How to Decompose Exchange Rate Misalignment into Domestic and Global Factor using Global VAR Approach.

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Talking points

Motivation for a Global VAR:

- Small Open Economy assumption may not hold for many countries;
- There are many customs unions, common markets, free trade areas;
- Growing Financial market integration;
- Free movement labour areas;

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Effective equilibrium RER based on fundamentals

From intertemporal macroeconomic models it's possible to obtain to steady state equations:

$$\overline{tb} = -r * \overline{NFA} \quad (1)$$

$$\overline{RER} = -\phi \overline{tb} + \lambda \overline{X} \quad (2)$$

$r_s = r_{real} - g_{gdp}$, r_{real} is the real interest rate and $g_{gdp}$is ths real GDP growth rate..

- First equation states that a country can run a trade deficits if revenues from NFA are large enough;
- Second equation states that if a country can run a trade deficit in equilibrium the RER has to appreciate;

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$$\overline{tb} = -r * \overline{NFA} \quad (3)$$

$$\overline{RER} = -\phi \overline{tb} + \lambda \overline{X} + \delta \bar{W} \quad (4)$$

$$\overline{X} = \Phi \overline{Z} \quad (5)$$

$r_s = r_{real} - g_{gdp}$, r_{real} is the real interest rate and $g_{gdp}$is ths real GDP growth rate and $\overline{X}$ is a domestic variable and $\overline{Z}$ and $\overline{W}$ are variables that affect fundamentals.

- First equation states that a country can run a trade deficits if revenues from NFA are large enough;
- Second equation states that if a country can run a trade deficit in equilibrium the RER has to appreciate
- Third Equation links domestic fundamentals to external variables;

Talking Points

Traditional Approach

- Fundamental Real exchange rate is calculated using a econometric model:
  - Cointegration techniques based on selected series associated with fundamentals (Faruquee, 1994, IMF Working Paper, 90);
  - Some possible choices of the fundamentals variables
    - net international investment position as GDP share;
- Econometric Questions:
  - Detect long run relationship - cointegration analysis;
  - Perform permanent and transitory decomposition to better understand the adjustment towards equilibrium;
    - Gonzalo and Granger (1995) decomposition is the most common choice;

Problems not addressed under the traditional approach

- Do not tackle possible interdependence among countries fundamentals:
  - GVAR is a good option;
- Challenges to overcome:
  - Curse of dimensionality;
  - Inference of the number of cointegrated relationships;

Talking Points

GVAR structure

- Steps to estimate GVAR:
  - Add weighted variable to each unit model and estimate the proper congruent VECMX;
  - Test for weak exogeneity;
  - Solve the global model;

GVAR and error correction representation

We can write the Global VECM as:

$$\Delta X_t = AB'WX_{t-1} + \tilde{\Gamma}_1 \Delta Z_{it-1} + ... + \tilde{\Gamma}_{k-1} \Delta Z_{t-k+1} + \tilde{\Phi} D_t + \tilde{\Gamma}_{0,1} \Delta \overline{X}_t + \tilde{\varepsilon}_t \quad (6)$$

Defining $\Gamma^*_{0,1} W \Delta X_t \equiv \tilde{\Gamma}_{0,1} \Delta \overline{X}_t$, and after some algebra, we obtain equation below:

$$[I - \Gamma^*_{0,1} W] \Delta X_t = AB'WX_{t-1} + \tilde{\Gamma}_1 \Delta Z_{it-1} + ... + \tilde{\Gamma}_{k-1} \Delta Z_{t-k+1} + \tilde{\Phi} D_t + \tilde{\varepsilon}_t \quad (7)$$

Assume that we can calculate the inverse of matrix $[I - \Gamma^*_{0,1} W]$, then, the global model can be solved, yielding the solution to the global VECM, as shown in below:

$$\Delta X_t = A^* B'WX_{t-1} + \tilde{\Gamma}^*_1 \Delta Z_{it-1} + ... + \tilde{\Gamma}^*_{k-1} \Delta Z_{t-k+1} + \tilde{\Phi}^* D_t + \tilde{\varepsilon}^*_t . \quad (8)$$

Permanent and transitory decomposition under GVAR

- The transitory component is given by (9):

$$T_t^{GVAR} = A^*(B'WA^*)^{-1}B'WX_t - E(A^*(B'WA^*)^{-1}B'WX_t) \quad (9)$$

- The permanent component is defined as the difference between the actual values of the series and the transitory component given in (9).
- The matrix given by (10) contains the weights that each cointegrated relationship will contribute to the transitory component:

$$LF^{GVAR} = A^*(B'WA^*)^{-1}. \quad (10)$$

- The exchange rate misalignment can be calculated for country i by picking the country's real exchange rate in vector T_t^{GVAR} :

$$mis_{i,t}^{GVAR} \equiv [\ 0 \quad \dots \quad 0_{p(i-1)} \quad 1 \quad 0 \quad \dots \quad 0\ ]T_t^{GVAR}. \quad (11)$$

Evaluating the GVAR:

.

Let's also assume that the analysis from a traditional CVAR with no external variables shows evidence of two cointegrated relationships.

$$\begin{bmatrix} ECM_{1,t} \\ ECM_{2,t} \end{bmatrix} = \tilde{\beta} WX_t = \begin{bmatrix} 1 & * & 0 & 0 & c_1 \\ 0 & 1 & * & * & c_2 \end{bmatrix} WX_t \qquad (12)$$

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Assume that after cointegration tests for a particular country j, the number of cointegration vectors is 3. The vectors will have the structure given by (13).

$$\begin{bmatrix} ECM_{1,t} \\ ECM_{2,t} \\ ECM_{3,t} \end{bmatrix} = \tilde{\beta} WX_t = \begin{bmatrix} 1 & * & * & * & * & * & * & * & c_1 \\ * & 1 & * & * & * & * & * & * & c_2 \\ * & * & 1 & * & * & * & * & * & c_3 \end{bmatrix} WX_t \qquad (13)$$

where $X_t = [LRER_t, NFA_t, TB_t, BS_t, WLRER_t, WNFA_t, WTB_t, WBS_t, 1]$.

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Identifying Restrictions on Cointegrated Space

The previous evidence of cointegration suggests identifying restrictions on the cointegration space of the country j in the GVAR.
The cointegrated space must be like the ones of equation (14)

$$\begin{bmatrix} ECM_{1,t} \\ ECM_{2,t} \\ ECM_{3,t} \end{bmatrix} = \tilde{\beta} WX_t = \begin{bmatrix} 1 & * & 0 & 0 & 0 & 0 & 0 & 0 & c_1 \\ 0 & 1 & * & * & 0 & 0 & 0 & 0 & c_2 \\ * & * & 1 & * & * & * & * & * & c_3 \end{bmatrix} WX_t \qquad (14)$$

Further Identifying Restrictions:

- The relationships can be identified by imposing zero restriction on some coefficients.
- One possibility is to test whether
  - Third vector is a relationship between domestic fundamentals and external fundamentals, and
  - First and second relationships are identifying the system of equations (1) and (2) .

$$\begin{bmatrix} ECM_{1,t} \\ ECM_{2,t} \\ ECM_{3,t} \end{bmatrix} = \tilde{\beta} WX_t = \begin{bmatrix} 1 & 0 & * & * & 0 & 0 & 0 & 0 & c_1 \\ 0 & 1 & * & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & * & 1 & * & 0 & * & * & * & c_3 \end{bmatrix} WX_t \qquad (15)$$

Decomposing the exchange rate misalignment

Imposing these restrictions , it is possible to decompose misalignment into two pieces:

$$mis_{i,t}^{GVAR} = T_{i,t}^{DOM} + T_{i,t}^{EXT} \quad (16)$$

By calculating $mis_{i,t}^{GVAR} - mis_{i,t}^{VECM}$ it is possible to obtain, similar to the Blinder-Oaxaca decomposition, a decomposition of the factor that explains the changes from one methodology to the other:

$$mis_{i,t}^{GVAR} - mis_{i,t}^{VECM} = (\frac{h_2}{h_1} - 1)h_1 f_{1,t} + h_2(f_{2,t} - f_{1,t}) + T_{i,t}^{EXT} \quad (17)$$

where h_2 and h_1 are the weights, in GVAR and CVAR respectively, of the domestic vectors on misalignment, and f_2 and f_1 are the estimated cointegrated vectors, in GVAR and CVAR, under the same identifying restrictions.

Talking Points

Brief Database Description

- Real Effective Exchange Rate - end of period - IFS-IMF and BIS-CPI index ;
- NFA/GDP - Milesi & Ferreti database until 2000 and IFS-IMF;
- Relative Prices between Non-tradables and tradables goods - IFS-IMF;
- Trade Balance/GDP - World Bank
- Weights for country j in the GVAR are the trade's share of country i in total trade volume of country j;
- Period of the Sample: 1970 to 2012;
- Frequency: annual.

Talking Points

Autometrics Strategy: Step 1

- The full estimation of the system (with the external variables) should easily consume the degrees of freedom.
- To deal with this problem, in a first step, initially we assume the relative per capita GDP growth as weakly exogenous, reducing the system to three equations,
- Then we run model selection procedure called Autometrics to select the number of lags (one or two) and the weakly exogenous variables added in the model.
- If the selected system of equations fails in any of diagnostic tests, we perform one more time the model selection procedure by adding impulse and level dummies to control for possible structural change and outliers.

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Autometrics Strategy: Step 2

The general unrestricted model (GUM) is given by the following equation:

$$\Delta x_{i,t} = \sum_{h=1}^{q} \theta_{1h}^{1} V_{ht}^{i} + \sum_{h=1}^{T_i} \theta_{2h}^{1} IS(T_h) + \sum_{h=1}^{T_i} \theta_{2h}^{1} DIS(T_h) + u_i^1, \quad (18)$$

where

$$IS(T_i) = \begin{cases} 1 & if \quad t = T_i \\ 0 & if \quad t \neq T_i \end{cases}, DIS(T_i) = \begin{cases} 1 & if \quad t = T_i \\ -1 & if \quad t = T_i + 1 \\ 0 & otherwise \end{cases}.$$

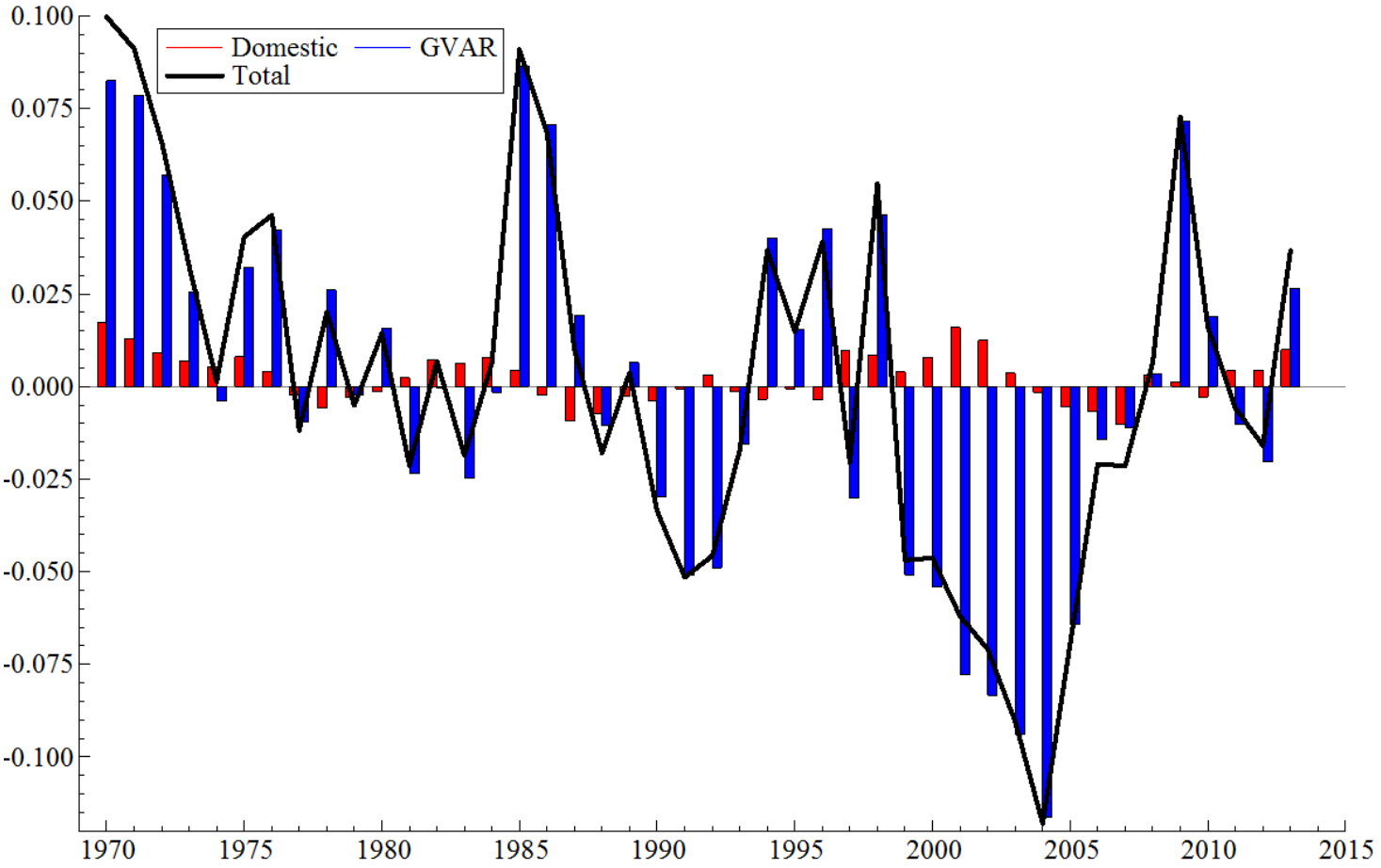
and $V^i = V_1^i, V_2^i, ..., V_q^i$ contains all GVAR's country i variables.

Testing Overidentifying assumptions

Country	External Variables Selected	Long-Run Relationships	LR Test
Australia	WRER, WNFA, WBS	2	1.27
Austria	WRER, WNFA, WTB	3	-
Belgium	WRER	1	0.59
Brazil	WRER, WNFA, WTB, WBS	3	-
Canada	WNFA, WTB	0	1.79
China	WRER, WBS	2	0.05
Colombia	WRER, WNFA	2	0.02
Denmark	WNFA	1	3.70
Finland	WNFA, WTB	3	-
France	WRER, WTB	1	1.76
Germany	WTB, WBS	2	0.17
Greece	-	1	2.60
India	WRER, WNFA	2	1.02
Indonesia	WNFA, WTB	3	-
Ireland	WRER, WBS	0	3.55
Italy	WTB, WBS	0	4.54
Japan	WRER, WBS	2	4.20*
Korea	WRER, WTB	2	1.59
Mexico	WRER, WTB	1	1.01
Netherlands	WRER, WNFA, WTB	2	0.02
New Zealand	WNFA, WTB, WBS	2	0.16
Portugal	WTB	1	4.92
Singapore	WBS	1	1.86
Spain	WTB	1	9.41**
Sweden	WRER, WTB	2	0.79
Switzerland	WTB	2	0.06
Turkey	WRER, WNFA, WTB	1	0.96
United Kingdom	WRER, WNFA, WTB, WBS	3	-
United States	WRER, WNFA, WTB	2	0.01
Uruguay	WBS	2	0.02

Talking Points

Misalignment: United States



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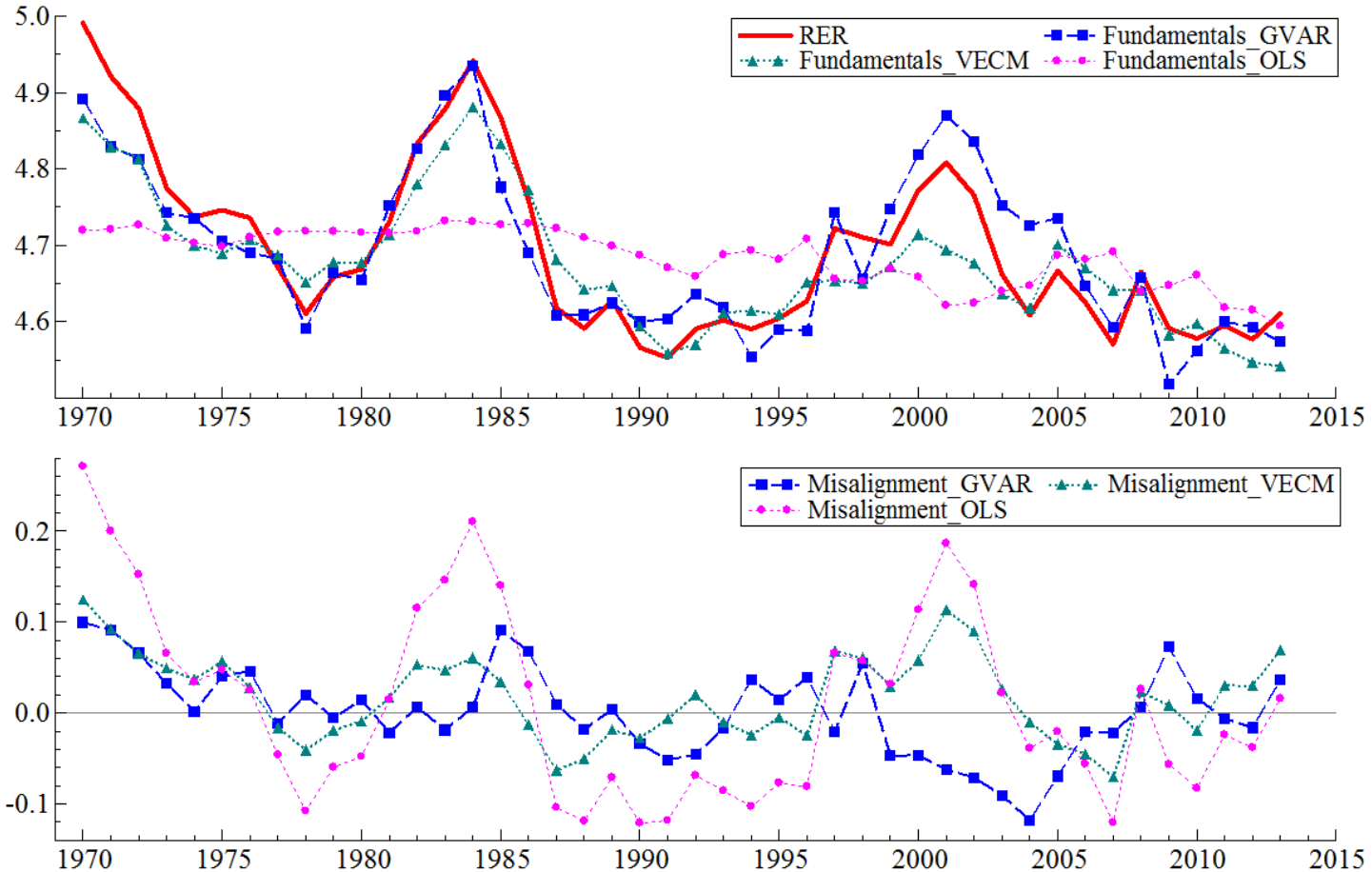
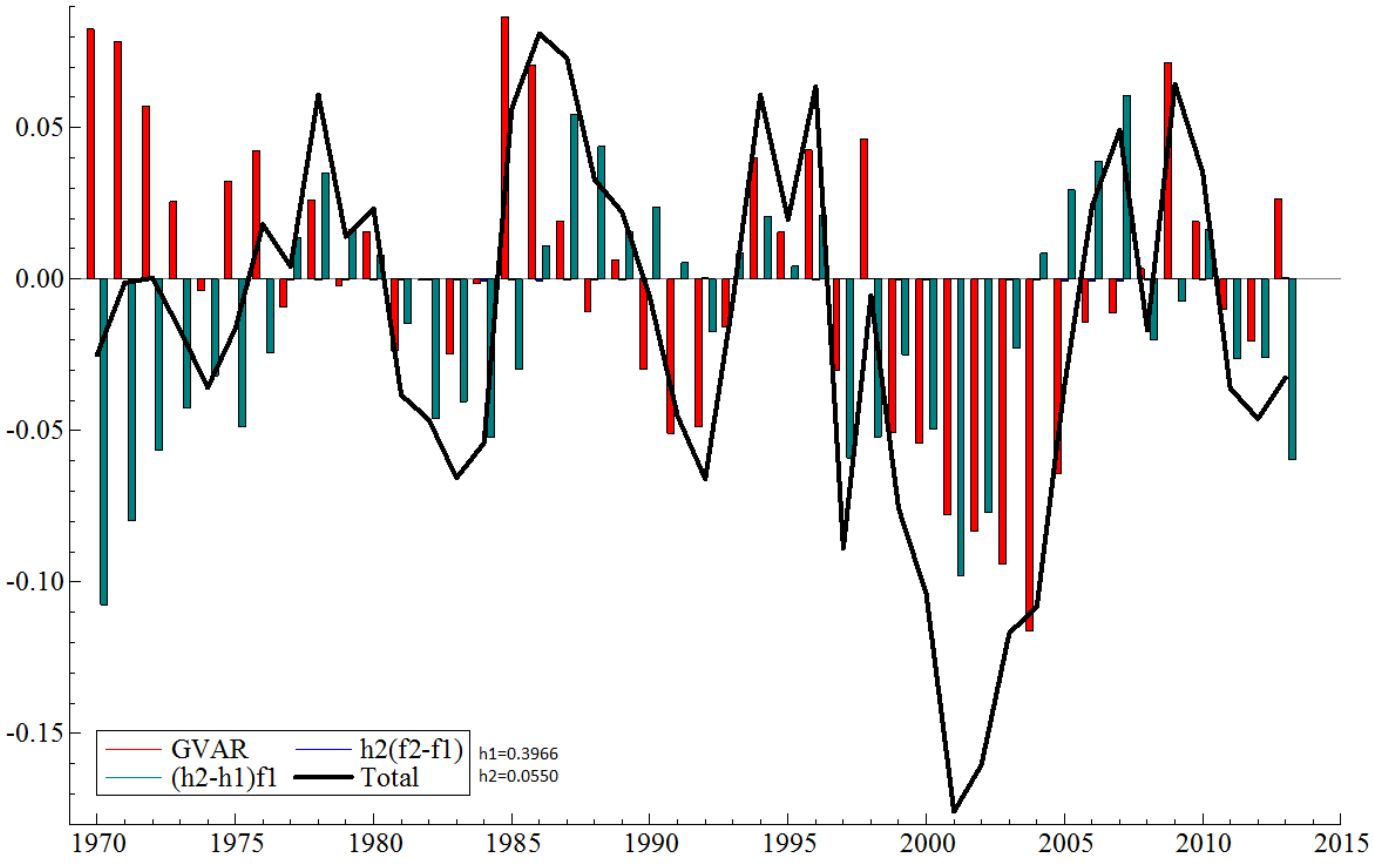
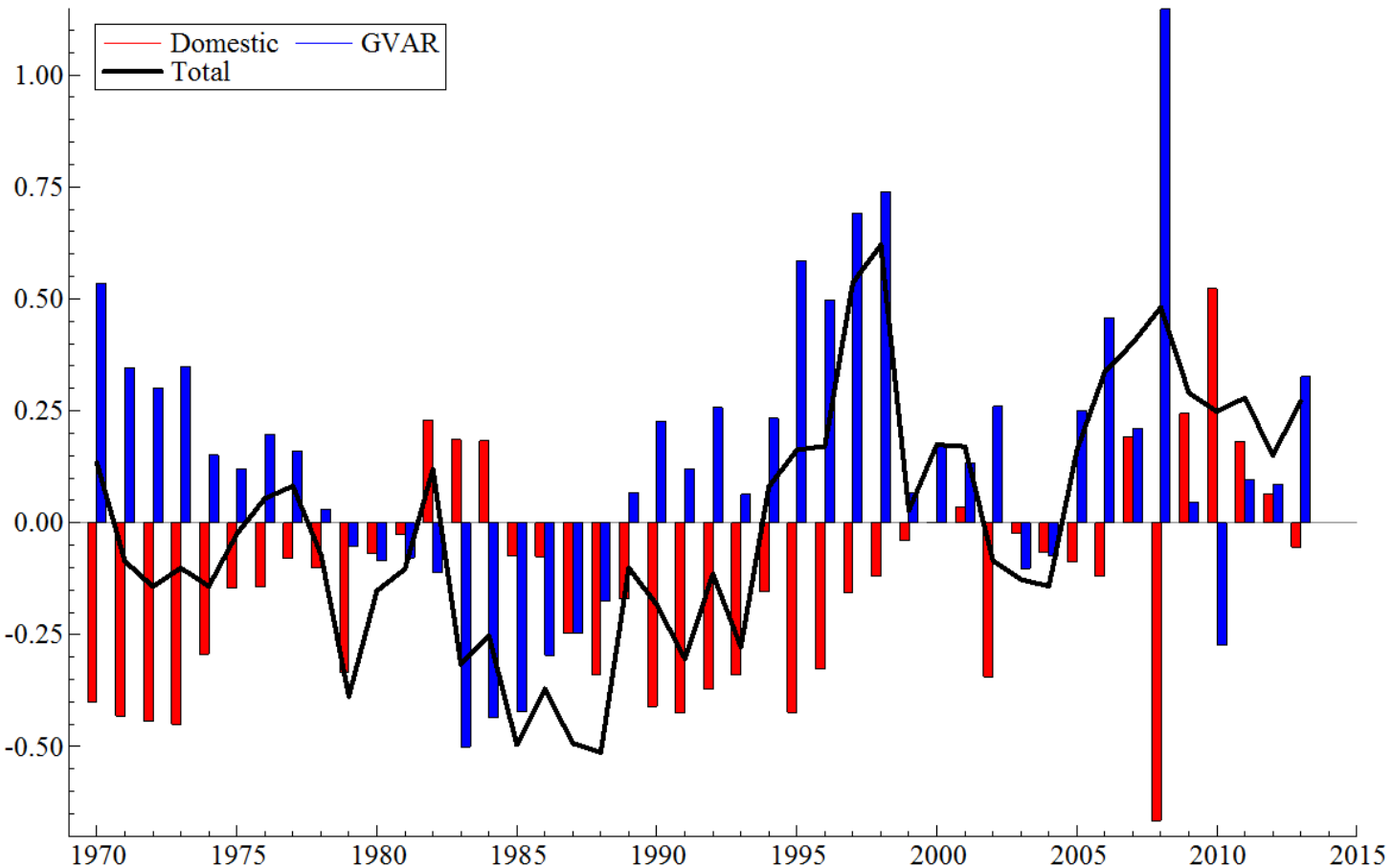


Differences between GVAR and Traditional Approach: United States



Misalignment: Brazil



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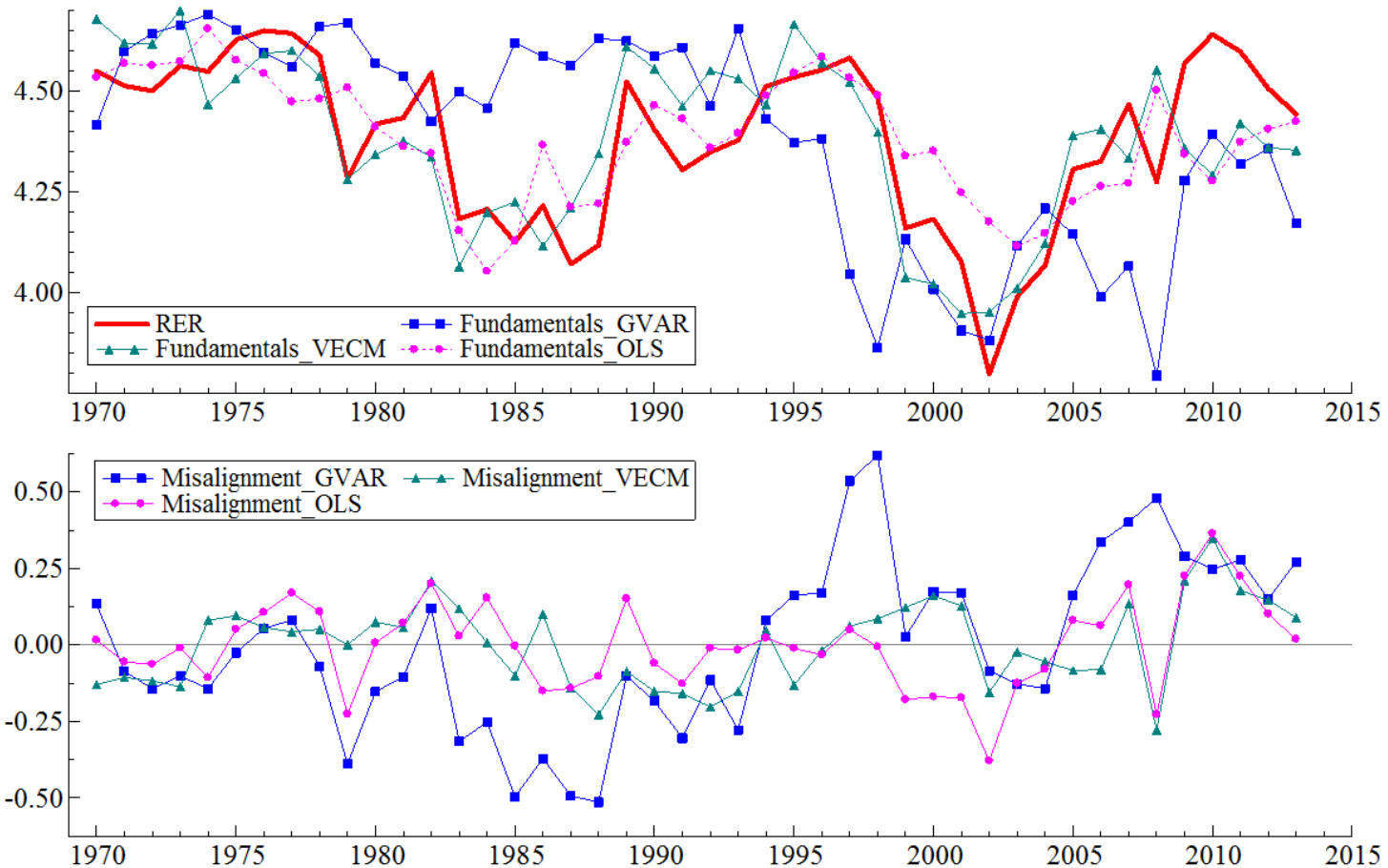

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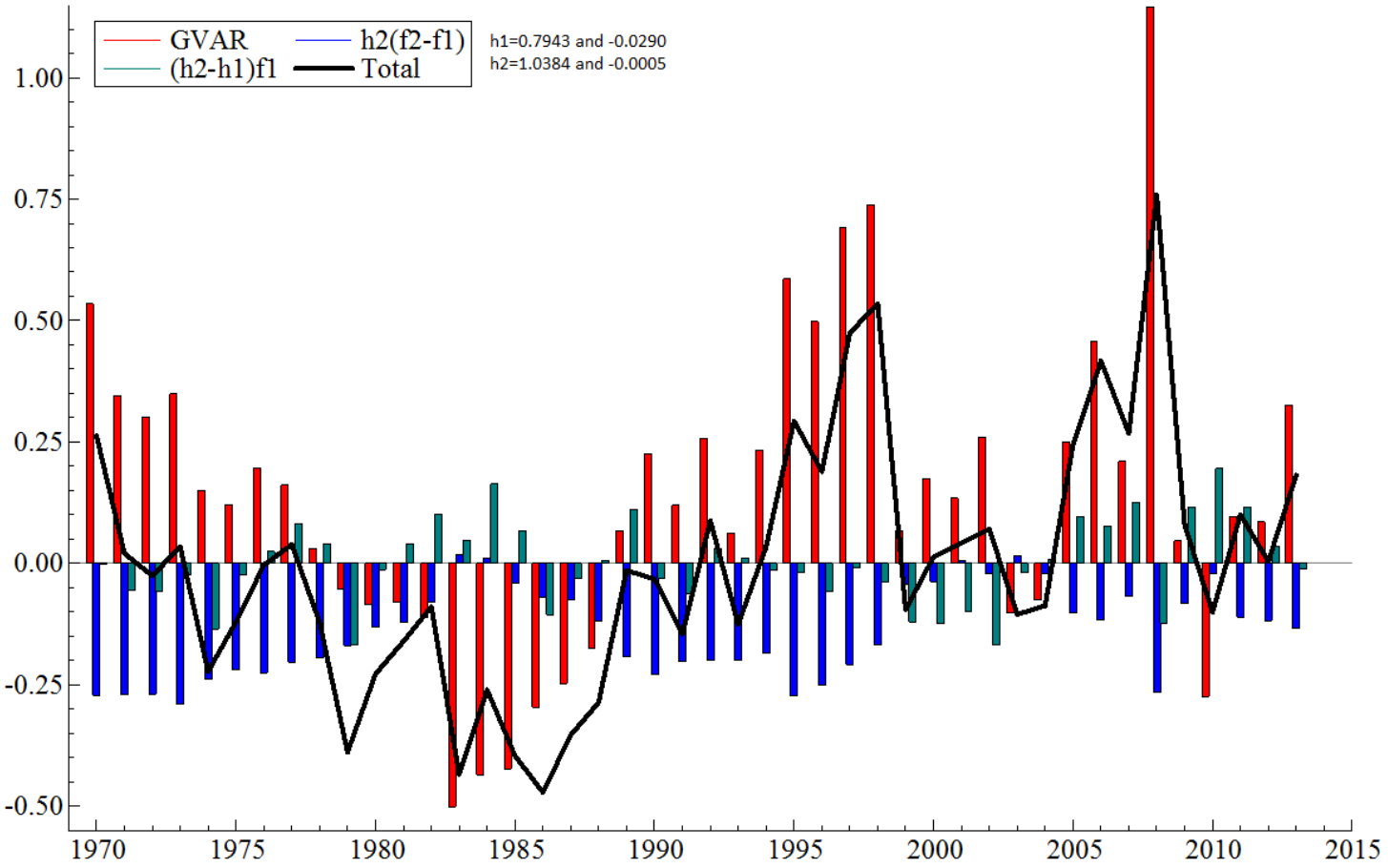

Possible extensions

- Include a broader set of variables in each countries models;
- Try different weights in GVAR;
- Search for additional sources of interdependence and global factors;
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Conclusions

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- These effects can change exchange rate misalignment estimates;
- It's possible impose economic meaningful restrictions in cointegration relationships, allowing us to decompose the exchange rate misalignment;
- For Brazil and United States, e.g., the estimated misalignments from GVAR are very different from those estimated with traditional methodologies.

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