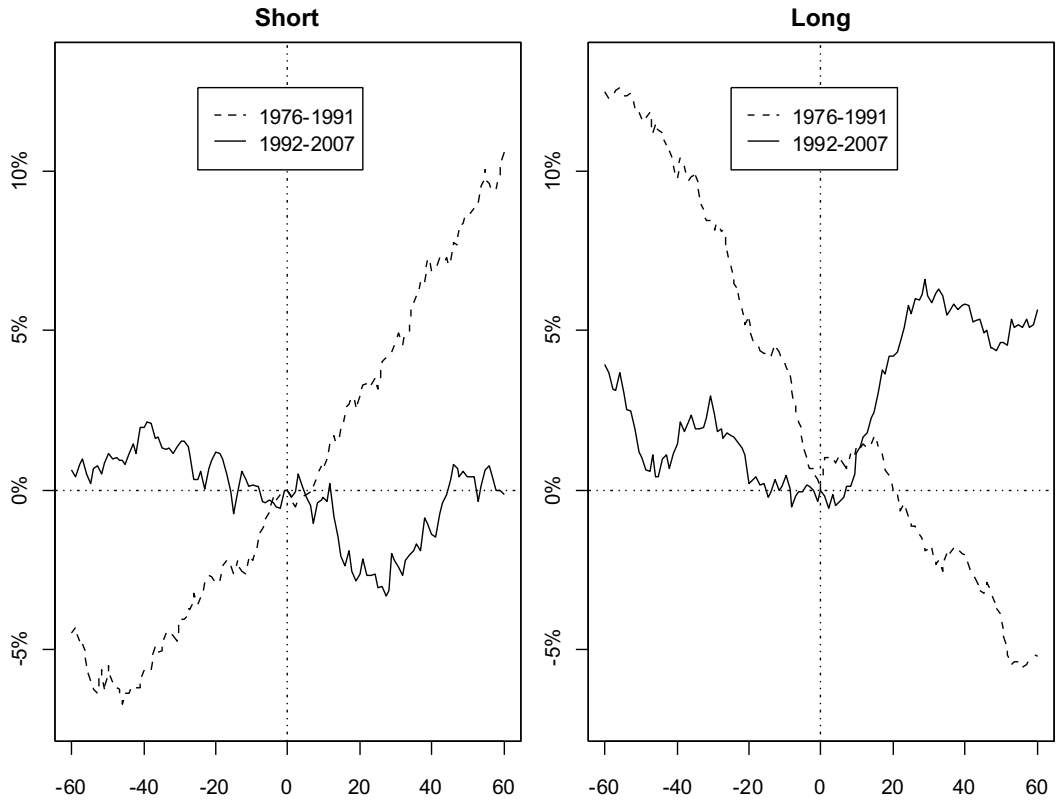
In fall 2008 the rapid ”unwinding of carry trades” was associated with extreme currency movements



EMPIRICAL RESULTS: PRICE EFFECT OF CARRY TRADE ACTIVITY

Figure 5. Spot exchange rate development around entry into carry portfolio, two sub-periods.

This figure shows the development of spot exchange rate 60 months before and 60 months after the currency entering a portfolio in two different sub-periods: 1976-1991 (light gray line) and 1992-2007 (dark gray line). *Short* refers to portfolio of short positions in low interest rate currencies, *Long* refers to portfolio of long positions in high interest rate currencies. The dash line represents the period 1976-1991, and the solid line represents the period 1992-2007. t=0 represents the month of entry into the portfolio.



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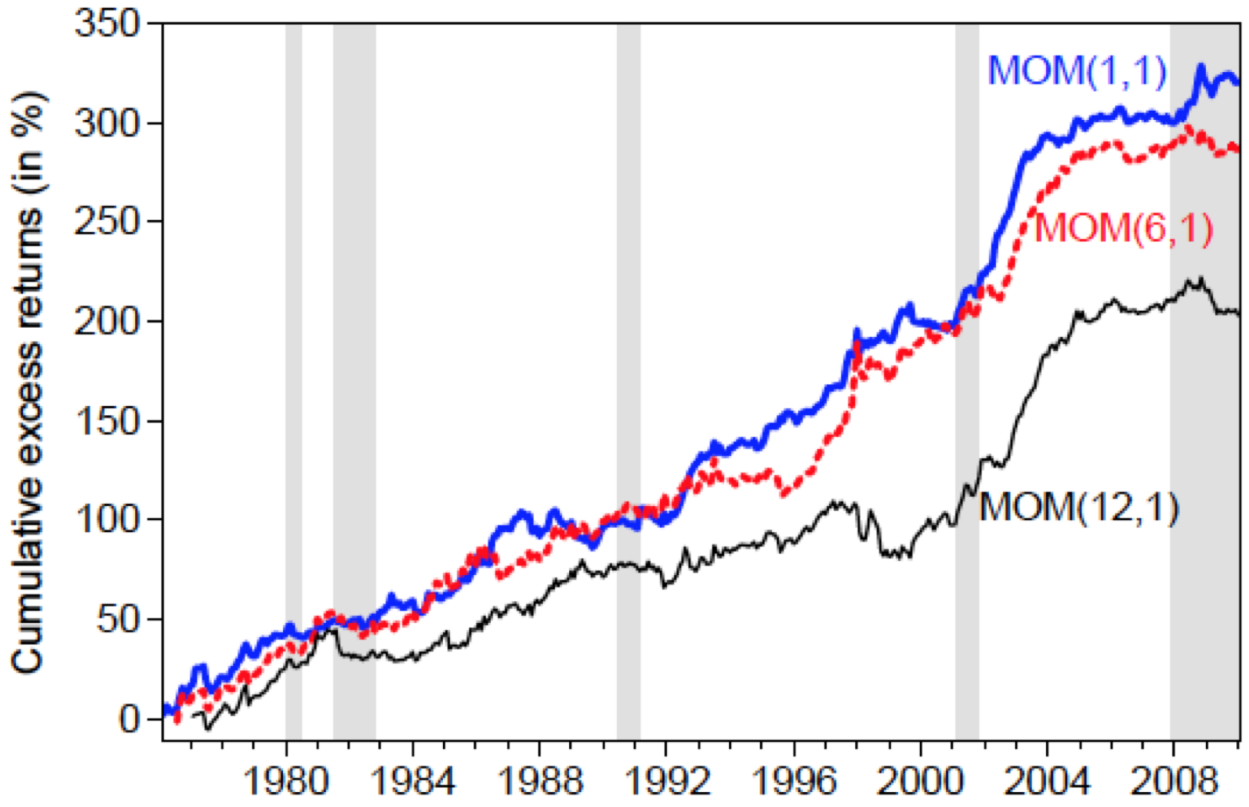
Momentum also works in currencies

- $M_{f,h}$ = momentum portfolio that is formed based on f month's past returns and is held for h months

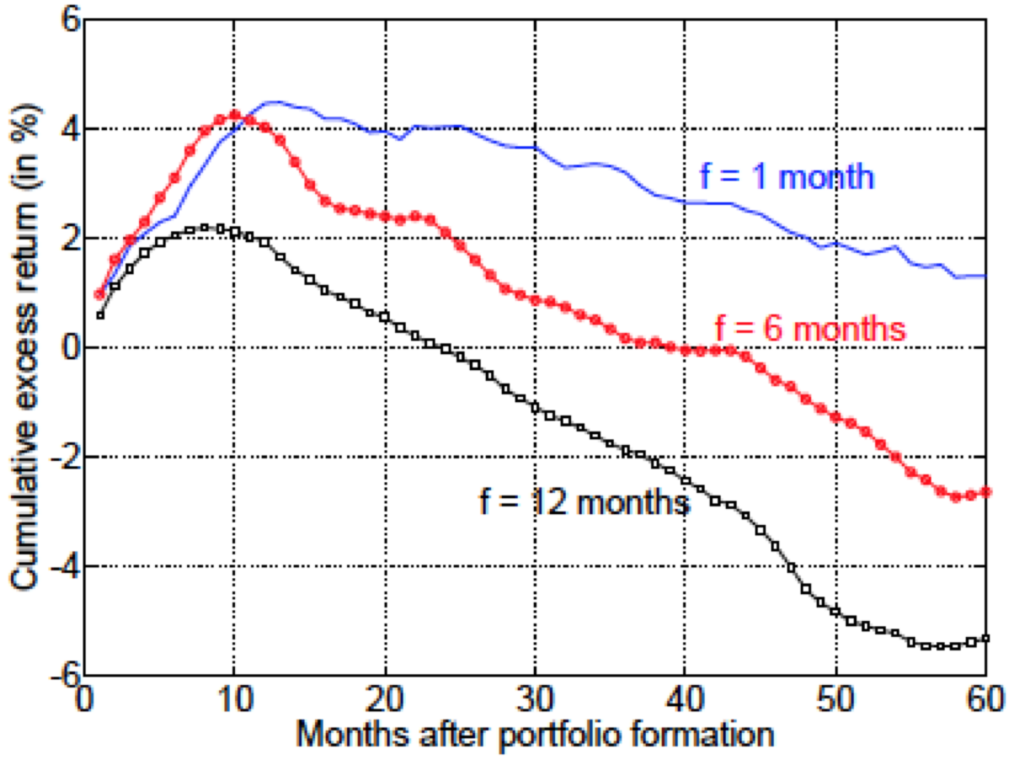
- In contrast to stocks, there is no short-term reversal even in one month momentum strategy $M_{1,1}$

Momentum in currency markets



This figure shows cumulative log excess returns (not adjusted for transaction costs) accruing to three different momentum returns. The momentum strategies are for a formation period of 1, 6, and 12 months, respectively, and the holding period is one month. The bold, blue line shows returns to the momentum strategy with a one month formation period (MOM(1,1) in the figure), the dashed, red line shows returns to a strategy with a six months formation period (MOM(6,1)), whereas the thin, black line shows returns to a momentum strategy with a twelve months formation period (MOM(12,1)). Shaded areas correspond to NBER recessions.

Figure 4. Long-horizon momentum excess returns



This figure shows cumulative average excess returns to three different long-short currency momentum portfolios after portfolio formation. Momentum portfolios differ in their formation period ($f = 1, 6, 12$ months) and post-formation returns are shown for $1, 2, \ldots, 60$ months following the formation period (i.e. we build new portfolios each months but track these portfolios for the first 60 months after their formation so that we are effectively using overlapping horizons). Excess returns are monthly and the sample period is 1976:1 – 2010:1.

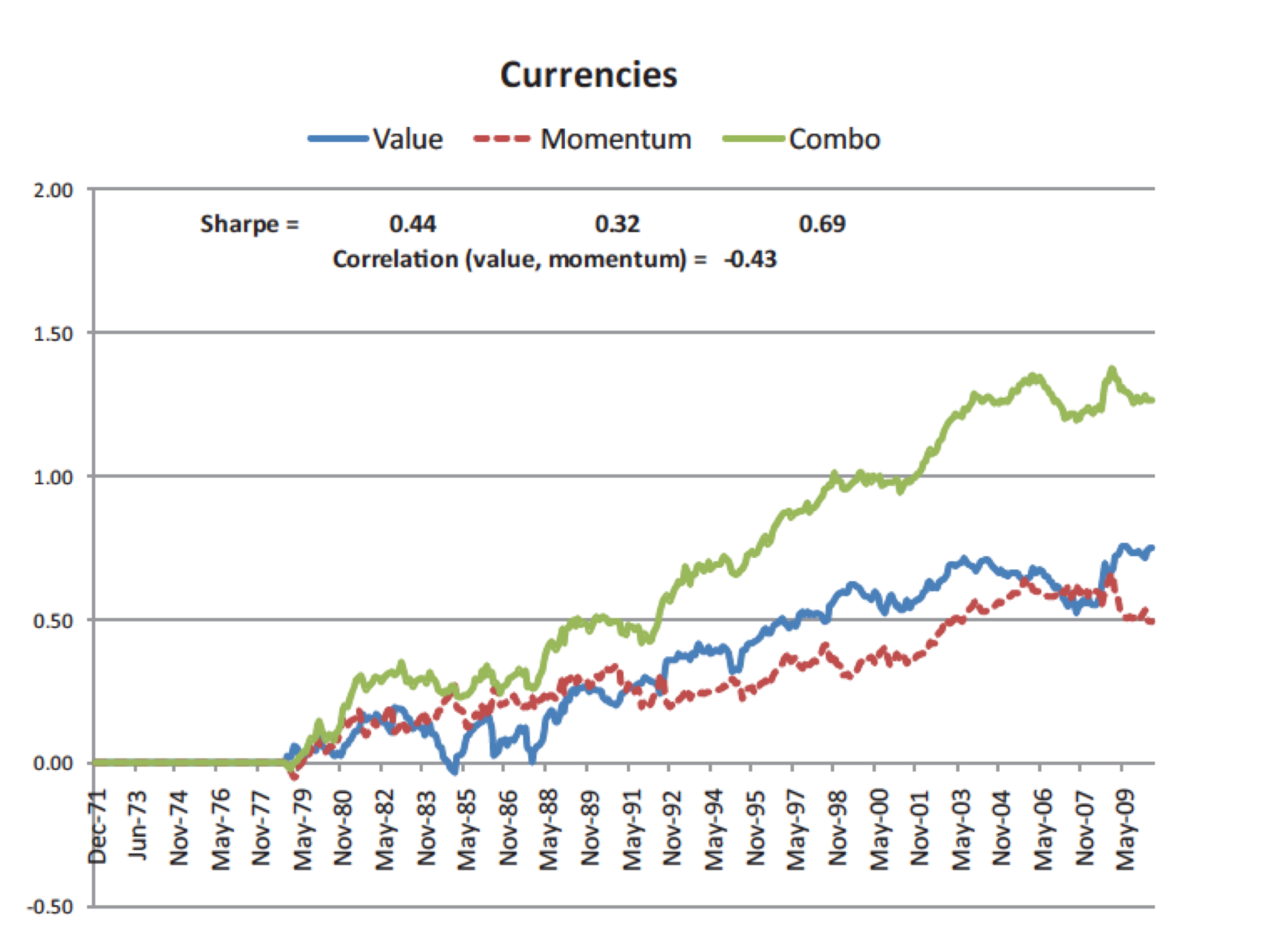
Measure of value

Longer term reversal measure:

Barros and Santa-Clara use yet another factor to forecast currency investment returns: Long-term reversal.

Long-term reversal is the cumulative real currency depreciation in the previous five years, standardized cross-sectionally.

This is effectively the same measure as the notion of "currency value" used in Asness, Moskowitz, and Pederson (2009).


Currencies
Value
Momentum
Combo
Sharpe =
0.44
0.32
0.69
Correlation (value, momentum) = -0.43
2.00
1.50
1.00
0.50
0.00
-0.50
Dec-71
Jun-73
Nov-74
May-76
Nov-77
May-79
Nov-80
May-82
Nov-83
May-85
Nov-86
May-88
Nov-89
May-91
Nov-92
May-94
Nov-95
May-97
Nov-98
May-00
Nov-01
May-03
Nov-04
May-06
Nov-07
May-09

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Conclusion

- Predictability in international fixed income returns

- Carry
- Momentum
- Long-term reversal

- There are good reasons to believe the phenomena continue to exist, but are diminshed over time as arbitrage capital keeps increasing