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Walking Down the Exchange Rates Predictability Lane

A short essay on why the subject of exchange rate predictability reemerged and what its future may hold

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1. Introduction

The realization that exchange rate models fail to outperform a random walk may have felt like a blow as much as the 10th century Muslim alchemists' refutation of lead transmutation into gold. It arguably started with Meese and Rogoff (1983), after which others followed, leading to the compilation of Sarno and Taylor's (2002), in which they conclude that none of the available exchange rate models can beat a random walk in forecasting. Yet, as of now it seems this parallel is not as accurate as it used to feel. Engel, Mark and West (2007) posited in their work *Exchange Rate Models Are Not as Bad as You Think* that it is not so much as out-of-sample forecasting test of the available exchange rate models don't beat a random walk. Rather, they actually *behave* like a random walk. This short paper revisits this argument, and assesses promising results of another exchange rate forecasting model, based on the Taylor Rule.

2. "Not as bad as you think"

In their analysis, Engel, Mark and West break down the exchange rate models into the below structure.

$$(1) \qquad s_t = (1-b)\boldsymbol{a}_1\boldsymbol{x}_t + b\boldsymbol{a}_2\boldsymbol{x}_t + bE_t[s_{t+1}]$$

Where,

s_t: Log of the exchange rate measured as the log of the domestic currency price of foreign currency, at time t;

b: Discount factor;

$\boldsymbol{a}$: Vector of coefficients (1,n);

$\boldsymbol{x}$: Vector of economic fundamentals (n,1).

They argue that the available models interpret the exchange rate as a sum of present value fundamentals, regardless of what those fundamentals are, being them born from a money demand model or Dornbusch's (1976) delayed overshooting model, to use the two examples brought by the original paper.

A forward solution of the above equation is given by the one below.

$$(2) \qquad s_t = (1-b)E_t\left[\sum_{j=0}^{\infty}\left[b^j \boldsymbol{a}_1 \boldsymbol{x}_{t+j}\right]\right] + bE_t\left[\sum_{j=0}^{\infty}\left[b^j \boldsymbol{a}_2 \boldsymbol{x}_{t+j}\right]\right]$$

They then demonstrate that the exchange rate in equation (2) behaves as a random walk if either of the below group of conditions are satisfied:

(i) $\boldsymbol{a}_1\boldsymbol{x}_t$ and $\boldsymbol{a}_2\boldsymbol{x}_t$ are both random walks; or
(ii) $\boldsymbol{a}_2\boldsymbol{x}_t$ is I(1) and b → 1; or
(iii) $\boldsymbol{a}_1\boldsymbol{x}_t$ is I(1), $\boldsymbol{a}_2\boldsymbol{x}_t$ is null and b → 1.

Demonstration for (i) lies on the basis that a sum of random walks is a random walk. Demonstration for (ii) is developed similarly as for (iii), considering that the first component of (2), the one with $\boldsymbol{a}_1\boldsymbol{x}_t$, is multiplied by (1-b), which approaches zero as b →1. Demonstration for (iii) starts with a given $\phi \neq 1/b$ that satisfies:

$$(3) \qquad \Delta\boldsymbol{x}_t = \phi\Delta\boldsymbol{x}_{t-1} + \varepsilon_t$$

Being ε_t i.i.d., (3) is an I(1) process. Using (3) in (2) and assuming $\boldsymbol{a}_2\boldsymbol{x}_t$ null, the authors arrive at:

$$(4) \qquad s_t = \frac{\phi(1-b)}{1-\phi b}\Delta\boldsymbol{x}_{t-1} + s_{t-1} + \frac{1}{1-\phi b}\varepsilon_t$$

Finally, (4) is a random walk if and only if b = 1.

The bottom line of this development is that, when modeling exchange rate as the sum of present values of a set of fundamentals until t = ∞, the exchange rate tends to a random walk when the discount factor is high. Thus, the comparison of results between these models and a random walk is misleading.

3. "Where do we go from here?" – The Taylor Rule

Engel, Mark and West also critique the lack of modeled impact of monetary policy in the exchange rates. In the last couple of decades, most countries have shifted to an inflation targeting monetary policy. Some quite explicitly like Brazil, New Zealand, South Africa, Canada, the United Kingdom and in many ways, the European Union. In others, the relationship between inflation and interest rates has been mapped with success long before any official press release, such as the United States (Taylor, 1993) and Japan (Clarida, Gali, Gertler, 1998).

There are several variations to the Taylor rule. The original proposition is as follows.

$$(5) \qquad i_t = \alpha_0 + \alpha_1\pi_t + \alpha_2\pi_t^{gap} + \alpha_3 y_t^{gap} + \varepsilon_t$$

Where,

i: Target rate set by the country's Central Bank;
π: Expected year-end inflation;
π^{gap}: Deviation from inflation target (expected inflation minus inflation target);
y^{gap}: Output gap;
ε: Error term.

This is format is far from ubiquitous. A smoothing parameter has been added by Orphanides (1997) and which reflects the apparent tendency of the monetary policy committee to apply only part of the decision (p) to the rate on the day of the meeting, and another part $(1-p)$ is left for the following monetary policy meeting.

On the choice of variables, there are variations in which either inflation gap or output gap are removed in a given country, new variables are added, or different indexes have been used for the same variable – Bernanke (2015), regarding the inflation variable, to give one example. Orphanides (1997) suggests replacing actual measures for forecasts given at the time of the monetary decision. Clarida, Gali and Gertler (1998) include the real exchange rate to capture a tendency of central bankers to raise interest rates when their currency depreciates, and also assess foreign interest rates as relevant information for the domestic central bank, which will be further developed by Engel, Mark and West, as shown below. One more variable inclusion worth mentioning is a trade-weighted index as proxy of a basket of exchange rate. This was introduced by Huang, Margaritis and Mayes (2001) on the policy rule of New Zealand, supported not only by the inflationary pressures of the exchange rate in a country with capital mobility, but also by the explicit defense of a stable currency from the Reserve Bank of New Zealand.

The Taylor Rule has since its proposition been used as a measuring rule for monetary policy. Judd and Rudebusch (1998) apply regime breaks to compare inflation aversion and output gap aversion of the Fed chairmen Arthur Burns (1970 – 1978), Paul Volcker (1979 – 1987) and Alan Greenspan (1987 – 2006). Barcellos and Portugal (2007) do a similar job for the Brazilian Central Bank chairmen, and counter the by-then argument that the monetary policy had changed. Costa (2018) uses regime breaks to back the proposal that the Brazilian government had apparently abandoned inflation targeting. Salgado, Garcia and Medeiros (2005) use regime break to differentiate between crises and tranquil periods.

The list of applications of Taylor Rule are extensive and beyond the scope of this essay. Many have pointed significant flaws in Taylor Rule related studies, perhaps most relevantly Österholm (2005), but in general it is agreed to some extent that there are some transmission mechanisms between exchange rates and interest rates.

Referring back to Engel, Mark and West, among other alternatives, they suggest linking the uncovered interest rate parity (UIP) to a version of the Taylor Rule (with a form of smoothing factor $0 < \delta < 1$ and the real exchange rate q among the exogenous variables).

$$(6) \qquad \begin{cases} i_t = \alpha_1 E_t[\pi_{t+1}] + \alpha_2 q_t + \alpha_3 y_t^{gap} + \delta i_{t-1} + u_t \\ i_t^* = \alpha_1 E_t^*[\pi_{t+1}] + \alpha_3 y_t^{*gap} + \delta i_{t-1}^* + u_t^* \\ i_t - i_t^* = E_t[s_{t+1}] - s_t + \rho_t \end{cases}$$

Stars denote series observed at a foreign (exogenous) country, such as the US as observed by the rest of world. From (6), and keeping in mind that $q_t \equiv s_t + p_t^* - p_t$, and that $\pi_t \equiv p_t - p_{t-1}$, the forward-looking solution is:

$$(7) \qquad q_t = b \sum_{j=0}^{\infty} \left[b^j E_t[z_{t+j}] \right]$$

Being:

$$(8) \quad \begin{cases} b = \frac{1}{1+\alpha_2} \\ z_t = -\left((\alpha_1 - 1)(E_t[\pi_{t+1}] - E_t^*[\pi_{t+1}^*]) + \alpha_3\left(y_t^{gap} - y_t^{*gap}\right) + \delta(i_{t-1} - i_{t-1}^*) + \epsilon_t\right) \\ \epsilon_t = u_t - u_t^* - \rho_t \end{cases}$$

This solution implies three assumptions. First, coefficients are the same for every country. Second, the real exchange rates are the sum of present value expectations in monetary policy (although in this model, the discount factor distances itself from 1 as the real exchange rate becomes more relevant to the home country's monetary policy). Third, the premium on the UIP (ρ_t) is normally distributed with an average of 0. We will revisit these assumptions shortly.

This is not the only model they propose, nor is this one alone what leads the authors to conclude that "we have found evidence that the monetary models do help to forecast changes in exchange rates" (Engel, Mark and West, 2007, pg. 44). Their results seem to indicate that their model is just as good as a random walk. They use Theil's U-statistic, and assign the variable u to measure the ration of the root-mean-square prediction error of the model and that of a random walk. In this fashion, if $u < 1$, the model is better than a random walk. Their 93-quarter-horizon panel analysis of 18 countries produces poor results for 1-quarter forecast (two countries with u-stat over or equal to 0.99), and 12 countries with u between 1.0 and 1.1). Results for the 16-quarter forecast are slightly better, with 4 countries with u-stat between 0.83 and 0.98, but no other countries with u lower than 1.04. They find significantly better results when comparing their model to a random walk with a drift, but acknowledge the drift is just a special case of a random walk.

This conclusion takes us back to the assumptions. Starting with the first assumption, though this may be a necessity for their solution to exist, it is highly unlikely that all governments would act exactly alike to every given situation. The third assumption's impact can be reduced by adding a constant to the regression. Regarding the second assumption, if the home country's monetary policy is insensible to the real exchange rate, not only would that revert back to Engel's, Mark's and West's main argument, but also severely weaken their model. It is advised to test for the significance of α_2, which could point to a more thorough reframing of the equation system (in comparison to the other two notes).

4. Possible extensions

Since *Exchange Rate Models Are Not as Bad as You Think*, many followed building upon this work. I selected two other references which pose as further argument that some may have jumped the gun in giving up on exchange rate predictability.

Molodtsova and Papell (2009) did a very extensive study on exchange rate predictability. They use monthly data to assess predictability of exchange rates for 12 OECD countries vis-à-vis the United States from 1973 to 1998. Their models follow the logic described above, with variants for homogeneity (whether or not the foreign countries have the same coefficients as the US), smoothing (whether or not foreign countries smooth their monetary policy decisions), symmetry (whether foreign countries target the exchange rate directly in their monetary policy, assuming the US does not, or exchange rates and interest rates are bound solely by UIP), and constant (if any or all monetary policy targets differ from those of the United States, there will be a constant in the model). In total, 48 models were tested, including different indexes for output gap. Some of those variants had significant results of predictability against the random walk. They conclude the "strongest results are found with the symmetric Taylor rule model with heterogeneous coefficients, smoothing and a constant." (Molodtsova and Papell, 2009, pg. 19).

Finally, in another work worth mentioning, and to fuel even further the discussion, Clarida and Waldman (2008) produced an interesting analysis on predictability of exchange rates. They study the very-short-term effect of inflation on exchange rates, more specifically how the impact of inflation related news can affect the nominal exchange rates. With data spanning from 2001 to 2005, they conclude that, for inflation targeting countries, higher-than expected inflation (on official press releases, when compared to market surveys compiled by Bloomberg News Service) bring the exchange rate significantly down within 10 minutes. They also find no such effect for the two non-inflation-targeting countries analyzed. Other impacts are also modeled, such as changes in inflation target, which only stands as further evidence that there is a mechanism of transmission – between inflation, monetary policy and exchange rates – still to be mapped.

Many have followed Mark, Engel and West's *Exchange Rate Models Are Not as Bad as You Think*, and many others surely will still do so. If some assumptions are open to debate, the authors have made a case so compelling on exchange rate predictability that the sole existence of such debate already points to a strong case against throwing exchange rates to the lady luck of random walk.

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