Confronting our FEERs

a Bayesian-model-selection-based robustness analysis

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Outline

Why do We want to Estimate EQFX?

- IMF uses both BEER and FEER models for biannual exchange rate surveillance
- Major commercial banks usually also build models of this type.
- ECB has been using BEERs and FEERS for many years:
    - International discussions on exchange rates (especially when the euro is very low or very high).
    - Input to ERM II assessment notes: for countries wishing to enter ERM II or entering the euro area.
    - Discussions on IMF art. IV: euro area as well as individual euro area countries.
    - Assessment of intra-euro area imbalances.
    - Input for stress testing in FX exposure in neighbouring countries.
    - Input for ESRB risk assessment

Behavioural Equilibrium Exchange Rates (BEER)

- Starting point: Purchasing Power Parity (PPP): price levels across countries equalise.
- Empirical implication: real exchange rates are stationary.
- Empirical observation: they are not!
- So can some “fundamentals” explain deviations from PPP?
- A long list; the most uncontroversial one is relative GDP per capita: richer countries tend to have higher relative price levels.
- Other macroeconomic fundamentals: trade balance, relative government expenditure, terms of trade.

Fundamental Equilibrium Exchange Rate (FEER)

- Also called “Macroeconomic Balance” model.
- Definition: The exchange rate consistent with internal and external balance.
- Internal balance: the country is operating at a level of output consistent with full employment and low inflation.
- External balance: a sustainable current account position as reflected by the underlying and desired net capital flows, which depend on net savings that are, in turn, determined by factors such as consumption smoothing and demographic factors.
- The FEER approach can be characterised as normative in the sense that it delivers an equilibrium exchange rate consistent with ‘ideal’ economic conditions.

FEER Pros and Cons.

FEER pros:

- A richer, more structural definition of equilibrium.
- It can be used to “tell a story”.
- Theoretically appealing.

FEER cons:

- Conceptually: REER only mechanism of CA adjustment: no role for domestic factors.
- Empirically: Structure difficult to implement: shortcuts needed.
- If a country runs a CA balance its exchange rate is never misaligned (read: euro).
- Usually calibrated; very non-robust when estimated.

The FEER structure: 4 building blocks

The FEER is given by this simple equation:

$$\frac{dCA}{dREER} = \sigma = \lambda(1-\beta_M)\frac{M}{Y} + (\lambda^*(1-\beta_X)-1)\frac{X}{Y}$$
$$dREER = \frac{1}{\sigma}\left(CA^{NORM} - CA^U\right).$$

λ is the exchange rate pass-through to import prices,
λ^* is the pass-through to export prices,
β_M and β_X denote the absolute values of the import and export price elasticities,
$\frac{M}{Y}$ and $\frac{X}{Y}$ are import and export ratios to GDP.
CA^*, CA^U are the sustainable and underlying current account

The Marshall-Lerner condition holds if $\sigma < 0$:

The trade balance will adjust when $\sigma < 0$, i.e. when

$$\lambda(1-\beta_M)\frac{M}{Y} + (\lambda^*(1-\beta_X)-1)\frac{X}{Y} < 0$$

$$\beta_M > \frac{\lambda\frac{M}{Y} - \frac{X}{Y} + \lambda^*\frac{X}{Y} - \beta_X\lambda^*\frac{X}{Y}}{\lambda_M\frac{M}{Y}}$$

$$\beta_M > 1 - \frac{(1-\lambda^* + \beta_X\lambda^*)}{\lambda}\frac{X}{M}$$

$$\beta_M > 1 - \frac{1-(1-\beta_X)\lambda^*}{\lambda}\frac{X}{M}.$$

In the simple case where TB=0 and ERPT =1, we get

$$\beta_M > 1 - \frac{Xr}{Mr}\beta_X$$

$$\beta_M + \beta_X > 1$$

We take the FEER at face value and investigate its robustness

- Informally: recent paper by B. Schnatz, looking at the range of uncertainty in FEER estimates focusing on the Chinese renminbi
- Formally: using Bayesian variable selection
- We look at the effect of uncertainty about estimates of 3 of the 4 FEER building blocks:
  - Trade elasticities β_X and β_M
  - Exchange rate pass-through λ and λ^*
  - Current account norm CA^*
  - We disregard the effect of uncertainty on the underlying current account (use WEO projection)

Informal sensitivity analysis: Illustration from Schnatz 2011, renminbi example

Source of estimate	Beta_X	Beta_M	Reaction of CA to REER	CA norm	Required REER change
Will./Cline	0.78	1.00	-0.30	3.0%	11.1%
Ahamed	1.50	1.00	-0.57	3.0%	5.8%
Coudert	0.50	0.95	-0.17	3.0%	19.0%
Isard AE	0.71	0.92	-0.24	3.0%	13.6%
Isard EME	0.53	0.69	-0.10	3.0%	33.3%
Isard (-0.1)	0.43	0.59	-0.03	3.0%	117.4%
Isard (-0.2)	0.33	0.49	0.04	3.0%	-76.9%
Bussiere et al	0.48	0.43	0.01	3.0%	-578.9%
Will./Cline	0.53	0.69	-0.10	3.0%	33.3%
Will.	0.53	0.69	-0.10	-1.0%	73.7%
Will./Mahar	0.53	0.69	-0.10	-2.8%	91.8%
Wang	0.53	0.69	-0.10	3.1%	32.3%
Coudert	0.53	0.69	-0.10	-1.5%	78.7%
Chinn/Ito	0.53	0.69	-0.10	2.0%	43.4%
Gruber/Kamin	0.53	0.69	-0.10	0.5%	58.5%
Bussiere et al	0.53	0.69	-0.10	2.3%	40.9%

Note: Assuming import and export ERPT =1, exports = 38% of GDP, imports = 33% of GDP, CA =6.3%

A formal look at robustness: Bayesian model selection

The starting point:

$$Y = \alpha + X_m\beta + \varepsilon_t$$

where X_m can be any subset of $X = (X_1, ..., X_P)$.

- Must identify which variables have a coefficient so close to zero that it is more efficient to ignore them.
- For P regressors, we have 2^P possible choices of subsets.
- The exact calculation of the posterior distribution is infeasible for large models
- Monte Carlo Markov Chain (MCMC) methods are used to explore the model space by simulation to find models with high posterior probability.

The model search setup: Model space prior

Independence prior with equal weights:

- Letting λ_i index models,

$$p(\lambda) = \prod w_i^{\lambda_i}(1 - w_i)^{1-\lambda_i}$$

- Each x_i enters the model independently of the other variables, with probability $p(\lambda_i = 1) = w_i$.
- We use a uniform prior, where $w_i = w = 0.5$, so that $p(\lambda) = 1/2^p$.
- This puts more weight on models of size $p/2$, while setting w smaller can put more weight on parsimonious models.

The model search setup: Parameter prior

- Gaussian prior for the coefficients, centred at zero
- The distribution of the regression coefficients given the model choice is

$$p(\beta_\lambda|\sigma^2,\lambda) = N(0,\sigma^2\Sigma_\lambda)$$

- with an inverse gamma prior on the variance:

$$p(\sigma^2|\lambda) = IG(\delta, Q)$$

- The hyperparameters:
  - $\delta = 3$ for the shape parameter (the smallest possible value such that the mean of the distribution exists)
  - Scale parameter Q which is comparable in size with the error variance of $y_t|x_t$.

The core of the paper: Using Bayesian variable selection method to formally investigate robustness

- Estimated each parameter underlying σ for each country,
- Found a lot of variability for each parameter both within each country and among countries.
- Mapped uncertainty on each parameter to a distribution for σ: when the distribution crosses zero, there are areas of the parameter space where the Marshall-Lerner condition does not hold.
- If M-L does not hold:
  - as $\sigma \to 0$ no real exchange rate depreciation can make the CA move
  - if $\sigma > 0$ need an appreciation to reduce a deficit!

1. The current account norm

Static regression on 3-year moving averages: results across all models and 57 countries

	10%	median	90%	Theory sign
rel GDP	-0.02	0.04	0.22	+
rel trend GDP	-2.28	-0.26	0.44	+
rel GDP gap	-0.19	-0.02	0.04	-
rel GDP growth rate	-0.07	0.00	0.07	-
rel gov't deficit	-0.37	0.01	0.59	-
rel age dependence	-5.24	-0.04	1.19	-
rel old ratio	-5.42	0.02	12.18	-
rel young ratio	-8.29	-2.24	1.43	-
rel population growth	-1.33	-0.02	4.99	-
rel energy dependence	-0.01	0.00	0.00	-
rel openness	-0.15	-0.01	0.10	+

Table:

2. The trade elasticities

$$\Delta \log(Mvol)_{it} = \alpha_{Mi} + \sum_{j=01}^{J_i} \beta_{M,ji} \cdot \Delta \log P_{M,it-j} + \sum_{j=0}^{J_i} \phi_{M,ji} \cdot \Delta \log P_{it-j}$$
$$+ \sum_{k=0}^{K_i} \psi_{M,ki} \cdot \Delta \log GDPvol_{it-k} + \sum_{l=1}^{L_i} \rho_{M,li} \cdot \Delta \log Mvol_{it-l} + \varepsilon_{it}$$

$$\Delta \log(Xvol)_{it} = \alpha_{Xi} + \sum_{j=0}^{J_i} \beta_{X,ji} \cdot \Delta \log P_{X,it-j} + \sum_{j=0}^{J_i} \phi_{M,ji} \cdot \Delta \log P^{*}_{it-j}$$
$$+ \sum_{k=0}^{K_i} \psi_{X,ki} \cdot \Delta \log Mvol\_world_{t-k} + \sum_{l=1}^{L_i} \rho_{X,l} \cdot \Delta \log Xvol_{it-l} + \nu_{it}$$

from which the long-run elasticities:

$$\beta^{LR}_{M,i} = \frac{\sum_{j=0}^{J_i} \beta_{M,,ji}}{1 - \sum_{l=1}^{L_i} \rho_{M,li}}, \qquad \beta^{LR}_{X,i} = \frac{\sum_{j=0}^{J_i} \beta_{X,,ji}}{1 - \sum_{l=1}^{L_i} \rho_{X,li}}$$

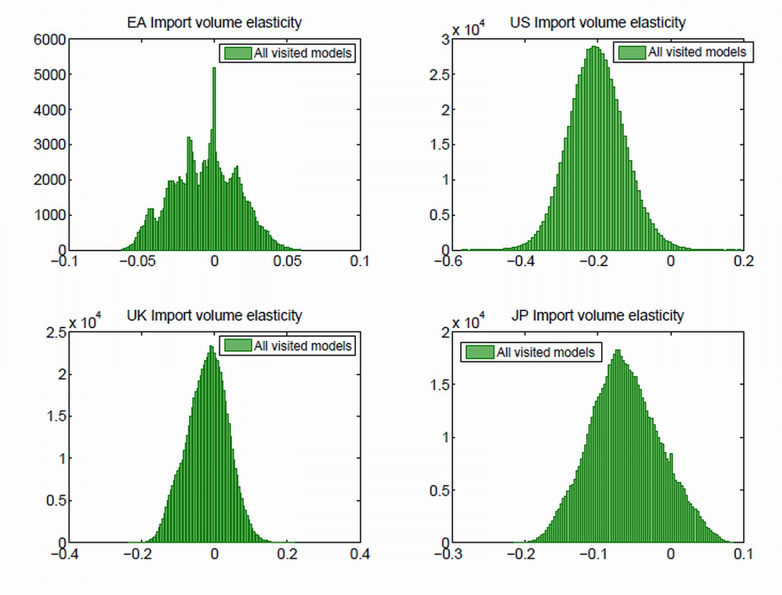
3. The exchange-rate pass-through

$$\Delta \log P_{Mit} = \alpha + \sum_{k=1}^{K_i} \rho_{ik} \Delta \log P_{Mi,t-k} + \sum_{p=0}^{P_i} \lambda_{ip} \Delta \log NEER_{i,t-p} + \sum_{q=0}^{Q_i} \phi_{iq} \Delta \log P_{i,t-q} + \sum_{j=0}^{J_i} \theta_{ij} \Delta \log P^*_{i,t-j} + \varepsilon_{it}$$

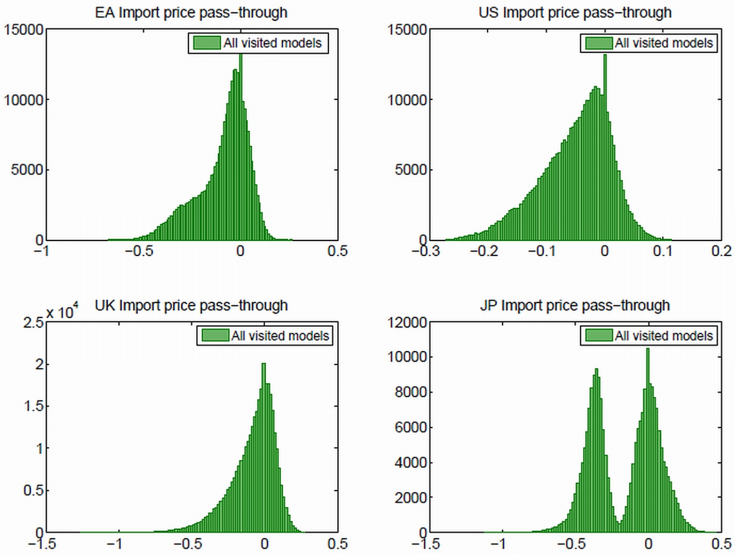
with long-run ERPT given by:

$$\lambda_{it}^{LR} = \frac{\sum_{p=0}^{P_i} \lambda_{ip}^{M}}{1 - \sum_{k=1}^{K_i} \rho_{ik}^{M}}$$

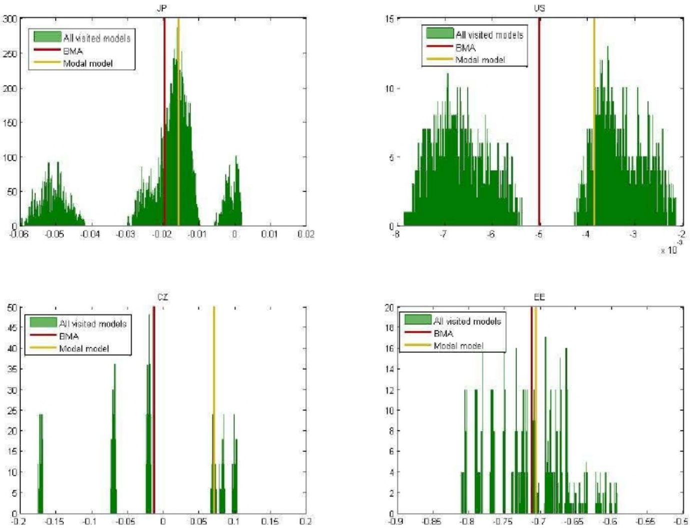
Estimated distribution of β_M for 4 countries



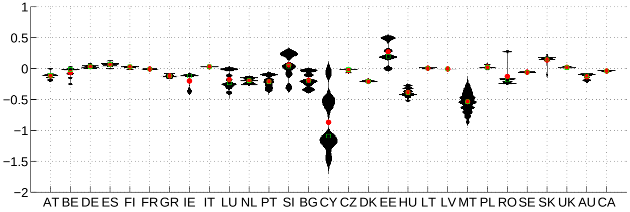
Estimated distribution of λ for 4 countries

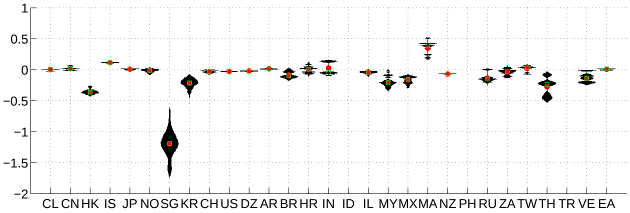


Combining the building blocks into the distribution of σ: robustness problem



Distribution of σ country by country: Non-robustness...

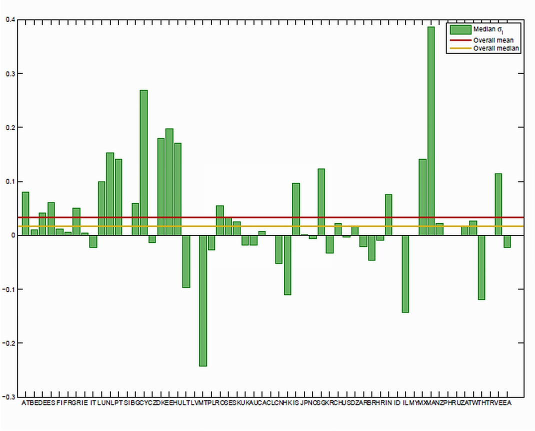




Green squares indicate the median, red circles the mean

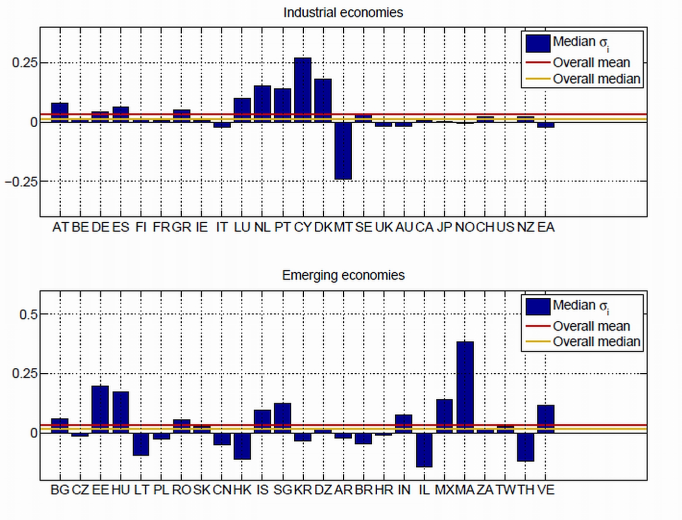
...and heterogeneity in the median estimates

- using panel methods is a bad idea
- even mean-group estimators could be distorted by outliers



Heterogeneity even within country groups

Grouping the elasticities into industrial and emerging markets would not help:



Conclusions

- The uncertainty around the trade elasticities and exchange rate passthough maps into very large uncertainty around the sensitivity of the current account to exchange rates (and Marshall-Lerner condition)
- Compounded with uncertainty about current account benchmarks: very large model uncertainty!
- This leads to doubt the robustness of FEER results
- Also find much heterogeneity in the estimates across countries: speaks against using panel methods (which dominate the literature)