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The Harrod-Balassa-Samuelson Effect: Reconciling the Evidence

ECB - BoC Workshop : "Exchange Rates and Macroeconomic Adjustment"
15 -16 June 2011

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Introduction & Motivation: HBS Hypothesis

- Developed by Harrod (1933), Balassa (1964) and Samuelson (1964)
- To explain sustained real exchange rate (RER) appreciations in rapidly growing economies, via productivity increases
  - Strongest evidence in Japan and Eastern Europe
- Posits that relatively strong productivity growth in the tradables sector raises the relative price of nontradables and the RER
- Provides an argument against long-run purchasing power parity

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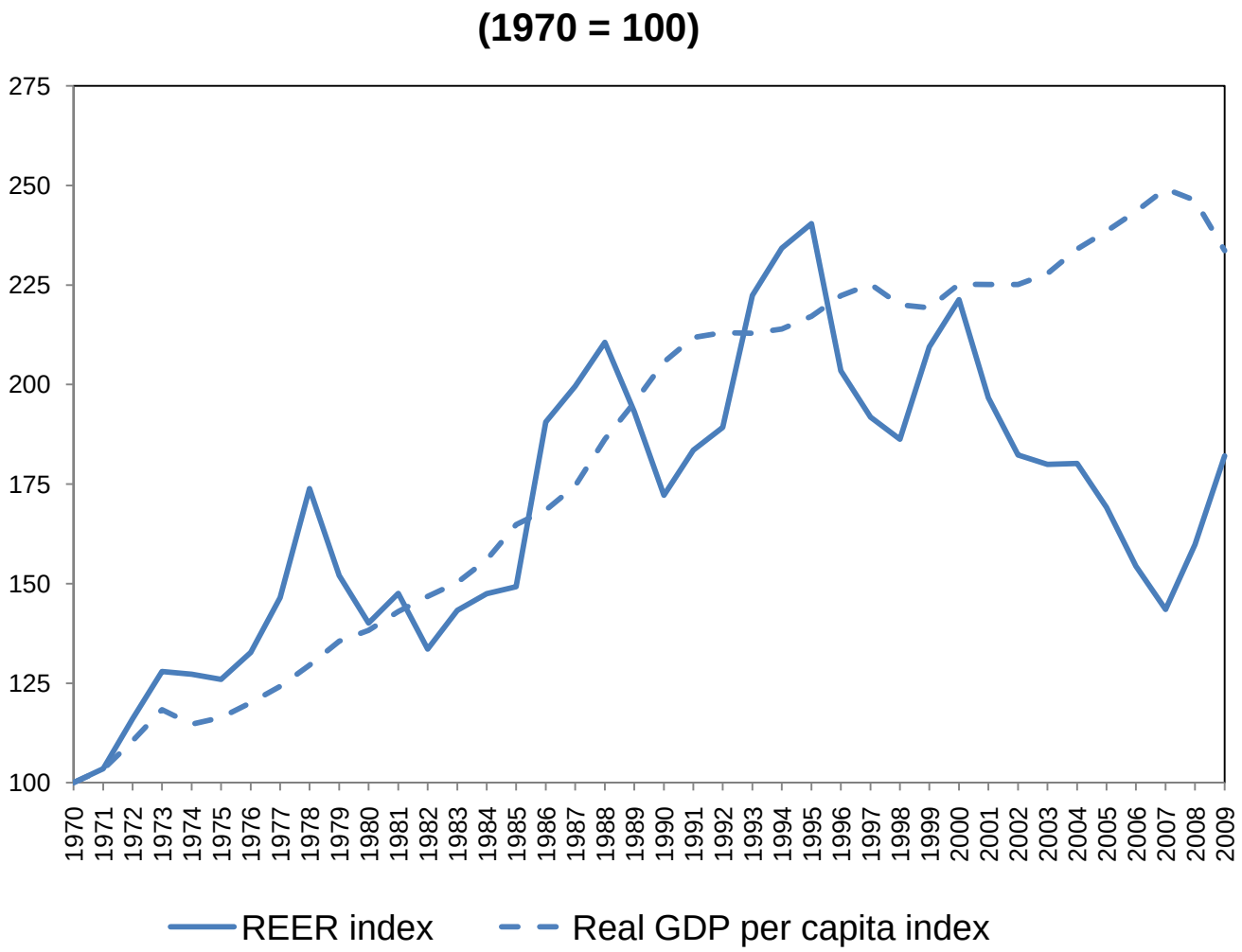
Japan: RER and Real Per Capita Income



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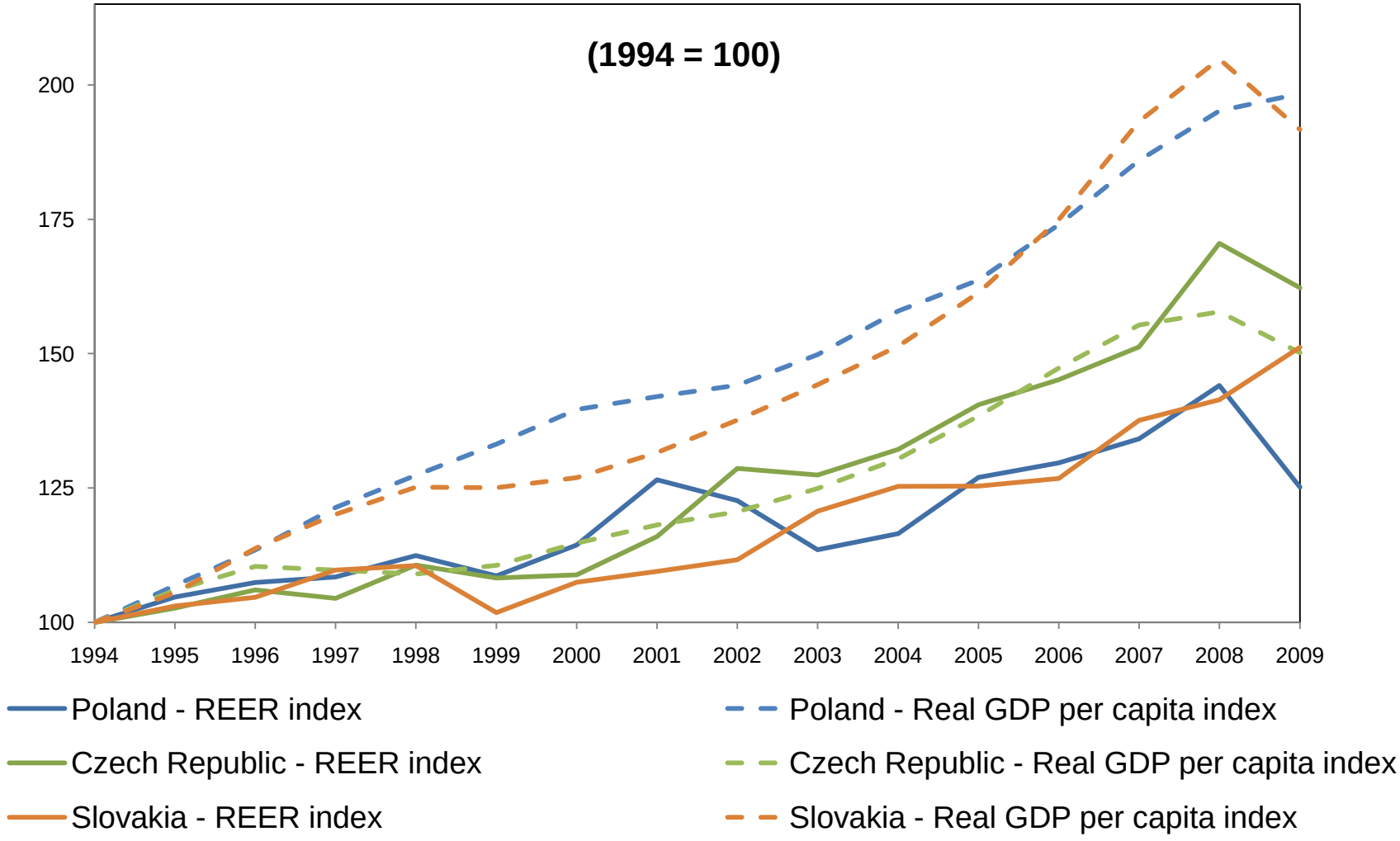
Poland, Czech & Slovakia: RER & Real Per Capita Income



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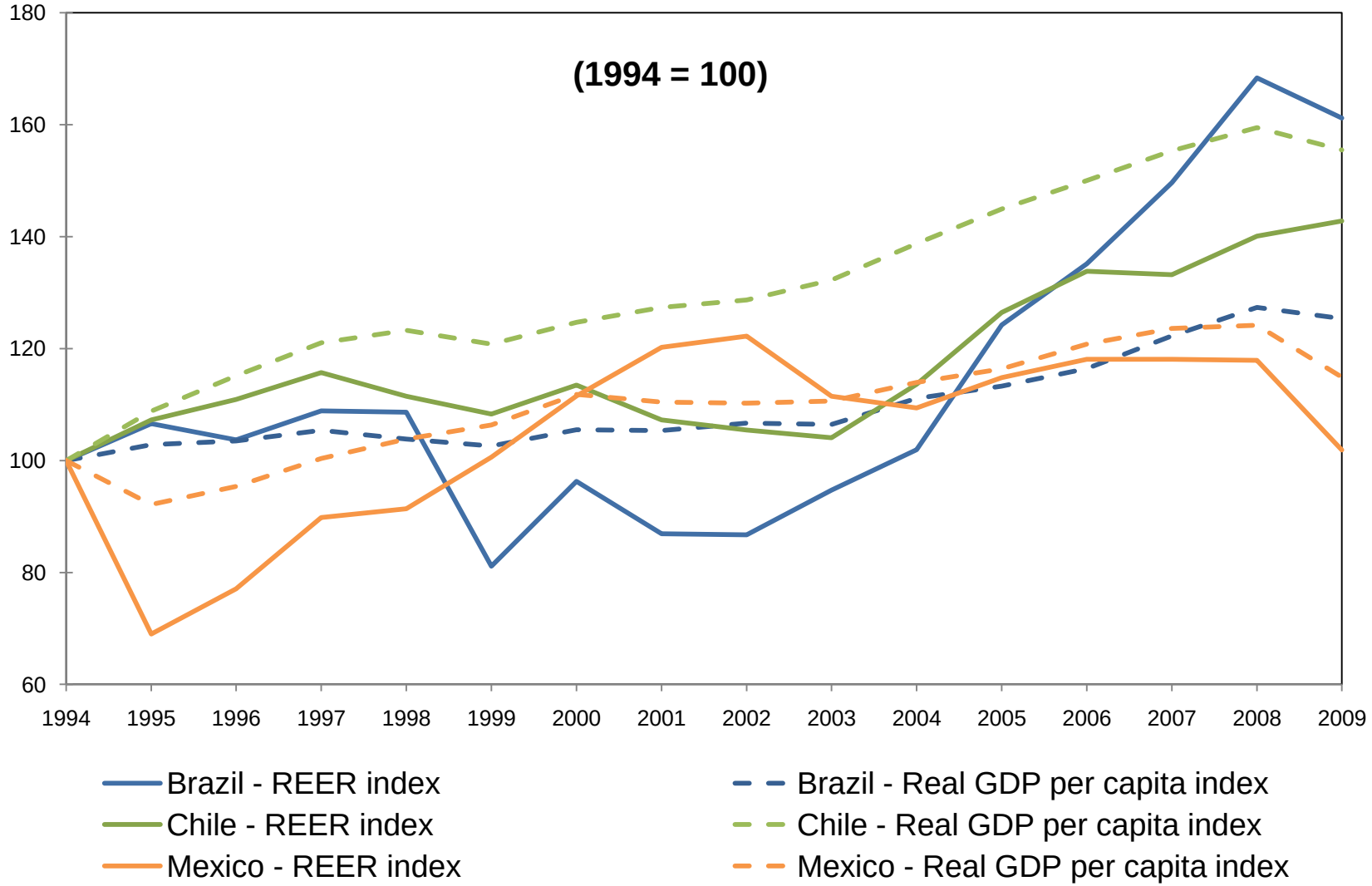
Brazil, Chile and Mexico: RER & Per Capita Income



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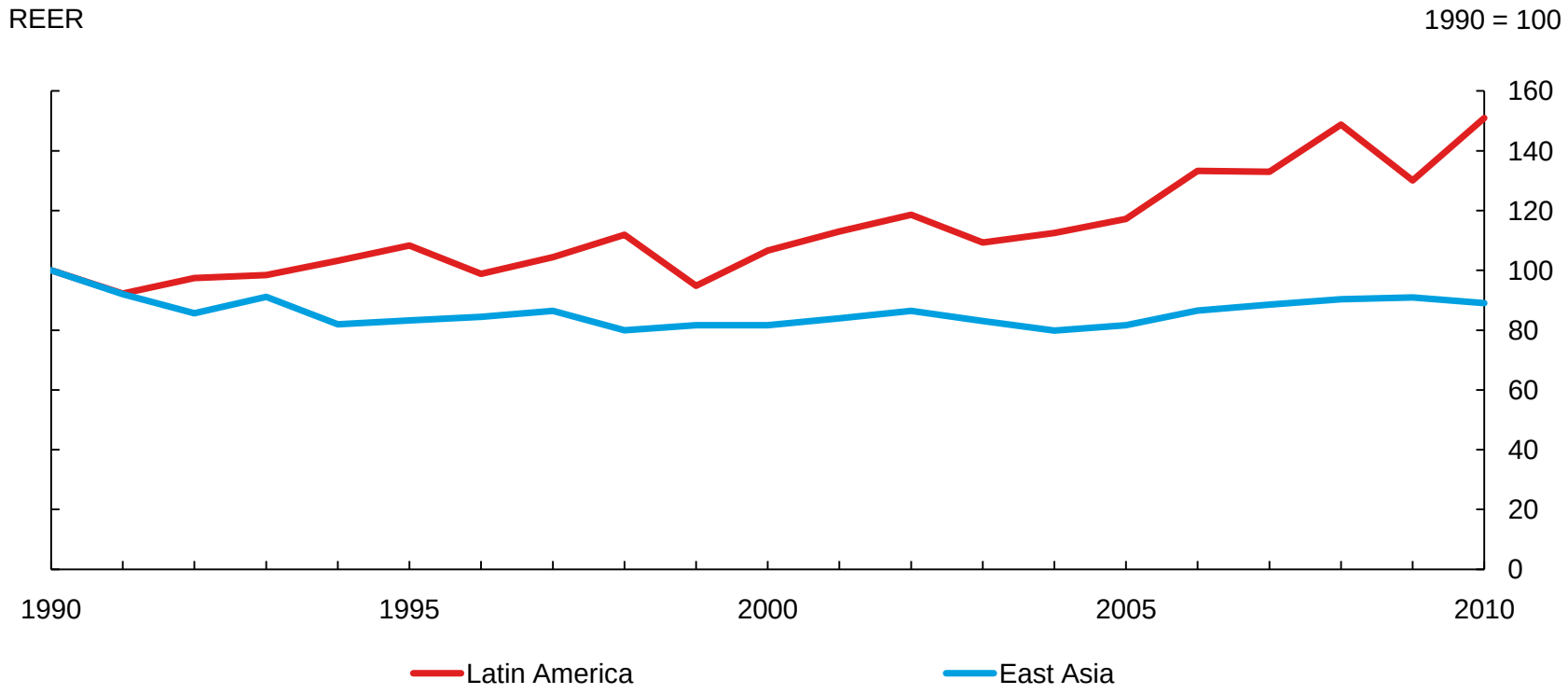
RER adjustment in Latin America versus East Asia

Chart 2: EME Real Effective Exchange Rate



Source: JP Morgan

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Purpose: Reconciling the evidence

- The main purpose of the paper is to attempt to reconcile the mixed evidence surrounding the HBS hypothesis
- Both theoretically and empirically
- Derive a theoretically based empirical model
  - Using per-capita income is not a true test of HBS hypothesis
- Estimate the model using a consistent OECD panel database on labour productivity by sector

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Methodology / Outline

1. Derive the *conventional* empirical model for the HBS hypothesis

2. Derive an *extended* version of the empirical model of the HBS hypothesis using a monopolistically competitive model

3. Estimate the empirical model using time series/panel data techniques

4. Interpret and reconcile the results

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Theoretical Framework

- Derive the empirical relations to represent the HBS hypothesis
- Two countries (home and foreign), one factor (labour), and two composite goods (tradable and nontradable goods)
- Focus on long-run effects: Assume flexible prices, financial autarky, mobile labour and balanced trade
- To facilitate comparison across two models, assume CES aggregators and a continuum of goods in tradable and nontradable bundles

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The Conventional Model

Consumption: Aggregate, Nontradable and Tradable

$$C = \left[\gamma^{1/\varepsilon} C_N^{(\varepsilon-1)/\varepsilon} + (1-\gamma)^{1/\varepsilon} C_T^{(\varepsilon-1)/\varepsilon} \right]^{\varepsilon/(\varepsilon-1)}$$

$$C_N = \left[\int_{i \in \Omega_N} C_N(i)^{(\sigma-1/\sigma} di \right]^{\sigma/(\sigma-1)}$$

$$C_T = \left[\int_{j \in \Omega_T} C_T(j)^{(\sigma-1/\sigma} dj \right]^{\sigma/(\sigma-1)}$$

Production: Nontradable and Tradable

$$Y_N(i) = A_N L_N(i)$$

$$Y_T(j) = A_T L_T(j)$$

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The Conventional Model

Real Exchange Rate Relation:

- Each country's tradable/nontradable productivity ratio affects the RER via the relative price of nontradables

- Assume that the share of nontradables is same across countries, the RER is related to home/foreign productivity ratio in each sector

- Letting a hat over a variable denote the log deviation from its initial value, obtain a typical form of the HBS relation:

$$\hat{Q} = \gamma(\hat{A}_T - \hat{A}_T^*) - \gamma(\hat{A}_N - \hat{A}_N^*)$$

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Monopolistic Competition Model

- Monopolistic competition in each sector with symmetrical firms and free entry

- Nontradable good is still an aggregate of (nontradable) varieties

- Tradable good now is of a continuum of home & foreign varieties:

$$C_T = \left[\theta^{1/\eta} C_H^{(\eta-1)/\eta} + (1-\theta)^{1/\eta} C_F^{(\eta-1)/\eta} \right]^{\eta/(\eta-1)},$$

$$C_H = \left[\int_{j \in \Omega_H} C_H(j)^{(\sigma-1)/\sigma} dj \right]^{\sigma/(\sigma-1)}, C_F = \left[\int_{j^* \in \Omega_F} C_F(j^*)^{(\sigma-1)/\sigma} dj^* \right]^{\sigma/(\sigma-1)}$$

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Monopolistic Competition Model

- $1/A_N$ and $1/A_H$ units of labor to produce a unit of a domestic non-tradable and a tradable variety

- ϕ/A_N and ϕ/A_H fixed amounts for non-production activities

- In the monopolistic competition model, home-foreign productivity differentials affect the RER through two additional channels:
  1. the terms of trade
  2. the number of home and foreign varieties

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Monopolistic Competition Model

Real Exchange Rate Relation:

- Solve the model to derive:

$$\hat{Q} = (\gamma + \mathrm{T}_1 + \mathrm{N}_1)(\hat{A}_F - \hat{A}_H^*) + (-\gamma + \mathrm{T}_2 + \mathrm{N}_2)(\hat{A}_N - \hat{A}_N^*)$$

- γ represents the conventional effect via the nontraded/traded price ratios
- T_1, T_2 are the terms of trade channel effects
- N_1, N_2 are the number of number of varieties channel effects

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The Terms of Trade Channel

- The effects through the terms of trade channel depend on:

  1. ε - elasticity of substitution between tradables & nontradables

  2. η - elasticity of substitution between home & foreign tradables

  3. $\theta - \theta^*$ - home bias in the consumption of tradable goods

- The effects via the number of varieties channel also depends on the same parameters

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Data

- Annual data from 1977 to 2006 – 30 observations per country
- 16 OECD countries: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Korea, the Netherlands, Norway, Portugal, Sweden, U.K. and U.S.
- RER and productivity differential data are calculated relative to the average of the rest of the sample
- RER is obtained using NER and CPI from the IMF's *IFS database*
- Labour productivity is output per employee in four tradable goods industries and five nontradable goods industries from the OECD's *STAN database*

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Regression model and estimation

- Dynamic OLS specification (to incorporate co-integration)

$ln\ Q_i = \delta_i + \beta_{iT}(ln A_{iT} - ln A_{wT}) + \beta_{iN}(ln A_{iN} - ln A_{wN})$ + one lead and one lag of the first differences

- HBS Hypothesis: $\beta_{iT} > 0$ and $\beta_{iN} < 0$

- Three different panel DOLS techniques:
  1. Fixed -Effect Panel: Homogeneous LR & SR coefficients
  2. Pooled Mean-Group Panel: Homogeneous LR coefficients
  3. Group Mean Panel: Panel average of heterogeneous LR coefficients

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Estimation results: World Base

DOLS Estimation Technique	Tradable Productivity Differential	Nontradable Productivity Differential
Fixed-Effect Panel	-0.31** (0.13)	0.43 (0.32)
Pooled-Mean Group Panel	-0.19*** (0.04)	0.04 (0.12)
Group-Mean Panel	-0.48*** (0.10)	0.29*** (0.13)
Dependent Variable: *ln*RER	Sample: 1977-2006	

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Estimation Results: Other Notable Findings

- Using the U.S. or Germany as the basis for comparison does not change the qualitative nature of the results
  - Values/significance of the coefficients change somewhat
- The results using aggregate productivity as the explanatory variable, as a proxy for per capita income, are more mixed
- Estimates by country are very heterogeneous with no obvious pattern

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Interpreting and Reconciling the Results

- The mixed results are consistent with other findings
  - E.g., Peltonen and Sager (ECB, 2009)

- Theoretical reconciliation
  - Numerically simulating the theoretical monopolistic competition model with different estimates for key substitution elasticities

- Empirical reconciliation
  - Investigate robustness of the results

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Home-Foreign Goods Substitution Elasticity

- The effect of the tradable productivity differential depends on η
  - Below a critical value, the effects (via the terms of trade and number of varieties channels) can cause a real depreciation
  - The increase in home productivity causes an increase in supply and a decline in the terms of trade

- Thus, the conventional HBS effect can be offset and even reversed for a small enough value of η

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Tradable-Nontradable Substitution Elasticity

- If $\varepsilon > 1$ the nontradable productivity differential causes a RER appreciation via the terms of trade
  - E.g., a productivity increase in home nontradables would raise the share of nontradables and reduce the supply of tradables, thereby increasing the terms of trade

- The nontradable productivity differential could also cause a real appreciation via the number of varieties

- Thus, the sign of the coefficient of non-tradable productivity differential in the conventional model could also be reversed

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Reconciling the Results: Numerical Simulation

- We use data for OECD countries (averaged over periods & countries) to set the nontradable share equal to 0.73 and the home bias equal to 0.3.
- We let the elasticity of substitution between varieties (σ) equal to 6 based on the evidence on mark-ups ~ 20%
- Estimates of the elasticity of substitution between home and foreign tradable goods (η) range from <1 to >>1
- Estimates of elasticity of substitution between tradable and non-tradable goods (ε) has received less attention, but worth exploring
  - Typically assumed to be close to one

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Numerical simulation: Effects on *ln*Q (RER)

ε	η	$ln\ A_T - ln\ A_T^*$	$ln\ A_N - ln\ A_N^*$
1.0	3.0	0.594	-0.801
1.0	1.0	-0.091	-0.802
1.0	0.5	-1.659	-0.803
2.0	3.0	0.532	-0.756
2.0	1.0	-0.227	-0375
2.0	0.5	-0925	0.009
3.0	3.0	0.476	-0.705
3.0	1.0	-0.300	-0.130
3.0	0.5	-0.733	0.219

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Empirical robustness

- Consider different samples periods
- Signs of estimated LR coefficients on the productivity differentials are sensitive to the sample period
- Lee and Tang (2007) also find that the results are sensitive to the definition of productivity (TFP versus labour)

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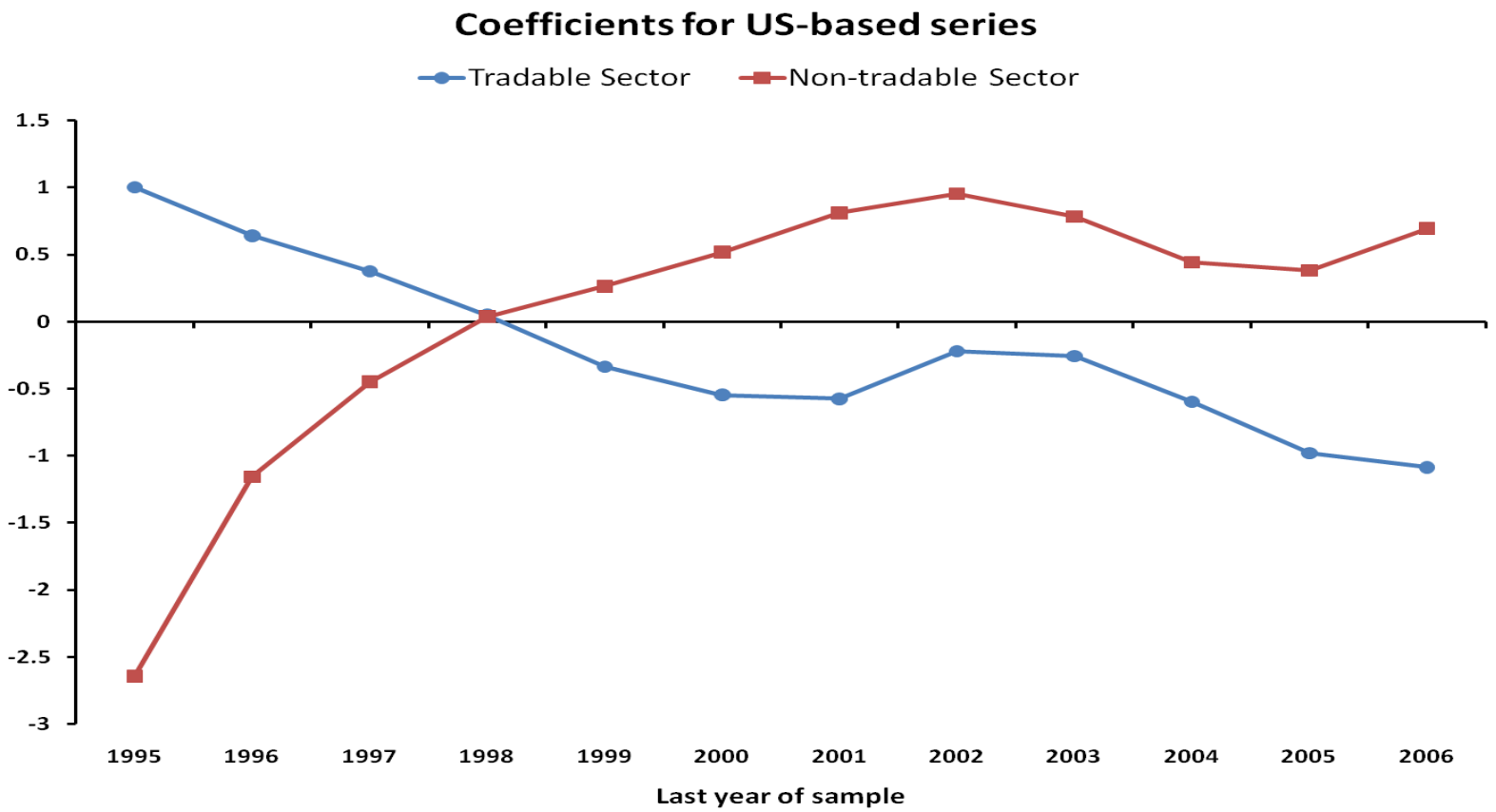
Recursive Regression Results: U.S. Base



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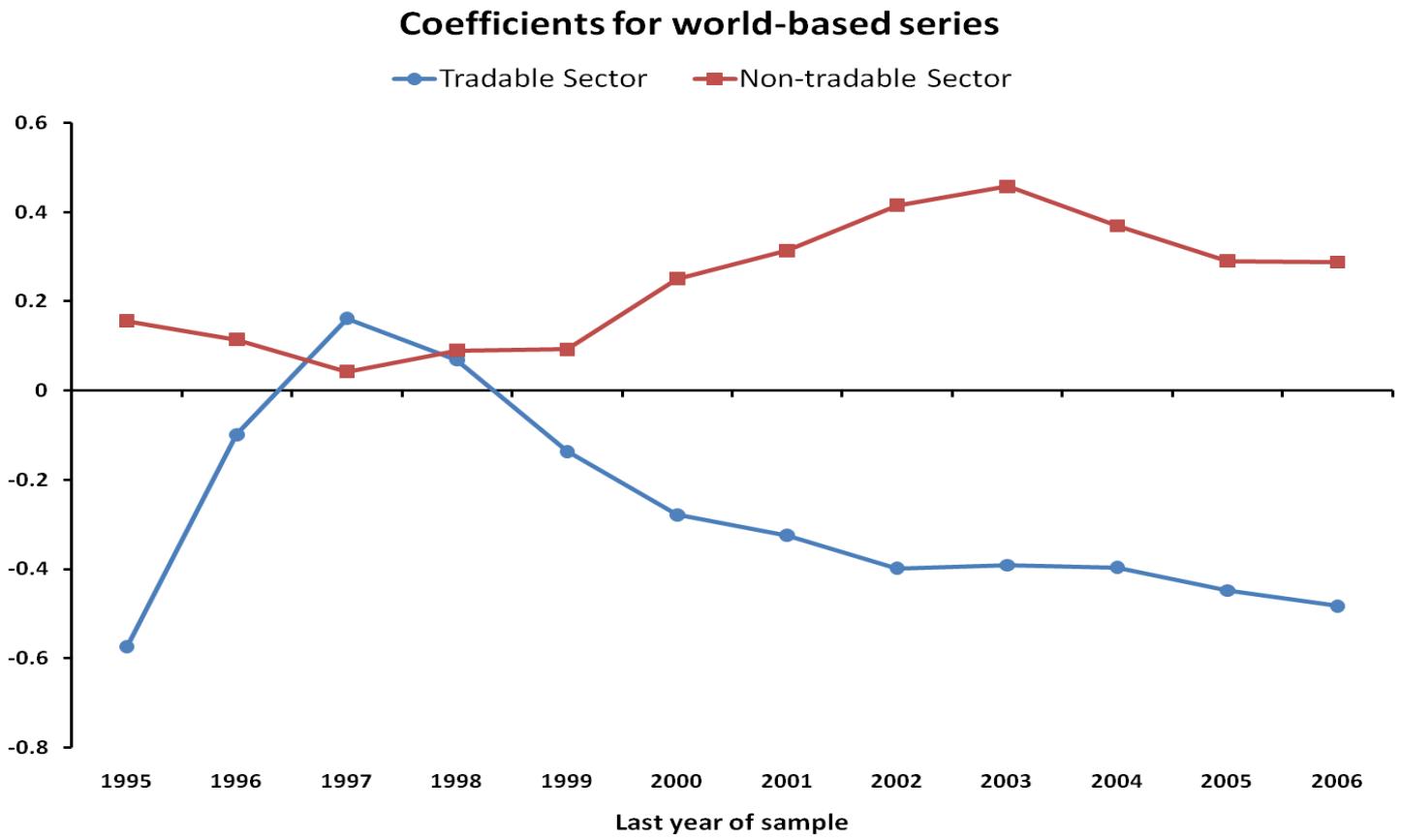
Recursive Regression Results: World Base



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Concluding remarks

- Made progress in understanding mixed empirical results for HBS hypothesis by extending theoretical model

- Empirical results are unstable over time and across countries
  - Sample may be too short to obtain low-frequency estimates
  - Time series/panel techniques unable to remove cyclical effects and other macro factors

- Future work:
  - Investigate the empirical results further (e.g., RER & China)
  - Build a dynamic version of model to replicate mixed empirical results

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Extra slides

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The Terms of Trade Channel

- The effects through the terms of trade adjustment are

$$T_1 = \frac{\sigma[\gamma(1-\beta)+\beta](1-\gamma+\gamma\tilde{\varepsilon})}{(\sigma-1)\Delta}$$

$$T_2 = \frac{-\sigma\gamma[\gamma(1-\beta)+\beta](\tilde{\varepsilon}-1)}{(\sigma-1)\Delta}$$

$$\Delta \equiv 1-(1-\gamma+\gamma\tilde{\varepsilon})(1-\beta)-\eta(1+\beta)$$

$$\tilde{\varepsilon} \equiv \varepsilon(\sigma-1)/(\sigma-\varepsilon), \beta = \theta-\theta^*$$

- The effects depend on:
  - ε the elasticity of substitution between tradables & nontradables
  - η the elasticity of substitution between home & foreign tradables
  - β the home bias in the consumption of tradable goods

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The Number of Varieties Channel

- The effects through the adjustment of number of varieties are

$$N_1 = \frac{\tilde{\varepsilon}\gamma}{\sigma - 1}\left[1 + \frac{(1 - \gamma + \gamma\tilde{\varepsilon})}{\tilde{\Delta}}\right]$$

$$N_2 = \frac{-\tilde{\varepsilon}\gamma}{\sigma - 1}\left[1 + \frac{\gamma(\tilde{\varepsilon} - 1)}{\tilde{\Delta}}\right]$$

- These effects also depend on the two elasticities and home bias

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Implications for the Productivity Effects

- Adjustment in terms of trade can weaken or even reverse the effect of the tradable productivity differential on RER via supply effects
  - (Benigno and Thoenissen, 2003)

- The effect through the number of varieties channel has not been fully explored

- The role of the two channels for the effect of the nontradable productivity differential also needs to be examined

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Home-Foreign Substitution Elasticity: Estimates

- Controversy about the value of the elasticity of substitution between home and foreign tradable goods

- Estimates based on macro models indicate that the value of this elasticity is low and below 1.0 (Bergin, 2006; Lubik and Schorfheide, 2005)

- Studies based on the disaggregated trade data suggest the average value of the elasticity to be much larger (Imbs and Mejean, 2009)

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Tradable-Nontradable Substitution Elasticity: Estimates

- Elasticity of substitution between tradable and non-tradable goods has received less attention
  - Typically assumed to be close to one

- But this assumption is not based on empirical estimation, and this elasticity could be greater than one

- Given the uncertainty about the values of the two elasticities, we consider a wide range of values for these elasticities