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**Equilibrium Interest Rate in the Case of Small Open Economy:  
Application for Ukraine**

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NBU Open research seminar  
Kyiv, 6 October 2017



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# 1. Introduction: Motivation of research

## Benchmark for assessing the state of monetary policy

**Neutral (equilibrium) interest rate** is defined as the short-term risk-free real interest rate, at which inflation is stable on target and the output gap equals to zero

Key policy rate is  
**above**  
neutral



**contractionary**  
monetary  
policy



Key policy rate is  
**equal**  
to neutral



**neutral**  
monetary  
policy



Key policy rate is  
**below**  
neutral



**stimulating**  
monetary  
policy





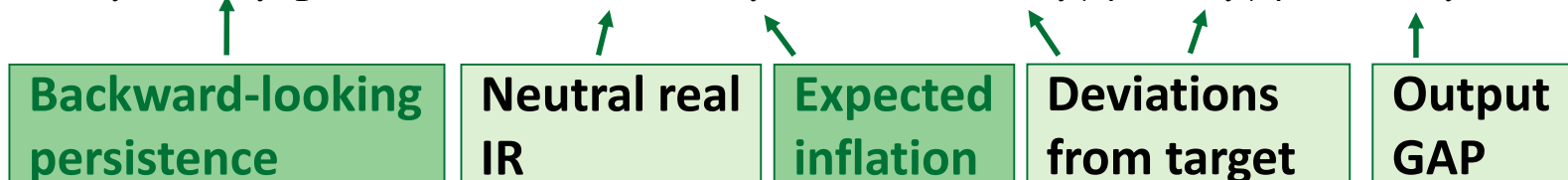
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# 1. Introduction: Motivation of research

## Application of neutral rate in policy analysis

- Important role of equilibrium interest rate in monetary theory providing a benchmark for measuring the stance of monetary policy and setting policy rate consequently (e.g., using Taylor rate)

$$i_t = \alpha i_{t-1} + (1 - \alpha) [(\bar{r}_t + \pi_t^{\text{exp}}) + \beta(\pi_{t+4} - \pi_{t+4}^{\text{arg}}) + \gamma y_t^{\text{gap}}]$$



- The topic of measuring the equilibrium interest rate attracted wide-scale attention in the literature recently, with much of the focus turned to advanced economies where ultra-low interest rates were not able to provide needed stimulus as real equilibrium interest rate fell significantly as well
- We extend this analysis to the case of small open economy and apply it on Ukrainian data in order to facilitate the monetary policy decision making at the National Bank of Ukraine



## 2. Literature review: Definition and concepts of equilibrium interest rate Equilibrium vs neutral vs natural and short-term vs medium-term concepts

Natural rate	Equilibrium / Neutral rate
<ul style="list-style-type: none"><li>■ <b>Wicksellian</b> concept (1898): `the natural rate of interest [is] the real yield of <b>capital in production</b>`</li><li>■ Natural rate is fully determined in the real sector of economy and is a <b>marginal rate of return on physical capital</b></li><li>■ Loan rates tends to adjust to natural rate but could diverge from it because of credit expansion or contraction by banks</li></ul>	<ul style="list-style-type: none"><li>■ <b>Keynes</b> (1936): the “neutral” or “optimum” rate of interest prevails in equilibrium where output and employment are such that the elasticity of employment as a whole is zero (GDP on its potential level in modern terms)</li><li>■ Neutral rate is determined on financial market and balances saving and investments</li></ul>

Nowadays, for the purposes of monetary policy making, the natural and neutral rates are used to express the same concept. It is a medium-term concept of the **equilibrium interest rate**, which is defined as short-term risk free real interest rate consistent with output at its potential level and inflation at its target level after the effects of all cyclical shocks have disappeared.



## 2. Literature review: Methodology for estimation of equilibrium interest rate

### Statistical methods

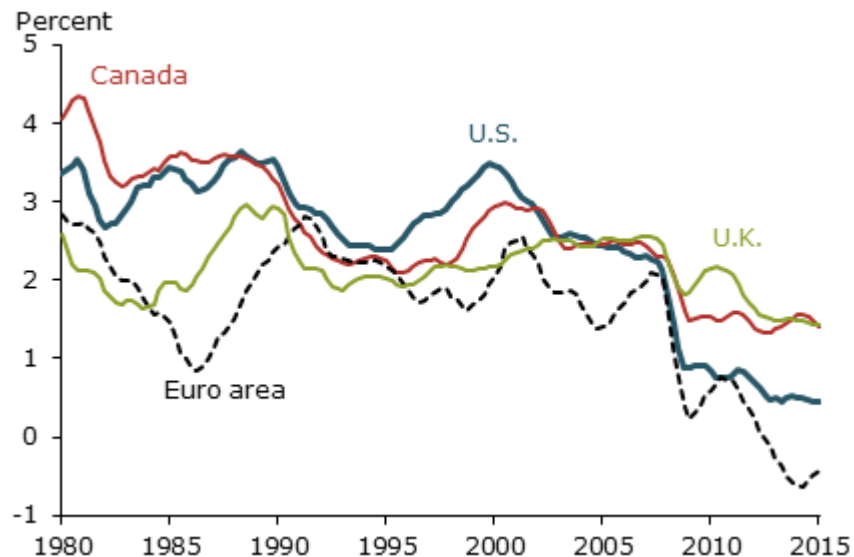
Methods	Examples	Caveats for Ukraine
1) Semi-structural models estimated with Kalman filter	Laubach and Williams (2003)	Usually, such models do not account for external sector and ER focusing primarily on domestic factors
2) Univariate statistical filters	Perelli and Roache (2014)	Huge volatility in the real interest rate caused by historically volatile inflation and exchange rate peg make results poor acceptable due to high uncertainty
3) DSGE models	Dorich et al. (2014), Del Negro et al. (2015)	DSGE models impose strong theoretical restrictions that are exposed to misspecifications. Outcomes are too volatile
4) Extracting information from financial market	Basdevant et al. (2004), Giammarioli and Valla (2004)	Financial markets are currently underdeveloped in Ukraine. The data sample with active monetary policy is short



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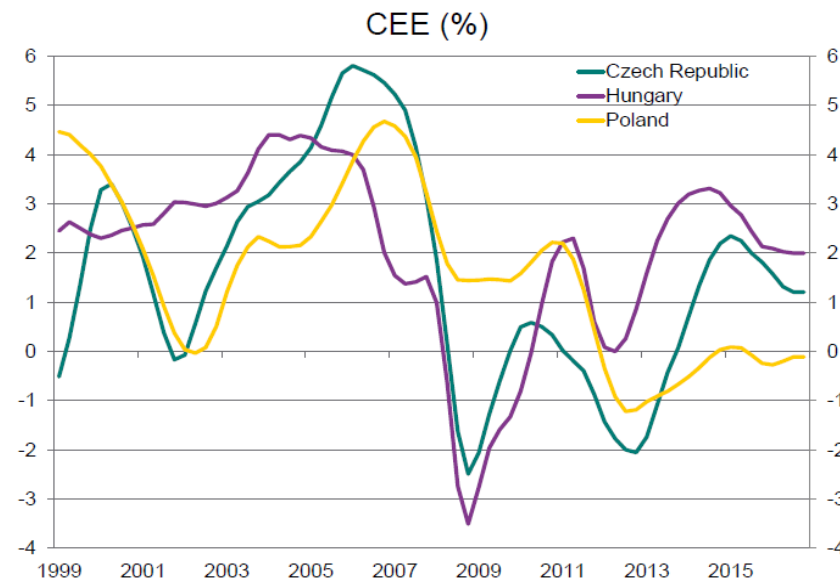
## 2. Literature review: Recent trends in advanced and emerging economies

### Falling equilibrium interest rates



Source: Holston, Laubach, and Williams (2016)

- shifting demographics
- slower productivity growth and general savings glut
- supply and demand for funds



Source: Stefanski (2017)

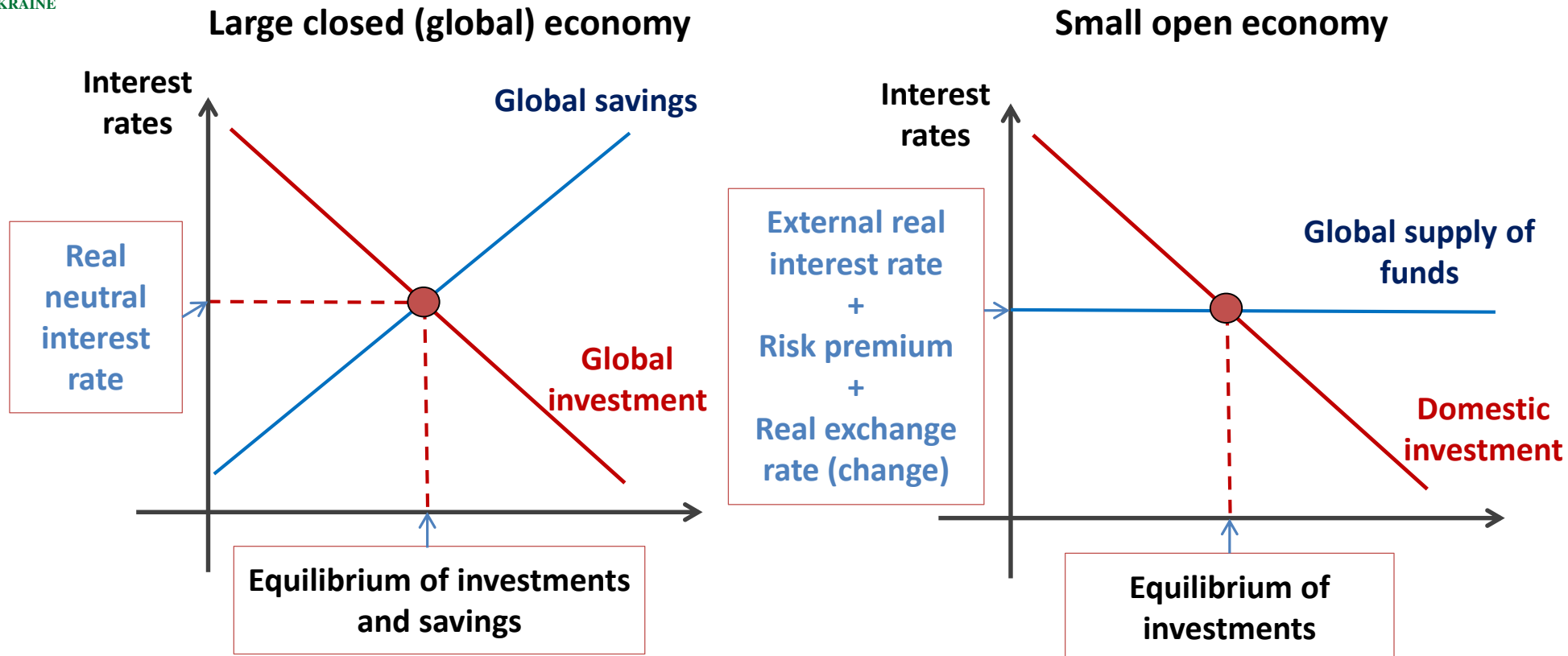
- lower potential growth
- lower population growth
- convergence to developed economies



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### 3. Methodology for estimation in small open economy: Analytical framework

#### Large closed economy vs. Small open economy



- For a **small open** economy the supply of capital is shaped by global factors
  - 'the neutral rate in Canada would be determined solely by global factors' (Mendes, 2014)
- Internal factors have an impact through the exchange rate and the risk premium





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### 3. Methodology for estimation in small open economy: Analytical framework Adjusting global price of capital by domestic factors

$$\text{Real Neutral IR (Ukraine) + RER} = \text{Real Neutral IR (World) + Risk Premium}$$

#### Aggregate Real Return on Capital (UA)

Investor`s benefit

compounds of 2 parts:

- 1) Regular flows (in this formula – real interest rate)
- 2) Income from change in value of investment (in this formula – change in real exchange rate)

#### Real Cost of Capital (World)

The cost of capital for small open economy is heavily dependent on world price of capital

**Risk premium.** Investors require **compensation for entering the market** due to:

- large and persistent debt positions
- poor quality economic policy and inadequate transparency
- concerns over unexpectedly currency moves
- small or illiquid markets making it more difficult or costly to pull out of an investment



### 3. Methodology: Model for estimation with Kalman filter NBU's Quarterly Projection Model (QPM)

**QPM** is small semi-structural new-Keynesian model with rational expectations

- ad-hoc structure (follows microeconomic principles derived equations but does not use such approach explicitly)
- forward looking variables, thus is not subject to Lucas critics
- *The origins of the model came from QPM of the Bank of Canada and Czech National Bank (similar models are used by central banks of Serbia, Armenia, Slovak Republic and many others)*
- Describes monetary policy transmission mechanism policy channels and is not neutral to monetary shocks in short and middle run
  - QPM reflects monetary policy neutrality that is consistent with inflation target in long run
- The model is calibrated (both - parameters and steady state values)
- The concept of the model is the state space representation of macroeconomic variables where trends and gaps are unobservable components (state variables) estimated with Kalman filter



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### 3. Methodology: Model for estimation with Kalman filter QPM's equations (1)

#### Output gap (IS curve):

$$\hat{y}_t = \alpha_1 \hat{y}_{t-1} + \beta_1 \hat{y}_{t+1} - \gamma_1 \hat{z}_{t-1} - \delta_1 \hat{lr}_{t-1} + \theta_1 \hat{w}_t + \vartheta_1 \hat{y}_t^* + \mu_1 \hat{tot}_t + \rho_1 f_t + \varepsilon_{1,t}$$

$\hat{z}_t$  - real ER gap

$\hat{lr}_t$  - credit rate (short-term interest rate + credit premium) gap

$\hat{w}_t$  - real wage gap

$\hat{y}_t^*$  - main trade-partners GDP gap

$\hat{tot}_t$  - terms of trade gap

$f_t$  - fiscal impulse



### 3. Methodology: Model for estimation with Kalman filter QPM's equations (2)

#### Core inflation (forward-looking expectation-augmented Phillips curve):

$$\begin{aligned} \pi_t^{\text{core}} = & \alpha_2 \pi_{t-1}^{\text{core}} + \beta_2 \pi_{t+1} + (1 - \alpha_2 - \beta_2)(\pi_{t-1}^* - \Delta s_{t-1} + \Delta \bar{z}_{t-1}) \\ & + \gamma_2 \hat{y}_t - \delta_2 \hat{z}_{t-1} + \theta_2 \hat{w}_t + \vartheta_2 (\pi_t^{\text{food}} - \pi_t^{\text{T}}) + \varepsilon_{2,t} \end{aligned}$$

$\pi_t$  - headline inflation

$\pi_t^*$  - main trade-partners inflation

$\Delta s_t$  - change in nominal effective ER (appreciation)

$\Delta \bar{z}_t$  - change in real effective ER trend (appreciation)

$\pi_t^{\text{food}}$  - raw food inflation

$\pi_t^{\text{T}}$  - inflation target

Similar equations for raw food inflation, administrative inflation and fuel prices changes which together with core inflation and corresponding weights composite **headline inflation**



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### 3. Methodology: Model for estimation with Kalman filter QPM's equations (3)

Nominal exchange rate against USD (UIP condition augmented by ER smoothing mechanism):

$$s_t^{usd} = \alpha_3 s_{t+1}^{usd} + (1 - \alpha_3) \left( s_{t-1}^{usd} + 2(\Delta \bar{z}_t^{usd} + \pi_t^T - \pi_t^{usT})/4 \right) + (i_t^{us} - i_t + \text{prem}_t)/4 + \varepsilon_{3,t}$$

$\Delta \bar{z}_t^{usd}$  - change in trend real exchange rate against USD (appreciation)

$\pi_t^{usT}$  - US inflation target

$i_t^{us}$  - short-term nominal interest in USD (3 months LIBOR)

$i_t$  - short-term nominal interest rate

$\text{prem}_t$  - sovereign risk premium



### 3. Methodology: Model for estimation with Kalman filter QPM's equations (4)

#### Short-term interest rate (Taylor-type monetary policy rule):

$$i_t = \alpha_4 i_{t-1} + (1 - \alpha_4) (\bar{r}_t + \pi 4_{t+3}^{\text{exp}} + \beta_4 (\pi 4_{t+3}^{\text{exp}} - \pi_{t+3}^T) + \gamma_4 \hat{y}_t) + \varepsilon_{4,t}$$

$\bar{r}_t$  - real neutral rate

$\pi 4_{t+3}^{\text{exp}}$  - projected annual inflation in a year

#### Change in trend real exchange rate against USD (nominal and real convergence reflecting Balassa-Samuelson effect):

$$\Delta \bar{z}_t^{\text{usd}} = \alpha_5 \Delta \bar{z}_{t-1}^{\text{usd}} + (1 - \alpha_5) \beta_5 (\Delta \bar{y}_t - \Delta \bar{y}_t^{\text{us}}) + \gamma_5 \Delta \overline{tot}_t + \varepsilon_{5,t}$$

$\Delta \bar{y}_t$  - potential output growth

$\Delta \bar{y}_t^*$  - US potential output growth in US

$\Delta \overline{tot}_t$  - change in trend terms of trade



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## 4. Results for Ukraine: Empirical application to historical data

### Data description

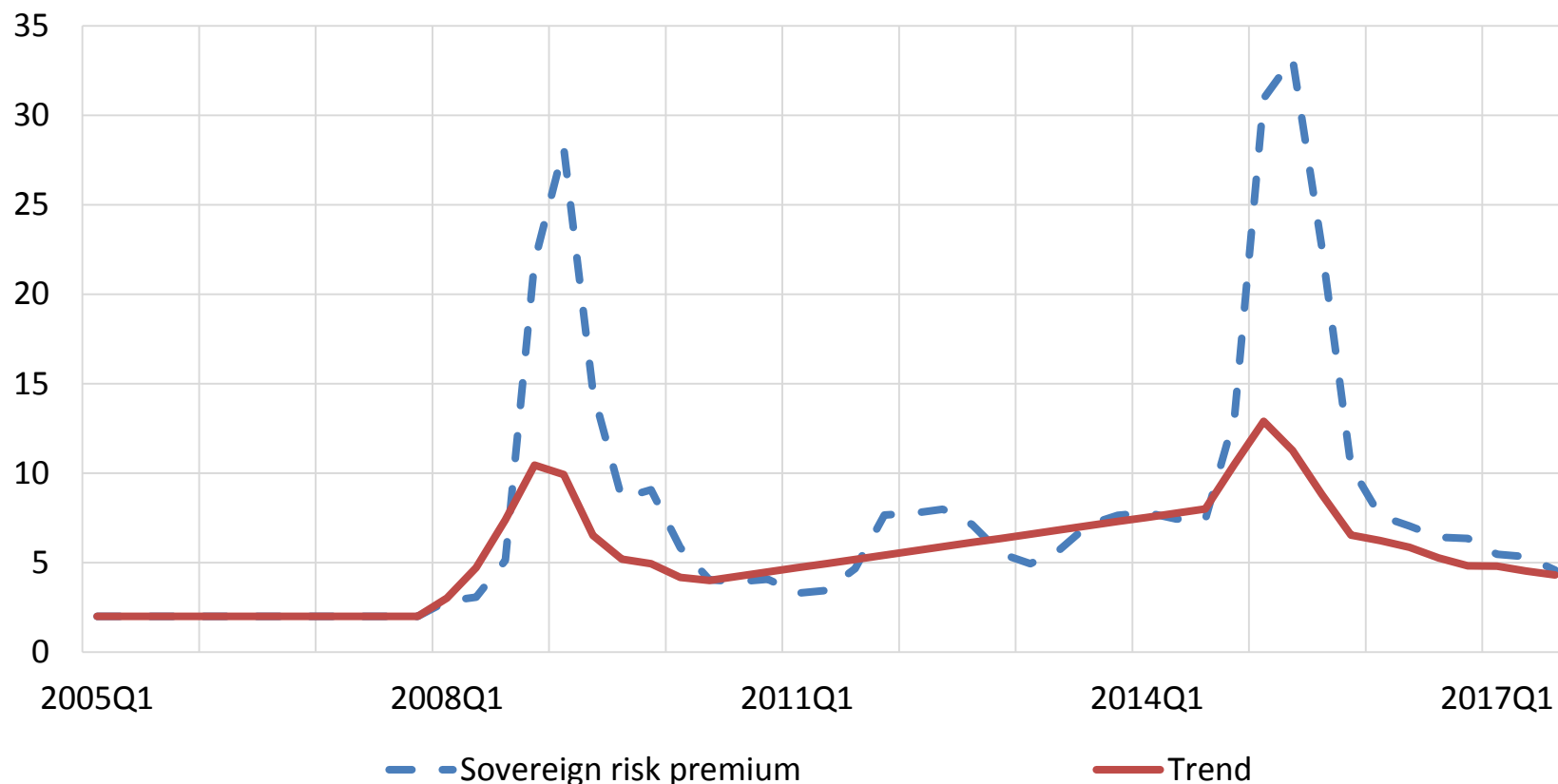
Variable	Definition	Source
Real interest rate	Nominal average interbank overnight rate minus model-consistent inflation expectations	NBU; own estimates
Nominal short-term interest rate in USD	3 months LIBOR in USD	Thomson Reuters
Real neutral interest rate in USD	Natural interest rate in the US estimated via Laubach and Williams (2003) methodology	Federal Reserve Bank San Francisco
Real exchange rate against USD	Nominal UAH/USD exchange rate adjusted for CPI inflation in Ukraine and in the USA	NBU; State Statistical Service; Thomson Reuters; own estimates
Risk premium	Difference between yields on sovereign state euro-bonds denominated in USD and 10Y US Treasuries	Cbonds; own estimates



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## 4. Results for Ukraine: Empirical application to historical data

### Risk premium



- The sovereign risk premium was above 3% since 2008. It abnormally surged twice during the crises episodes
- Since the last surge in 2014-2015, it has been gradually decreasing
- Risk premium trend reflects the overall dynamics of the indicator, however mitigates excessive volatility and abnormal surges

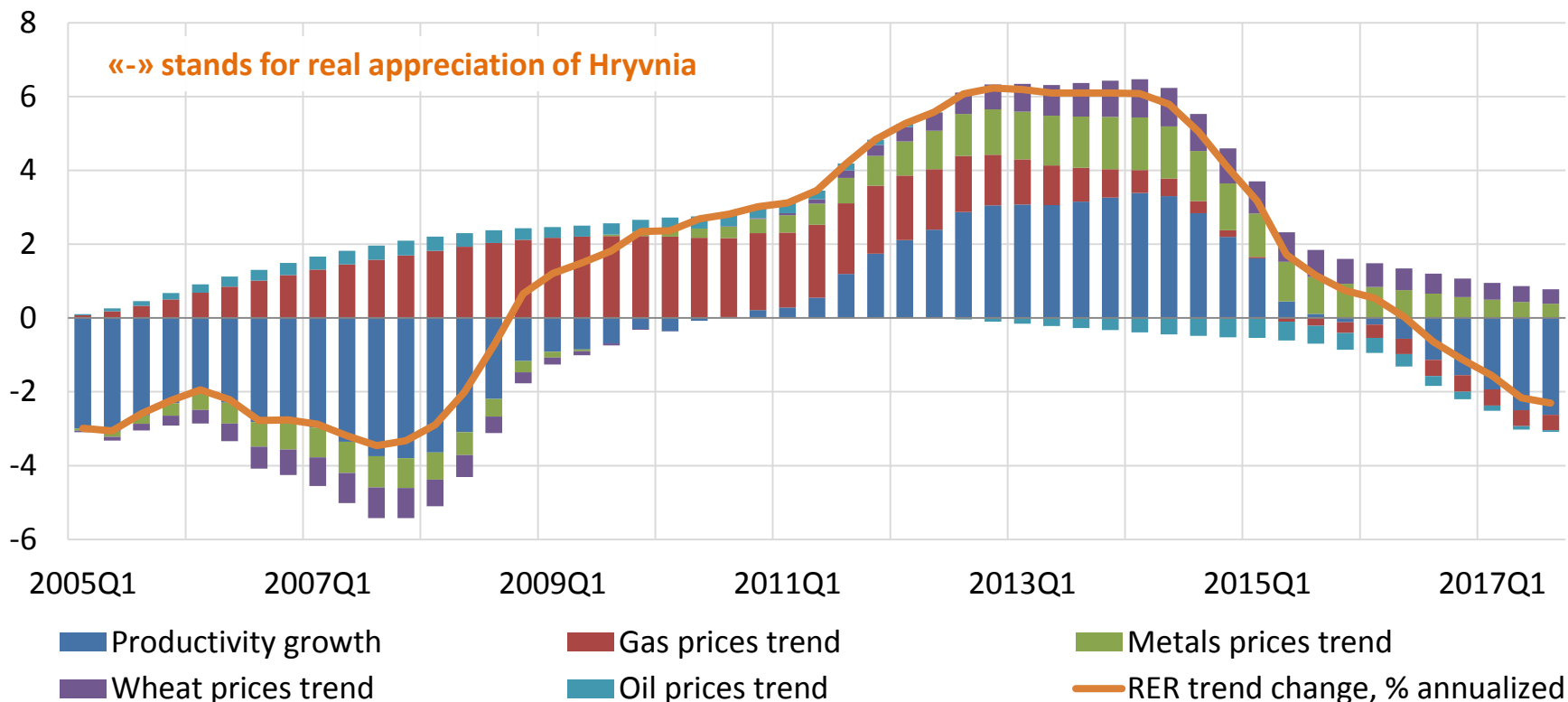




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## 4. Results for Ukraine: Empirical application to historical data

### Real exchange rate against USD



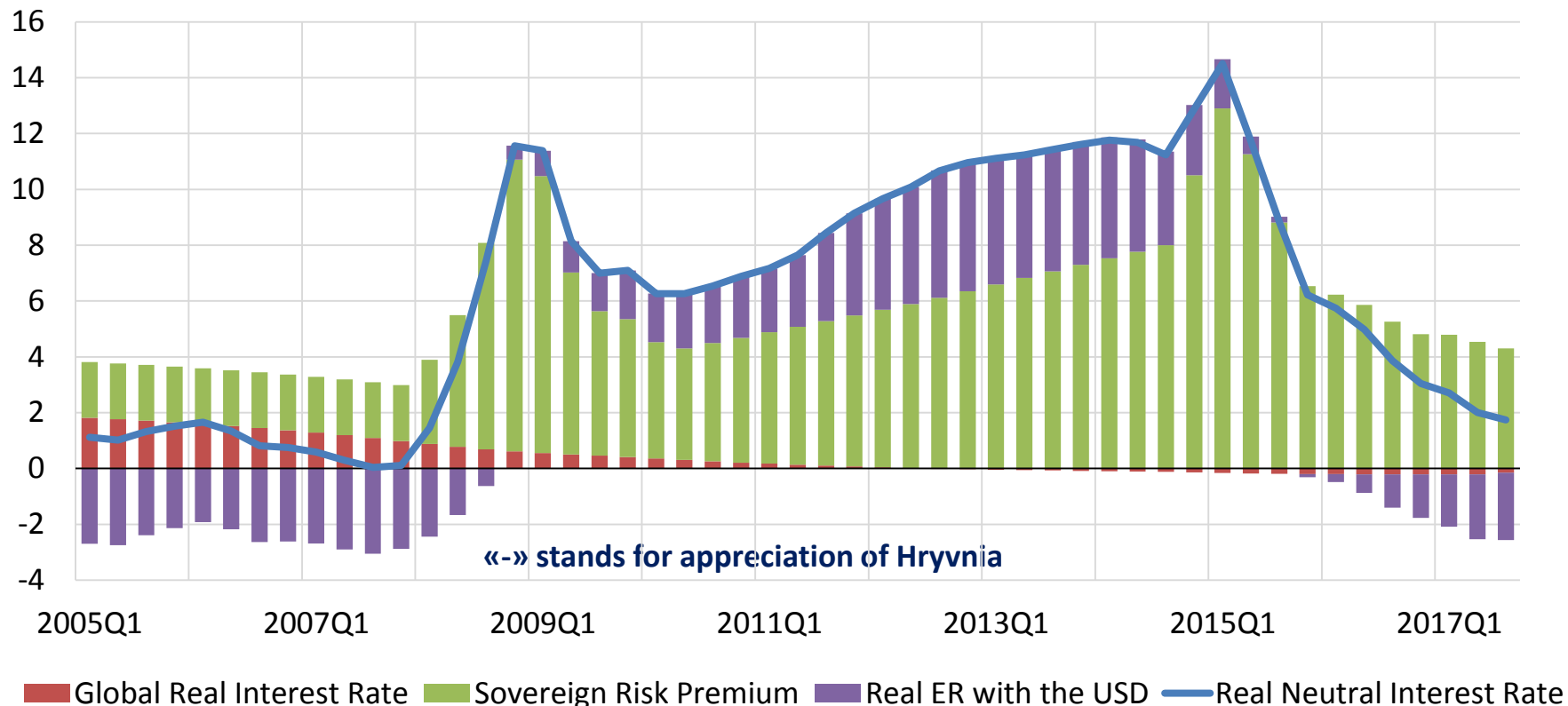
- The productivity was improving due to real convergence until 2009. In 2009 – 2014, the process disrupted after the crisis and due to stalled reforms
- The terms of trade trends were unfavorable for Ukraine for the last 10 years (because of a transfer to market prices for gas and global trend in lowering prices for commodities). Real exchange rate trend depreciated by almost 30% during the period



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## 4. Results for Ukraine: Empirical application to historical data

### Equilibrium real rate



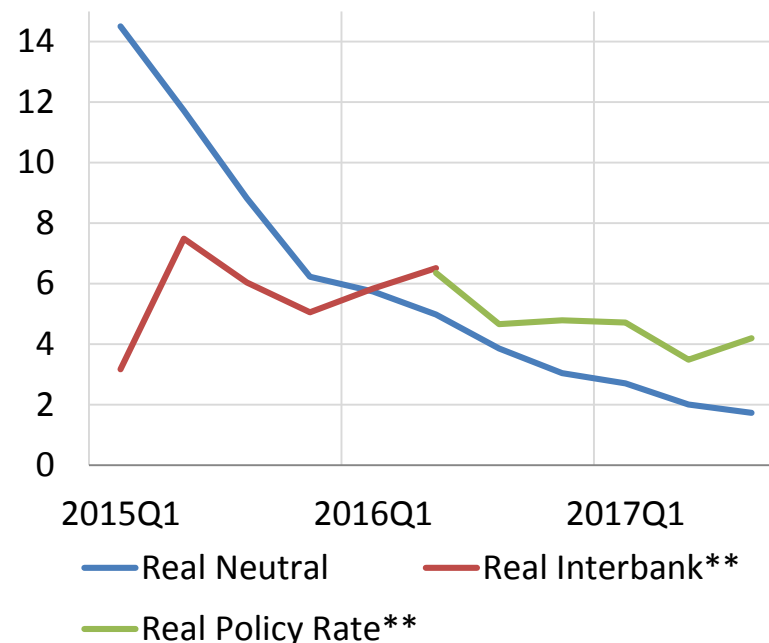
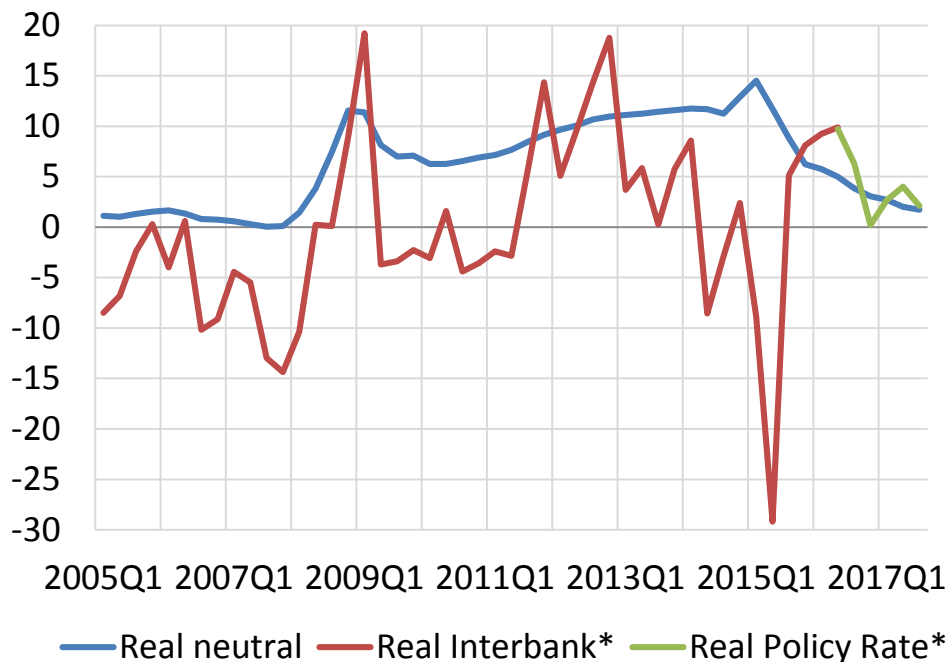
- **2005-2008Q1:** fluctuations from 0 to 2% as a result of excessive supply of global liquidity and fast growing economy
- **2008H-2015H1:** fluctuations from 6 to 15% reflecting 2 crises and poor economic performance between them as well as real depreciation and high risk premium
- **2015H2-nowdays:** has fallen to 2% as a consequence of rebounding economy, favorable terms of trade and improving public finances



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## 4. Results for Ukraine: Empirical application to historical data

### Monetary policy stance



\* Deflated by model-consistent inflation expectations

\*\* Deflated by expectations of financial analytics

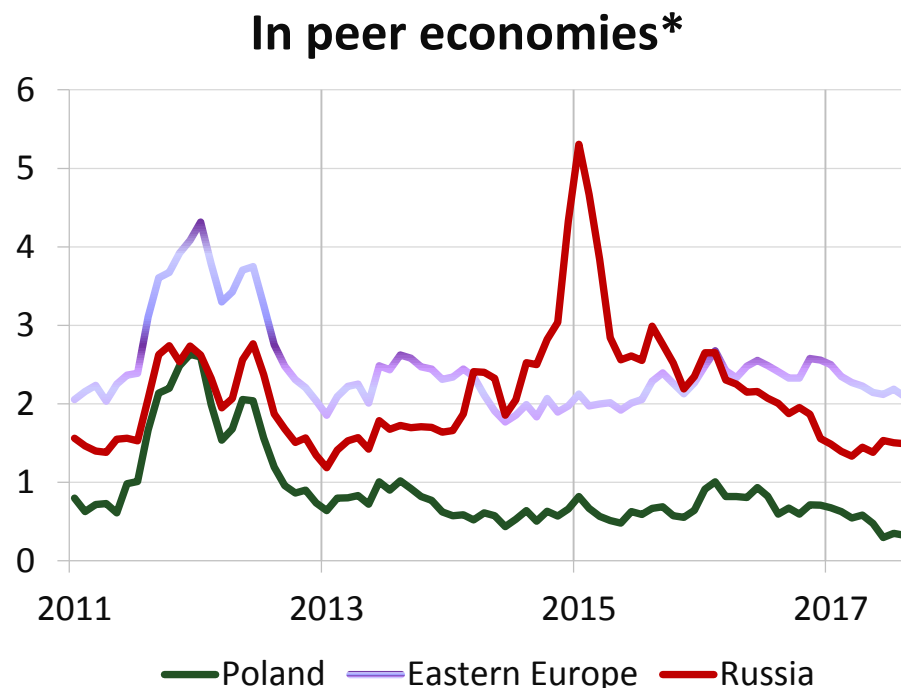
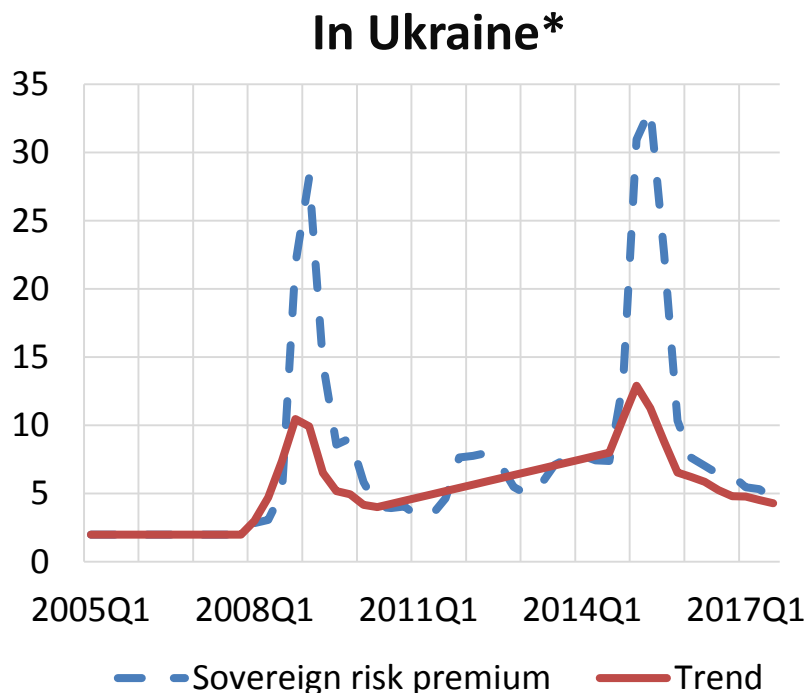
- Historically monetary policy was mostly accommodative as a result of fixed ER regime and fiscal dominance
- In periods of high devaluation pressures the NBU was shrinking liquidity, which led to increase in market interest rates. However, such hike in interest rates usually was short-lived and followed by further easing
- During the last 2 years, monetary policy has been tight enough to ensure rapid disinflation, improve expectations, and resist inflation shocks



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## 4. Results for Ukraine: Empirical application to historical data

### Risk premium



\* The risk premium is calculated as a difference between yields on sovereign state euro-bonds denominated in USD and US Treasuries

- In the medium-term perspective, risk premium approaches 3% - the value that was last reached before 2008
- In the long-term perspective, risk premium is projected to decrease to 1.5-2%, which is the average for the peer-economies for the last 10 years



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## 4. Results for Ukraine: Assessment of future trends

Real ER trend growth estimate is based on Phillips et al. (2013)

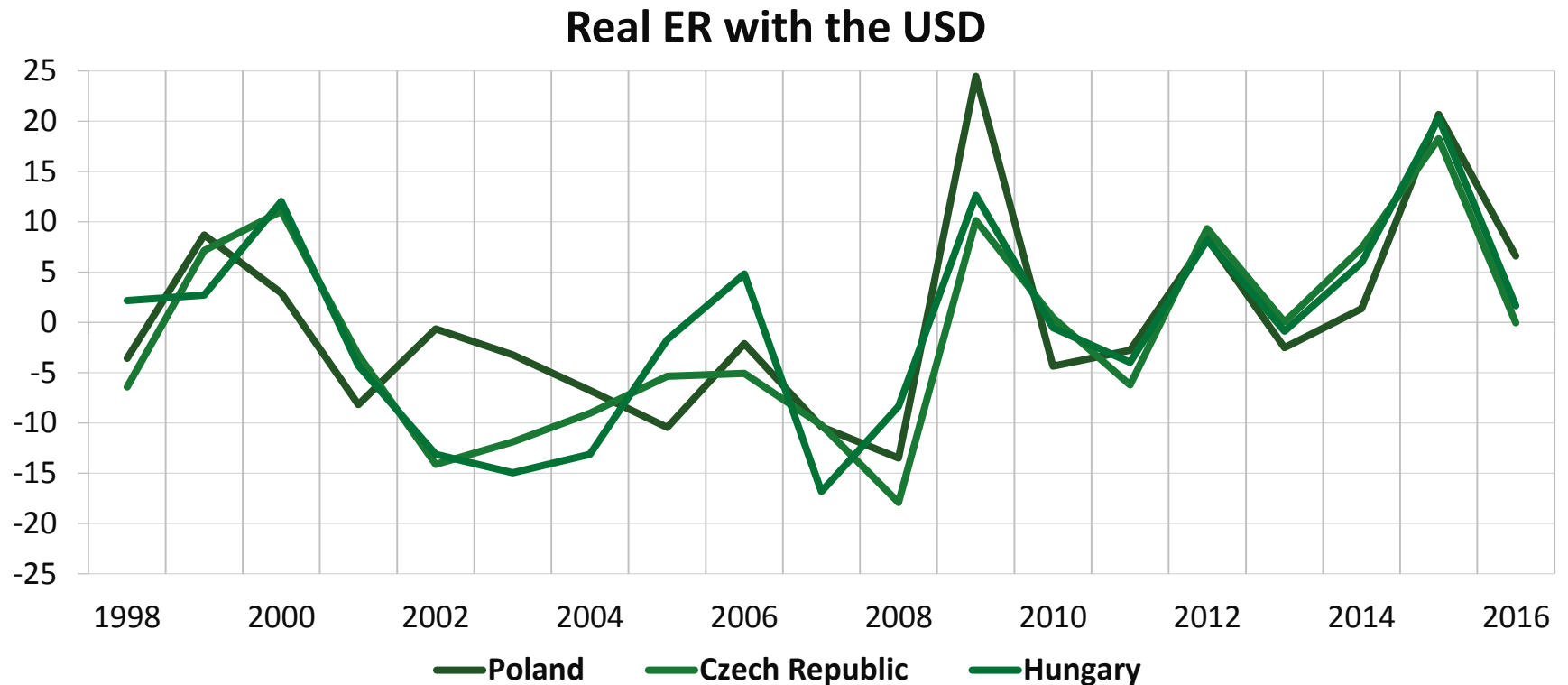
Variable	Coefficient	Estimate for Ukraine	Impact
Relative GDP per capita * K openness	0.40	2.90	1.17
Global risk aversion	-0.24	0	0
Share of domestic debt own by residents	0.34	0	0
Relative population growth	3.50	-0.90	-3.15
Relative GDP in 5 years	2.32	2.00	4.64
Terms of trade	0.08	0	0
Avg(export, import)/GDP	-0.36	0	0
Share of admin. prices	-1.86	0	0
Health expenditures/GDP	1.78	0	0
FX Net Reserves/GDP * K controls	-0.43	1.00	-0.43
Real rate differential * K openness	0.49	0.50	0.25
Private credit/GDP	0.13	4.00	0.52
<b>Long-term change in RER (Total)</b>			<b>3</b>



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## 4. Results for Ukraine: Assessment of future trends

### Real ER trend growth in comparison with peers



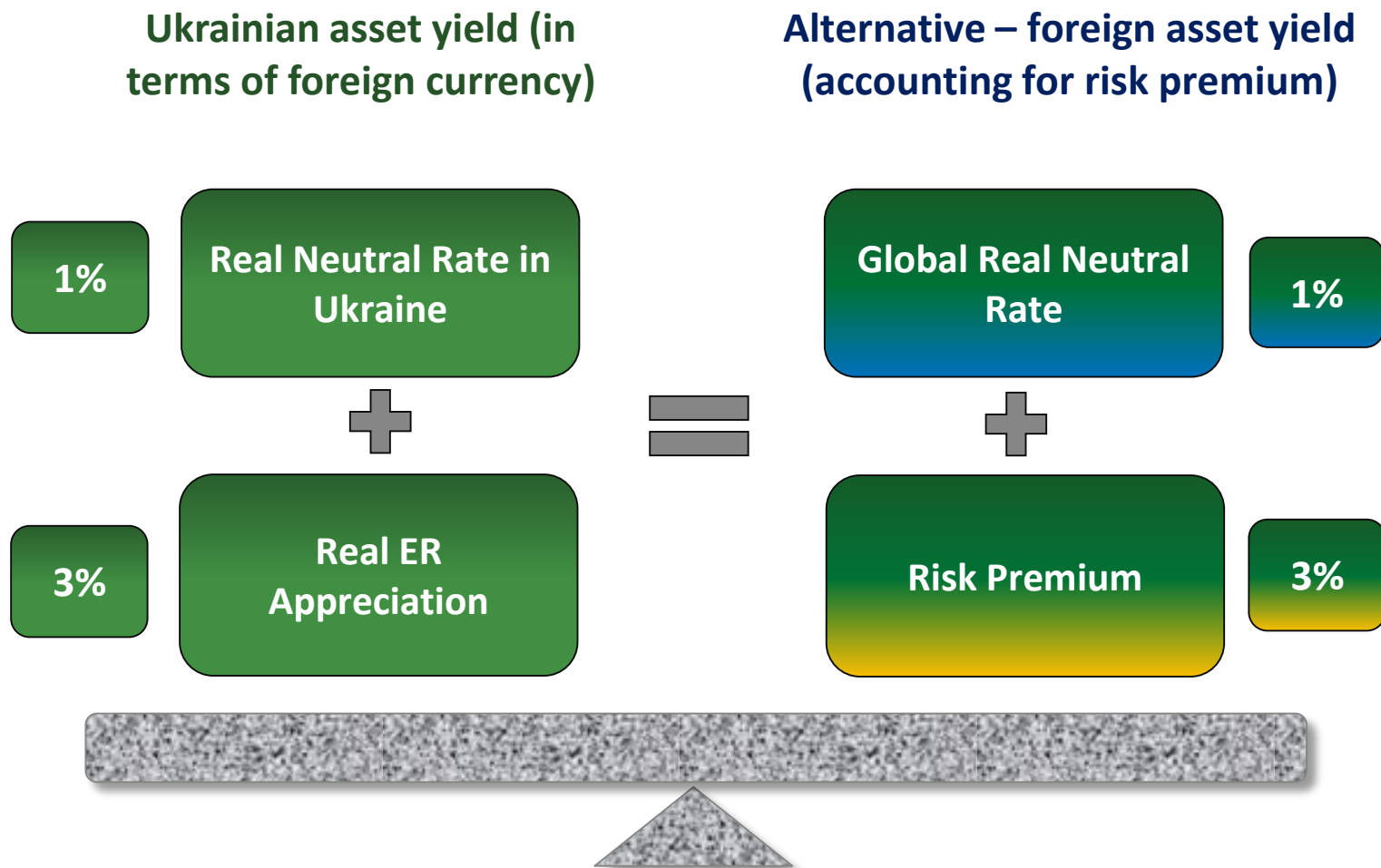
- Appreciation of the Real ER against the USD in Ukraine is projected to be 3% annually in the medium-term perspective
- Such appreciation in the peer-economies on average was above 3.5% annually for the 10 years period until 2008
- For the last 20 years, average Real ER with the USD appreciation in the peer-economies was about 1% annually, which is a reason for us to expect slower ER appreciation in Ukraine in the long-term perspective



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## 4. Results for Ukraine: Assessment of future trends

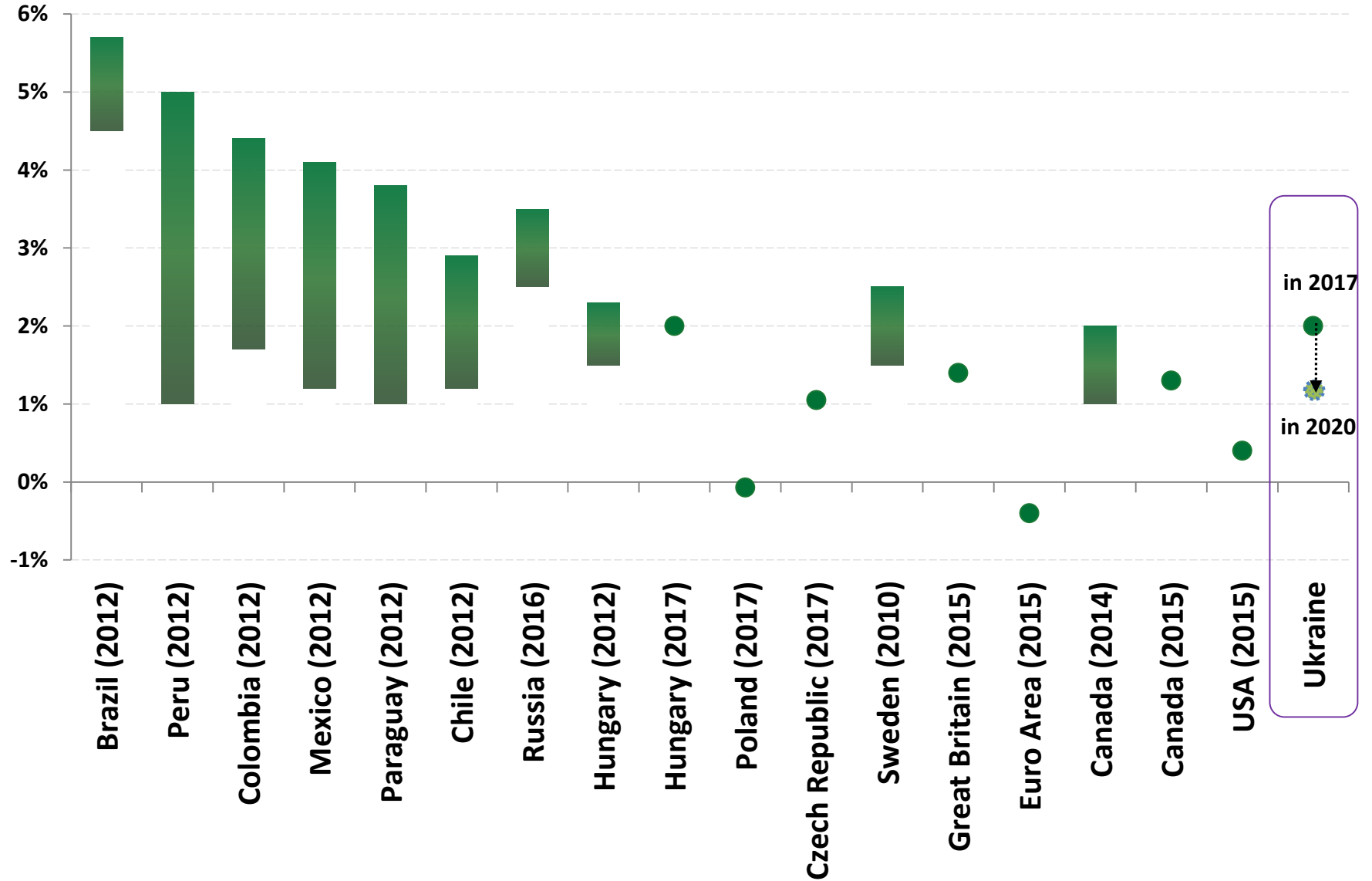
### Equilibrium interest rate





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## Survey of recent estimates for other countries







## 5. Conclusions

- Neutral rate is an important variable for monetary analysis and policy making. It serves as gauge that allows to make the conclusion on whether monetary policy is restrictive or stimulating
- To estimate neutral rate for Ukraine, we use small open economy approach based on **uncovered interest rate parity** as most relevant in such case, especially for policy-making purposes
- According to our estimate, the level of neutral rate in Ukraine is about 2% currently and going to approach approximately 1% in 2020
- In medium run the **neutral interest rate in Ukraine** is going to **decrease** as a result of **appreciating real exchange rate and lowering risk premium**
- The measure of neutral rate gives useful tool for policy analysis as for:
  - **the past:** short-term interest rates remained below the neutral rate for prolonged periods during exchange rate peg era (up to 2014) resulting in high and volatile inflation
  - **the medium-term perspective:** key policy rate of the NBU needs to be preserved sufficiently higher than neutral level in order to secure disinflation process and stabilize expectations close to inflation target



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