Predictability and ‘Good Deals’ in Currency Markets

Richard Levich
(New York University)
Valerio Potì
(Dublin City University)

EFM-EDHEC 2008 Symposium on Risk and Asset Management

19th April 2008

Presented by

Valerio Potì

Outline

- This paper: a novel methodology to test weak EMH in FX markets
  - ✓ Background/motivation
  - ✓ Empirical application
  - ✓ Implications
  - ✓ Extensions/Open Issues

EMH

- EMH stated in terms of returns:
  - ✓ deviations of returns from investors' expected returns are unpredictable using available information (RE) and zero on average
  - ✓ expected returns equal equilibrium rates

$$r_{t+1} = E_t(r_{t+1}) + u_{t+1}$$

$$E(r_{t+1}|I_t) = \mu_{t+1} \quad \text{and} \quad E(u_{t+1}|I_t) = 0$$

Joint Hypothesis Problem

- Need to define the equilibrium expected return benchmark
  - ✓ we need an ***equilibrium asset pricing model***
- In tests of EMH, H_0 is usually EMH + asset pricing model, then you need to know $E_t(r_{t+1}) = \mu_{t+1}$
- What about H_0 : ‘EMH’ + ‘$|\mu_{t+1}| \leq bound$’?
- This is the hypothesis I will investigate
- First, will recast ‘$|\mu_{t+1}| \leq bound$’ as ‘$R^2 \leq bound$’

SDF Volatility and Expected Returns

- In the SDF representation of the asset pricing problem $p = E(mx)$, then

$$E_t\left(r_{i,t+1}\right) = -(1+R_{f,t})Cov_t\left(r_{i,t+1}, m_{t+1}\right)$$

$$= -(1+R_{f,t})Corr_t\left(r_{i,t+1}, m_{t+1}\right)\sigma_t\left(r_{i,t+1}\right)\sigma_t\left(m_{t+1}\right)$$

$$\Rightarrow \quad \left|\mu_{t+1}\right| \leq \underbrace{(1+R_{f,t})\ \sigma_t\left(r_{i,t+1}\right)}_{>0}\sigma_t\left(m_{t+1}\right) \qquad (1)$$

$$\sigma^2\left(\mu_{t+1}\right) \leq E\left(\mu_{t+1}^2\right) \leq (1+R_f)^2\sigma^2\left(r_{i,t+1}\right)\sigma^2\left(m_{t+1}\right) \qquad (2)$$

R^2 Bound

- Dividing through by the variance of the asset return, the 2nd inequality gives a bound on predictability:

$$\frac{\sigma^2\left(\mu_{t+1}\right)}{\sigma^2\left(r_{i,t+1}\right)} \equiv R^2 \leq (1+R_f)^2 \sigma^2\left(m_{t+1}\right)$$

How Do We Set the Bound?

- Two ways to do this:
  - ✓ find a-priori information about available maximal SRs (tricky)
  - ✓ impose preference restrictions and rule out good deals
- Ross' (2005) followed the 2nd route, by identifying a plausible bound on the RRA of the marginal stock market investor and using this to limit curvature of utility/MU, i.e.

$$\sigma^2(m_{t+1}) \leq \sigma^2(m_{V,t+1}) = RRA_V^2 \sigma^2(r_{m,t+1})$$

Computing the Bound

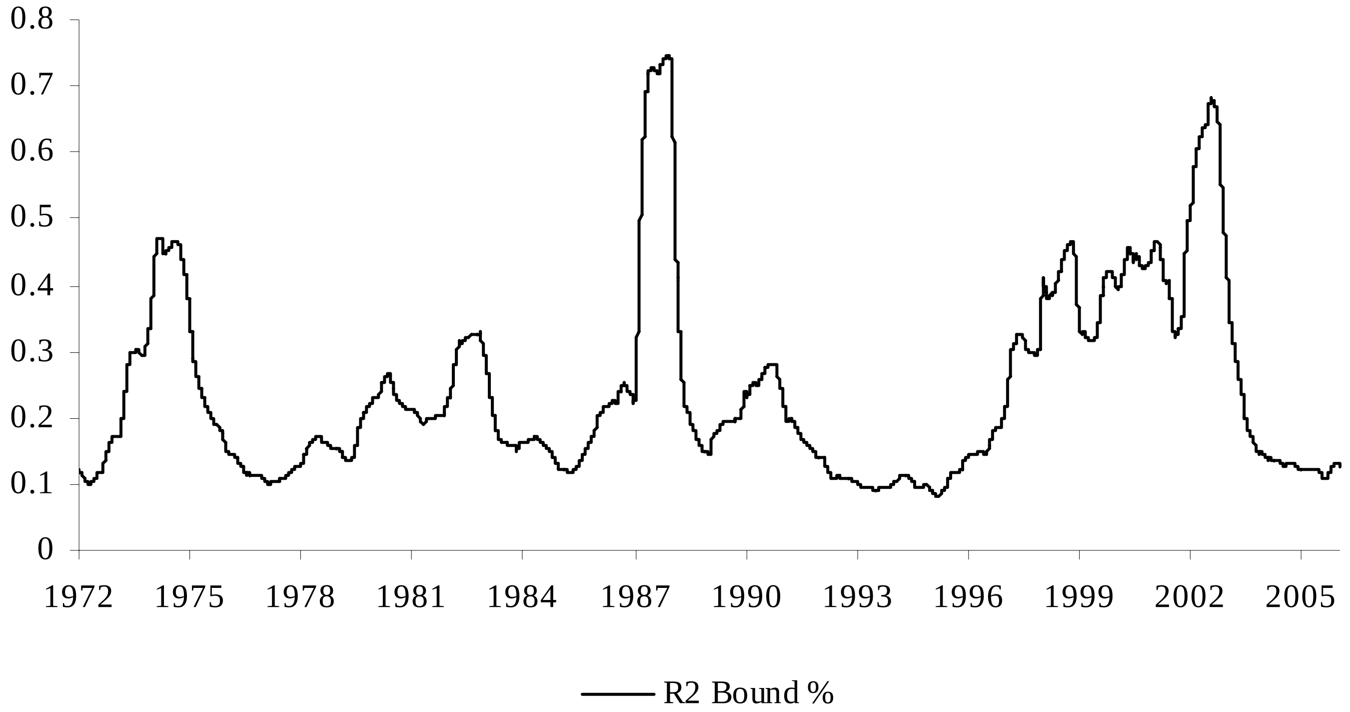
- I compute the SDF volatility upper bounds using the moments of the S&P500 Index over the period 1952-2002, under two different upper bounds on RRA
  - ✓ The first bound is 2.5 and corresponds to the RRA of the marginal stock market investor, assuming the CAPM holds with respect to the S&P500 index over the period 1927-2005, i.e. RRA_V s.t.

$$\bar{r}_{S\&P500,t+1} = (1+\overline{R}_{T-Bill})RRA_V\hat{\sigma}^2(r_{S\&P500,t+1})$$

  - ✓ The second bound is 5 and corresponds to the bound suggested by Ross (2005)

Estimated Annualized Bound

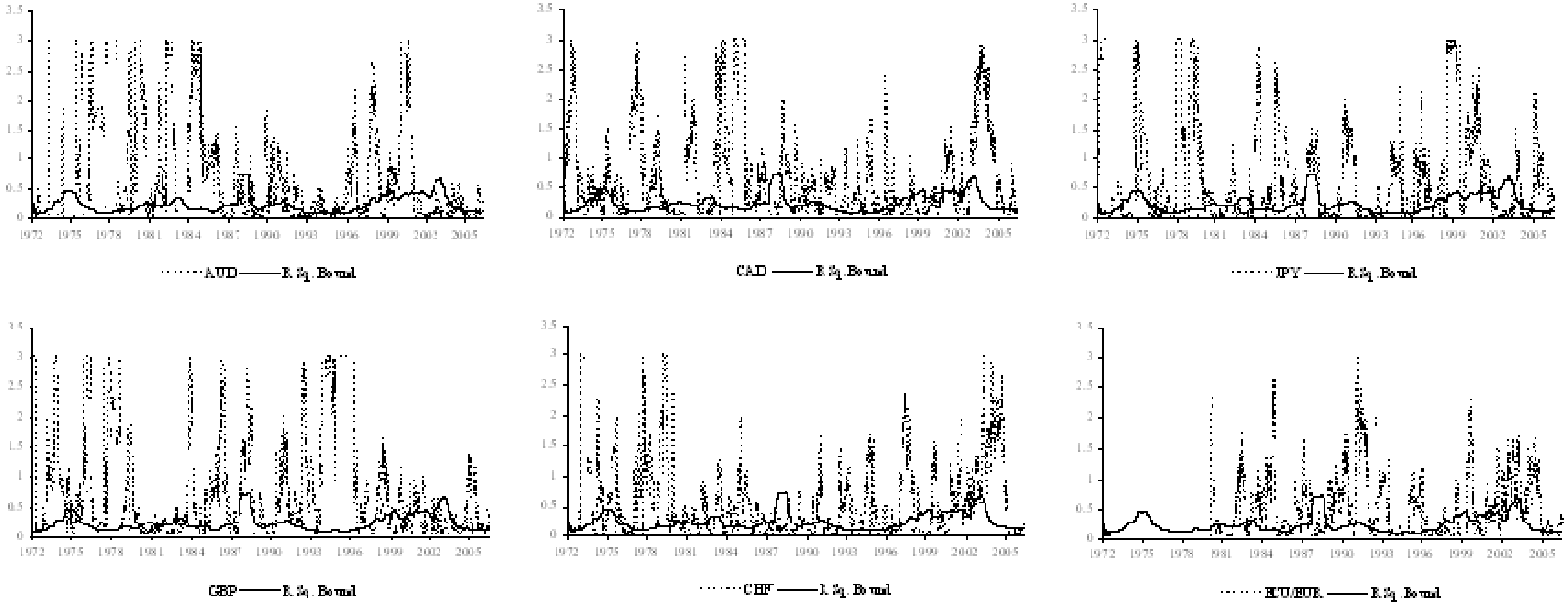
RRA = 5, daily GARCH(1,1) volatilities, yearly investment horizon, i.e. daily volatilities are integrated over yearly rolling windows



Dataset

- Daily returns on the exchange rate against the US Dollar of the main currencies for the period 1971-2006:
  - ✓ Australian and Canadian Dollar (AUD and CAD, respectively)
  - ✓ the Euro (denoted as ECU/EUR because we combine data on the ECU before the introduction of the Euro and on the latter after its launch)
  - ✓ Japanese Jen (JPY)
  - ✓ British Pound (GPB)
  - ✓ Swiss Franc (CHF).

Predictability vs. Bound



Significance of Predictability

- Bootstrapped percentage 2-Tailed confidence intervals:

	1971-2006	1971-1983	1984-1995	1996-2006
$Bound_{RRA=2.5}$	0.06	0.05	0.06	0.07
$Bound_{RRA=5}$	0.24	0.20	0.22	0.26
		AR(5)		
AUD				
10%			*0.10 0.94	*0.09 0.64
5%			*0.08 1.05	*0.07 0.72
1%			0.04 1.21	0.04 0.90
CAD				
10%	*0.06 0.34	**0.41 1.42	*0.08 0.60	**0.37 1.42
5%	0.05 0.37	**0.35 1.55	*0.06 0.65	**0.29 1.62
1%	0.03 0.45	**0.26 1.87	0.03 0.82	0.17 1.78
JPY				
10%	0.03 0.25	*0.09 0.66	*0.06 0.55	*0.07 0.56
5%	0.03 0.28	*0.07 0.73	0.04 0.63	0.04 0.65
1%	0.01 0.35	0.04 0.95	0.02 0.85	0.02 0.99
GPB				
10%	**0.43 1.73	**0.38 1.65	*0.12 0.80	0.05 0.48
5%	**0.36 1.90	**0.31 1.78	*0.10 0.92	0.03 0.53
1%	0.21 2.35	**0.23 2.24	0.05 1.08	0.02 0.67
CHF				
10%	0.01 0.15	*0.06 0.48	*0.07 0.57	*0.22 1.07
5%	0.01 0.17	0.04 0.57	0.05 0.63	*0.18 1.17
1%	0.01 0.20	0.02 0.69	0.02 0.77	*0.13 1.51
ECU/EUR				
10%			*0.10 0.70	*0.14 0.86
5%			*0.08 0.79	*0.11 0.97
1%			0.05 0.97	*0.07 1.29
		ARMA(5,1)		
CAD				
10%		**0.62 1.92		
5%		**0.56 2.07		
1%		**0.39 2.39		

Transaction Costs

- Not all predictability is exploitable due to transaction costs
- Formally, predictability in (say) daily returns on a certain asset is the squared max SR from trading once a day the asset itself

$$\frac{\sigma^2(\mu_t)}{\sigma^2(r_{i,t})} = \frac{\mu'\mu/T - (\mu' i/T)^2}{\sigma^2(r_{i,t})} = \frac{\mu'\mu}{T\sigma^2(r_{i,t})} - \frac{(\mu' i/T)^2}{\sigma^2(r_{i,t})} \cong \frac{\mu'\mu}{T\sigma^2(r_{i,t})} = \mu'\Sigma^{-1}\mu$$

- Where,

$$\Sigma = \begin{vmatrix} \sigma_0^2(r_{i,1}) & 0 & .. & & \\ 0 & \sigma_1^2(r_{i,2}) & 0 & .. & \\ .. & 0 & \sigma_2^2(r_{i,3}) & 0 & .. \\ .. & .. & 0 & ... & 0 \\ .. & & .. & 0 & \sigma_T^2(r_{i,T+1}) \end{vmatrix}$$

Transaction Costs of Maximal SR Strategies (1996-2006)

- Transactions costs for a switch from long to short have declined from about 0.10% in the 1970s to about 0.02% in the last few years, e.g. Frenkel and Levich (1975, 1977), McCormick (1979), Neely, Weller and Ulrich (2006)

t.c. (bps)	**0**	**1**	**2**	**3**	**5**
AUD	57.3	37.2	17.4	-2.3	-41.7
CAD	128.5	81.45	34.5	-12.4	-106.3
JPY	49.1	19.03	-11.0	-41.1	-101.2
GBP	48.4	34.2	20.0	5.7	-22.7
CHF	104.3	75.9	47.7	19.6	-36.7
ECU/EUR	82.1	52.4	22.7	-7.1	-66.6

Significance of Predictability

- Confidence intervals from posterior distribution of coefficient of determination
- Posterior distribution generated using ‘Giggs Sampling’

	1971-2006	1971-1983	1984-1995	1996-2006
$Bound_{RRA=2.5}$	0.06	0.05	0.06	0.07
$Bound_{RRA=5}$	0.24	0.20	0.22	0.26
AUD				
R^2	0.11	0.21	0.21	0.13
5^{th} percent.	-0.02	-0.30	0.00	-0.05
CAD				
R^2	0.13	0.74	0.16	0.18
5^{th} percent.	0.00	**0.28	-0.01	-0.02
JPY				
R^2	0.07	0.19	0.13	0.06
5^{th} percent.	-0.04	-0.12	-0.03	-0.12
GPB				
R^2	0.21	0.65	0.34	0.12
5^{th} percent.	*0.06	*0.11	*0.11	-0.07
CHF				
R^2	0.01	0.08	0.07	0.03
5^{th} percent.	-0.10	-0.26	-0.10	-0.13
ECU/EUR				
R^2	0.17	0.92	0.29	0.20
5^{th} percent.	-0.01	-0.17	-0.00	0.00

Conclusions

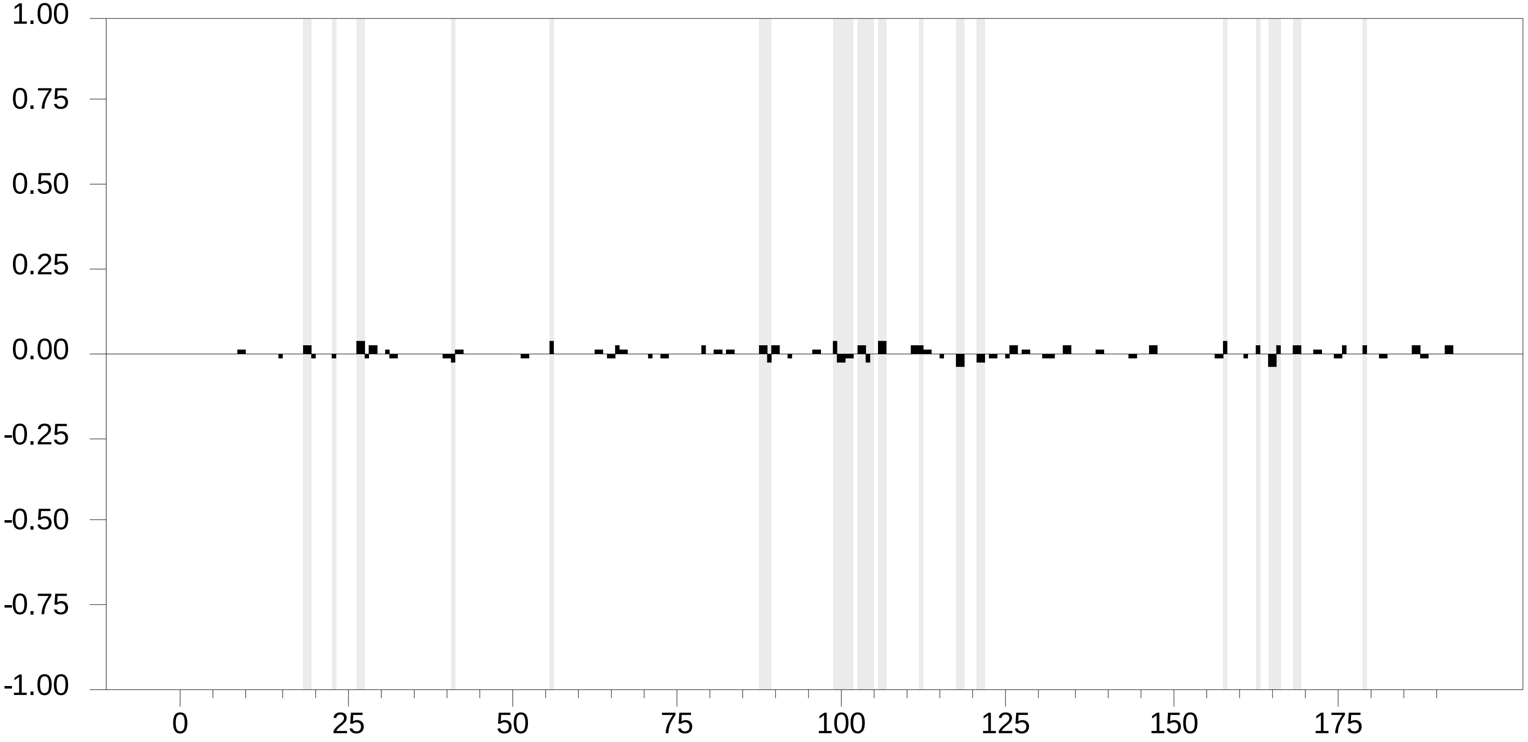
- Even under a conservative upper bound on relative risk aversion, i.e. $RRA_V = 5$, predictability often violates a theoretically motivated upper bound.
- Under zero transaction costs, this evidence implies violation of the EMH under a broad class of asset pricing models and for conservative to realistic values of the marginal investor's relative risk aversion.
- Excess-predictability in currency returns is still present in recent sample periods, against widely held view that profitability of trading rules has disappeared for main currencies, e.g. Taylor (2005).
  - ✓ But transactions costs are of an order of magnitude that rules out excess predictability
  - ✓ Transaction costs, however, do not make trading rules unprofitable

Extensions

- Lo's (2004) AMH vs. EMH: need to check whether excess-predictability is trending downwards over time, e.g. Neely, Weller and Ulrich (2006).
- Do Central Banks interventions spur excess-predictability? LeBaron (1998) found that excess-profitability of MA trading rules disappears when Fed is not active. Opportunity to compare impact of Fed and ECB impact on excess predictability.
- More generally, can we predict excess-predictability? If so, we can use this to refine trading rules, i.e. trade only when you expect excess-predictability to minimize transaction costs.

Open Issue

- Little question: how do you capture very high order lag auto-correlation? (plot refers to serial correlation of CAD at lags 1-200)
  - ✓ Fractionally integrated ARMA (ARFIMA), else?



End of Presentation

- Questions?
- Comments?
- Suggestions (very welcome!!!)?