Empirical Modeling of Dollar Exchange Rates

Forecasting and Policy Implications

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Presentation at

Congressional Budget Office

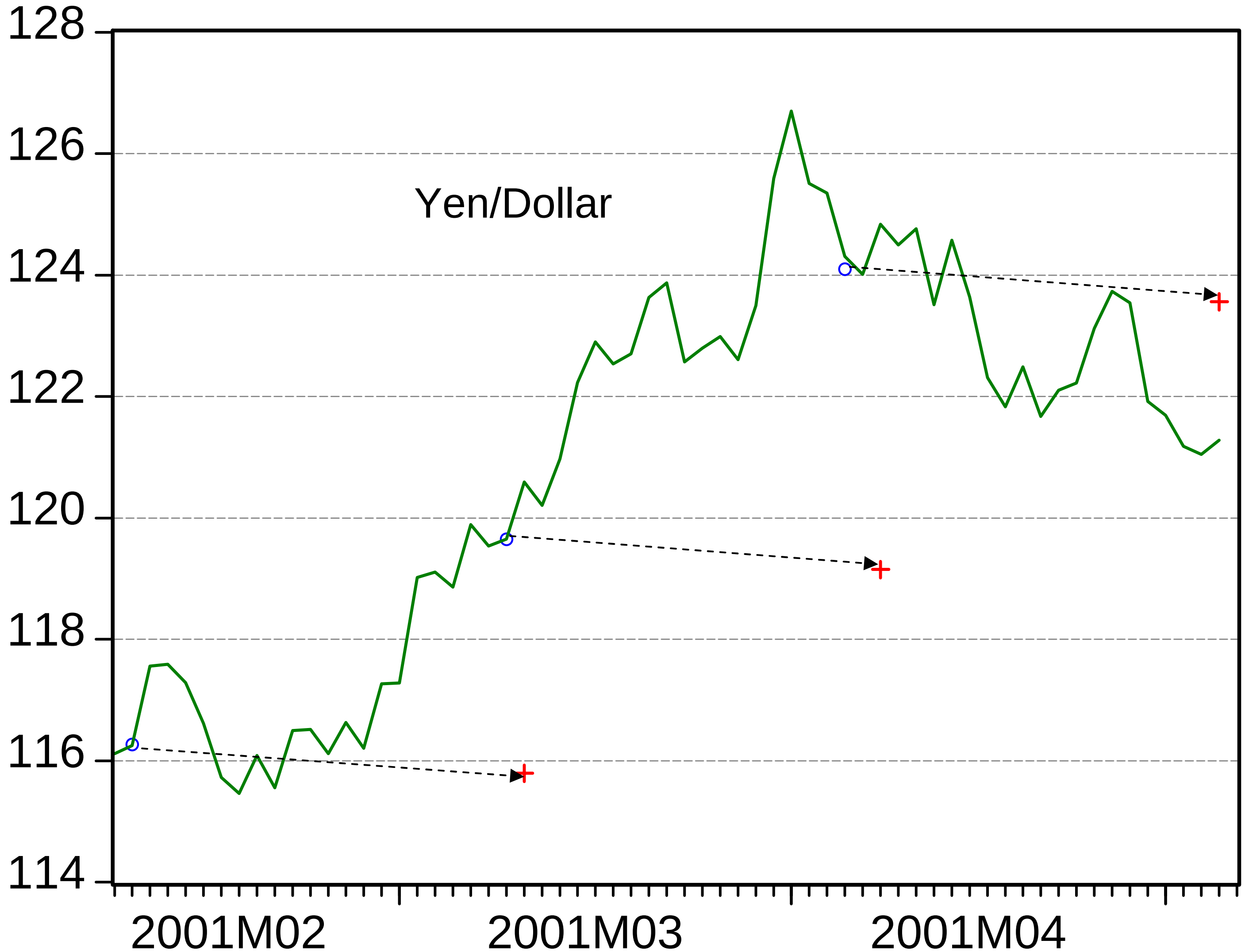
June 29, 2005

Motivation (I)

Uncovered interest parity doesn't work

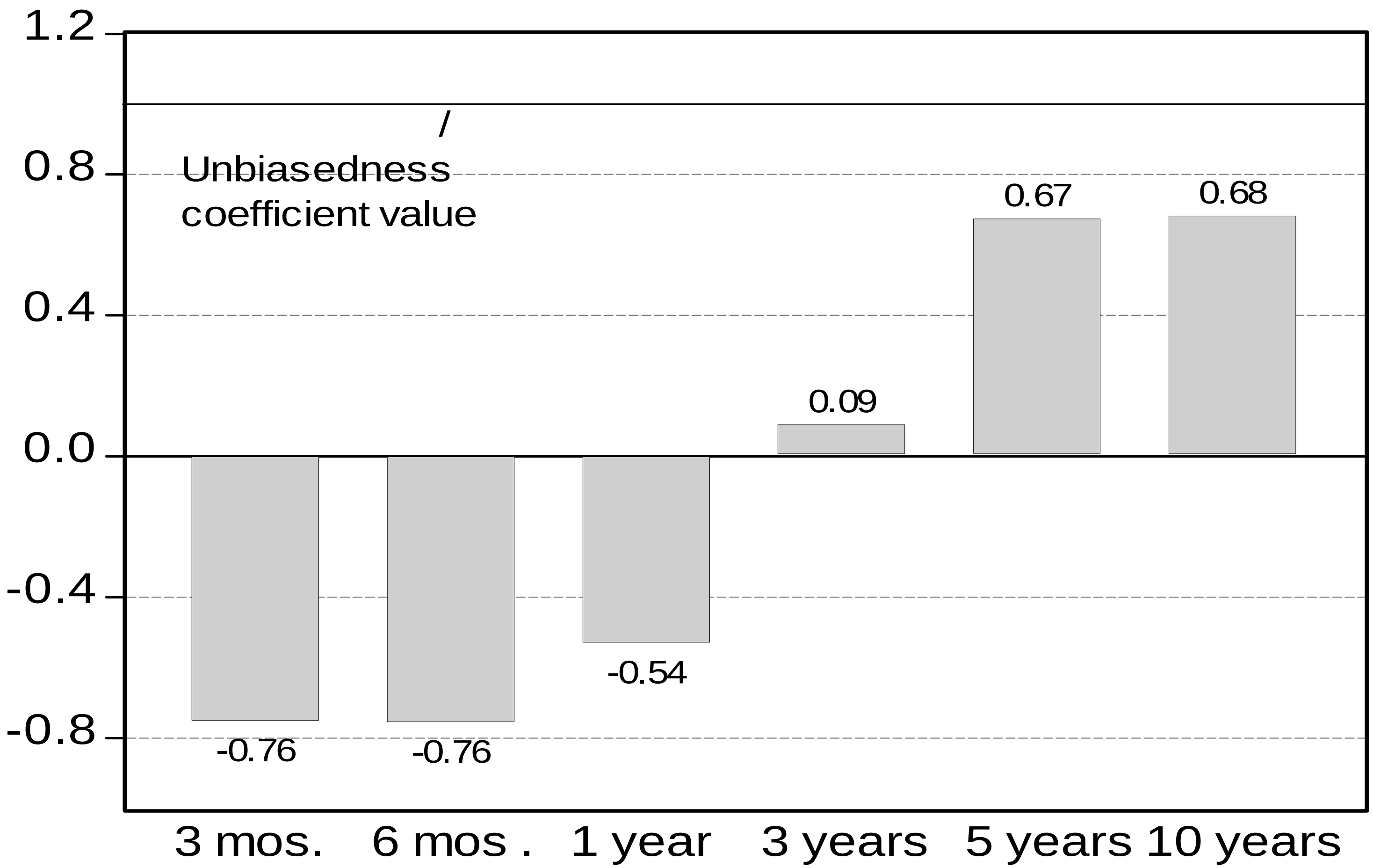
Yen/Dollar rate

Date	spot	1 mo. fwd
Feb. 8, 2001	116.27	115.80
Mar. 9, 2001	119.65	119.15
Apr. 5, 2001	124.10	123.56



Source: Bloomberg, Pacific exchange rate services

$$s_{t+k} - s_t = \alpha + \beta\ (f_t^k - s_t) + \varepsilon_{t,t+k}.$$



Source: Chinn (2005)

Motivation (II)

Issues in the academic literature

- Misconception regarding unpredictability
- Recent events (€ fall and rise)
- Recent empirical results:

  long horizons, nonlinearities, panels
- The dollar and NIIP

A comprehensive evaluation

(Cheung, Chinn,Garcia-Pascual, f'coming, *JIMF*)

- Three new models compared
- Five currencies ag. dollar (& yen)
- Two specifications time series specs.
- Two (three) forecasting periods
- Three forecast horizons
- Three prediction criteria

Findings in CCG-P

- A random walk can’t be beaten
- Structural models do better (DoC)
- Sticky price model holds up well
- IRP is useful predictor, *at long horizons*

The Models

$$s_t = \beta_1 m_t + \beta_2 y_t + \beta_3 i_t + \beta_4 \pi_t + u_t \quad (1)$$

Sticky price monetary model

$$s_t = \beta_1 m_t + \beta_2 y_t + \beta_3 i_t + \beta_5 z_t + u_t \quad (2)$$

Productivity model

The Models (cont'd)

$$s_t = p_t + \beta_5 \omega_t + \beta_6 r_t + \beta_7 gdebt_t + \beta_8 tot_t + \beta_9 nfa_t + u_t \qquad (3)$$

Composite model (aka BEER, or GS "Fair Value"

$$s_{t+k} = s_t + i_{t,k} \qquad (4)$$

Interest rate parity

Estimation

- Rolling regressions
- ECM vs. first differences

$$s_t = X_t \Gamma + u_t \qquad (5)$$

$$\Delta s_t = \Delta X_t \Gamma + u_t \qquad (6)$$

$$s_t - s_{t-k} = \delta_0 + \delta_1 (s_{t-k} - X_{t-k} \Gamma) + u_t \qquad (7)$$

Forecasting

- ECT estimated *recursively* in EC specifications
- Ex ante vs. ex post
- IRP not estimated, categorized as error correction

Forecast Comparison

- MSE criterion

  MSE(model *j*)/MSE(rw)

  Diebold-Mariano (1995) test
- Direction of Change

  Value > 0.5 implies outprediction
- "Consistency" (Cheung & Chinn, '98)

  Same I(d), cointegration, unit elasticity

Results: MSE

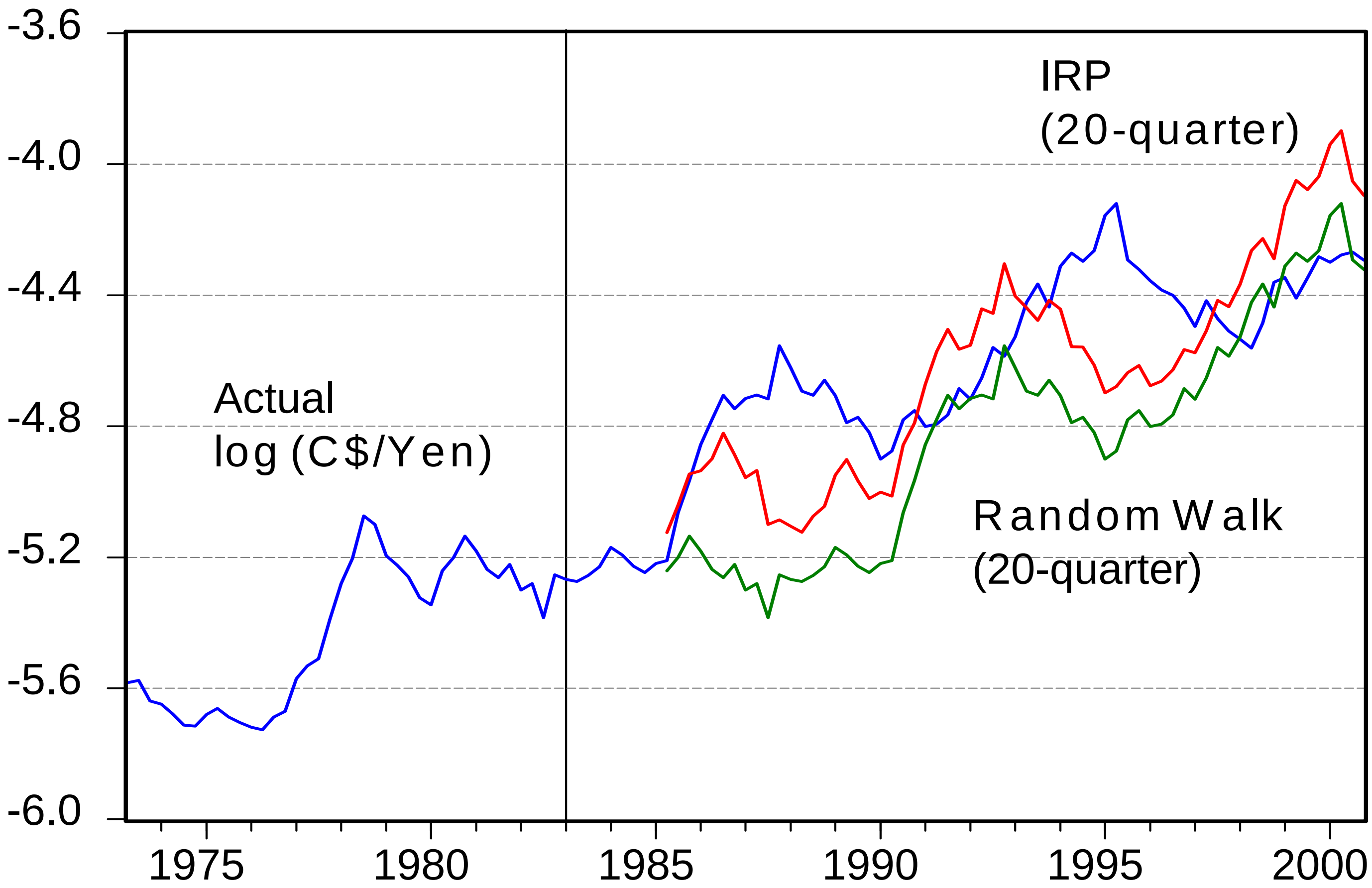
- Structural model performance is unimpressive
- Best: IRP, 20 qtr., C$/yen, 1983-2000
- Worst: first diff. composite 20 qtr. for pound/US$, 1983-2000
- Difficulty in estimating short run dynamics

Selected results: MSE

Table 2: The MSE Ratios from the Yen-Based Exchange Rates

		Sample 1: 1987 Q2 - 2000 Q4			Sample 2: 1983 Q1-2000 Q4		
Specification	Horizon	S-P	IRP	PROD	S-P	IRP	PROD
Panel B: CAN$/Yen							
ECM	1	1.1569	1.0225	1.0830	1.0244	0.9964	0.9827
		0.1101	0.6270	0.0505	0.8506	0.9252	0.8502
	4	1.3197	1.0679	1.0916	1.0386	0.9561	1.1492
		0.1194	0.7063	0.2399	0.8085	0.7305	0.1427
	20	1.2658	0.5416	1.0806	1.2267	0.4774	1.3773
		0.0873	0.0562	0.4042	0.1715	0.0353	0.2400
FD	1	1.0497		1.0193	1.0092		0.9950
		0.5369		0.8017	0.9199		0.9510
	4	1.0918		1.0984	0.7931		0.8635
		0.6933		0.7169	0.3591		0.5372
	20	0.8840		0.8338	1.0639		1.3366
		0.8657		0.8156	0.9239		0.6536

C$/Yen Forecasts



More selected results: MSE

Table 1: The MSE Ratios from the Dollar-Based Exchange Rates

		Sample 1: 1987 Q2 - 2000 Q4				Sample 2: 1983 Q1-2000 Q4			
Specification	Horizon	S-P	IRP	PROD	BEER	S-P	IRP	PROD	BEER
Panel A: BP/$									
ECM	1	1.0465	1.0081	0.9954	1.0853	1.0499	1.0455	1.0418	1.0487
		0.4089	0.8832	0.8968	0.2083	0.3098	0.3183	0.3030	0.4484
	4	1.1273	1.0918	1.0169	1.0993	1.1416	1.1228	1.0850	1.1272
		0.5031	0.6204	0.8022	0.2532	0.1714	0.3095	0.2369	0.2245
	20	1.8089	1.3421	1.0953	1.3395	1.4568	0.8406	1.5450	2.1793
		0.0143	0.2402	0.4109	0.1684	0.0707	0.5178	0.0918	0.0570
FD	1	1.0411		1.0055	1.1914	1.0858		1.0792	1.0230
		0.4337		0.9399	0.2167	0.1345		0.3367	0.9010
	4	1.1195		1.1235	1.8806	1.2498		1.4551	1.4476
		0.3147		0.5237	0.0008	0.1487		0.1755	0.3510
	20	1.8908		2.5310	6.9525	3.2231		5.5574	6.0151
		0.1769		0.0205	0.0000	0.1953		0.0189	0.0013

Results: DoC

- DoC results more positive (17% at 10% MSL)
- Predictability greatest at long horizons
- IRP only works at long horizons

Selected results: DoC

Table 4: Direction of Change Statistics from the Yen-Based Exchange Rates

		Sample 1: 1987 Q2 - 2000 Q4			Sample 2: 1983 Q1-2000 Q4		
Specification	Horizon	S-P	IRP	PROD	S-P	IRP	PROD
Panel B: CAN$/Yen							
ECM	1	0.5455	0.5000	0.4364	0.5833	0.5343	0.5278
		0.5002	1.0000	0.3452	0.1573	0.5584	0.6374
	4	0.4808	0.5893	0.4615	0.5797	0.6438	0.5362
		0.7815	0.1815	0.5791	0.1854	0.0140	0.5472
	20	0.4167	0.7679	0.4444	0.4528	0.7969	0.5283
		0.3173	0.0001	0.5050	0.4922	0.0000	0.6803
FD	1	0.5091		0.5091	0.4722		0.5000
		0.8927		0.8927	0.6374		1.0000
	4	0.5385		0.5769	0.6377		0.6232
		0.5791		0.2673	0.0222		0.0407
	20	0.6944		0.6944	0.7359		0.7170
		0.0196		0.0196	0.0006		0.0016

Discussion

- Best model/spec./currency combinations do not carry over
- Error correction does best in outperformance at long horizons (ignoring significance)
- IRP is well represented in this group

Other Approaches

- Nonlinearities (Sarno-Taylor ESTAR)
- Panel cointegration (Mark and Sul; Groen)
- Long run relationships: net foreign assets

Nonlinearities in the Real Rate

- Start with long run relative PPP

$$s_t = \mu + p_t - p_t^* + \varepsilon_t \qquad \varepsilon_t \sim I(0) \qquad (8)$$

- Define the real exchange rate

$$q_t \equiv s_t - p_t + p_t^* \qquad (9)$$

- Standard approaches are to test for unit root in (8) or cointegration in (9)

Thresholds

- If you believe in arbitrage, then there is a band of non-reversion (Obstfeld & A.M. Taylor)
- If you believe in reaction functions, etc., then smooth threshold (M.P. Taylor et al.)

$$[q_t - \mu] = \sum_{j=1}^{p} \beta_j [q_{t-j} - \mu] + \sum_{j=1}^{p} \beta_j^* [q_{t-j} - \mu] \Phi [\theta; q_{t-d} - \mu] + \varepsilon_t$$

$$\Phi [\theta; q_{t-d} - \mu] = 1 - \exp[-\theta^2 [q_{t-d} - \mu]^2$$

- Few f'casting papers

Panel regressions

- Back to the monetary model (Mark, 1995)
- Using cross-currency variation to obtain “better” estimates
- Panel of OECD currencies, 1973q1-97q1
- Test for (panel) cointegration
- Use estimated cointegrating vectors to do out of sample prediction

The econometric model

$$\Delta s_{it+1} = \beta x_{it} + e_{it+1} \quad (2)$$

$$e_{it+1} = \gamma_i + \theta_{t+1} + u_{it+1}, \quad (3)$$

Table 1

Panel dynamic OLS based cointegration tests

Fundamentals	Numeraire	β_{pdols}	t-ratio	P-value[a]	P-value[b]
Monetary	US	0.010	**4.930**	**0.000**	**0.002**
	Switzerland	0.006	**2.219**	**0.050**	**0.067**
	Japan	0.007	**3.877**	**0.002**	**0.001**
PPP	US	−0.016	**−4.626**	**0.998**	**0.999**
	Switzerland	−0.019	**−7.417**	**0.992**	**0.989**
	Japan	−0.022	**−4.077**	**1.000**	**1.000**

[a] Parametric bootstrap P-value.

[b] Nonparametric bootstrap P-value. P-value is the proportion of the bootstrap distribution that lies to the *right* of the asymptotic t-ratio calculated from the data. A two-tailed test rejects the null hypothesis at the 5% level if the P-value is above 0.975 or below 0.025.

Mark and Sul, “Nominal exchange rates…” *JIE* (2001)

Performance of the panel regression

Panel outperforms random walk

Table 5

Out-of-sample forecasts of US dollar returns. Bootstrapped P-values generated assuming cointegration

Country	U^a	P-value[d]	P-value[e]	U^b	P-value[d]	P-value[e]	U^c
A. One-quarter ahead forecasts							
Australia	1.024	0.991	0.904	**0.988**	**0.083**	0.102	1.036
Austria	**0.984**	**0.001**	**0.013**	**0.994**	0.231	0.259	**0.990**
Belgium	**0.999**	0.269	0.424	1.000	0.441	0.442	**0.998**
Canada	**0.985**	**0.020**	**0.074**	1.003	0.534	0.496	**0.982**
Denmark	1.014	0.989	0.912	**0.998**	0.361	0.365	1.016
Finland	1.001	0.708	0.527	**0.992**	0.137	0.152	1.009
France	**0.994**	**0.024**	0.155	1.000	0.440	0.426	**0.994**
Germany	**0.986**	**0.006**	**0.056**	**0.992**	0.188	0.222	**0.994**
Great Britain	**0.983**	**0.028**	**0.077**	**0.988**	0.102	0.131	**0.996**
Greece	1.016	0.995	0.909	1.012	0.883	0.891	**0.984**
Italy	**0.997**	0.174	0.269	1.004	0.598	0.537	**0.994**
Japan	1.003	0.831	0.579	**0.998**	0.343	0.332	1.005
Korea	**0.912**	**0.001**	**0.002**	**0.974**	**0.020**	**0.034**	**0.936**
Netherlands	**0.986**	**0.004**	**0.041**	**0.992**	0.193	0.226	**0.994**
Norway	**0.998**	0.202	0.380	**0.992**	0.164	0.193	1.006
Spain	**0.996**	0.115	0.341	1.024	0.736	0.691	**0.993**
Sweden	**0.975**	**0.008**	**0.034**	**0.987**	**0.079**	0.101	**0.988**
Switzerland	**0.982**	**0.002**	**0.008**	**0.988**	**0.073**	**0.092**	**0.995**
Mean	**0.991**	**0.002**	**0.010**	**0.996**	0.135	0.145	**0.995**
Median	**0.995**	**0.025**	0.163	**0.993**	0.131	0.173	**0.994**

Mark and Sul, "Nominal exchange rates…" *JIE* (2001)

Long horizon performance

B. Sixteen-quarter ahead forecasts							
Australia	**0.864**	0.127	0.222	**0.728**	**0.045**	**0.053**	1.186
Austria	**0.837**	**0.070**	0.131	**0.549**	**0.006**	**0.008**	1.525
Belgium	**0.405**	**0.001**	**0.001**	**0.577**	**0.009**	**0.015**	**0.703**
Canada	**0.552**	**0.005**	**0.009**	**0.601**	**0.015**	**0.023**	**0.919**
Denmark	**0.858**	**0.092**	0.174	**0.732**	**0.069**	**0.071**	1.172
Finland	**0.859**	**0.099**	0.164	**0.631**	**0.006**	**0.012**	1.360
France	**0.583**	**0.002**	**0.004**	**0.683**	**0.033**	**0.048**	**0.854**
Germany	**0.518**	**0.001**	**0.003**	**0.440**	**0.001**	**0.001**	1.178
Great Britain	**0.570**	**0.004**	**0.012**	**0.601**	**0.015**	**0.018**	**0.948**
Greece	1.046	0.657	0.594	**0.854**	0.738	0.817	**0.787**
Italy	**0.745**	**0.003**	**0.016**	**0.878**	0.195	0.207	**0.849**
Japan	**0.996**	0.476	0.433	**0.895**	0.222	0.219	1.113
Korea	**0.486**	**0.001**	**0.012**	**0.682**	**0.048**	**0.067**	**0.714**
Netherlands	**0.703**	**0.006**	**0.032**	**0.399**	**0.001**	**0.001**	1.762
Norway	**0.537**	**0.001**	**0.002**	**0.829**	0.126	0.133	**0.648**
Spain	**0.672**	**0.006**	**0.028**	1.219	0.178	0.182	**0.859**
Sweden	**0.372**	**0.001**	**0.001**	**0.541**	**0.004**	**0.004**	**0.687**
Switzerland	**0.751**	**0.019**	**0.049**	**0.575**	**0.007**	**0.007**	1.307
Mean	**0.686**	**0.001**	**0.001**	**0.690**	**0.001**	**0.001**	1.032
Median	**0.688**	**0.001**	**0.001**	**0.656**	**0.001**	**0.003**	**0.933**

Mark and Sul, "Nominal exchange rates…" *JIE* (2001)

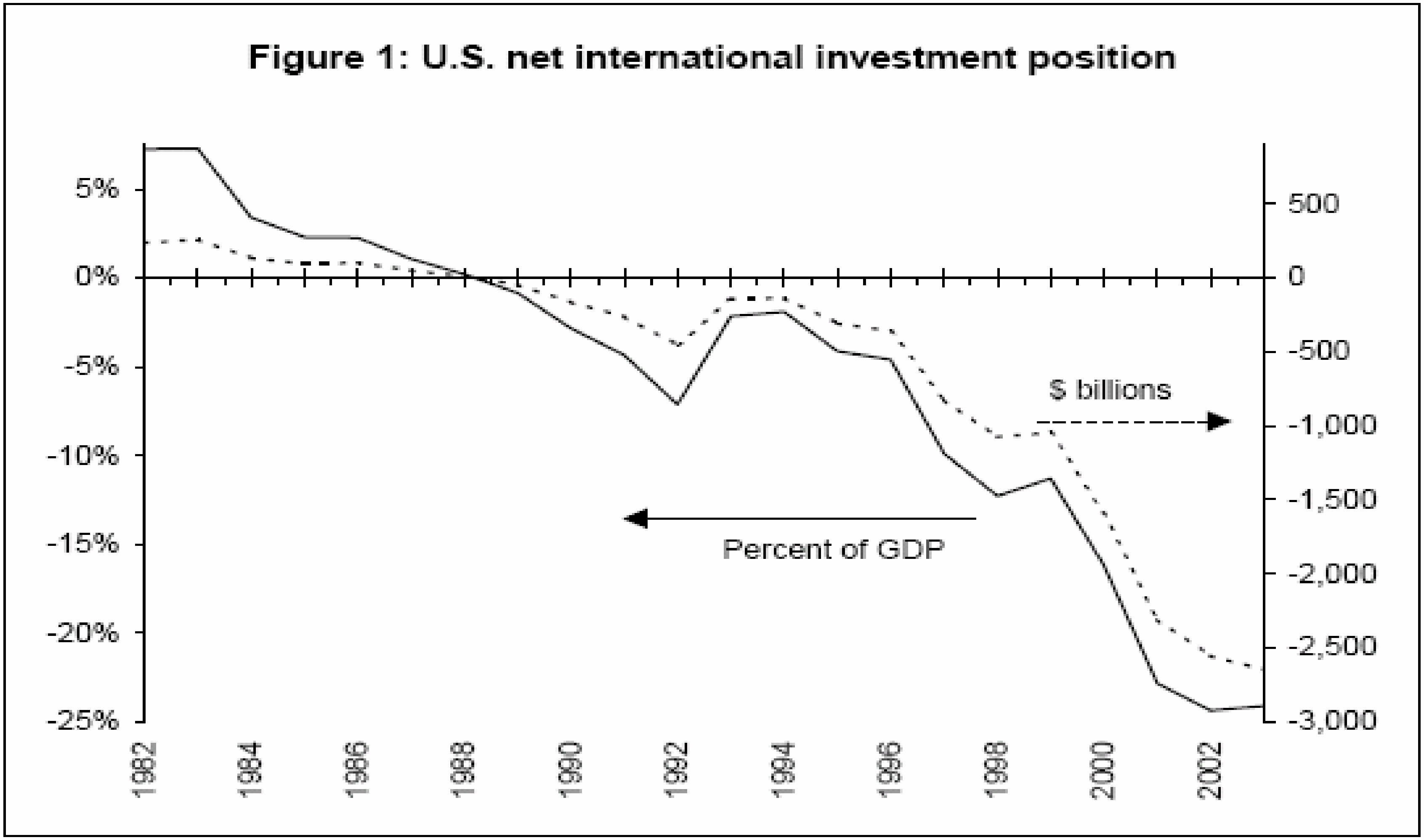
Panel Results

- Cointegration holds
- A random walk is outpredicted
- Results improve at long horizons
- Results robust to alternative base currencies

The Current Dollar Swing

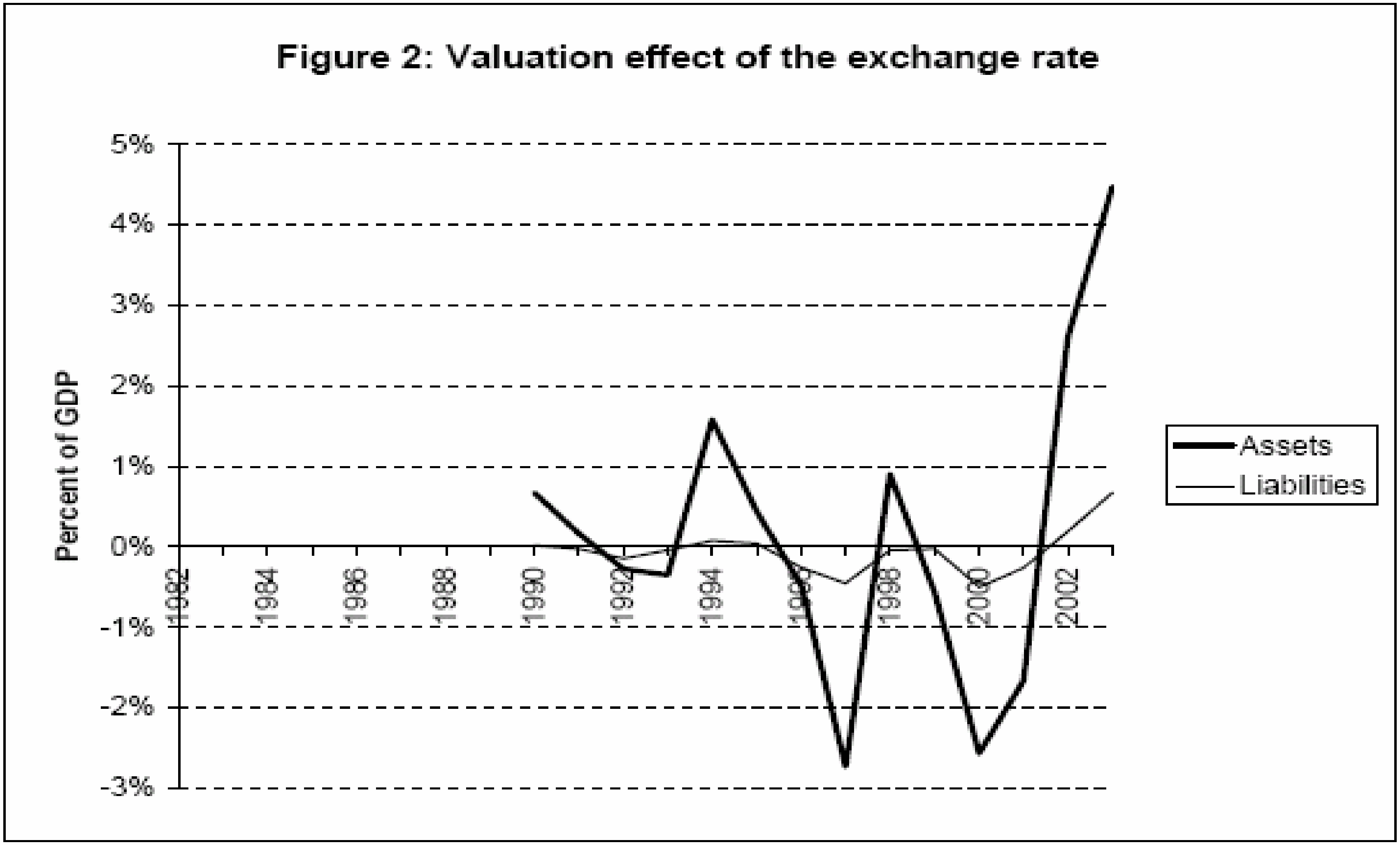
- Recently, each year the NIIP declines by *less* than the current account deficit
- Net income is positive, even though the US has been a net debtor for years
- Tille (2003) early on noted this for US, following Lane and Milesi-Ferretti (more countries)

Graphically



Tille, “Fin. integration & the wealth effect of exchange rate changes” (2004)

A possible resolution



Tille, “Fin. integration & the wealth effect of exchange rate changes” (2004)

Two way causality dollar & debt?

- These calculations indicate that dollar movements can have a large impact
- Up to nearly the entire current account deficit can be financed by valuation effects
- As long as the dollar continues to decline.
- If the dollar affects NIIP, could it be that NIIP affects the dollar?

Gourinchas-Rey

- Propose a framework for NFA-ex rate movements
- Builds upon reversion to trend in NFA
- And an intertemporal budget constraint
- So a deficit can be closed by either the traditional trade channel (net exports), or
- Closed by revaluation effects
- NB: depreciation works in same direction

Normalized net exports/net assets

- *Nxa* is normalized so export weight is unity
- This means it's measured in same units as exports.
- Interpretation: *nxa* is (approx.) the %age increase in exports necessary to restore ext. balance

$$nxa_t = x_t - 0.91m_t + 0.79a_t - 0.47l_t$$

Econometrics

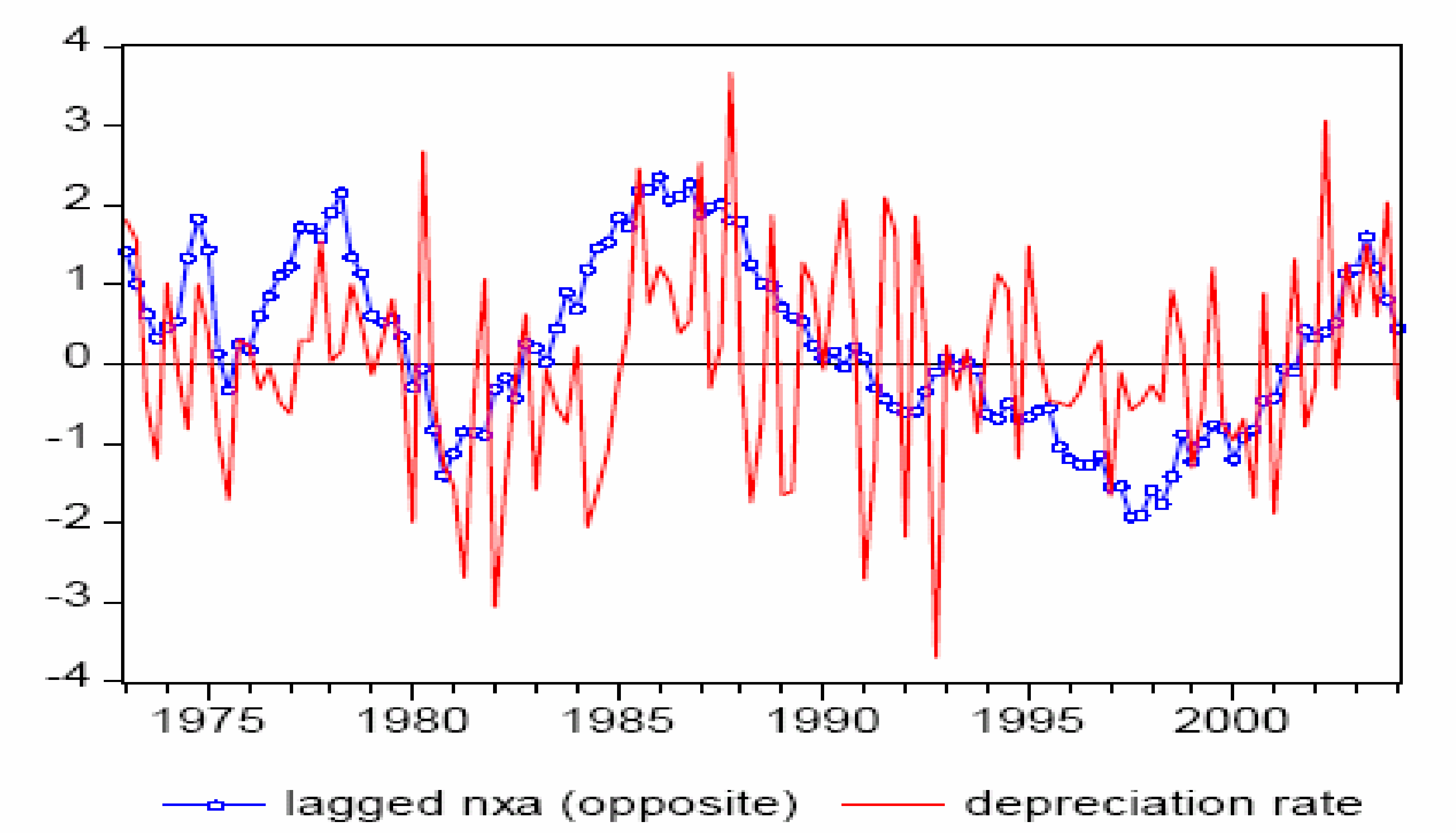
$$nxa_t = -\sum_{j=1}^{+\infty} \rho^j E_t r_{t+j} - \sum_{j=1}^{+\infty} \rho^j E_t \Delta nx_{t+j} \qquad (11)$$
$$\equiv nxa_t^r + nxa_t^{\Delta nx}$$

First part: component that f'casts future ret.

Second: component that f'casts nx growth

Estimate using VAR

Prediction of exchange rate?



Gourinchas and Rey, “International Financial Adjustment” (2005)

Forecasting returns

#	nxa_{t-1} (s.e.)	lag (s.e.)	dp_{t-1} (s.e.)	dp^*_{t-1} (s.e.)	xm_{t-1} (s.e.)	R^2
	Panel A: Real Total Net Foreign Portfolio Return r_t					
1	**-0.41** (0.08)					0.10
2		0.15 (0.08)				0.02
3			-0.37 (2.43)	0.90 (2.02)		0.00
4					**-0.42** (0.10)	0.07
5	**-0.32** (0.11)				-0.17 (0.13)	0.10
6	**-0.58** (0.21)	0.06 (0.08)	-3.18 (2.06)	1.28 (1.75)	0.01 (0.29)	0.15

Gourinchas and Rey, “International Financial Adjustment” (2005)

Predicting exchange rates (I)

#	nxa_{t-1} (s.e.)	lag (s.e.)	$i_{t-1} - i^*_{t-1}$ (s.e.)	xm_{t-1} (s.e.)	R^2	nxa_{t-1}	lag	$i_{t-1} - i^*_{t-1}$	xm_{t-1}	R^2
	Panel G: FDI-weighted depreciation rate					Panel H: Trade weighted depreciation rate				
1	**-0.08**				0.08	**-0.09**				0.11
	(0.02)					(0.02)				
2		0.05			0.00		0.13			0.01
		(0.07)					(0.08)			
3			-0.09		0.00			**-1.03**		0.05
			(0.32)					(0.36)		
4				**-0.09**	0.06				**-0.11**	0.10
				(0.03)					(0.04)	
5	**-0.06**			-0.03	0.07	**-0.06**			-0.06	0.11
	(0.02)			(0.04)		(0.02)			(0.04)	
6	**-0.07**	0.12	0.78	-0.03	0.07	**-0.08**	**-0.45**	**-2.26**	-0.04	0.17
	(0.02)	(0.16)	(0.68)	(0.04)		0.04	(0.15)	(0.57)	(0.03)	

Table 6: Forecasting Quarterly Rates of Depreciation. Sample: 1973:1 to 2004:1. Robust standard errors in parenthesis.

Gourinchas and Rey, “International Financial Adjustment” (2005)

Predicting exchange rates (II)

Currency	nxa_{t-1} (s.e.)	R^2
UK pound	**-0.07** (0.03)	0.03
Canadian dollar	-0.02 (0.02)	0.01
Swiss franc	**-0.16** (0.04)	0.08
Japanese yen	**-0.12** (0.04)	0.06
Deutschmark (Euro)	**-0.16** (0.04)	0.10

Gourinchas and Rey, "International Financial Adjustment" (2005)

What matters at what horizon

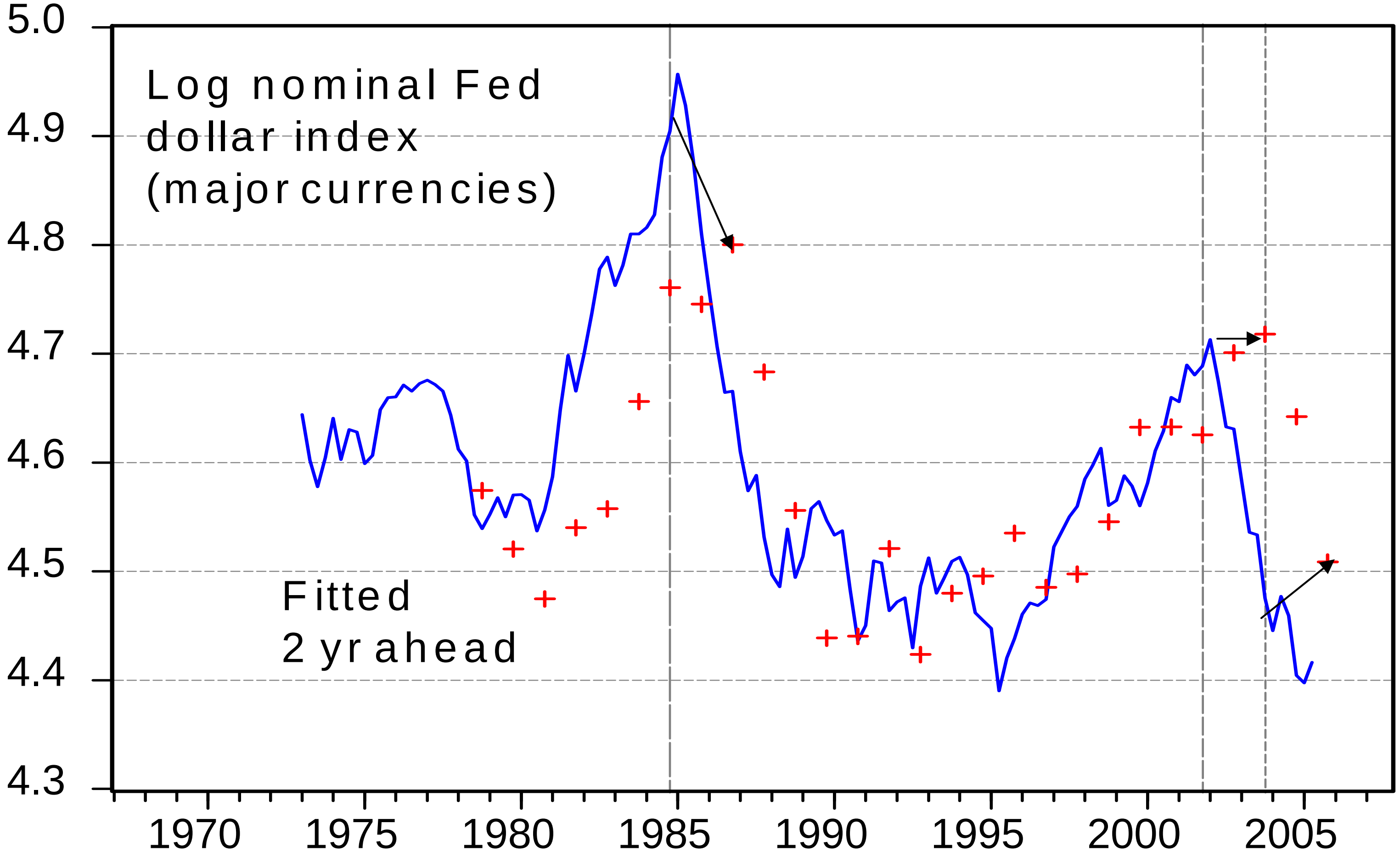
	Forecast Horizon (quarters)							
	1	2	3	4	8	12	16	24
	Real Total Net Portfolio Return $r_{t,k}$							
nxa	**-0.41**	**-0.40**	**-0.41**	**-0.39**	**-0.27**	**-0.18**	**-0.12**	**-0.04**
	(0.08)	(0.06)	(0.05)	(0.04)	(0.03)	(0.03)	(0.03)	(0.02)
$\bar{R}^2(1)$	[0.10]	[0.17]	[0.24]	[0.27]	[0.24]	[0.15]	[0.10]	[0.02]
$\bar{R}^2(2)$	[0.12]	[0.22]	[0.31]	[0.35]	[0.32]	[0.22]	[0.14]	[0.04]
	Real Total Excess Equity Return $r^{ae}_{t,k} - r^{le}_{t,k}$							
nxa	**-0.12**	**-0.12**	**-0.11**	**-0.11**	**-0.06**	**-0.03**	-0.01	0.02
	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
$\bar{R}^2$ (1)	[0.06]	[0.10]	[0.14]	[0.15]	[0.09]	[0.03]	[0.00]	[0.02]
$\bar{R}^2$ (2)	[0.09]	[0.17]	[0.23]	[0.26]	[0.20]	[0.11]	[0.07]	[0.13]
	Net Export growth $\Delta nx_{t,k}$							
nxa	**-0.07**	**-0.07**	**-0.06**	**-0.06**	**-0.05**	**-0.05**	**-0.05**	**-0.03**
	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$\bar{R}^2$ (1)	[0.04]	[0.07]	[0.09]	[0.11]	[0.18]	[0.27]	[0.33]	[0.36]
$\bar{R}^2$ (2)	[0.03]	[0.07]	[0.10]	[0.15]	[0.35]	[0.56]	[0.66]	[0.77]
	FDI-weighted effective nominal rate of depreciation $\Delta e_{t,k}$							
nxa	**-0.08**	**-0.08**	**-0.08**	**-0.07**	**-0.07**	**-0.05**	**-0.04**	**-0.02**
	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$\bar{R}^2$ (1)	[0.08]	[0.14]	[0.24]	[0.28]	[0.35]	[0.36]	[0.32]	[0.14]
$\bar{R}^2$ (2)	[0.11]	[0.22]	[0.37]	[0.44]	[0.57]	[0.61]	[0.61]	[0.35]

Questions about the use of G-R

- How much of the results are driven by two large depreciations?
- How comfortable are we with statistical-based rather than economic-based predictions?

A first cut using G-R

(in-sample)



Source: author's calculations

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