The Asymmetric Effects of Exchange Rate on Inflation: A Quantile NARDL Approach

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Why Study Exchange Rate Pass-Through (ERPT)?

Inflation Targeting:

Exchange rate changes influence domestic inflation, particularly considering the high import content of CPI (Skufi, et al., 2024)

Literature on Albania

Traditional models & assume symmetry and homogeneity in ERPT (Hledik, et al., 2021; Skufi et al., 2019, Tanku, et al., 2007)

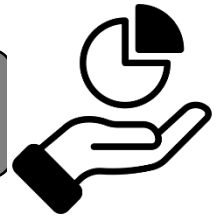
Research Question

Does the degree of ERPT vary depending on whether inflation is high or low?

What should be the correct policy response in the presence of non-linearity?

Approach and Contribution:

Approach



Contribution

Quantile Nonlinear Autoregressive Distributed Lags
Shin et al. (2014) & Cho et al. (2015)

Vis-à-vis earlier approaches QNARDL allows us to test for the possibility that the time series are cointegrated…

…but the relationship is not linear along direction of change in exchange rate

…and the relationship is not linear along inflation levels

Introduces a novel methodology to the analysis of ERPT

Expands the empirical literature on ERPT by providing country-specific evidence

Quantifies the asymmetry (depreciation vs. appreciation) and heterogeneity (across inflation quantiles)

Selected literature review

Early literature:

is focused on ERPT to import prices (Menon, 1995)

Literature expands to the macroeconomic indicators

indicates that the impact of exchange rate on inflation can be asymmetric (Bussière, 2007; Katrakilidis & Trachanas, 2012)

The source of asymmetry might be related to several sources

Import composition (Gopinath, 2015; Ortega & Osbat 2020)
Business cycles (Ben Cheikh et al., 2018; Ortega & Osbat 2020)
Inflation level (López-Villavicencio, 2017; Cheikh & Zaied, 2020)
Inflation regime (Caselli & Roitman, 2016; Cheikh & Zaied, 2020; Arsić et al., 2022)
Nature of the shock (Corsetti et al., 2008; Comunale & Kunovac, 2017; Forbes et al., 2018)

Literature on Albania:

ERPT on traded CPI (Tanku, et al., 2007)
ERPT via import prices (Skufi & Kika, 2019)
ERPT in a macromodel set-up (Hledik, et al., 2021; Skufi et al., 2024)

Model Variables:

Inflation

Economic activity

Money supply

Monetary policy

Exchange rate

Foreign inflation

Oil prices

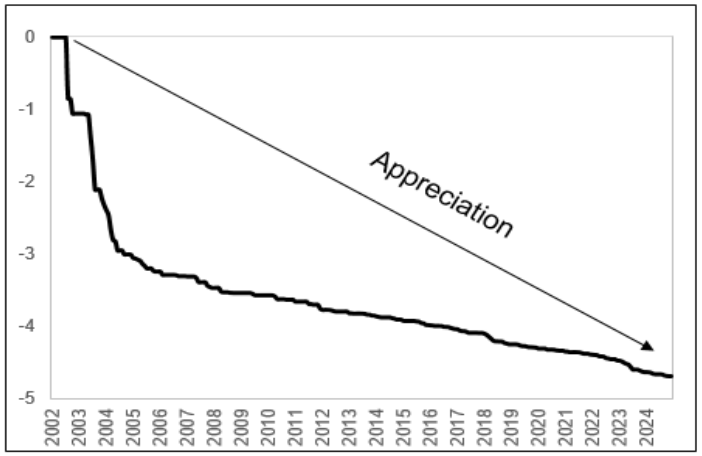
QNARDL

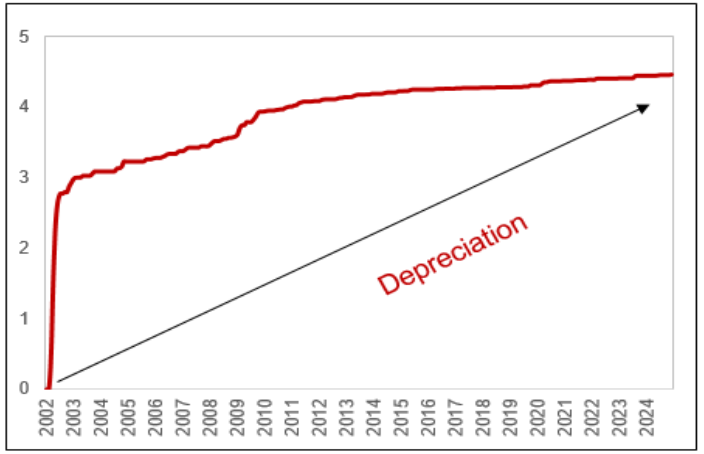
Exchange rate partial sum decomposition

$$LEK\_EUR_t = LEK\_EUR_t^0 + LEK\_EUR_t^+ + LEK\_EUR_t^-$$

$$LEK\_EUR_t^+ = \sum_{j=1}^{t} \Delta LEK\_EUR_j^+ = \sum_{j=1}^{t} max(\Delta LEK\_EUR_j, 0)$$

$$LEK\_EUR_t^- = \sum_{j=1}^{t} \Delta LEK\_EUR_j^- = \sum_{j=1}^{t} min(\Delta LEK\_EUR_j, 0)$$





Source: Authors' calculations.
Note: The partial sum is calculated on LEK_EUR natural logarithm values.

QNARDL Model:

Empirical representation

$$Q_{\Delta CPI\_AL_t}(\tau|\cdot) = \rho(\tau)(CPI\_AL_{t-1} - \beta^{+}(\tau)LEK\_EUR^{+}_{t-1} -$$

$$\beta^{-}(\tau)LEK\_EUR^{-}_{t-1} - \phi_1(\tau)GDP_{t-1} - \phi_2(\tau)HCPI\_EA_{t-1} -$$

$$\phi_3(\tau)REPO_{t-1} - \phi_4(\tau)M2_{t-1} + \alpha(\tau) + \sum_{i=1}^{p-1}\gamma_i(\tau)\Delta CPI\_AL_{t-i} +$$

$$\sum_{j=0}^{q-1}(\delta_j^{+}(\tau)\Delta LEK\_EUR^{+}_{t-j} + \delta_j^{-}(\tau)\Delta LEK\_EUR^{-}_{t-j}) +$$

$$\sum_{l=0}^{s-1}(\theta_{1l}(\tau)\Delta GDP_{t-l} + \theta_{2l}(\tau)\Delta HCPI\_EA_{t-l} + \theta_{3l}(\tau)\Delta REPO_{t-l} +$$

$$\theta_{4l}(\tau)\Delta M2_{t-l}) + \sum_{m=0}^{r-1}\psi_m(\tau)\Delta P\_OIL_{t-m} + \varepsilon_t$$

where:

CPI_AL – inflation, LEK_EUR – exchange rate, GDP – economic activity, HCPI_EA-foreign inflation, REPO – monetary policy, M2 – money supply, P_OIL – oil price, τ – conditional quantile, ε – error term, t – time index, p,q,s,r – lags, the rest are parameters

Optimal lag length

Quantile index (τ)	CPI_AL	GDP	HCPI_EA	REPO	M2	LEK_EUR	P_OIL
0.1	1	6	0	0	3	2	1
0.2	1	5	0	0	2	0	1
0.5	1	1	0	0	3	0	0
0.8	2	2	0	0	2	0	1
0.9	2	5	0	3	2	0	2

Note: The AIC determines the optimal lag length.
Source: Authors' calculations.

Results: NARDL

Panel A: Results of NARDL estimation								
	ρ	ϕ_1	ϕ_2	ϕ_3	ϕ_4	β^+	β^-	α
	-0.38 ***	0.15 ***	0.28 ***	-0.17 ***	-0.08	0.08 ***	0.05 ***	-0.56 ***
	-(9.89)	(6.77)	(8.78)	(-5.08)	(-7.52)	(5.22)	(4.21)	(-9.87)
Panel B: Results of QNARDL estimation								
Quantile index (τ)	$\rho(\tau)$	$\phi_1(\tau)$	$\phi_2(\tau)$	$\phi_3(\tau)$	$\phi_4(\tau)$	$\beta^+(\tau)$	$\beta^-(\tau)$	$\alpha(\tau)$
0.1	-0.31 ***	0.05 ***	0.24 ***	-0.19 ***	0.00	0.04 ***	0.01	-0.33 ***
	(-5.96)	(4.60)	(4.34)	(-3.74)	(0.00)	(2.69)	(0.34)	(-5.98)
0.2	-0.22 ***	0.03 ***	0.16 ***	-0.11 ***	0.01	0.05 ***	0.00	-0.09
	(-5.30)	(3.47)	(4.32)	(-3.12)	(1.00)	(2.72)	(-0.02)	(0.14)
0.5	-0.16 ***	0.00 *	0.10 ***	-0.08 ***	0.00	0.05 ***	-0.01	0.19 *
	(-4.66)	(1.99)	(4.24)	(-3.23)	(0.81)	(4.61)	(0.38)	(2.26)
0.8	-0.25 ***	0.01 *	0.21 ***	-0.18 ***	0.01 **	0.06 ***	0.01	0.01
	(-5.66)	(1.83)	(4.60)	(-4.05)	(2.35)	(3.87)	(0.34)	(0.07)
0.9	-0.49 ***	0.03 **	0.33 ***	-0.24 ***	0.02 **	0.13 ***	-0.02	0.31
	(-7.70)	(2.08)	(4.44)	(-2.96)	(2.41)	(4.27)	(-0.61)	(1.00)

Source: Authors' calculations

Note: ***, **, * represent statistical significance at 1 %, 5 % and 10 %. T-statistics are in parentheses

Results: QNARDL adjustement speed & monetary policy

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Results: QNARDL economic activity & foreign inflation

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Panel B: Results of QNARDL estimation								
Quantile index (τ)	$\rho(\tau)$	$\phi_1(\tau)$	$\phi_2(\tau)$	$\phi_3(\tau)$	$\phi_4(\tau)$	$\beta^+(\tau)$	$\beta^-(\tau)$	$\alpha(\tau)$
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Source: Authors' calculations

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Results: QNARDL exchange rate

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Source: Authors' calculations

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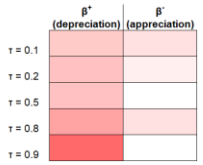
Main findings:

Exchange rate fluctuations have a positive effect on inflation



Long-Run Asymmetry across Quantiles:

High inflation amplifies ERPT

Depreciation Effects (β+):

Strong and statistically significant

Increase with higher inflation quantiles

Appreciation Effects (β^-):

Mostly insignificant

Confirm asymmetric pass-through

Policy Takeaways:

IMPORTANT

ERPT is state-dependent: stronger during high inflation episodes

Depreciation shocks require closer policy attention

Conventional symmetric models may underestimate exchange rate risks

It is recommended to integrate asymmetry into monetary policy frameworks

Future work:

Specific channels through which asymmetries manifest

Sectoral inflation breakdown

Role of expectations and imported inflation

Thank you for attention!

Contact details:

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Descriptive statistics:

	Mean	Median	Max.	Min.	Std. Dev.	ADF	PP
CPI_AL[1]	89.7	90.2	118.6	66.5	13.8	2.2 ***	1.9 ***
GDP[2]	122975.8	122941.9	182186.1	61677.5	26218.4	-0.5 ***	-1.4 ***
HCPI_EA[1]	94.3	94.7	121.1	76.4	11.2	0.9 ***	1.7 ***
P_OIL[1]	86.4	83.0	152.6	21.6	31.2	-3.0 *	-2.7 **
REPO[3]	3.6	3.3	8.5	0.5	2.1	-3.0 *	-2.4 ***
LEK_EUR[1]	128.4	126.8	142.2	98.3	10.6	0.9 ***	1.0 ***
M2[2]	657596.6	692706.9	1052575.0	321621.8	183259.9	0.7 ***	0.7 ***

Source: Authors' calculations

Note: Variables expressed in [1, 2, 3] are in indexes, million Lek and percent respectively. We use the ADF and PP tests with a constant on all the variables; ***, **, * represent statistical significance at 1 %, 5 % and 10 %. All variables exhibit unit root.

Bound Test:

Quantile index (τ)	0.1	0.2	0.5	0.8	0.9
F-statistic	4.46 ***	6.58 ***	4.91 ***	6.71 ***	6.33 ***
	(-4.26)	(-5.57)	(-5.53)	(-5.82)	(-7.70)

Critical Values	CV at 10%	CV at 5%	CV at 1%
Stationary bound	2.03	2.32	2.96
	(-2.57)	(-2.86)	(-3.43)
Non-stationary bound	3.13	3.50	4.26
	(-4.23)	(-4.57)	(-5.19)

Source: Authors' calculations