The Scapegoat Theory of Exchange Rates: The First Tests

Marcel Fratzscher* **Lucio Sarno**** **Gabriele Zinna *****

* European Central Bank and CEPR

** Cass Business School and CEPR

*** Bank of England

December 2010

Motivation

- Time-varying parameters is a key explanation for the failure of exchange rate models (Meese and Rogoff 1983, 1988).
- Instability in the relationship between exchange rates and fundamentals ex post (Rossi 2006, Sarno and Valente 2008, Cheung and Chinn 2001).
- Scapegoat theory of exchange rates (Bacchetta and van Wincoop 2004, 2009):
  - highly unstable relationship not explained by frequent and large changes in structural parameters,
  - even when allowing for rationality of agents and Bayesian learning...
  - ... but by *expectations* about these structural parameters.

Scapegoat theory of exchange rates

- Limited knowledge of agents.
  - they have accurate idea about structural parameters in long-term,
  - but significant uncertainty over the short- to medium-term.
- If currency movements over the short- to medium-term inconsistent with their priors
  - potentially due to unobservable fundamentals...
  - ...or incorrect weight to fundamentals,
  - rational to search for scapegoat: assign additional weight to some fundamental,
  - usually one that seems out of sync with longer-term equilibrium.

Role of scapegoats

"The FX market sometimes seems like a serial monogamist. It concentrates on one issue at a time, but the issue is replaced frequently. ... But uncertainties are being resolved... The market may move back to an earlier love . . . "

(FT, November 8 2010)

- Anecdotal evidence for financial markets.
- Fundamental is more likely to become a scapegoat:
  - the larger the (unexplained) exchange rate movement *and*
  - the more this particular fundamental seems out of line with its long-run equilibrium.

Approach of paper

- Empirical test of scapegoat theory of exchange rates.
- Novel data on surveys of market participants of exchange rate scapegoats
  - 6 key fundamentals.
  - 12 currencies (advanced and emerging economies).
  - monthly surveys for 10-year period (2001-2009).
- Data on FX order flow as proxy for unobservables / liquidity trade
  - matching to scapegoat data.

2 Hypotheses

- Hypothesis #1: Scapegoat model outperforms benchmark models
  - two benchmarks (constant parameter; time-varying parameter models).
  - strong support along three performance criteria (goodness-of-fit, information, market-timing test).
  - robustness; and for all 12 currencies.
- Hypothesis #2: Determinants of scapegoats
  - theory: fundamental becomes scapegoat if size of deviation from equilibrium large and there is sizeable shock to unobservables.
  - empirical: strong and robust evidence, for all currency groups and for all macroeconomic variables.

$$\begin{aligned}\Delta s_t &= \mathbf{f}_t((1-\lambda)\boldsymbol{\beta}_t + \lambda \mathbf{E}_t\boldsymbol{\beta}_t) + (1-\lambda)b_t + \lambda \sum_{i=1}^{T} f_t \left(\mathbf{E}_t\boldsymbol{\beta}_{t-i} - \mathbf{E}_{t-1}\boldsymbol{\beta}_{t-i}\right) \\ \boldsymbol{\beta}_t &= \boldsymbol{\beta}_{t-1} + \mathbf{v}_t\end{aligned}$$

$\mathbf{f}_t$ = $(f_{1,t}, f_{2,t}, \ldots, f_{N,t})'$ vector of macro-fundamentals,
$\boldsymbol{\beta}_t$ = $(\beta_{1,t}, \beta_{2,t}, \ldots, \beta_{N,t})'$ vector of structural params,
$\mathbf{E}_t\boldsymbol{\beta}_t$ = $(E_t\beta_{1,t}, E_t\beta_{2,t}, \ldots, E_t\beta_{N,t})'$ vector of expected params,
$\mathbf{v}_t$ = $(\mathbf{v}_{1,t}, \mathbf{v}_{2,t}, \ldots, \mathbf{v}_{N,t})'$ vector of i.i.d. shocks to structural params,
b_t is the unobservable, and λ the discount factor.

... so that the impact of f_t on Δs_t is

$$\frac{\partial \Delta s_t}{\partial f_t} = (1-\lambda)\beta_t + \lambda E_t\beta_t + \lambda \sum_{i=0}^{T} f_{t-i} \frac{\partial E_t\beta_{t-i}}{\partial f_t}$$

Empirical models

- Our empirical counterpart to Bacchetta and van Wincoop is

$$SCA : \Delta s_t = f_t' \beta_t + (\tau_t f_t)' \gamma + \delta x_t + u_t$$

$$\beta_t = \beta_{t-1} + \mathbf{v}_t$$

where τ_t are the surveys (or scapegoat param), x_t is the order flow (or unobservable), and $E\beta_t = E\tau_t$.

- The two benchmark models are

$$\begin{aligned} CP &: \Delta s_t = f_t' \beta + u_t \\ TVP &: \Delta s_t = f_t' \beta_t + u_t \end{aligned}$$

Identifying scapegoats

- Novel survey data by Consensus Economics
  - 40-60 FX market participants, mostly asset managers, in many different locations globally, little turnover.
  - relative: "rank the current importance of a range of different factors in determining exchange rate movements".
  - quantitative: "on a scale from 0 (no influence) to 10 (very strong influence)".
  - 30 currencies vis-a-vis USD (some EUR).
  - six key macro factors relative the reference country: short-term interest rates, long-term interest rates, growth, inflation, trade/current account, and equity flows.
  - monthly on broader set of FX surveys, surveys about FX scapegoats every 3 to 6 months.
  - period 2001-2009, focus on 6 advanced country currencies and 6 EME currencies.

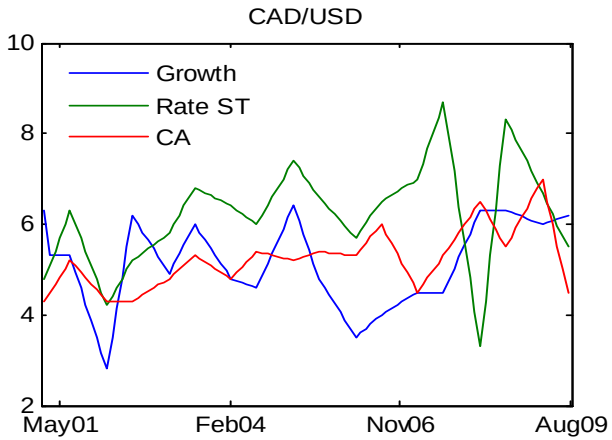
Fundamentals and exchange rate data

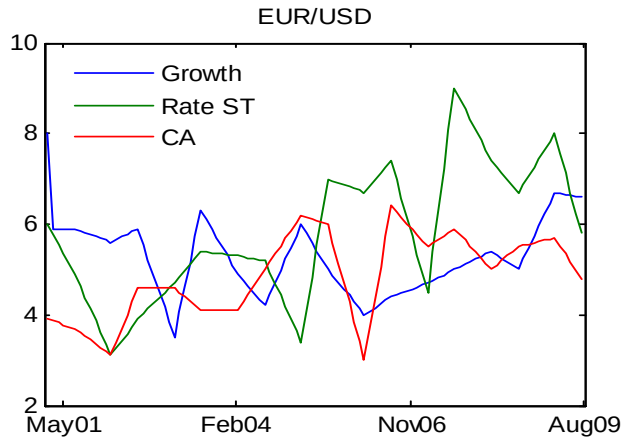
- Match monthly scapegoat data with the actual macroeconomic fundamentals.
- To obtain monthly data frequency, use trade balance instead of the current account, and use quarterly GDP growth figures (IMF IFS).
- Actual macro fundamentals calculated relative to those of reference country.
- Scaling of scapegoat variables: mean and standard deviation identical to those of actual macro variable.
- Exchange rate data: nominal bilateral exchange rate, defined as *foreign price of the domestic currency*, change over past month.

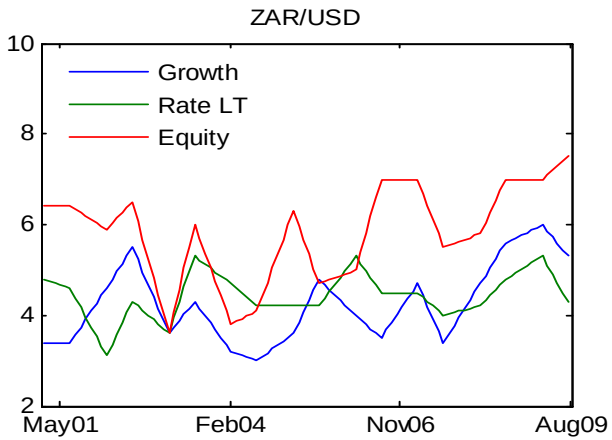
Example of scapegoat survey

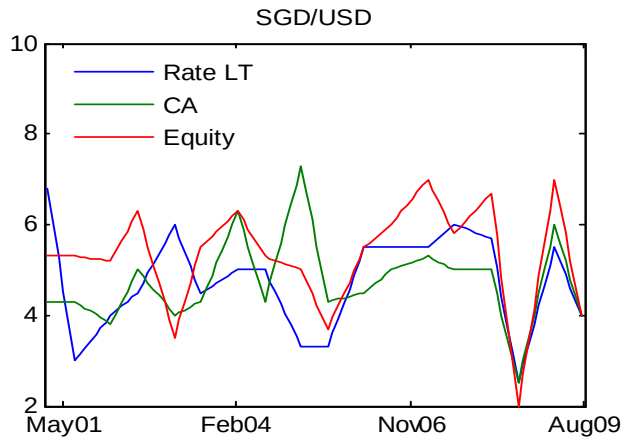
- March 2005

Stylised facts about scapegoats









Order flow data

- Order flow as proxy for unobservable fundamentals
- scapegoat theory, capture unobservables for two reasons:
  - test whether unobservables exert significant effect on exchange rates
  - control for unobservables in order to test whether scapegoats exert additional effect on exchange rates.
- Comprehensive dataset of order flow for all 12 currencies in sample over 2001-10 period.
- Order flows are bilateral vis-a-vis reference currency; source is UBS
- Match order flow data to scapegoat data: cumulative monthly order flow on business day previous to latest survey
- Extension: also order flow from different types of investors (esp. hedge funds, asset managers).

- For the CP model we simply draw the hyperparameters conditional on the data, assuming an independent inverse Gamma-Normal prior distribution.

- For TVP and SCA there are two steps. First, we draw a history of states (β) conditional on the hyperparams (Q, δ, γ) and data ($[\Delta s^T, f^T, x^T, \tau^T]$), using Carter and Kohn (1994) simulation smoother. Then, we draw the hyperparams conditional on the states and data.

- The priors used in the paper are diffuse, and their distributions are chosen for convenience following a number of papers (Kim and Nelson, 1999; Sargent and Cogley, 2001; Primiceri, 2005).

- We perform 60,000 replications of which the first 40,000 are burned-in, and we save 1 every 10 draws of the last 20,000 replications.

Selecting macro fundamentals.

- We use only three fundamentals for per regression, as too many params to be estimated in SCA and TVP.
- But we allow the set of macro fundamentals to be country specific, using the following general-to-specific method:

$$\Delta s_t = \gamma_1 \tau_{1,t} f_{1,t} + \ldots + \gamma_6 \tau_{6,t} f_{6,t} + u_t,$$

where we exclude the variable with the lowest t-statistic. We repeat the same procedure until we end up with 3 macro variables.

Panel A: Industrialized Economies

	ΔGrowth	ΔInflation	ΔRate ST	ΔRate LT	CA	ΔEquity	Order Flow
AUD/USD	-	-	2.7740	-1.8539	-	-2.2589	-0.0014
			[2.56;2.98]	[-2.06;-1.66]		[-2.47;-2.04]	[-0.10;0.10]
CAD/USD	0.2607	-	0.2021	-	-0.0545	-	-0.3411
	[0.12;0.40]		[0.08;0.33]		[-0.15;0.04]		[-0.42;-0.26]
EUR/USD	-0.5794	-	-1.5785	-	-0.0139	-	-0.4868
	[-0.71;-0.45]		[-1.81;-1.35]		[-0.18;0.16]		[-0.578;-0.39]
JPY/USD	-0.1591	-	-	-0.4977	-	0.8436	-0.4858
	[-0.30;-0.01]			[-0.66;-0.33]		[0.60;1.09]	[-0.58;-0.39]
CHF/EUR	-0.3471	-	-	-0.3970	-1.2065	-	0.0889
	[-0.46;-0.23]			[-0.54;-0.25]	[-1.42;-0.99]		[-0.01;0.18]
GPB/USD	-0.2795	-	0.1806	-	-0.3539	-	-0.4460
	[-0.41;-0.15]		[0.03;0.33]		[-0.50;-0.21]		[-0.55;-0.34]

Panel B: Emerging Market Economies

	ΔGrowth	ΔInflation	ΔRate ST	ΔRate LT	CA	ΔEquity	Order Flow
CZK/EUR	-	0.0374	-0.7624	-	-	0.7667	-0.6236
		[-0.09;0.17]	[-1.00;-0.55]			[0.60;0.94]	[-0.75;-0.50]
MXN/USD	-	-	-0.0182	-0.0327	-	-0.1285	-0.0960
			[-0.14;0.11]	[-0.11;0.04]		[-0.25;-0.01]	[-0.19;-0.01]
PLN/EUR	-	-0.5406	-	-0.1750	-	-0.2034	-1.2759
		[-0.73;-0.35]		[-0.35 -0.01]		[-0.37;-0.04]	[-1.53;-1.03]
ZAR/USD	-0.5384	-	-	0.3323	-	1.9966	-1.2611
	[-0.73;-0.34]			[0.21;0.46]		[1.77;2.22]	[-1.46;-1.05]
SGD/USD	-	-	-	-1.5527	1.4127	-0.4255	-0.7519
				[-1.80;-1.33]	[1.22;1.61]	[-0.60;-0.25]	[-0.88;-0.62]
KRW/USD	-	1.2672	-	-	-0.4800	0.6495	-0.1961
		[1.06;1.48]			[-0.65;-0.31]	[0.49;0.81]	[-0.29; -0.11]

Three metrics

- Adjusted R^2, both unconditional and conditional to assess the relative contribution of macro fundamental, scapegoat and order flow.
- The Akaike information criterion (AIC), and the residual sum of squares.
- Two market timing test:
  - Hit ratio (the proportion of time the sign of the predicted value ($\widetilde{\Delta s_t}$) correctly matches the one of the realized change in exchange rates (Δs_t))
  - Henriksson and Merton (1981) test

$$I_{\{\Delta s_t > 0\}} = \varphi_0^{HM} + \varphi_1^{HM} I_{\{\widetilde{\Delta s_t} > 0\}} + \varepsilon_t$$

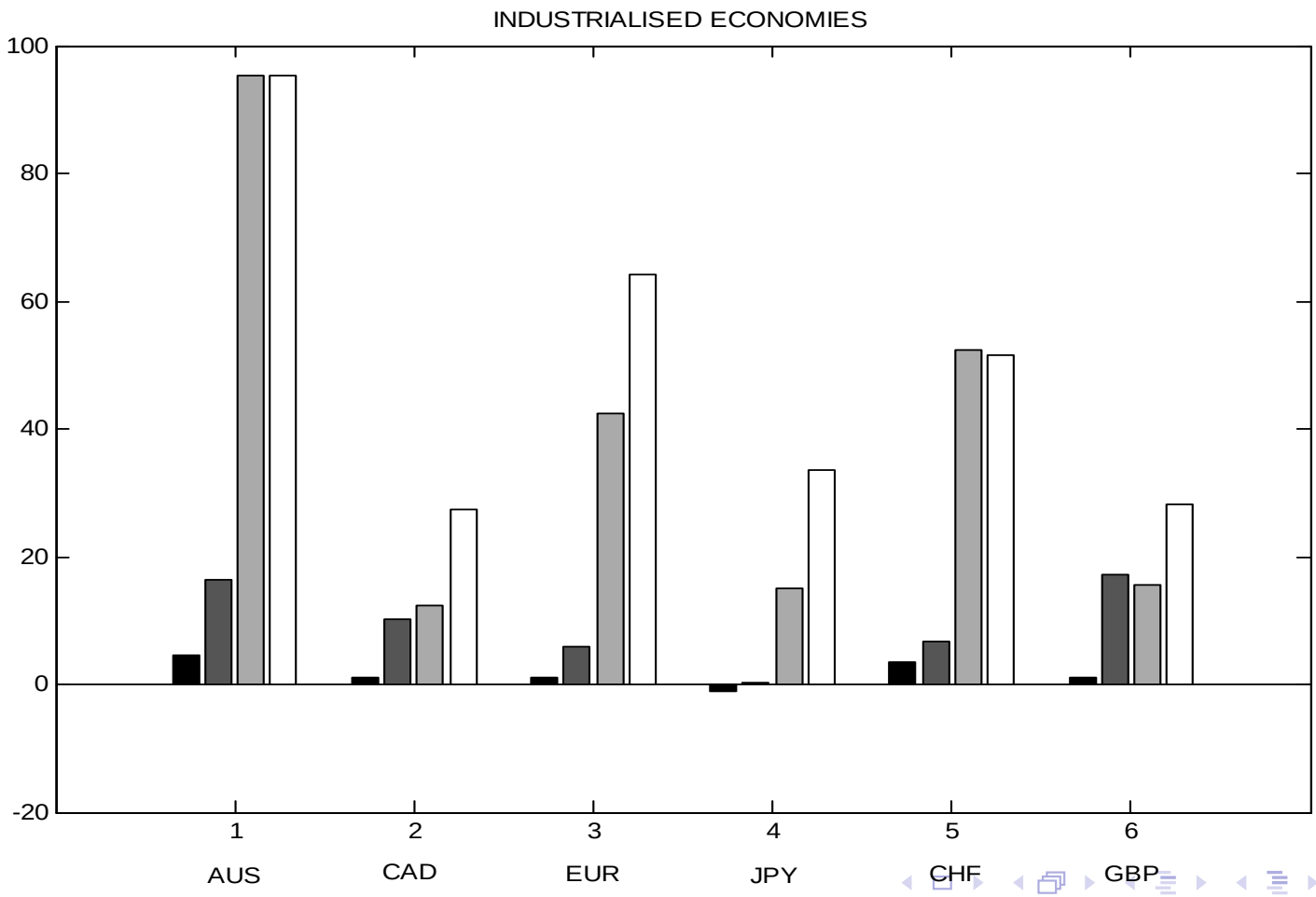
Panel A: Industrialized Economies

		Expl. Variance		Information Criteria		Market-Timing Tests	
		R^2	R^2adj	log(SSR/T)	AIC	HR(%)	HM(SE)
AUD/USD	CP	7	5	-0.09	-0.03	56	0.12(0.01)
	TVP	19	16	-0.35	-0.29	66	0.32(0.08)
	SCA	96	95	-3.31	-3.17	97	0.94(0.03)
CAD/USD	CP	4	1	-0.05	0.01	59	0.18(0.10)
	TVP	13	10	-0.30	-0.25	65	0.32(0.09)
	SCA	32	27	-0.54	-0.40	70	0.39(0.10)
EUR/USD	CP	4	1	-0.05	0.01	52	0.04(0.09)
	TVP	9	6	-0.22	-0.16	66	0.32(0.07)
	SCA	67	64	-1.35	-1.22	86	0.73(0.07)
JPY/USD	CP	2	0	-0.03	0.03	50	0(-)
	TVP	3	0	-0.12	-0.06	66	0.32(0.09)
	SCA	38	34	-0.58	-0.46	78	0.57(0.08)
CHF/EUR	CP	6	4	-0.08	-0.02	64	0.28(0.08)
	TVP	9	7	-0.21	-0.15	65	0.30(0.08)
	SCA	55	51	-1.12	-0.98	75	0.49(0.08)
GBP/USD	CP	4	1	-0.05	0.01	50	0.01(0.09)
	TVP	20	17	-0.35	-0.29	61	0.25(0.08)
	SCA	33	28	-0.21	-0.08	74	0.48(0.08)

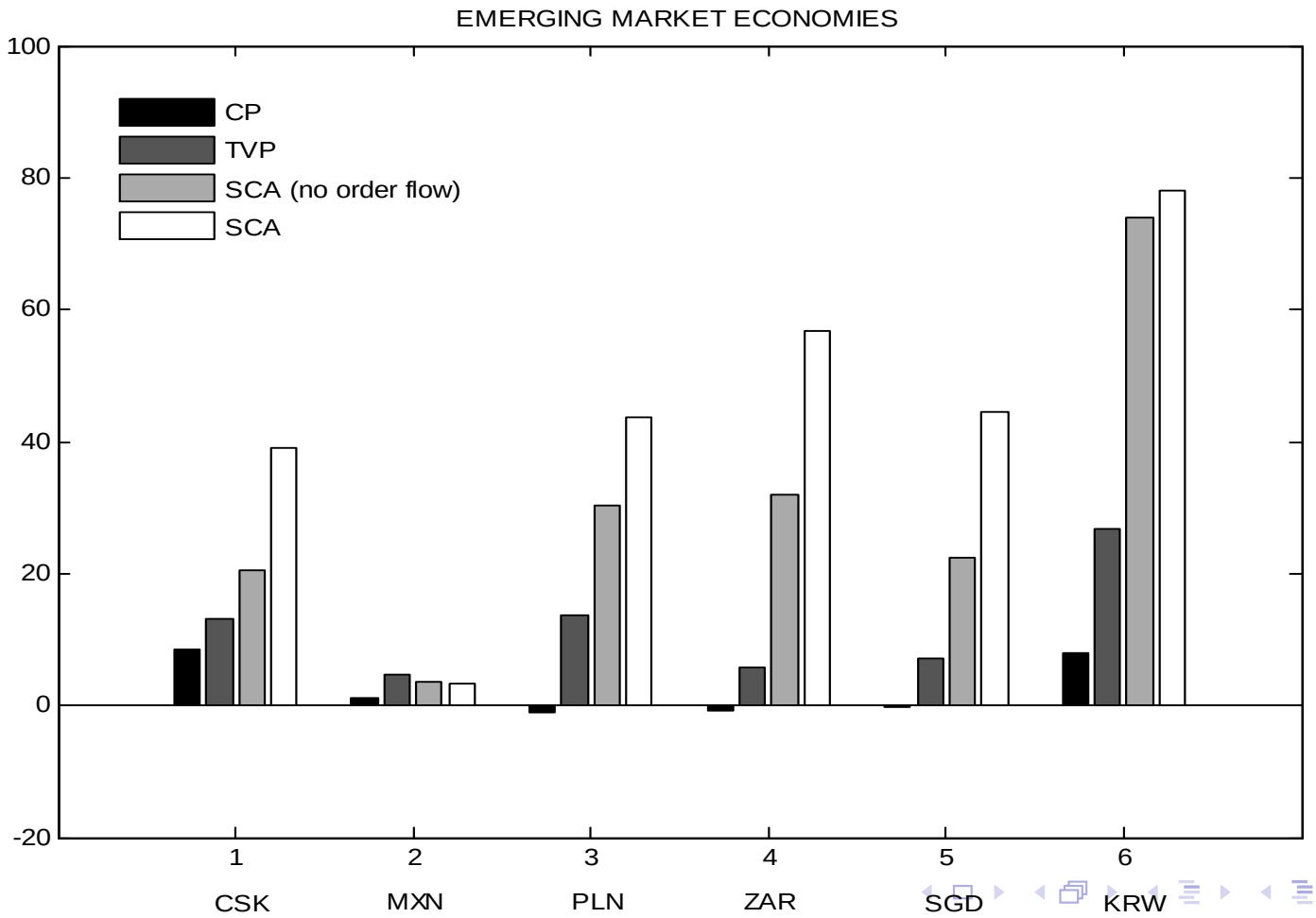
Panel B: Emerging Market Economies

		Expl. Variance		Information Criterion		Market-Timing Tests	
		R^2	R^2adj	log(SSR/T)	AIC	HR(%)	HM(SE)
CZK/EUR	CP	11	9	-0.13	-0.07	56	0.12(0.10)
	TVP	16	13	-0.23	-0.17	58	0.16(0.10)
	SCA	43	39	-0.29	-0.16	66	0.31(0.11)
MXN/USD	CP	4	1	-0.05	0.01	50	0.01(0.08)
	TVP	8	5	-0.15	-0.09	55	0.08(0.10)
	SCA	10	3	-0.17	-0.03	56	0.10(0.10)
PLN/EUR	CP	2	0	-0.03	0.03	52	0.04(0.09)
	TVP	16	14	-0.29	-0.23	63	0.29(0.09)
	SCA	48	44	0.50	0.64	56	0.13(0.10)
ZAR/USD	CP	2	0	-0.03	0.03	56	0.13(0.11)
	TVP	8	6	-0.19	-0.13	62	0.24(0.10)
	SCA	60	57	-0.30	-0.17	75	0.51(0.09)
SGD/USD	CP	3	0	-0.04	0.02	59	0.17(0.11)
	TVP	10	7	-0.19	-0.13	70	0.41(0.08)
	SCA	48	44	-0.30	-0.16	75	0.49(0.08)
KRW/USD	CP	11	8	-0.13	-0.07	63	0.25(0.08)
	TVP	30	27	-0.64	-0.58	66	0.32(0.10)
	SCA	80	78	-1.83	-1.69	85	0.71(0.08)

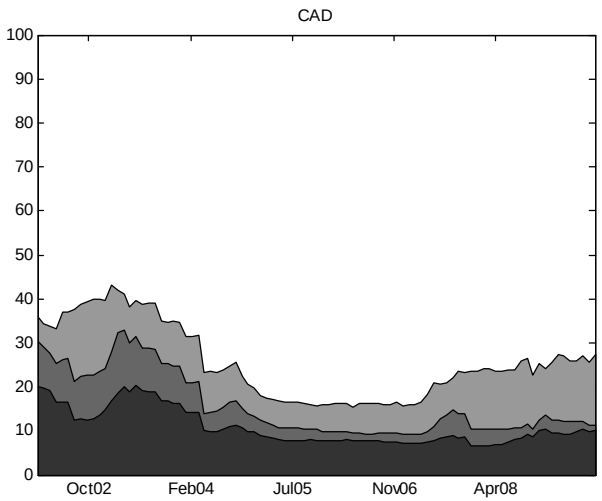
Unconditional adj-R2

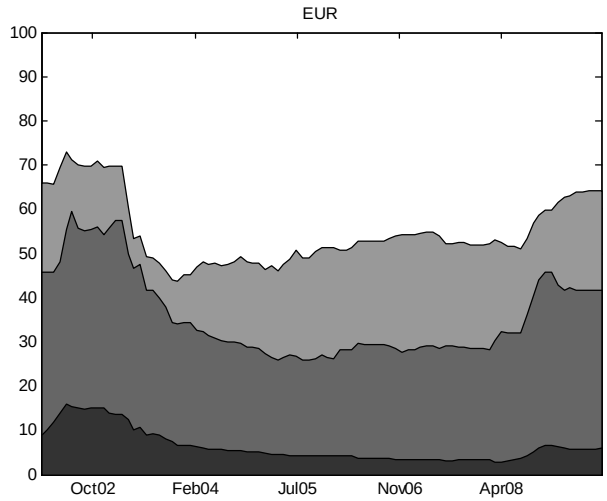


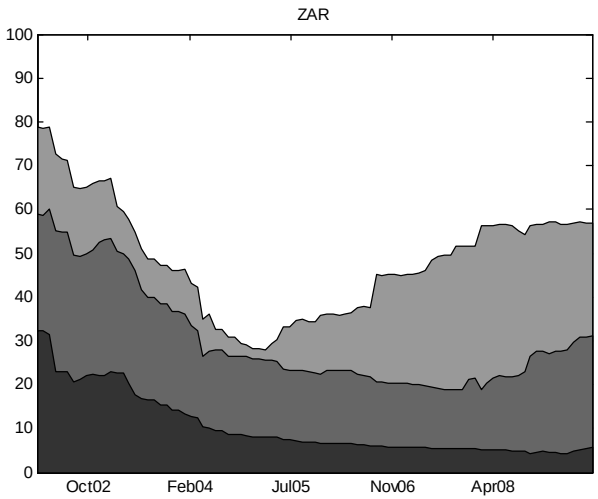
Unconditional adj-R2

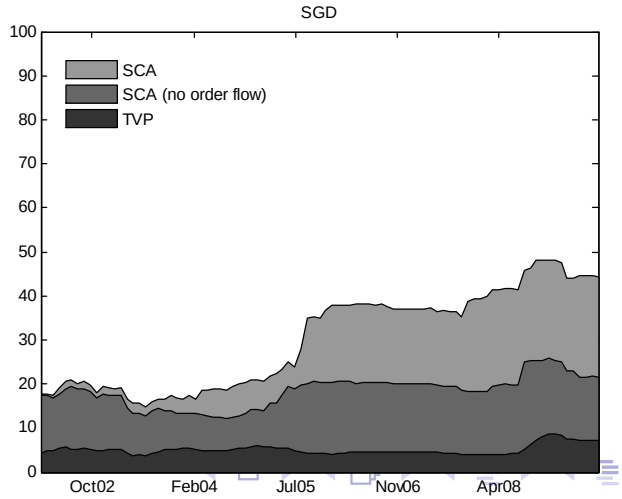


Rolling adj-R2









When does a fundamental become a scapegoat?

$$\tau_{t,i} = \varphi_0 + \varphi_1 \left| x_t \times f_{t,i} \right| I_{\{\tau_{t,i} > \tau_{t,-i}\}} + \varepsilon_t$$

x_t = order flow.

$f_{t,i}$ = macro factor.

$I_{\{\tau_{t,i} > \tau_{t,-i}\}}$ = 1 if survey $(\tau_{t,i})$ exceeds the two remaining surveys $(\tau_{t,-i})$.

Panel A: All Countries						
	ΔGrowth	ΔInflation	ΔRate ST	ΔRate LT	CA	ΔEquity
φ_1	0.44	1.12	0.47	0.40	0.28	0.42
(SE)	(0.07)	(0.16)	(0.07)	(0.14)	(0.10)	(0.14)
R^2adj (%)	10.2	24.9	11.5	5.0	4.3	2.3
R^2_Nadj (%)	19.8	37.9	28.2	8.7	8.3	5.1
N	199	73	199	264	191	298

Panel B: Industrialised Economies						
	ΔGrowth	ΔInflation	ΔRate ST	ΔRate LT	CA	ΔEquity
φ_1	0.40	-	0.55	0.48	0.38	0.76
(SE)	(0.06)	-	(0.09)	(0.15)	(0.10)	(0.30)
R^2adj (%)	9.6	-	14.5	7.6	8.2	2.1
R^2_Nadj (%)	19.8	-	32.2	10.9	16.2	2.2
N	161	-	134	112	131	74

Panel C: Emerging Market Economies						
	ΔGrowth	ΔInflation	ΔRate ST	ΔRate LT	CA	ΔEquity
φ_1	0.96	1.12	0.34	0.33	0.07	0.39
(SE)	(0.18)	(0.16)	(0.08)	(0.20)	(0.12)	(0.15)
R^2adj (%)	18.1	24.9	6.7	3.1	0.0	2.5
R^2_Nadj (%)	23.7	37.8	19.6	5.6	0.0	5.7
N	38	73	65	152	60	224

Conclusions

- The present paper is the first test of the scapegoat theory of exchange rates (Bacchetta and van Wincoop, 2004, 2010).
- Based on novel survey measures of FX scapegoats for 12 currencies, and proprietary order flow data (unobservables), we find empirical evidence that strongly supports the empirical implications of the scapegoat theory:
  - The scapegoat model outperforms (in-sample) two benchmark models for a large number of countries and across three performance criteria.
  - Both the scapegoat and order flow are important, and their relative contributions vary across countries and time.
  - A macroeconomic fundamental is picked as a scapegoat at times when it shows large movements combined with large changes in the unobservable.