NATIONAL BANK OF UKRAINE

NONLINEAR EXCHANGE RATE PASS-THROUGH TO DOMESTIC PRICES IN UKRAINE

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Open Research Seminar, NBU, July 22, 2016

Introduction

- **Exchange rate pass-through** (ERPT) – the percentage change in the price of imported good in local currency resulting from a one percent change in the nominal exchange rate
- Understanding the mechanism of ERPT is important for monetary policy

- "**Hot issue**" for Ukraine:
  - small open economy
  - transition to inflation targeting
  - from fixed towards floating exchange rate
  - uncertainties due to military conflict

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  - from fixed towards floating exchange rate
  - uncertainties due to military conflict

- **Empirical literature for Ukraine is scarce:**

Source	Price Index	Data set	Exchange Rate	ERPT
Korhonen & Wachtel (2005)	CPI	1999 – 2004	USD	0.63 – 0.64
			EUR	0.24 – 0.28
Beckmann & Fidrmuc (2013)	CPI	1999 – 2010	USD	0.45
			EUR	0.25
Novikova & Volkov (2012)	CCPI	2004 – 2012	USD	0.35 – 0.47
Faryna (2016, forthcoming)	CCPI	2001 – 2015	USD	0.40 – 0.42
			EUR	0.20 – 0.21
			NEER	0.27 – 0.28
			RUB	0.09 – 0.10

Introduction

- This paper aims to estimate ERPT to consumer prices in UKRAINE considering nonlinearities with respect to the **direction** and **magnitude** of exchange rate movements

- Agenda:
  - ✓ Introduction
  - Brief literature survey
  - Analytical framework
  - Estimation approach and data description
  - Estimation results
  - Concluding remarks

Brief Literature Survey

- **Asymmetric pass-through from depreciation and appreciation**
- Micro-founded ***"pricing to market"*** theory
- Mark-up responsiveness has an opposite nature:
  - Appreciation has a ***positive*** effect on a foreign exporter's mark-up
  - Depreciation has a ***negative*** effect on a foreign exporter's mark-up

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- **Perfect competition:**
  - *Foreign firm care about market share*
  - Appreciation: ~~*mark-up change*~~ → *price change* → **high ERPT**
  - Depreciation: *mark-up change* → ~~*price change*~~ → **low ERPT**

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- **Imperfect competition:**
  - *Substantial market power of a foreign firm*
  - Appreciation: *mark-up change* → ~~*price change*~~ → **low ERPT**
  - Depreciation: ~~*mark-up change*~~ → *price change* → **high ERPT**

Brief Literature Survey

- **Nonlinear pass-through from small and large exchange rate changes**
- The change of the invoice price – ***"menu costs"***:
  - Small ER changes: ~~*change of the invoice price*~~ in order to avoid menu costs
  - Large ER changes: *change of the invoice price* in order to maintain market share
- Foreign firms' price-setting behavior matters

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- **Producer currency pricing (PCP) strategy:**
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- **Local currency pricing (LCP) strategy:**
  - *Invoice price – importer's currency*
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  - Large ER changes: *change of the invoice price* → *change of the price in local currency* → **high ERPT**

Analytical Framework

- Consider a single Foreign exporting firm
- Profit-maximization problem:

$$\max_{P^H} \pi = \frac{P^H Q}{E} - C(Q)$$

where

π	*exporting firm's profit in Foreign currency*
E	*exchange rate of Home currency per unit of exporting firms currency*
P^H	*price in Home currency*
$C(Q)$	*cost function in the Foreign currency*
Q	*quantity demanded*

- First-order condition yields to:

$$P_t^H = E_t \mu_t C_t^F$$

where

C_t^F	*marginal cost of exporting firm*
μ_t	*mark-up over marginal costs*

Analytical Framework

- Foreign firm's mark-up depends on the demand pressure in the Home market *(see Bailliu & Fujii (2004) and Cheikh (2013))*:

$$\mu_t = \eta/(\eta - 1) = \mu(Y)$$

where

η	*price elasticity for demand of importing product*
Y	*demand conditions in the destination country*

- Nonlinear mark-up responsiveness considering exchange rate fluctuations:

$$\mu_t = \mu\left(Y, E^{\gamma(D)}\right)$$

where

$\gamma(D)$	*transition function*
$D = \Delta e_{t-i}$	*percentage change of exchange rate.*

- A simple log-linear reduced-form ERPT equation would be:

$$p_t^H = \alpha + \beta e_t + \gamma(D) e_t + \delta c_t^F + \rho y_t^H + \varepsilon_t$$

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Analytical Framework

- Joint ERPT coefficient is measured as $(\boldsymbol{\beta} + \boldsymbol{\gamma}(\boldsymbol{D}))$
- Transition function $\boldsymbol{\gamma}(\boldsymbol{D})$ may be further defined as:

$$\boldsymbol{\gamma}(\boldsymbol{D}) = \begin{cases} 0, & if \;\; D > D^* \\ \varphi, & otherwise \end{cases}$$

- Two ERPT coefficients:
  - if $D > D^*$ ERPT is $(\boldsymbol{\beta} + \mathbf{0}) = \boldsymbol{\beta}$;
  - if $D \leq D^*$ ERPT is $(\boldsymbol{\beta} + \boldsymbol{\varphi})$
- Threshold value of exchange rate change $\boldsymbol{D^* = 0}$ divides extreme cases into regimes of appreciation and depreciation
- Threshold value of exchange rate change $\boldsymbol{D^* = \gamma}$ divides extreme cases into regimes of small and large exchange rate changes

Analytical Framework

- **ERPT to consumer prices:**
  - $\boldsymbol{p^H}$ and $\boldsymbol{e}$ usually follow non-stationary process – differentiation results in inflation equation, as in *Bailliu & Fujii (2004)*
  - include inflation persistence to account for adaptive expectations, as in *Nogueira & Miguel (2007)*
  - include lagged values of all independent variables to account for relationship in dynamics

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- **Theoretical inflation equation:**

$$\Delta p_t^H = \alpha + \sum_{i=1}^{n} \theta_i \Delta p_{t-i}^H + \sum_{i=0}^{k} \left(\beta_i + \gamma(D)\right) e_{t-i} + \sum_{i=0}^{q} \delta_i c_{t-i}^F + \sum_{i=0}^{r} \rho_i y_{t-i}^H + \varepsilon_t$$

Estimation Approach

- **Autoregressive Distributed Lag (ARDL) model:**

$$Y_t = a_0 + \sum_{i=1}^{n} a_{1,i} Y_{t-i} + \sum_{i=0}^{k} a_{2,i} X_{t-i} + \varepsilon_t$$

where

Y_t	*dependent variable*
X_t	*independent variable*
$a_{1,i}, a_{2,i}$	*parameters of the model*
a_0	*constant*
ε_t	*white noise.*

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- **Nonlinear parameters, as in *Pollard and Coughlin (2004)*:**

$$Y_t = a_0 + \sum_{i=1}^{n} a_{1,i} Y_{t-i} + \mathrm{D}^{+} \sum_{i=0}^{k} a_{2,i} X_{t-i} + \mathrm{D}^{-} \sum_{i=0}^{k} a_{3,i} X_{t-i} + \varepsilon_t$$

$$D^{+} = \begin{cases} 1, if \ \Delta X_{t-i} > \gamma \\ 0, if \ \Delta X_{t-i} \leq \gamma \end{cases}; \qquad \mathrm{D}^{-} = \begin{cases} 0, if \ \Delta X_{t-i} > \gamma \\ 1, if \ \Delta X_{t-i} \leq \gamma \end{cases}$$

where

D^{+} & D^{-}	*dummy variables for high and low regimes*
ΔX_{t-i}	*transition variable*
γ	*threshold value*

Estimation Approach

Coefficient interpretation:

- If all variables in equation:
  - in logarithms
  - in first differences

- *The percentage change of dependent variable resulting from 1% change of each regressor*

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ERPT dynamic multiplier:

- Lag coefficient:

0.	$\beta_0 = a_{20}$
1.	$\beta_1 = a_{11}\beta_0 + a_{21}$
2.	$\beta_2 = a_{11}\beta_1 + a_{12}\beta_0 + a_{22}$
jth	$\beta_j = \sum_{i=1}^{n} a_{1,i}\beta_{j-i}$

- Cumulative coefficient:

$$\beta_{\text{full}} = \sum_{j=0}^{\infty} \beta_j = \frac{\sum_{i=1}^{n} a_{2,i}}{1 - \sum_{i=0}^{k} a_{1,i}}$$

Data Description

- Monthly frequency
- 2007:01 – 2016:04
- Disaggregated **Consumer Price Indices (CPIs)**:
  - All consumer prices – 258 indices
  - Core consumer prices – 182 indices
  - Raw food prices – 47 indices
  - Core food prices – 50 indices
  - Core nonfood prices – 104 indices
  - Prices of tradables – 151 indices
  - Prices of import tradables – 129 indices

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- Exchange Rate – **Nominal Effective Exchange rate (NEER)**
  - *Positive change – depreciation*
  - *Negative change – appreciation*
- Demand conditions – **Industrial Production Index (IPI) gap**
  - *The difference of seasonally adjusted IPI and HP-filtered IPI in logarithms*
- Supply conditions – **Fuel Price Index (FPI)** from IMF Commodity Price Statistics
  - *Brent oil*
  - *Natural gas, and*
  - *Coal prices*

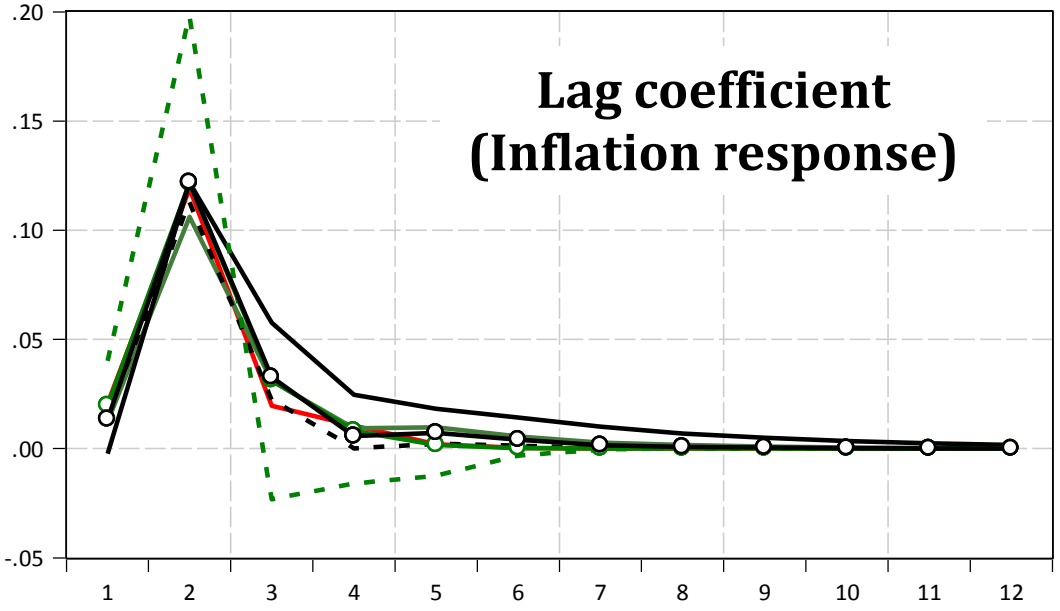
Estimation Results

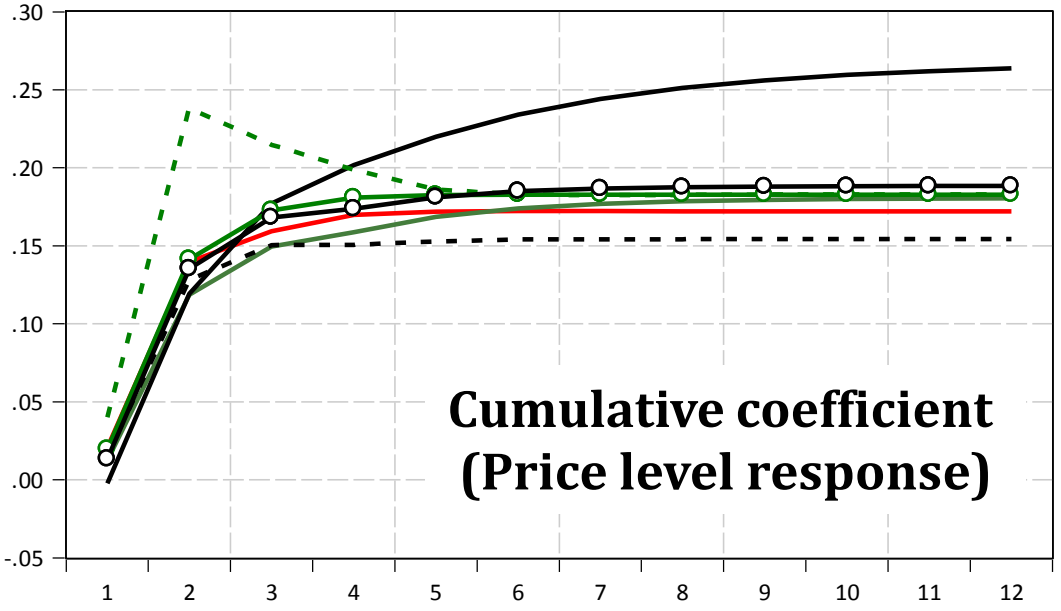
- **Linear ARDL:**

$$CPI_t = a_0 + \sum_{i=1}^{3} a_{1,i} CPI_{t-i} + \sum_{i=0}^{3} a_{2,i} NEER_{t-i} + \sum_{i=1}^{2} a_{3,i} IPI_{t-i} + \sum_{i=0}^{2} a_{4,i} FPI_{t-i} + \varepsilon_t$$

Linear exchange rate pass-through

Consumer Prices	Core Consumer Prices	Raw Food Prices	Core Food Prices	Core Narrow Prices	Prices of Tradables	Import Tradables
0.172	0.181	0.183	0.268	0.154	0.183	0.189
[0.012]	[0.009]	[0.054]	[0.024]	[0.009]	[0.011]	[0.009]





Estimation Results

Asymmetric ERPT for Ukraine:

- Transition variable: $\Delta neer_{t-3}$
- Threshold value (TV):

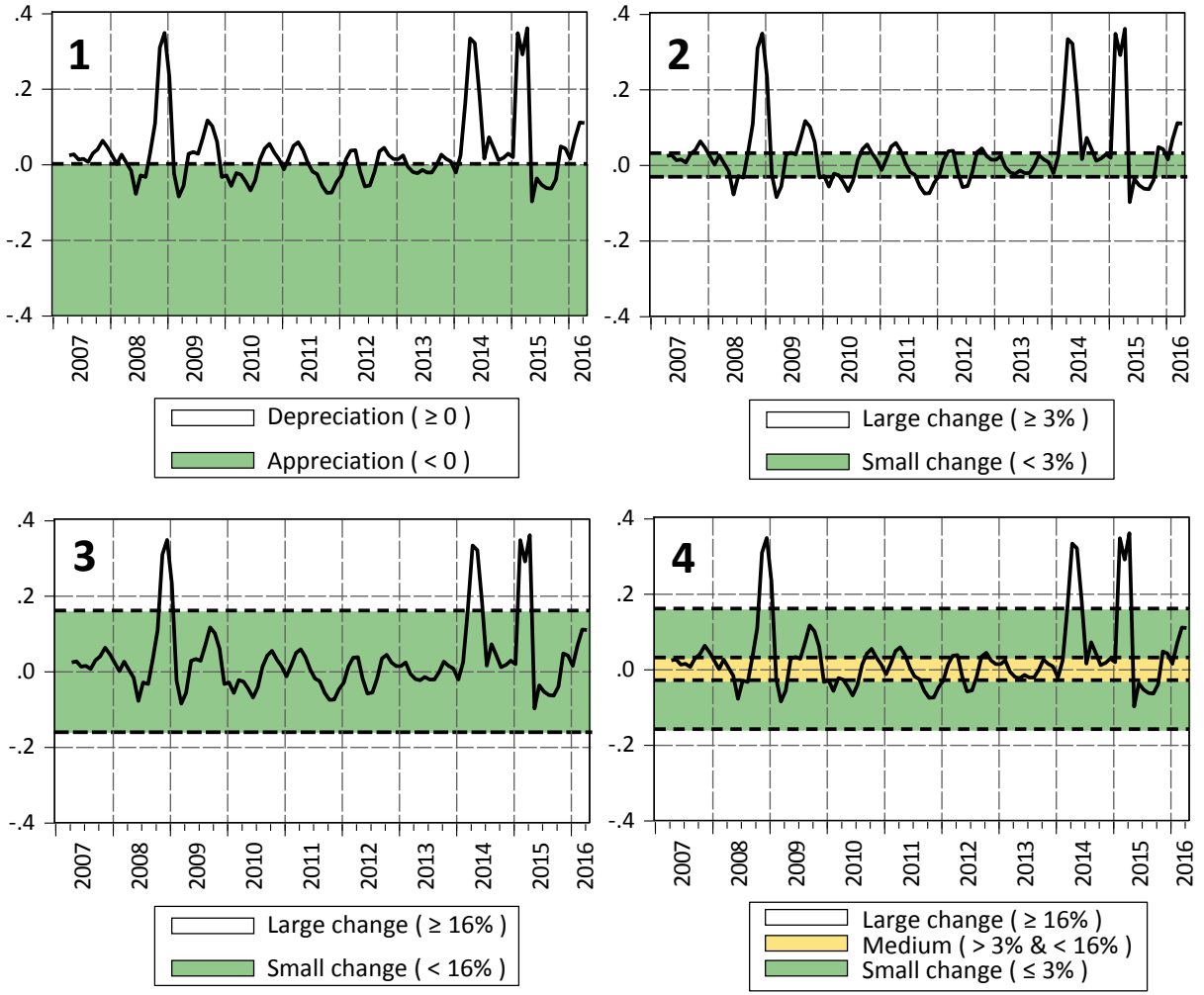
1. ***TV = 0%***, for
   depreciation $\Delta neer_{t-3} \geq 0\%$
   appreciation $\Delta neer_{t-3} < 0\%$

2. ***TV= 3*** (MED.), for
   large $abs(\Delta neer_{t-3}) \geq 3\%$
   small $abs(\Delta neer_{t-3}) < 3\%$

3. ***TV = 16*** (2 SE), for
   large $abs(\Delta neer_{t-3}) \geq 16\%$
   small $abs(\Delta neer_{t-3}) < 16\%$

4. ***TV(1) = 3 & TV(2) = 16***, for
   small $abs(\Delta neer_{t-3}) \leq 3\%$,
   large $abs(\Delta neer_{t-3}) \geq 16\%$
   medium $3\% < abs(\Delta neer_{t-3}) < 16\%$

Transition variable (1 quarter NEER change) and threshold values



Estimation Results

Asymmetric ERPT from depreciation and appreciation

	Consumer Prices	Core Consumer Prices	Raw Food Prices	Core Food Prices	Core Narrow Prices	Prices of Tradables	Prices of Import Tradables
Depreciation	**0.221**	**0.276**	0.100	0.417	**0.246**	**0.262**	**0.299**
(61% obs.)	**[0.015]**	**[0.011]**	[0.07]	[0.034]	**[0.012]**	**[0.014]**	**[0.012]**
Appreciation	0.068	-0.122	**0.728**	0.270	-0.24	-0.109	-0.215
(39% obs.)	[0.044]	[0.031]	**[0.199]**	[0.093]	[0.033]	[0.038]	[0.034]
H_0:	###	###	###		###	###	###

Notes:

1. *numbers are ERPT coefficients*
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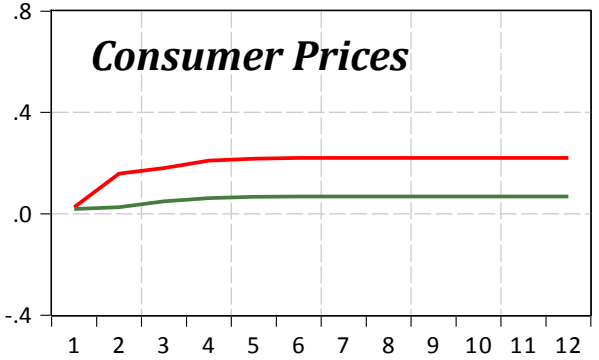
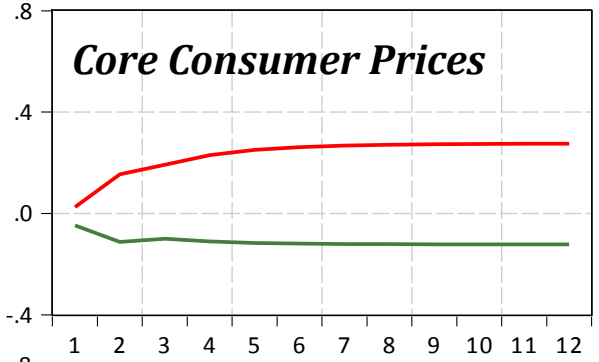
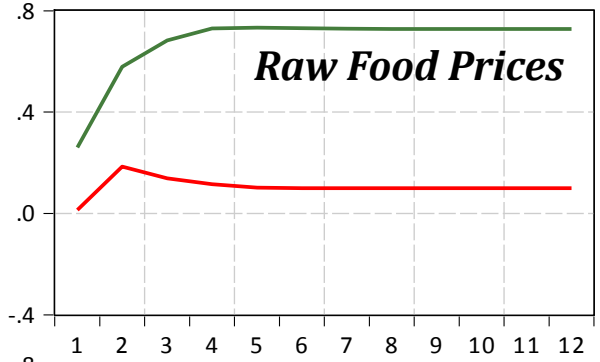
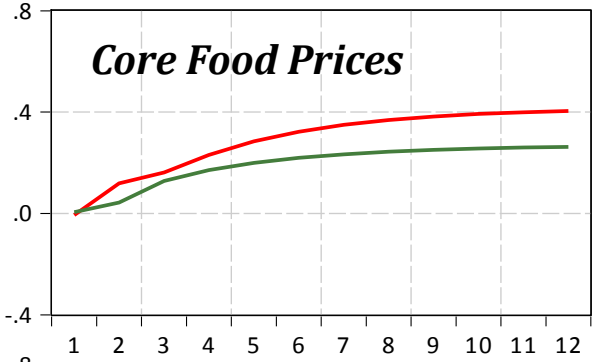
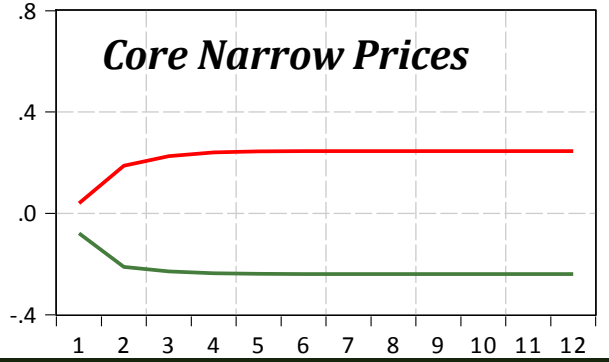
3. *γ – threshold value*
4. *###, ##, # indicate 1, 5, 10 % significance level to reject linearity hypotheses:*
   H_0: depreciation = appreciation

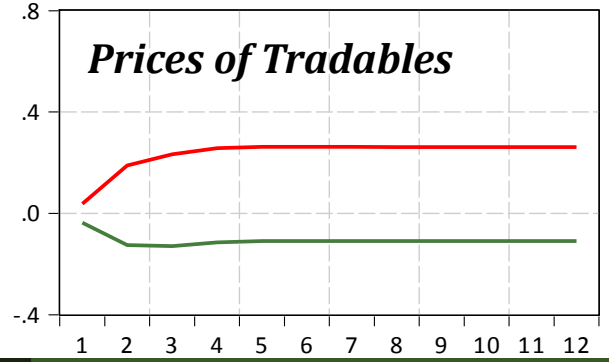


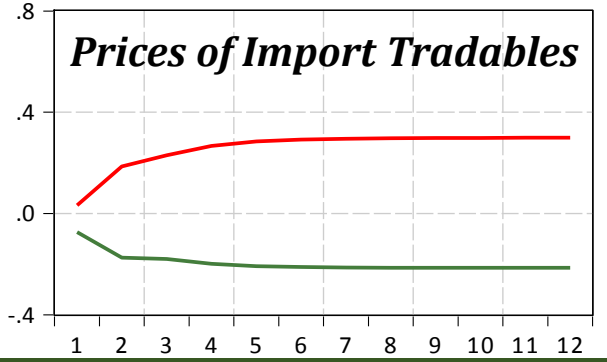












Depreciation (≥ 0)

Appreciation (< 0)

Estimation Results

Nonlinear ERPT from small and large exchange rate changes

		Consumer Prices	Core Consumer Prices	Raw Food Prices	Core Food Prices	Core Narrow Prices	Prices of Tradables	Prices of Import Tradables
Median: $\gamma \approx 0.03$	***Large*** *(55% obs.)*	0.161 [0.012]	0.169 [0.009]	0.175 [0.055]	0.232 [0.025]	0.148 [0.010]	0.180 [0.011]	0.179 [0.01]
	Small *(45% obs.)*	**0.724 [0.072]**	**0.351 [0.053]**	**2.203 [0.326]**	**0.780 [0.140]**	0.209 [0.057]	**0.416 [0.064]**	**0.275 [0.058]**
	H_1:	###	###	###	###		###	#
2 SE: $\gamma \approx 0.16$	***Large*** *(9% obs.)*	**0.231 [0.018]**	**0.257 [0.013]**	0.271 [0.083]	**0.616 [0.042]**	**0.191 [0.014]**	**0.246 [0.016]**	**0.266 [0.014]**
	Small *(91% obs.)*	-0.008 [0.024]	0.019 [0.016]	0.144 [0.101]	0.082 [0.045]	-0.014 [0.017]	0.031 [0.019]	-0.002 [0.017]
	H_1:	###	###		###	###	###	###

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4. *###, ##, # indicate 1, 5, 10 % significance level to reject linearity hypotheses: H_1: small= large*

Estimation Results

Nonlinear ERPT from small and large exchange rate changes

		Consumer Prices	Core Consumer Prices	Raw Food Prices	Core Food Prices	Core Narrow Prices	Prices of Tradables	Prices of Import Tradables
$\gamma_2 \approx 0.03$ & $\gamma_2 \approx 0.16$	***Large*** *(9% obs.)*	0.231 [0.018]	**0.258 [0.013]**	0.253 [0.082]	**0.617 [0.041]**	**0.188 [0.014]**	0.243 [0.016]	**0.266 [0.014]**
	Medium *(46% obs.)*	-0.008 [0.024]	-0.031 [0.017]	-0.009 [0.108]	-0.04 [0.048]	-0.043 [0.018]	-0.007 [0.021]	-0.048 [0.018]
	Small *(45% obs.)*	**0.714 [0.073]**	**0.336 [0.051]**	**2.287 [0.328]**	**0.737 [0.145]**	**0.214 [0.055]**	**0.420 [0.064]**	**0.263 [0.056]**
	H_1:	###		###			###	
	H_2:	###	###	##	###	###	###	###
	H_3:	###	###	###	###	###	###	###

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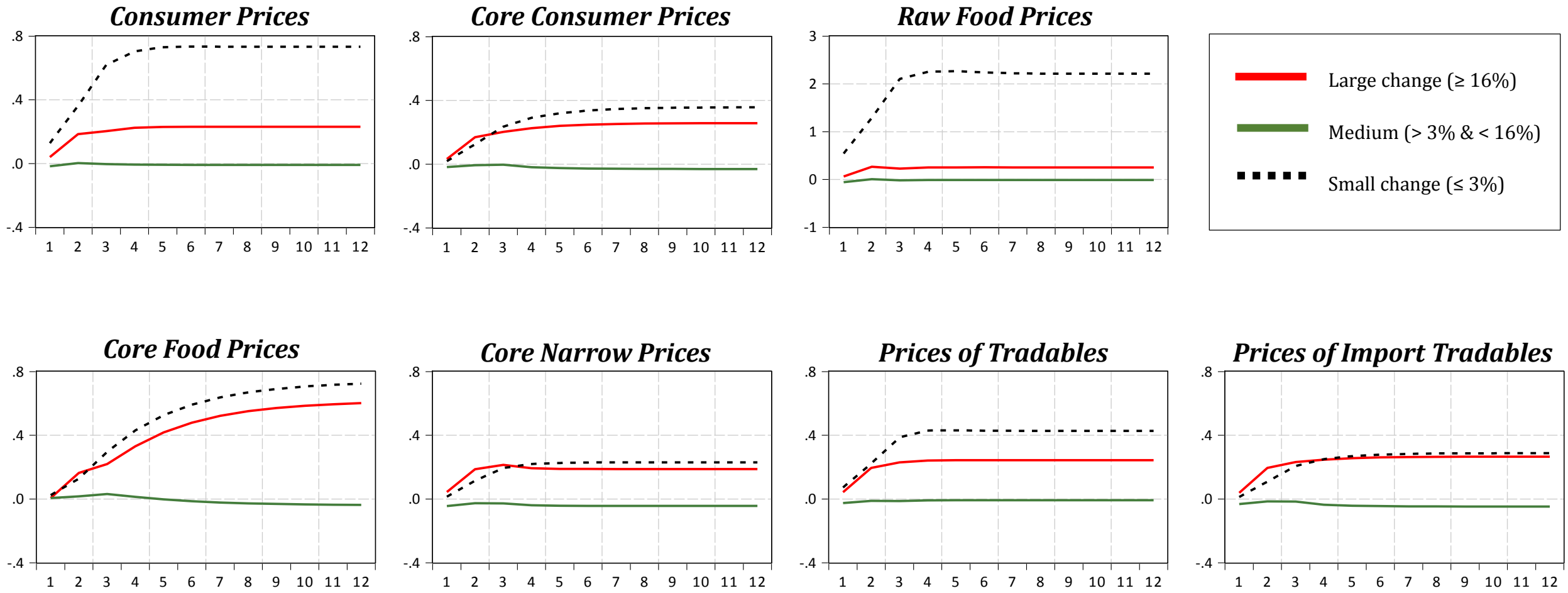
Estimation Results

Nonlinear ERPT from small and large exchange rate changes



Concluding Remarks

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- The ability of the NBU to attain its inflation targets requires a thorough understanding of the extent to which consumer prices respond to exchange rate movements

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- Our findings:
  - for most price groups the pass-through effect from depreciation is higher than from appreciation – weak competition in Ukraine
  - small changes have a considerable effect on price adjustments in Ukraine, while moderate changes are insignificant –menu costs for foreign producers
  - the pass-through effect rises in the case of extremely large exchange rate depreciations under the crisis conditions

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- The National Bank of Ukraine should be aware that consumer prices in Ukraine are sensitive to small and extremely large NEER changes, while the pass-through effect is statistically insignificant in the case of moderate NEER fluctuations
- Other sources of nonlinearities in the ERPT mechanism (e.g., inflation environment, business cycles, exchange rate volatility) may be the subject of further research.

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THANK YOU