The Efficiency of the Global Market for Final Goods and Productive Capabilities

Georg Strasser
Boston College

Microeconomic Sources of Real Exchange Rate Behavior
Conference at Vanderbilt University

September 25th, 2010

Cost of Crossing a Border

- Trade flows
  (McCallum, AER 1995; Engel and Rogers, AER 1996; Anderson and van Wincoop, AER 2003)
- Factor flows
  (Cushman, RES 1985; Eaton and Kortum, IER 1999)
- Financial transactions
  (Ahearne et al., JIE 2004; Portes and Rey, JIE 2005)

How costly are borders?

- Are all types of flows equally affected by border frictions?
- Between which countries are the most separating borders?
- What causes the cost imposed by borders?

Definition of Productive Capabilities

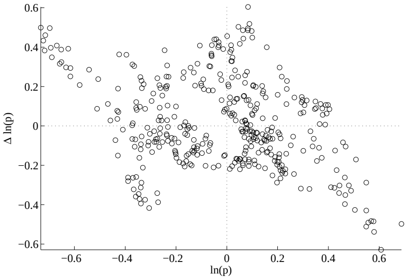
- Machinery
- Technology, Patents, Organizational Knowledge
- Firm-specific Human Capital

... if invested in the productive sector of the economy

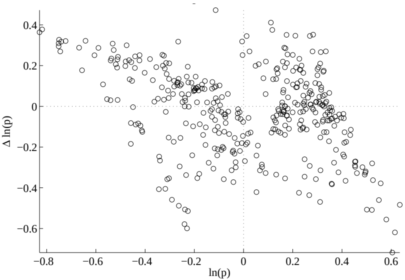
Nonlinearity in Data

24-month Changes in Real Exchange Rate of Productive Capabilities vs. Initial Levels

Canada – USA



Germany – USA



Outline

Model of Real Imbalances (1/2)

- Two countries with productivities α, α^* and stochastic depreciation shocks $\tilde{z}(t)$, $\tilde{z}^*(t)$
- One-good economy, good differentiated by location (K,K^*)
- Cost of physically relocating goods, $1-r$
- Complete financial markets

Deviations from LOP because of frictions in goods market

Model of Real Imbalances (2/2)

$$V(K,K^*) = \max_{\substack{c(t),c^*(t),\\ \Xi(r)}} E_t \int_0^\infty e^{-\rho(u-t)} \left(\frac{q}{\gamma} c(u)^\gamma + \frac{1-q}{\gamma} (c^*(u))^\gamma \right) du$$

s.t.

$$\begin{aligned} dK(t) &= (\alpha K(t) - c(t))\, dt + K(t) d\tilde{z}(t) - dX(t) + r dX^*(t) \\ dK^*(t) &= (\alpha^* K^*(t) - c^*(t))\, dt + K^*(t) d\tilde{z}^*(t) + r dX(t) - dX^*(t) \end{aligned}$$

(Symmetric version: Dumas, RFS 1992;
Link to decentralized economy: Basak and Croitoru, JIE 2007)

Model Solution

- Homogeneity of value function, real imbalance $\omega \equiv \frac{K}{K^*}$
- Problem simplifies to second order ordinary differential equation in ω with functional $I(\omega) = K^{*-\gamma} V(K, K^*)$
- Optimal range of no relocation, $\Xi(r) = [\underline{\omega}(r), \overline{\omega}(r)]$

Model Solution: Boundary Conditions

(for upper boundary) Value matching

$$V_K(K,K^*) = rV_{K^*}(K,K^*)$$

Smooth pasting

$$V_{KK}(K,K^*) = rV_{KK^*}(K,K^*)$$

$$V_{K^*K}(K,K^*) = rV_{K^*K^*}(K,K^*)$$

implying

$$\frac{I'(\overline{\omega})}{\gamma I(\overline{\omega})} = \frac{r}{1+r\overline{\omega}}$$

$$\frac{I''(\overline{\omega})}{\gamma I(\overline{\omega})} = \frac{r^2(\gamma-1)}{(1+r\overline{\omega})^2}$$

Sustainable Imbalances at Low Relocation Cost

Maximum imbalance $\overline{\omega} = max(K/K^*)$,
symmetric case $\alpha = \alpha^*$, low relocation cost $r = 0.82$

Risk av.	Risk (σ)				
$(1-\gamma)$	0^+	0.02	0.1	0.5	∞
0	∞	∞	∞	∞	∞
0.1	7.3	8.9	13	19	20
0.5	1.49	1.91	3.2	4.5	4.7
1	1.22	1.60	2.60	3.4	3.5
1.5	1.14	1.50	2.38	2.95	2.97*
2	1.10	1.46	2.26	n.a.	2.70*
3	1.07	1.42	2.11	n.a.	2.41*

* reported at $\sigma_{max}(\gamma)$

Sustainable Imbalances at High Relocation Cost

Maximum imbalance $\overline{\omega} = max(K/K^*)$,
symmetric case $\alpha = \alpha^*$, high relocation cost $r = 0.66$

Risk av.	Risk (σ)				
$(1-\gamma)$	0^+	0.02	0.1	0.5	∞
0	∞	∞	∞	∞	∞
0.1	58	69	98	134	141
0.5	2.25	2.85	4.7	7.8	8.3
1	1.50	1.96	3.4	5.3	5.5
1.5	1.31	1.75	3.0	4.5	4.5^*
2	1.23	1.66	2.83	n.a.	4.0^*
3	1.14	1.59	2.62	n.a.	3.4^*

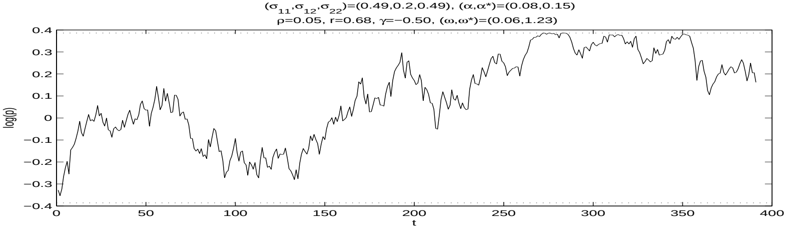
* reported at $\sigma_{max}(\gamma)$

Real Exchange Rate

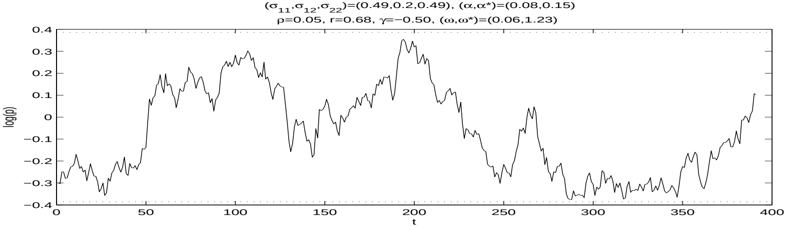
$$p(\omega) = \frac{V_K(K,K^*)}{V_{K^*}(K,K^*)} = \frac{I'(\omega)}{\gamma I(\omega) - \omega I'(\omega)}$$

Simulated log(p) Process - Examples

Realization 1

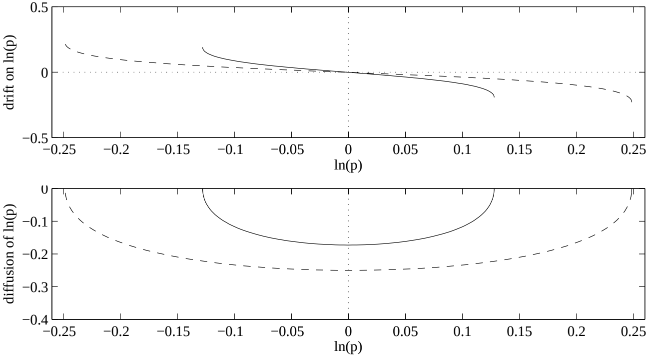


Realization 2



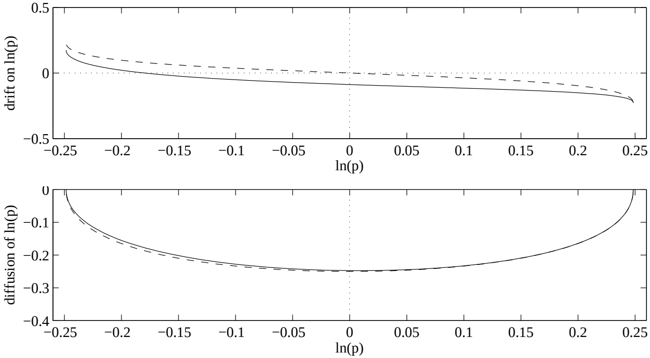
Model Solution: Effect of Relocation Cost

Drift and Diffusion of ln(p)
(—: $1-r=0.22$, – –: $1-r=0.12$)



Model Solution: Effect of Asymmetry

Drift and Diffusion of ln(p), Countries Differing by Productivity Mean (—: $\alpha = \alpha^*$, $--$: $\alpha > \alpha^*$)



Real Exchange Rate for Productive Capabilities

- Market values

$$M(t) = V_K\left(K(t), K^*(t)\right) K(t) e(t)$$

($e(t)$: nominal exchange rate to numeraire currency)

- (Inflation-adjusted) Book values

$$B(t) = K(t) e(t) V_W\left(K(t), K^*(t)\right) \varphi$$

(φ: country specific accounting constant)

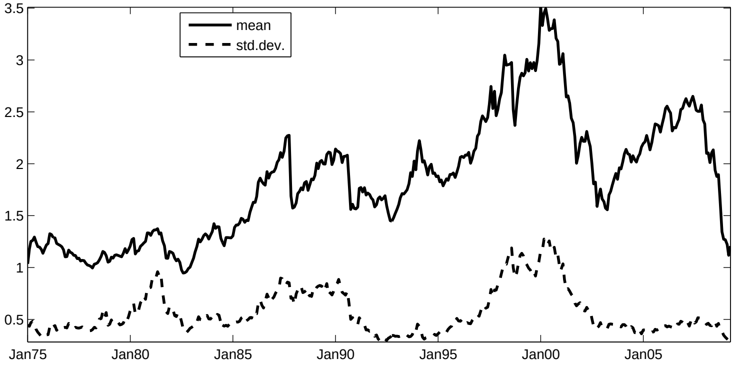
- Real exchange rate

$$p(\omega) = \frac{V_K(K, K^*) K / (V_W(\cdot) K)}{V_{K^*}(K, K^*) K^* / (V_W(\cdot) K^*)} = \frac{M/B}{M^*/B^*} \frac{\varphi}{\varphi^*}$$

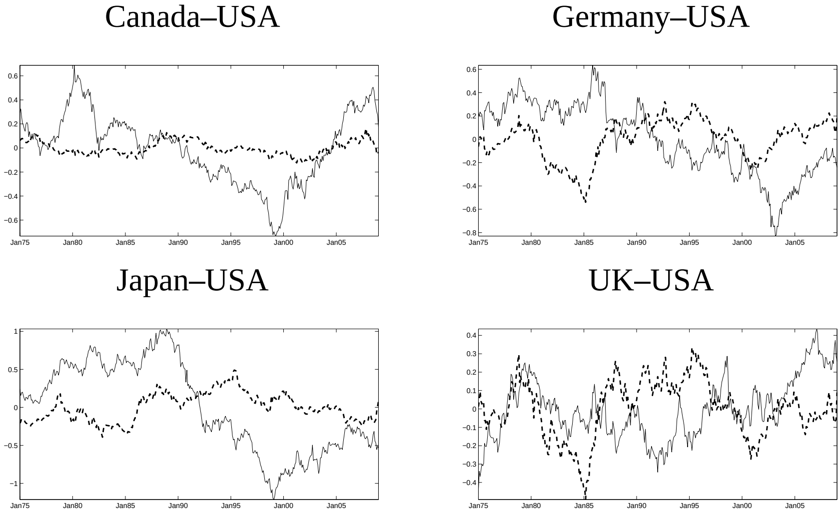
- Adjust $p(\omega)$ for accounting constant $\frac{\varphi}{\varphi^*}$ by setting midrange of $log(p(\omega))$ to zero

Market-to-book Ratios

Average and std. deviation of market-to-book ratios across countries



Real Exchange Rates



Estimation Problem

- No explicit solution to structural model
- Latent process of ω (filtering $\omega(t)$ from $p(t)$ is hard)
- Even after filtering no closed-form solution of likelihood function because of discreteness of data

Indirect inference
(Gouriéroux et al., JAE 1993; Gallant and Tauchen, ET 1996)

- Requires calculating only $p(\omega)$ from model-generated ω, computationally cheap
- Accounts for discretization error

(Generalized) ESTAR Model

Haggan and Ozaki (BMA 1981), Teräsvirta (JASA 1994)

$$p_t - p_{t-1} = (1 - \Phi(\theta; p_{t-d} - \mu)) \left(\beta_0 + \beta_1 p_{t-1} + \sum_j \beta_j p_{t-j} \right)$$

$$- (\Phi(\theta; p_{t-d} - \mu)) p_{t-1} + \varepsilon_t$$

$$\varepsilon_t \sim N(0, \sigma_t^2)$$

$$\sigma_t^2 = (1 - \tilde{\Phi}(\tilde{\theta}; p_{t-d} - \mu)) \sigma_1^2 + (\tilde{\Phi}(\tilde{\theta}; p_{t-d} - \mu)) \sigma_2^2$$

Transition functions

mean $\Phi(\theta; p_{t-d} - \mu) = 1 - exp\left(-\theta\,(p_{t-d} - \mu)^2\right)$

variance $\tilde{\Phi}(\tilde{\theta}; p_{t-d} - \mu) = 1 - exp\left(-\tilde{\theta}\,(p_{t-d} - \mu)^2\right)$

Stationarity of ESTAR Regimes

	inner regime (AR)		outer regime (AR $\times\Phi$)	
	avg. root	non-stationary	avg. root	non-stationary
final goods	1.009	29%	1.068	0
productive capabilities	0.999	53%	1.080	0

Relocation Cost for Final Goods

(vs. USA)	$1-r$		$1-r$		$1-r$
Canada	**0.02**	Italy	0.11	Switzerland	0.16
	(0.00)		(0.07)		(0.02)
Sweden	0.02	Denmark	0.12	Belgium	0.18
	(0.00)		(0.02)		(0.02)
Norway	0.07	**UK**	**0.13**	Austria	0.21
	(0.01)		(0.01)		(0.01)
Hongkong	0.09	Singapore	0.14	**Japan**	**0.22**
	(0.01)		(0.01)		(0.02)
Germany	**0.11**	Spain	0.14	France	0.26
	(0.02)		(0.02)		(0.06)
Netherlands	0.11	Australia	0.16		
	(0.01)		(0.02)		

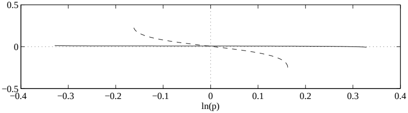
Relocation Cost for Productive Capabilities

(vs. USA)	$1-r$		$1-r$		$1-r$
Canada	**0.11**	Denmark	0.17	**Japan**	**0.28**
	(0.02)		(0.07)		(0.01)
UK	0.11	Netherlands	0.18	Sweden	0.36
	(0.00)		(0.00)		(0.06)
Germany	0.15	Belgium	0.18	Spain	0.51
	(0.02)		(0.09)		(0.73)
Austria	0.16	Australia	0.21	Norway	0.53
	(0.05)		(0.02)		(0.02)
Switzerland	0.16	France	0.25	Hongkong	0.54
	(0.01)		(0.01)		(0.11)
Italy	0.16	Singapore	0.27		
	(0.03)		(0.04)		

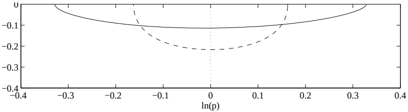
Drift and Diffusion, Productive Capabilities (Comparison to Germany – USA)

Japan – USA

Drift of $ln(p)$

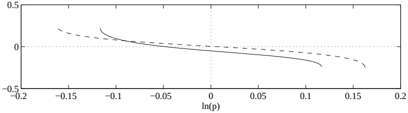


Diffusion of $ln(p)$

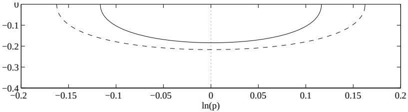


UK – USA

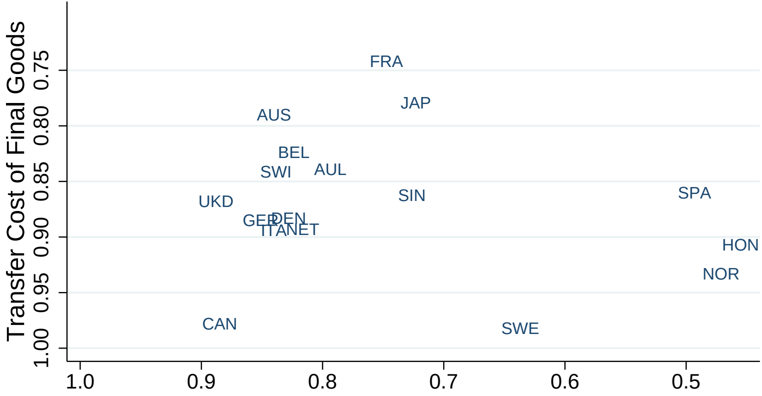
Drift of $ln(p)$



Diffusion of $ln(p)$



Comparison of Border Effect for Productive Capabilities with Effect for Final Goods



Components of Relocation Cost

	productive capabilities $log(r_{CAP})$	final goods $log(r_{WPI})$
Distance	-0.17	-0.11*
	(0.21)	(0.06)
Common language	0.06	0.06
	(0.14)	(0.04)
Δ GDP	-0.05	0.03
	(0.06)	0.02
Constant	-0.32	-0.35
	(0.63)	(0.18)
Adj. R^2	-0.11	0.20

Summary of Findings

- Small relocation cost of final goods (2%-25%), trade cost related
- Large relocation costs for productive capabilities (10%-50%), not trade cost related
- Little correlation of relocation cost between categories

“Glacial” hittimes, Example Germany-USA

first hit of	starting at	final goods	productive capabilities
any boundary	ω_0	1.3	1.0
upper boundary $\overline{\omega}$	ω_0	4.2	3.0
lower boundary $\underline{\omega}$	ω_0	4.2	3.0
balanced level ω_0	$\overline{\omega}$	1.4	0.9
balanced level ω_0	$\underline{\omega}$	1.4	1.1

"Glacial" hittimes, Example Japan-USA

first hit of	starting at	final goods	productive capabilities
any boundary	ω_0	3.8	10
upper boundary $\overline{\omega}$	ω_0	12	127
lower boundary $\underline{\omega}$	ω_0	14	131
balanced level ω_0	$\overline{\omega}$	6.1	9.3
balanced level ω_0	$\underline{\omega}$	3.1	56

Conclusion

1. Nonlinearities in time dimension carry information on frictions in real economy
2. Geographic distance key cost determinant only for final goods, ability and willingness to adapt for productive capabilities
3. Slow mean reversion despite “narrow” borders