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Currency Carry Trades and Funding Risk

Sara Ferreira Filipe, University of Luxembourg

Matti Suominen, Aalto University

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Agenda

- Introduction
- Model
- Empirical Findings
- Conclusion

Introduction

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- **Currency Carry Trades:**
  - Carry trade: Invest in high interest rate currencies while borrowing in the low interest rate currencies
  - Due to failure of the Uncovered Interest Rate Parity carry trade has been a very successful investment strategy (e.g., Burnside, Eichenbaum, Kleshchelski and Rebello, 2011, Lustig, Roussanov and Verdelhan, 2011).
  - 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.

Closely related literature:

- Shleifer and Vishny (1997)
- Gromb and Vayanos (2002)
- Jylhä and Suominen (2011)

} Limits of Arbitrage, segmented markets, role for carry trades

- Brunnermeir and Pedersen (2009)
- Brunnermeier, Nagel and Pedersen (2009)

} Concept of funding liquidity, effect for carry trades

- Adrian and Shin (2010) } Equity prices drive funding liquidity

- Hattori and Shin (2009) } Special role of Japanese financial markets in carry trades

- Santa-Clara and Yan (2010) } Estimating equity risks using derivatives

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Agenda

- Introduction
- Model
- Empirical Findings
- Conclusion

Model

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- Two countries.

- Nominal fixed income securities (effectively the net supply of these securities equals the money supply M).

- Money has value in the production, marginal value of money is stochastic.

- Markets are segmented: only part of the investors in both countries can invest in or short foreign bonds.

- Borrowing constraints, investors cannot borrow more that h_i in country i's currency, where h_i is stochastic.

- Interest rates and exchange rates are determined in the equilibrium.

Model

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Speculators maximize:

$$\underset{m_{i,t},b_{i,t},b_{j,t}}{Max} - E_t e^{-ac_{t+1}} \quad \text{s.t.}$$

$$c_{t+1} = \left(w_t - m_{i,t} + p_{i,t}\frac{m_{i,t}}{\pi_{i,t}}\right)(1+r_f) + f_i(m_{i,t}) + \sum_{n=i,j} b_{n,t}(\pi_{n,t+1} - p_{n,t}(1+r_f))$$

$$b_{i,t} \geq -h_{i,t}, \quad b_{j,t} \geq -h_{j,t}.$$

Domestic investors maximize:

$$\underset{m_{i,t},b_{i,t}}{Max} - E_t e^{-ac_{t+1}} \quad \text{s.t.}$$

$$c_{t+1} = \left(w_t - m_{i,t} + p_{i,t}\frac{m_{i,t}}{\pi_{i,t}}\right)(1+r_f) + f_i(m_{i,t}) + b_{i,t}(\pi_{i,t+1} - p_{i,t}(1+r_f))$$

$$b_{i,t} \geq -h_{i,t}.$$

Model

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- First order conditions and market clearing imply
  - Equilibrium exchange rates: π_i, π_j
  - Equilibrium bond prices: p_i, p_j
  - Equilibrium production and consumption

Model

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- When shocks to the countries' production technologies are sufficiently correlated, when the number of unconstrained investors is small enough, they engage in equilibrium in carry trades: borrow from the low interest rate country and invest in high interest rate country.

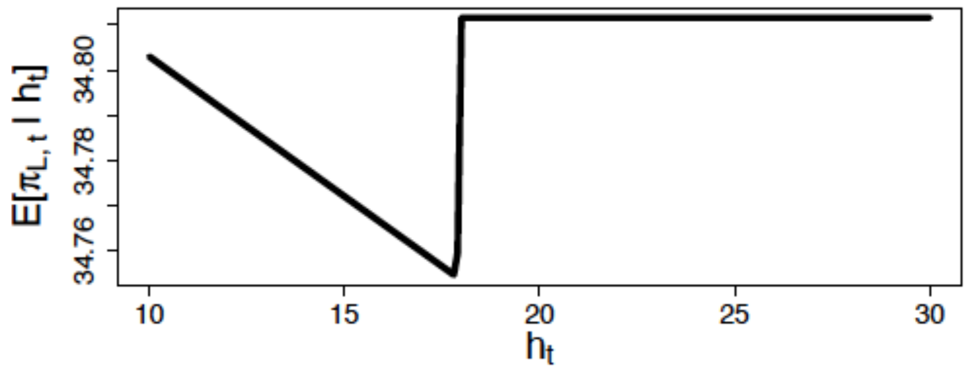
- We can solve the model explicitly in two regions: borrowing constraints always bind, or they never bind. In the third region, where the borrowing constraints bind with some probability, we resort to numerical solutions.

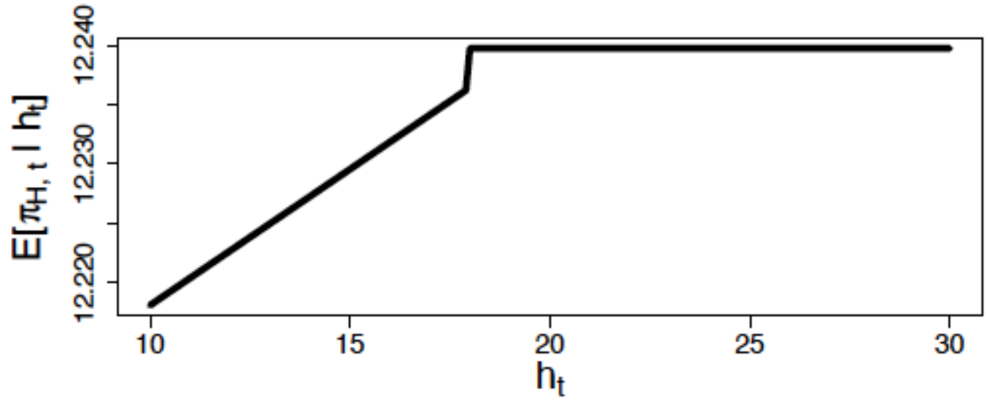
- We assume that unconstrained investors are in both countries, but can show that the investors in low interest rate countries benefit more from being unconstrained.

Model

- Model predicts:
  - higher volatility in exchange rates when funding constraints bind.
  - lower correlation between exchange rates when the funding constraints bind.
  - model also predicts skewness in returns
  - and currency crashes when the constraints start to bind.

Numerical solution for the model





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Agenda

- Introduction
- Model
- Empirical Findings
    - Carry Trade
    - Special role of Japan
    - Empirical setup
    - Our results

Conclusion

Sample

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- 2000-2011

- 10 developed countries' currencies: Australian dollar (AUD), Canadian dollar (CAD), Danish krone (DKK), Euro (EUR), Japanese yen (JPY), New Zealand dollar (NZD), Norwegian krone (NOK), Swedish krona (SEK), Swiss franc (CHF) and UK pound (GBP).

Carry Trade Returns

Monthly Carry Trade Returns: Summary statistics

Strategy	Mean	Std. Dev.	Skewness	Kurtosis	Median
HmL	0.0070 (0.0035)	0.0416	-1.3407	7.3109	0.0111
AUmJP	0.0059 (0.0038)	0.0459	-1.2298	7.8532	0.0103
HmL3	0.0040 (0.0020)	0.0244	-0.8174	5.3299	0.0065
HmL5	0.0022 (0.0014)	0.0173	-0.8826	5.7698	0.0041

Carry Trade Returns

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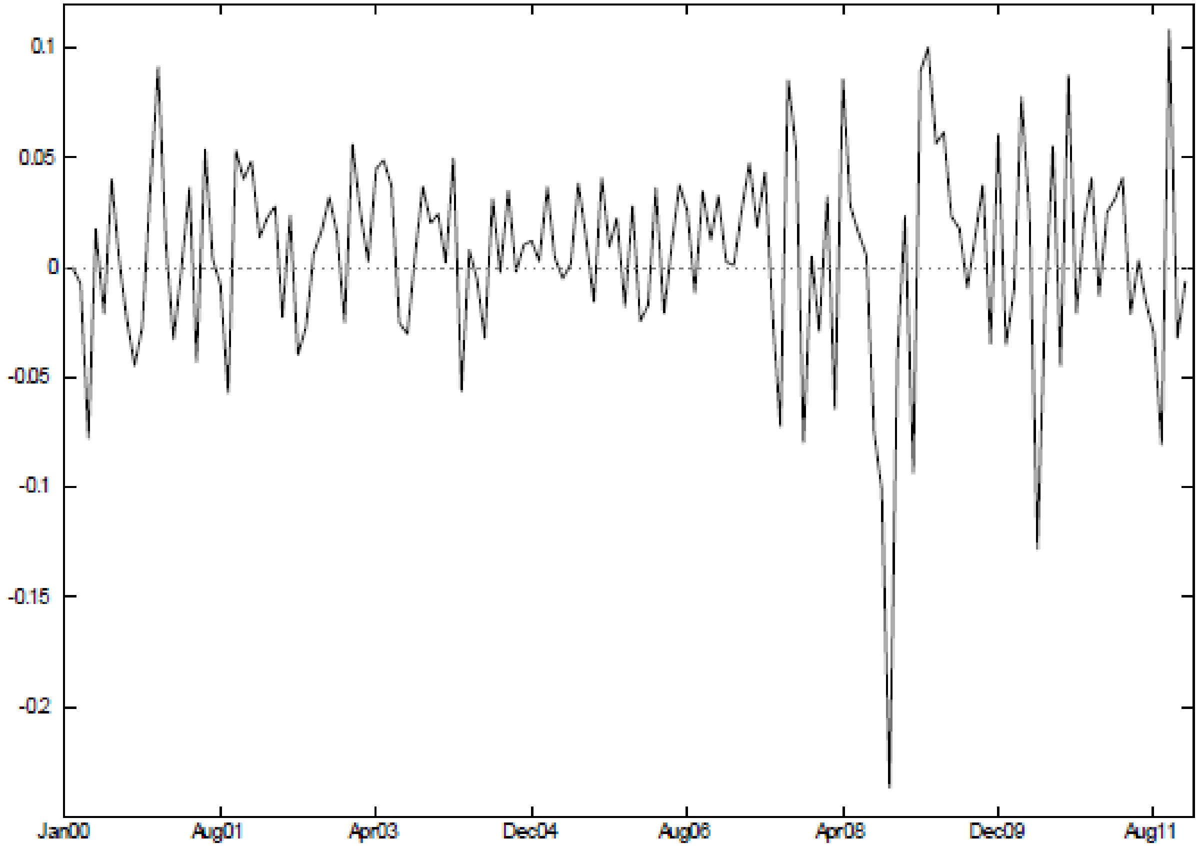
Monthly returns to the AUD / JPY carry trade:



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Agenda

- Introduction
- Model
- Empirical Findings
    - Carry Trade
    - Special role of Japan
    - Empirical setup
    - Our results

Conclusion

The Watanabe Family

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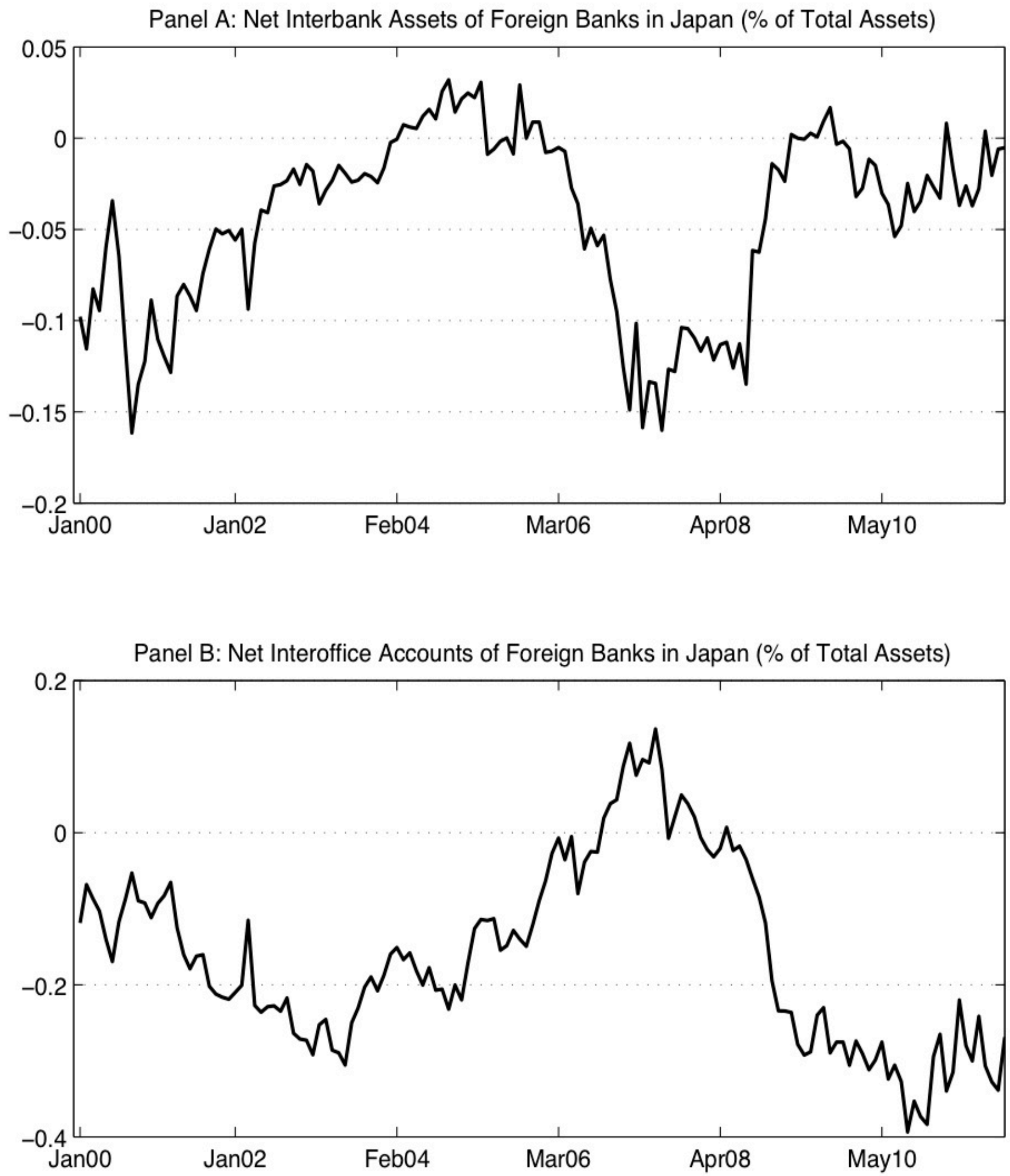
The Economist magazine, August 2007:

”…Japanese retail investors … carry trade's greatest enthusiasts. The metaphorical Mr and Mrs Watanabe account for around 30% of the foreign-exchange market in Tokyo by value and volume of transactions, according to currency traders, double the share of a year ago. Meanwhile, the size of the retail market has more than doubled to about $15 billion a day. One reason for the surge is margin trading. Brokers are offering leverage of as much as 200 times the down-payment (though the average is more like 20 to 40 times). In July Japanese retail investors' short positions on the yen … exceeded the amount taken by traders on the Chicago Mercantile Exchange..."

Also international flows suggest major role of Japan

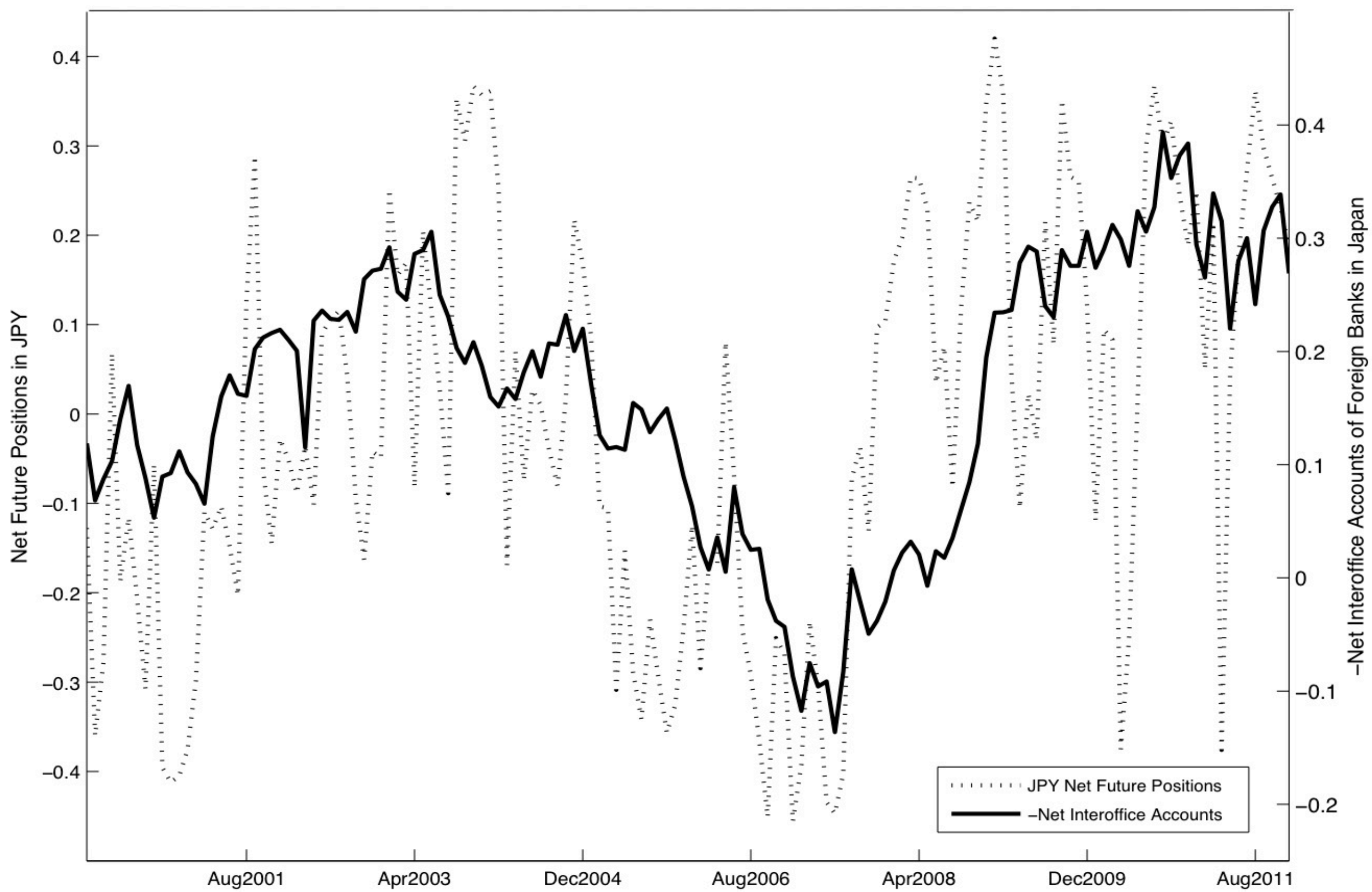


As shown in Hattori and Shin (2010), the Net Interoffice Accounts of banks which have subsidiaries in Japan is highly correlated with their subsidiaries borrowings in Japan.

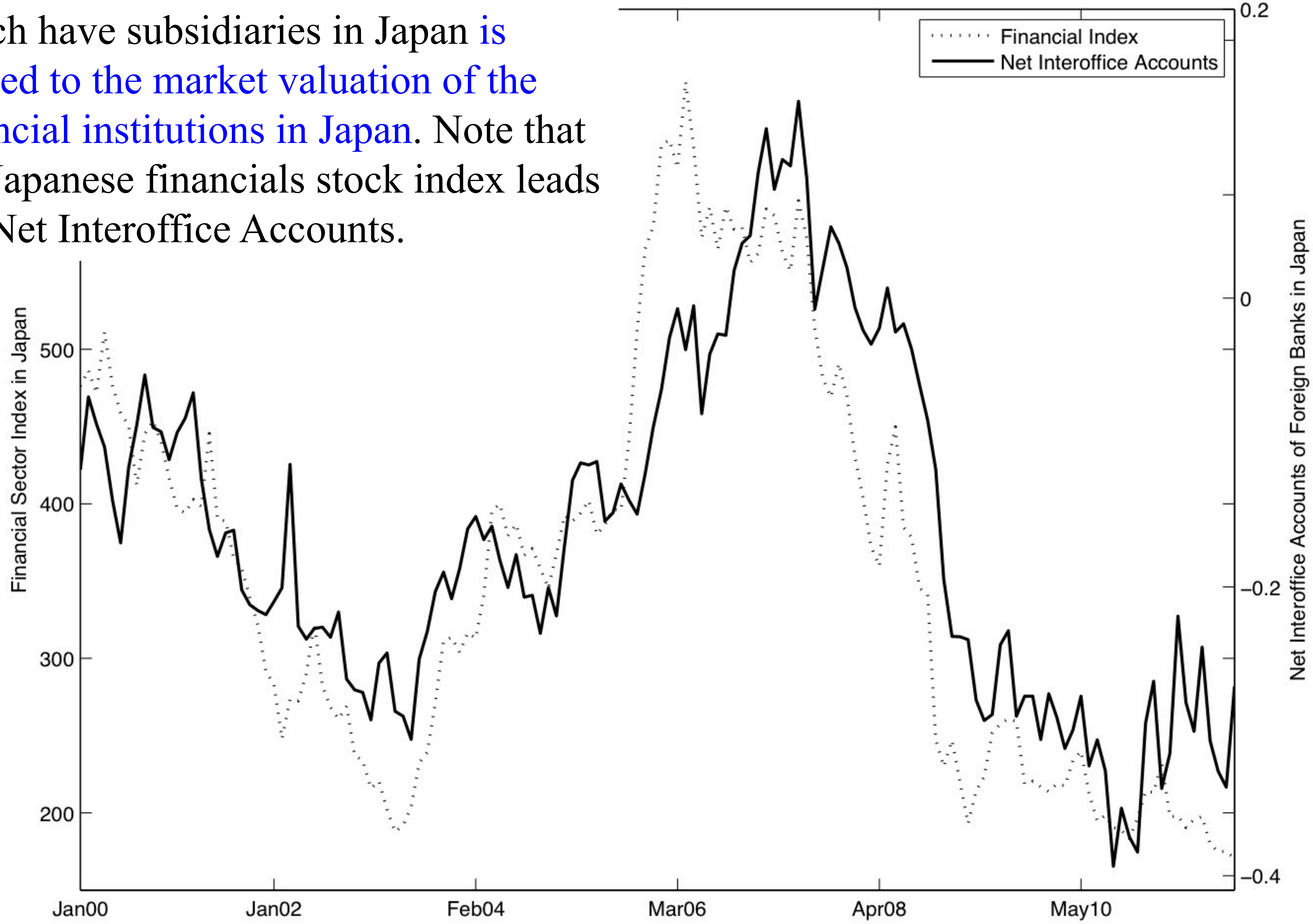
➡

International banks channel large amount of yen out of Japan!

The Net Interoffice Accounts of banks which have subsidiaries in Japan is closely related to the speculative futures positions in yen at the CFTC in US. As Hattori and Shin (2010) argue, it seems likely that these banks' international borrowings are closely related to currency carry trades involving yen.



The Net Interoffice Accounts of banks which have subsidiaries in Japan is related to the market valuation of the financial institutions in Japan. Note that the Japanese financials stock index leads the Net Interoffice Accounts.



Special role of funding currencies

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The evidence from Japan, presented above, leads us to expect that the financial market conditions in major funding currency countries, most notably Japan, are likely to have a large, separate effect on the global currency trading activity and currency markets on top of any effects of the global financial market conditions!

Agenda

- Introduction
- Model
- Empirical Findings
    - Carry Trade
    - Special role of Japan
    - Empirical setup
    - Our main results

Conclusion

Carry traders' funding conditions

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We argue:

1) Domestic investors' carry trade funding conditions depend on the local equity market conditions a) as their equity holdings make up large part of their collateral; and b) equity market conditions in local markets affect the local banks' ability to lend if they hold large positions in local equity (as e.g. Japan); and c) the financial institutions own equity market valuations move with the market. In line with the arguments presented in Adrian and Shin (2010) we expect the financial intermediaries equity prices to best reflect the banks' overall ability to offer credit to their customers that trade carry.

2) We expect that also the foreign carry trade investors' ability to obtain funding in the funding currency is affected by the funding currency's local equity market conditions (especially the market equity capital of the local financial intermediaries).

Estimating funding risk

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We assume funding countries' equity market conditions determine the carry traders' funding conditions. Given this, we look at the funding countries' equity market risks to determine funding risks for the related currencies (we look at the risks in the overall equity market in the funding countries, rather than just the risks in the financial intermediaries equity prices due to better data for the overall equity markets).

Although for tractability our model did not consider the possibility of equity market crashes, we do consider them in our empirical application as equity market crashes exist in reality. Even though crashes materialize only rarely in the equity markets, we can use options markets to infer the probability of crashes as Santa-Clara and Yan (2010) did in explaining the US equity market risk premium.

Our proxy for funding risk in any given currency, is therefore the equity index options implied volatility and crash risk in the respective countries (Japan. Switzerland, US and Australia). Data source: Thomson Reuters.

Estimating funding risk

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Santa-Clara and Yan (2010)

The dynamics of the stock market index is modeled as:

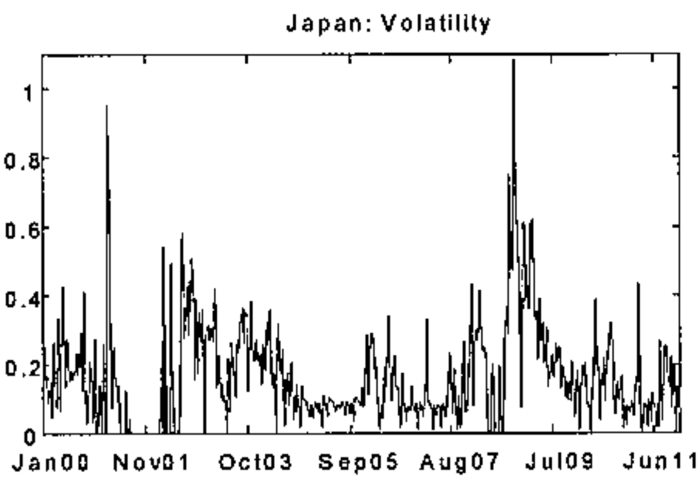
$$dS = \left(r + \phi - \lambda \mu_Q\right) S dt + Y S dW_S + Q S dH$$

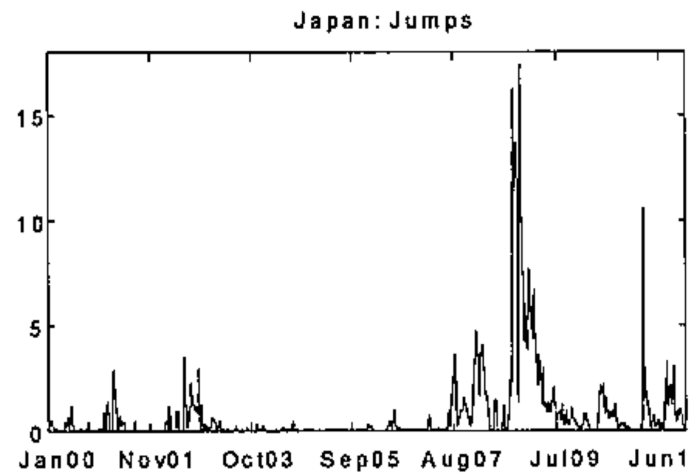
$$dY = \left(\mu_Y + \kappa_Y Y\right) dt + \sigma_Y dW_Y$$

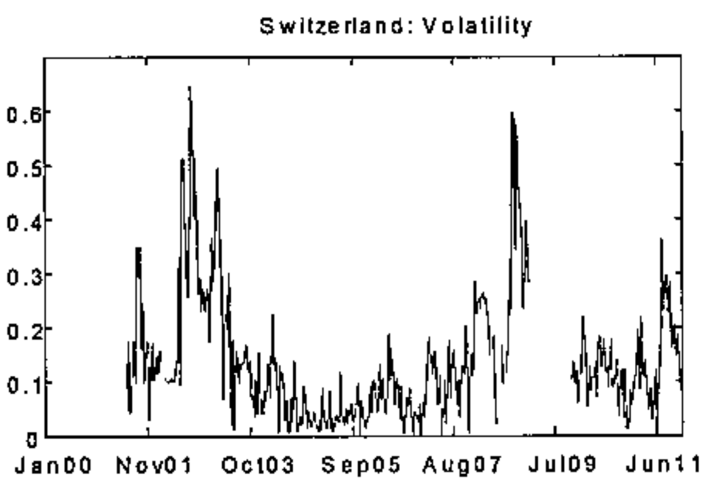
$$dZ = \left(\mu_Z + \kappa_Z Z\right) dt + \sigma_Z dW_Z$$

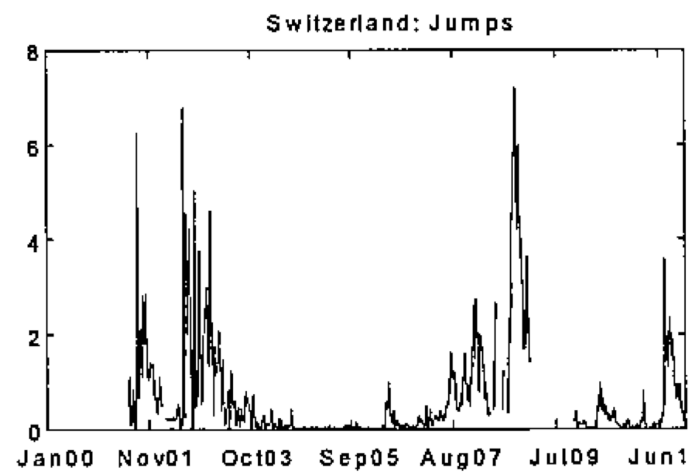
$$\ln(1+Q) \approx N\left(\ln\left(1+\mu_Q\right) - \frac{1}{2}\sigma_Q^2, \sigma_Q^2\right)$$

Here *H* denotes Poisson process. We then estimate $v = Y^2$ and $\lambda = Z^2$ from equity index options data


Japan: Volatility
1
0.8
0.6
0.4
0.2
0
Jan00 Nov01 Oct03 Sep05 Aug07 Jul09 Jun11


Japan: Jumps
15
10
5
0
Jan00 Nov01 Oct03 Sep05 Aug07 Jul09 Jun11


Switzerland: Volatility
0.6
0.5
0.4
0.3
0.2
0.1
0
Jan00 Nov01 Oct03 Sep05 Aug07 Jul09 Jun11


Switzerland: Jumps
8
6
4
2
0
Jan00 Nov01 Oct03 Sep05 Aug07 Jul09 Jun11

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Agenda

- Introduction
- Model
- Empirical Findings
    - Carry Trade
    - Special role of Japan
    - Empirical setup
    - Our results

Conclusion

Predictions: FX Volatility (monthly)

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Explaining currency volatility (average volatility of all currencies against USD) with our measures of funding risks in Japan

FX^σ	(1)		(3)		(4)	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
λ^{JP}	0.0011**	9.99	——		0.0009**	7.71
$\sqrt{\nu}^{JP}$	0.0017	0.78	——		0.0012	0.57
JP Fin.	——		——		-0.0004**	-3.21
TED	——		0.0021*	2.04	0.0005	1.10
const.	0.0056**	17.48	0.0056**	12.59	0.0070**	14.93
$Adj.R^2$	64.42%		22.86%		67.79%	
VIF	[1.78]				[2.99]	

Predictions: Currency Correlations

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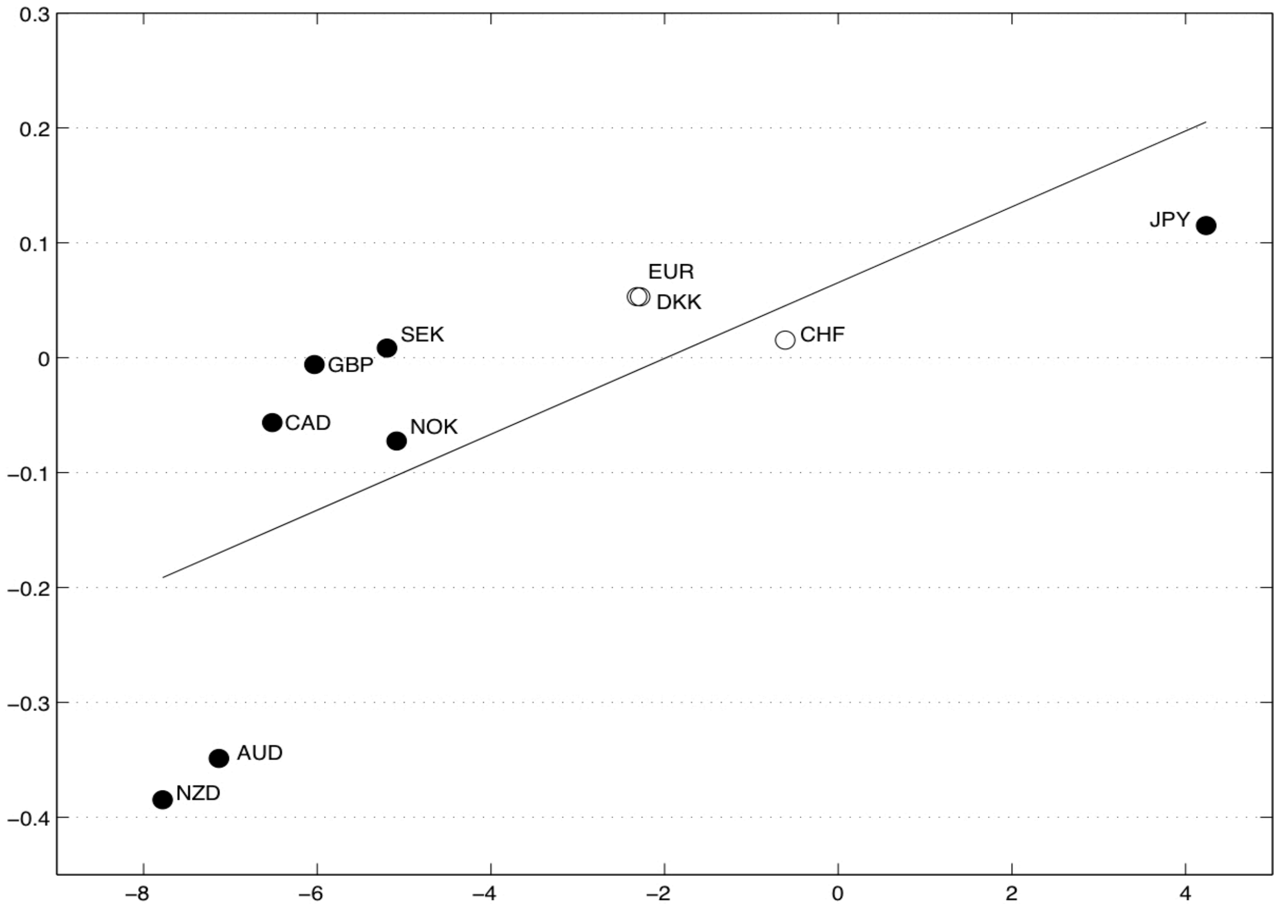
Explaining correlations between AUD/JPY with funding risk in Japan:

AU/JP	(1)		(3)		(4)	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
λ^{JP}	-0.1300**	-3.58	—		-0.0673*	-2.16
$\sqrt{\nu}^{JP}$	0.0384	0.10	—		0.0432	0.13
JP Fin.	—		—		0.0507	1.92
TED	—		-0.3542**	-5.07	-0.2577**	-3.26
const.	0.2885**	3.16	0.3893**	5.41	0.2056	1.90
$Adj.R^2$	23.10%		20.28%		28.45%	

Predictions: The currency skewness is related to the its exposure to the crash risk in the Japanese equity market

Currency Skewness



Currency Exposure to Crash Risk in the Japanese Equity Market

Predictions: Crashes

- Estimate a Probit model to explain crashes in AUD/JPY carry trades. Crashes are defined as returns < -1 standard dev.

	(1)		(2)		(3)		(4)	
	Coef.	z-stat	Coef.	z-stat	Coef.	z-stat	Coef.	z-stat
$\Delta\lambda^{JP}$								
L0.	0.9148**	2.63	——		0.6522*	2.08	1.9317**	3.48
L1.	0.1834	1.68	——		——		1.0221*	2.49
L2.	0.3421**	2.56	——		——		1.4137**	2.97
L3.	0.6614*	2.29	——		——		1.8674**	4.16
ΔTED								
L0.	——		2.3471*	2.50	1.5774*	2.40	3.3636	1.82
L1.	——		1.7988**	3.12	——		0.1328	0.14
L2.	——		0.6304	1.63	——		-3.4263*	-2.05
L3.	——		0.3573	0.38	——		-3.2563*	-2.36
const.	-1.5650**	-8.66	-1.4450**	-6.03	-1.5601**	-7.47	-2.1882**	-5.75
$PseudoR^2$	26.82%		29.52%		30.23%		54.12%	

Predictions: Weekly Trading Activity

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Net futures positions of non-commercial traders at CFTC

Panel A: Futures AU-JP

	(1)		(2)		(3)		(4)	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
λ^{JP}	-0.0353**	-4.64	——		——		-0.0046	-0.52
$\sqrt{\nu}^{JP}$	-0.9380**	-8.85	——		——		-0.7309**	-6.90
JP Fin.	——		0.0010**	10.13	——		0.0009**	7.65
TED	——		——		-0.1515**	-6.10	-0.1291**	-3.97
const.	0.4861**	21.31	-0.0938**	-2.58	0.3518**	19.83	0.1825**	4.31
$Adj.R^2$	27.59%		17.53%		5.50%		36.45%	

Various funding liquidity and funding risk measures can explain 36% of the trading activity. Japanese measures alone explain 28% of trading activity.

Consistent with theory, for individual currencies our funding risk measures from Japan explain best the main investment currency, AUD (Adj. R^2 = 14.8%).

Predictions: Carry Trade Returns

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We now divide v and λ to expected and unexpected components:

- Fit an AR(3)
- Expected part: fitted values v^e and λ^e
- Unexpected part: residuals v^u and λ^u

Predictions: Monthy Carry Trade Returns

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Strategy	AUmJP		HmL	
	Coef.	t-stat	Coef.	t-stat
λ^e	0.0168**	2.95	0.0148*	2.40
$\sqrt{\nu^e}$	0.0761	1.34	-0.0121	-0.23
λ^u				
L0.	-0.0670**	-8.55	-0.0576**	-8.48
L1.	-0.0214*	-2.38	-0.0281**	-2.98
L2.	-0.0367**	-4.48	-0.0413**	-4.66
L3.	-0.0110*	-2.17	-0.0184**	-2.65
$\sqrt{\nu^u}$				
L0.	-0.2586*	-1.96	-0.0033	-0.03
const.	-0.0217*	-2.17	-0.0032	-0.35
$Adj.R^2$	42.25%		36.30%	

...and other results

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Japanese measures can better predict carry trade returns than the US funding risk measures. Results are robust to including other common factors to explain carry trade returns such as TED spread, stock returns, VIX.

		(1)	
		Coef.	t-stat
Japan	λ^e	-0.0147	-1.27
	$\sqrt{\nu}^e$	-0.2036**	-2.64
	λ^u		
	L0.	——	
	L1.	0.0225	1.22
	L2.	-0.0049	-0.32
	$\sqrt{\nu}^u$		
	L0.	——	
	L1.	0.6280**	3.82
	L2.	0.4363**	2.83
const.		0.0548**	4.13
$Adj.R^2$		16.92%	

		(2)	
		Coef.	t-stat
US	λ^e	-0.0252*	-2.17
	$\sqrt{\nu}^e$	-0.0461	-0.58
	λ^u		
	L0.	——	
	L1.	0.0494	1.96
	L2.	0.0350	1.58
	$\sqrt{\nu}^u$		
	L0.	——	
	L1.	-0.0697	-0.35
	L2.	0.2081	0.91
const.		0.0343**	2.87
$Adj.R^2$		2.98%	

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Agenda

- Introduction
- Model
- Empirical Findings
- Conclusion

Conclusions

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We have theoretically argued that:

- Time variation in carry trade funding countries' funding conditions and funding risk can affect carry trade returns, currency volatilities, explain skewness in carry trade returns, and lead to currency crashes.

We have presented evidence that

- The funding risk in Japan is an important determinant of currency rates, their volatility, correlations and skewness. Funding risk in Japan affects also speculative activity and speculators' returns from carry trading. Finally, the funding conditions in Japan are associated with currency crashes.
- A major funding currency's (Japan's) funding risk can matter more than that of the US for carry trade activity and returns, or the funding risk of the main investment currency, Australia. Similar conclusions are obtained in our sample also if instead of Japan we look at arguably the second most important funding currency, Switzerland.

Conclusions

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Our results challenge the integrated markets models where global carry trade risk only are viewed as relevant by highlighting the role of the financial markets of a major funding currency.

Our theory predicts that carry trading be more popular in funding countries. We present empirical evidence to support this view. Finally, we presented several pieces of empirical evidence that are consistent with the idea that the funding conditions in a major carry trade country, Japan, significantly affect carry trade activity and global financial markets.

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THANK YOU FOR YOUR ATTENTION ☺

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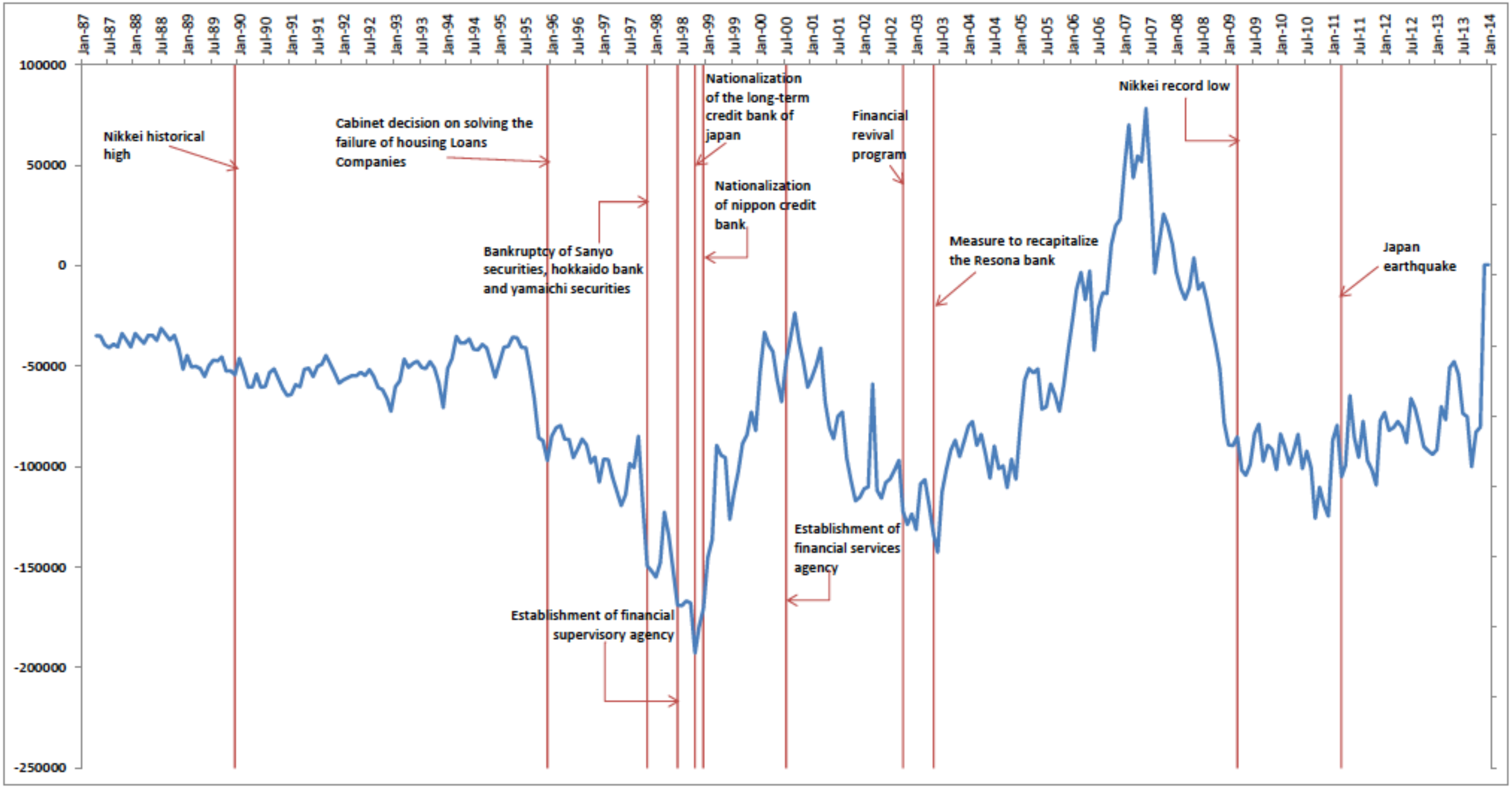

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Table 8: Regional carry trade returns and funding liquidity

This table documents the contemporaneous relationship between the main funding countries' liquidity measures and carry portfolios' monthly excess returns in EMEA, Asia Pacific and Americas. VIX, VSMI and VXJ are the main volatility indexes and TED, S-TED and J-TED are the differences between 3-month LIBOR and 3-month Treasury bill in U.S., Switzerland and Japan, respectively. The change variables are denoted by delta (Δ). In HmL strategy, I borrow (invest in) the currency with the smallest (largest) forward discount. HmL3 follows the same principle, but instead of one currency I go long (short) in the three currencies with the three largest (smallest) forward discounts. The t-statistics are computed using robust standard errors and ***, **, and * indicates statistical significance at 1%, 5%, and 10% confidence level respectively. The reported R^2 values are adjusted R^2s. Panel A reports the monthly data for full sample period from 1/1999 to 1/2014. Panel B excludes the financial crisis (8/2007 – 3/2009).

Panel A: Full sample

	EMEA				Asia Pacific				Americas	
	HmL		HmL3		HmL		HmL3		HmL	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
VSMI	-0.0139	-0.25	-0.0177	-0.59	——		——		——	
ΔVSMI	-0.4579***	-4.14	-0.2932***	-4.82	——		——		——	
VXJ	——		——		-0.1346*	-1.65	-0.0935***	-2.67	——	
ΔVXJ	-----		-----		0.0481	0.64	-0.0029	-0.07	-----	
VIX	——		——		0.0022	0.03	0.0301	0.87	-0.0205	-0.58
ΔVIX	——		——		-0.3087***	-2.69	-0.1642***	-3.07	-0.2968***	-4.75
S-TED	0.1284	0.11	0.1104	0.15	——		——		——	
ΔS-TED	0.9359	0.73	0.4139	0.55	——		——		——	
J-TED	——		——		3.0202	0.92	0.2708	0.19	——	
ΔJ-TED	——		——		-7.1484	-0.81	-1.3510	-0.37	——	
TED	——		——		0.1245	0.13	-0.6552	-1.62	-1.1577*	-1.93
ΔTED	——		——		-2.9970*	-1.93	-0.5431	-0.83	1.0985	1.19
const.	1.2850	1.27	0.7265	1.35	3.4193***	3.66	2.4357***	4.77	1.2737*	1.91
Adj. R^2	16.65 %		19.46 %		16.31 %		33.13 %		22.18 %	

Source: J-P Väänänen, Masters thesis, Aalto