Estimation and assessment of measures of the natural rate of interest: Evidence from LA economies with inflation targeting *

Erick Lahura (BCRP), José Aguilar (BCRP) y Marco Vega (BCRP)

XLI Encuentro de Economistas del BCRP (Lima, Peru)

24 de Octubre de 2023

* The views expressed here are those of the authors and not necessarily of the BCRP

Contents

Introduction

- Era of low interest rates since the global financial crisis, specially in advanced economies, promoted research on the natural rate of interest (NRI).
- Recent period of high inflation has pushed back to higher interest rates.
- Key references: Laubach y Williams (2003) and Woodford (2003).

Introduction

- K. Wicksell (1898): The natural rate of interest (NRI) is the rate compatible with a stable price level.
- If $r_t > r_t^n$, lower output and lower prices, and viceversa.
- Woodford (2003) and New Keynesian framework:
  - NRI relates to productivity shocks, consumers' preferences.
  - Taylor rule to achieve NRI and price stability.

Introduction

- NRI is useful for monetary policiy and financial stability:
  - To determine the stance of monetary policy: if the real short-term interest rate is below (above) the NRI, then monetary policy is expansive (contractive)
  - To assess potential threatens to financial stability: excessive risk-taking if real interest rates < NRI.
- **Fundamental problem**: NRI is unobservable.

Introduction

Estimation of the NRI: Several alternatives.

- Univariate filters (HP) or multivariate filters (Kalman filter), combined with theoretical relationships (Laubach y Williams, 2003; Holston et al., 2017, among others).
- Econometric models: TVP-VAR with stochastic volatility (Lubik y Matthes, 2015; Wang y Kwan, 2021, among others) and cointegration (Benati, 2020, 2023).
- Estimation and/or calibration of theoretical models (Doojav and Gantumur , 2020; Zhang et al., 2021). DGSE models (Giammarioli and Valla, 2004; Barsky et al., 2014).
- Borio (2021): indicators of expectations of market participants: e.g. a real forward rate (not control by the CB).

Introduction

Objective

- Estimate and assess two measures of the NRI for Chile and Peru (LATAM, IT).
- Estimation:
  - Time-varying parameter vector autoregression model with stochastic volatility (TVP-VAR-SV), Lubik y Matthes (2015).
  - M1 velocity is the permanent component of the real interest rate Benati (2020, 2023).
- Assessment: Transitory shocks do not affect NRI in the long run

Contents

Methodology

- Estimation of NRI: TVP-VAR-SV and Money Velocity
- Asessment: SVAR with long-run restrictions.

Methodology

Estimation: TVP-VAR-SV

- Proposed by Lubik y Matthes (2015): the rate of growth of GDP, inflation and ex ante real interest rate.
- Bayesian techniques as in Primiceri (2005) and Del Negro y Primiceri (2015).
- The NRI is the conditional long-run (5-year) forecast of the observed ex ante real interest rate.

Methodology

Estimation: TVP-VAR-SV

- Let $y_t = (g_t, \pi_t, r_t)'$ and 2 lags (TVP-VAR convention). Then:

$$y_t = c_t + B_{1,t} y_{t-1} + B_{2,t} y_{t-2} + u_t \qquad t = 1, \ldots, T. \qquad (1)$$

  - $u_t \sim N(0, \Omega_t)$
  - $c_t, B_{1,t}, B_{2,t}$ and $Var(u_t) = \Omega_t)$ are time varying.

- The variance covariance matrix Ω_t is descomposed as:

$$\Omega_t = A_t^{-1} \Sigma_t \Sigma_t' A_t^{-1'}$$

Methodology

Estimation: TVP-VAR-SV

- Details of $\Omega_t = A_t^{-1}\Sigma_t\Sigma_t' A_t^{-1'}$:

$$A_t = \begin{pmatrix} 1 & 0 & 0 \\ \alpha_{21,t} & 1 & 0 \\ \alpha_{31,t} & \alpha_{32,t} & 1 \end{pmatrix} \quad , \quad \Sigma_t = \begin{pmatrix} \sigma_{1,t} & 0 & 0 \\ 0 & \sigma_{2,t} & 0 \\ 0 & 0 & \sigma_{2,t} \end{pmatrix}$$

- Then, TVP-VAR-SV can be written as:

$$y_t = c_t + B_{1,t}y_{t-1} + B_{2,t}y_{t-2} + A_t^{-1}\Sigma_t\varepsilon_t \qquad , t = 1, \ldots, T.$$

where $Var(\varepsilon_t) = I_n$.

Methodology

Estimation: TVP-VAR-SV

- In compact form: $y_t = X_t' B_t + A_t^{-1} \Sigma_t \varepsilon_t$.

- It is assumend that the time varying parameters follow random walk processes:

$$\begin{aligned} \beta_t &= \beta_{t-1} + v_{\beta,t} \\ \alpha_t &= \alpha_{t-1} + v_{\alpha,t} \\ \log \sigma_t &= \log \sigma_{t-1} + v_{\sigma,t} \end{aligned}$$

where $u_t, v_{\beta,t}, v_{\alpha,t}, v_{\sigma,t}$ are mutually independent.

Methodology

Estimation: TVP-VAR-SV

- Assumptions:
  - Initial states for the coefficients, the covariances, log volatilities and hyperparmeters are independent of each other.
  - Priors for the hyperparameters Q, W and the blocks of S are distributed as independent inverse-Wishart.
  - Normal priors on the entire sequences of $B's$, $\alpha's$, and $\log \sigma's$ (conditional on Q, W, and S).
- Posterior distributions of B, A, and Σ and V are evaluated using Gibbs sampling as in Del Negro and Primiceri (2015).

Methodology

Estimation: TVP-VAR-SV

- The first 6 years to calibrate the priors distributions.
- Following Wang y Kwan (2021), draw 10,000 samples from the posterior distribution, discard first 2,000 samples (chain should converge).
- NRI is the conditional 5-year (long run) forecast of the observed ex ante real interest rate:

$$r_t^* = (0,0,1) * E_t(y_{t+20}) = (0,0,1) * X_t' \beta_t^{20}$$

Methodology

Estimation: M1 velocity

- Benati (2020): M1 velocity is, approximately, the permanent component of the short-term rate.
- Implication: Decision of wealth allocation to non interest-bearing M1, react to permanent shocks to the opportunity cost, essentially ignoring transitory shocks.
- Then, M1 velocity can be considered as a reliable estimate of the nominal NRI Benati (2023).
- Estimation of NRI based on Cochrane (1994): permanent component of GDP from consumption information.

Methodology

Estimation: M1 velocity

- The permanent component of the nominal NRI, R_t^P, is determined by permanent shocks to inflation, π_t^P, and to real NRI r_t^N:

$$R_t^P = \pi_t^P + r_t^N$$

- Under IT, permanent changes in M1 velocity reflect permanent fluctuations in the NIR, and thus:

$$V_t = \beta_1 + \beta_2 r_t^N + v_t$$

Methodology

Estimation: M1 velocity

- A two-step proedure:
  - Project the monetary policy rate on M1 velocity and get estimated nominal NR.
  - Real TNI = estimated nominal TNI and the inflation target (or avergae inflation).
- Econometrically: (i) Cointegrated VAR as in Cochrane (1994), (ii) Projection using OLS regression.

Methodology

Assessment: SVAR with long-run restrictions

- Criterion: the NRI does not react to transitory shocks (shocks that have no long-run effect on real interest rate).
- Estimation of a two-variable VAR for the ex-ante real interest rate r_t and r_t^N.
- Identification of transitory and permanent shocks: a transitory shock has no effect on the ex ante real interest rate in the long-run.
- r_t^N is a good NRI measure if (i) the response of r_t^N to a transitory shock is close to zero, and (ii) the contribution of the transitory shock to the variance of r_t^N is very small.

Methodology

Assessment: SVAR with long-run restrictions

- The VMA representation for Δr_t and Δr_t^N in terms of fundamental innovations can be written as:

$$\begin{bmatrix} \Delta r_t \\ \Delta r_t^N \end{bmatrix} = \begin{bmatrix} \bar{r} \\ \bar{r}^N \end{bmatrix} + \sum_{i=0}^{\infty} \begin{bmatrix} \phi_{11}(i) & \phi_{12}(i) \\ \phi_{21}(i) & \phi_{22}(i) \end{bmatrix} \begin{bmatrix} \varepsilon_{t-i}^P \\ \varepsilon_{t-i}^T \end{bmatrix} \tag{2}$$

- Identificantion using a long-run restriction (Blanchard and Quah, 1989): an innovation to ε_t^T has no long-run effect on the ex ante real interest rate, i.e. $\sum_{i=0}^{\infty} \phi_{12}(i) = 0$.

Methodology

Assessment: SVAR with long-run restrictions

- r_t^N is a good NRI measure if:
  - i Cumulative IRF to ε_t^T shocks is close to zero: $\sum_{i=0}^{\infty} \phi_{22}(i) \rightarrow 0$.
  - ii The contribution of ε_t^T shocks to fluctuations in r_t^N is close to zero.

Data

TVP-VAR-SV

- The data obtained from the corresponding central banks.
- Peru: 1995Q4-2023Q2 for Peru, Chile: 1997Q1-2023Q2.
- Series: real GDP growth, the ex-ante real interest rate, and inflation.
- Real GDP growth: percentage changes on year-over-year basis.
- Inflation: annual growth rate of CPI excluding food and energy.

Data

TVP-VAR-SV

- The ex-ante real interest rate: policy interest rate minus inflation expectations (four-quarter moving average of past inflation).
- 24 quarters used as the presample to calibrate priors and include 2 lags in the VAR, the estimated NRI starts in 2002Q2 for Peru and 2003Q3 for Chile.
- The estimation of TVP-VAR-SV was perform in R using the package “bvarsv” Krueger (2022).

Data

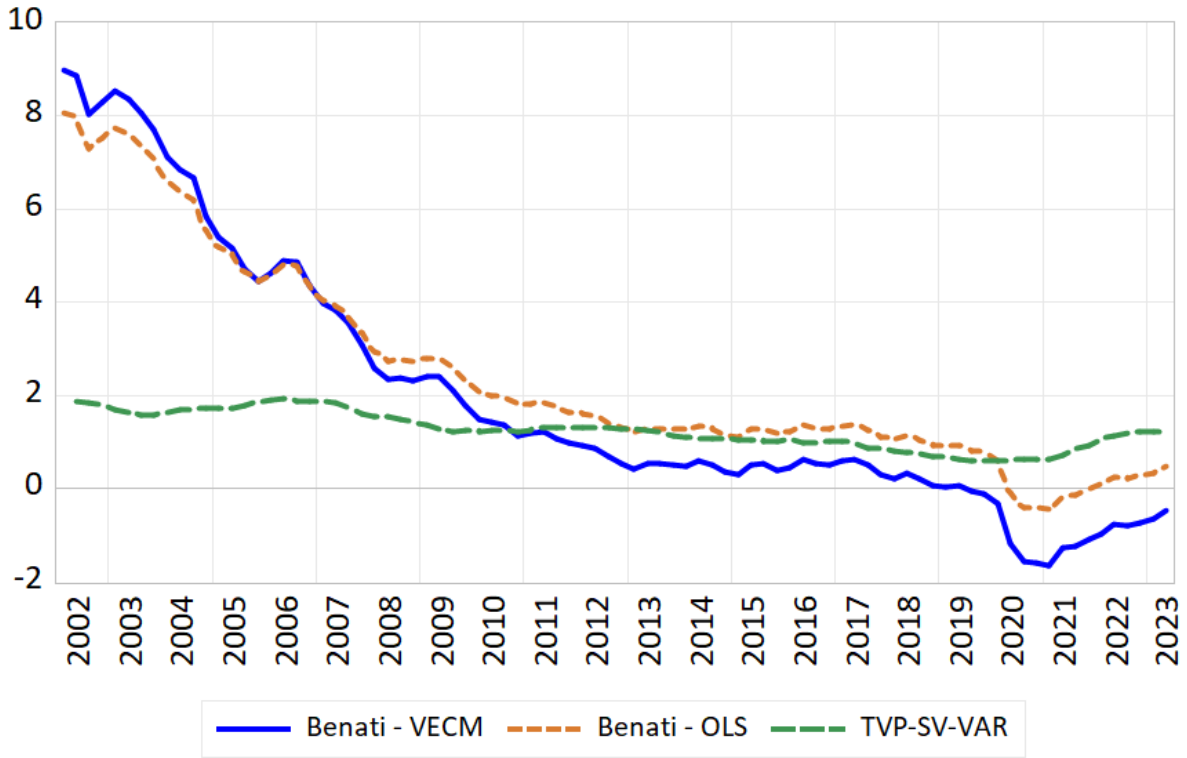
Money velocity

- Real interest rate as the difference between nominal interest rate and the inflation target.
- M1 velocity is the ratio between nominal GDP and M1.

Contents

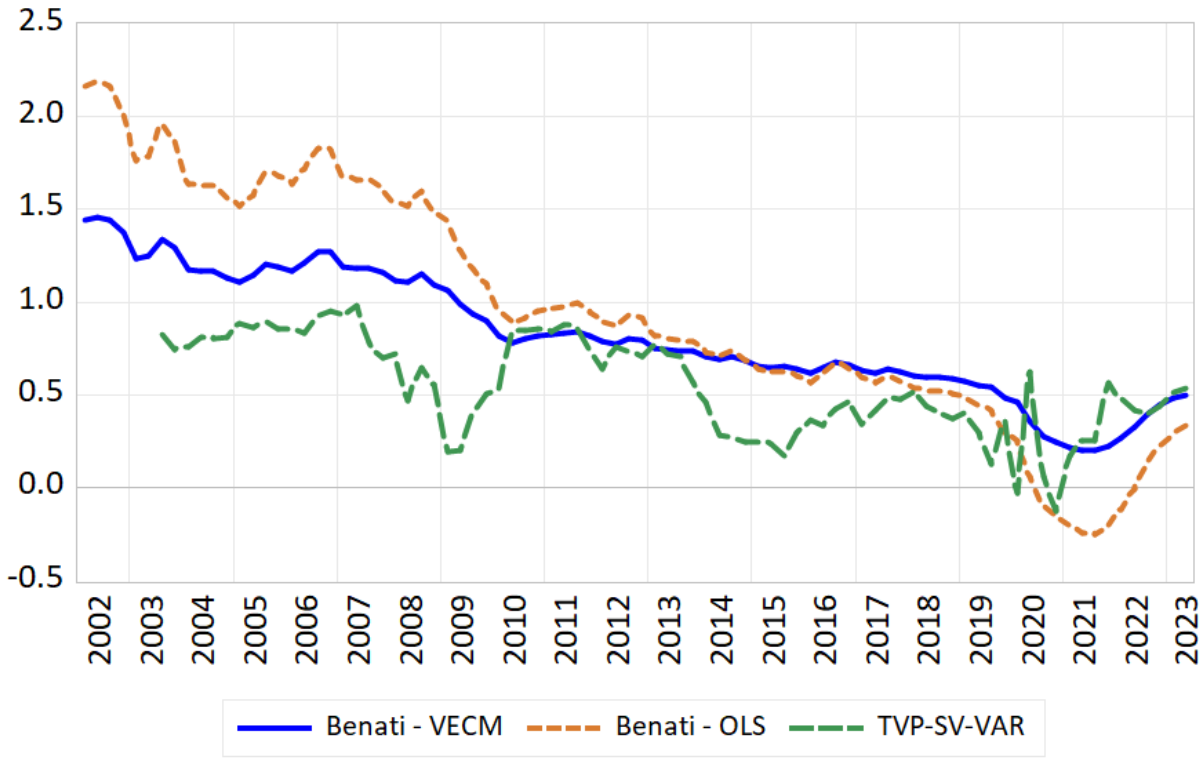
Results

Estimation of the NRI: Peru, 1995Q4-2023Q2.



Results

Estimation of the NRI: Chile, 1997Q1-2023Q2.



Results

Assessment: Cumulative IRF after a transitory shock.

Table. NRI estimates for Perú: Cumulative IRF

Quarter	Benati-VECM	Benati-OLS	TVP-VAR-SV
1	-0.04*	-0.03*	0.01*
2	0.00	0.00	0.01
3	0.04	0.04	0.01
4	0.09	0.07	0.01
8	-0.01	-0.01	0.00
20	0.00	0.00	0.00

Results

Assessment: Variance decomposition.

Table. NRI estimates for Peru: Variance decomposition

Quarter	Benati-VECM	Benati-OLS	TVP-VAR-SV
1	2.98	2.98	16.99
2	4.49	4.49	10.78
3	7.37	7.37	10.10
4	9.96	9.96	9.69
8	17.43	17.43	10.38
20	17.86	17.86	10.44

Results

Assessment: Cumulative IRF after a transitory shock.

Table. NRI estimates for Chile: Cumulative IRF

Quarter	Benati-VECM	Benati-OLS	TVP-VAR-SV
1	-0.02*	-0.04*	0.04*
2	-0.02*	-0.05*	0.04*
3	-0.01	-0.01	0.01
4	0.00	0.01	0.02
8	0.01	0.01	0.00
20	0.00	0.00	0.00

Results

Assessment: Variance decomposition.

Table. NRI estimates for Chile: Variance decomposition

Quarter	Benati-VECM	Benati-OLS	TVP-VAR-SV
1	42.66	42.66	5.74
2	36.89	36.89	5.12
3	48.59	48.59	8.38
4	49.31	49.31	8.32
8	48.68	48.68	8.67
20	49.56	49.56	8.69

Contents

Conclusions

- We estimated and assessed two measures of NRI for Chile and Perú: (i)TVP-VAR-SV Lubik y Matthes (2015), and (ii) M1 velocity Benati (2023).
- Assessment based on identification of transitory shocks to real interest rate.
- Criterion: NRI does not react to transitory structural shocks (IRF, VD).
- Both are good measures, TVP-NRI measures are relatively superior.

Conclusions

The agenda

- Include Brazil, Colombia, and Mexico.
- Assess other measures, e.g. Laubach y Williams (2003) and Holston et al. (2017).

References

Benati,L. (2020). Money velocity and the natural rate of interest. Journal of Monetary Economics, 116: 117-134.

Benati, L. (2023). A New Approach to Estimating the Natural Rate of Interest. Journal of Money, Credit and Banking.

Blanchard, O., and Quah, D. (1989). The Dynamic Effects of Aggregate Demand and Supply Disturbances. *American Economic Review, 79*(4): 655-73.

Cochrane, J. H. (1994). Permanent and Transitory Components of GNP and Stock Prices. *Quarterly Journal of Economics, 109*(1), 241-265.

Del Negro, M., and Primiceri, G. (2015). Time varying structural vector autoregressions and monetary policy: A corrigendum. *Review of Economic Studies, 82*(4), 1342-1345.

Holston, K., Laubach, T. and Williams, J. (2017). Measuring the

Estimation and assessment of measures of the natural rate of interest: Evidence from LA economies with inflation targeting

Erick Lahura (BCRP), José Aguilar (BCRP) y Marco Vega (BCRP)

XLI Encuentro de Economistas del BCRP (Lima, Peru)

24 de Octubre de 2023