The Predictive Information Content of External Imbalances for Exchange Rates Returns: How Much is It Worth?

3^{rd} Bank of Canada–European Central Bank Workshop

Pasquale Della Corte[a] Lucio Sarno[b] Giulia Sestieri[c]

[a]University of Warwick

[b]Cass Business School and CEPR

[c]European Central Bank

June 19, 2009

Background

- **Exchange Rate Predictability**
  - Economic fundamentals generally fail to outperform a naïve random walk model (Meese and Rogoff, *JIE*, 1983)
  - Forecasting nominal exchange rate returns is a difficult exercise at short horizon (Mark, *AER*, 1995; Berkowitz and Giorgianni, *ReStat*, 1999)
- **Disconnect Puzzle**
  - High persistent fundamentals and discount factor close to unity (Engel and West, *JPE*, 2005)
  - Failure to capture parameter instability (Rossi, *IER*, 2005; Sarno and Valente, *JEEA*, 2009)
  - Higher-order expectations and information heterogeneity (Bacchetta and van Wincoop, *AER*, 2006)

International Financial Adjustment

- Gourinchas and Rey (2007) explore the implication of the intertemporal budget constraint

$$nxa_t \approx -\sum_{i=1}^{\infty} \rho^i E_t \left(r_{t+i} + \Delta nx_{t+i} \right)$$

  - nxa_t is a linear combination of detrended components of exports, imports, external assets and liabilities
  - r_{t+1} is the real return on net foreign assets
  - Δnx_{t+1} is the detrended net export growth
  - ρ is the discount factor

nxa_t must forecast either future portfolio returns or future net export growth, or both

Global Measure

- A measure of **cyclical external imbalances** incorporating information from the detrended trade balance and the foreign asset position

$$nxa_t \equiv |\mu^a|\, \epsilon_t^a - |\mu^l| \epsilon_t^l + |\mu^x|\, \epsilon_t^x - |\mu^m|\, \epsilon_t^m$$

  - μ^a : average share of assets in the net foreign assets
  - μ^x : average share of exports in the trade balance
  - ϵ_t^l : stationary component of (log) liabilities to wealth ratio
  - ϵ_t^m : stationary component of (log) imports to wealth ratio

nxa_t rises with assets and exports and declines with imports and liabilities

International Financial Adjustment (cont'd)

- Deteriorations in external imbalances ($nxa_t < 0$) imply
  - future trade surpluses $E_t \Delta nx_{t+1} > 0$ (**trade channel**)
  - high returns on the net foreign portfolio $E_t r_{t+1} > 0$ (**valuation channel**)
- The exchange rate plays a critical role
  - today's imbalances contain valuable information about future exchange rate returns
  - *nxa* contains out-of-sample forecasting power at all horizons between one and 16 quarters

Punch Line

- Extensive literature on statistical measures but not on the economic value criteria
  - Exchange rate volatility (West, Edison and Cho, *JIE*, 1993)
  - Long-horizon predictability (Abhyankar, Sarno and Valente, *JIE*, 2005)
  - Short-horizon predictability (Della Corte, Sarno and Tsiakas, *RFS*, 2009)
- Is the predictive information in *nxa* economically significant?
  - how does an investor exploit FX predictability?
  - can we construct a bilateral measure of *nxa*?
- An economic assessment of the predictive ability of cyclical external imbalances both in-sample and out-of-sample

Bilateral Measure

- Estimating the following predictive regression

$$\Delta_k s_{t+k}^{(i)} = \alpha + \beta nxa_t^{(i)} + \varepsilon_{t+k}$$

  - $\Delta_k s_{t+k}^{(i)}$: nominal exchange rate return between the US dollar and the currency i
  - $nxa_t^{(i)}$: bilateral measure of cyclical external imbalances between the US and the foreign country i

- Bilateral data on external assets and liabilities are not available and $nxa_t^{(i)}$ is not directly observable

Modeling FX Returns (cont'd)

- We estimate $nxa_t^{(i)}$ using a IV estimator
  - regress the US global nxa_t on a set of instruments
  - use the fitted value as a proxy for nxa
- Instruments
  - global nxa_t for the foreign country i
  - detrended net exports $nx_t^{(i)}$ between the US and the foreign economy i

$$nx_t^{(i)} \equiv |\mu^{x^{(i)}}|\epsilon_t^{x^{(i)}} - |\mu^{m^{(i)}}|\epsilon_t^{m^{(i)}}$$

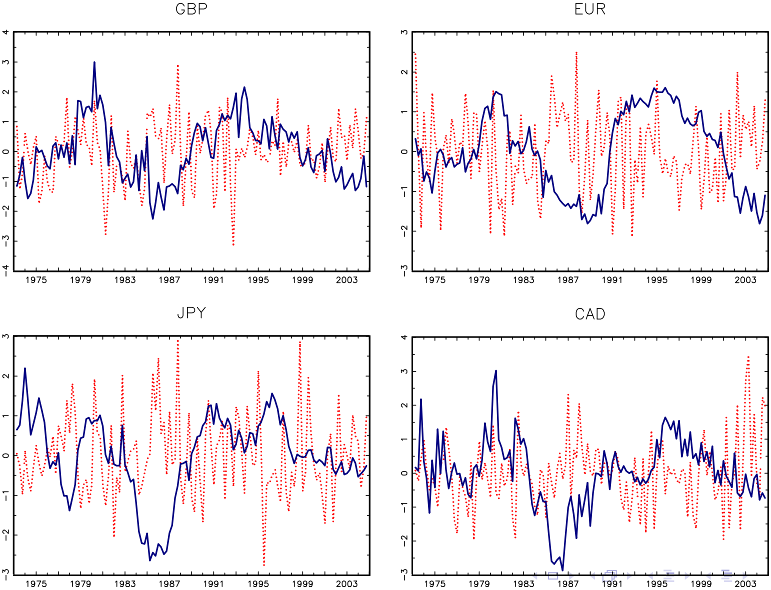
Data

- **FX rates**
  - quarterly data from *Datastream*: Mar 1973 - Dec 2004
  - bilateral US dollar exchange rates: GBP, EUR, JPY, and CAD
- **External Assets and Liabilities**
  - aggregate annual data from Lane & Millesi-Ferretti (2007)
  - aggregate quarterly data by linear interpolation and extrapolation
- **Exports and Imports**
  - aggregate quarterly data from National Statistic Databases
  - bilateral quarterly data the Bureau of Economic Analysis (BEA)
- **Net Worth**
  - aggregate annual data from National Statistic Databases
  - aggregate quarterly data by linear interpolation and estrapolation

Predictive Regression

k	1	2	3	4	8	12	16
				USD/GBP			
β/k	-0.045 $(-0.146, 0.111)$	-0.034 $(-0.129, 0.112)$	-0.047 $(-0.131, 0.075)$	-0.048 $(-0.130, 0.084)$	-0.055 $(-0.141, 0.054)$	-0.060^{*} $(-0.150, 0.015)$	-0.074^{**} $(-0.158, -0.009)$
R^2	0.01	0.01	0.01	0.02	0.03	0.06	0.15
				USD/EUR			
β/k	-0.134^{***} $(-0.262, -0.052)$	-0.128^{***} $(-0.246, -0.049)$	-0.127^{***} $(-0.243, -0.048)$	-0.128^{***} $(-0.255, -0.054)$	-0.113^{***} $(-0.212, -0.049)$	-0.063^{***} $(-0.170, -0.041)$	-0.058^{***} $(-0.151, -0.035)$
R^2	0.06	0.11	0.18	0.22	0.28	0.28	0.32
				USD/JPY			
β/k	-0.178^{***} $(-0.300, -0.073)$	-0.172^{***} $(-0.271, -0.070)$	-0.154^{**} $(-0.225, -0.044)$	-0.142^{**} $(-0.207, -0.019)$	-0.107^{*} $(-0.1734, 0.010)$	-0.059 $(-0.128, 0.045)$	-0.035 $(-0.094, 0.042)$
R^2	0.09	0.14	0.18	0.20	0.22	0.11	0.06
				USD/CAD			
β/k	-0.007 $(-0.039, 0.062)$	-0.022 $(-0.054, 0.038)$	-0.022 $(-0.049, 0.034)$	-0.027 $(-0.049, 0.025)$	-0.040^{**} $(-0.058, -0.002)$	-0.037^{**} $(-0.055, -0.001)$	-0.030^{*} $(-0.047, 0.001)$
R^2	0.02	0.02	0.03	0.05	0.20	0.28	0.30

Exchange Rate Returns and Bilateral Cyclical Imbalances



Economic Value

- **Objective**
  - Assess the economic value of exchange rate predictability in the context of dynamic asset allocation strategies
- **Framework**
  - Mean-variance analysis for the optimal portfolio choice of risk-averse investors
  - West, Edison & Cho (*JIE*, 1993), Fleming, Kirby & Ostdiek (*JF*, 2001), Marquering & Verbeek (*JFQA*, 2004), Han (*RFS*, 2006), Della Corte, Sarno & Thornton (*JFE*, 2008), Della Corte, Sarno & Tsiakas (*RFS*, 2009)
- **Question**
  - How much would a risk-averse investor be willing to pay to switch from a portfolio strategy based on the Random Walk model to one that exploits the predictive information in *nxa*?

Maximum Return Strategy

- Maximize expected portfolio return subject to a target portfolio volatility:

$$\max_{w_t} w_t' \mu_{t+1|t} + \left(1 - w_t' \iota\right) r_f$$

$$s.t. \left(\sigma_p^*\right)^2 = w_t^{'} \Sigma_{t+1|t} w_t$$

- Solution:

$$\begin{aligned} w_t &= \frac{\sigma_p^*}{\sqrt{C_t}} \Sigma_{t+1|t}^{-1} \left(\mu_{t+1|t} - \iota r_f\right) \\ C_t &= (\mu_{t+1|t} - \iota r_f)' \Sigma_{t+1|t}^{-1} (\mu_{t+1|t} - \iota r_f) \end{aligned}$$

- Each model specification delivers a set of

$$\mu_{t+1|t} = E_t\left[r_{t+1}\right] \quad \text{and} \quad \Sigma_{t+1|t} = E_t\left[\left(r_{t+1} - \mu_{t+1|t}\right)\left(r_{t+1} - \mu_{t+1|t}\right)'\right]$$

Dynamic Strategies

- **Setting**
  - Each quarter, a US investor allocates his wealth between the domestic bond (US), and 4 foreign bonds (Canada, Germany, Japan and UK)
  - At the beginning of each period, the foreign bonds deliver a riskless return in local currency
  - The only risk exposure is FX risk

- **Dynamic Rebalancing**
  - At the end of each period, the investor estimates the model specification
  - Conditioning on these estimates, he forecasts the one-period ahead conditional means and variance-covariances
  - He dynamically rebalances his portfolio by computing new optimal portfolio weights for the maximum return strategy

Utility-Based Performance Measure

- **Quadratic Utility**

$$U\left(W_{t+1}\right)=W_{t+1}-\frac{\lambda}{2}W_{t+1}^{2}=W_{t}R_{p,t+1}-\frac{\lambda}{2}W_{t}^{2}R_{p,t+1}^{2}$$

where

$$R_{p,t+1}=R_f+w_t'\left(R_t-\iota R_f\right)$$

- **Average Realized Utility** (West, Edison & Cho, *JIE*, 1993)
  - set the investor's RRA equals to a constant

$$RRA_t=\frac{\lambda W_t}{1-\lambda W_t}=\delta$$

  - expected utility generated by a given level of initial wealth

$$\overline{U}\left(\cdot\right)=\frac{W_0}{T}\sum_{t=0}^{T-1}\left\{R_{p,t+1}-\frac{\delta}{2\left(1+\delta\right)}R_{p,t+1}^{2}\right\}$$

Utility-Based Performance Measure

- **Performance Fee** (Fleming, Kirby & Ostdiek, *JF*, 2001)
  - Equate the average utilities for competing portfolios

$$\sum_{t=0}^{T-1}\left\{\left(R^*_{p,t+1}-\Pi\right)-\frac{\delta}{2\left(1+\delta\right)}\left(R^*_{p,t+1}-\Phi\right)^2\right\}=\sum_{t=0}^{T-1}\left\{R_{p,t+1}-\frac{\delta}{2\left(1+\delta\right)}R^2_{p,t+1}\right\}$$

  - $R^*_{p,t+1}$ is the gross portfolio return constructed using the NXA strategy
  - $R_{p,t+1}$ is gross portfolio return implied by the RW strategy
  - Φ is the value that makes the investor indifferent between the two alternative strategies

Φ measures the maximum performance fee a risk-averse investor is willing to pay to switch from the RW to the NXA strategy

Utility-Free Performance Measure

- **Manipulation-free performance measure** (Goetzmann, Ingersoll, Spiegel & Welch, *RFS*, 2007)

$$M\left(R_p\right) = \frac{1}{(1-\delta)} \ln \left\{ \sum_{t=0}^{T-1} \left(\frac{R_{p,t+1}}{R_f} \right)^{1-\delta} \right\}$$

  - $M\left(R_p\right)$ is an estimate of the premium return after adjusting for risk

- We build on this criterion

$$\Theta = M\left(R_p^*\right) - M\left(R_p\right)$$

  - Θ interpreted as the certainty equivalent return

The performance measure Θ does not require
the assumption of quadratic utility to rank portfolios

- **A Critical Factor**
  - essential to assess the profitability of trading strategies
  - difficult to determine (type of investor, different components, value of the transaction)

- **Break-even Transaction Cost** (Han, *RFS*, 2006)
  - the proportional transaction cost, τ^{be}, making an investor indifferent between competing strategies
  - the transaction costs equal to a fixed proportion of the value traded in each bond

$$\tau \left| w_t - w_{t-1} \frac{(1 + r_t)}{(1 + r_p)} \right|$$

  - the maximum level of transaction cost an investor is willing to pay

Empirical Evidence

- In-sample and out-of-sample analysis
  - Target portfolio volatilities: $\sigma_p^* = \{8\%,\ 10\%,\ 12\%\}$
  - Degree of Relative Risk Aversion: $\delta = 6$
  - Performance measures: Φ and Θ in annualized basis points
  - Break-even transaction costs: τ^{be} in quarterly basis points
- **In-Sample Period**
  - March 1973 to December 2004
- **Out-of-Sample Period**
  - March 1993 to December 2004
  - Rolling window of 20 years

Economic Value

σ_p^*	RW			NXA					
	μ_p	σ_p	SR_p	μ_p	σ_p	SR_p	Φ	Θ	τ^{be}
				In-Sample					
8%	13.4	9.0	0.70	14.9	8.7	0.90	148	142	134
10%	15.0	11.1	0.71	16.9	10.7	0.91	185	177	137
12%	16.6	13.3	0.71	18.8	12.7	0.91	222	212	141
				Out-of-Sample					
8%	12.9	9.9	0.88	14.5	7.8	1.32	160	155	153
10%	15.1	12.3	0.88	17.1	9.7	1.32	200	192	164
12%	17.2	14.8	0.88	19.6	11.7	1.32	241	230	175

Robustness I

- **Small Sample Bias**
  - The low number of observations might cause small sample bias in parameter estimates
  - This estimation error would affect the portfolio weights leading to sub-optimal asset allocation
  - The estimates are adjusted by generating 10,000 time series by means of block-bootstrap

Economic Value and Small Sample Bias

σ_p^*	RW			NXA					
	μ_p	σ_p	SR_p	μ_p	σ_p	SR_p	Φ	Θ	τ^{be}
				In-Sample					
8%	13.4	9.0	0.70	15.0	8.7	0.90	151	145	136
10%	15.0	11.1	0.71	16.9	10.8	0.91	189	181	139
12%	16.6	13.3	0.71	18.9	12.8	0.91	227	217	143
				Out-of-Sample					
8%	12.9	9.9	0.88	15.1	7.8	1.38	220	212	190
10%	15.1	12.3	0.88	17.8	9.8	1.39	275	267	203
12%	17.2	14.8	0.88	20.5	11.7	1.39	331	315	216

Robustness II

- We examine the impact of imposing **economically meaningful restrictions** (Campbell & Thomson, *RFS*, 2008)
- **Rest 1**
  - the model suggest a negative relation between $\Delta s_{t+1}^{(i)}$ and $nxa_t^{(i)}$
  - we set $\widehat{\beta}$ equals to zero when it is estimated with a positive sign
- **Rest 2**
  - a positive value of $nxa_t^{(i)}$ should imply a negative forecast of $\Delta s_{t+1}^{(i)}$
  - we set $E_t(\Delta s_{t+1}^{(i)})$ equals to zero when it is sign is the same as $nxa_t^{(i)}$
- **Rest 1&2**
  - both *Rest 1* and *Rest 2* are simultaneously imposed

Economic Value and Economic Restrictions

	RW			NXA					
σ_p^*	μ_p	σ_p	SR_p	μ_p	σ_p	SR_p	Φ	Θ	τ^{be}
				Rest 1					
8%	12.9	9.9	0.88	14.5	7.8	1.32	157	152	153
10%	15.1	12.3	0.88	17.0	9.7	1.32	197	189	164
12%	17.2	14.8	0.88	19.6	11.6	1.32	236	225	175
				Rest 2					
8%	12.9	9.9	0.88	15.4	8.8	1.28	253	244	132
10%	15.1	12.3	0.88	18.2	10.9	1.28	316	304	136
12%	17.2	14.8	0.88	21.0	13.1	1.28	380	362	140
				Rest 1&2					
8%	12.9	9.9	0.88	15.4	8.8	1.28	250	241	131
10%	15.1	12.3	0.88	18.2	10.9	1.28	314	301	134
12%	17.2	14.8	0.88	21.0	13.1	1.28	375	358	138

Robustness III

- The data to construct the predictive variable might be available in 'real time'
- We lag $nxa_t^{(i)}$ in the conditioning information set as

$$\Delta s_t = \alpha + \beta nxa_{t-Lag}^{(i)} + \varepsilon_t$$

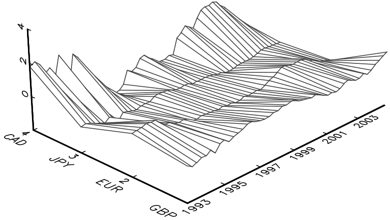
  - the predictive variable is available with a given delay *Lag*
  - $Lag = 2$ (6-month time delay)
  - $Lag = 4$ (1-year time delay)

Economic Value in 'Real Time'

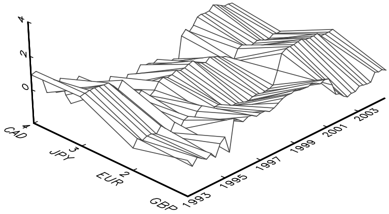
σ^*_p	NXA_{Lag1} Φ	NXA_{Lag1} Θ	NXA_{Lag1} τ^{be}	NXA_{Lag2} Φ	NXA_{Lag2} Θ	NXA_{Lag2} τ^{be}	NXA_{Lag4} Φ	NXA_{Lag4} Θ	NXA_{Lag4} τ^{be}
				No Rest					
8%	160	155	153	157	154	64	-93	-91	–
10%	200	192	164	197	191	66	-117	-113	–
12%	241	230	175	236	228	68	-140	-134	–
				Rest 1					
8%	157	152	153	166	162	70	-96	-93	–
10%	197	189	164	207	201	73	-120	-115	–
12%	236	225	175	249	240	75	-143	-137	–
				Rest 2					
8%	253	244	132	343	331	133	125	119	86
10%	316	304	136	429	411	136	156	148	92
12%	380	362	140	514	491	137	187	176	98
				Rest 1&2					
8%	250	241	131	343	331	133	122	117	85
10%	314	301	134	429	411	136	153	145	91
12%	375	358	138	514	491	140	184	173	96

Out-of-Sample Portfolio Weights

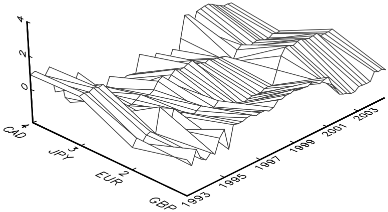
RW



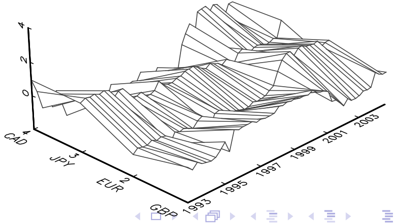
NXA



$NXA_{Rest1\&2}$



NXA_{Lag2}



Conclusions

- We extend Gourinchas and Rey (2007) by constructing bilateral measures of cyclical imbalances
- We use criteria of economic significance for exchange rate predictability
  - bilateral measures of external imbalances delivers substantial economic gains
  - impact of transaction costs, small sample bias and economic restrictions
- A promising result in the context of the empirical literature on exchange rate models and fundamentals