International Investment Positions and Exchange Rate Dynamics: A Dynamic Panel Analysis

Michael Binder\textsuperscript{1}  Christian J. Offermanns\textsuperscript{2}

\textsuperscript{1}Goethe University Frankfurt and Center for Financial Studies

\textsuperscript{2}Goethe University Frankfurt
Empirical evidence on the adjustment of the real exchange rate to a “long-run equilibrium level” in line with Purchasing Power Parity (PPP) has been mixed.

It appears essential to view the PPP hypothesis as (at most) conditionally valid, in environments of sufficiently large arbitrage opportunities.

Taking into account the large increases in countries’ external imbalances observed over the last few decades, in this paper we relate such arbitrage opportunities to a country’s international investment position.
Modelling Approach

We propose and develop a new dynamic panel model that

1. takes into account appealing features from state of the art cross-country panel models (distinguishing long- and short-run dynamics, capturing heterogeneous short-run dynamics and cross-sectional dependence of shocks) and

2. introduces *conditional* long-run homogeneity across countries in parametric (conditional pooled mean group – CPMG) and non-parametric (state kernel mean group – SKMG) form
Related Literature: Exchange Rate Dynamics


Dynamic Panel Models with Cross-Sectional Dependence (I)

Our analysis takes as its starting point the panel autoregressive distributed lag (PARDL) model with unobserved common factors $f_t$, in error-correction representation:

$$
\Delta y_{it} = \mu_i + \alpha_i y_{i,t-1} + \beta'_i x_{it} + \sum_{k=1}^{p_i-1} \phi_{ik} \Delta y_{i,t-k} + \sum_{k=0}^{q_i-1} \delta'_{ik} \Delta x_{i,t-k} + \alpha_i (y_{i,t-1} - \theta'_i x_{it}) + \lambda'_i f_t + \varepsilon_{it}.
$$

Following Pesaran (2006), the common factor effects may be captured by adding cross-sectional averages of the observables to the model.
Established approaches in the literature to the estimation of PARDL models include:

- **Mean Group (MG) approach:** Modelling even the long-run coefficients as *heterogeneous* across countries ($\theta_i \neq \theta_j$, $i \neq j$), estimating the model for each country separately, and then computing averages of country-specific parameter estimates.

- **Pooled Mean Group (PMG) approach:** Modelling the long-run coefficients as *homogeneous* across countries ($\theta_i \equiv \theta$, $\forall i$) and estimating the model subject to this pooling restriction.
Our first approach to capturing interdependence between the long-run equilibrium and a conditioning, predetermined state variable, $\tilde{z}_{i,t-1}$, is parametric and specifies:

$$\theta(\tilde{z}_{i,t-1}) = \sum_{s=0}^{\tau} \gamma_s^{(\theta)} \cdot c_s(\tilde{z}_{i,t-1}),$$

where $c_s(\cdot)$ is the $s$-th order term of an orthogonal polynomial which depends on $\tilde{z}_{i,t-1}$, and $\gamma_s^{(\theta)}$ enters the vector of homogeneous conditional long-run coefficients. We call this the Conditional Pooled Mean Group (CPMG) approach. (Note: For parsimony, among the short-run coefficients we only model $\alpha_i$ to explicitly depend on $\tilde{z}_{i,t-1}$.)
Dynamic Panel Models with Conditionally Homogeneous Long-Run Dynamics: SKMG

Our second approach to capturing interdependence between the long-run equilibrium and the conditioning, predetermined state variable, $\tilde{z}_{i,t-1}$, is non-parametric and models $\theta_i$ as a non-parametric function of $\tilde{z}_{i,t-1}$ using a kernel function. The estimation is based on a modified residual sum of squares:

$$\min \sum_{i=1}^{N} \sum_{t=1}^{T_i} \kappa(\tilde{z}_{i,t-1} - \tilde{z}_{j,s-1}) \varepsilon_{it}^2, \quad j = 1, 2, \ldots, N, \quad s = 1, 2, \ldots, T_i,$$

where $\kappa$ denotes the kernel function.

We call this the State Kernel Mean Group (SKMG) approach.

(Note: Among the short-run coefficients we again only model $\alpha_i$ as now depending non-parametrically on $\tilde{z}_{i,t-1}$.)
Our database computes net foreign asset (NFA) positions by augmenting stock figures with accumulation of flows. Here we analyze 65 countries over the time period 1970 – 2004.

- 19 industrial countries: AUS, AUT, CAN, CHE, DEU, DNK, ESP, FIN, FRA, GBR, ITA, JPN, KOR, NLD, NOR, NZL, PRT, SWE, USA.

- 12 emerging market economies: ARG, CHL, CRI, ISR, LBY, MEX, MYS, PAN, TUR, URY, SGP, VEN.

- 34 developing countries: BFA, BOL, BRA, CIV, COL, DOM, ECU, EGY, GHA, GTM, HND, HTI, IND, JAM, JOR, KEN, LKA, MAR, MDG, MMR, NGA, PAK, PER, PHL, PNG, PRY, SDN, SEN, SLE, SLV, SYR, THA, TGO, UGA.
Net Foreign Asset Positions as a Ratio to GDP
65 Countries, 1970 to 2004
Empirical Analysis: Model Specification

\[ \Delta e_{it} = \mu_i + \alpha_i(\tilde{z}_{i,t-1}) \left[ e_{i,t-1} - \theta_i(\tilde{z}_{i,t-1})' \begin{pmatrix} p_{it} \\ p^*_i \end{pmatrix} \right] + \eta_i \bar{e}_t + \zeta_i(\bar{p}_t - \bar{p}_t^*) + \sum_{k=1}^{p_i-1} \phi_{ik} \Delta e_{i,t-k} + \sum_{k=0}^{q_{i1}-1} \delta_{1ik} \Delta p_{i,t-k} + \sum_{k=0}^{q_{i2}-1} \delta_{2ik} \Delta p_{i,t-k} + \sum_{k=0}^{p_i-1} \nu_{ik} \Delta \bar{e}_{t-k} + \sum_{k=0}^{\max(q_{1i},q_{2i})-1} \varsigma_{ik} (\Delta \bar{p}_{t-k} - \Delta \bar{p}_{t-k}^*) + \varepsilon_{it}. \]

Invoking the Pesaran (2007) panel unit root test and the Westerlund (2005) panel cointegration test, we find evidence that \( p \), \( p^* \) and \( e \) are \( I(1) \), and that there is a cointegrating relation between these variables conditional on \( \tilde{z} \).
Empirical Analysis: Estimation Methods

MG: \[ \alpha_i(\tilde{z}_{i,t-1}) = \alpha_i, \quad \theta_i(\tilde{z}_{i,t-1}) = \theta_i. \]

PMG: \[ \alpha_i(\tilde{z}_{i,t-1}) = \alpha_i, \quad \theta_i(\tilde{z}_{i,t-1}) = \theta. \]

CPMG: \[ \alpha_i(\tilde{z}_{i,t-1}) \text{ and } \theta_i(\tilde{z}_{i,t-1}) = \theta(\tilde{z}_{i,t-1}) \]
are modelled using first-/third-order Chebyshev polynomials.

SKMG: \[ \alpha_i(\tilde{z}_{i,t-1}) \text{ and } \theta_i(\tilde{z}_{i,t-1})/\alpha_i(\tilde{z}_{i,t-1}) = \beta_i(\tilde{z}_{i,t-1}) \]
are modelled using a Gaussian kernel combined with first-order Chebyshev polynomials.

The \( \tilde{z}_{i,t-1} \)-series is constructed using the trend component of a one-sided Hodrick Prescott filter, with various specifications of the cycle length.
A Comparison of (Average) Parameter Estimates under MG, PMG, CPMG and SKMG
AIC Lag Selection, 65 Countries, 1970 – 2004

\[ \Delta e_{it} = \alpha_i(\tilde{z}_{i,t-1}) \left[ e_{i,t-1} - \theta_1(\tilde{z}_{i,t-1})p_{it} - \theta_2(\tilde{z}_{i,t-1})p_{it}^* \right] \\
+ \chi'g_t + \Sigma_j \delta'_{ij} \Delta w_{i,t-j} + \varepsilon_{it} \]

<table>
<thead>
<tr>
<th></th>
<th>MG</th>
<th>PMG</th>
<th>CPMG</th>
<th>SKMG</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\alpha)</td>
<td>-0.4945</td>
<td>-0.3732</td>
<td>-0.3979</td>
<td>-0.3674</td>
</tr>
<tr>
<td></td>
<td>(0.0366)</td>
<td>(0.0321)</td>
<td>(0.0314)</td>
<td>(0.0001)</td>
</tr>
<tr>
<td>(\theta_1)</td>
<td>-0.1938</td>
<td>0.8231</td>
<td>0.8176</td>
<td>0.5881</td>
</tr>
<tr>
<td></td>
<td>(0.5433)</td>
<td>(0.0231)</td>
<td>(0.0128)</td>
<td>(0.0205)</td>
</tr>
<tr>
<td>(\theta_2)</td>
<td>-0.6549</td>
<td>-0.5490</td>
<td>-0.6916</td>
<td>-0.5530</td>
</tr>
<tr>
<td></td>
<td>(0.3051)</td>
<td>(0.0722)</td>
<td>(0.0128)</td>
<td>(0.0175)</td>
</tr>
</tbody>
</table>

*Note:* Standard errors are given in parentheses below coefficients; figures in bold face denote significance at the 5% level.
Variations of Long-Run Coefficients: Conditional Pooled Mean Group (CPMG) Approach (I)
AIC Lag Selection, 65 Countries, 1970 – 2004

\[ \omega = 10 \]
Variations of Long-Run Coefficients: Conditional Pooled Mean Group (CPMG) Approach (II)
AIC Lag Selection, 65 Countries, 1970 – 2004

Binder / Offermanns
Goethe University
Variations of Long-Run Coefficients: State Kernel Mean Group (SKMG) Approach
AIC Lag Selection, 65 Countries, 1970 – 2004

Binder / Offermanns
Goethe University
The estimation results for the full sample of 65 countries are qualitatively rather robust to a sample split based on income levels.

Quantitatively, the definition of “limited negative” NFA to GDP ratios is affected: PPP in high and middle income countries appears to be a relevant anchor for foreign exchange markets for smaller international investment position imbalances than for low income countries.
Robustness of Estimation Results With Respect to Exchange Rate Regimes

Splitting our full sample of 65 countries on the basis of the Levy-Yeyati and Sturzenegger (2005) *de facto* exchange rate regime classification into a sub-sample of “sticky exchange rates” and a sub-sample of “floating exchange rates”, we find no evidence that our conditioning of medium- to long-run exchange rate dynamics on the international investment position would be driven by exchange rate regimes.
Splitting our full sample of 65 countries into two sub-samples of countries with relatively high/low degrees of price stability, we find no evidence that our conditioning of medium- to long-run exchange rate dynamics on the international investment position would be driven by a country’s price stability record.
Splitting our full sample of 65 countries into two sub-samples of countries with relatively small/large terms of trade shocks, we find no evidence that our conditioning of medium- to long-run exchange rate dynamics on the international investment position would be driven by the magnitude of a country’s terms of trade shocks.
Our methodological framework seems well suited to making progress on computing anchors for medium- and long-run exchange rate dynamics in heterogeneous cross-country environments.

We find surprisingly strong support for PPP as an anchor for exchange rate determination in environments of “limited negative” NFA to GDP ratios.

For other international investment position environments, PPP is of little help to provide guidance for medium- and long-run exchange rate dynamics.
# List of Countries