ESTIMATING EQUILIBRIUM EXCHANGE RATES: ARE THEY SUITED FOR POLICY PURPOSES?

AN APPLICATION TO CEE ACCEDING COUNTRIES

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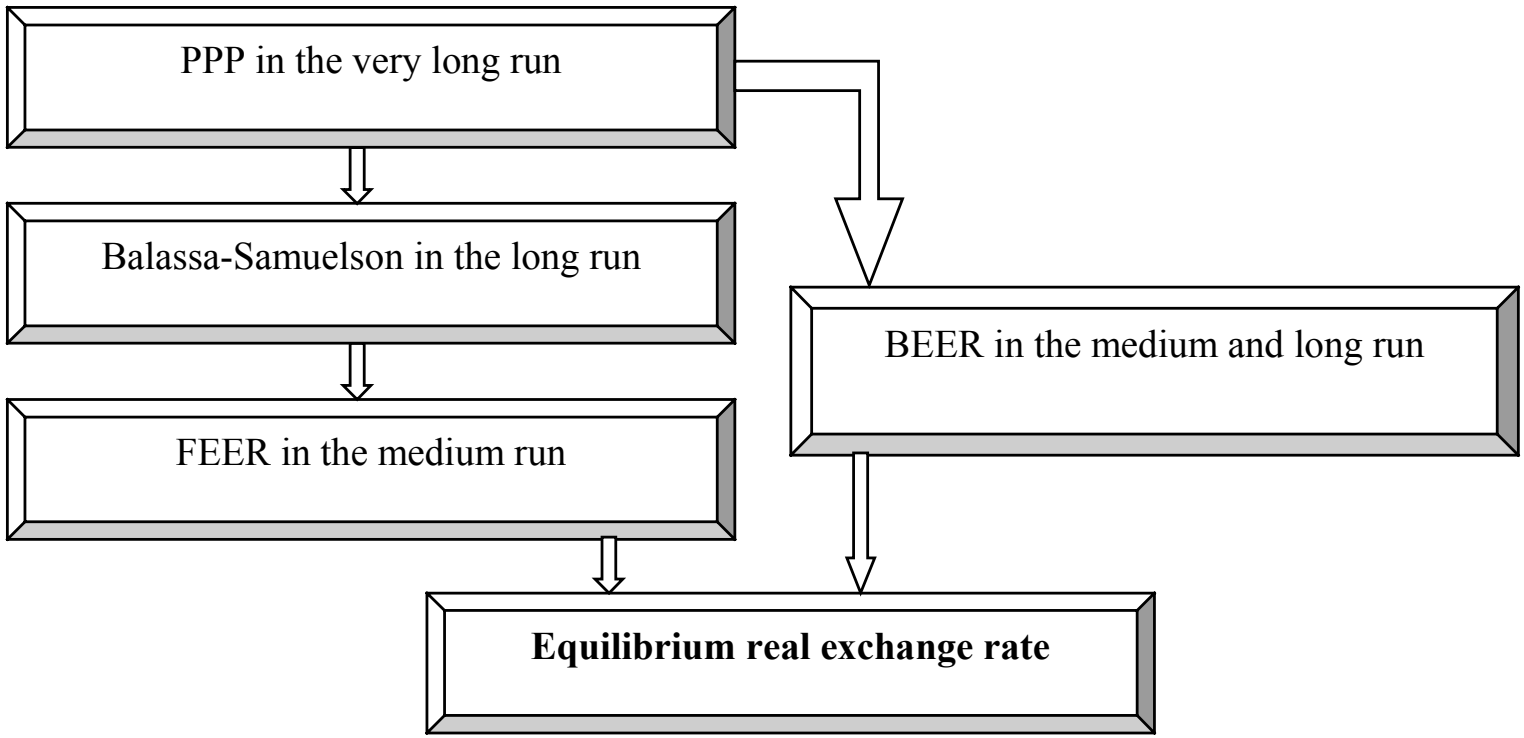
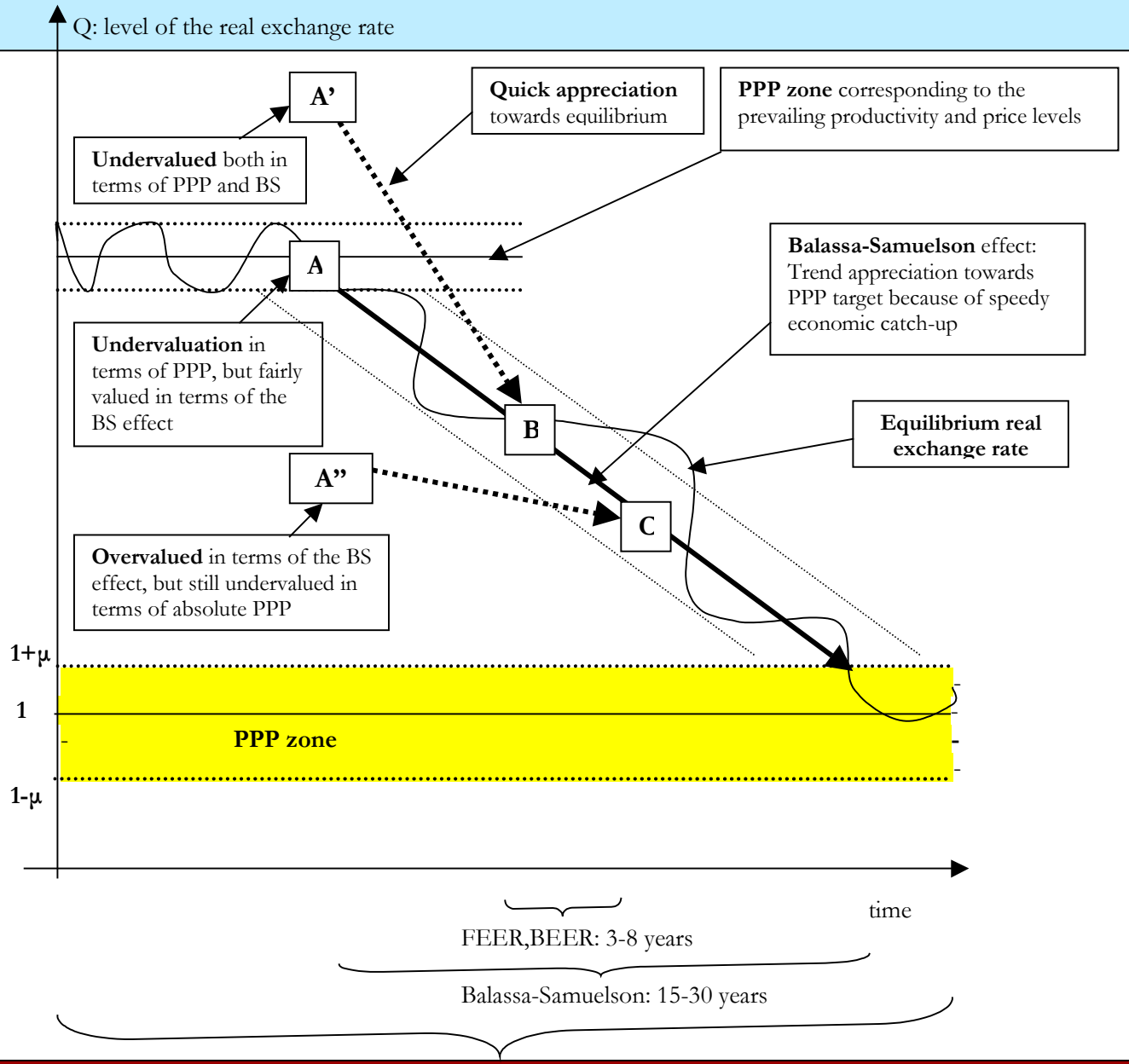
Different models to the EqRER



The trend appreciation of the equilibrium real exchange rate



Absolute PPP

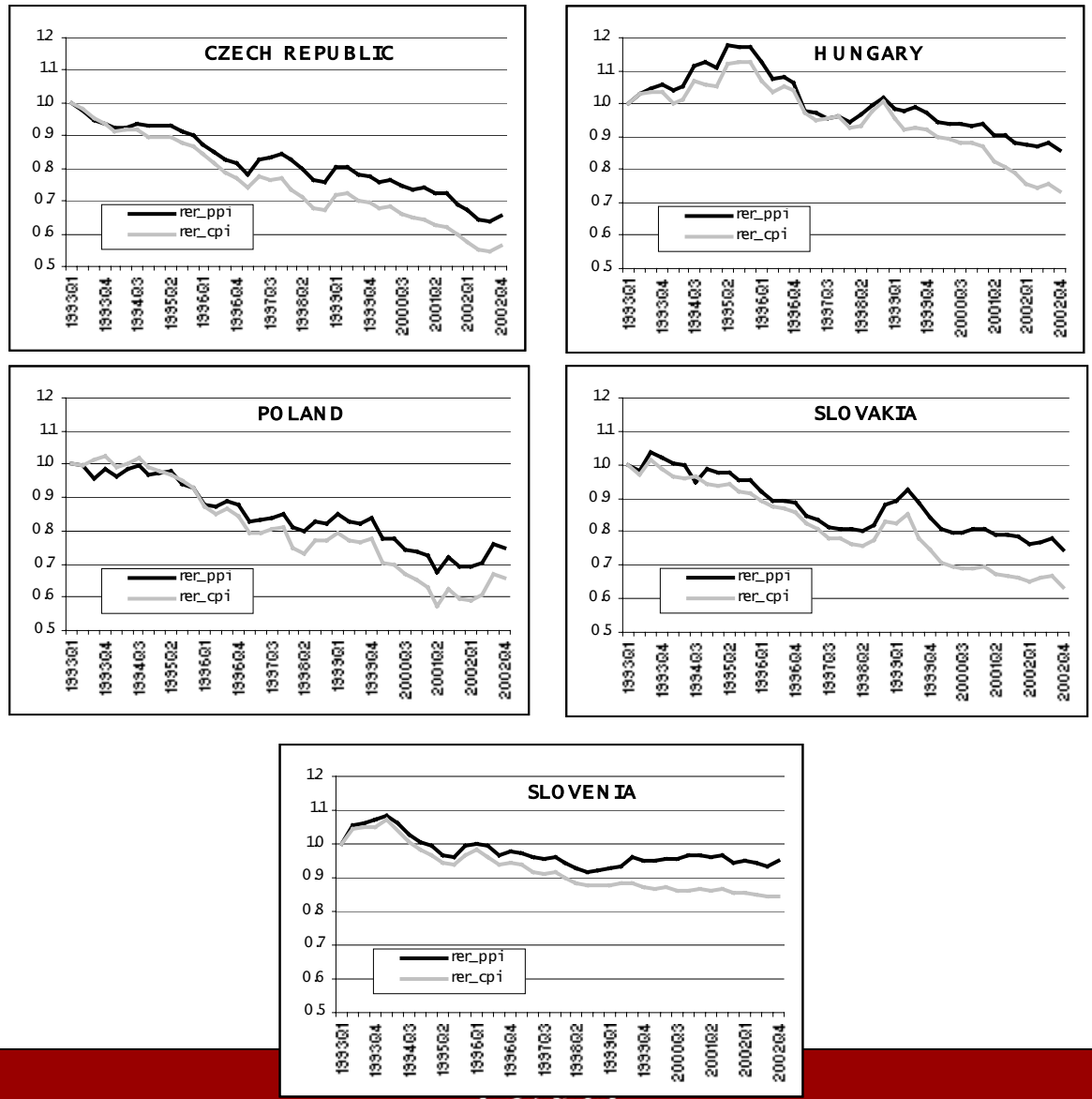
Absolute PPP

Table 1. PPP and the real exchange rate in 1996

	PPP= P/P*	Nominal exchange rate (NER)	NER/PPP = real exchange rate in level and undervaluation (in %)	
		Home currency / USD		
Czech Republic	11.7	27.15	2.32	132%
Hungary	72.6	152.60	2.10	110%
Poland	1.36	2.66	1.95	95%
Slovakia	12.2	30.65	2.51	151%
Slovenia	96.0	135.40	1.41	41%
		Home currency / DEM		
Czech Republic	5.76	18.04	3.13	213%
Hungary	35.76	101.40	2.84	184%
Poland	0.67	1.77	2.64	164%
Slovakia	6.01	20.37	3.39	239%
Slovenia	47.29	89.97	1.90	90%

PPI-based real appreciation

Figure 1 The CPI and PPI-based real exchange rate vis-à-vis the German mark/Euro, 1993-2002



Weak BS effect

-Initial undervaluation at the onset

-Tradable prices also contain non-tradable components => part of the PPI-based real appreciation may be an equilibrium phenomenon

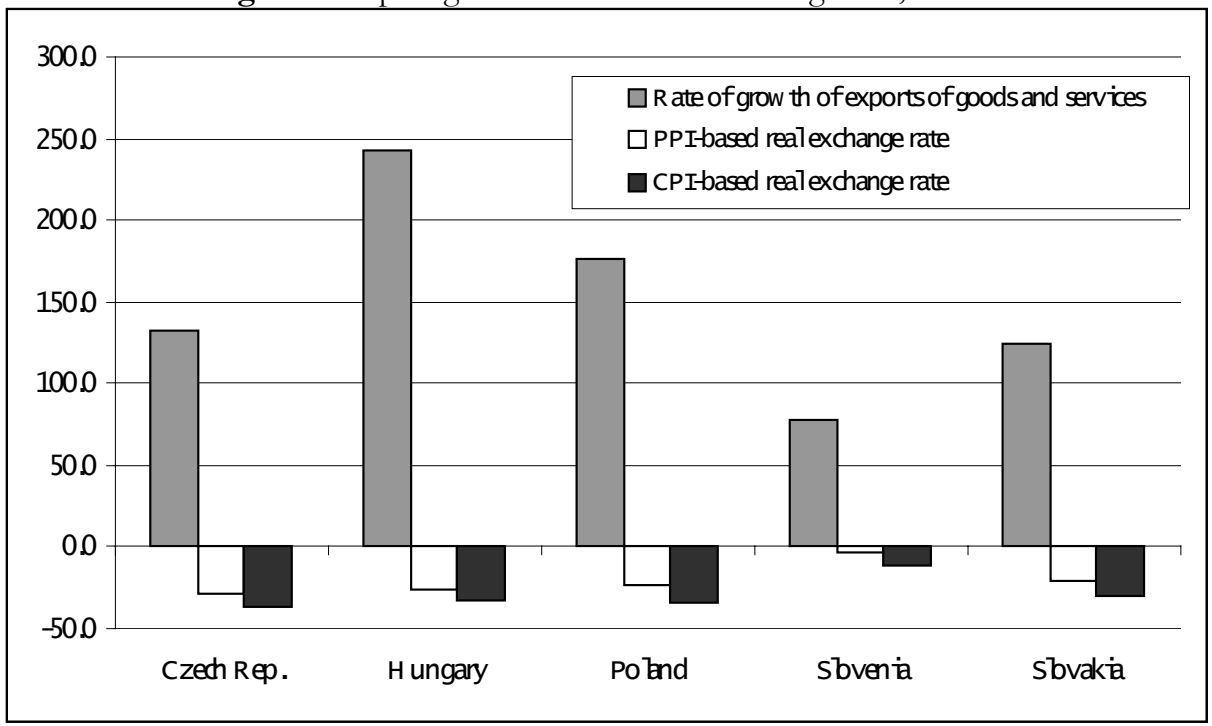
-Quality improvements => overstatement of inflation

-Trend increase in income per capita => demand pressure on tradable goods

-Differing weights and regulated prices when computing the CPI-based RER

Export growth

Figure 2 Export growth and the real exchange rate, 1995-2002



PPI-based real appreciation and consumer preferences

Supply side

$$Y = f(A, t, K, L) \tag{4}$$

$$Y^* = f(A^*, t^*, K^*, L^*) \tag{5}$$

$t^* > t$ and $\Delta t^* < \Delta t$

Demand side

$$D = C_D(\overset{+}{Y}, \overset{+}{t}, \overset{-}{P/P^*}) + C_F(\overset{+}{Y}, \overset{-}{t}, \overset{+}{P/P^*}) \tag{6}$$

$$D^* = C_D^*(\overset{+}{Y^*}, \overset{+}{t}, \overset{-}{P/P^*}) + C_F^*(\overset{+}{Y^*}, \overset{+}{P/P^*}) \tag{7}$$

Assumption: no capital flows => current account (CA) = trade balance (TB)

Equilibrium is determined:

$$CA = 0 \tag{7}$$

$$P \cdot Q = P^* Q^* \tag{8}$$

Substituting the foreign demand for domestic good (exports) and the domestic demand for foreign good (imports) into Eq. (8):

$$CA = 0 = P/P^* \cdot C_D^*(\overset{+}{Y^*}, \overset{+}{t}, P/\overset{-}{P^*}) - C_F(\overset{+}{Y}, \overset{-}{t}, P/\overset{+}{P^*}) \tag{9}$$

A change of the relative price due to the growth of technology in the domestic economy can be shown from the total differential of this equilibrium condition. Normalising P* to 1 (P denotes the relative price henceforth), the total differential becomes:

$$dCA = P \cdot \left[\frac{\partial C_D^*}{\partial Y^*} dY^* + \frac{\partial C_D^*}{\partial t} dt + \frac{\partial C_D^*}{\partial P} dP \right] - \left[\frac{\partial C_F}{\partial Y} \frac{\partial Y}{\partial t} dt + \frac{\partial C_F}{\partial t} dt + \frac{\partial C_F}{\partial P} dP \right] \tag{10}$$

Setting the rate of growth of foreign GDP to 0, i.e. $dY^* = 0$, and re-arranging, the total differential becomes:

$$\frac{dP}{dt} = \frac{P \cdot \frac{\partial \overset{+}{C_D^*}}{\partial t} - \frac{\partial \overset{+}{C_F}}{\partial Y} \frac{\partial Y}{\partial t} - \frac{\partial \overset{-}{C_F}}{\partial t}}{\frac{\partial \overset{+}{C_F}}{\partial P} - P \cdot \frac{\partial \overset{-}{C_D^*}}{\partial P}} \tag{13}$$

Overall effect of t on P: increase in exports and decrease in imports related to higher technological content is larger or not than an increase in imports related higher income

Reduced form

$$RER = RER(\overset{-}{PROD}, \overset{-}{REG}, \overset{-}{RIR}, \overset{+}{FDEBT}, \overset{+/-}{OPEN}, \overset{+/-}{TOT}, \overset{+/-}{GOV},) \quad (15)$$

Labour productivity in industry (PROD) :

Regulated prices (REG)

The real interest rate differential (RIR)

Foreign debt as percentage of GDP (FDEBT)

Openness (OPEN)

Terms of trade (TOT)

Government debt over GDP (GOV)

Data issues

Hungary: 1992:Q1 to 2002:Q4

Czech Republic, Poland, Slovakia, Slovenia: 1993:Q1 to 2002:Q4

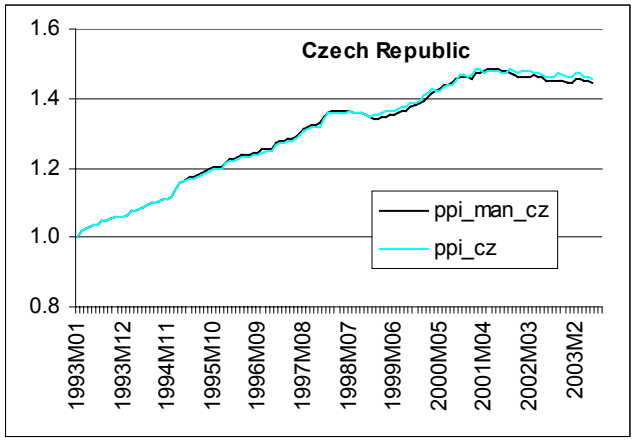
Estonia, Latvia and Lithuania: 1994:Q1 to 2002:Q4

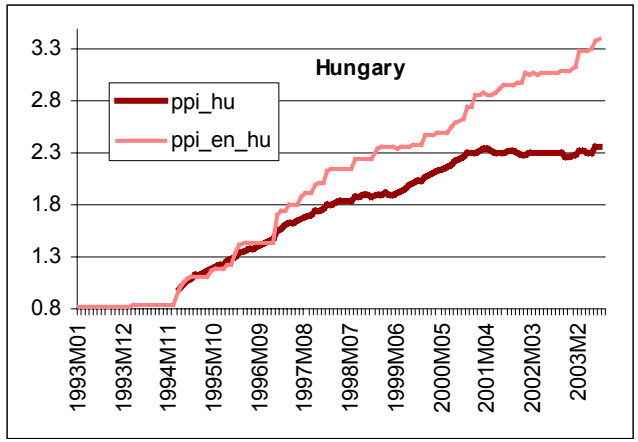
Croatia: 1995:Q1 to 2002:Q4

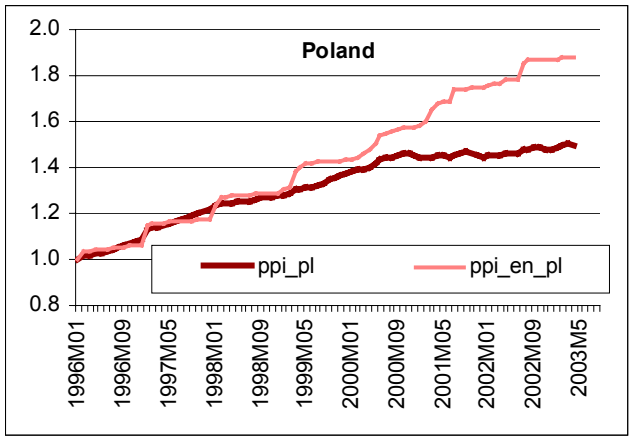
- **Real exchange rate**, CPI and PPI-based, vis-à-vis Germany
- **Average labour productivity**: PROD1, PROD2, PROD3, real GDP
- **Real GDP** in the domestic and the reference economies
- **Real interest rate differential** towards Germany (CPI and PPI based).
- **Gross foreign debt** as percentage of GDP
- **Government debt** as percentage of GDP (calculated as cumulated government deficit over GDP)
- **Openness** computed as nominal exports and imports of goods and services expressed in nominal GDP
- **Terms of trade** obtained as export prices over import prices. Data is available only for the Czech Republic, Hungary and Poland.
- **Regulated prices differential** against Germany (Latvia, Lithuania and Croatia only with proxies)

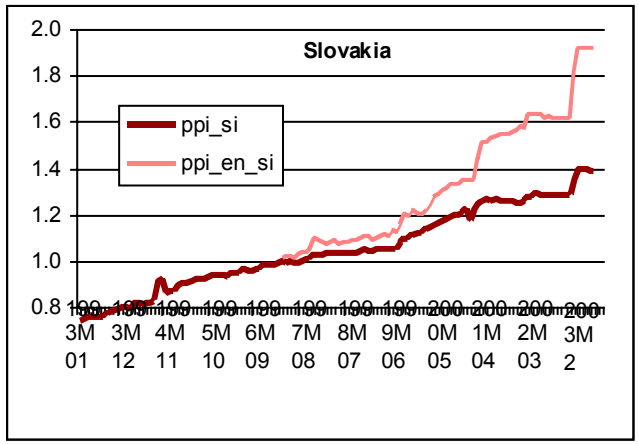
Data issues

Figure 3 Regulated prices in the producer price index









Econometric Issues - Time Series

Engle Granger

$$Y_t = \beta_0 + \sum_{i=1}^{n} \beta_i X_{i,t} + \varepsilon_t \qquad (16)$$

DOLS / Saikkonen (1991) and Stock and Watson (1993)/

$$Y_t = \beta_0 + \sum_{i=1}^{n} \beta_n X_{i,t} + \sum_{i=1}^{n} \sum_{j=-k_1}^{k_2} \gamma_{i,j} \Delta X_{i,t-j} + \varepsilon_t \qquad (17)$$

ARDL /Pesaran et al. (2001)/

$$\Delta Y_t = \beta_0 + \rho(Y_{t-1} + \sum_{i=1}^{n} \beta_n X_{i,t-1}) + \sum_{j=1}^{l_1} \eta_j \Delta Y_{t-j} + \sum_{i=1}^{n} \sum_{j=0}^{l_2} \gamma_{i,j} \Delta X_{i,t-j} + \varepsilon_t \qquad (18)$$

Bounds testing approach: $H_0 : \rho = \beta_1 = ... = \beta_n = 0$ against $H_1 : \rho \neq 0, \beta_1 \neq 0, ..., \beta_n \neq 0$.

JOHANSEN

$$\varepsilon_t = \underbrace{\sum_{i=1}^{p-1} \Phi_i \Delta Y_{t-i}}_{\substack{\text{short-term} \\ \text{deviations}}} + \underbrace{Y_t - \left[m_0 + m_1 t + (1 + \alpha\beta') Y_{t-1} \right]}_{\text{long-term.relationship}}$$

Econometric Issues

Panel unit root tests: IPS(2003)

Panel cointegration tests:

- Kao (1999)
- Pedroni (1999)
  group rho-statistic, group pp-statistic, group ADF-statistic

Coefficient estimates:

- OLS
- FMOLS
- DOLS

Real exchange rate determination

Table 2a Time series cointegration tests for the CPI-based real exchange rate, Czech Republic

Czech Republic, 1994, eq4

	EG		DOLS			ARDL(2,1)		JOH.		
		SIC(0,1)		AIC,HQ(1,2)		SIC,AIC,HQ		M3,k=2		
SIC	1	-4.839**	3	-5.422**	4	-5.287**	7.281** 5%	R=0	105.39***	RS ok
AIC	1	-4.839**	3	-5.422**	4	-5.287**		R=1	55.15***	AC ok
HQ	1	-4.839**	3	-5.422**	4	-5.287**		R=2	24.38	JB 0.056
								R=3	8.99	ST 1
								R=4	1.29	

	coeff	t-stat	Coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat
CONST	0.004	0.249	0.016	0.776	0.05	1.236	-0.003	-0.175		
PROD3	-0.324	-4.762	-0.51	-5.313	-0.857	-4.347	-0.349	-4.233	-4.406	-7.295
REGD	-0.136	-2.132	-0.103	-1.369	-0.135	-1.036	-0.112	-2.169	-1.699	-3.078
GOV	-2.748	-6.603	-2.903	-5.445	-2.083	-2.075	-2.759	-4.452	8.306	2.196
TOT	-1.021	-4.061	-1.132	-4.105	-1.176	-2.132	-1.007	-3.670	-1.346	-0.621

Czech Republic, 1994, eq8

	EG		DOLS			ARDL(1,1)		JOH.		
		SIC,HQ(0,1)		AIC(1,1)		SIC,AIC,HQ		M3,k=3		
SIC	1	-5.199**	3	-5.528**	3	-5.339**	6.84**	R=0	73.04***	RS ok
AIC	1	-5.199**	3	-5.528**	3	-5.339**		R=1	32.23***	AC ok
HQ	1	-5.199**	3	-5.528**	3	-5.339**		R=2	8.99	JB 0..016
								R=3	0.01	ST 1

	coeff	t-stat	Coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat
CONST	-0.013	-0.961	-0.01	-0.552	0.011	0.538	0.008	0.37		
PROD2	-0.701	-5.51	-0.948	-7.198	-1.021	-6.568	-0.793	-4.108	-0.649	-16.641
REGD	-0.362	-6.713	-0.361	-3.674	-0.379	-2.667	-0.471	-3.066	-0.457	-32.643
FDEBT	0.19	4.089	0.292	4.043	0.308	3.063	0.326	3.514	0.278	18.533

Czech Rep.: RER_PPI

Table 2b Time series cointegration tests for the PPI-based real exchange rate, Czech Republic

Czech Republic, 1994, eq4

	EG		DOLS			ARDL (2,1)		JOH.		
			SIC(0,1)		AIC,HQ(1,2)	SIC,AIC,HQ		M3,k=2		
SIC	1	-4.902**	3	-5.784**	4	-5.449**	7.594**	R=0	100.64***	RS no
AIC	1	-4.902**	3	-5.784**	4	-5.449**		R=1	49.04***	AC ok
HQ	1	-4.902**	3	-5.784**	4	-5.449**		R=2	21.60	JB 0..092
								R=3	6.34	ST 1
								R=4	0.24	

	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat
CONST	0.013	0.976	0.039	1.859	0.071	1.684	0.02	1.267		
PROD3	-0.294	-4.49	-0.52	-5.442	-0.825	-4.017	-0.375	-4.456	-2.065	-5.736
REGD	-0.003	-0.043	0.028	0.371	0.012	0.087	-0.011	-0.203	-0.937	-1.928
GOV	-2.534	-6.334	-2.652	-4.992	-2.093	-2.001	-2.282	-3.962	6.784	2.028
TOT2	-0.807	-3.341	-1.054	-3.839	-1.098	-1.911	-0.839	-3.396	-6.116	-3.424

Czech Republic, 1994, eq8

	EG		DOLS(1,1)		ARDL(1,1)		JOH.		
			SIC,AIC,HQ		SIC,AIC,HQ		M3,k=3		
SIC	1	-5.122**	4	-5.604**	6.163**		R=0	84.06***	RS ok
AIC	1	-5.122**	4	-5.604**			R=1	39.56***	AC ok
HQ	1	-5.122**	4	-5.604**			R=2	9.23	JB 0..012
							R=3	0.06	ST 1

	Coeff	t-stat	coeff	t-stat	Coeff	t-stat	coeff	t-stat
CONST	-0.002	-0.19	0.032	1.655	0.023	1.079		
PROD2	-0.632	-5.155	-0.974	-6.791	-0.716	-3.927	-0.699	-19.971
REGD	-0.22	-4.227	-0.21	-1.596	-0.317	-2.334	-0.359	-25.643
FDEBT	0.189	4.236	0.259	2.793	0.293	3.145	0.278	19.857

Hungary: RER_CPI

Table 3a Time series cointegration test for the CPI-based real exchange rate Hungary

Hungary, 1993 eq4

	EG		DOLS				ARDL(1,0)		JOH		
			SIC(0,0)		AIC,HQ(2,2)		SIC,AIC,HQ		M3,k=3		
SIC	0	-5.036**	1	-5.073**	0	-5.393**	2.742[a]		R=0	93.61***	RS no
AIC	0	-5.036**	1	-5.073**	0	-5.393**			R=1	58.77***	AC ok
HQ	0	-5.036**	1	-5.073**	0	-5.393**			R=2	33.26**	JB 0.011
									R=3	10.81	ST 1 or 2?
									R=4	0.54	

	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat
CONST	0.014	1.431	0.01	0.847	0.119	1.789	0.021	0.853		
PROD2	-1.156	-13.642	-1.109	-10.982	-0.969	-2.426	-0.963	-2.082	-1.121	-20.757
FDEBT	0.397	6.475	0.356	5.549	-0.062	-0.245	0.228	1.208	0.107	2.744
GOV	1.363	5.019	1.601	5.853	3.041	6.453	1.778	2.111	2.465	10.489
OPEN	0.368	6.986	0.299	4.41	-0.028	-0.086	0.141	0.76	0.169	4.568

Note: As for Table 2.

Hungary, 1994 eq5

	EG		DOLS				ARDL(1,2)		JOH		
			SIC(1,3)		AIC,HQ(2,3)		ARDL_SIC		M3,k=3		
SIC	0	-2.136	1	-4.848**	1	-6.825**	3.466[a]		R=0	74.14***	RS no
AIC	0	-2.136	4	-4.834**	4	-4.69**			R=1	20.46	AC ok
HQ	0	-2.136	4	-4.834**	4	-4.69**			R=2	7.77	JB 0.002
									R=3	1.18	ST 1

	Coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat
CONST	0.04	1.733	-0.052	-3.593	-0.047	-1.633	-0.031	-1.234		
PROD3	-1.306	-4.37	-2.344	-12.02	-2.489	-7.493	-2.099	-3.164	-2.099	-22.570
FDEBT	0.553	4.25	0.811	9.482	0.908	6.795	0.622	2.551	0.730	19.211
OPEN	0.148	1.296	0.59	6.855	0.633	4.052	0.434	2.346	0.511	13.447

Note: As for Table 2.

Hungary: RER_PPI

Table 3b Time series cointegration tests for the PPI-based real exchange rate, Hungary

Hungary, 1993 eq4

	EG		DOLS				ARDL(1,0)	JOH		
			SIC(0,0)		AIC,HQ(2,2)		SIC,AIC,HQ	M3,k=3		
SIC	0	-5.036**	1	-5.073**	0	-5.393**	2.742[a]	R=0	54.44	RS no
AIC	0	-5.036**	1	-5.073**	0	-5.393**		R=1	33.36	AC ok
HQ	0	-5.036**	1	-5.073**	0	-5.393**		R=2	15.70	JB 0.014
								R=3	5.11	ST 1 ?
								R=4	0.10	

	coeff	t-stat	coeff	t-stat	Coeff	t-stat	coeff	t-stat	coeff	t-stat
CONST	0.014	1.431	0.01	0.847	0.119	1.789	0.021	0.853		
PROD2	-1.156	-13.642	-1.109	-10.982	-0.969	-2.426	-0.963	-2.082	-0.701	-10.785
FDEBT	0.397	6.475	0.356	5.549	-0.062	-0.245	0.228	1.208	0.412	8.583
GOV	1.363	5.019	1.601	5.853	3.041	6.453	1.778	2.111	2.302	9.473
OPEN	0.368	6.986	0.299	4.41	-0.028	-0.086	0.141	0.76	0.032	0.711

Note: As for Table 2.

Hungary, 1994 eq5

	EG		DOLS				ARDL		JOH	
			SIC,HQ(2,3)		AIC(3,3)		SIC(1,0)	AIC,HQ(1,1)	M3,k=3	
SIC	0	-2.747	1	-5.936**	1	-8.101**	2.109	4.032*	R=0	45.09* RS no
AIC	0	-2.747	1	-5.936**	3	-5.068**			R=1	20.24 AC ok
HQ	0	-2.747	1	-5.936**	3	-5.068**			R=2	8.16 JB 0.1
									R=3	3.58 ST 1?

	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat	Coeff	t-stat	coeff	t-stat
CONST	0.056	4.15	-0.001	-0.017	-0.058	-0.787	0.088	1.959	0.059	2.357		
PROD3	-0.7	-3.993	-1.967	-5.821	-2.951	-2.735	-0.565	-0.924	-0.902	-2.077	-1.098	-7.572
FDEBT	0.543	7.117	0.958	7.041	1.319	3.636	0.286	0.839	0.401	1.677	0.549	9.305
OPEN	-0.009	-0.139	0.486	3.059	0.927	1.916	-0.165	-0.868	0.004	0.029	0.056	1.000

Note: As for Table 2.

Poland: RER_CPI

Table 4a Time series cointegration tests for the CPI-based real exchange rate Poland

Poland, 1993 eq1

	EG		DOLS				ARDL				JOH	
			SIC(2,0)		AIC,HQ(3,3)		SIC(1,0)		AIC,HQ(3,0)		M3,k=2	
SIC	0	-3.552	0	-4.134**	0	-6.486**	3.552[a]		5.533**		R=0	21.69
AIC	0	-3.552	0	-4.134**	0	-6.486**					R=1	5.04
HQ	0	-3.552	0	-4.134**	0	-6.486**					R=2	1.19
	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat		
CONST	-0.046	-3.51	-0.054	-4.1	-0.078	-3.665	-0.06	-2.382	-0.054	-2.463		
PROD1	-0.836	-14.029	-0.893	-14.277	-1.056	-14.051	-0.83	-2.878	-0.808	-3.46		
INTCPI	-0.008	-4.269	-0.009	-4.501	-0.007	-3.049	-0.008	-2.059	-0.008	-2.398		

Note: As for Table 2.

Poland, 1993 eq5

	EG		DOLS(3,3)		ARDL(1,0)		JOH.		
			SIC,AIC,HQ		SIC,AIC.HQ		M3,k=2		RS ok
SIC	0	-3.674	2	-5.911**	4.634**		R=0	58.40***	AC ok
AIC	0	-3.674	2	-5.911**			R=1	25.44	JB 0.390
HQ	0	-3.674	2	-5.911**			R=2	9.89	ST 1
							R=3	0.32	
	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat	
CONST	-0.026	-1.497	-0.021	-0.386	0.007	0.224			
PROD3	-0.988	-13.67	-1.215	-6.748	-1.075	-3.757	-0.850	-7.870	
INTCPI	-0.006	-2.892	-0.005	-0.7	-0.008	-2.109	-0.023	-11.500	
FDEBT	0.165	3.005	0.322	1.465	0.338	3.234	0.269	3.165	

Note: As for Table 2.

Poland: RER_CPI

Poland, 1993 eq6

	EG		DOLS			ARDL			JOH		
			SIC,HQ(0,1)		AIC(1,2)	SIC(1,0)		AIC,HQ(1,1)	M3,k=2		
SIC	0	-4.136	0	-5.295**	2	-6.388**	5.977**	3.966*	R=0	83.91**	R
AIC	3	-4.088	0	-5.295**	2	-6.388**			R=1	39.93	A
HQ	0	-4.136	0	-5.295**	2	-6.388**			R=2	18.36	JB
									R=3	3.99	
									R=4	0.03	

	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat
CONST	-0.056	-3.052	-0.084	-5.005	-0.117	-4.293	-0.073	-2.123	-0.083	-1.978		
PROD1	-1.1	-7.932	-1.342	-10.031	-1.565	-6.62	-1.731	-5.04	-1.62	-3.898	-1.005	-11.824
INTCPI	-0.009	-3.959	-0.012	-5.234	-0.017	-4.198	-0.009	-1.798	-0.011	-1.79	-0.016	-16.000
GOV	0.912	1.726	3.011	5.203	4.417	3.338	4.239	3.805	4.467	4.047	1.748	4.883
OPEN	0.216	1.73	0.393	3.35	0.665	3.43	0.43	2.02	0.484	2.266	0.373	4.973

Note: As for Table 2.

Poland, 1994 eq1

	EG		DOLS(2,3)		ARDL(1,0)		JOH		
			SIC,AIC.HQ		SIC,AIC,HQ		M3,k=3		
SIC	0	-3.451	0	-7.575**	3.543[a]		R=0	54.40**	RS ok
AIC	0	-3.451	3	-4.768**			R=1	20.93	AC ok
HQ	0	-3.451	3	-4.768**			R=2	4.87	JB 0.003
							R=3	0.03	ST 1

	coeff	t-stat	coeff	t-stat	Coeff	t-stat	coeff	t-stat
CONST	-0.01	-0.325	-0.026	-0.381	-0.017	-0.246		
PROD1	-0.907	-10.63	-1.02	-6.571	-0.923	-2.843	-0.944	-11.238
INTCPI	-0.007	-3.154	-0.014	-2.688	-0.01	-2.329	-0.018	-11.250
FDEBT	0.14	1.640	0.299	1.474	0.181	0.948	0.333	3.742

Poland: RER_PPI

Table 4b Time series cointegration tests for the PPI-based real exchange rate Poland

Poland, 1993 eq1

	EG		DOLS				ARDL(1,0)		JOH		
			SIC,HQ(0,0)		AIC(2,3)		SIC,AIC,HQ		M3,k=1		
SIC	0	-5.608**	0	-6.229**	0	-7.657**	13.601**		R=0	41.05***	RS ok
AIC	0	-5.608**	0	-6.229**	2	-2.647			R=1	4.06	AC ok
HQ	0	-5.608**	0	-6.229**	2	-2.647			R=2	0.19	JB 0.685
	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat	t-stat	coeff	ST 1
CONST	-0.013	-1.629	-0.024	-3.499	-0.03	-3.096	-0.025	-3.293			
PROD1	-0.483	-12.305	-0.458	-12.873	-0.634	-10.78	-0.453	-4.83	-0.453	-13.324	
INTPPI	-0.006	-5.746	-0.007	-7.536	-0.005	-3.666	-0.007	-5.386	-0.007	-7.778	

Note: As for Table 2.

Poland, 1993 eq2

	EG		DOLS				ARDL(1,0)		JOH		
			SIC,HQ(0,0)		AIC(2,3)		SIC,AIC,HQ		M3,k=6		
SIC	0	-4.815**	0	-4.847**	0	-6.105**	6.985**		R=0	43.96***	RS no
AIC	0	-4.815**	0	-4.847**	2	-1.69			R=1	5.63	AC ok
HQ	0	-4.815**	0	-4.847**	2	-1.69			R=2	1.16	JB 0.000
	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat	t-stat	coeff	ST 1?
CONST	-0.006	-0.627	-0.017	-1.953	-0.025	-1.531	-0.024	-1.882			
PROD2	-0.500	-10.447	-0.478	-10.619	-0.757	-9.035	-0.458	-3.168	-0.544	-23.652	
INTPPI	-0.006	-4.731	-0.007	-5.795	-0.001	-0.605	-0.007	-3.699	-0.004	-6.667	

Note: As for Table 2.

Poland, 1993 eq3

	EG		DOLS(0,0)		ARDL(1,0)		JOH		
	EG_cointegration		SIC,AIC,HQ		SIC,AIC,HQ		M3,k=6		
SIC	0	-4.945**	0	-6.194**	11.309**		R=0	56.22***	RS no
AIC	0	-4.945**	0	-6.194**			R=1	18.28**	AC ok
HQ	0	-4.945**	0	-6.194**			R=2	2.41	JB 0.006
	coeff	t-stat	coeff	t-stat	coeff	t-stat	t-stat	coeff	ST 1
CONST	-0.022	-3.067	-0.032	-4.909	-0.036	-3.972			
PROD3	-0.516	-12.353	-0.469	-12.327	-0.454	-4.32	-0.557	-46.417	
INTPPI	-0.006	-6.008	-0.008	-7.841	-0.008	-5.059	-0.006	-20.000	

Slovakia: RER_CPI

Table 5 Time series cointegration test, Slovakia

Slovakia, 1993, eq1

	EG		DOLS(0,0) SIC,AIC,HQ		ARDL(2,0) SIC,AIC,HQ		Johansen M3,k=1	
SIC	1	-3.71*	2	-3.851*	5.686**		R=0	10.67
AIC	2	-3.718*	2	-3.851*			R=1	2.54
HQ	1	-3.71*	2	-3.851*			R=2	0.03
	Coeff	t-stat	coeff	t-stat	coeff	t-stat		
CONST	0.007	0.685	0.007	0.518	0.025	1.311		
GDP	-0.602	-5.58	-0.61	-5.361	-0.655	-2.863		
REGD	-0.343	-5.571	-0.346	-5.389	-0.333	-3.247		

Note: As for Table 2.

Slovakia, 1993, eq5

	EG		DOLS(0,0)		ARDL(2,0) SIC,AIC,HQ		Johansen M3,k=1	
SIC	2	-4.113**	2	-4.014**	4.654*		R=0	14.91
AIC	2	-4.113**	2	-4.014**			R=1	5.59
HQ	2	-4.113**	2	-4.014**			R=2	0.19
	Coeff	t-stat	Coeff	t-stat	coeff	t-stat		
CONST	0.01	0.879	0.008	0.493	0.01	0.462		
REGD	-0.31	-3.922	-0.318	-3.78	-0.303	-2.512		
GOV	-1.305	-4.667	-1.284	-4.307	-1.312	-2.255		

Note: As for Table 2.

Slovakia, 1993, eq2

	EG		DOLS SIC(0,0)		AIC(3,1)		HQ(0,2)		ARDL SIC(2,0)		AIC(2,3)		HQ(1,2)		Johansen M3,k=1	
SIC	0	-2.81	0	-3.462	0	-3.227	1	-4.429**	4.624*		5.01**		3.891[A]		R=0	17.50
AIC	1	-3.383	0	-3.462	2	-4.177**	1	-4.429**							R=1	4.52
HQ	100%	-3.383	0	-3.462	2	-4.177**	1	-4.429**							R=2	0.78
	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat	Coeff	t-stat		
CONST	0.064	5.553	0.071	5.518	0.088	3.706	0.113	6.376	0.075	2.149	0.11	2.924	0.123	2.908		
GDP	-1.337	-25.118	-1.372	-25.39	-1.437	-23.263	-1.458	-26.622	-1.37	-3.145	-1.457	-3.493	-1.465	-3.117		
INTCPI	0.005	5.768	0.006	6.212	0.003	3.085	0.006	6.365	0.006	3.313	0.006	3.637	0.007	3.222		

Note: As for Table 2.

Slovenia: RER_CPI

Table 6 Time series cointegration test, Slovenia

Slovenia, 1993, eq4

	EG		DOLS(2,3) SIC,AIC,HQ		ARDL(2,3) SIC,AIC,HQ		Johansen M3,k=2	
SIC	0	-5.041***	1	-6.695***	10.127**		R=0	63.26***
AIC	1	-4.092***	1	-6.695***			R=1	21.41***
HQ	0	-5.041***	1	-6.695***			R=2	6.18***
	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat		
CONST	-0.107	-12.28	-0.144	-9.02	-0.111	-1.812	RS	Ok
REGD	-0.158	-16.225	-0.131	-8.946	-0.16	-3.281	AC	Ok
INTCPI	0.004	6.683	0.005	5.48	0.001	0.474	JB	0.504

Note: As for Table 2.

Slovenia, 1993, eq5

	EG		DOLS SIC(2,0)		AIC, HQ(3,3)		ARDL SIC(1,1)		AIC(2,3)		HQ(2,1)		JOH. M3,k=2		
SIC	0	-3.92*	0	-2.865	0	-3.966**	3.711[a]		4.56*		2.482		R=0	50.00***	RS ok
AIC	3	-1.426	0	-2.865	4	-3.747*							R=1	12.90	AC ok
HQ	0	-3.92*	0	-2.865	4	-3.747*							R=2	2.14	JB 0.2
	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	ST 1
CONST	-0.124	-10.779	-0.197	-16.349	-0.178	-10.096	-0.035	-0.156	-0.804	0.912	-0.015	-0.033	0.028	2.592	
PROD1	-0.742	-10.857	-0.438	-6.777	-0.652	-6.439	-1.119	-1.306	2.424	-0.901	-1.332	-0.868	-0.273	-3.138	
INTCPI	0.004	3.946	0.01	10.523	0.007	4.555	-0.011	-1.002	0.089	-1.924	-0.021	-0.868	0.014	12.727	

Note: As for Table 2.

Panel specifications

Panel 5, PROD1,PROD2,PROD3,GDP

Panel 8

Panel 9

Table 7 Estimated panel specifications

	Y	X1	X2	X3	X4	X5
Eq1 :	RERCPI	PROD1/PROD2/PROD3/GDP	INTCPI	REGDIFF	FDEBT	OPEN3
Eq2 :	RERCPI	PROD1/PROD2/PROD3/GDP	INTCPI	REGDIFF	FDEBT	GOV
Eq3 :	RERCPI	PROD1/PROD2/PROD3/GDP	INTCPI	REGDIFF	OPEN3	GOV
Eq4 :	RERCPI	PROD1/PROD2/PROD3/GDP	INTCPI	FDEBT		
Eq5 :	RERCPI	PROD1/PROD2/PROD3/GDP	INTCPI	REGDIFF	FDEBT	
Eq6 :	RERCPI	PROD1/PROD2/PROD3/GDP	INTCPI	REGDIFF	GOV	
Eq7 :	RERCPI	PROD1/PROD2/PROD3/GDP	INTCPI	REGDIFF	OPEN3	

Panel estimates

Table 8 Panel OLS estimates for Equations 3 and 6

	PROD	RIR	REG	OPEN	GOV
Equation3					
Panel 5, 1993-2002, PROD2	-0.44	-0.005	-0.13	0.14	-1.24
Panel 5, 1994-2002, PROD2	-0.64	-0.006	-0.10	0.14	-1.26
Panel 8, 1994-2002, PROD3	-0.19	-0.006	-0.44	0.32	-1.27
Panel 8, 1994-2002, GDP	-0.33	-0.005	-0.41	0.34	-1.02
Panel 8, 1995-2002, GDP	-0.27	-0.009	-0.36	0.17	-1.18
Panel 9, 1995-2002, GDP	-0.33	-0.007	-0.36	0.18	-1.02
Equation6					
Panel 5, 1993-2002, PROD1	-0.34	-0.004	-0.11		-1.29
Panel 5, 1994-2002, PROD1	-0.37	-0.006	-0.14		-1.41
Panel 5, 1993-2002, PROD3	-0.32	-0.004	-0.13		-1.50
Panel 8, 1994-2002, PROD3	-0.18	-0.007	-0.35		-1.38
Panel 8, 1995-2002, PROD3	-0.15	-0.01	-0.31		-1.54
Panel 5, 1993-2002, GDP	-0.41	-0.004	-0.13		-1.01
Panel 8, 1994-2002, GDP	-0.25	-0.007	-0.34		-1.20
Panel 8, 1995-2002, GDP	-0.29	-0.01	-0.27		-1.34
Panel 9, 1995-2002, GDP	-0.35	-0.008	-0.28		-1.17

Equilibrium exchange rates

Table 10a Equilibrium exchange rates based on time series estimates, Czech Republic

	Average 2002	4th quarter 2002
Nominal exchange rate	30.79	30.86
Eq_94_4 RERCPI=f(PROD3, REG, TOT, GOV)		
EG	40.0 *(+29.9%)*	39.96 *(+29.5%)*
ARDL	40.3*(+31.1%)*	40.32 *(+30.6%)*
Eq_94_8 RERCPI=f(PROD2, REG, FDEBT)		
EG	31.3 *(+1.8%)*	31.0 *(+0.4%)*
DOLS(0,1)	33.2 *(+7.8%)*	32.58 *(+5.6%)*
DOLS(1,1)	32.1 *(+4.3%)*	31.48 *(+2.0%)*
ARDL	33.3 *(+8.2%)*	32.77 *(+6.2%)*
Johansen	34.7 *(+12.7%)*	34.22 *(+10.9%)*
Eq_94_8 RERPPI=f(PROD2, REG, FDEBT)	PPI	
EG	35.0 *(+13.8%)*	34.55 *(+12.0%)*
ARDL	33.5 *(+8.9%)*	33.01 *(+7.0%)*

Hungary

Table 10b Equilibrium exchange rates based on time series estimates, Hungary

	Average 2002	4th quarter 2002
Nominal exchange rate	242.6	239.2
Eq_93_4 RERCPI=f(PROD2, GOV, OPEN, FDEBT)		
EG	247.2 *(+1.9%)*	245.1 *(+2.5%)*
DOLS	250.6 *(+3.3%)*	249.0 *(+4.1%)*
Johansen	256.1 *(+5.6%)*	255.3 *(+6.7%)*
Eq_93_4 RERPPI=f(PROD2, GOV, OPEN, FDEBT)		
EG	261.2 *(+7.6%)*	254.2 *(+6.3%)*
Eq_94_5 RERCPI=f(PROD1, FDEBT, OPEN)		
EG	251.7 *(+3.7%)*	252.7 *(+5.6%)*
DOLS(1,3)	240.0 *(-1.1%)*	239.4 *(+0.1%)*
DOLS(2,3)	227.8 *(-6.1%)*	226.9 *(-5.2%)*
ARDL	236.8 *(-2.4%)*	236.7 *(-1.0%)*
Johansen	247.2 *(+1.9%)*	247.0 *(+3.3%)*
Eq_94_5 RERPPI=f(PROD1, FDEBT, OPEN)		
DOLS(1,3)	227.9 *(-6.1%)*	221.0 *(-7.6%)*
DOLS(2,3)	219.2 *(-9.7%)*	211.1 *(-11.8%)*

Poland

	Average 2002	4th quarter 2002
Nominal exchange rate	3.849	4.00
Eq_93_1 RERCPI=f(PROD1, INTCPI)		
DOLS(2,0)	3.856 *(+0.2%)*	3.767 *(-5.8%)*
DOLS(3,3)	3.539 *(-8.1%)*	3.443 *(-13.9%)*
Johansen	4.032 *(+4.7%)*	3.947 *(-1.3%)*
Eq_93_1 RERPPI=f(PROD1, INTPPI)		
EG	4.099 *(+6.5%)*	4.071 *(+1.8%)*
DOLS(0,0)	4.153 *(+7.9%)*	4.128 *(+3.2%)*
DOLS(2,3)	3.786 *(-1.7%)*	3.746 *(-6.4%)*
ARDL	4.164 *(+8.2%)*	4.139 *(+3.5%)*
Eq_93_2 RERPPI=f(PROD2, INTPPI)		
EG	4.075 *(+5.9%)*	4.052 *(+1.3%)*
DOLS	4.122 *(+7.1%)*	4.100 *(+2.5%)*
ARDL	4.165 *(+8.2%)*	4.145 *(+3.6%)*
Eq_93_3 RERCPI=f(PROD1, INTCPI)		
DOLS	3.972 *(+3.2%)*	3.893 *(-2.7%)*
ARDL	4.202 *(+9.2%)*	4.129 *(+3.2%)*
Eq_93_3 RERPPI=f(PROD1, INTPPI)		
EG	4.151 *(+7.8%)*	4.130 *(+3.2%)*
DOLS	4.243 *(+10.2%)*	4.226 *(+5.6%)*
ARDL	4.273 *(+11.0%)*	4.257 *(+6.4%)*
Eq_93_5 RERCPI=f(PROD1, INTCPI, FDEBT)		
ARDL	3.53 *(-8.3%)*	3.480 *(-13.0%)*
Johansen	3.966 *(+3.0%)*	3.921 *(-2.0%)*
Eq_93_6 RERCPI=f(PROD1, INTCPI, GOV OPEN)		
DOLS(0,1)	4.673) *(+21.4%)*	4.634 *(+15.9%)*
DOLS(1,2)	5.284 *(+37.3%)*	5.279 *(+32.0%)*
Johansen	4.977 *(+29.3%)*	4.929 *(+23.2%)*
ARDL(1,0)	4.289 *(+11.4%)*	4.254 *(+6.3%)*
ARDL(1,1)	4.749 *(+23.4%)*	4.734 *(+18.3%)*
Eq_94_1 RERCPI=f(PROD1, INTCPI, FDEBT)		
Johansen	3.556 *(-7.6%)*	3.499 *(-12.5%)*

Derived from panel

Table 11a Equilibrium exchange rates and misalignment based on selected panel estimates
2002 averages

	Czech Rep	Hungary	Poland	Slovakia	Slovenia
Nominal exchange rate	**30.79**	**242.6**	**3.849**	**42.66**	**226.2**
Equation3, P5, PROD1, 94-02	39.88 *(+29.3%)*	227.7 *(-6.1%)*	4.167 *(+8.2%)*	53.60 *(+25.6%)*	204.4 *(-9.6%)*
Equation3, P8, GDP, 95-02	41.10 *(+33.5%)*	225.3 *(-7.1%)*	3.844 *(-0.1%)*	47.21 *(+10.6%)*	154.4 *(-31.8%)*
Equation4, P5, PROD1, 94-02	36.72 *(+19.3%)*	198.4 *(-18.2%)*	3.815 *(-0.9%)*	51.38 *(+20.4%)*	214.0 *(-5.4%)*
Equation6, P8, PROD3, 95-02	40.22 *(+30.6%)*	222.5 *(-8.3%)*	3.902 *(+1.4%)*	50.59 *(+18.6%)*	168.3 *(-25.6%)*
Equation6, P8, GDP, 95-02	41.42 *(+34.5%)*	224.3 *(-7.5%)*	3.913 *(+1.7%)*	46.67 *(+9.4%)*	169.8 *(-25%)*

Note: In parentheses: over(+)/under(-)valuation of the exchange rate.

Table 11b Equilibrium exchange rates and misalignment based on selected panel estimates
4th quarter 2002

	Czech Rep	Hungary	Poland	Slovakia	Slovenia
Nominal exchange rate	**30.86**	**239.2**	**4.00**	**41.74**	**229.5**
Equation3, P5, PROD1, 94-02	39.46 *(+27.9%)*	228.0 *(-4.7%)*	4.107 *(+2.7%)*	53.60 *(+28.4%)*	206.6 *(-10.0%)*
Equation3, P8, GDP, 95-02	41.06 *(+33.0%)*	227.9 *(-4.7%)*	3.828 *(-4.3%)*	47.59 *(+14.0%)*	155.5 *(-32.2%)*
Equation4, P5, PROD1, 94-02	36.11 *(+17.0%)*	197.3 *(-17.5%)*	3.735 *(-6.6%)*	50.99 *(+22.2%)*	219.3 *(-4.5%)*
Equation6, P8, PROD3, 95-02	40.18 *(+30.2%)*	225.7 *(-5.7%)*	3.879 *(-3.0%)*	50.99 *(+22.2%)*	169.8 *(-26.0%)*
Equation6, P8, GDP, 95-02	41.29 *(+33.8%)*	226.7 *(-5.3%)*	3.893 *(-2.7%)*	46.91 *(+12.4%)*	171.3 *(-25.4%)*

Table 12a Equilibrium exchange rates and misalignment
Equation 6 RERCPI=f(PROD/GDP, REG, RIR, GOV), 2002 averages

	Czech Rep	Hungary	Poland	Slovakia	Slovenia
Nominal exchange rate	**30.79**	**242.6**	**3.849**	**42.66**	**226.2**
P5 93-02 PROD1	44.81 *(+45.5%)*	245.9 *(+1.4%)*	4.466 *(+16.0%)*	54.57 *(+27.9%)*	213.9 *(-5.4%)*
P5 93-02 PROD3	43.31 *(+40.7%)*	271.9 *(+12.1%)*	4.546 *(+18.1%)*	56.68 *(+32.9%)*	197.1 *(-12.9%)*
P5 93-02 GDP	44.81 *(+45.5%)*	261.3 *(+7.7%)*	4.439 *(+15.3%)*	48.89 *(+14.6%)*	193.5 *(-14.4%)*
P5 94-02 PROD1	43.63 *(+41.7%)*	233.4 *(-3.8%)*	4.260 *(+10.7%)*	53.35 *(+25.1%)*	205.3 *(-9.3%)*
P8 94-02 PROD3	38.82 *(+26.1%)*	210.6 *(-13.2%)*	3.689 *(-4.1%)*	49.42 *(+15.9%)*	159.1 *(-29.6%)*
P8 94-02 GDP	39.97 *(+29.8%)*	209.4 *(-13.7%)*	3.695 *(-4.0%)*	45.64 *(+7.0%)*	160.0 *(-29.3%)*
P8 95-02 PROD3	40.22 *(+30.6%)*	222.5 *(-8.3%)*	3.902 *(+1.4%)*	50.59 *(+18.6%)*	168.3 *(-25.6%)*
P8 95-02 GDP	41.42 *(+34.5%)*	224.3 *(-7.5%)*	3.913 *(+1.7%)*	46.67 *(+9.4%)*	169.8 *(-24.9%)*
P9 95-02 GDP	40.92 *(+32.9%)*	219.7 *(-9.4%)*	3.815 *(-0.9%)*	45.60 *(+6.9%)*	165.7 *(-26.7%)*

Table 12b Equilibrium exchange rates and misalignment
Equation 6 RERCPI=f(PROD/GDP, REG, RIR, GOV), 4th quarter 2002

	Czech Rep	Hungary	Poland	Slovakia	Slovenia
Nominal exchange rate	**30.86**	**239.2**	**4.00**	**41.74**	**229.5**
P5 93-02 PROD1	44.45 *(+44.0%)*	247.7 *(+3.5%)*	4.42 *(+10.5%)*	54.75 *(+31.2%)*	216.7 *(-5.6%)*
P5 93-02 PROD3	43.21 *(+40.0%)*	275.5 *(+15.2%)*	4.51 *(+12.7%)*	57.17 *(+37.0%)*	199.2 *(-13.2%)*
P5 93-02 GDP	44.59 *(+44.5%)*	263.5 *(+10.2%)*	4.416 *(+10.4%)*	49.12 *(+17.7%)*	195.5 *(-14.8%)*
P5 94-02 PROD1	43.28 *(+40.2%)*	234.8 *(-1.8%)*	4.214 *(+5.3%)*	53.49 *(+28.2%)*	207.7 *(-9.5%)*
P8 94-02 PROD3	38.79 *(+25.7%)*	213.5 *(-10.7%)*	3.665 *(-8.4%)*	49.81 *(+19.3%)*	160.4 *(-30.1%)*
P8 94-02 GDP	39.88 *(+29.2%)*	211.8 *(-11.5%)*	3.676 *(-8.1%)*	45.88 *(+9.9%)*	161.2 *(-29.8%)*
P8 95-02 PROD3	40.18 *(+30.2%)*	225.7 *(-5.7%)*	3.879 *(-3.0%)*	50.99 *(+22.2%)*	169.8 *(-26.0%)*
P8 95-02 GDP	41.29 *(+33.8%)*	226.7 *(-5.2%)*	3.893 *(-2.7%)*	46.91 *(+12.4%)*	171.3 *(-25.4%)*
P9 95-02 GDP	40.77 *(+32.1%)*	221.8 *(-7.3%)*	3.793 *(-5.2%)*	45.80 *(+9.7%)*	167.0 *(-27.2%)*

Results from the literature

Country	*Author*	*Year*	*Mis.*
Czech R.	Šmidková (1998)	1996	Eff: -1%- +5%
	Begg et al. (1999)	1997	Eff: NM
	Frait-Komárek (1999)	1998	Slightly +
	Kim-Korhonen (2002)	1999	Eff: -10%
	Coudert-Couhard (2002)	2001	EUR: -3/+1%
	Lommatzsch-Tober (2002b)	2001	Eff: 0%-+15%
	Égert-Lahrèche (2003)	2001	Eff:+15%
	Šmídková et al.(2002)	2002	Eff. +8-9%
	Rahn (2003)	2002	Eff. +9.7/+11%
			EUR+13.7/+14.7%
	Crespo-Cuaresma et al. (2003)	2002	EUR: +16.%
	Alberola (2003)	2003	Eff:+10%
Hungary	Avallone- Lahrèche (1999)	1997	Eff: NM
	Begg et al. (1999)	1997	Eff: Slightly +
	Coudert (1999)	1997	USD: NM
	Kim-Korhonen (2002)	1999	Eff: +40%
	Coudert-Couhard (2002)	2001	EUR: +2/+4%
	Lommatzsch-Tober (2002b)	2001	Eff: NM
	Égert-Lahrèche (2003)	2001	Eff: NM
	Crespo-Cuaresma et al. (2003)	2002	EUR:-5.6%
	Csajbók-Kovács (2002)	2002	Eff: overvalued
	Šmídková et al.(2002)	2002	Eff. +6%
	Csajbók(2003)	2002	+3/+10%
	Rahn (2003)	2002	Eff. –3%/+5%
			EUR+2.5%/+8.6%
	Alberola (2003)	2003	Eff: +10/+12%

Results from the literature

Country	*Author*	*Year*	*Mis.*
Poland	Begg et al. (1999)	1997	Slightly +?
	Kim-Korhonen (2002)	1999	Eff: NM
	Kemme-Teng	1999	Eff. +2-+10%
	Lommatzsch-Tober (2002b)	2001	Eff: +10%
	Coudert-Couhard (2002)	2001	EUR: +3/+5%
	Égert-Lahrèche (2003)	2001	Eff: +15%
	Rawdanowicz (2002)	2002	Eff: NM
	Šmídková et al.(2002)	2002	Eff. +10-+12%
	Rahn (2003)	2002	Eff. +8%/13%
			EUR. +13%/+17%
	Crespo-Cuaresma et al. (2003)	2002	EUR: +14.3%
	Alberola (2003)	2003	Eff: -10%
	Rubaszek (2003)	2002	EUR:+8%
		2003	EUR:Slightly undervalued
Slovakia	IMF (1998)	1997	Eff: NM
	Begg et al. (1999)	1997	Eff: NM
	Kim-Korhonen (2002)	1999	Eff: NM
	Égert-Lahrèche (2003)	2001	+8%
	Crespo-Cuaresma et al. (2003)	2002	-1.3%
Slovenia	Begg et al. (1999)	1997	Slightly +?
	Coudert-Couhard (2002)	2001	EUR: +1/+2%
	Égert-Lahrèche (2003)	2001	Eff: NM
	Šmídková et al.(2002)	2002	Eff. NM
	Rahn (2003)	2002	Eff. -3%
			EUR. -6%
	Hana-Damjan (2003)	2003	Eff: -2/+1.6%

Yet to be done

PMGE

Long-term values (Gonzalo-Granger approach)

Increase the size of the panel

Concluding remarks

That’s all folks!