Exchange Rate Prediction Redux: New Models, New Data, New Currencies

Yin-Wong CHEUNG, City University Hong Kong
Menzie D. CHINN, University of Wisconsin & NBER
Antonio GARCIA PASCUAL, Barclays
Yi ZHANG, University of California, Davis

NBP Workshop on Forecasting
Narodowy Bank Polski (NBP) Warsaw, Poland
November 26-27, 2018

Introduction

Predicting FX(!?)

"There may be more forecasting of exchange rates with less success than almost any other variable."

(July 2002, Alan Greenspan, former Federal Reserve Chairman)

"I have no idea where exchange rates will go in the future and I have no intention of ever starting to forecast exchange rates."

(Nov 2004, Mervyn King, former Bank of England governor)

Empirical evidence (academic)

Mixed, at best, if not negative

Current Exercise

(Re-)assess the predictive performance of FX models

- Consider more models, more data
- Recent developments/models

Along these dimensions

- Four new models (c.f. CCGP, 2005)
- Five currencies: C$, BP, JY, SFr, Euro (vs USD)
- Cointegration vs First Difference
- Evaluation periods: post-1982, post-dot.com, post-GFC
- Three prediction horizons: 1-, 4- and 20-quarter
- Three evaluation criteria: MSE, DOC, consistency

Main Takeaways

Best model/spec/currency combinations do not carry over

Different evaluation criteria, different results

- MSE criterion: A random walk can't be beaten often
  - Longer horizon predictions relatively better performance
  - PPP does relatively well
- DoC criterion: give better results for structural models

- Consistency criterion: ambiguous results

"Recent" models no better than "old" models

An extensive but not exhaustive exercise

The Models

Uncovered interest rate parity:

(1) $$s_{t+k} = s_t + \hat{i}_{t,k}$$

Relative purchasing power parity:

(2) $$s_t = \beta_0 + \hat{p}_t$$

Sticky price monetary model:

(3) $$s_t = \beta_0 + \beta_1 \hat{m}_t + \beta_2 \hat{y}_t + \beta_3 \hat{i}_t + \beta_4 \hat{\pi}_t + u_t$$

Behavioral equilibrium exchange rate (BEER) model: ω: non-tradable

(4) $$s_t = \beta_0 + \hat{p}_t + \beta_5 \hat{\omega}_t + \beta_6 \hat{r}_t + \beta_7 \hat{g}debt_t + \beta_8 tot_t + \beta_9 nfa_t + u_t$$

Taylor rule fundamentals: $\tilde{y}$: output gap

(5) $$s_{t+k} - s_t = \beta_0 + \beta_1 \hat{\tilde{y}}_t + \beta_2 \hat{\pi}_t + u_t$$

Real interest differential:

(6) $$s_t = \beta_0 + \beta_1 (\hat{i}_t^{shadow} - \hat{\pi}_t) + u_t$$

Sticky price monetary model augmented by VIX and 3-mth spread

(7) $$s_t = \beta_0 + \beta_1 \hat{m}_t + \beta_2 \hat{y}_t + \beta_3 \hat{i}_t + \beta_4 \hat{\pi}_t + \beta_5 VIX_t + \beta_6 TED_t + u_t$$

Yield curve slope (10 year minus three month yields):

(8) $$s_{t+k} - s_t = \beta_0 + \beta_1 (\hat{i}_t) + \beta_2 (slope_t) + u_t$$

Data

m, *IP*, *i*, CPI, PPI: *IFS*

Output gap: full sample HP filtered IP

Long term interest rates: Chinn & Meredith, Chinn & Quayyum

NFA: Lane & Milesi-Ferretti interpolated using CA data

Gov't debt: *IFS*, BIS, interpolated

Shadow rates: Wu-Xia, IMF

Estimation

Generic specification: $s_t = X_t\Gamma + u_t$

First difference: $\Delta s_t = \Delta X_t\Gamma + u_t$; *ex post*

ECM: $s_t - s_{t-k} = \delta_0 + \delta_1(s_{t-k} - X_t\hat{\Gamma}) + u_t$; *ex ante*

$\hat{\Gamma}$ estimated as the data window moves

Not "real time" data

IRP: not estimated, categorized as error correction

PPP: ECT incorporated long run relationship

Predictions: rolling regression

Prediction Comparison

MSE criterion: MSE(model *j*)/MSE(rw) [Diebold-Mariano-West]

DoC criterion: Value > 0.5

Consistency criterion: same I(d), cointegration, unit elasticity

Prediction periods

Period I: 1983q1-2014q4

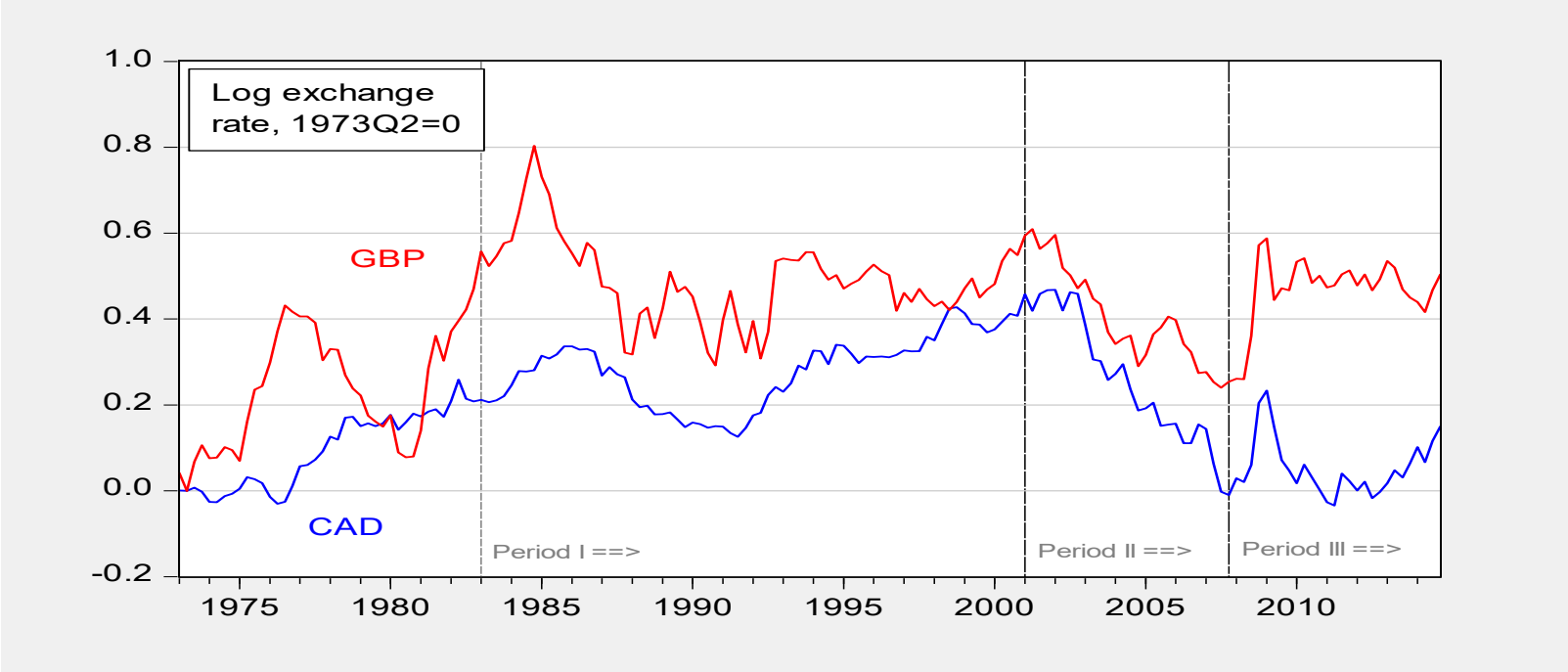
Period II: 2001q1-2014q4

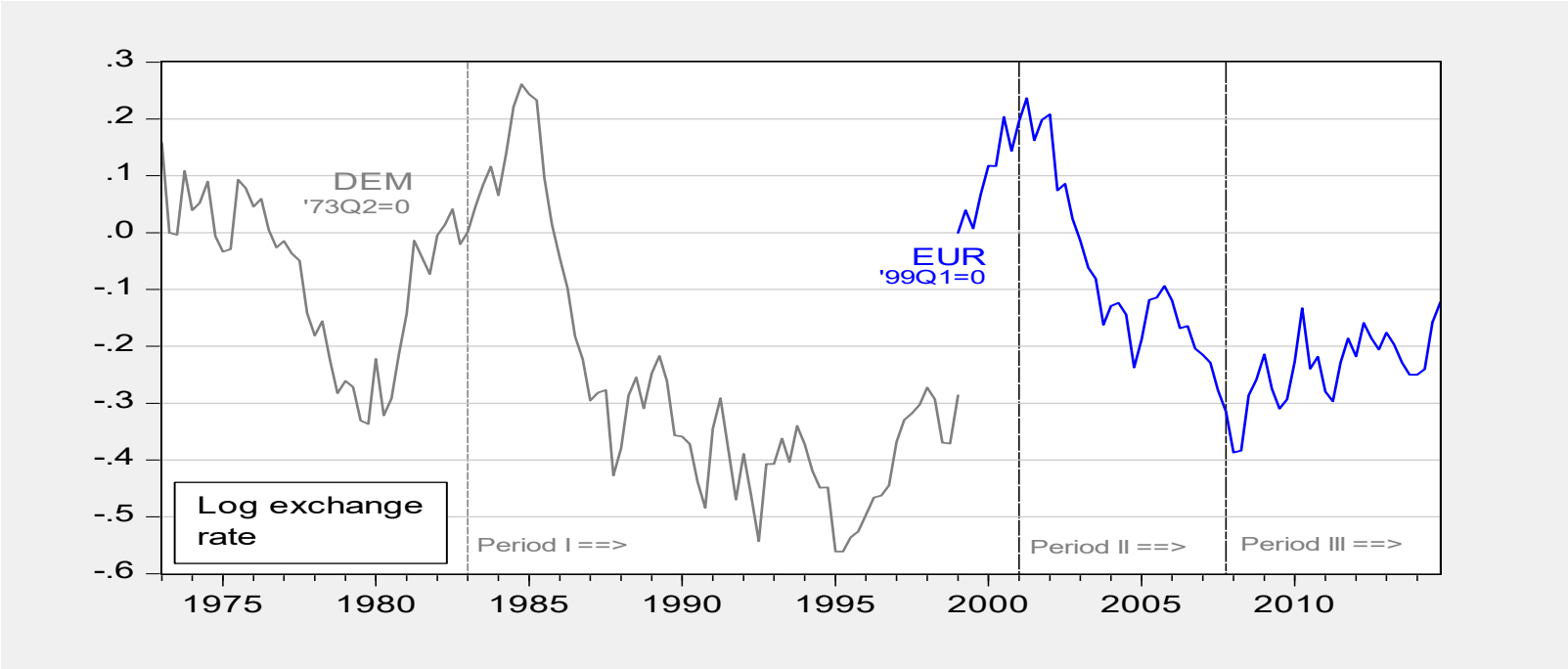
Period III: 2007q4-2014q4

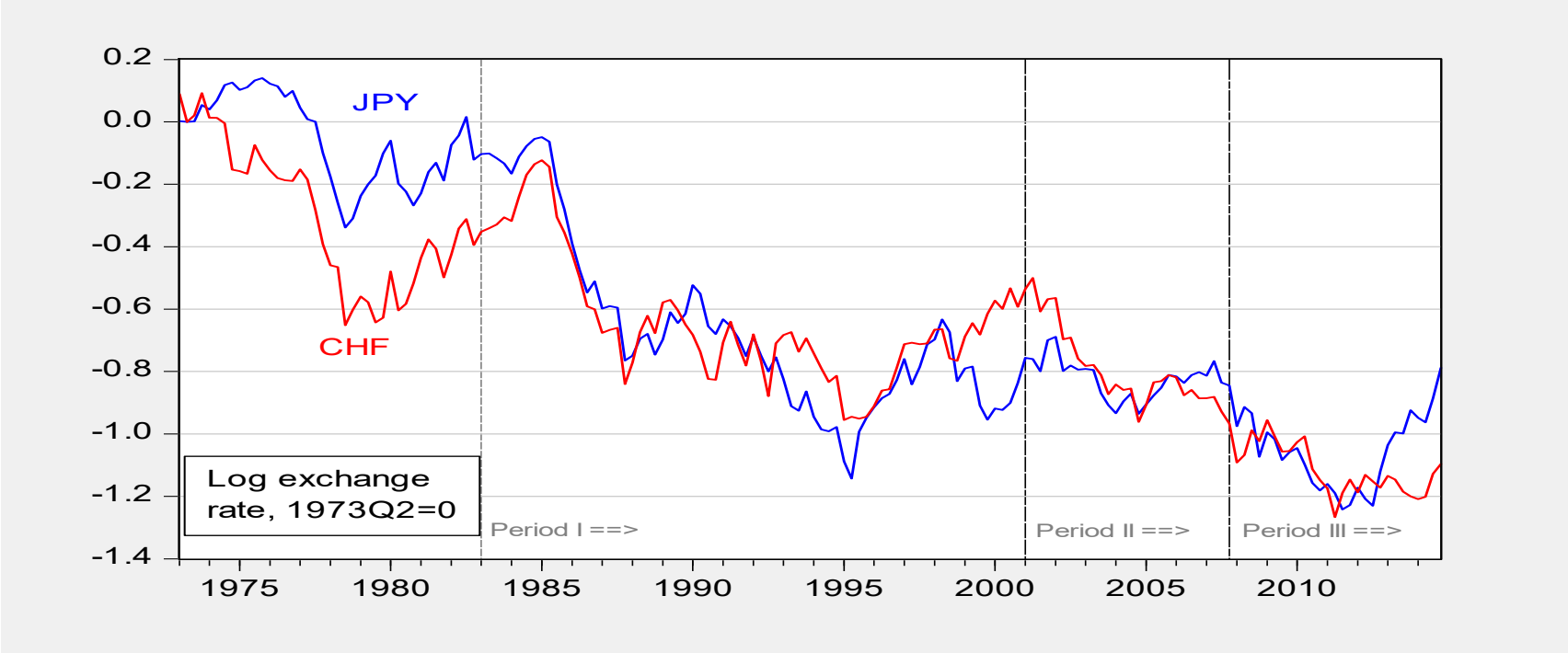
Prediction horizons

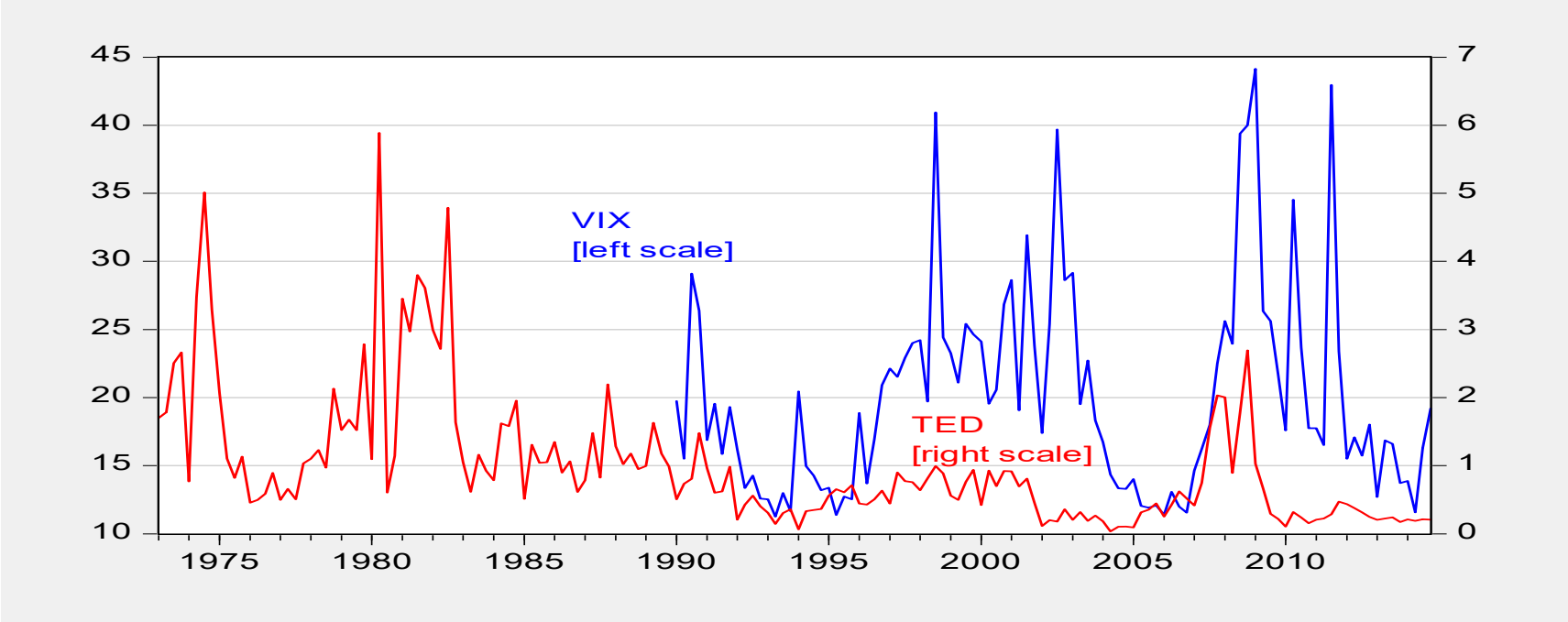
One quarter, four quarters, twenty quarters

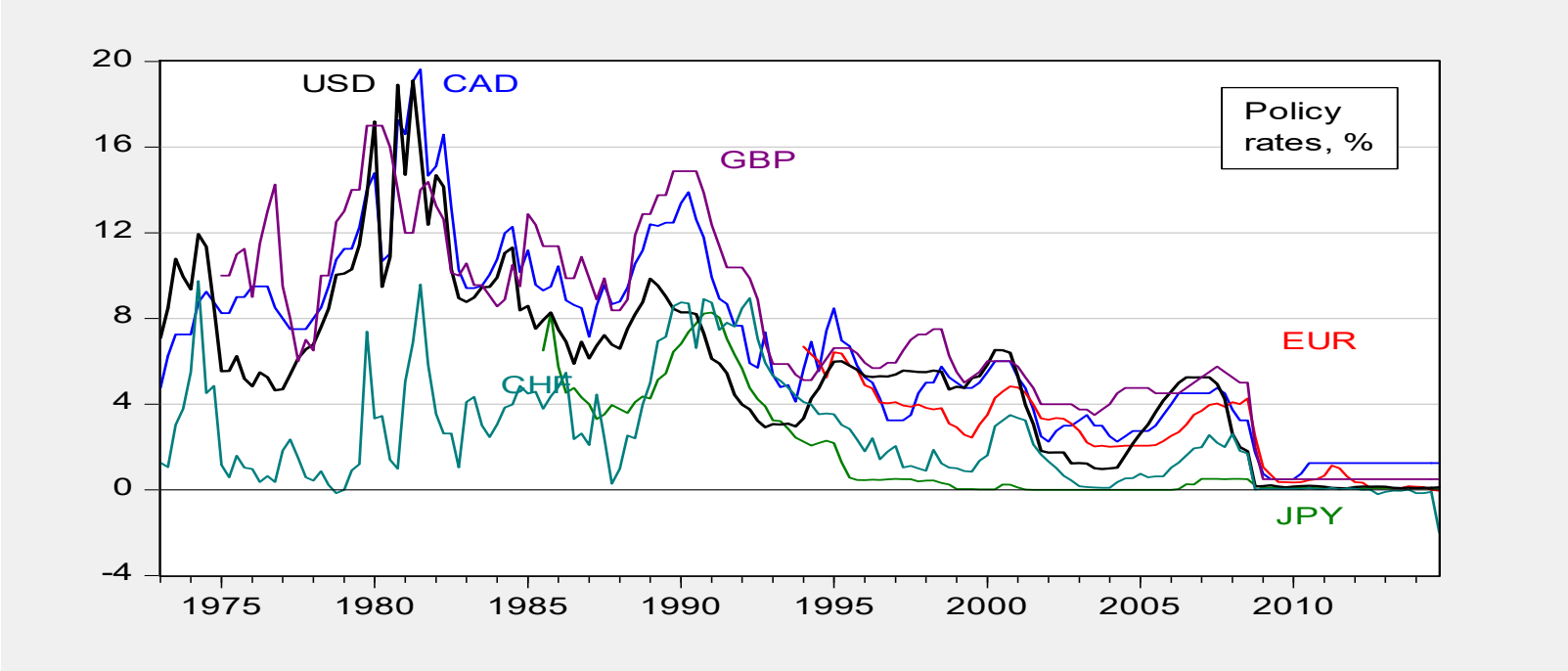
Prediction cases: 462

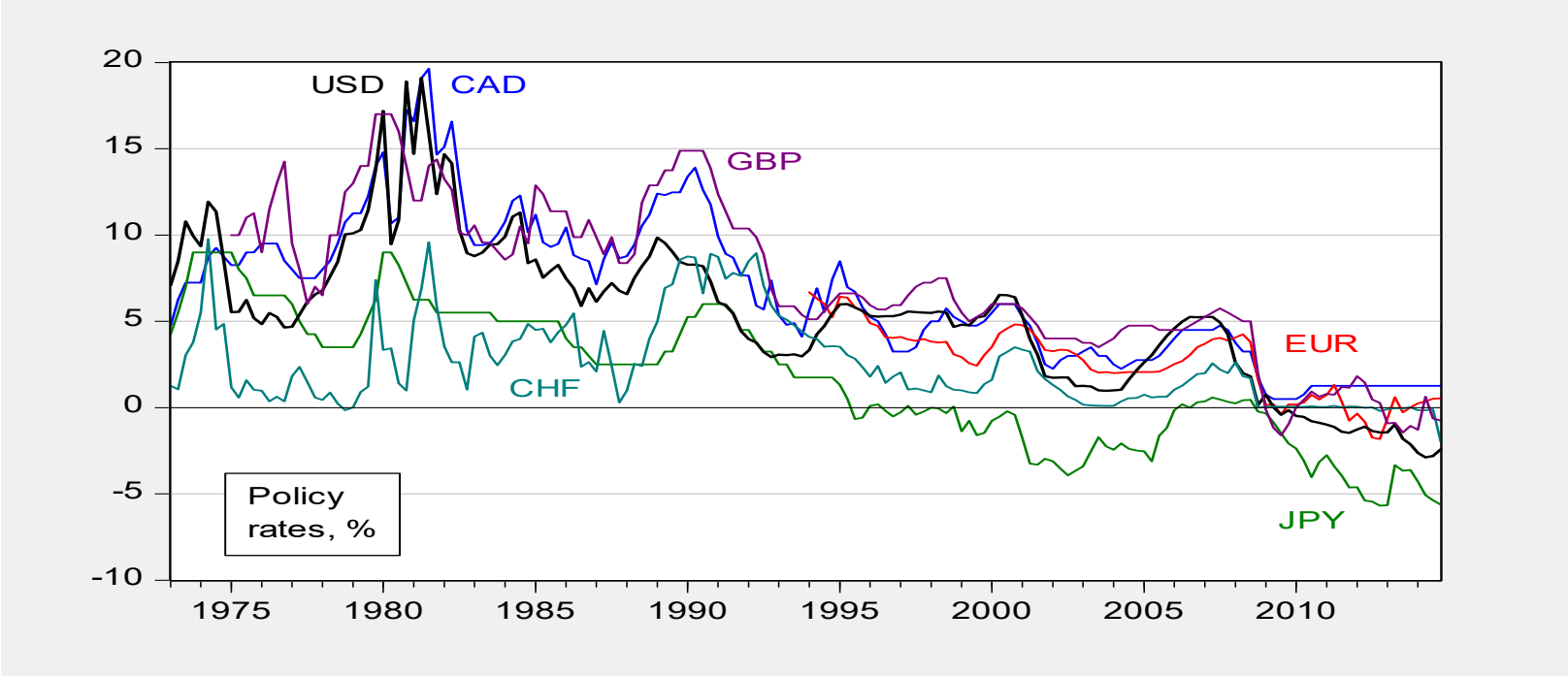

Log exchange rate, 1973Q2=0
GBP
CAD
Period I ==>
Period II ==>
Period III ==>
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
1975
1980
1985
1990
1995
2000
2005
2010


DEM
'73Q2=0
EUR
'99Q1=0
Log exchange rate
Period I ==>
Period II ==>
Period III ==>
.3
.2
.1
.0
-.1
-.2
-.3
-.4
-.5
-.6
1975
1980
1985
1990
1995
2000
2005
2010


0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
JPY
CHF
Log exchange rate, 1973Q2=0
Period I ==>
Period II ==>
Period III ==>
1975
1980
1985
1990
1995
2000
2005
2010


45
40
35
30
25
20
15
10
7
6
5
4
3
2
1
0
VIX
[left scale]
TED
[right scale]
1975
1980
1985
1990
1995
2000
2005
2010


20
16
12
8
4
0
-4
USD
CAD
GBP
CHF
EUR
JPY
Policy rates, %
1975
1980
1985
1990
1995
2000
2005
2010


20
15
10
5
0
-5
-10
USD
CAD
GBP
CHF
EUR
JPY
Policy rates, %
1975
1980
1985
1990
1995
2000
2005
2010

Prediction Results: MSE (1)

At the 10% level of significance

72 out of 462 outperformance (16.2%) [CCG-P (2005): < 1%]

124 underperformance (26.8%)

Among outperformance cases

Period I, 28 (38.9%) > Period II > Period III

At 20-quarters horizon, 26 (36.1%); failure, 70 (56.5%)

ECM (59) > FD (13); failure FD (74) > ECM (50)

Model – Periods I, II, III: PPP

PPP (ECM), 28 (72%) of 39

Good – Period I: Yen (ECM); Periods II & III: BP (ECM);

Bad – Periods I & II, SFR (FD); Period III, Euro

Best currency/spec/model/period: BP, ECM, PPP, Period III

The MSE ratios from selected dollar-based exchange rates (*Period I: 1983q1-2014q4*)

Specification	Horizon	PPP	SPMM	BEER	IRP	RID	TRF	SPMA	YCS
Panel B: Yen/$									
ECM	1 quarter	0.917	0.932		1.016	0.957	0.899		0.878
		0.044	0.116		0.719	0.292	0.069		0.036
	4 quarter	0.825	0.895		1.110	0.875	0.883		0.754
		0.010	0.014		0.125	0.009	0.017		0.000
	20 quarter	0.524	0.950		1.050	0.935	0.946		0.729
		0.000	0.006		0.006	0.004	0.007		0.001
FD	1 quarter	1.062	1.158			1.050			
		0.224	0.073			0.337			
	4 quarter	1.084	1.195			1.074			
		0.507	0.170			0.608			
	20 quarter	1.857	2.176			1.884			
		0.058	0.003			0.038			
Panel C: SF/$									
ECM	1 quarter	0.941	0.991			0.967	0.926		
		0.088	0.755			0.300	0.059		
	4 quarter	0.813	0.969			0.986	0.940		
		0.004	0.278			0.362	0.068		
	20 quarter	0.398	1.080			1.024	1.171		
		0.000	0.002			0.000	0.048		
FD	1 quarter	1.062	1.306			1.074			
		0.088	0.050			0.046			
	4 quarter	1.156	1.656			1.160			
		0.032	0.000			0.041			
	20 quarter	2.309	1.615			1.975			
		0.000	0.185			0.022			

The MSE ratios from selected dollar-based exchange rates (*Period II: 2001q1-2014q4*)

Specification	Horizon	PPP	SPMM	BEER	IRP	RID	TRF	SPMA	YCS
Panel C: SF/$									
ECM	1 quarter	0.919	0.988	0.972	1.005	1.069	0.998	0.995	1.079
		0.242	0.628	0.572	0.536	0.504	0.702	0.628	0.576
	4 quarter	0.703	1.022	1.143	0.983	1.209	1.008	1.157	1.428
		0.042	0.022	0.417	0.031	0.979	0.014	0.783	0.220
	20 quarter	1.214	1.772	1.513	0.797	1.269	1.781	2.767	2.648
		0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
FD	1 quarter	1.100	1.032	1.764		0.989		1.408	
		0.259	0.949	0.025		0.346		0.079	
	4 quarter	1.101	1.034	3.031		1.036		1.793	
		0.232	0.051	0.000		0.027		0.006	
	20 quarter	1.598	1.328	***16.795***		1.038		5.045	
		0.000	0.000	***0.000***		0.000		0.000	
Panel D: BP/$									
ECM	1 quarter	0.912	1.016	0.970	0.984	0.942	0.994	1.020	1.025
		0.099	0.514	0.362	0.734	0.490	0.900	0.663	0.166
	4 quarter	0.704	1.015	1.007	0.932	1.045	0.919	0.977	1.053
		0.026	0.900	0.731	0.897	0.124	0.490	0.585	0.053
	20 quarter	0.266	0.898	1.107	1.019	1.111	0.909	0.938	1.022
		0.000	0.097	0.003	0.804	0.009	0.090	0.843	0.254
FD	1 quarter	0.931	1.026	0.641		1.080		1.166	
		0.518	0.684	0.304		0.360		0.149	
	4 quarter	0.864	1.077	0.658		1.047		1.292	
		0.046	0.349	0.126		0.001		0.008	
	20 quarter	0.798	0.900	0.440		1.167		1.405	
		0.018	0.223	0.000		0.025		0.001	

The MSE ratios from selected dollar-based exchange rates (*Period III: 2007q4-2014q4*)

Specification	Horizon	PPP	SPMM	BEER	IRP	RID	TRF	SPMA	YCS
Panel D: BP/$									
ECM	1 quarter	0.896	0.968	0.935	0.960	0.943	0.962	1.015	1.023
		0.042	0.275	0.254	0.182	0.332	0.194	0.997	0.874
	4 quarter	0.568	0.938	1.011	0.885	1.045	0.961	0.978	1.028
		0.012	0.090	0.539	0.095	0.788	0.512	0.717	0.573
	20 quarter	***0.040***	0.753	1.019	0.870	1.025	0.665	0.874	1.105
		0.003	0.213	0.310	0.125	0.305	0.027	0.234	0.777
FD	1 quarter	0.848	1.102	0.515		1.114		1.159	
		0.201	0.363	0.329		0.289		0.401	
	4 quarter	0.911	1.392	0.554		1.041		1.078	
		0.071	0.226	0.250		0.697		0.999	
	20 quarter	1.085	1.579	0.141		1.035		0.760	
		0.440	0.306	0.284		0.568		0.891	
Panel E: EU/$									
ECM	1 quarter	0.876	0.979	0.905	0.986	0.996	0.960	0.985	0.949
		0.188	0.722	0.743	0.401	0.480	0.660	0.680	0.903
	4 quarter	0.558	1.043	1.072	0.946	1.142	1.153	0.849	1.276
		0.008	0.023	0.042	0.157	0.030	0.031	0.288	0.052
	20 quarter	0.310	1.253	1.205	0.945	1.169	1.897	1.308	1.431
		0.008	0.000	0.000	0.050	0.000	0.000	0.000	0.000
FD	1 quarter	0.994	1.197	1.341		1.079		1.589	
		0.669	0.096	0.211		0.283		0.053	
	4 quarter	1.101	1.269	6.023		1.201		1.202	
		0.009	0.017	0.027		0.005		0.200	
	20 quarter	1.476	2.020	11.974		1.582		3.391	
		0.000	0.000	0.001		0.000		0.053	

Prediction Results: MSE (2)

RID model – best Period I (2, 11)

Taylor rule model – best Period I (7, 2)

VIX/TED augmented – best Period III (3, 6)

YCS – best Period I (3, 1)

Hard to fit a standard model to euro/dollar

The four "recent" models

20 outperformance vs 65 underperformance cases

The four "old" models

52 outperformance vs 59 underperformance cases

Overall, the performance is not impressive

Possible exception – PPP (ECM)

Prediction Results: Direction of Change

At the 10% level of significance

134 outperformance cases (29.0%) Vs 27 underperformance cases (5.8%)

Among outperformance cases

ECM (89) > FD (45)

20 QTRS: 62 46.2% (Period II: 30); 4 QTRS: 46 34.3%; 1 QTR: 26 19.4%

Underperformance

Period III: 14 (Euro: 10)

Good Models

Period I: PPP; Periods II & III: BEER

Good currencies

Period I: Yen (ECM); Periods II & III: SFR (ECM)

DoC results are more encouraging

Direction of change statistics from selectd dollar-based exchange rates (*Period I: 1983q1-2014q4*)

Specification	Horizon	PPP	SPMM	BEER	IRP	RID	TRF	SPMA	YCS
Panel B: Yen/$									
ECM	1 quarter	0.539	0.586		0.516	0.555	0.555		0.656
		0.377	0.052		0.724	0.216	0.216		0.000
	4 quarter	0.576	0.600		0.504	0.672	0.600		0.752
		0.089	0.025		0.929	0.000	0.025		0.000
	20 quarter	0.716	0.670		0.688	0.661	0.550		0.688
		0.000	0.000		0.000	0.001	0.292		0.000
FD	1 quarter	0.492	0.516			0.539			
		0.860	0.724			0.377			
	4 quarter	0.600	0.552			0.608			
		0.025	0.245			0.016			
	20 quarter	0.550	0.596			0.495			
		0.292	0.044			0.924			

Direction of change statistics from selectd dollar-based exchange rates (*Period II: 2001q1-2014q4*)

Specification	Horizon	PPP	SPMM	BEER	IRP	RID	TRF	SPMA	YCS
Panel C: SF/$									
ECM	1 quarter	0.536	0.607	0.589	0.518	0.518	0.554	0.589	0.536
		0.593	0.109	0.181	0.789	0.789	0.423	0.181	0.593
	4 quarter	0.566	0.698	0.623	0.642	0.585	0.679	0.566	0.453
		0.336	0.004	0.074	0.039	0.216	0.009	0.336	0.492
	20 quarter	0.730	0.865	1.000	0.946	1.000	0.892	0.838	0.838
		0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000
FD	1 quarter	0.482	0.536	0.554		0.536		0.607	
		0.789	0.593	0.423		0.593		0.109	
	4 quarter	0.717	0.755	0.509		0.736		0.509	
		0.002	0.000	0.891		0.001		0.891	
	20 quarter	1.000	1.000	0.297		1.000		0.405	
		0.000	0.000	0.014		0.000		0.250	

Direction of change statistics from selectd dollar-based exchange rates (*Period III: 2007q4-2014q4*)

Specification	Horizon	PPP	SPMM	BEER	IRP	RID	TRF	SPMA	YCS
Panel C: SF/$									
ECM	1 quarter	0.483	0.379	0.621	0.586	0.483	0.586	0.586	0.552
		0.853	0.194	0.194	0.353	0.853	0.353	0.353	0.577
	4 quarter	0.423	0.654	0.615	0.462	0.538	0.654	0.577	0.615
		0.433	0.117	0.239	0.695	0.695	0.117	0.433	0.239
	20 quarter	0.200	1.000	1.000	0.800	1.000	1.000	1.000	1.000
		0.058	0.002	0.002	0.058	0.002	0.002	0.002	0.002
FD	1 quarter	0.448	0.517	0.517		0.552		0.448	
		0.577	0.853	0.853		0.577		0.577	
	4 quarter	0.654	0.654	0.615		0.654		0.615	
		0.117	0.117	0.239		0.117		0.239	
	20 quarter	1.000	1.000	1.000		1.000		0.300	
		0.002	0.002	0.002		0.002		0.206	
Panel E: EU/$									
ECM	1 quarter	0.655	0.448	0.517	0.552	0.414	0.483	0.483	0.517
		0.095	0.577	0.853	0.577	0.353	0.853	0.853	0.853
	4 quarter	0.769	0.462	0.577	0.538	0.423	0.538	0.577	0.500
		0.006	0.695	0.433	0.695	0.433	0.695	0.433	1.000
	20 quarter	0.900	0.100	0.100	0.800	0.100	0.100	0.100	0.100
		0.011	0.011	0.011	0.058	0.011	0.011	0.011	0.011
FD	1 quarter	0.414	0.379	0.414		0.379		0.483	
		0.353	0.194	0.353		0.194		0.853	
	4 quarter	0.423	0.462	0.500		0.423		0.500	
		0.433	0.695	1.000		0.433		1.000	
	20 quarter	0.100	0.100	0.100		0.100		0.400	
		0.011	0.011	0.011		0.011		0.527	

Prediction Results: Consistency

At the 10% level of significance

275 (59.5%) cases reject no-cointegration

Among cointegrated cases

ECM (158) > FD (117)

20 QTRS: 50 (Periods I, II, III: 10, 3, 37)

Models

Periods I & II: SPMM; Period III: RID

Currencies

Period I & III: BP (ECM); Periods II: YEN (ECM)

No rejecting the (1, -1) restriction

Only 8 cases: Period III (5 cases)

The consistency evidence: ambiguous

Cointegration is "strong" but "One-to-One" property is "weak"

Cointegration between selected dollar-based exchange rates and their forecasts (*Period I: 1983q1-2014q4*)

Specification	Horizon	PPP	SPMM	BEER	IRP	RID	TRF	SPMA	YCS
Panel D: BP/$									
ECM	1 quarter	8.710	42.517	62.709	8.384	117.159	68.513		14.307
		0.512	0.001	0.001	0.545	0.001	0.001		0.087
	4 quarter	34.164	38.779	39.665	38.147	41.653	34.689		45.750
		0.001	0.001	0.001	0.001	0.001	0.001		0.001
	20 quarter	13.792	14.063	14.508	14.626	15.233	14.851		15.379
		0.104	0.095	0.081	0.078	0.063	0.072		0.060
FD	1 quarter	93.173	82.837	72.536		138.032			
		0.001	0.001	0.001		0.001			
	4 quarter	40.322	37.764	24.937		38.056			
		0.001	0.001	0.002		0.001			
	20 quarter	16.402	17.582	21.326		13.373			
		0.042	0.027	0.007		0.120			

Cointegration between selected dollar-based exchange rates and their forecasts (*Period II: 2001q1-2014q4*)

Specification Panel B: Yen/$	Horizon	PPP	SPMM	BEER	IRP	RID	TRF	SPMA	YCS
ECM	1 quarter	18.439	44.046	41.331	5.209	42.452	22.192	43.350	8.795
		0.020	0.001	0.001	0.869	0.001	0.005	0.001	0.503
	4 quarter	17.580	18.473	17.083	15.584	18.020	16.338	17.122	16.418
		0.027	0.019	0.033	0.056	0.023	0.043	0.032	0.041
	20 quarter	16.479	5.066	5.354	3.614	5.631	7.406	7.858	6.199
		0.040	0.882	0.856	0.974	0.828	0.645	0.599	0.769
FD	1 quarter	40.862	56.223	25.468		65.609		35.570	
		0.001	0.001	0.001		0.001		0.001	
	4 quarter	16.679	16.184	13.565		15.594		16.181	
		0.038	0.045	0.113		0.056		0.045	
	20 quarter	3.898	3.624	6.840		3.897		11.642	
		0.962	0.974	0.703		0.962		0.213	

Cointegration between selected dollar-based exchange rates and their forecasts (*Period III: 2007q4-2014q4)*

Specification	Horizon	PPP	SPMM	BEER	IRP	RID	TRF	SPMA	YCS
Panel D: BP/$									
ECM	1 quarter	14.234	13.530	27.554	28.427	26.970	13.658	26.140	16.500
		0.089	0.114	0.001	0.001	0.001	0.109	0.001	0.040
	4 quarter	17.780	17.377	17.357	17.216	17.180	18.608	20.105	17.109
		0.025	0.029	0.029	0.031	0.031	0.018	0.010	0.032
	20 quarter	40.217	32.386	30.639	30.963	31.291	32.030	26.682	34.418
		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
FD	1 quarter	35.498	20.861	17.396		43.574		42.512	
		0.001	0.008	0.029		0.001		0.001	
	4 quarter	16.863	23.915	26.191		17.659		23.508	
		0.035	0.003	0.001		0.026		0.003	
	20 quarter	33.814	26.296	14.840		33.347		25.529	
		0.001	0.001	0.073		0.001		0.001	

Results of the (1,-1) restriction test: selected dollar-based exchange rates (*Period I: 1983q1-2014q4*)

Specification	Horizon	PPP	SPMM	BEER	IRP	RID	TRF	SPMA	YCS
Panel B: Yen/$									
ECM	1 quarter	7.444	70.187		1.938	38.347	41.802		11.466
		0.006	0.000		0.164	0.000	0.000		0.001
	4 quarter	39.305	40.019		37.206	37.851	37.666		29.576
		0.000	0.000		0.000	0.000	0.000		0.000
	20 quarter	14.702							
		0.000							

Results of the (1,-1) restriction test: dollar-based exchange rates (*Period II: 2001q1-2014q4*)

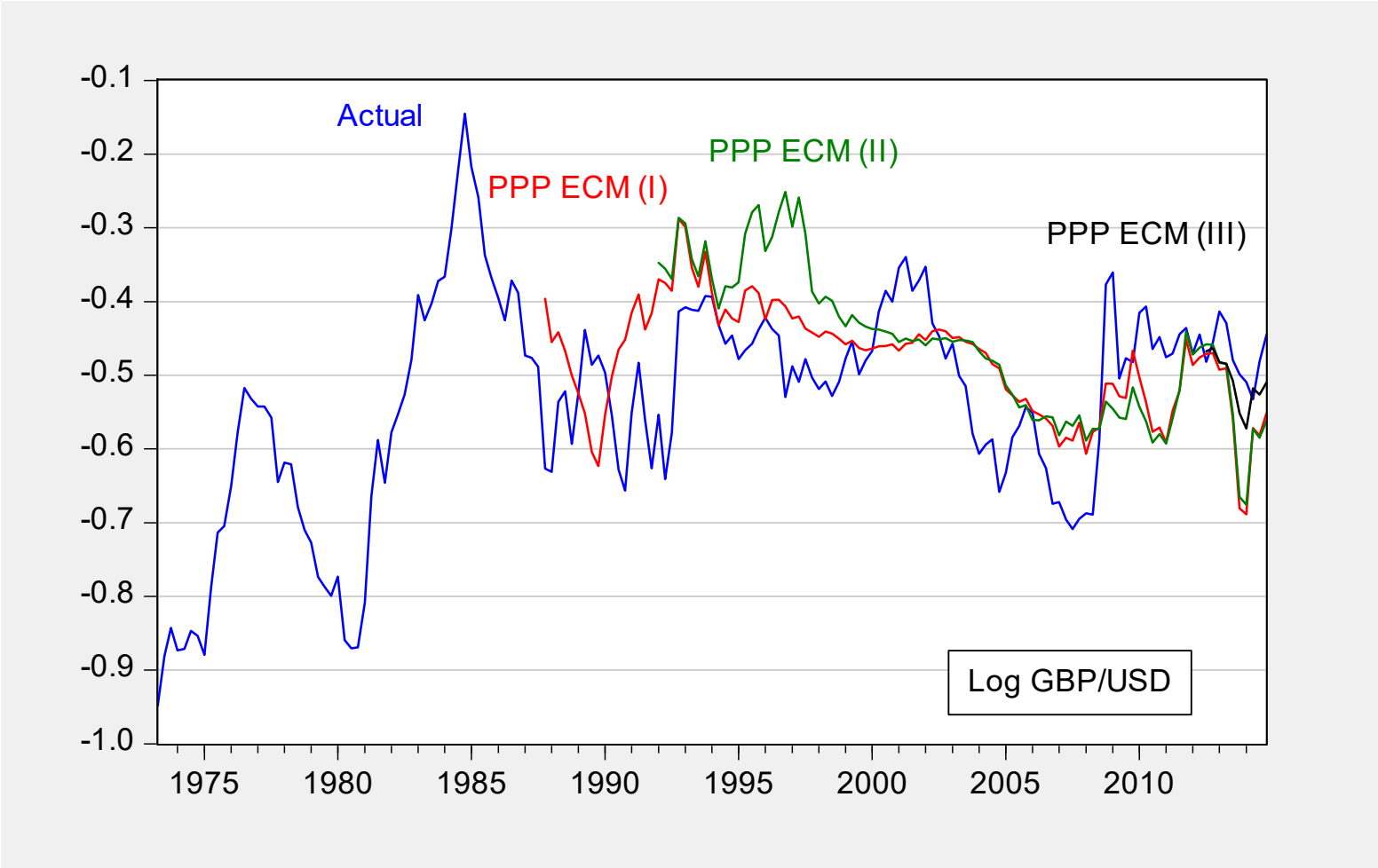
Specification	Horizon	PPP	SPMM	BEER	IRP	RID	TRF	SPMA	YCS
Panel C: SF/$									
ECM	1 quarter		49.744	15.483		33.032	55.732	32.060	
			0.000	0.000		0.000	0.000	0.000	
	4 quarter	4.088	5.534	3.346	4.274	6.125	4.072	5.947	2.483
		0.043	0.019	0.067	0.039	0.013	0.044	0.015	0.115
	20 quarter								
FD	1 quarter	31.427	64.961	19.402		28.778		30.701	
		0.000	0.000	0.000		0.000		0.000	
	4 quarter	4.106	5.328	0.671		3.929		4.347	
		0.043	0.021	0.413		0.047		0.037	
	20 quarter								

Results of the (1,-1) restriction test: dollar-based exchange rates (*Period III: 2007q4-2014q4*)

Specification	Horizon	PPP	SPMM	BEER	IRP	RID	TRF	SPMA	YCS
Panel A: CAN$/$									
ECM	1 quarter		13.318				14.330		
			0.000				0.000		
	20 quarter				3.621	4.723	1.454	13.163	9.883
					0.057	0.030	0.228	0.000	0.002
Panel B: Yen/$									
ECM	1 quarter	0.061	9.839		29.138	15.213		25.960	23.109
		0.805	0.002		0.000	0.000		0.000	0.000
	20 quarter		9.690						
			0.002						
Panel C: SF/$									
FD	1 quarter	25.108	27.850	20.559		9.336		38.181	
		0.000	0.000	0.000		0.002		0.000	
	20 quarter	12.353		19.139		8.141		0.399	
		0.000		0.000		0.004		0.528	
Panel E: EU/$									
ECM	1 quarter		6.076	8.654	1.205	8.971	10.031		
			0.014	0.003	0.272	0.003	0.002		
	4 quarter					9.241		11.945	9.982
						0.002		0.001	0.002
	20 quarter					13.164	10.728	8.591	
						0.000	0.001	0.003	
FD	1 quarter	19.218	18.193	11.159		28.555		20.088	
		0.000	0.000	0.001		0.000		0.000	
	20 quarter			0.258		21.621			
				0.611		0.000			

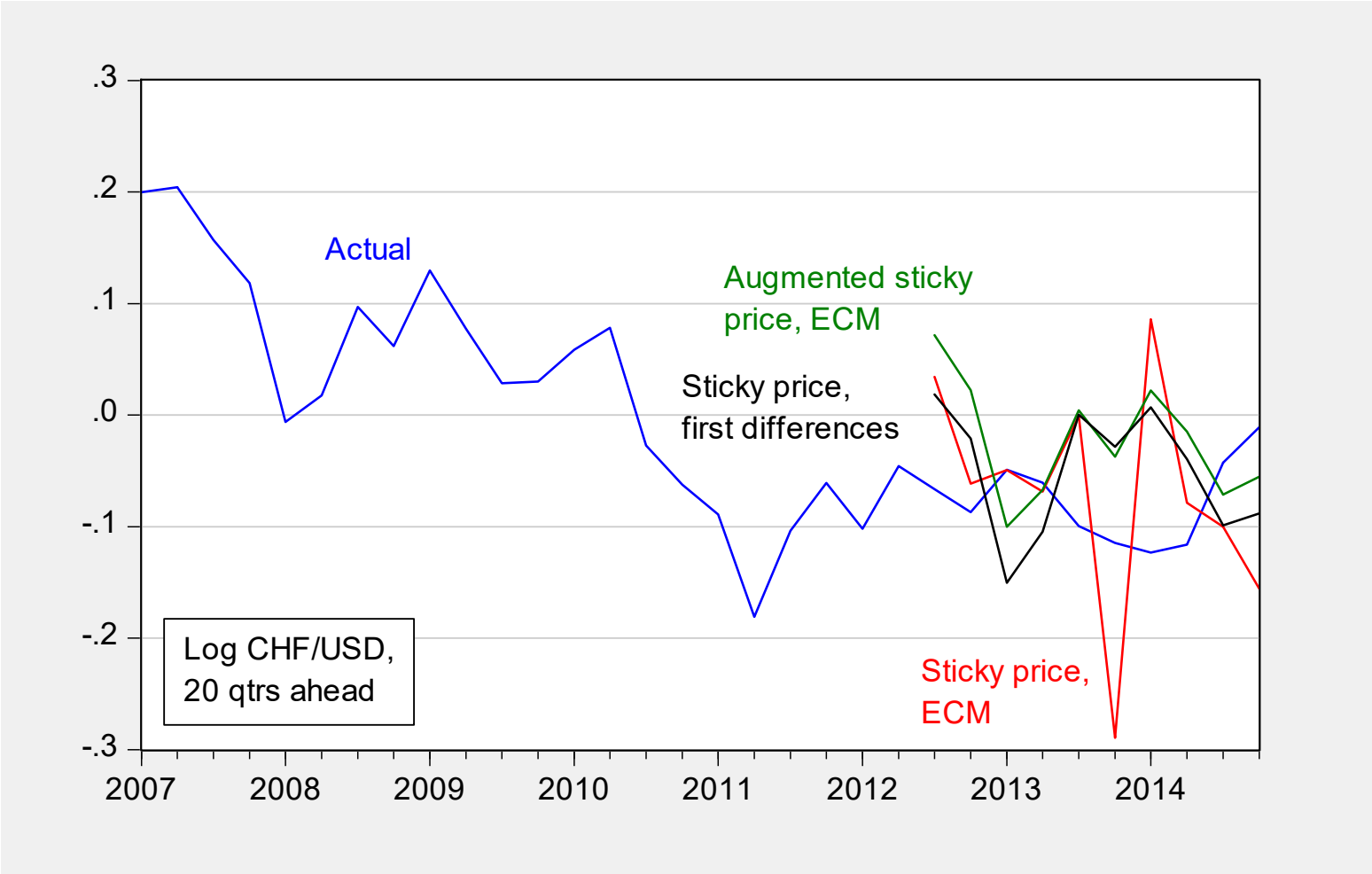
Good/Bad Performance: Examples

Best: GBP/USD, 20-quarter ahead; PPP(ECM, III)



Worst: SFR, BEER, FD, 20 QTR, II; MSE ratio 16.8

Another case: CHF/USD, 20-QTR, SPMA III



The performance of a particular model/currency combination does not typically carry over from one out-of-sample period to the other, nor from one specification to the other

Conclusions

Best model/spec/currency combinations do not carry over alternative out-of-sample periods, prediction horizons….

Different criteria, different implications

- MSE: unimpressive; but better than CCGP (2005)
  - Performance seems better at longer horizons
  - PPP (ECM) – an encouraging spot
- Doc: results are more positive than those of MSE
- Consistency: ambiguous

ECM does better than FD

"New" models are no better

Epilogue

It is an extensive, but not exhaustive, study

Other models/specifications

- Microstructure models, balance sheets; rational Inattention…
- Nonlinearities, factor models, structural models, panel models…

Bayesian approach

- Learning, model averaging

Other test for prediction performance

- Clarke-West

Other prediction evaluation criteria

- Economic profits, utility-based method

Developed countries Vs developing countries