Linear-Gaussian Laubach–Williams State-Space Estimation and Decomposition of the Natural Rate of Interest – r^*: Evidence from Poland

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Abstract

The aim of the study is to obtain a time-varying estimate of Poland's natural rate of interest (NRI) -r^* and to provide a structural decomposition that separates trend growth (g) from other persistent determinants (z) within a semi-structural Laubach–Williams state-space framework. Quarterly data for 2010Q1–2025Q1 are analysed, with parameters estimated by Gaussian maximum likelihood and latent states inferred via Kalman filtering and smoothing in a linear-Gaussian state-space model. The measurement system links centred log industrial production, core inflation, a lagged real-rate input for the IS relation, and an activity-growth measurement equation that anchors the trend-growth state and improves identification of long-run versus cyclical movements. The ex-ante real policy rate is constructed as the nominal policy proxy minus survey-based expected inflation quantified via the Carlson–Parkin mapping. The resulting r^* exhibits pronounced regime variation, remaining moderately positive in the early 2010s, declining into negative territory around 2019–2021, and rising sharply after the pandemic, with a minimum of -1.34% (2020Q3), a maximum of 3.07% (2023Q4), and a sample mean of 0.76% (annualised). Uncertainty is reported using 95% intervals derived from smoothed-state covariances, and robustness checks indicate that the main turning points are preserved under calibration-variance (Q/H) perturbations and selected model-class extensions, while policy-rule closure generates the largest deviations. The results imply that monetary-policy stance diagnostics based on the natural-rate gap should be communicated jointly with uncertainty bands and sensitivity analysis, as inferred levels are specification- and end-sample-sensitive even when regime shifts remain stable. The contribution is a Poland-focused, identification-oriented LW-SSM implementation with an explicit decomposition and a transparent robustness protocol suitable for policy-relevant inference.

Keywords

natural rate of interest (r^*); linear-Gaussian inference; Kalman filter; monetary policy stance

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