On the Unstable Relationship between Exchange Rates and Macroeconomic Fundamentals

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Some Background

- it is well known that the relationship between exchange rates and observed macro fundamentals is not very strong
- at the same time anecdotal, survey and econometric evidence all suggest that this relationship is highly unstable

Anecdotal Evidence

- widely reported in the financial press that traders regularly change the weight they attach to different macro indicators; two typical examples:

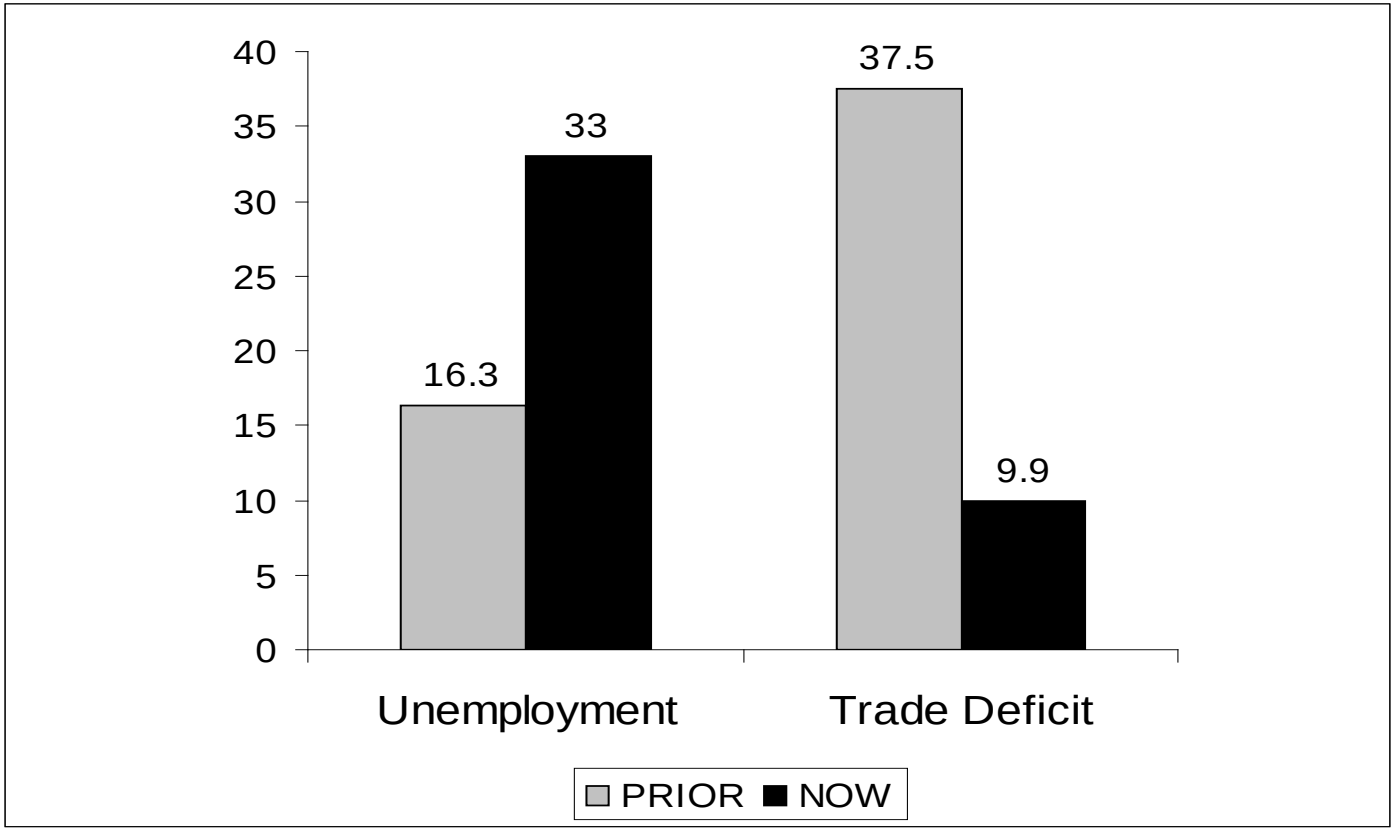
The dollar's latest stumble ... came despite optimistic economic data from the US. But analysts said the movement of the US currency was no longer driven by growth fundamentals. All the focus is on the deficit now…

FT, Dec. 1, 2003

The dollar's resilience in the wake of dire US economic data has raised the prospect that the currency market may be experiencing one of its periodic changes in focus. FT, Feb. 11, 2008.

Survey Evidence

Survey U.S. FX traders in 1998 (Cheung-Chinn, 2001):
Which economic announcements have the biggest impact on the foreign exchange market, five years ago vs. now?



Econometric Evidence

- Sarno and Valente (2008) find that “(exchange rate models) that optimally use the information in the fundamentals change often and this implies frequent shifts in the parameters”
- Rossi (2005) conducts a battery of parameter instability tests in reduced form exchange rate equations and finds “overwhelming evidence of parameter instability”

What can Account for Such Reduced Form Parameter Instability?

- could happen when structural parameters are known and very volatile, but implausible
- we show that a highly unstable reduced form relationship between the exchange rate and macro fundamentals naturally develops when structural parameters:
  1. are unknown (unobservable)
  2. change slowly (e.g. slow changes in preferences, technology parameters, parameters related to financial innovation or institutional reform)
  3. but can change considerably over a long period of time

Intuition

- if parameters can change significantly in the long run, there is considerably uncertainty about their level
- this leads to so-called “scapegoat” effects
- example: assume that a dollar appreciation is driven by an unobserved fundamental (e.g. liquidity trade)
- if at the same time there happens to be strong output growth, agents can “blame” the appreciation on the output growth, and change their view of parameters accordingly
- reduced form parameters will depend on expectations of structural parameters rather than the actual values

Standard Monetary Model

$$E_t s_{t+1} - s_t = i_t - i_t^* + \phi_t \qquad (1)$$

$$\mu m_t = p_t - \alpha i_t + \gamma' z_t + \upsilon_t \qquad (2)$$

$$\mu m_t^* = p_t^* - \alpha i_t^* + \gamma' z_t^* + \upsilon_t^* \qquad (3)$$

$$s_t = p_t - p_t^* \qquad (4)$$

Standard Monetary Model

This can be written as

$$E_t s_{t+1} - s_t = i_t - i_t^* + \phi_t \qquad (1)$$

$$i_t - i_t^* = \frac{1}{\alpha} s_t - \frac{1}{\alpha}(F_t + b_t) \qquad (2)$$

where

$$F_t = \mu(m_t - m_t^*) - \gamma' z_t \equiv \mathbf{f}_t' \boldsymbol{\beta} \qquad (1)$$

$$b_t = -(\upsilon_t - \upsilon_t^*) \qquad (2)$$

Standard Monetary Model

For example, when ϕ_t=0 and b_t and $\Delta\mathbf{f}_t$ are i.i.d.

$$\Delta s_t = \Delta\mathbf{f}_t'\boldsymbol{\beta} + (1-\lambda)\Delta b_t$$

where $\lambda=\alpha/(1+\alpha)$.

We introduce time-varying parameters by replacing

$$\Delta F_t = \Delta\mathbf{f}_t'\boldsymbol{\beta}$$

with

$$\Delta F_t = \Delta\mathbf{f}_t'\boldsymbol{\beta}_t$$

Relation between Exchange Rate and Fundamentals

- solving the present value exchange rate eqn., we get

$$\frac{\partial \Delta s_t}{\partial \Delta f_{nt}} = (1-\lambda)\beta_{nt} + \lambda E_t \beta_{nt} + \lambda \sum_{i=0}^{T} \Delta \mathbf{f}'_{t-i} \frac{\partial E_t \boldsymbol{\beta}_{t-i}}{\partial \Delta f_{nt}}$$

- if instead parameters are known:

$$\frac{\partial \Delta s_t}{\partial \Delta f_{nt}} = \beta_{nt}$$

Computing Expectations of Parameters

- assume

$$\beta_{nt} = \beta + \sum_{i=1}^{T} \theta_i \varepsilon_{n,t-i+1} \qquad \varepsilon_{n,t} \sim N(0, \sigma_\beta^2)$$

- assume T=1000 months (limits number of unknown parameter innovations for which expectations need to be computed)
- compute expectations of parameter innovations from a signal extraction problem

Scapegoat Effect

- agents observe current and past values of

$$F_t + b_t = \sum_{i=0}^{\infty} \Delta \mathbf{f}'_{t-i} \boldsymbol{\beta}_{t-i} + b_t$$

- in combination with the process of the parameters, this is used to compute expectations of parameters
- there is confusion between the unobserved fundamental b_t and the unknown parameters β_{t-j}
- both are unobserved
- if b_t rises, agents raise their expectation of parameters associated with fundamentals with positive innovations
- those fundamentals then become a scapegoat

Scapegoat Effect

- in general expectations depend on parameter innovations themselves, changes in macro fundamentals and b_t (scapegoat effects) and innovations in other parameters (another type of scapegoat effect)

Calibration

- we calibrate the model (process of b_t, ϕ_t and fundamentals) to data on exchange rates, interest rates and macro fundamentals for 5 countries
- the only parameters that we do not estimate or calibrate are associated with the process for the unknown β_{nt}
- even when there is evidence of parameter instability, data generally can tell us very little about the nature of this process (e.g. Elliott and Timmermann, 2008)

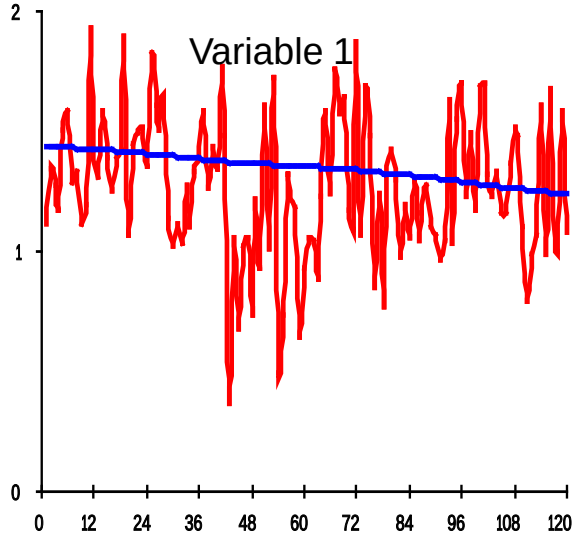
Process Parameters

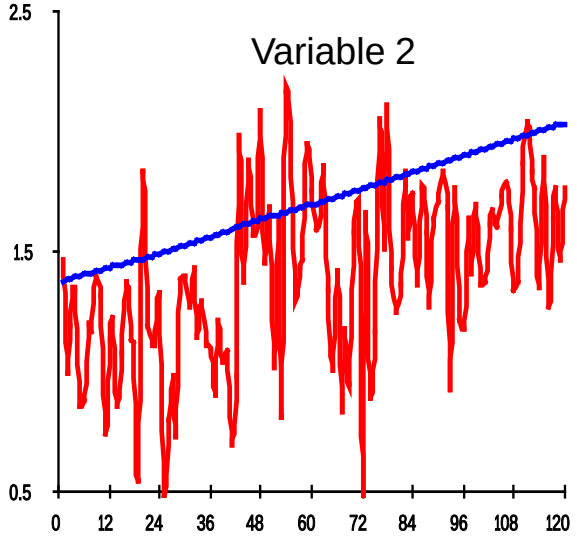
- assume that monthly changes in structural parameters are small (set the standard deviation of $\Delta\beta_{nt}$ equal to 0.3% of the parameter mean β=1)
- consider different processes
- show that a highly unstable relationship between the exchange rate and macro fundamentals occurs when uncertainty about β_{nt} is much larger than uncertainty about the monthly changes $\Delta\beta_{nt}$
- significant uncertainty about the *level* of the parameter leaves ample room for scapegoat effects that generate such an unstable relationship

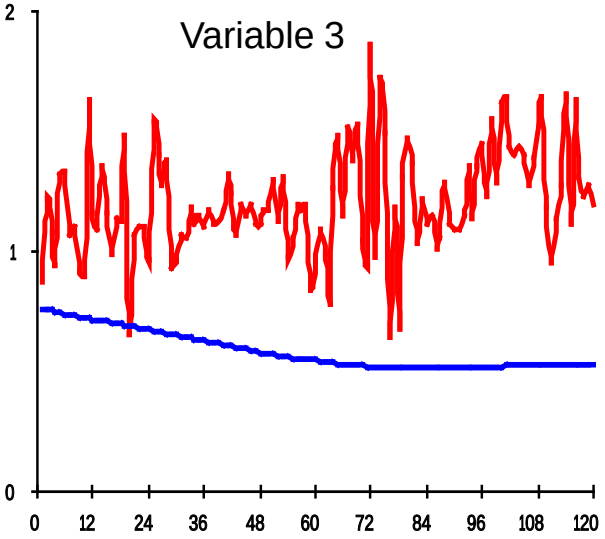
Illustration

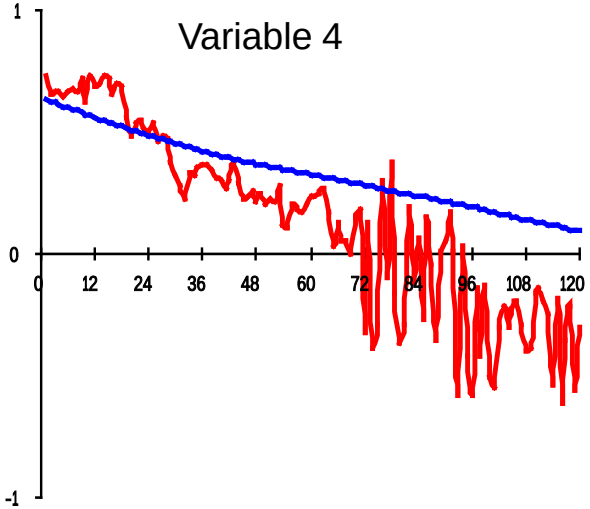
- focus here on the benchmark parameterization, where we choose the process such that there is maximum uncertainty about β_{nt} relative to $\Delta\beta_{nt}$
- parameters then change gradually (an innovation leads to a gradual increase for 500 months)
- assume 5 fundamentals and correspondingly 5 parameters β_{nt}

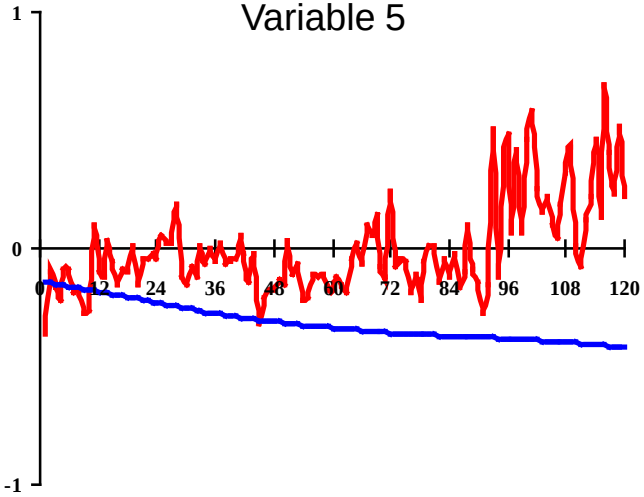
Figure 1 Derivative Δs_t with respect to Δf_{nt} (10 years)*





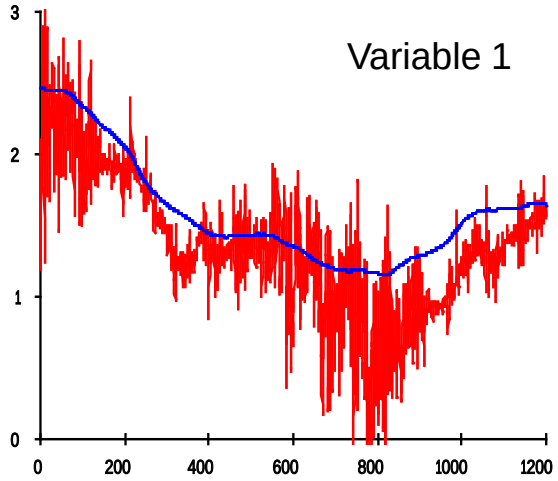


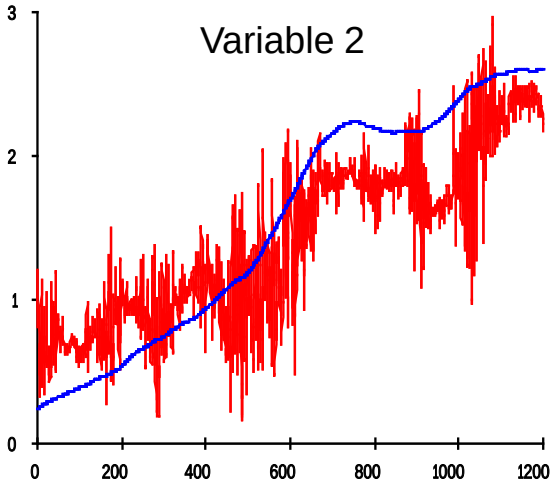


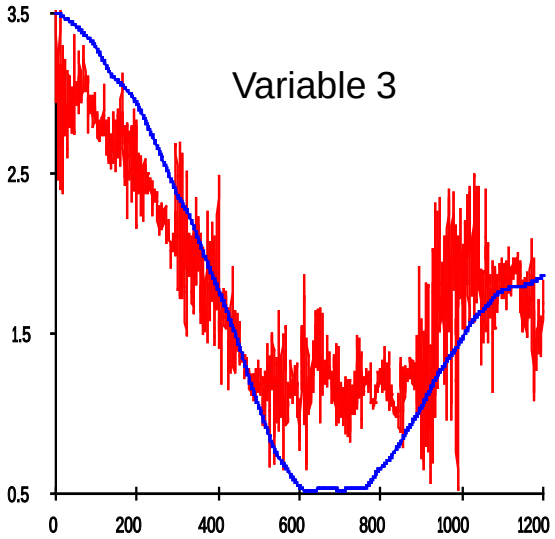


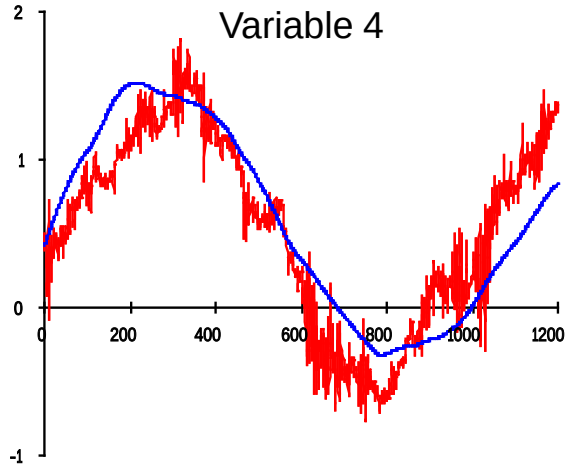
* The smooth line is β_{nt}, while the volatile line represents the derivative of Δs_t with respect to Δf_{nt}.

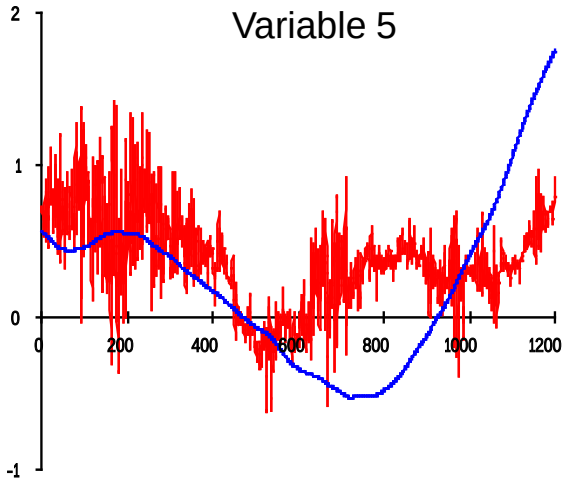
Figure 2 Derivative Δs_t with respect to Δf_{nt} (100 years)*











* The smooth line is β_{nt}, while the volatile line represents the derivative of Δs_t with respect to Δf_{nt}.

Other Parameter Processes

- under this benchmark process for β_{nt} the s.d. of the monthly change of the reduced form derivative $\partial \Delta s_t / \partial \Delta f_{nt}$ is 85 times as large as the s.d. of monthly changes $\Delta \beta_{nt}$ in structural parameters
- we call this the scapegoat ratio as it results from scapegoat effects
- we have considered other processes where there is much less uncertainty about β_{nt} relative to $\Delta \beta_{nt}$

Other Parameter Processes

- limited uncertainty about the level of the parameters reduces scapegoat effects
- for example, when β_{nt} follows an AR process (AR coefficient 0.99), the scapegoat ratio is only 1.6
- this means that like the structural parameters, the reduced form derivative $\partial \Delta s_t / \partial \Delta f_{nt}$ does not change much from month to month

Conclusion

- anecdotal, survey and econometric evidence suggest that the relationship between the exchange rate and macro variables is highly unstable
- we developed a model where such instability naturally develops when structural parameters are unobserved and can change gradually over time
- significant uncertainty about the level of parameters leads to scapegoat effects whereby agents frequently and significantly revise their views of parameters
- this leads to an unstable reduced form relationship between the exchange rate and macro fundamentals