Sources of Risk in Currency Returns

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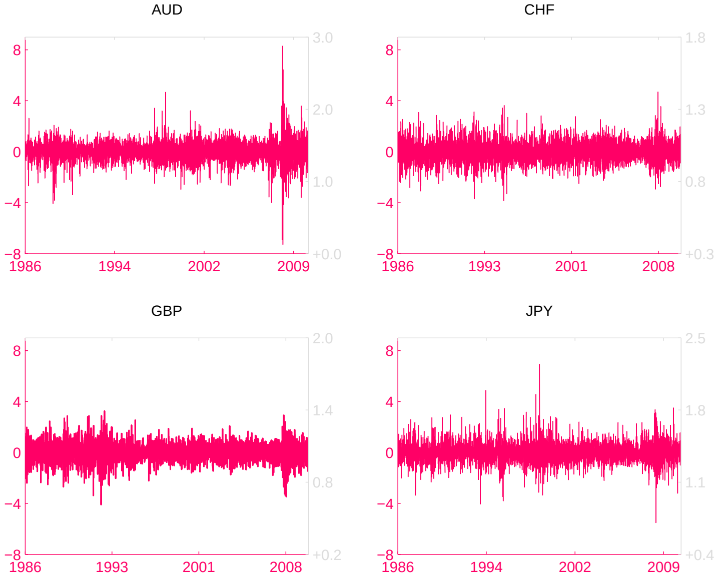
Excess currency returns

- Borrow $\$e^{-r_t}$ at the interest rate r_t
- The exchange rate is S_t (pay $\$S_t$ for £1)
- Convert \$ into $£1/S_t \cdot e^{-r_t}$ and invest for one period at the UK interest rate $\tilde{r}_t$
- At the end of the period, receive $£1/S_t \cdot e^{\tilde{r}_t - r_t}$
- Convert the cash back into $\$S_{t+1}/S_t \cdot e^{\tilde{r}_t - r_t}$ at the prevailing exchange rate S_{t+1}
- Finally, repay the loan with interest, i.e., one unit of the domestic currency
- In this paper, we will always treat USD as a domestic currency

Which types of risk affect currency returns?



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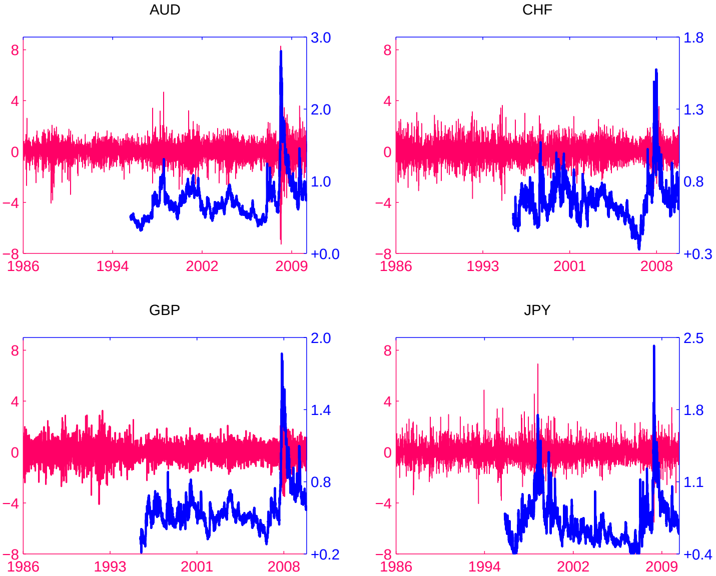

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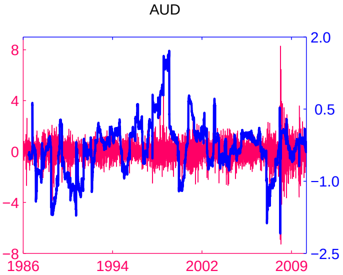

Basic properties of excess currency returns

		Mean	Std Dev	Skewness	Kurtosis	Nobs
AUD	Return	0.0186	0.7435	-0.3870	13.7202	6332
	$\Delta\sqrt{IV}$	0.0109	3.7661	0.9077	9.7290	3933
CHF	Return	0.0057	0.7232	0.1194	4.7841	6521
	$\Delta\sqrt{IV}$	0.0073	3.8057	0.9966	9.8095	3823
GBP	Return	0.0096	0.6197	-0.2337	5.6832	6521
	$\Delta\sqrt{IV}$	0.0142	4.0001	1.3884	44.2683	3823
JPY	Return	0.0003	0.6950	0.3626	8.0878	6393
	$\Delta\sqrt{IV}$	-0.0045	4.8257	1.0395	10.7764	3934
SPX	Return	0.0090	1.1803	-1.3584	32.9968	6521
	$\Delta\sqrt{VIX}$	0.0089	5.8997	0.5096	6.7502	3914

How important are these risks?

- We quantify relative importance of the different sources of risk
  1. Stochastic variance
  2. Jumps in currencies
  3. Jumps in variance

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- We quantify relative importance of the different sources of risk
  1. Stochastic variance
  2. Jumps in currencies
  3. Jumps in variance
- We estimate a joint model of FX/IV using Bayesian MCMC
  - Main advantage: jump times and sizes are a by-product of estimation

Relation to Uncovered Interest Parity

- s_t is the log spot exchange rate
- f_t is the log one-period forward exchange rate
- r_t is the domestic, or low, one-period bond yield
- $\tilde{r}_t$ is the foreign, or high, one-period bond yield
- UIP:

$$E_t(s_{t+1} - s_t) = f_t - s_t \equiv r_t - \tilde{r}_t$$

- Fama's regression:

$$y_{t+1} = (s_{t+1} - s_t) - (r_t - \tilde{r}_t) = \alpha + \beta(r_t - \tilde{r}_t) + \varepsilon_{t+1}$$

- $\hat{\beta} \approx -3$, hence the puzzle

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- $\hat{\beta} \approx -3$, hence the puzzle
- This paper does not explain the puzzle
- This paper makes a first step by analysing ε_{t+1}

Summary of findings

- Three types of jumps:
  1. Variance: probability is affected by the variance itself
  2. USD depreciation (up): probability is affected by the US interest rate
  3. USD appreciation (down): probability is affected by the non-US interest rate

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- Jumps in FX are connected to major macro and political news
- Jumps in variance are not – "economic uncertainty"
- Jumps contribute 25%, on average to the total currency risk; can be as high as 40%
- Estimated currency risk premiums are in conflict with baseline equilibrium models

Literature

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$$y_{t+1} \quad = \quad \mu_t + v_t^{1/2} w_{t+1}^s + z_{t+1}^u - z_{t+1}^d$$

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h_t^k &= h_0^k + h_r^k r_t + \tilde{h}_r^k \tilde{r}_t + h_v^k v_t, \; k = u, d, v \text{ [jump intensity]} \\
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- We also add information from options:

$$IV_t = \alpha_{iv} + \beta_{iv} v_t + \text{error}$$

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- Use time-series of daily carry returns and one-month at-the-money IVs to estimate parameters and state realizations

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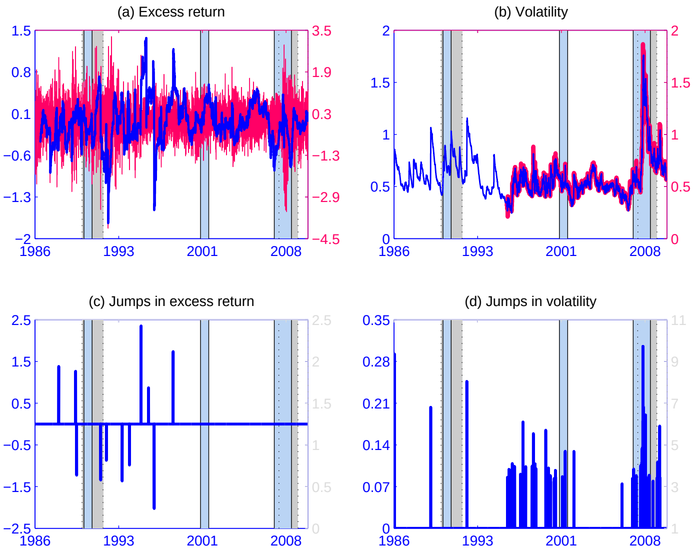
- Implications:
  - On average, 1.3 to 2.6 jumps in variance per year; average jump size increases vol by 20% to 40%
  - On average, 0.4 to 1.3 jumps in currencies per year; average jumps size is 1.2% to 1.6%
  - Third cumulant $\kappa_{3t}(s_{t+1} - s_t) = 6\theta^3 h_r(r_t - \tilde{r}_t)$
  - The loading $\mu_r \approx -3$ as in Fama's regression

GBP excess returns, estimated states, jump intensities



▸ Other currencies

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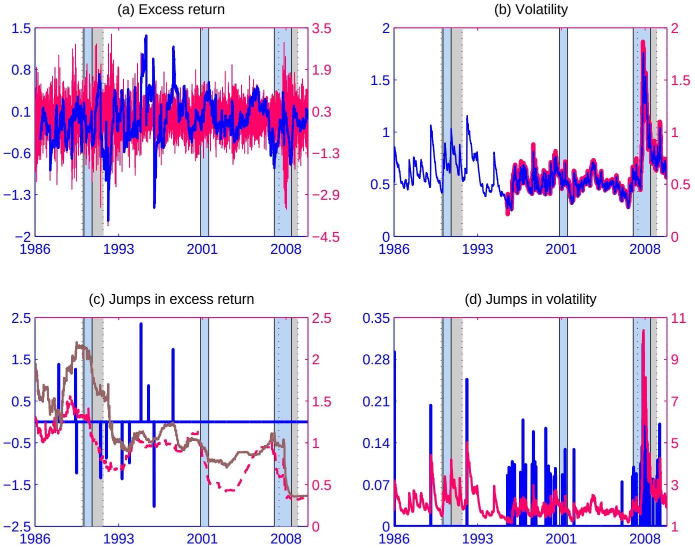

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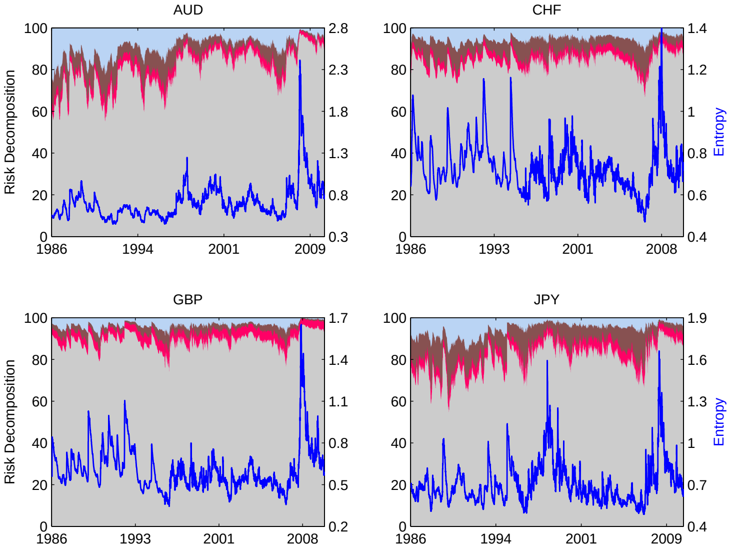
$$L_t(S_{t+n}/S_t) = \log E_t(e^{s_{t+n}-s_t}) - E_t(s_{t+n}-s_t)$$

- Intuition:

$$L_t = \kappa_{2t}(s_{t+n}-s_t)/2! + \kappa_{3t}(s_{t+n}-s_t)/3! + \kappa_{4t}(s_{t+n}-s_t)/4! + \ldots,$$

where κ_j is the jth cumulant of $s_{t+n}-s_t$

Decomposition of entropy



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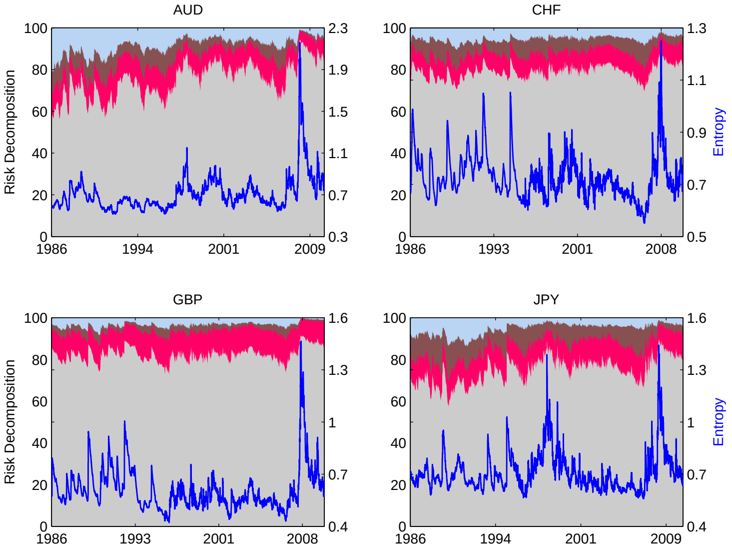
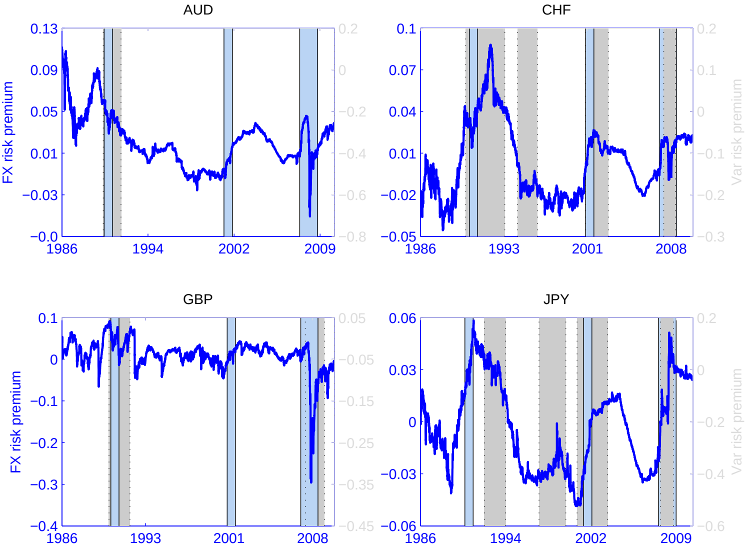


Risk Premiums



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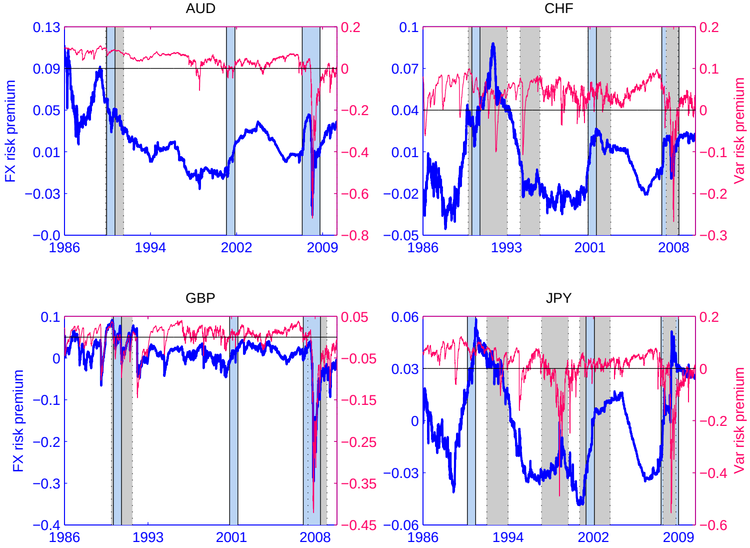

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- What are jumps – disasters or something else?
- Probabilities of jumps in FX vs variance are different in economically meaningful way
- Ex-ante FX risk premia from the non-US perspective do not conform to the basic intuition
- What is the economic mechanism generating the positive variance premiums?

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- We study risks in carry returns
  - Identify and describe sources of risks
  - Measure risk premiums (RP)
  - Compare the dynamics of RP with the predictions of the structural models

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- We study risks in carry returns
  - Identify and describe sources of risks
  - Measure risk premiums (RP)
  - Compare the dynamics of RP with the predictions of the structural models
- We find that
  - Both normal and jump risks are important
  - Jump risks have time-varying nature
  - Jumps in FX can be linked to news. Jumps in vol cannot
  - Jumps are not necessarily idiosyncratic
  - Estimated dynamics of RP pose challenges for structural models

Literature Review

- Joint currency/implied variance time-series analysis w/o jumps
  - Brandt and Santa-Clara (2002); Graveline (2006)
- Hedging jump risk with options
  - Burnside, Eichenbaum, Kleshchelski, and Rebelo (2011); Jordà and Taylor (2009); Jurek (2009)
  - Farhi, Fraiberger, Gabaix, Ranciere, and Verdelhan (2009)
- Option-based models of currencies with jumps in FX only
  - Bates (1996); Carr and Wu (2007)
  - Bakshi, Carr, and Wu (2008)
- Equilibrium models of FX with jumps
  - Farhi and Gabaix (2008); Guo (2007); Plantin and Shin (2011)
- News and FX
  - Andersen, Bollerslev, Diebold, and Vega (2003)
- Jumps in variance of equity returns
  - Broadie, Chernov, and Johannes (2007); Duffie, Pan, and Singleton (2000); Eraker, Johannes, and Polson (2003)
- Entropy as generalised variance
  - Alvarez and Jermann (2005); Backus, Chernov, and Martin (2011); Backus, Chernov, and Zin (2011); Martin (2011) Back

Diagnostics: An AUD example

	SV	SVJV	SVJVC-P
skewness^C	-0.3080	-0.3074	-0.2004
	(-0.3308, -0.2860)	(-0.3304, -0.2855)	(-0.2408, -0.1599)
kurtosis^C	4.1472	4.0822	3.4892
	(4.0677, 4.2366)	(4.0006, 4.1810)	(3.3802, 3.6055)
autocorrelation^C	-0.0281	-0.0271	-0.0324
	(-0.0311, -0.0252)	(-0.0303, -0.0241)	(-0.0406, -0.0242)
skewness^{IV}	0.0402	0.0303	0.0310
	(-0.0373, 0.1181)	(-0.0466, 0.1070)	(-0.0459, 0.1080)
kurtosis^{IV}	3.0618	3.0385	3.0375
	(2.9103, 3.2314)	(2.8902, 3.2034)	(2.8896, 3.2033)
autocorrelation^{IV}	0.1043	0.0634	0.0637
	(0.0749, 0.1336)	(0.0331, 0.0937)	(0.0334, 0.0940)
IVvar	0.0064	0.0034	0.0034
	(0.0041, 0.0122)	(0.0021, 0.0070)	(0.0021, 0.0070)

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Diagnostics: A CHF example

	SV	SVJV	SVJVC-P
skewness^{C}	0.1178	0.1282	0.0586
	(0.0994, 0.1365)	(0.1078, 0.1486)	(0.0182, 0.0983)
kurtosis^{C}	3.9497	3.9438	3.4333
	(3.8825, 4.0198)	(3.8919, 4.0011)	(3.3373, 3.5405)
autocorrelation^{C}	-0.0203	-0.0198	-0.0272
	(-0.0227, -0.0179)	(-0.0226, -0.0170)	(-0.0352, -0.0192)
skewness^{IV}	0.0224	0.0201	0.0210
	(-0.0574, 0.1022)	(-0.0585, 0.0985)	(-0.0573, 0.0995)
kurtosis^{IV}	3.0648	3.0399	3.0406
	(2.9091, 3.2378)	(2.8887, 3.2097)	(2.8890, 3.2094)
autocorrelation^{IV}	0.0777	0.0565	0.0564
	(0.0459, 0.1094)	(0.0247, 0.0883)	(0.0246, 0.0881)
IVvar	0.0010	0.0006	0.0006
	(0.0007, 0.0017)	(0.0004, 0.0011)	(0.0004, 0.0011)

Diagnostics: A GBP example

	SV	SVJV	SVJVC-P
skewness^C	-0.0407	-0.0211	-0.0232
	(-0.0606, -0.0202)	(-0.0436, 0.0012)	(-0.0609, 0.0143)
kurtosis^C	3.9181	3.8540	3.4947
	(3.8427, 4.0061)	(3.7784, 3.9423)	(3.4006, 3.5969)
autocorrelation^C	0.0009	0.0006	-0.0027
	(-0.0024, 0.0040)	(-0.0038, 0.0047)	(-0.0094, 0.0037)
skewness^{IV}	0.0352	0.0212	0.0215
	(-0.0443, 0.1146)	(-0.0565, 0.0995)	(-0.0568, 0.0998)
kurtosis^{IV}	3.0710	3.0293	3.0296
	(2.9160, 3.2461)	(2.8798, 3.1972)	(2.8786, 3.1977)
autocorrelation^{IV}	0.0791	0.0510	0.0510
	(0.0483, 0.1096)	(0.0204, 0.0814)	(0.0204, 0.0815)
IVvar	0.0011	0.0004	0.0004
	(0.0007, 0.0019)	(0.0003, 0.0008)	(0.0003, 0.0008)

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Diagnostics: A JPY example

	SV	SVJV	SVJVC-P
skewness^C	0.3348	0.3360	0.1298
	(0.3060, 0.3650)	(0.3038, 0.3668)	(0.0799, 0.1800)
kurtosis^C	4.8254	4.7148	3.6054
	(4.7109, 4.9645)	(4.5982, 4.8361)	(3.4829, 3.7445)
autocorrelation^C	-0.0146	-0.0140	-0.0221
	(-0.0176 -0.0116)	(-0.0174, -0.0108)	(-0.0312, -0.0131)
skewness^{IV}	0.0568	0.0278	0.0311
	(-0.0210, 0.1349)	(-0.0495, 0.1054)	(-0.0465, 0.1087)
kurtosis^{IV}	3.0707	3.0430	3.0423
	(2.9175, 3.2420)	(2.8940, 3.2100)	(2.8923, 3.2098)
autocorrelation^{IV}	0.1042	0.0758	0.0768
	(0.0733, 0.1349)	(0.0443, 0.1070)	(0.0453, 0.1083)
IVvar	0.0061	0.0029	0.0037
	(0.0036, 0.0125)	(0.0017, 0.0059)	(0.0021, 0.0078)

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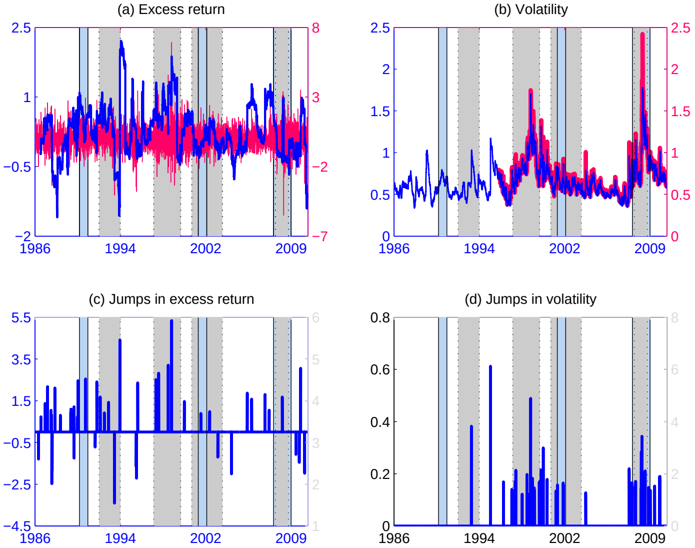
JPY excess returns, estimated states, jump intensities



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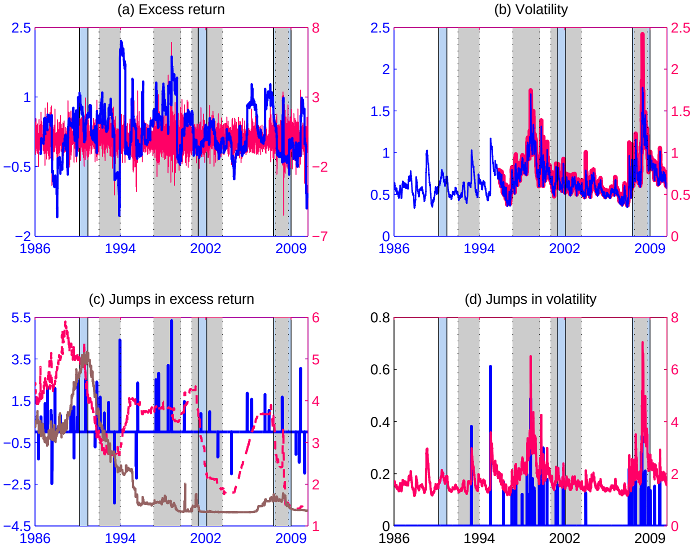

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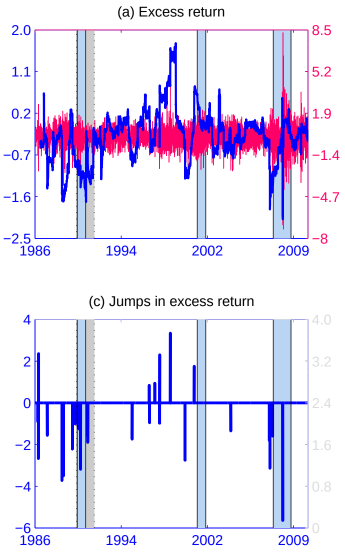
AUD excess returns, estimated states, jump intensities



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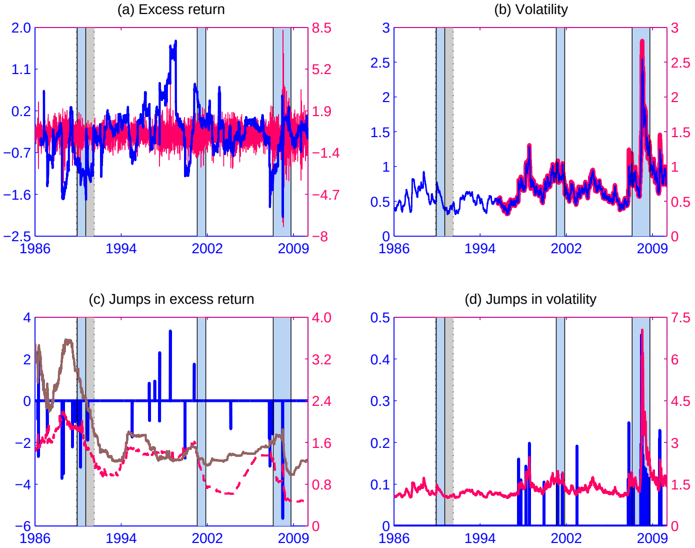

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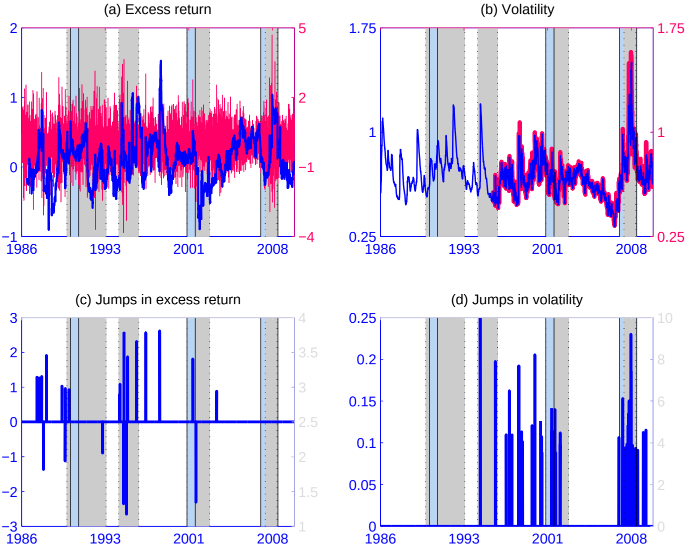
CHF excess returns, estimated states, jump intensities



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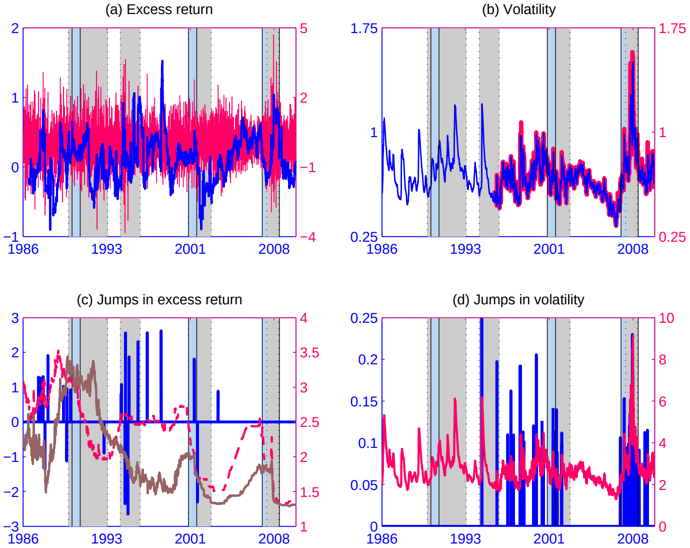
CHF excess returns, estimated states, jump intensities



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