National Bank of Poland

Asymmetry of the exchange rate pass-through: An exercise on the Polish data

Jan Przystupa
Ewa Wróbel

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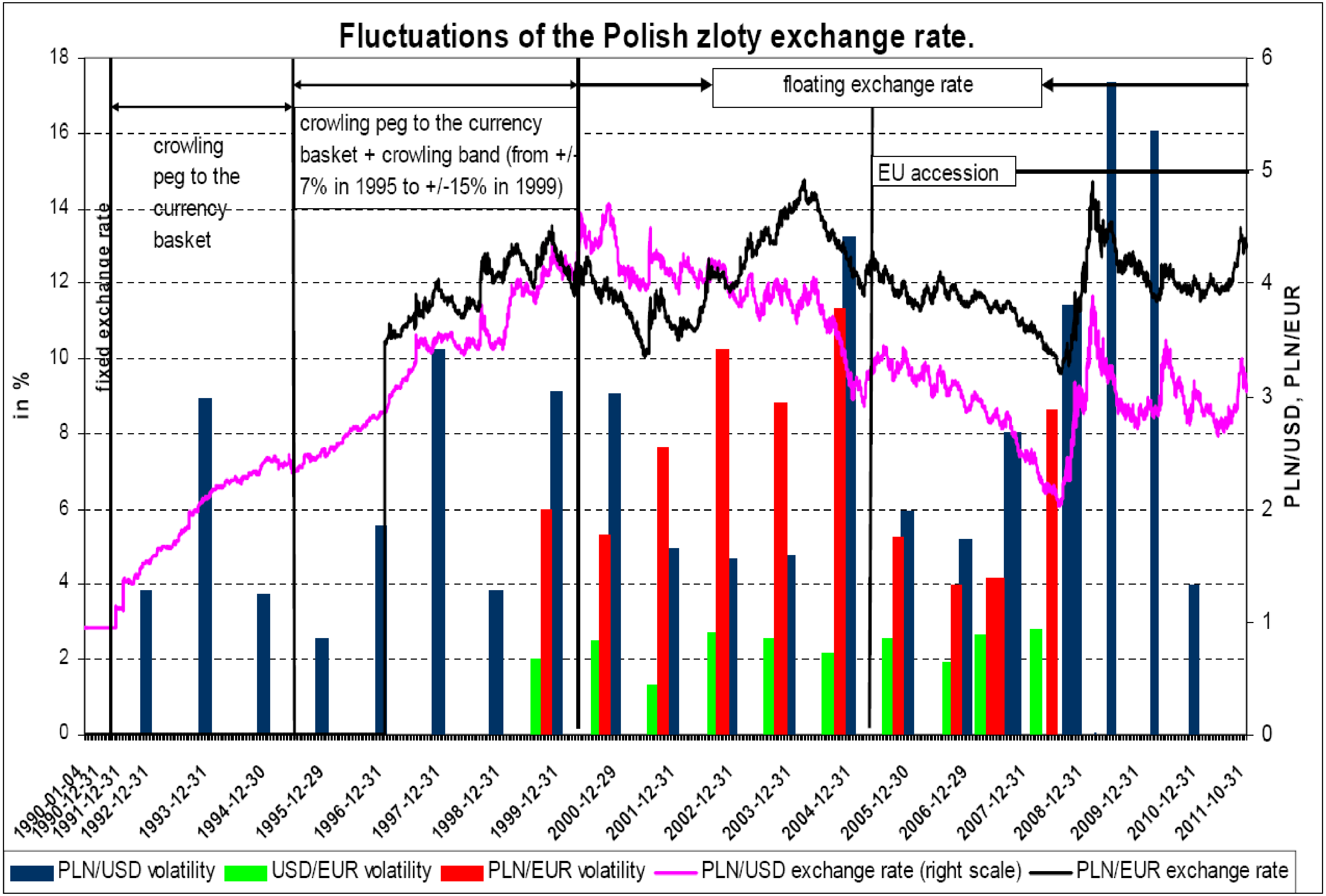
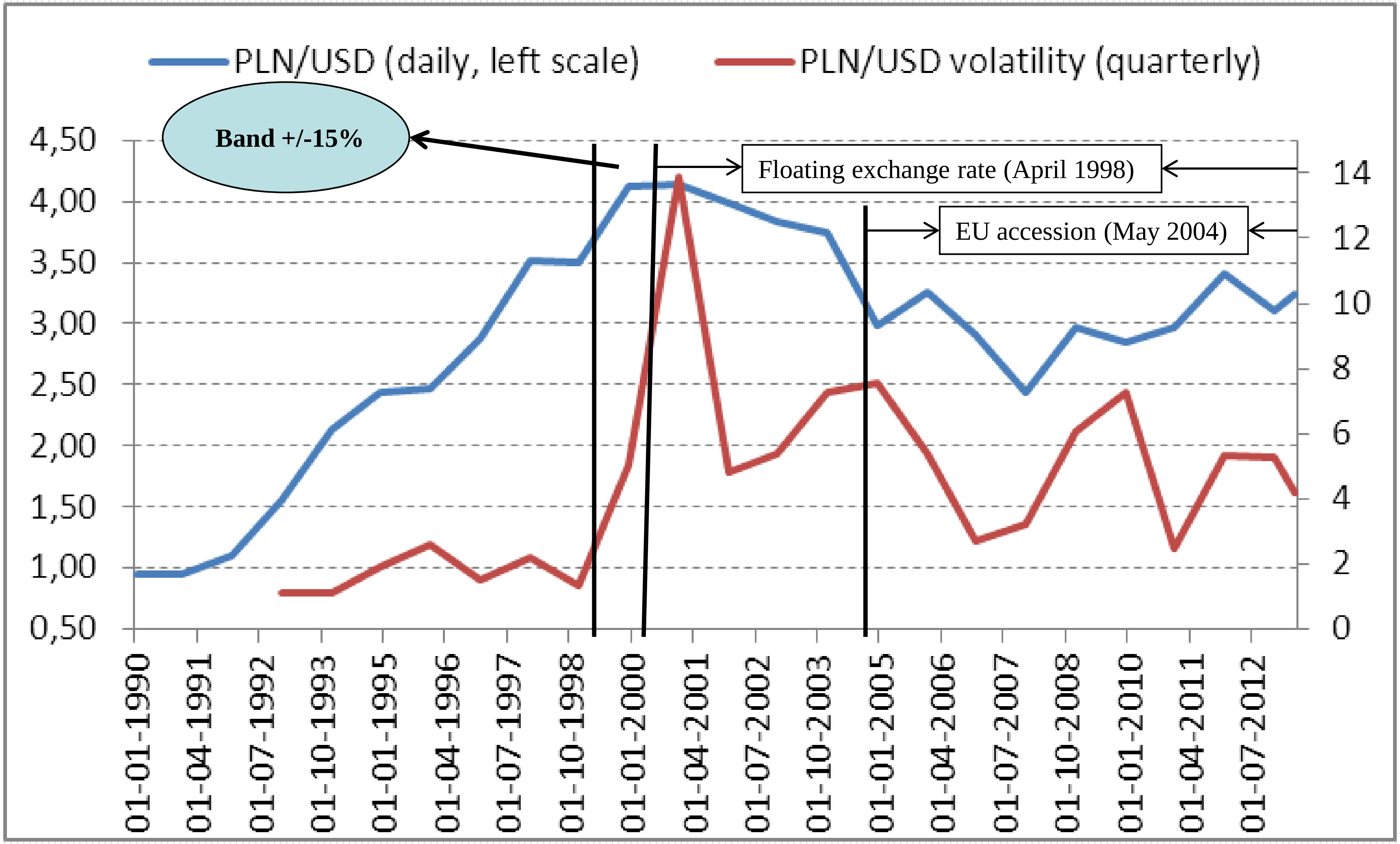


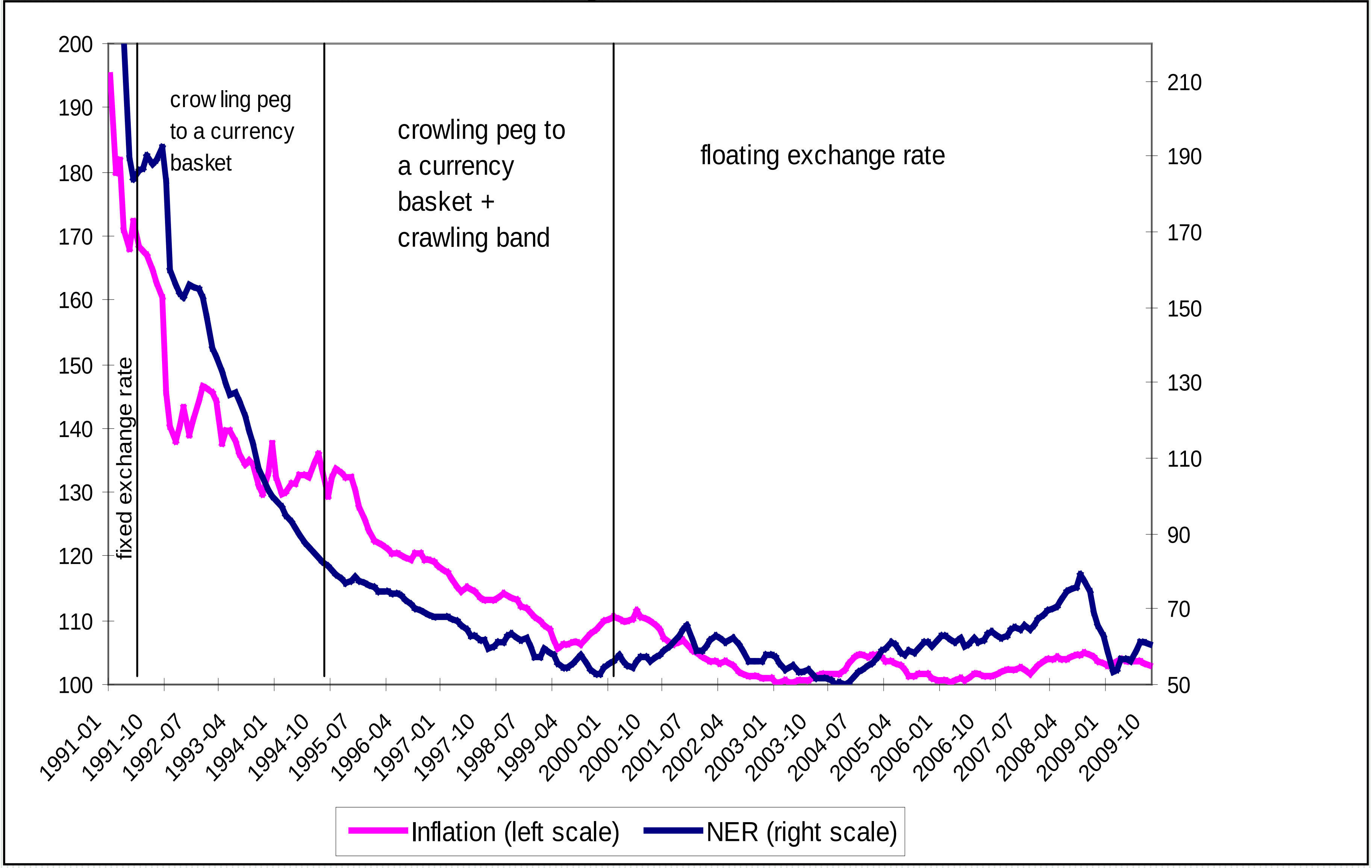
Fluctuations of the Polish zloty exchange rate.
fixed exchange rate
crowling peg to the currency basket
crowling peg to the currency basket + crowling band (from +/- 7% in 1995 to +/-15% in 1999)
floating exchange rate
EU accession
in %
PLN/USD, PLN/EUR
0
2
4
6
8
10
12
14
16
18
0
1
2
3
4
5
6
1990-01-04
1990-12-31
1991-12-31
1992-12-31
1993-12-31
1994-12-30
1995-12-29
1996-12-31
1997-12-31
1998-12-31
1999-12-31
2000-12-29
2001-12-31
2002-12-31
2003-12-31
2004-12-31
2005-12-30
2006-12-29
2007-12-31
2008-12-31
2009-12-31
2010-12-31
2011-10-31
PLN/USD volatility
USD/EUR volatility
PLN/EUR volatility
PLN/USD exchange rate (right scale)
PLN/EUR exchange rate

PLN/USD fluctuations



The exchange rate

Exchange rate vs. inflation



MOTIVATION

Understanding how prices respond to exchange rate is of key importance for any open economy.

An extra stimulus:

FAQ:

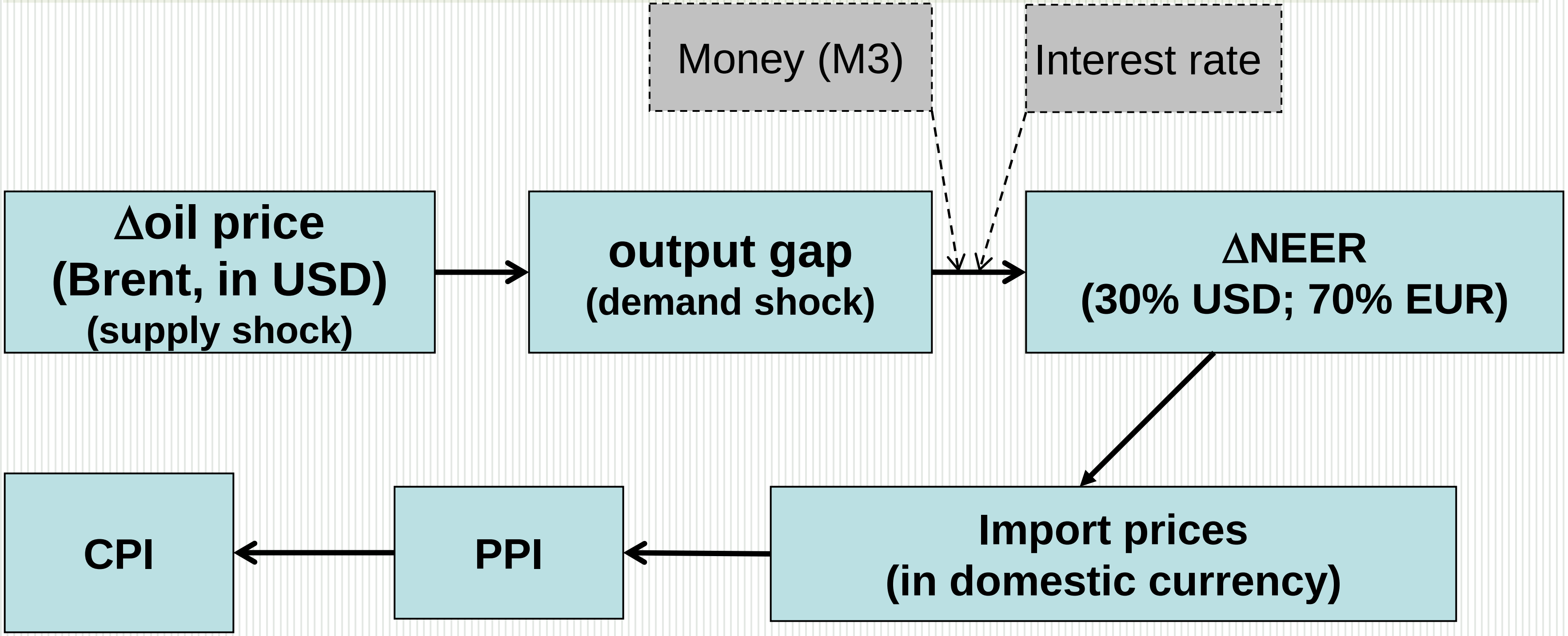
- What is an impact of currerent depreciation (appreciation) on consumer prices?
- Does it depend on the scale of the ex changes or on the phase of the business cycle?
- What is the pricing policy of the foreign exporting firms towards the Polish market?

To answer these questions we propose a complex investigation of the exchange rate channel of the monetary transmission mechanism for an open economy with the floating exchange rate regime.

First: we assessed the level of the exchange rate pass-through.

Based on McCarthy (1999) where the impact of a sequence of supply, demand and exchange rate shocks on the import, producer and consumer prices is examined. Since it is a popular method we used it for the sake of comparability with other studies and to have an idea about the level of the pass-through effect in Poland.

Flowchart of the *pass-through* effect.



McCarthy's model (1999)

π_m - index of the import transaction prices expressed in the domestic currency;

ε_m - unexpected change of the import price

$$\pi_m = E_{t-1}(\pi_m) + \alpha_1\varepsilon_s + \alpha_2\varepsilon_d + \alpha_3\varepsilon_e + \varepsilon_m$$

π_w - price index of the sold production of industry (PPI);

ε_w - unexpected change of the production price

$$\pi_w = E_{t-1}(\pi_w) + \beta_1\varepsilon_s + \beta_2\varepsilon_d + \beta_3\varepsilon_e + \beta_4\varepsilon_m + \varepsilon_w$$

π_c - consumption price index (CPI);

ε_c - unexpected change of the CPI

$$\pi_c = E_{t-1}(\pi_c) + \gamma_1\varepsilon_s + \gamma_2\varepsilon_d + \gamma_3\varepsilon_e + \gamma_4\varepsilon_m + \gamma_5\varepsilon_w + \varepsilon_c$$

Coefficients explain a part of the shock assigned to the corresponding variable

Exchange rate pass-through. Estimation based on the McCarthy's SVAR

$$PT(z_t)_h = \frac{\Delta z_{t,t+h}}{\Delta e_{t,t+h}}$$

Pass-through effect: changes of the variable *z* (import, production, consumption prices) from *t* to *t+h* being the response on the exchange rate changes between *t* and *t+h*

Pass-through effect after →	**2 quarters**		**4 quarters**		**8 quarters**	
for ↓	**Est.02**	**Est.11**	**Est.02**	**Est.11**	**Est.02**	**Est.11**
Import transaction prices (PM)	**0.51**	**0.46**	**0.69**	**0.67**	**0.79**	**0.71**
Price index of the sold production of industry (PPI)	0.27	0.19	0.50	0.33	0.59	0.38
Consumption price index CPI)	0.17	0.10	0.36	0.16	0.42	0.18

Exchange rate pass-through. Estimation based on the McCarthy's SVAR

Time decomposition of the pass-through effect.

Time decomposition of the pass-through effect for ↓ (total P-T=100)	**Quarter after shock**				
	Q_0	Q_1	Q_2	Q_3	Q_4-Q_8
Import transaction prices (PM)	17	49	25	4	5
Price index of the sold production of industry (PPI)	12	35	29	10	14
Consumption price index CPI)	10	42	31	7	10

Assessing the level of the exchange rate pass-through to the import prices and pricing to market (PTM) with cointegration technics.

Cointergating vector, exchange rate - NEER

$$p_t^{IMP} = \alpha_0 + \alpha_1 e_t + \alpha_2 p_t^F + \alpha_3 p_t^H + \alpha_4 y_t^H + \varepsilon_t$$

	VECM (cointegration Johansen), t-stat in [ ]
unrestricted	
α_1	-0.91 [5.92]
α_2	1.44 [2.21]
α_3 (If significant then PTM exists)	0.95 [5.19]
restricted: $\alpha_1 = \alpha_2$ (If significant then PT is full)	Chi-square=0.56, p. 0.45
α_1	-0.81 [7.50]
α_2	0.81 [7.50]
α_3	1.13 [17.65]
restricted: $\alpha_1 = \alpha_2 = 1$ (Law of one price)	Chi-square=9.64, p. 0.008
restricted: $\alpha_1 = \alpha_2 = 1$, $\alpha_3 = 0$ (Unit homogeneity)	Chi-square=11.1, p. 0.011
restricted: $\alpha_1 = \alpha_2 = 1$ (Unit coeff. at EX & FP)	Chi-square=10.21, p. 0.006

Cointegrating vector, bilateral exchange rate EUR/PLN

$$p_t^{IMP} = \alpha_0 + \alpha_1 e_t + \alpha_2 p_t^F + \alpha_3 p_t^H + \alpha_4 y_t^H + \varepsilon_t$$

	VECM (cointegration Johansen), t-stat in [ ]	Fully modified least squares t-stat in [ ]
unrestricted		
α_1	-0.71 [2.47]	-0.68 [4.73]
α_2	0.41 [0.35]	0.74 [1.09]
α_3	0.83 [2.27]	0.82 [4.4]
restricted: $\alpha_1 = \alpha_2$	Chi-square=0.03, p. 0.86	Chi-square=0.018, p. 0.91
α_1	-0.78 [5.28]	-0.67 [7.15]
α_2	0.78 [5.28]	0.67 [7.15]
α_3	0.71 [7.22]	0.84 [15.29]
restricted: $\alpha_1 = \alpha_2 = 1$	Chi-square=7.24, p. 0.026	Chi-square=12.46, p. 0.002
restricted: $\alpha_1 = \alpha_2 = 1$, $\alpha_3 = 0$	Chi-square=7.49, p. 0.058	Chi-square=260, p. 0.000
restricted: $\alpha_1 = \alpha_2 = 1$	Chi-square=6.87, p. 0.032	Chi-square=40.0, p. 0.000

Dynamic import price equations

$$\Delta p_t^{IMP} = \beta_0 + \beta_1 EC_{t-1} + \sum_{i=0}^{4} \beta_{2,i}\Delta e_{t-i} + \sum_{i=0}^{4} \beta_{3,i}\Delta p_{t-i}^{F} + \sum_{i=0}^{4} \beta_{4,i}\Delta p_{t-i}^{H} + \sum_{i=1}^{4} \beta_{5,i}\Delta p_{t-i}^{IMP} + v_t$$

Table A11. Dynamic import price equation

Variable	Coefficient	t-stat
β_0	0.0011	0.16
β_1 Return to equilibrium	-0.464	-3.02
$\beta_{2,0}$ EX pass-through (short term)	0.51	3.94
$\beta_{4,0}$ PTM	0.898	1.82

Table A 12. Dynamic import price equation: appreciation of the EUR/PLN, usable obs.: 24.

Variable	Coefficient	t-stat, p-value in ( )
β_0^A	-0.0023	-0.16 (0.874)
β_1^A	-0.654	-2.96 (0.008)
$\beta_{2,0}^A$	**0.55**	1.58 (0.131)
$\beta_{4,0}^A$	1.29	1.8 (0.091)

$$A_t = \begin{cases} 1 & \text{if } \Delta e_t \prec 0 \\ 0 & \text{otherwise} \end{cases}$$

Table A 13. Dynamic import price equation: depreciation of the EUR/PLN, usable obs.: 20

Variable	Coefficient	t-stat
β_0^D	-0.0055	-0.39
β_1^D	~~-0.225~~	-1.03
$\beta_{2,0}^D$	**0.59**	2.07
$\beta_{4,0}^D$	~~0.77~~	1.12

$$D_t = \begin{cases} 1 & \text{if } \Delta e_t \succ 0 \\ 0 & \text{otherwise} \end{cases}$$

Dynamic import price equations

$$\Delta p_t^{IMP} = \beta_0 + \beta_1 EC_{t-1} + \sum_{i=0}^{4} \beta_{2,i} \Delta e_{t-i} + \sum_{i=0}^{4} \beta_{3,i} \Delta p_{t-i}^{F} + \sum_{i=0}^{4} \beta_{4,i} \Delta p_{t-i}^{H} + \sum_{i=1}^{4} \beta_{5,i} \Delta p_{t-i}^{IMP} + v_t$$

Table A14. Dynamic import price equation: positive EC, usable obs.: 21.

Variable	Coefficient	t-stat
β_0^{EC+}	0.00183	0.08
β_1^{EC+}	~~-0.31~~	-0.63
$\beta_{2,0}^{EC+}$	0.66	4.27
$\beta_{4,0}^{EC+}$	~~0.003~~	0.0031

Table A15. Dynamic import price equation: negative EC, usable obs.: 23.

Variable	Coefficient	t-stat
β_0^{EC-}	-0.019	-1.62
β_1^{EC-}	-0.65	-2.01
$\beta_{2,0}^{EC-}$	~~0.16~~	0.82
$\beta_{4,0}^{EC-}$	2.0	3.39

EC+ import prices are lower than the equilibrium level determined by exporters' prices and domestic prices

EC- import prices are higher than the equilibrium level determined by exporters' prices and domestic prices

Exchange rate pass-through models based on the Phillips curve

$$\pi_{t,k}^{q_i} = \alpha_{1,k}^{q_i} E_t \pi_{t+1} + (1 - \alpha_{1,k}^{q_i} - \alpha_{2,k}^{q_i})\pi_{t-1} + \alpha_{2,k}^{q_i}(\Delta e_{t-1}^{r}) + \alpha_{3,k}^{q_i} y_{t-2} + \varepsilon_t$$

where:

π stands for inflation (CPI);

q_i is a variable (i=1…4) stands for:

i=1 → output gap (y);

i=2 → Δ nominal effective exchange rate (Δe);

i=3 → volatility of the nominal effective exchange rate (s);

i=4 → inflation (π): actual inflation – inflation target (π*);

k=1,2; Threshold estimated with SETAR (**S**elf-**E**xciting **T**hreshold **A**uto**R**egresive) model

k=1 for $q_i > \tau$ (τ = threshold);

k=2 for $q_i \leq \tau$

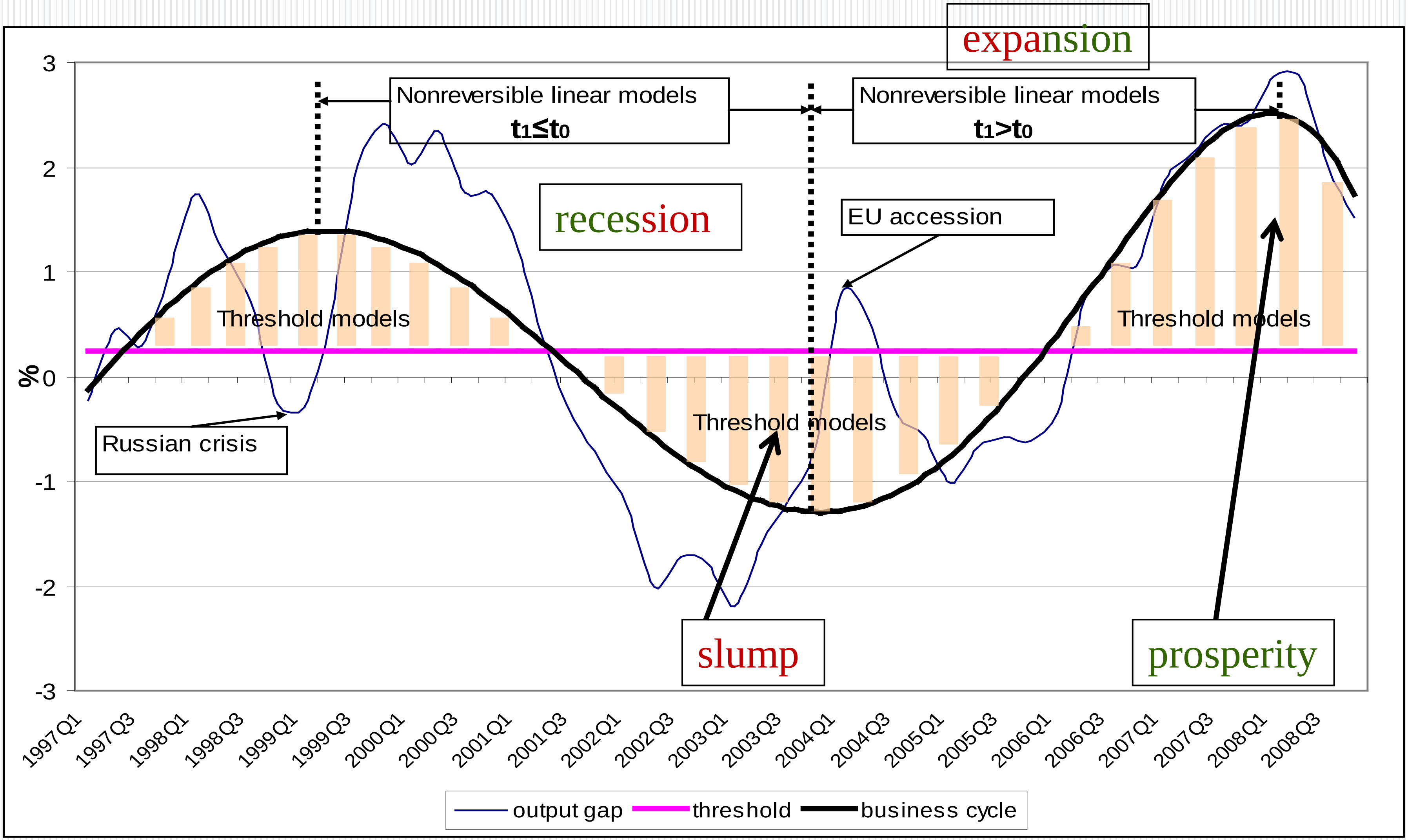
k=3,4; Investigate nonreversibility of the linear functions through segmenting the variables.

k=3 for $q_i > q_{i-1}$

k=4 for $q_i \leq q_{i-1}$

e_{t-1}^{r} is a nominal effective exchange rate (in log) plus foreign inflation (HICP in the euro zone; in log)

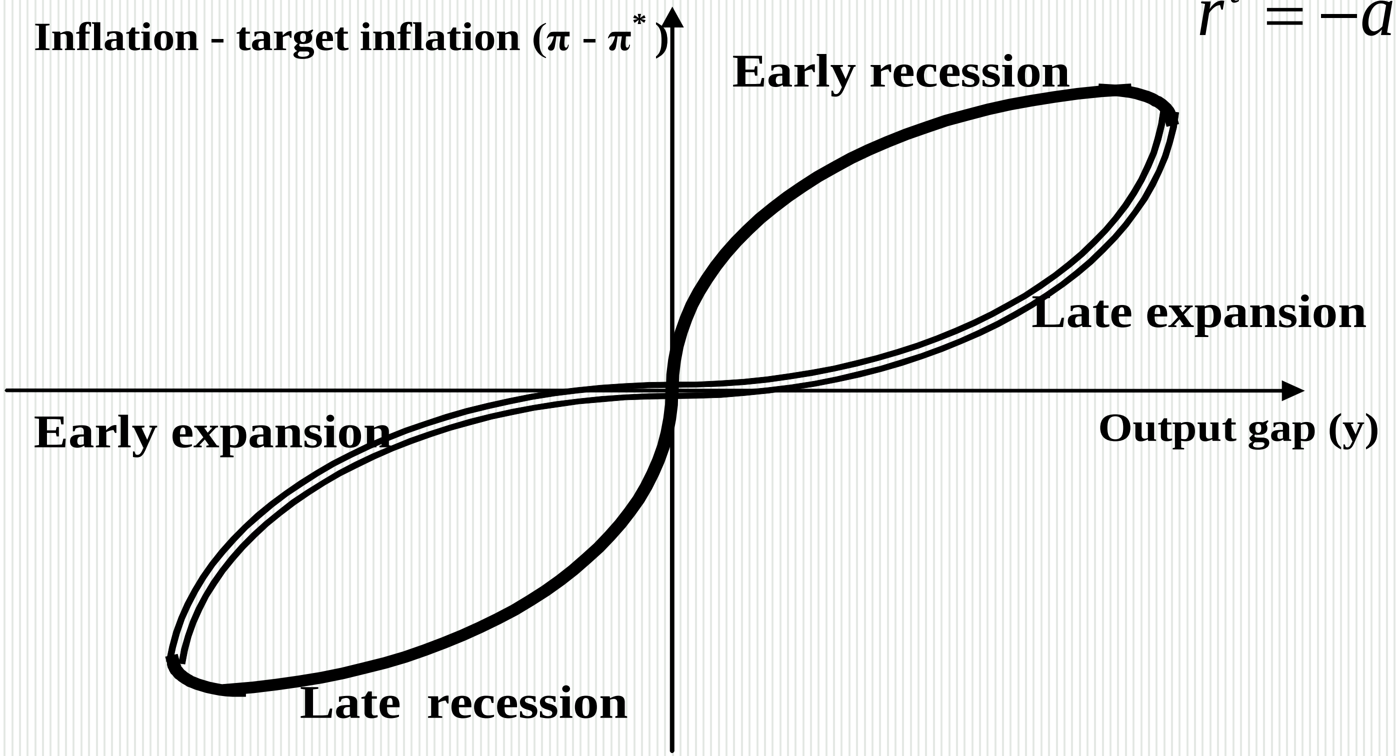
The economic interpretation of the threshold model and model based on nonreversibility of the linear functions



The economic interpretation of the threshold model and model based on nonreversibility of the linear functions

$$r^t = a^2 \cos t\theta$$

$$r^t = -a^2 \cos t\theta$$

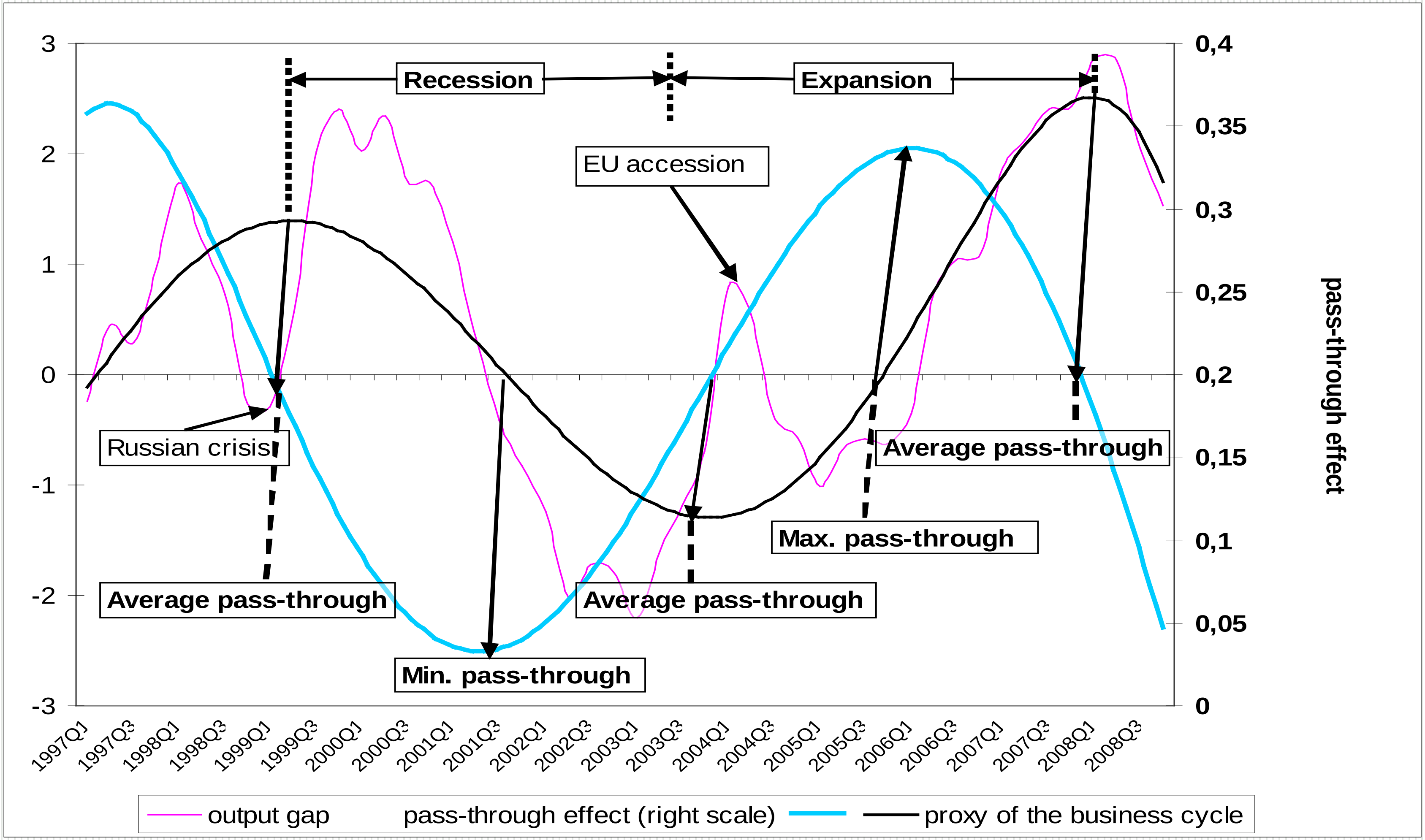


Two-leaf clover curve

The asymmetry of the exchange rate pass-through to the consumer prices

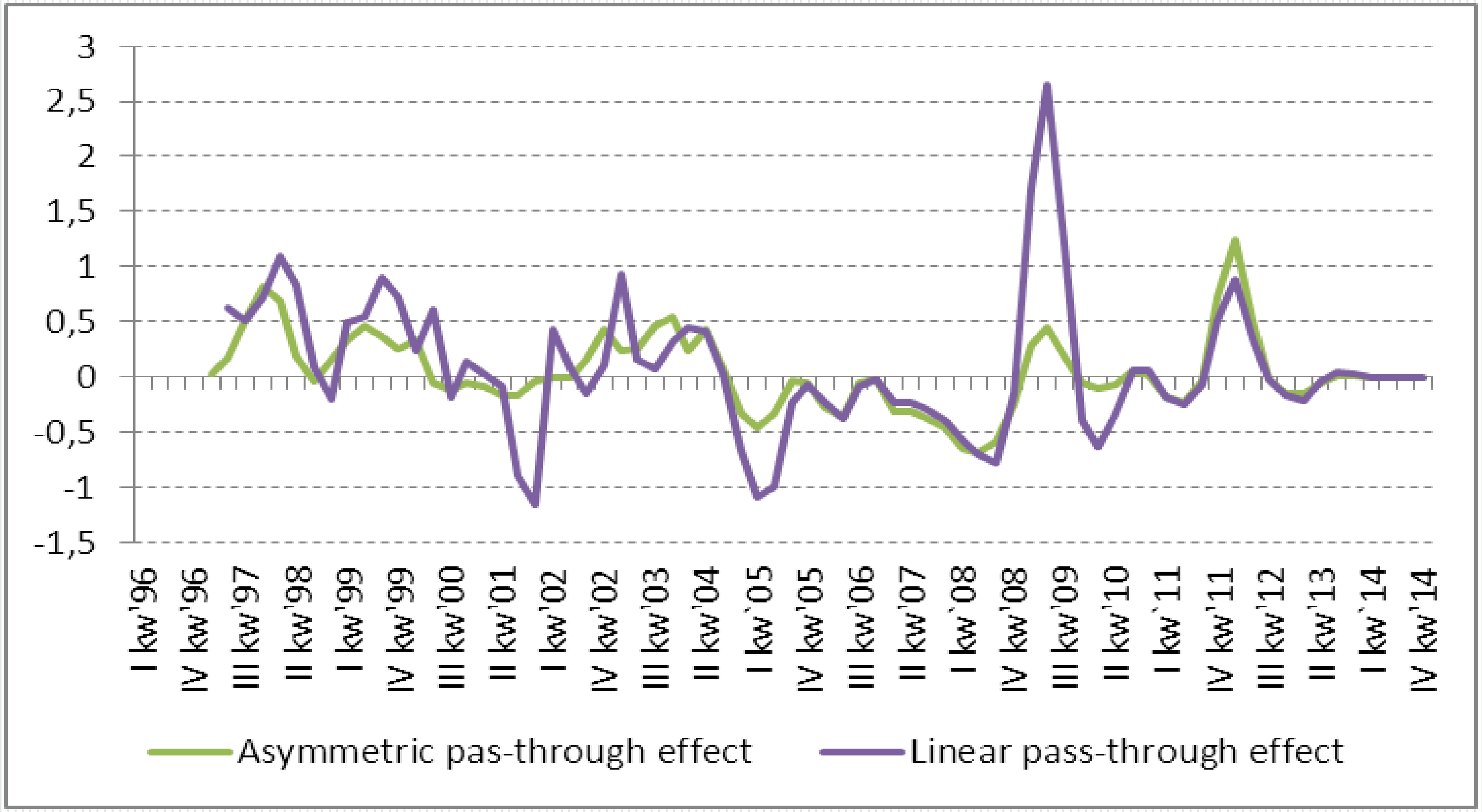
Asymmetry of the exchange rate pass-through to CPI related to:	Threshold models (τ = threshold)		Nonreversible linear models	
	variable > τ	variable ≤ τ	$t_1 > t_0$	$t_1 \leq t_0$
Output gap (y)	τ = 0.24%		0.274	0.091
	0.192	0.179		
Δ nominal effective exchange rate (Δe)	τ = 2.08%		0.018	0.238
	0.065	0.239		
Volatility of the nominal effective exchange rate (s)	τ = 4.32%		0.139	0.141
	0.247	0.549		
Inflation (π)	τ = level of official inflation target		0.160	0.183
	0.195	0.201		
Pass-through (general)	0.229			

The asymmetry of the exchange rate pass-through to the consumer prices



This is coherent with the behavior of enterprises in the business cycle, conditioning their investment decisions on expected profits with a maximum in the early expansion and a minimum in the early recession. The enterprises' propensity to change prices follows profit expectations.

Exchange rate pass-through and inflation.



	I q`08	II q'08	III q'08	IV q'08	I q`09	II q'09	III q'09	IV q'09	I q`10	II q'10	III q'10	IV q'10	I q`11	II q'11	III q'11	IV q'11	I q`12	II q'12	III q'12	IV q'12	I q`13
Linear PT	-0,651	-0,684	-0,592	-0,256	0,284	0,441	0,182	-0,051	-0,102	-0,070	0,056	0,012	-0,183	-0,235	-0,047	0,717	1,241	0,510	-0,026	-0,149	-0,160
Asym.PT	-0,573	-0,707	-0,783	-0,157	1,707	2,646	1,199	-0,404	-0,642	-0,339	0,051	0,065	-0,190	-0,246	-0,067	0,509	0,885	0,356	-0,028	-0,177	-0,217

Figures shown in the table indicate by how many percentage points inflation in a given quarter would be higher (-) or lower (+) than the counterfactual inflation that assumes no exchange rate changes. A year on year impact is calculated as an average impact in the consecutive four quarters.

THANK YOU ☺