NBP Narodowy Bank Polski

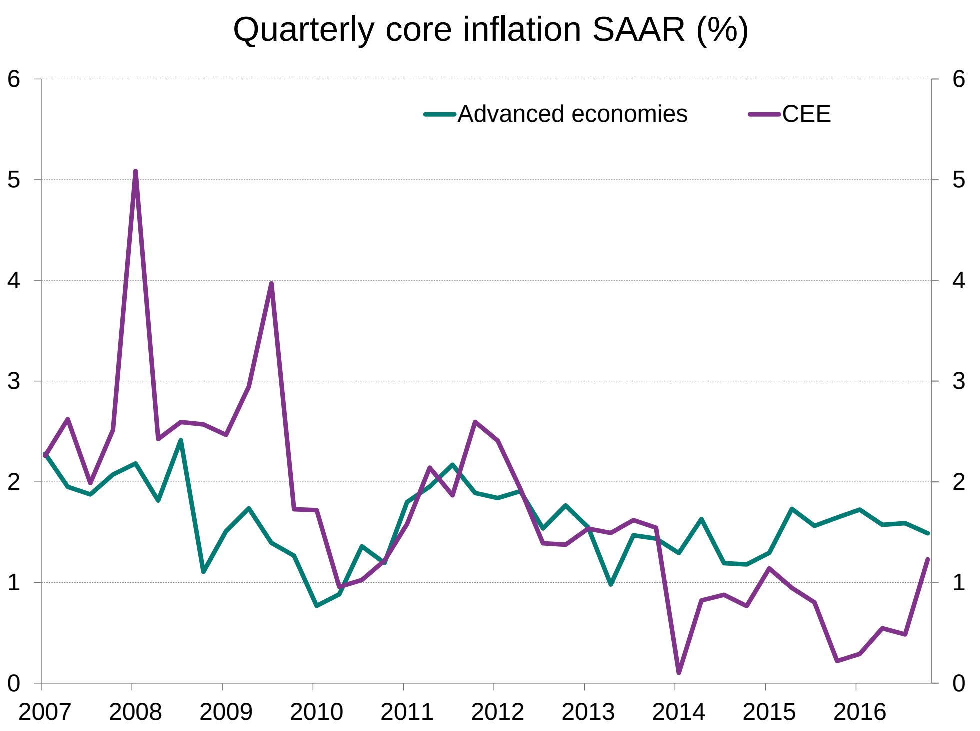
Maciej Stefański / Junior Economist, Economic Analysis Department

Natural rate of interest: spillovers from advanced economies to Central and Eastern Europe

NBP-SNB Joint Seminar, 11 May, Zurich

Presentation plan

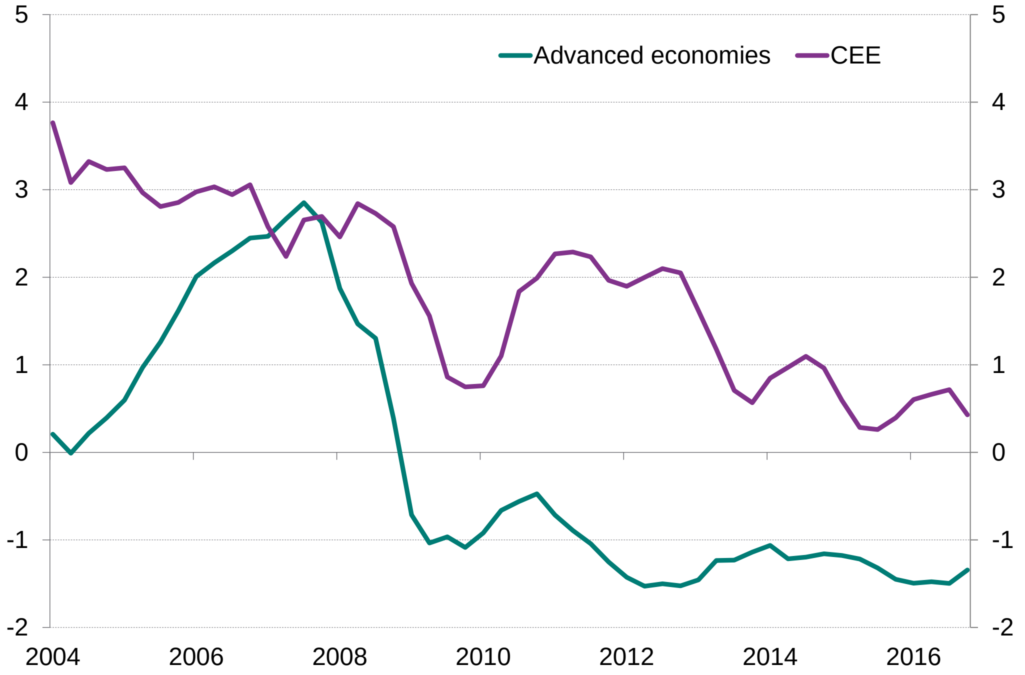
Inflation in CEE has been in a downward trend since the crisis…



GDP PPP-weighted indices. Advanced economies: Canada, Euro Area, US, UK.
CEE: Czech Republic, Hungary, Poland.

Source: Own calculations based on OECD data.

While real interest rates have been falling, though they are higher than in advanced economies



Real interest rate is a difference between central bank benchmark interest rate and annual core inflation.

GDP PPP-weighted indices. Advanced economies: Canada, Euro Area, US, UK.
CEE: Czech Republic, Hungary, Poland.

Source: Own calculations based on OECD and Bloomberg data.

Potential explanations

- Inflation more dependent on external factors – oil prices and inflation abroad
- Natural interest rate has fallen significantly

I investigate the latter and try to answer why it happened – if it happened

Natural rate of interest

- It is a real interest rate that would emerge under elastic prices and if shocks were absent. In such a case inflation is on target and output gap is zero (Woodford, 2003)
- Laubach and Williams (2003) developed the most popular method of its estimation
- I use the framework from their latest study (Holston et al., 2017) as a starting point
- Main innovation – the use of capacity utilisation data in order to better pin down output gap and hence the z_t variable which covers determinants of natural interest rate other than the potential growth rate

Framework

- A system of equations estimated with Kalman filter:
  - Phillips curve:

$$\pi_t = \sum_{i=1}^{4} b_{\pi,i}\pi_{t-i} + b_y\tilde{y}_t + \epsilon_{\pi,t}$$

  - IS curve:

$$\tilde{y}_t = a_y cu_t + \frac{a_r}{2}\sum_{j=1}^{2}(r_{t-j} - r^*_{t-j}) + \epsilon_{\tilde{y},t}$$

  - Natural rate of interest:

$$r^*_t = 400(g_t + z_t)$$

  - Remaining equations:

$$y_t = y^*_t + \tilde{y}_t$$
$$y^*_t = y^*_{t-1} + g_{t-1}$$
$$g_t = g_{t-1} + \epsilon_{g,t}$$
$$z_t = z_{t-1} + \epsilon_{z,t}$$

Variables description

π_t - core inflation

y_t - ln GDP

y_t^* - ln potential GDP

$\tilde{y}_t$ - output gap (as a fraction rather than percentage)

cu_t - capacity utilisation (deviation from mean)

r_t - real interest rate

r_t^* - natural interest rate

g_t - potential GDP growth (quarterly)

z_t - other determinants of natural interest rate

Constraints and priors

- $\sum b_{\pi,i} = 1$

- $\frac{var(\epsilon_{g,t})}{var(\epsilon_{\tilde{y},t})} = \frac{var(\epsilon_{z,t})}{var(\epsilon_{\tilde{y},t})}$ = variance of HP-filtered potential output growth / variance of HP-filtered output gap

- Prior values and variances of state variables are also taken from HP-filtered data

Data

- Sample covers 4 advanced economies: United States, Euro Area, United Kingdom and Canada as well as 3 CEE economies: Poland, Czech Republic and Hungary
- Quarterly data, ending in 2016Q4 and starting in:
  - 1980Q4 for Canada, US and UK,
  - 1995Q4 for Czech Republic and Hungary,
  - 1998Q2 for Poland,
  - 1998Q4 for the Euro Area.

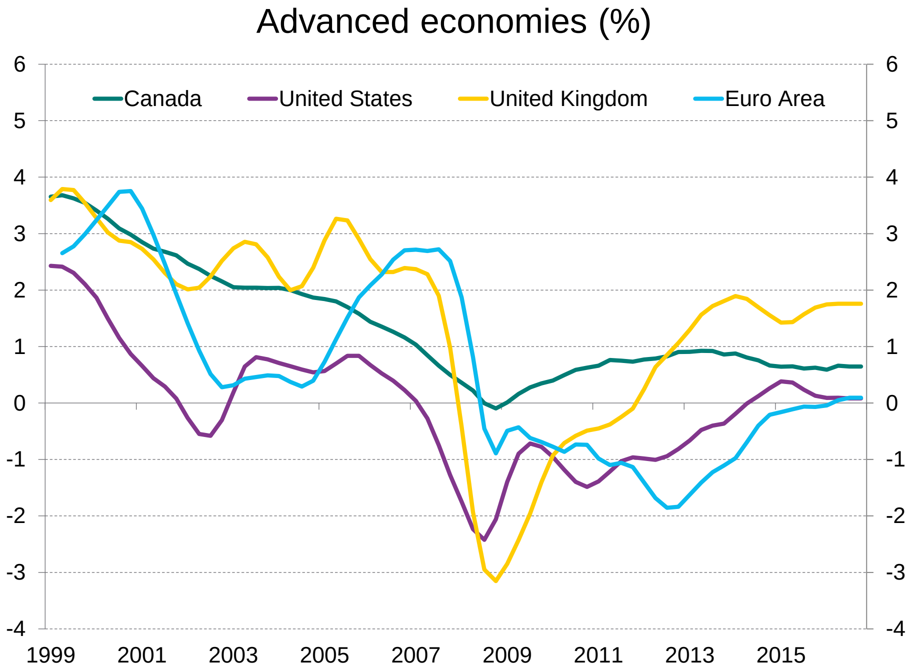
- Inflation: quarterly inflation excluding food and energy from OECD, seasonally adjusted and annualised
- Real interest rate: central bank benchmark rate (for Hungary and Euro Area the 3-month interbank offer rate) from Bloomberg minus annual core inflation
- Capacity utilisation: deviation from sample mean capacity utilisation in the manufacturing sector from Bloomberg
- GDP: in constant prices and national currency, from OECD

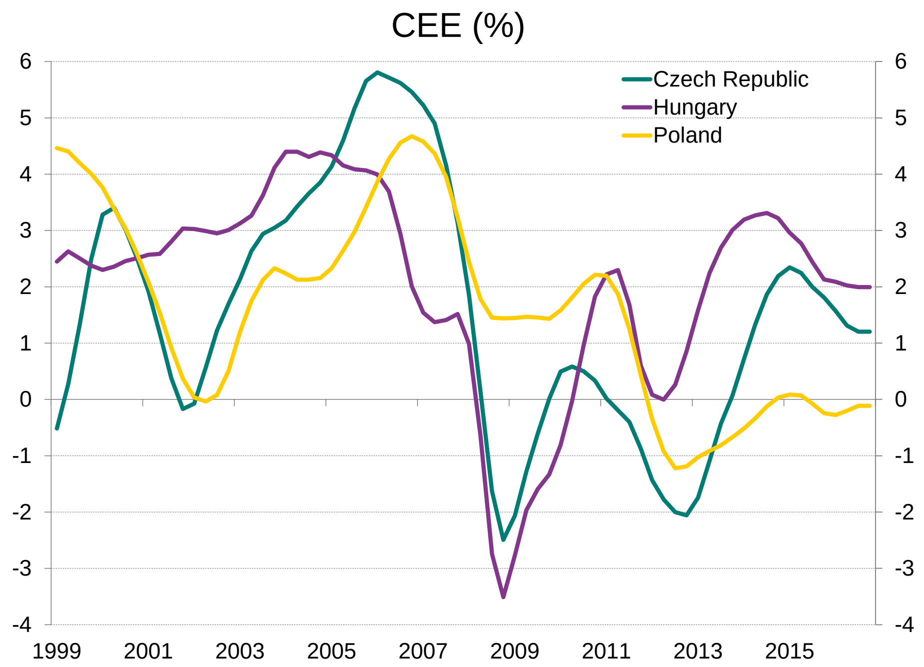
Individual country estimation

- The model is estimated separately for each country

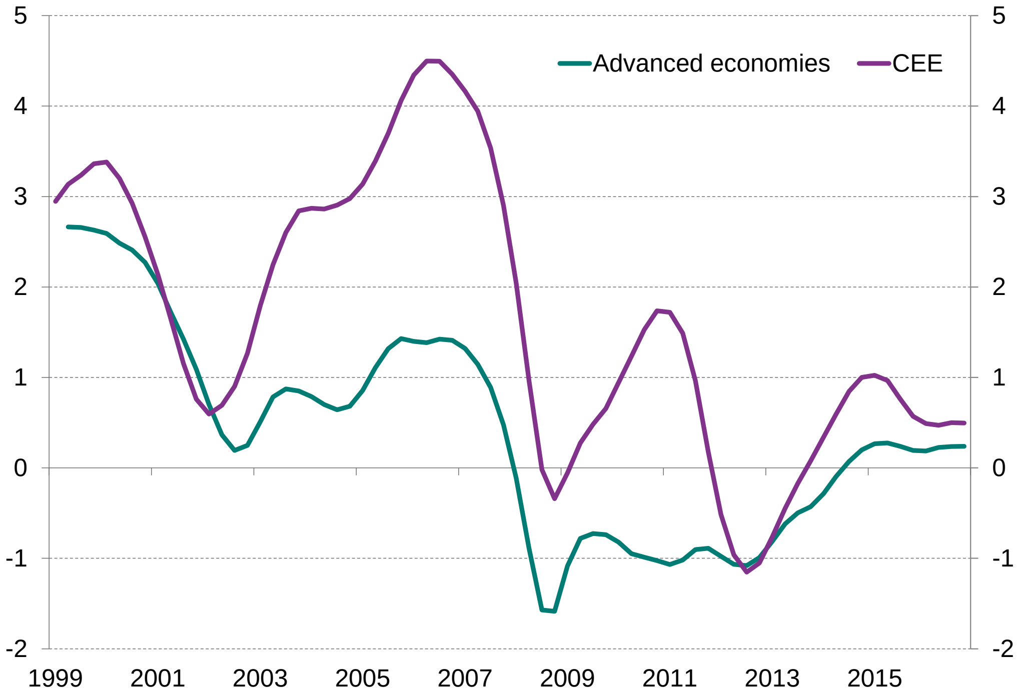
- Several tweaks to the model are made for individual countries in order to improve the significance of the interest rate gap in the IS equation (a_r parameter) and output gap in the Phillips curve (b_y parameter):
  - Canada: 2 lags of output gap instead of capacity utilisation in the IS equation;
  - Canada and Czech Republic: 1st lag of output gap instead of contemporaneous output gap in the Phillips curve;
  - United Kingdom, Euro Area and Poland: 8 lags of inflation instead of 4 in the Phillips curve;
  - Hungary: 3rd lag of output gap instead of contemporaneous output gap in the Phillips curve.

Natural interest rate estimates





Natural interest rate estimates



GDP PPP-weighted indices. Advanced economies: Canada, Euro Area, US, UK.
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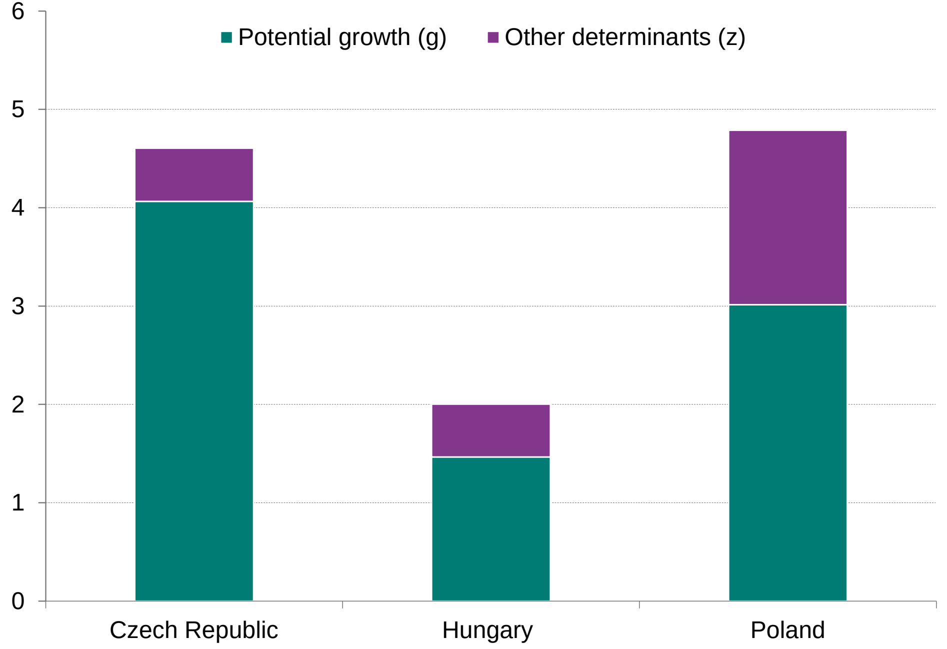
The decline in CEE NRI since the crisis was driven mostly by *g*

The fall in natural interest rate since the pre-crisis peak (percentage points)*



* For Hungary 2006Q1 instead of the pre-crisis peak.

Potential drivers of a fall in CEE natural interest rate

	Internal	External
Potential growth	• Decline in steady state output level • Slowdown in population growth • Convergence	• Slowdown in the pace of technology frontier advancement
Other determinants	• Population ageing • Shifts in preferences	• Population ageing abroad • Shifts in preferences abroad

Decomposing the slowdown in potential growth of CEE

- A very simple Solow-type growth model predicts:

$$\hat{y} = \hat{A}_f + \lambda\left(\left(\frac{y}{L}\right)^{*}(s,n) - \frac{y}{L}\right) + n$$

- The above equation is estimated using Arellano-Bover (1995) dynamic panel data approach on a panel of 181 countries between 1992 and 2015 to obtain the TFP growth rate at the frontier ($\hat{A}_f$), the speed of convergence (λ) and the CEE steady state gap

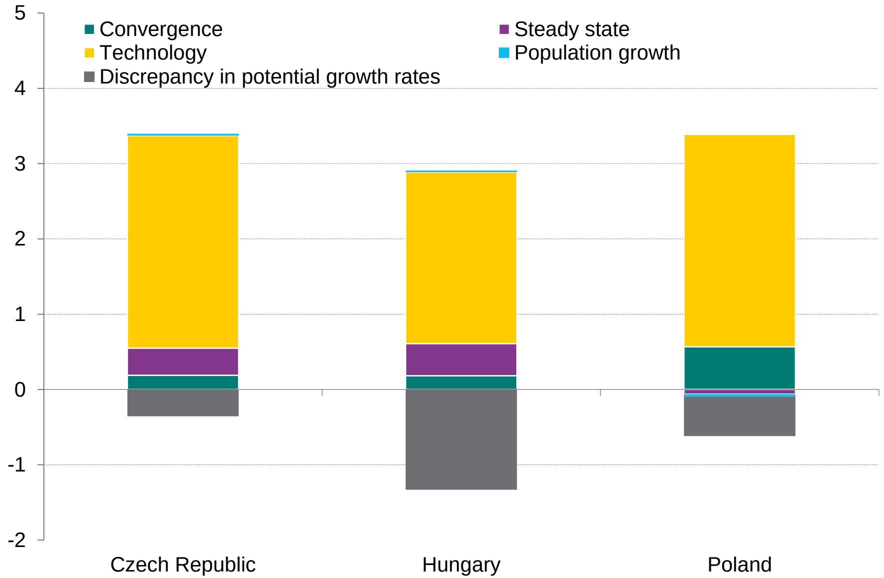
- This allows me to decompose the slowdown in CEE potential growth

The slowdown is almost exclusively of external nature

- 83.8% of CEE potential GDP slowdown between 2006 and 2015 was driven by external factors (TFP growth at the frontier)

- Hence, spillovers to potential growth are responsible for 61.8% of a fall in CEE natural interest rates

CEE potential growth slowdown between 2006 and 2015 (percentage points)*



* For Hungary between 2005 and 2015.

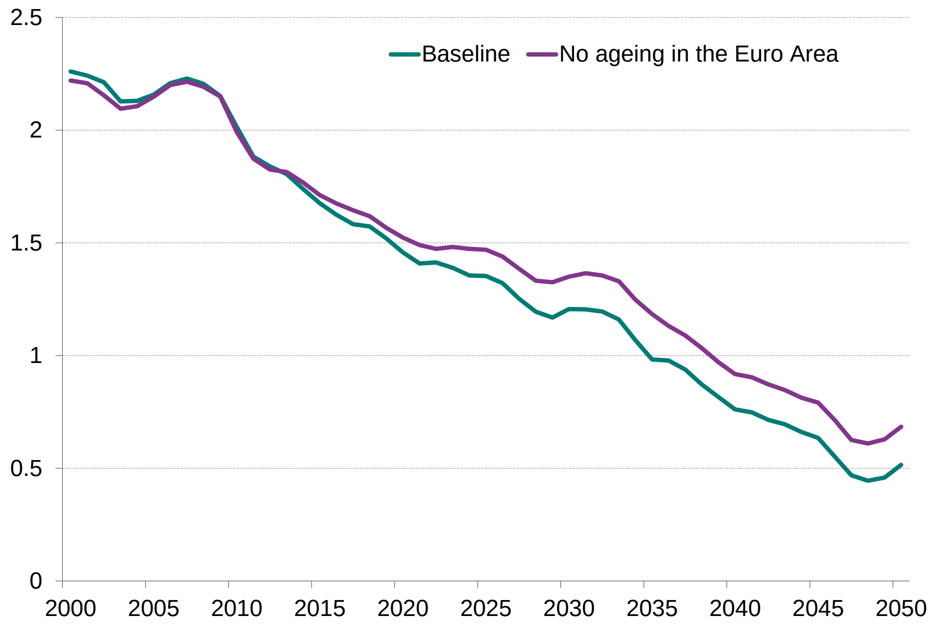
The growth slowdown stemming from convergence calculated assuming steady state determinants remain constant at the 2006 level (2005 for Hungary).

Grey bars show the discrepancy between potential growth rates estimated from the growth model and the Kalman filter.

Population ageing also played a part in NRI developments

- Bielecki et al. (2017) estimate the impact of population ageing on the natural interest rate in Poland, taking into account both domestic and euro area demographic developments
- Population ageing increases supply of savings as older cohorts have higher propensity to save
- Population ageing caused a 0.6 pp fall in NRI since 2006, which explains 13% of the total decline in NRI
- Spillovers from the euro area were limited and amounted to 0.06 pp

Natural interest rate in Poland as determined by demographics



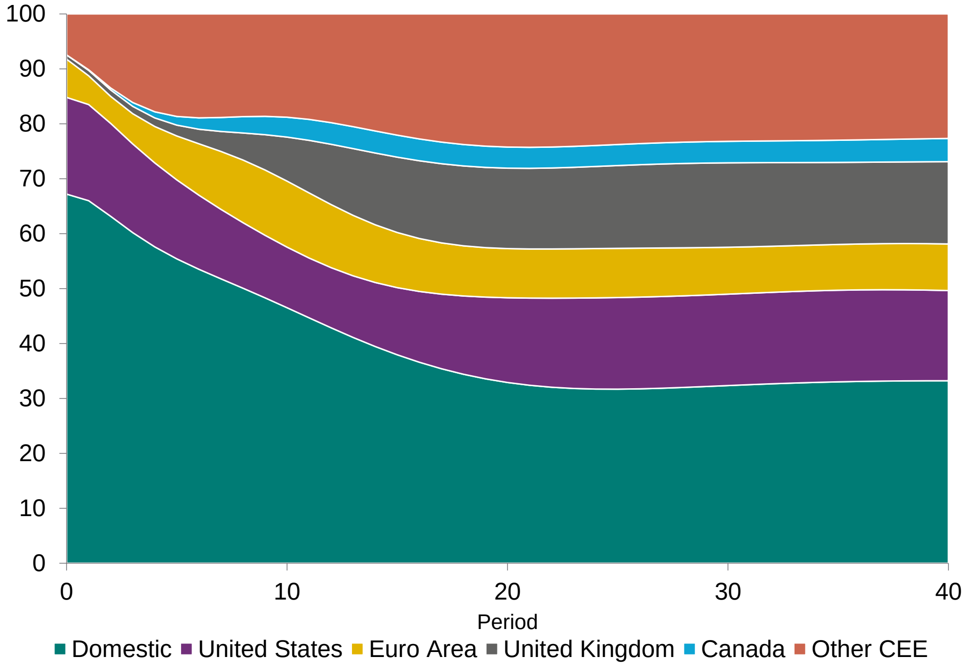
Source: Bielecki et al. (2017)

Alternative approach – variance decomposition from a SVAR model

- A simple SVAR model with Cholesky-style restrictions and a 1 lag is estimated on NRI estimates for all 7 countries
- Additional zero restrictions imposed on Canada’s impact on CEE
- Ordering: US, Euro Area, UK, Canada, Poland, Czech Republic, Hungary

Spillovers amount to 2/3 of CEE natural interest rate variance

Variance decomposition of NRI estimates: CEE countries*



* GDP-PPP weighted estimates for Poland, Czech Republic and Hungary.

Conclusion

- Spillovers from advanced economies seem to be responsible for at least half of the decline in CEE natural interest rates since the crisis:
  - Global factors explain over 80% of a decline in potential growth rates, and hence over 60% of the fall in natural interest rates;
  - Population aging in the euro area contributed to the fall in NRI only marginally;
  - Other spillover channels might be at play – e.g. lower interest rates might be required to keep the exchange rates steady as rates abroad fall;
  - Variance decomposition of natural interest rate estimates confirms that spillovers to CEE countries are high – 44% of CEE NRI variance is explained by spillovers from advanced economies and 67% by all spillovers.

Caveats

- Natural interest rates estimates are imprecise (standard errors range from 1.1 to 3.5 pp), subject to large revisions (current Laubach-Williams 2006-2008 estimates for the US are 1.5 pp lower than the ones formulated at the time) and sensitive to model specification (Laubach and Williams, 2003)

- The growth model is simplistic and its estimation results most likely biased due to endogeneity of the key investment variable and the lack of variables which control (well) for country TFP growth differences

- Variance decomposition is highly sensitive to model (especially lag) specification and CEE countries tend to have (too) high impact on each other and advanced economies

What will the future bring?

- Demographics will put a downward pressure on the NRI in the longer run – Bielecki et al. (2007) estimate the natural rate will fall by a further 1.1 pp by 2050 in Poland
- Demographics will also influence the potential growth rate as working age population and employment start falling (e.g. in Poland working age population is projected to be falling at the annual rate of 0.5-1.5% over the next 30 years)
- The big unknown is the TFP growth – will it rebounce? Population ageing makes it difficult - ageing workforce will put a downward pressure on labour productivity, while falling population and lower future demand might reduce incentives to innovate and invest

Literature

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- Solow, R. M. (1956). *A Contribution to the Theory of Economic Growth*. Quarterly Journal of Economics, 70, 65-94.
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We protect the value of money

Appendix

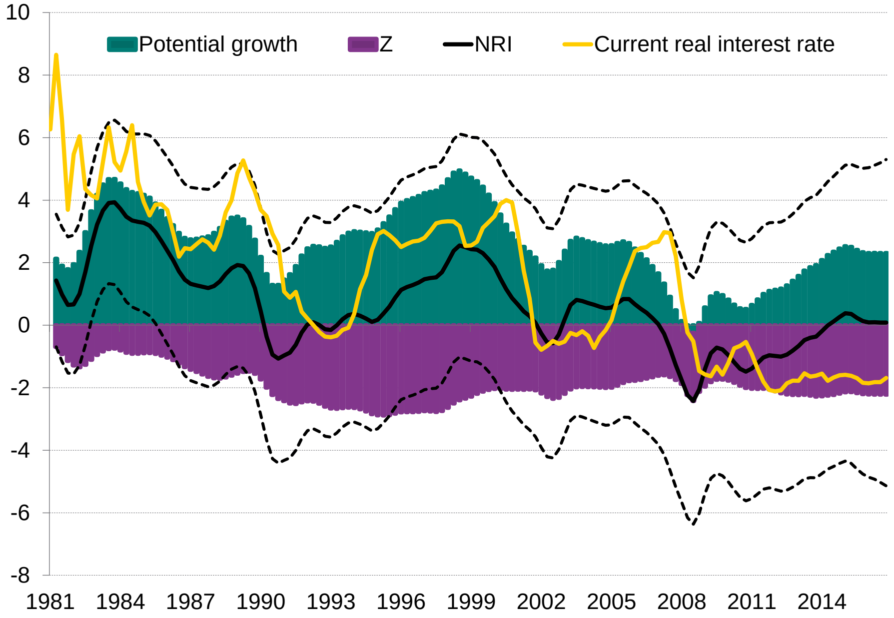
Kalman filter parameter estimates

Parameter	United States	Euro Area	United Kingdom	Canada	Poland	Czech Republic	Hungary
Sample	1980Q4-2016Q4	1998Q4-2016Q4	1980Q4-2016Q4	1980Q4-2016Q4	1998Q2-2016Q4	1995Q4-2016Q4	1995Q4-2016Q4
b_y	22.817	2.575	21.544	18.987	46.806	10.165	46.970
	(4.623)	(1.557)	(1.527)	(2.829)	(3.142)	(0.572)	(1.857)
a_y	0.00394	0.00310	0.00193	-	0.00152	0.00215	0.00083
	(11.516)	(5.371)	(5.377)		(2.347)	(3.095)	(1.445)
a_r	-1.002	-3.548	-1.342	-0.218	-1.018	-1.660	-1.103
	(3.575)	(4.015)	(4.243)	(1.877)	(3.145)	(1.879)	(2.609)
S.E. (sample average)							
r^*	1.801	1.128	2.273	1.828	1.377	3.545	2.473

t-statistics in parentheses.

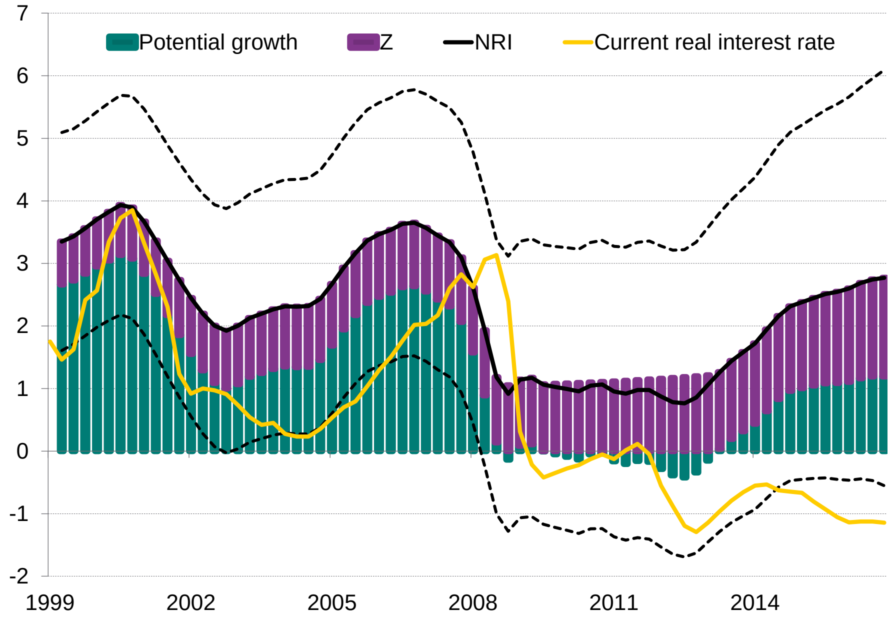
Natural interest rate estimates

United States (%)



Dashed lines represent 95% confidence band.

Euro Area (%)



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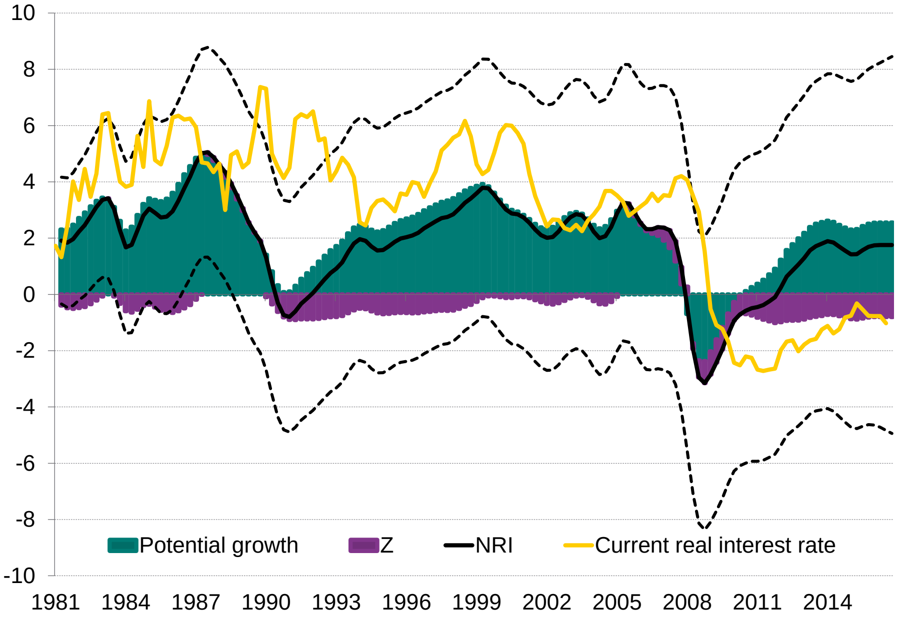
Natural interest rate estimates

United Kingdom (%)



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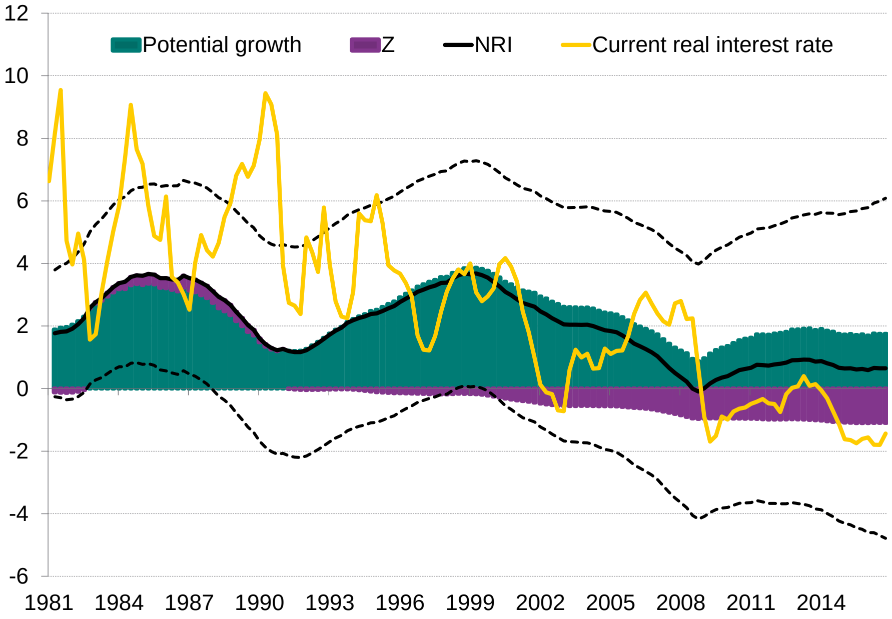
Canada (%)



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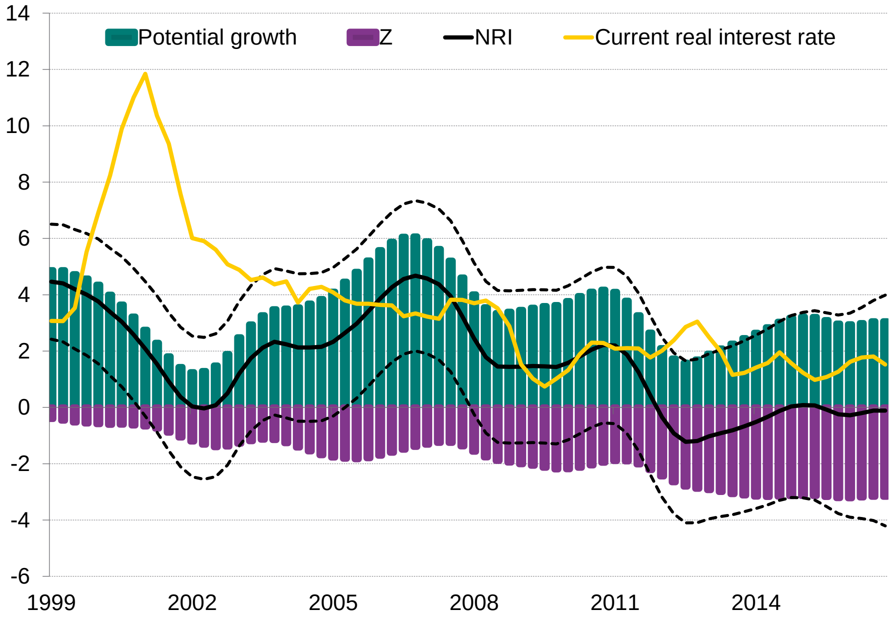
Natural interest rate estimates

Poland (%)



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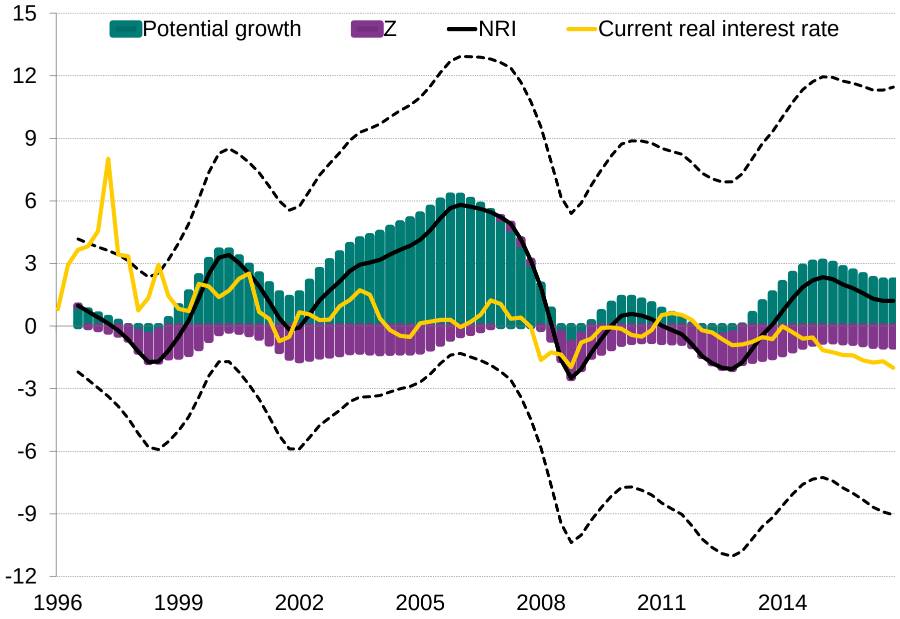
Czech Republic (%)



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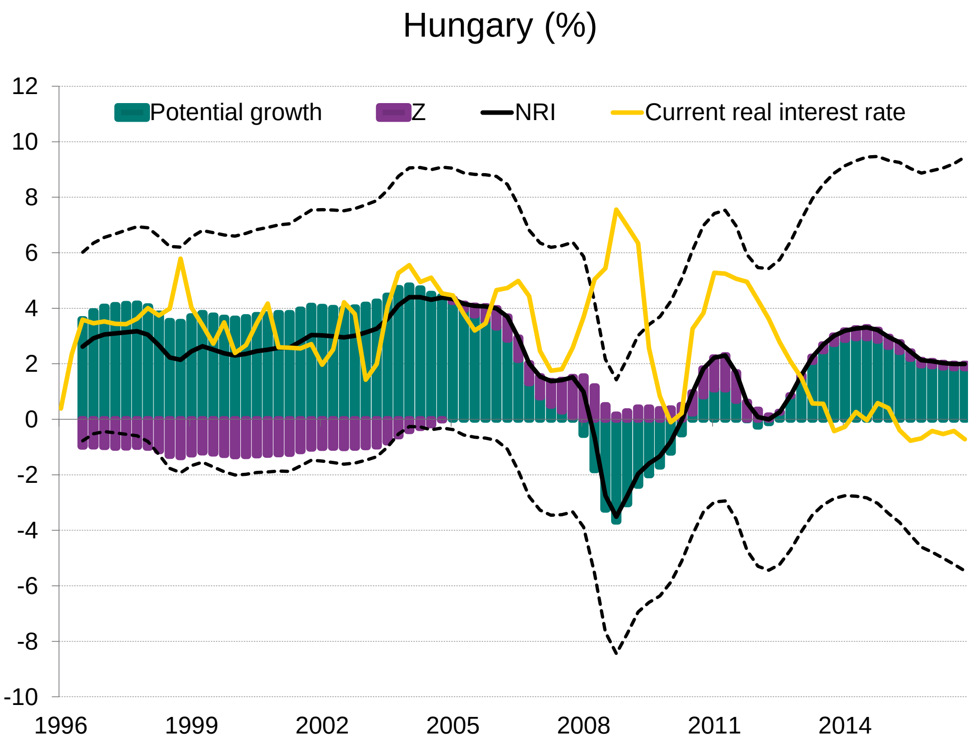
Natural interest rate estimates



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Growth model estimation

- Following Islam (1995), I estimate the model on levels:

$$\left(\frac{y}{L}\right)_{i,t} = e^{-\lambda}\left(\frac{y}{L}\right)_{i,t-1} + \alpha s_{i,t} + \beta ln\left(n_{i,t} + g + \delta\right) + \mu_i + \eta_t + \varepsilon_{i,t}$$

$\frac{y}{L}$ - ln GDP per capita PPP; λ - speed of convergence; s – ln gross fixed capital formation (% of GDP); n – population growth; $g + \delta$ = 0.07; μ_i - cross-country fixed effect; η_t - time fixed effect.

- Data is annual, covers 181 countries between 1992 and 2015 (panel nearly balanced).

- Arellano-Bover (1995) dynamic panel data system GMM with orthogonal deviations is used for estimation. The number of lags of GMM instruments is chosen so that the number of instruments does not exceed the number of countries.

Growth model estimation results

Variable	Coefficient
L.$\frac{y}{L}$	0.9835
	(192.46)
s	0.0456
	(5.50)
$ln(n_{i,t} + g + \delta)$	-0.0553
	(2.23)
No. of observations	3936
No. of countries	181
No. of instruments	154
Hansen test (p-value)	0.034

t-statistics in parentheses.

Growth decomposition

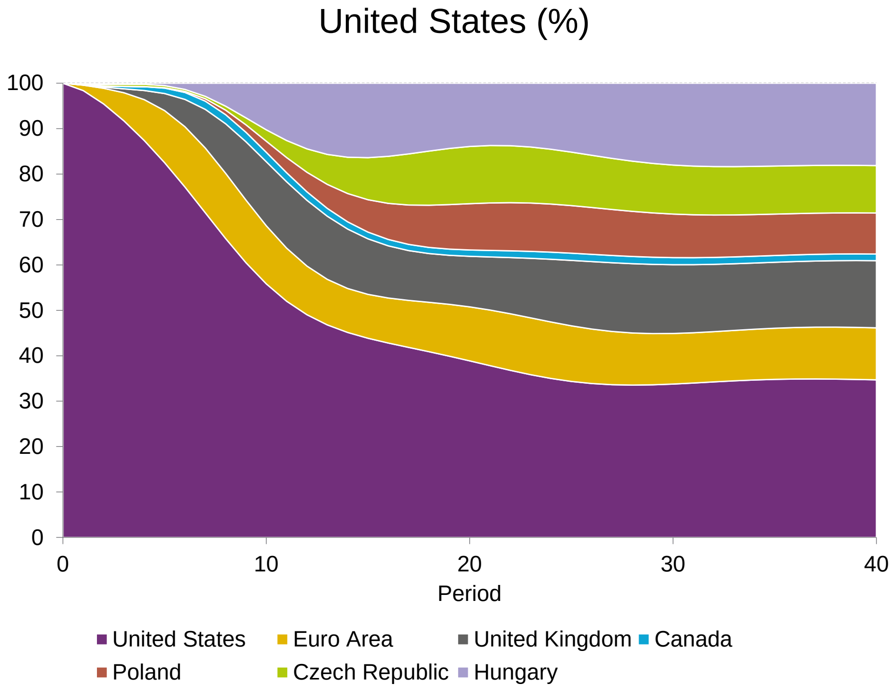
- η_t is interpreted as the TFP growth rate at the frontier

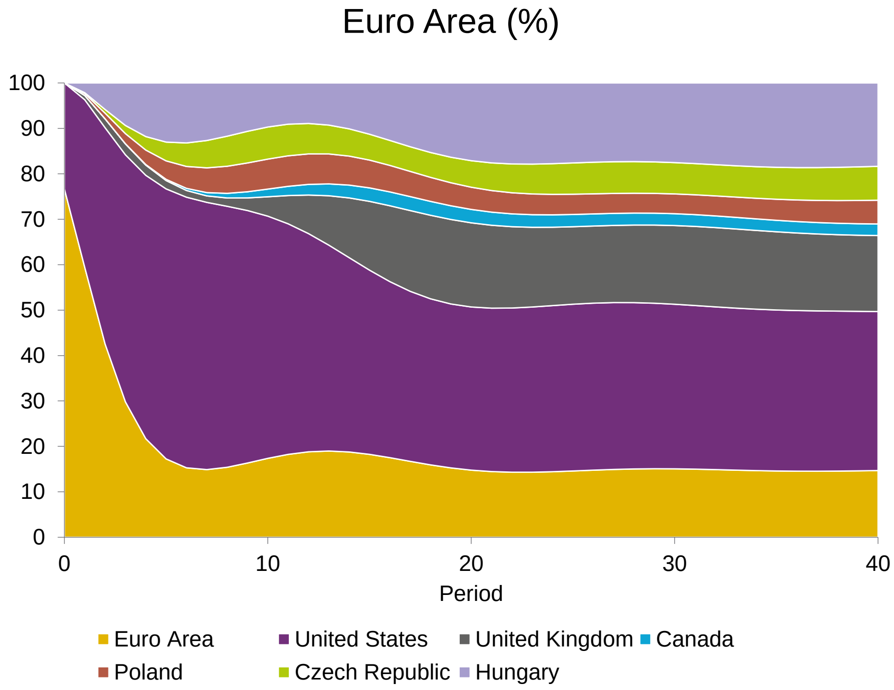
- GDP growth resulting from convergence is calculated in the following way:
$$\hat{y}_{i,t}^{c} = e^{-\lambda}\left(\frac{y}{L}\right)_{i,t-1} + \alpha s_{i,2006} + \beta ln\left(n_{i,2006} + g + \delta\right) + \mu_i - \left(\frac{y}{L}\right)_{i,t}$$

- While growth resulting from steady state movements is the difference between actual convergence (2006 replaced by *t* in the above formula) and $\hat{y}_{i,t}^{c}$

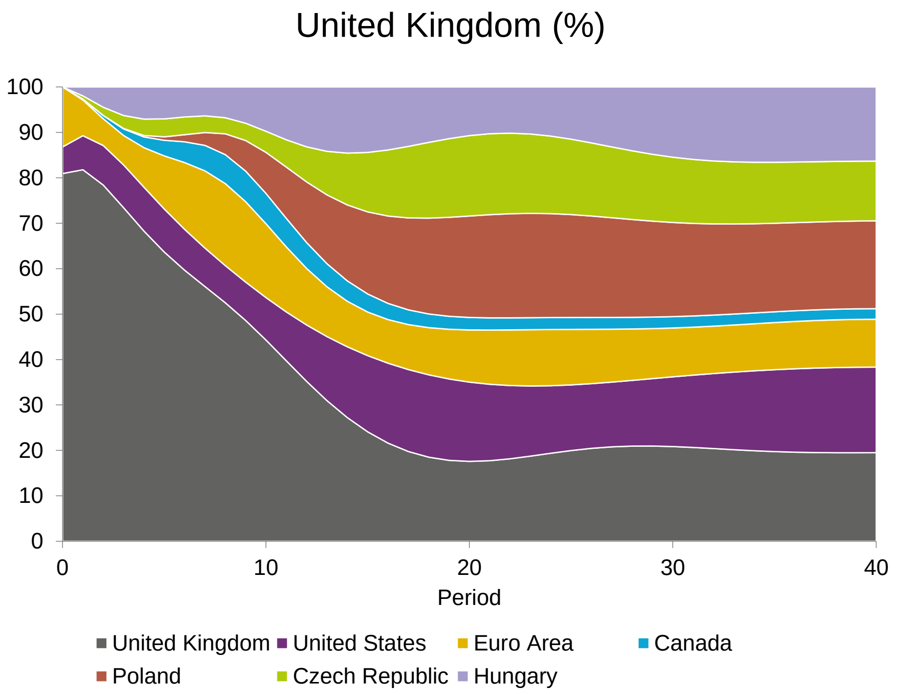
- Residual is interpreted as output gap, hence $\hat{y}_{i,t}^{pot} = \hat{y}_{i,t}^{c} + \hat{y}_{i,t}^{ss} + \eta_t + n_{i,t}$

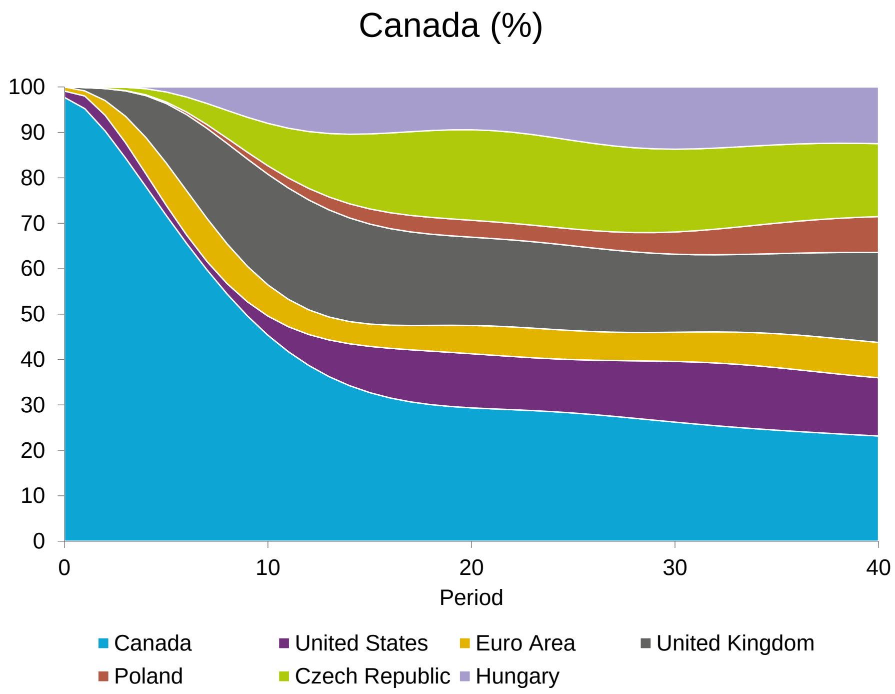
Variance decompositions





Variance decompositions





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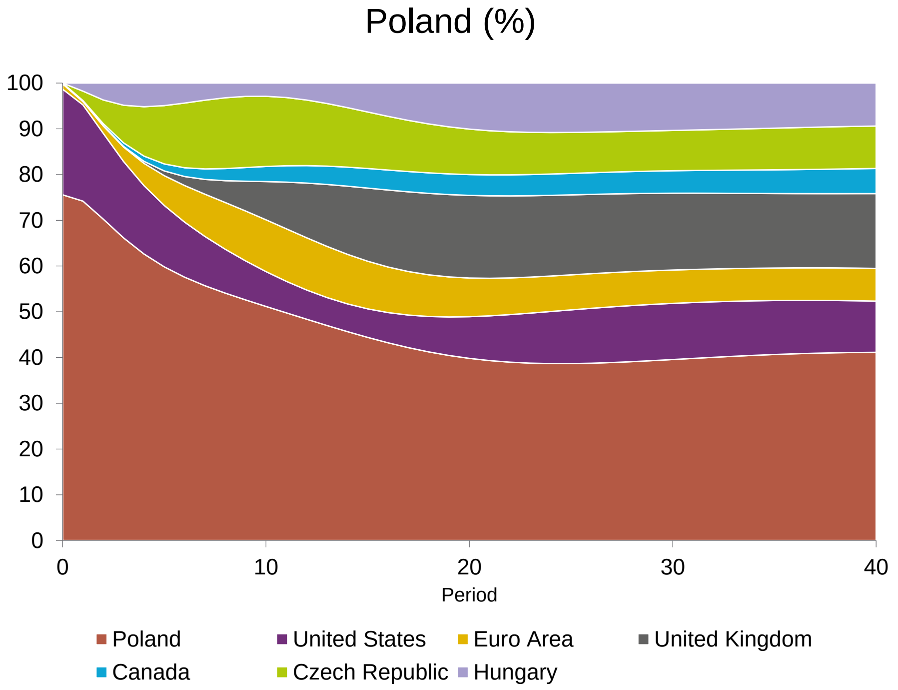

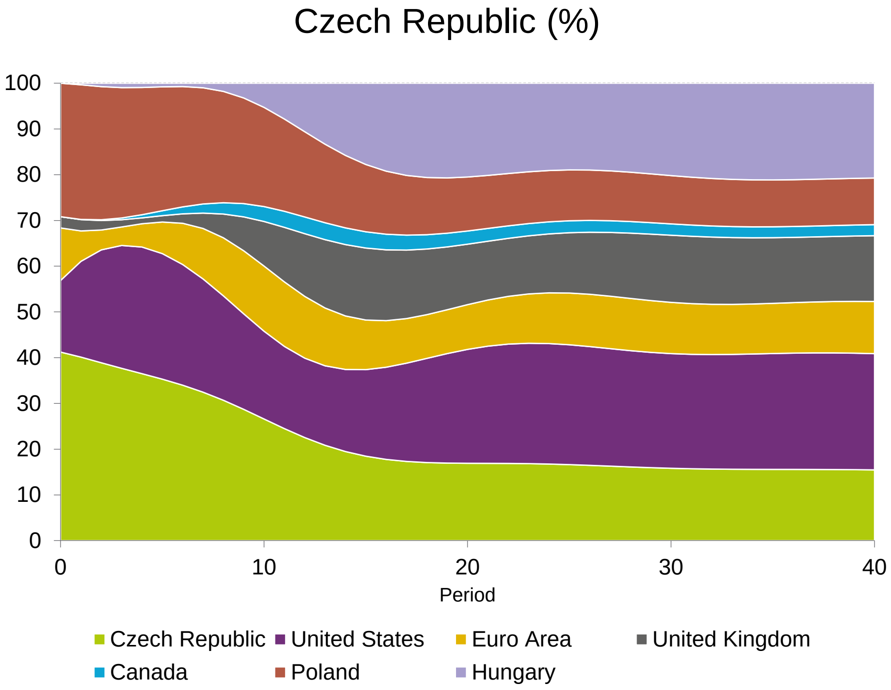

Variance decompositions