DT
DECON

DOCUMENTO DE TRABAJO

Nº 537

REGIME-SWITCHING, STOCHASTIC VOLATILITY AND IMPACTS OF MONETARY POLICY SHOCKS ON MACROECONOMIC FLUCTUATIONS IN PERU

Paola Alvarado Silva,
Moisés Cáceres Quispe
y Gabriel Rodríguez

Departamento
Académico de Economía

PUCP

DOCUMENTO DE TRABAJO N° 537

Regime-Switching, Stochastic Volatility and Impacts of Monetary Policy Shocks on Macroeconomic Fluctuations in Peru

Paola Alvarado Silva, Moisés Cáceres Quispe y Gabriel Rodríguez

Agosto, 2024

PUCP
Departamento Académico de Economía

DOCUMENTO DE TRABAJO 537
http://doi.org/10.18800/2079-8474.0537

Regime-Switching, Stochastic Volatility and Impacts of Monetary Policy Shocks on Macroeconomic Fluctuations in Peru

Documento de Trabajo 537

@ Paola Alvarado Silva, Moisés Cáceres Quispe y Gabriel Rodríguez

Editado:

Av. Universitaria 1801, Lima 32 – Perú.
Teléfono: (51-1) 626-2000 anexos 4950 - 4951
econo@pucp.edu.pe
https://departamento-economia.pucp.edu.pe/publicaciones/documentos

Encargado de la Serie: Gabriel Rodríguez
Departamento de Economía – Pontificia Universidad Católica del Perú
gabriel.rodriguez@pucp.edu.pe
Primera edición – Agosto, 2024

ISSN 2079-8474 (En línea)

Regime-Switching, Stochastic Volatility and Impacts of Monetary Policy Shocks on Macroeconomic Fluctuations in Peru*

Paola Alvarado Silva†
Pontificia Universidad Católica del Perú

Moisés Cáceres Quispe‡
Pontificia Universidad Católica del Perú

Gabriel Rodríguez§
Pontificia Universidad Católica del Perú

This Version: August 15, 2024

Abstract

This paper utilizes regime-switching VAR models with stochastic volatility (RS-VAR-SV) to analyze the impact and evolution of monetary policy shocks and their contribution to the dynamics of GDP growth, inflation, and the interest rate in Peru for the period from 1994Q3 to 2019Q4. The main findings are: (i) the best-fitting models incorporate only SV; (ii) there are two distinct regimes coinciding with the implementation of the inflation targeting (IT) scheme; (iii) the volatility of GDP growth and inflation began to decrease in the early 1990s, while interest rate volatility declined following IT implementation; and (iv) pre-IT, monetary policy shocks accounted for 15%, 30%, and 90% of the forecast error variance decomposition for inflation, GDP growth, and the interest rate in the long term, respectively. Following IT adoption, monetary policy ceased to be a source of uncertainty for the economy. These results are robust to changes in priors, domestic and external variables, the number of regimes, and the ordering and number of variables of the model.

JEL Classification: C11, C32, C52, E51, E52.

Keywords: Regime-Switching VAR, Stochastic Volatility, Marginal Likelihood, Bayesian Models, Monetary Policy, Peru.

*This document is drawn from the Thesis of Paola Alvarado Silva and Moisés Cáceres Quispe at the Faculty of Social Sciences of the Pontificia Universidad Católica del Perú (PUCP). We appreciate the comments from Paul Castillo B. (Central Reserve Bank of Peru and PUCP). Any remaining errors are the responsibility of the authors.

†Department of Economics, Pontificia Universidad Católica del Perú, 1801 Universitaria Avenue, Lima 32, Lima, Perú, E-Mail Address: paola.alvarados@pucp.edu.pe.

‡Department of Economics, Pontificia Universidad Católica del Perú, 1801 Universitaria Avenue, Lima 32, Lima, Peru, E-Mail Address: moises.caceres@pucp.edu.pe.

§Address for Correspondence: Gabriel Rodríguez, Department of Economics, Pontificia Universidad Católica del Perú, 1801 Universitaria Avenue, Lima 32, Lima, Perú, Telephone: +511-626-2000 (4998), E-Mail Address: gabriel.rodriguez@pucp.edu.pe. ORCID ID: https://orcid.org/0000-0003-1174-9642.

Cambio de Regimen, Volatilidad Estocástica e Impactos de Choques de Política Monetaria sobre las Fluctuaciones Macroeconómicas en Perú*

Paola Alvarado Silva†
Pontificia Universidad Católica del Perú

Moisés Cáceres Quispe‡
Pontificia Universidad Católica del Perú

Gabriel Rodríguez§
Pontificia Universidad Católica del Perú

Versión: 15 de Agosto 2024

Resumen

Este artículo utiliza modelos VAR de cambio de régimen con volatilidad estocástica (RS-VAR-SV) para analizar el impacto y la evolución de los choques de política monetaria y su contribución a la dinámica del crecimiento del PIB, inflación y la tasa de interés en el Perú para el período 1994T3 al 2019T4. Los principales hallazgos son: (i) los modelos que mejor se adaptan incorporan únicamente SV; (ii) existen dos regímenes distintos que coinciden con el implementación del esquema de metas de inflación (MEI); (iii) la volatilidad del crecimiento del PIB y la inflación comenzó a disminuir a principios de la década de 1990, mientras que la volatilidad de las tasas de interés disminuyó después de la implementación de MEI; y (iv) antes de MEI, los choques de política monetaria representaron el 15%, el 30% y el 90% de la descomposición de la varianza del error de predicción de la inflación, el crecimiento del PIB y la tasa de interés a largo plazo, respectivamente. Con la adopción de MEI TI, la política monetaria dejó de ser una fuente de incertidumbre para la economía. Estos resultados son robusto a los cambios en las priors, las variables internas y externas, el número de regímenes y el ordenamiento y número de variables del modelo.

Clasificación JEL: C11, C32, C52, E51, E52.

Palabras Clave: Modelo VAR con Cambio de Regimen, Volatilidad Estocástica, Verosimilitud Marginal, Modelos Bayesianos, Política Monetria, Perú.

*Este documento está basado en la Tesis de Licenciatura de Paola Alvarado Silva y Moisés Cáceres Quispe de la Facultad de Ciencias Sociales de la Pontificia Universidad Católica del Perú (PUCP). Apreciamos los comentarios de Paul Castillo B. (Banco Central de Reserva del Perú y PUCP). Los errores subsistentes son responsabilidad de los autores.

†Departmento de Economía, Pontificia Universidad Católica del Perú, Avenida Universitaria 1801, Lima 32, Lima, Perú, Correo Electrónico: paola.alvarados@pucp.edu.pe.

‡Departamento de Economía, Pontificia Universidad Católica del Perú, Avenida Universitaria 1801, Lima 32, Lima, Peru, Correo Electrónico: moises.caceres@pucp.edu.pe.

§Dirección de Correspondencia: Gabriel Rodríguez, Departamento de Economía, Pontificia Universidad Católica del Perú, Avenida Universitaria 1801, Lima 32, Lima, Perú, Teléfono: +511-626-2000 (4998), Correo Electrónico: gabriel.rodriguez@pucp.edu.pe. ORCID ID: https://orcid.org/0000-0003-1174-9642.

1 Introduction

Over the past three decades, Peru's economy has witnessed significant transformations. The period following the hyperinflation episode of 1988 to 1990 was pivotal, marked by the rollout of a sweeping macroeconomic stabilization reform package. This initiative, aimed at curbing rampant inflation and pulling the economy out of recession, included key measures such as abolishing capital and price controls, dismantling trade barriers, adopting a floating exchange rate regime, and embarking on financial market liberalization.

Integral to these reforms was a fundamental overhaul of the monetary policy framework in the early 1990s. This important change was marked by granting constitutional autonomy to the Central Reserve Bank of Peru (BCRP) in 1993 (Rossini and Vega, 2007; Armas et al., 2001), empowering the BCRP to implement a monetary policy independent of fiscal dominance, with price stability as its sole objective. From 1991 to 2001, this focus on price stability was maintained through careful control of monetary aggregates, allowing market forces to freely determine interest and exchange rates. By 1997, this strategy effectively curbed inflation to single digits. However, during this period, the correlation between money supply and inflation weakened, complicating the forecasting of monetary base growth and challenging the effectiveness of the monetary targets regime (Lahura, 2012).

In response, 2002 marked a strategic pivot for the BCRP with the adoption of an inflation targeting (IT) framework. This shift was driven by a continued pursuit of low and stable inflation, coupled with an aim to enhance the transparency and credibility of monetary policy. The IT regime initially set inflation targets ranging from 1.5% to 3.5%, which were further narrowed to 1% to 3% in September 2007, reinforcing the monetary policy's robustness and bolstering inflation expectation anchoring; see Castillo et al. (2011). A notable feature of this IT era, starting September 2003, was the transition from an operational target to a reference interest rate, providing a clear benchmark for other interest rates within the financial system and aiding in shaping inflation expectations.

Given these significant shifts in monetary policy practice, it stands to reason that both the transmission mechanism of monetary policy and its effect on economic variables have evolved over time. This paper delves into the nature and trajectory of monetary policy shocks, examining their influence on the dynamics of GDP growth, inflation, and the interest rate. While existing research often employs standard methodologies to gauge the impact of Peru's monetary policy, there is a scarcity of literature incorporating empirical frameworks that account for temporal variations in coefficients and volatilities. This study addresses this gap by introducing an application of regime-switching VAR models with stochastic volatility (RS-VAR-SV), following the approach proposed by Chan and Eisenstat (2018). The models were estimated using data from 1994Q3 to 2019Q4, including five key variables: terms-of-trade growth, real GDP growth, inflation, money growth, and the interest rate.

Out results suggest that models incorporating SV provide the best fit. Moreover, the economy is characterized by two distinct regimes, with a regime shift aligning with the 2002 IT adoption. Notably, the post-IT phase is marked by substantially lower volatility in domestic variables, particularly in the interest rate. A monetary policy shock, quantified as an unanticipated 100-basis point surge in the interest rate, triggers a 0.3% dip in GDP growth across both states. In the pre-IT regime, monetary policy shocks significantly influenced the forecast error variance decomposition for inflation, GDP growth, and the interest rate (15%, 30%, and 98% respectively, in the long term). However, the post-IT period sees a diminishing role of these shocks relative to external factors; and the historical decomposition shows that monetary policy shocks lose importance compared to foreign shocks post-2002. This shift not only reflects the diminished role of monetary policy as a source of economic uncertainty but also underscores the pivotal role of the BCRP in fostering macroeconomic stability through IT adoption.

The document is structured as follows: Section 2 presents an in-depth review of the empirical literature. Section 3 describes the estimated models and the methodology employed. Section 4 delves into data analysis, estimation results, and robustness exercises. Section 5 presents an analysis of the main conclusions considering an extension of the sample until 2023Q2 to include the pandemic period. Section 6 rounds off the discussion with the main conclusions.

2 Literature Review

Since Sims' seminal works (1972, 1980, and 1986), VAR models have become a staple in multivariate time series analysis, especially for studying the impacts of monetary policy shocks. Bernanke and Blinder (1992), Eichenbaum (1992), Gordon and Leeper (1994), Christiano et al. (1996), Leeper et al. (1996), Bernanke and Mihov (1998), and Christiano et al. (1999) provide comprehensive discussions on the use of VAR models for analyzing monetary policy transmission mechanisms. While the estimations depend on the measurement of monetary policy shocks—whether via interest rates or monetary aggregates—the consensus indicates that a contractionary monetary policy shock generally leads to a swift reduction in GDP, followed by a delayed negative price response.

However, these studies rest on the assumption of time-invariant parameters—an assumption seen as inadequate, given the evolving nature of economic series and their interrelationships. In response to this limitation, recent literature over the past two decades has introduced empirical frameworks accommodating changes in transmission mechanisms. These approaches, from an econometric standpoint, involve modeling temporal changes in parameters and variances (volatilities). Prominent among these are (i) time-varying parameter VAR models with stochastic volatility (TVP-VAR-SV) and (ii) regime-switching VAR models with stochastic volatility (RS-VAR-SV).[1]

The TVP approach assumes gradual parameter shifts and is typically modeled as a random walk. In the US, Cogley and Sargent (2001) develop a TVP-VAR model analyzing inflation, unemployment, and interest rate dynamics, assuming a constant variance-covariance matrix, a premise that may lead to overestimated parameter changes over time (Sims, 2001; Stock, 2001). Later, Cogley and Sargent (2005) expand this model to include SV, finding evidence of shifts in persistence and volatility of these variables, which indicates changes in monetary policy rules and inflation persistence in the 1970s.

Primiceri (2005) uses a TVP-VAR-SV model to assess the role of monetary policy in inflation dynamics, discovering evolving systematic and non-systematic shocks and a more aggressive interest rate response to inflation over time. Koop et al. (2009) further extend this model to include a mixture innovation approach, shedding light on when and how parameters change, and positing that monetary policy transmission mechanisms have evolved due to shifts in the volatility of exogenous shocks. More recently, Chan and Eisenstat (2018) use inflation, growth, and interest rate data to estimate a set of TVP-VAR-SV models, showing that monetary shocks significantly contract GDP and have a significant negative impact on inflation.

In Europe, Franta et al. (2014) examine the Czech Republic's monetary transmission mechanism, finding increased price sensitivity to monetary shocks and a relatively stable exchange rate pass-through over time. Arratibel and Michaelis (2014) indicate that GDP and prices in Poland have grown increasingly resilient to monetary and exchange rate shocks.

In Asia, Nakajima (2011) incorporates Japan's zero lower bound (ZLB) into the analysis, concluding that the dynamic relationship between monetary policy and domestic variables operates

[1] Other approaches used to measure non-linear impacts of monetary policy include smooth transition VAR (STVAR) models (Ryuzo and Tatsuyoshi, 2017), threshold VAR (TVAR) models (Klingelhöfer and Sun, 2018; Allen and Robinson, 2015), and endogenous-switching nonlinear SVAR models (Zha and Chen, 2017).

through changes in medium-term interest rates rather than policy interest rates.

In Africa, Bittencourt et al. (2016) observed that, following financial reforms in the 1980s in Malawi, monetary transmission aligned more closely with theoretical expectations by the mid-2000s, aided by stable macroeconomic conditions and positive structural shifts.

In Peru, research has predominantly focused on standard VAR models and extensions with recursive and non-recursive identification assumptions; see, for instance, Quispe (2000) and Castillo et al. (2011). However, few studies have considered the potential for temporal changes in monetary policy transmission mechanisms.

In line with TVP-VAR-SV models, Castillo et al. (2016) seek to identify the causes of Peru's "Great Moderation," finding that monetary policy has been instrumental in reducing the volatility of macroeconomic variables. Specifically, during the high volatility period (1983-1994), monetary policy shocks were the key drivers of macroeconomic instability. Similarly, Portilla et al. (2022) explore the evolution of monetary policy using TVP-VAR-SV models with a mixture innovation approach. They find that monetary shocks accounted for a significant portion of the uncertainty in domestic variables prior to IT adoption, but their influence declined after 2002. Likewise, Pérez Rojo and Rodríguez (2023) examine the changing impact of monetary policy, highlighting the critical role of the BCRP in diminishing monetary policy-related uncertainty following IT adoption.[2]

In RS model applications, abrupt parameter changes are a key feature. For the US, Lo and Piger (2005) estimate an RS-VAR model to examine temporal shifts in the cyclical component of output in response to monetary policy actions. Their findings indicate a statistically significant change in the coefficients that describe output's reaction to monetary policy. Similarly, Sims and Zha (2006) explore a set of these models, concluding that the best fit was achieved with a model solely incorporating SV. Additionally, among other time-varying coefficient models, the most accurate involve variations only in the monetary policy rule. Chan and Eisenstat (2018) estimate three RS-VAR models, finding that the model including only SV was most favored, followed by a version where both VAR coefficients and disturbance variances varied across regimes.

In Europe, Hendricks and Kempa (2008) investigate the asymmetrical transmission of the European Central Bank's monetary policy, concluding that the credit channel was a primary source of heterogeneity. Their analysis shows that the timing and duration of regime shifts are more synchronized in France, Germany, and Italy, compared to the more diverse patterns in the Netherlands and the UK.

In Asia, Fujiwara (2006) seeks to confirm a structural break in Japan's monetary policy effectiveness due to the non-negativity constraint on nominal interest rates. The results support the existence of a structural shift when the *de facto* zero nominal interest rate policy resumed, leading to weakened policy efficacy, though some slight positive effects of monetary easing remained.

In Africa, Anguyo et al. (2020) analyze Uganda's monetary policy using two RS models, one incorporating only changes in the monetary policy rule parameters and another with both parameters and volatilities varying over time. Their findings suggest that regime shifts were predominantly driven by exogenous events rather than alterations in the monetary policy rule.

Lastly, for Peru, this study marks a contribution to empirical literature as the first to utilize RS-VAR-SV models in assessing the impact and evolution of monetary policy shocks and their influence on GDP growth, inflation, and the interest rate over time.

[2] In addition to the TVP-VAR-SV model approach, Rossini and Vega (2007) estimate a Quarterly Forecast Model (MPT) to assess changes in the monetary policy transmission mechanism, finding that the interest rate and expectations channels are more important in the post-IT period.

3 Methodology

3.1 Models

3.1.1 VAR Model with Constant Coefficients and Variances (CVAR)

For the purpose of comparison with RS-VAR-SV models, a VAR model with constant coefficients and variance (CVAR) is utilized. The CVAR model is described as follows:

$$\mathbf{B_0}\mathbf{y}_t = \boldsymbol{\mu} + \sum_{j=1}^{p} \mathbf{B}_j y_{t-j} + \epsilon_t, \tag{1}$$

where $\epsilon_t \sim \mathcal{N}(\mathbf{0}, \mathbf{\Sigma})$, $\mathbf{y}_t$ is a vector of n endogenous variables, μ is an $n \times 1$ vector of intercepts,$\mathbf{B}_j$ is an $n \times n$ matrix o structural VAR coefficients, $\mathbf{B_{0S_t}}$ is a lower triangular $n \times n$ matrix with ones on the main diagonal representing contemporaneous effects, and $\mathbf{\Sigma}$ is an $n \times n$ positive definite, diagonal variance matrix.

3.1.2 Regime-Switching VAR Model with Stochastic Volatility (RS-VAR-SV)

Following the notation of Chan and Eisenstat (2018) (see also Sims and Zha, 2006), the following RS-VAR-SV model is proposed, where $S_t \in \{1, \ldots, r\}$ represents the regime indicator in period t and r is the number of regimes:

$$\mathbf{B}_{0S_t}\mathbf{y}_t = \boldsymbol{\mu}_{S_t} + \sum_{j=1}^{p} \mathbf{B}_{j,S_t}\mathbf{y}_{t-j} + \epsilon_t, \tag{2}$$

where $\epsilon_t \sim \mathcal{N}(\mathbf{0}, \mathbf{\Sigma}_{S_t})$ for $j = 1, \ldots, r$ are regime-specific parameters, and S_t is assumed to follow a Markov process with transition probability $P(S_t = j|S_{t-1} = i) = p_{ij}$.

To compare the baseline RS-VAR-SV model with its restricted versions, equation (2) can be rewritten, differentiating the time-varying coefficients into two groups: β'_{S_t} and γ'_{S_t}. The first group consists of a $k_{\beta_{St}} \times 1$ vector of intercepts and coefficients associated with time-varying lagged variables: $\boldsymbol{\beta}_{S_t} = vec((\boldsymbol{\mu}_{S_t}, \mathbf{B}_{1_{S_t}}, \ldots, \mathbf{B}_{p_{S_t}})')$. The second group consists of a $k_{\gamma_{St}} \times 1$ vector of time-varying coefficients characterizing the contemporaneous relations between variables $\boldsymbol{\gamma}_{S_t} = (\gamma_{1_{S_t}}, \ldots, \gamma_{k_{S_t}})'$, representing the elements of $\mathbf{B}_{0_{S_t}}$ below the main diagonal. With these two groups of parameters defined, equation (2) can be rewritten as:

$$\mathbf{y}_t = \widetilde{\mathbf{X}_t}\boldsymbol{\beta}_{S_t} + \mathbf{W}_t\boldsymbol{\gamma}_{S_t} + \epsilon_t \tag{3}$$

where $\epsilon_t \sim \mathcal{N}(\mathbf{0}, \mathbf{\Sigma}_{S_t})$, $\widetilde{\mathbf{X}}_t = \mathbf{I}_n \otimes (\mathbf{1}, \mathbf{y}'_{t-1}, \ldots, \mathbf{y}'_{t-p})$, and $\mathbf{W}_t$ is a $k_{\gamma_{St}}$ matrix containing appropriate elements of $-\mathbf{y}_t$.[3]

The general model described in equation (3) can be represented in the following state-space form:

$$\mathbf{y}_t = \mathbf{X}_t\boldsymbol{\theta}_{S_t} + \epsilon_t, \tag{4}$$

where $\boldsymbol{\theta}_{S_t} = (\boldsymbol{\beta}'_{S_t}, \boldsymbol{\gamma}'_{S_t})$, $\mathbf{X}_t$ is an $n \times k_{S_t}$ matrix defined as $\mathbf{X}_t = (\widetilde{\mathbf{X}}_t, \mathbf{W}_t)$ and the initial conditions are $\boldsymbol{\theta}_0 \sim \mathcal{N}(\mathbf{a}_\theta, \mathbf{V}_\theta)$. Additionally, the elements of the diagonal matrix $\mathbf{\Sigma}_{S_t}$ are assumed to be

[3] For example, when $n = 3$, $\mathbf{W}_t$ has the following form:

$$\mathbf{W}_t = \begin{bmatrix} 0 & 0 & 0 \\ -y_{1t} & 0 & 0 \\ 0 & -y_{1t} & -y_{2t} \end{bmatrix}.$$

independently distributed as $\sigma^2_{i,S_t} \sim \mathcal{IG}(v_{i,S_t}, S_{i,S_t})$ for $i = 1, ..., n$, where $\mathcal{IG}$ represents the inverse Gamma distribution.

Finally, five restricted versions of the RS-VAR-SV model are defined: (i) RS-VAR-SV-R1, without variability in the $\boldsymbol{\theta}$ parameters but with SV; (ii) RS-VAR-R2, with changing $\boldsymbol{\theta}$ parameters but without SV; (iii) RS-VAR-SV-R3, where only the intercepts change and SV is admitted; (iv) RS-VAR-SV-R4, with variability only in $\boldsymbol{\beta}_{S_t}$ and SV; and (v) RS-VAR-SV-R5, with variability only in $\boldsymbol{\gamma}_{S_t}$ and SV.

3.2 Estimation Algorithm: Gibbs Sampling

We use the Gibbs sampling algorithm to estimate the posterior parameters. This method involves dividing the parameters into blocks and estimating each one separately, conditioned on the updates of the other blocks. We use the following notation: $\boldsymbol{\theta} = \left[\boldsymbol{\theta}_1', .., \boldsymbol{\theta}_j'\right]'$, $\boldsymbol{\Sigma} = \left[\boldsymbol{\Sigma}_1', ...\boldsymbol{\Sigma}_j'\right]'$ for $j =$ 1,...,r; $\mathbf{y} = \left[\mathbf{y}_1',...,\mathbf{y}_T'\right]'$, $\mathbf{S} = \left[\mathbf{S}_1', ..., \mathbf{S}_T'\right]'$ and $\mathbf{P}$ is the transition probability matrix. According to Sims et al. (2008), the posterior distribution $p(\boldsymbol{\theta}, \boldsymbol{\Sigma}, \mathbf{S}, \mathbf{P} \mid \mathbf{Y}_T)$ is obtained by sampling the following posterior distributions: (i) $p(\boldsymbol{\theta}|\boldsymbol{\Sigma}, \mathbf{S}, \mathbf{P}, \mathbf{y})$, (ii) $p(\mathbf{P}|\boldsymbol{\theta}, \boldsymbol{\Sigma}, \mathbf{S}, \mathbf{y})$, (iii) $p(\boldsymbol{\theta}|\mathbf{P}, \boldsymbol{\Sigma}, \mathbf{S}, \mathbf{y})$, and (iv) $p(\boldsymbol{\Sigma}|\boldsymbol{\theta}, \mathbf{P}, \mathbf{S}, \mathbf{y})$.

Before starting step 1, to accelerate the convergence of the algorithm, we begin with at least an approximate estimation of the peak of the posterior density as suggested by Sims and Zha (2006). To initialize the Markov Chain, we set $\mathbf{S}(0)$, so that it divides the sample into two symmetrical subsamples depending on the number of regimes. In such a subsample, we calculate $\boldsymbol{\theta}^{(0)}$ y $\boldsymbol{\Sigma}^{(0)}$ using OLS. Additionally, the value of the symmetric matrix $\mathbf{P}^{(0)}$ satisfies $p_{ij} = 0.8$ with $i = j$ and $p_{ij} = 1/(r-1)$ with $i \neq j$.

To implement step (i), we use the Gibbs Sampling algorithm following the method proposed in Kim and Nelson (1999), Sims et al. (2006, and Bianchi and Melosi (2017). The algorithm for calculating smoothed and filtered probabilities is: $\omega_{t|t} = \frac{\omega_{t|t-1} \odot \eta_t}{\mathbf{1}'(\omega_{t|t-1} \odot \eta_t)}$, $\omega_{t+1|t} = \mathbf{P}\omega_{t|t}$ where $\omega_{t|T}$ are the filtered probabilities,η_t is the jth element of the conditional density $p(\mathbf{y}_t|\mathbf{S}_t = j, \mathbf{y}_{t-1}; \mathbf{P}, \boldsymbol{\theta}_{S_t}, \boldsymbol{\Sigma}_{S_t})$, and the symbol $\odot$ denotes element-by-element multiplication. To start the recursive calculation, we assume that the transition probability is 1/3. In the case of smoothed probabilities $\omega_{t|T}$, we consider the following algorithm: $\omega_{t|T} = \omega_{t|t} \odot \left[\mathbf{P}'(\omega_{t+1|T} \ (\div) \ \omega_{t+1|t})\right]$, where $(\div)$ denotes element-by-element division.

To implement step (ii), the transition probabilities are independent of $\mathbf{y}$ and the other model parameters, and we use a Dirichlet distribution following Chib (1996). For each row, we have: $\mathrm{P}(i, :) \sim Dir(\alpha_0 + \xi_{ij})$, where ξ_{ij} denotes the number of transitions from state i to state j, and α_0 is the prior value for this distribution. The values for α_0 are defined in section 4.2.

To implement step (iii), we follow Chan and Eisenstat (2018): $(\boldsymbol{\theta}_j|\mathbf{P}, \boldsymbol{\Sigma}, \mathbf{S}, \mathbf{y}) \sim \mathcal{N}(\widehat{\boldsymbol{\theta}}_j, \mathbf{K}_{j\theta}^{-1})$, where the mean of the normal distribution is $\widehat{\boldsymbol{\theta}} = \mathbf{K}_\theta^{-1}(\mathbf{V}_\theta^{-1}\mathbf{a}_\theta + \mathbf{X}'\boldsymbol{\Sigma}^{-1}\mathbf{y})$ and the variance is $\mathbf{K}_\theta = \mathbf{V}_\theta^{-1} + \mathbf{X}'\boldsymbol{\Sigma}^{-1}\mathbf{X}$ for $j = 1, ..., r$. The values for $\mathbf{a}_\theta$ and $\mathbf{V}_\theta$ are defined in section 4.2.

Step (iv) is implemented using the conditional distribution of the elements of the diagonal of $\boldsymbol{\Sigma}_j$ for $j = 1, ..., r$: $(\sigma^2_{ij}|\mathbf{y}, \theta, \mathbf{S}, \mathbf{P}) \sim \mathcal{IG}(\upsilon_0 + \frac{T}{2}, \mathbf{S}_0 + \frac{1}{2}\sum_{t=1}^{T}(\mathbf{y}_{jt} - \mathbf{X}_{jt}\theta_j)^2$, where $\mathcal{IG}$ represents the inverse Gamma distribution. The values for υ_0 and $\mathbf{S}_0$ are provided in section 4.2. Finally, steps (i) to (iv) are repeated N times, where N is the sum of the burn-ins in the sample and the number of iterations.

3.3 Model Comparison Criteria

A typical measure for comparing Bayesian models is the Bayes factor (BF), which is equivalent to the ratio of the marginal likelihoods $p(\mathbf{y}|M_i)/p(\mathbf{y}|M_j)$, where the numerator represents the marginal likelihood of model i and the denominator that of model j.

To obtain a less computationally costly estimate of the marginal likelihood, Chan and Eisenstat (2015) developed a cross-entropy method based on Importance Sampling. The proposed estimator is based on integrated likelihood, i.e., the conditional density of the data marginal to all latent states, and is formulated as follows:

$$\widehat{p}_{IS}(\mathbf{y}) = \frac{1}{N}\sum_{n=1}^{N}\frac{p(\mathbf{y}|\boldsymbol{\theta}_n)p(\mathbf{y}|\boldsymbol{\theta})}{g(\mathbf{y}|\boldsymbol{\theta}_n)}, \tag{5}$$

where $\boldsymbol{\theta}_1,\ldots,\boldsymbol{\theta}_n$ are independent draws obtained from the importance density $g(.)$. The cross-entropy method is used to optimally choose $g(.)$ such that an importance density is selected, enabling an estimator with zero variance. If this importance density is denoted as g^* and the posterior density as $g^* = g(\boldsymbol{\theta}) = p(\boldsymbol{\theta}|\mathbf{y}) = p(\mathbf{y}|\boldsymbol{\theta})/p(\boldsymbol{\theta})$, we have:

$$\widehat{p}_{IS}(\mathbf{y}) = \frac{1}{N}\sum_{n=1}^{N}\frac{p(\mathbf{y}|\boldsymbol{\theta}_n)p(\mathbf{y}|\boldsymbol{\theta})}{g(\mathbf{y}|\boldsymbol{\theta}_n)} = \frac{1}{N}\sum_{n=1}^{N}\frac{p(\mathbf{y}|\boldsymbol{\theta}_n)p(\mathbf{y}|\boldsymbol{\theta})}{p(\mathbf{y}|\boldsymbol{\theta}_n)p(\boldsymbol{\theta}_n)/p(\mathbf{y})} = p(\mathbf{y}). \tag{6}$$

Thus, $g(.)$ is chosen such that it is sufficiently close to g^* to minimize the variance of the estimator. To find g, the cross-entropy distance is used to measure the distance between two densities. A parametric family $\mathcal{F} = \{f(\boldsymbol{\theta};\mathbf{v})\}$ subject to a vector of parameters $\mathbf{v}$ is proposed, from which the importance density $f(\boldsymbol{\theta};\mathbf{v}^*) \in \mathcal{F}$ that is closest to g^* is found. The goal is to find $\mathbf{v}^*_{ce}$ such that the distance between the optimal density and the chosen density $f(\boldsymbol{\theta};\mathbf{v})$ is minimized:

$$\mathbf{v}^*_{ce} = \arg\min\left(\int g^*(\boldsymbol{\theta})\log g^*(\boldsymbol{\theta})d\boldsymbol{\theta} - p(\mathbf{y})^{-1}\int p(\mathbf{y}|\boldsymbol{\theta})p(\boldsymbol{\theta})\log f(\boldsymbol{\theta};\mathbf{v})d\boldsymbol{\theta}\right), \tag{7}$$

which is equivalent to maximizing the second part of the previous equation and obtaining its estimator:

$$\mathbf{v}^*_{ce} = \arg\max\frac{1}{L}\sum_{l=1}^{L}\log f(\boldsymbol{\theta}_l;\mathbf{v}), \tag{8}$$

where $\boldsymbol{\theta}_1,\ldots,\boldsymbol{\theta}_L$ are draws obtained from the posterior density. The algorithm can be summarized as: (i) obtain draws $\boldsymbol{\theta}_1,\ldots,\boldsymbol{\theta}_L$ from the posterior density $g^*(\boldsymbol{\theta}) = p(\boldsymbol{\theta}|\mathbf{y}) \propto p(\mathbf{y}|\boldsymbol{\theta})p(\boldsymbol{\theta})$ and find a solution for (8); (ii) generate random sampling $\boldsymbol{\theta}_1,\ldots,\boldsymbol{\theta}_N$ from the density $f(.;\widehat{\mathbf{v}}^*_{ce})$ and estimate the marginal likelihood through the estimator proposed in (5).

4 Empirical Results

4.1 Data

The models were estimated using quarterly data spanning from 1994Q3 to 2019Q4, for five key economic indicators: terms-of-trade growth, real GDP growth, inflation, money growth, and the interest rate, all drawn from the BCRP website. The interest rate series was constructed as follows: until Q3 2003, it was the average of the interbank rate, shifting to the reference interest rate from Q4 2003 onward. Both GDP and money series were deflated using the Consumer Price Index (CPI) and then seasonally adjusted using the TRAMO-SEATS method developed by Gómez and Maravall (1996).

Figure 1 illustrates the evolution of the series, displaying levels (left panel) and annual growth rates (right panel). Variables in levels are expressed in logarithms, except for the interest rate, presented in percentage points. A general increasing trend is observed in output and the CPI throughout the analysis period. Money growth also exhibits an increasing trend, although it has stabilized since 2015. The interest rate behavior before IT adoption was notably volatile. High interest rates towards the end of the 2000s coincided with a financial stress period, marked by adverse impacts on capital flows from the Asian and Russian crises. After 2002, the interest rate stabilized, ranging between 1.25% and 6.5%. Terms of trade initially increased until 2007Q3, followed by a sharp decline associated with the Global Financial Crisis (GFC). After the crisis, there was a rapid rise in terms of trade until 2011Q2, driven by higher export prices and volumes. However, from 2011Q2 to 2015Q2, terms of trade gradually fell due to declining commodity prices. From 2015Q2 to 2019Q4, terms of trade remained relatively stable.

Inflation decreased from double digits to single digits by 1997, falling to a low of -0.1% by the end of 2001. In subsequent years, inflation generally stayed within the target band (1% to 3%). Post-IT, GDP growth declined, particularly between 2008 and 2009, which correlated with the GFC, followed by a recovery until 2011Q2. A gradual moderation was observed thereafter until 2015Q2, with GDP stabilizing in line with slower terms-of-trade growth.

4.2 Priors

To complete the models' specifications, the parameter's priors are detailed. Priors for θ_0 are Gaussian: $\theta_0 \sim \mathcal{N}(\mathbf{a}_\theta, \mathbf{V}_\theta)$ and error covariance matrices for state equations are assumed diagonal: $\mathbf{\Sigma}_j = diag(\sigma^2_{1j}, ..., \sigma^2_{nj})$ for $i = 1, ..., n;\ j = 1, ..., r$;where $\sigma^2_i \sim \mathcal{IG}(\upsilon_0, \mathbf{S}_0)$. The general RS-VAR model sets $\mathbf{a}_\theta = \mathbf{0}$, $\mathbf{V}_\theta = 10 \times \mathbf{I}_{k_\theta}$, and $\upsilon_0 = 5$, $\mathbf{S}_0 = (\upsilon_0 - 1) \times \mathbf{I}_n$. Priors for other models follow values in line with their constraints. Transition probabilities are modeled using a Dirichlet distribution dependent on $\alpha_0 = \mathbf{2} \times \mathbf{1}_r$.

4.3 Results

Two lags were considered for model estimation, selected based on the Akaike Information Criterion (AIC) and the Schwarz Information Criterion (SIC). The ordering of variables, from most exogenous to most endogenous, is as follows: terms-of-trade growth, real GDP growth, inflation, money growth, and the interest rate. The Importance Sampling density was built using 11,000 simulations, discarding the first 1,000, so the marginal log-likelihood estimation uses the 10,000 integrated likelihood evaluations.

4.3.1 Evidence of Parameter Evolution and Stochastic Volatility

To assess time variability in parameters, following Bijsterbosch and Falagiarda (2015) and using a TVP-VAR-SV model, three tests are conducted: the trace test, the Kolmogorov-Smirnov test, and the t-test. Table 1 reports the results of these tests applied to a set of time-varying coefficients and volatilities, where γ_t is the vector of coefficients characterizing contemporary relationships between variables, β_t is the vector of intercepts and coefficients associated with the lags, and $\mathbf{h}_t$ contains the variances of disturbances.

The trace test assesses whether the prior of the variance-covariance matrix associated with the parameter's law of motion is smaller than the posterior. According to Cogley and Sargent (2005), if the trace is below the percentiles, it suggests that the coefficients are subject to multiple shocks and do not remain constant over time. Table 1 shows that the trace of the prior variance matrix is 0.16, a smaller value than the 16th percentile (0.19), the 50th percentile (0.28), and the 84th percentile (0.43), implying the presence of a volatility matrix with temporal changes.

The Kolmogorov-Smirnov test compares whether each parameter, at two different points in time, comes from the same continuous distribution. The t-test examines if parameters come from two distributions with the same mean. Both tests compare parameters in two different periods, first between 1994Q3 and 2006Q4, then between 2007Q1 and 2019Q4. The tests indicate that volatilities and most coefficients associated with the intercepts, lags, and contemporary relationships vary over time. When repeating the exercise with the split date shifted to 2002Q1 (IT adoption) it yields similar findings, as few parameters remain constant over time. These tests suggest the existence of temporal changes in parameters, justifying the use of RS-VAR-SV models.

Table 2 presents the results of model estimations across different regimes ($r = 2, 3, 4$) and for the CVAR model. These results encompass the marginal log-likelihood (Log-ML), the standard deviation, and a performance ranking of the models. Firstly, the CVAR model is significantly outperformed by the RS-VAR-SV-R1 models for $r = 2, 3, 4$, with significant BFs supporting them: 2.61×10^{15}, 2.91×10^{12}, and 3.96×10^{9} for $r = 2, 3, 4$, respectively. These findings are in line with Sims and Zha (2006) and Chan and Eisenstat (2018), highlighting that the key to improved model fit lies in integrating SV into the estimation rather than focusing on the temporal variability of coefficients.

Secondly, the RS-VAR-SV-R1 model with $r = 2$ best fits the data, suggesting that a two-state representation most accurately captures the economy's dynamics. This is backed by the BFs derived from contrasting the RS-VAR-SV-R1 models with $r = 3, 4$ against the RS-VAR-SV-R1 model with $r = 2$: 1.11×10^{-3} and 1.52×10^{-6}, respectively. Thirdly, the RS-VAR-SV-R3 model with $r = 2$ not only outperforms the CVAR model (BF of 2.00×10^{3}) but also shows a better fit compared to other RS-VAR-SV versions. Therefore, among SV models, including only temporal variation in intercepts provides a better fit than considering variations in other parameter groups; see Chan and Eisenstat (2018), Pérez Rojo and Rodríguez (2023) and Rodríguez et al. (2024).

Fourthly, in comparing the CVAR model with the RS-VAR-SV, RS-VAR-R2, RS-VAR-SV-R4, and RS-VAR-SV-R5 models, the analysis shows a preference for the CVAR model. The BFs for the RS-VAR-SV, RS-VAR-R2, RS-VAR-SV-R4, and RS-VAR-SV-R5 models with $r = 2$ compared to the CVAR model are 2.60×10^{-22}, 7.84×10^{-23}, 1.31×10^{-28}, and 2.49×10^{-5}, respectively. This suggests that SV models incorporating variation in specific parameter groups and models that consider only changes in the coefficients without including SV have a less accurate fit.

Figure 2 shows the evolution of transition probabilities for the first and second regimes.[4] The best-fitting models identify the economy as being in the initial state from 1994Q3 to 2001Q3, transitioning to the second state from 2001Q4 to 2019Q4. This change coincides with the implementation of IT, marked by the interest rate and inflation as key variables.

The average duration of the first regime is 5 quarters, whereas the second regime averages 44 quarters, indicating greater persistence in the latter. According to the RS-VAR-SV-R1 model, $p_{11} = 0.838$ y $p_{12} = 0.162$, while $p_{21} = 0.023$ and $p_{22} = 0.978$, suggesting that once the economy enters the second regime, it is unlikely to revert to the first.

There is also a shift in the correlation coefficient between money growth and inflation, changing from 0.6 in the first regime to -0.1 in the second. This aligns with Castillo et al. (2007) and BCRP (2008), who observe a significant decrease in the correlation between monetary aggregates

[4] Graphs were also made for the transition probabilities considering more regimes. However, in general the presence of two distinct regimes is observed throughout the sample, as the probabilities associated with more regimes do not exceed 0.5 and remain close to zero. For this reason, the remaining analysis is carried out considering only two regimes ($r = 2$).

and inflation post-IT, sometimes even turning negative for certain frequencies and variables. This diminished correlation post-2002 does not imply that monetary policy is less effective in controlling inflation, but rather the opposite. IT implementation has redirected monetary policy towards interest rate control and anchoring inflation expectations, reducing the role of monetary aggregates in determining inflation. The lower correlation post-2002 reflects increased confidence in the BCRP's ability to achieve its inflation target.

Table 3 presents the volatilities for the second state in models containing SV, using the first state as a reference with standard deviations normalized to 1. The volatility of terms-of-trade growth is higher in the second regime, ranging between 10% and 60% more depending on the model. In contrast, volatilities significantly decrease in the second state, with minimum and maximum volatilities ranging from 29.9% to 41.4% for GDP growth, 8.3% to 33.5% for inflation, and 22.8% to 48.6% for money growth depending on the model. Moreover, a notable reduction in interest rate variability of more than 82% is observed post-2002. The lower volatility of these key domestic variables is evidence of Peru's "Great Moderation," a period marked by declining volatilities since the early 2000s and relative stability over the past decade; see Castillo et al. (2016).

In the RS-VAR-SV-R1 model, the volatility of GDP growth and inflation in the second regime is 1.67% and 0.56%, compared to 2.65% and 0.75% in the CVAR model, respectively, indicating that the latter underestimates the volatility reduction in both variables. Conversely, the volatility of terms of trade and interest rates under the second regime in the RS-VAR-SV-R1 model is 24.69% and 7.85%, against 25.19% and 3.28% in the CVAR model, suggesting that the latter overestimates the volatility reduction in both variables.

These findings are consistent with Castillo et al. (2007), who reported significant volatility reductions in nominal variables following changes in monetary policy targets. Achieving low and stable inflation, monetary policy creates a conducive environment for economic activity, minimizing nominal distortions and removing a source of uncertainty for investment decisions. In this context, the monetary authority gains greater flexibility to respond to unforeseen events, such as financial crises; see Castillo et al. (2016). IT adoption has thus solidified the benefits of monetary stability and enhanced inflation control effectiveness, even amid volatile external conditions seen after the GFC (Castillo et al., 2015).

It is important to note that the remaining analysis (Figures 3-6) excludes the RS–VAR-SV, RS-VAR-R2, RS-VAR-SV-R4, and RS-VAR-SV-R5 models due to their poor performance compared to the CVAR model as per the log-ML criterion.[5] Hence, the focus will be on the RS-VAR-SV-R1 and RS-VAR-SV-R3 models, the best-fitting models that more aptly capture temporal changes in monetary policy transmission mechanisms, along with the CVAR model for comparative purposes.

4.3.2 Impulse-Response Functions (IRFs)

Figure 3 shows the impulse-response functions (IRFs) for GDP growth and inflation in response to a contractionary monetary policy (MP) shock and a contractionary monetary aggregate (MG) shock, represented by a 100 basis-point increase in the interest rate and a 1% decrease in money growth, respectively. The blue line represents the median response of the RS-VAR-SV-R1 ($r = 2$) and RS-VAR-SV-R3 ($r = 2$) models, while the red line corresponds to the CVAR model. The gray area indicates the 16% and 84% confidence bands for the previously discussed RS-VAR-SV models.

Theoretically, an MP shock negatively impacts GDP growth. Particularly under IT, the GDP response to MP shocks is more pronounced; see Ball and Sheridan (2004) and Brito and Bystedt (2010). This pattern is observed in models allowing changes in contemporaneous and lag-associated

[5] Figures for the IRFs, FEVDs, and HDs of these models are available upon request.

coefficients, a finding also reported by Lange (2016). However, in the RS-VAR-SV-R1 and RS-VAR-SV-R3 models, which include SV and changes in the intercept, the GDP response is uniform across both regimes. In this context, the GDP growth response under IT does not differ significantly from a monetary aggregates control scheme; see, for instance, Angeriz and Arestis (2006), Batini and Laxton (2007) and Mishkin and Schmidt-Hebbel (2007).

In the RS-VAR-SV-R1 model, the effect of this shock becomes non-significant after ten quarters in both regimes, causing a maximum contraction of -0.3% between the 4th and 5th quarters. This finding aligns with the research of Portilla et al. (2022), who report a similar timing for the maximum fall in GDP growth. Meanwhile, the contraction in the median GDP growth in the CVAR model mirrors that of the RS-VAR-SV-R1 model until the 8th quarter. In the case of the RS-VAR-SV-R3 model, the fall in GDP growth in response to the MP shock is non-significant in both regimes.

Regarding the response of inflation to an MP shock, the RS-VAR-SV-R1 model exhibits a *price puzzle* in the initial periods under both regimes, meaning an unexpected interest rate hike initially increases inflation. However, this *price puzzle* is minor and lasts only three quarters.[6] Additionally, this model shows a reduction in inflation starting from the 5th quarter, as the IRFs drop below zero, although this response is not significant. Furthermore, IRFs reach a maximum fall of about -0.15% in the 6th quarter. Portilla et al. (2022) also find a long-term effect on inflation, with maximum contraction occurring between the 8th and 10th quarters. Similarly, studies by Castillo et al. (2011), Lahura (2012), and Winkelried (2004) find that following a contractionary MP shock, price levels initially increase and decrease in the long term with some lag, possibly due to nominal rigidities. Castillo et al. (2011) also report that the negative impact of an MP shock on economic activity occurs sooner than on prices. Additionally, Pérez Forero (2015) estimates a hierarchical panel VAR to compare the effects of monetary shocks in Latin American countries, finding a short-term effect of these shocks on output, while prices respond in the medium term. In the RS-VAR-SV-R3 model, the *price puzzle* is significant for four quarters, and thereafter the response becomes non-significant in both regimes.

In the RS-VAR-SV-R1 and CVAR models, MG shocks similarly cause a decline in inflation and GDP growth. This negative reaction in GDP growth is significant across both states, dissipating after seven quarters. The maximum impact, near -0.2%, is slightly more pronounced in the second state and occurs between the 1st and 4th quarters, while the CVAR model tends to underestimate this decline in GDP growth for both states. In terms of inflation, the most significant contraction is about -0.1%, observed between the 4th and 5th quarters. Quispe (2000) also identifies a significant impact of monetary base shocks on inflation, peaking after two to four quarters. In the RS-VAR-SV-R3 model, an MG shock causes a similar peak in GDP growth contraction as in the RS-VAR-SV-R1 model. However, this contraction is more prolonged, lasting close to one year in both regimes, suggesting the RS-VAR-SV-R3 model overestimates the GDP growth decline following an MG shock. Regarding inflation, the IRF in response to a shock is similar in magnitude and duration as in the RS-VAR-SV-R1 model in both regimes.

Figure 4 presents the IRFs for the interest rate in response to a positive external shock, a positive aggregate demand (AD) shock, and a negative aggregate supply (AS) shock for the RS-VAR-SV-R1 (r = 2), RS-VAR-SV-R3 (r = 2), and CVAR models. Initially, a positive external shock, represented by an increase in terms-of-trade growth, impacts the interest rate ambiguously

[6] To address the *price puzzle*, strategies suggested by the literature were adopted, such as including a measure of commodity prices in the estimation to capture unobservable elements in central banks' assessment of inflation expectations (Sims, 1992) and incorporating monetary aggregate variables (Bernanke et al., 2005). While these strategies contribute to reducing the *price puzzle*, they do not eliminate it entirely. These results are available upon request.

due to a dual effect; see Winkelried (2013). On one hand, higher terms of trade lead to an increase in demand, inflation, and consequently the interest rate. On the other hand, improved terms of trade result in an increased dollar supply, leading to a contraction of the nominal exchange rate. This, in turn, causes a decrease in domestic inflation, which subsequently results in a reduction of the interest rate.

The results indicate a dominance of the first effect, as in the RS-VAR-SV-R1 and RS-VAR-SV-R3 models the response is positive and significant between the 6th and 12th quarters, peaking between 0.05% and 0.08%. BCRP (2018) reports that terms-of-trade shocks in Peru significantly increase GDP, investment, and consumption growth. Conversely, while the CVAR model's median IRF is positive from the 6th quarter onward, its initial response is negative, suggesting the second effect prevails in the early quarters, resulting in the CVAR model initially suggesting an incorrect direction for the interest rate response.

Secondly, a positive AD shock creating inflationary pressures predictably leads to an increase in the interest rate. In the RS-VAR-SV-R1 and RS-VAR-SV-R3 models, this effect is significant under both regimes, peaking at around 0.2% in the 5th quarter and becoming non-significant after the 8th quarter. However, the CVAR model underperforms, showing an uneven pattern, with the median IRFs decreasing in the early quarters, contrary to theoretical expectations. This underscores the importance of incorporating SV in estimations. After the third quarter, the CVAR model's response becomes positive, aligning with the other models.[7]

Thirdly, a negative AS shock leads to an increase in inflation, which in turn prompts a significant rise in the interest rate in both regimes, as evidenced in the RS-VAR-SV-R1 and RS-VAR-SV-R3 models. These models also reveal that the peak interest rate response is higher in the second regime (around 0.5%) compared to the first (approximately 0.4%), with this maximum effect occurring between the second and third quarters. Meanwhile, although the CVAR model's response aligns with the expected direction, it overestimates the magnitude of this effect, underscoring its limited performance. The interest rate's reaction to AS shocks suggests a trend towards more assertive responses. This observation aligns with the BCRP's mandate to maintain monetary stability and keep inflation within its target band; see BCRP (2021) and Portilla et al. (2022).

4.3.3 Forecast Error Variance Decomposition (FEVD)

Figure 5 displays the results of the forecast error variance decomposition (FEVD) for GDP growth, inflation, money growth, and the interest rate in response to MP, MG, AD, AS, and external shocks for the RS-VAR-SV-R1 ($r = 2$), RS-VAR-SV-R3 ($r = 2$) and CVAR models across three horizons: short (2 quarters), medium (8 quarters), and long term (20 quarters).

In the RS-VAR-SV-R1 and RS-VAR-SV-R3 models, the FEVD for GDP growth in the first regime is primarily explained by AD shocks, at nearly 80% in the short term and over 30% in the medium and long term (column 1, rows 1 and 3). In the second regime, the FEVD is largely influenced by external shocks, with AD shocks also playing a significant role (column 1, rows 2 and 4). The impact of external shocks is notably higher in the second regime, accounting for between 40% and 60% in the long term, compared to approximately 5% across all horizons in the first state. In contrast, the impact of MP shocks is minimal or non-existent for both models in the second regime. The CVAR model indicates a contribution of MP shocks between 5% and 10% across the short- and long-term horizons, implying an overestimation of MP shocks and an underestimation of external shocks in the second regime.

[7] The response of the interest rate to AD shocks is found in Gerlach and Smets (1995), Plante (2014), and Rodríguez et al. (2024).

Regarding the FEVD for inflation in the first regime, AS shocks account for between 50% and 80% across all horizons. The contribution of MP shocks is limited, increasing from 5% in the short run to 15% in the long run. In the second state (column 2, rows 2 and 4), AS shocks contribute nearly 45% across all horizons, with negligible MP shock involvement. These findings are consistent with Armas and Grippa (2008) and Portilla et al. (2022), who conclude that post-IT adoption, inflation fluctuations have been primarily driven by supply shocks. The CVAR model shows almost no contribution from MP shocks in the FEVD for inflation (column 2, row 5).

The FEVD for the interest rate is predominantly influenced by MP shocks under the first regime (column 4, rows 1 and 3) in both the RS-VAR-SV-R1 and RS-VAR-SV-R3 models, contributing over 90% and 85%, respectively, in the medium and long term. However, in the second regime, the relevance of MP shocks significantly drops to less than 20% in the medium and long term (column 4, rows 2 and 4). The CVAR model, on the other hand, indicates that MP shocks contribute nearly 50% to the interest rate FEVD in the medium and long term (column 4, row 5), indicating an overestimation of MP shocks in the second regime. The importance of other shocks (AD, AS, MG, and external) is minimal in the first regime, collectively contributing less than 5% and 10% in the medium and long term in the RS-VAR-SV-R1 and RS-VAR-SV-R3 models, respectively (column 4, rows 1 and 3). However, their importance increases in the second regime, collectively contributing 60% in the short term and 90% in the long term for both models. Particularly in these models, the significance of external shocks is markedly higher in the second regime.

Similar outcomes observed in countries like Canada and Indonesia indicate that with the adoption of the interest rate as a policy tool, the contribution of MP shocks to the FEVDs for GDP growth, inflation, and the interest rate has significantly diminished; see Aleem and Lahiani (2014) and Lange (2016).

In summary, before IT adoption, MP shocks explained a significant percentage of the (FEVD for key domestic variables. However, after the shift in the operational target, the contribution of MP shocks to the volatility of these variables drastically decreased, while the influence of external shocks generally increased post-2003. These findings align with research by Rossini and Vega (2007), Armas and Grippa (2008), and Portilla et al. (2022), suggesting that the transition to IT contributed to a sustained reduction in interest rate volatility.

The shift towards a regime where the interest rate became the operational target enhanced the BCRP's credibility in maintaining inflation within the target band and contributed to reducing interest rate variability, making monetary policy more predictable. Consequently, its movements could be internalized in the decision-making processes of market participants, reducing the impact of MP shocks on the volatility of major domestic variables and suggesting that monetary policy ceased to be a source of uncertainty for economic activity. Moreover, the increased relevance of external shocks in determining the volatility of domestic variables after IT adoption can be attributed to the economy's greater trade and financial openness; see, for instance, Mendoza (2013), Castillo et al. (2007), Rodríguez et al. (2018), Rodríguez et al. (2023) and Rodríguez et al. (2024).[8]

Lastly, it is worth noting that the RS-VAR-SV-R3 and RS-VAR-SV-R1 models offer an advantage over the CVAR model in analyzing the FEVD of domestic variables, as they capture changes in the contribution of MP shocks before and after IT adoption. Since the CVAR model does not capture this change, it underestimates the contribution of MP shocks in the first regime and overestimates it in the second.

[8] A similar composition of the FEVDs of GDP growth and inflation in the US and the Eurozone is found in Sousa and Zaghini (2008) and Lodge and Manu (2022).

4.3.4 Historical Decomposition (HD)

Figure 6 presents the historical decomposition (HD) results for GDP growth, inflation, and the interest rate in the RS-VAR-SV-R1 ($r = 2$), RS-VAR-SV-R3 ($r = 2$), and CVAR models.

Regarding the HD of GDP growth in the RS-VAR-SV-R1 model, the contribution of MP shocks has evolved over time, playing a significant role until 2002 and drastically diminishing thereafter, a finding also noted by Portilla et al. (2022). Pre-IT (1994Q3-2001Q4), MP shocks contributed negatively by -76.74% to growth, equivalent to a loss of about 2.80 percentage points. This implies that instead of an average growth rate of 3.65% during this period, GDP growth could have reached around 6.5% without the strong negative influence of MP shocks under the former monetary policy framework. In contrast, during the post-IT period (2002Q1-2019Q4), the observed growth rate was 5.12%, with MP shocks contributing negatively by -3.07%, equivalent to a loss of just 0.16 percentage points.

These results evidence a reduction in the negative impact of MP shocks on real economic activity following IT implementation. Moreover, in the RS-VAR-SV-R1 model, MP shocks contributed positively between 2004 and 2012 by 1.30%, translating to a gain of approximately 0.06 percentage points in growth. This aligns with Portilla et al. (2022), who find a positive contribution of MP shocks throughout the post-IT period. The RS-VAR-SV-R3 and CVAR models underestimate MP shock participation in the early years, while the CVAR model overestimates their contribution post-2002.

In the RS-VAR-SV-R1, RS-VAR-SV-R3, and CVAR models, AS shocks generally have a small impact on the HD for GDP growth, whereas AD shocks are present throughout the analysis horizon. In the two better-performing models (RS-VAR-SV-R1 and RS-VAR-SV-R3), AD shocks generally contribute negatively pre-2002, except in 1997, a year of high economic growth. Negative contributions of AD shocks between 2000 and 2001 can be attributed to domestic political tensions.

Furthermore, in these models, the participation of external shocks in the HD for GDP growth increases, particularly post-2002, as also noted by Jiménez et al. (2023) and Rodríguez et al. (2024). In the RS-VAR-SV-R1 model, external shocks contribute positively between 2002 and 2006, amid a global economic boom and consistent with Peru's reliance on external demand. They then negatively contribute in 2009 due to the GFC, and return to positive values in 2010-2012, associated with global economic recovery, especially in China. These findings suggest that, in recent years, fluctuations in Peruvian economic activity are mostly explained by demand and terms-of-trade shocks, unlike in developed economies; see Castillo et al. (2007).

The HD for inflation in the RS-VAR-SV-R1 and RS-VAR-SV-R3 models is primarily determined by AS shocks in both regimes. Meanwhile, MP shocks play a notable role pre-IT, while in the second regime, their contribution is near zero due to greater monetary stability. The CVAR model slightly overestimates MP shock participation in inflation under the second regime. However, in all three models AD and external shocks play a significant role throughout the entire period of analysis. This suggests a shift in the inflationary process: while the diminishing importance of MP shocks on inflation began in the 1990s, IT adoption has stabilized domestic components affecting inflation, making its variability mostly explained by supply and external shocks; see Gillitzer and Simon (2015). A similar result, with greater participation of external shocks, is also found in the FEVD for GDP growth and inflation in IT emerging Asian economies, like Indonesia, Korea, and Singapore; see Finck and Tillmann (2022).

Moreover, the HD for the interest rate up until 2002 in the RS-VAR-SV-R1 and RS-VAR-SV-R3 models is primarily explained by MP shocks. After IT implementation, the volatility of the interest rate, as well as the contribution of MP shocks to its HD, notably decreases, while the importance of other shocks increases, a result underscored by Pérez Rojo and Rodríguez (2023) and Portilla et al. (2022). However, the CVAR model shows that while the contribution of MP shocks declines post-2002, it remains relevant beyond this date, suggesting that using this model could lead to inaccuracies

Finally, AD shocks account for about 50% of the HD for the interest rate across the entire analysis period. Before the 2000s, AS shocks generally had a positive effect in all models, but this impact becomes predominantly negative in the following years. External shocks, initially minimal in the pre-IT period, gain greater relevance thereafter, with a positive contribution from 2005 to 2010 in all three models.

The evidence indicates that MP shocks played a crucial role in shaping the HD of key domestic variables during the pre-IT period. Their influence diminishes following IT implementation, which suggests effective management by the monetary authority. Specifically, the inflation stabilization policy through IT and the use of a Taylor rule for interest rate adjustments have proven beneficial. These strategies have enhanced the BCRP's credibility in keeping inflation within target. Similar trends are observed in Colombia, where post-IT adoption in 1999Q3, MP shocks saw a reduced impact in the HDs for GDP growth, inflation, and the interest rate; see Cadavid (2018).

5 Extending the Sample to Include the COVID-19 Pandemic

This section presents an analysis that extends the sample up to 2023Q2, thereby including the COVID-19 period. Table 6 displays the estimates of models across different regimes ($r = 2, 3, 4$) and the CVAR model, including Log-ML, standard deviation, and model rankings. A notable difference from the results in Table 2 is that the RS-VAR-SV-R1 model with $r = 3$ emerges as the most suitable, followed by the same model with $r = 2$. This suggests that the Peruvian economy during the post-COVID-19 period is better represented with a three-regime model. The subsequent analysis is centered on the RS-VAR-SV-R1 and RS-VAR-SV-R3 models, which demonstrate a relatively better fit and aptly capture changes during the post-COVID-19 period.

Figure 7 indicates that the economy was in a first regime until 2021Q3, transitioning to a second regime in subsequent quarters, and entering a third regime between 2020Q1 and 2021Q3, coinciding with the pandemic. The suspension of non-essential activities in 2020 led to an 11% decrease in GDP. In response, the BCRP initiated unprecedented monetary and financial measures from March 2020 to support financial markets in a deeply contracting economy. These measures aimed to reduce financing costs, supply liquidity to the financial system, and stabilize long-term interest rates and the exchange rate. In line with an expansive monetary policy, the BCRP significantly lowered its reference interest rate, maintaining it at a historic low of 0.25% for 16 months starting in April 2020, and began a gradual increase in July 2021. GDP that year experienced a "statistical rebound" of 13.3%, driven by the relaxation of sanitary restrictions and the vaccination rollout. Meanwhile, money (in real terms) expanded at double-digit rates from 2020Q1 to 2021Q3 due to precautionary demand during the pandemic, later moderating to negative rates.

The results suggest that post 2021Q4, the economy returned to the second regime, characterized by relative macroeconomic stability initiated with IT implementation. This return is supported by the normalization of growth rates of key macroeconomic variables after the pandemic-induced shocks. The economy's momentum waned in the second half of 2021 due to a lower statistical effect, and from 2021Q4, economic growth continued to decelerate, with GDP growing at single-digit rates.

Table 7 presents the volatilities of the second and third regimes for the RS-VAR-SV-R1 model, normalized relative to the first regime. The results show continued reduced volatility of domestic variables in the second regime. Notably, in the third regime, the volatility of GDP growth is 30 times that of the first state, reflecting the significant fall and subsequent rebound during the pandemic. Additionally, the interest rate volatility in the third regime is slightly higher than in the second, likely due to the BCRP's drastic rate reductions (up to 100 basis points in two consecutive months) to counter the negative impacts during the COVID-19 period.

Figures 8 and 9 show the IRFs of GDP growth and inflation to MP and MG shocks, represented by a 1% increase in the interest rate and money growth, respectively, for the RS-VAR-SV-R1 and RS-VAR-SV-R3 models. Generally, these findings align closely with the pre-pandemic estimation results.

Figures 10 and 11 illustrate the IRFs of the interest rate to AD, AS, and external shocks, represented by a 1% increase in GDP growth, inflation, and the terms of trade growth, respectively. Although the response is not statistically significant, the median of the IRFs for both models suggests a notably higher interest rate response to an AD shock in the third regime. This reflects the BCRP's intensified focus on addressing AD shocks, as observed during the COVID-19 crisis. Conversely, in the third regime, the interest rate reaction to an AS shock is similar to other regimes, attributable to the BCRP's policy of not reacting to shocks that induce inflation increases unless they influence inflation expectations, like during the pandemic.

Figures 12 and 13 present the FEVD of GDP growth, inflation, money growth, and the interest rate. Notably, in the third regime, the FEVD of these variables is predominantly explained by output shocks, indicating that significant output reductions during the pandemic contributed to the FEVD of the main domestic variables.

Figure 14 shows that in the quarters covering the COVID-19 pandemic, the HD of GDP growth is substantially explained by AD shocks. Additionally, there is a greater contribution of these shocks to the HD of inflation and the interest rate than in scenarios where the estimation sample only considers pre-pandemic quarters.

6 Robustness Analysis

This section outlines the results of six robustness exercises: (i) employing more diffuse priors; (ii) replacing total GDP with non-primary GDP and total inflation with core inflation; (iii) altering the ordering of inflation and money growth and the ordering of money growth and the interest rate; (iv) using a four-variable model excluding money growth and a six-variable model including exchange rate growth; (v) replacing growth of the terms of trade with growth of the S&P500 index and another replacing it with export price index growth; and (vi) estimating the models considering three and four regimes instead of two. The figures for these exercises are available in an appendix upon request. Table 4 displays the log-ML, and Table 5 shows the volatilities (normalized to the first regime) of the variables for the first five exercises.[9]

6.1 Change in Priors

We consider more diffuse priors in relation to Chan and Eisenstat (2018) to assess the sensitivity of the results. Following Lakdawala (2015), we changed the value of hyperparameter $V_\theta = 10 \times I_{k_\theta}$ to $V_\theta = 10^4 \times I_{k_\theta}$. Table 4 indicates that the models with the highest log-ML are RS-VAR-SV-R1 ($r = 2$) and RS-VAR-SV-R3 ($r = 2$), respectively. The BFs of the RS-VAR-SV-R1 and RS-VAR-SV-R3 models relative to the CVAR model are 1.05×10^{15} and 1.92×10^9, respectively, confirming that allowing for SV and/or changes in the intercept significantly improves the model fit. Conversely, the fit of the other models worsens, suggesting that the data do not favor the inclusion of changing coefficients.

[9] A robustness exercise was also conducted that changed the number of regimes from $r = 2$ to $r = 3$ and $r = 4$. The results uphold the findings of the main model and are available upon request.

Table 5 shows a reduction in the volatility of shocks to domestic variables, especially the interest rate. The response of GDP growth and inflation to MP and MG shocks in both regimes closely aligns with the baseline model. The interest rate shows a 0.25% increase in response to AD shocks and a 0.45% increase to AS shocks in the third quarter. In the case of external shocks, while the initial response of the interest rate is non-significant, it becomes progressively positive, increasing, and significant from the 5th quarter onward. This indicates an increasingly aggressive response by the BCRP to external shocks over time. For the CVAR model, the interest rate's response to AS shocks is nearly 1%, suggesting a significant overreaction by the BCRP to these shocks.

From the FEVD analysis, we find that the contribution of MP shocks to the FEVDs for GDP growth, inflation, and the interest rate are similar to the main model: 30%, 10%, and 95% respectively in the first regime and negligible in the second. The CVAR model's FEVDs for GDP growth, the monetary aggregate, and the interest rate shows that it underestimates MP shocks in relation to the first regime and overestimates them in relation to the second.

The HD of GDP growth reveals an increase from 3.54% pre-IT to 4.95% post-IT. The impact of MP shocks is -83.70% in the first state and -3.74% in the second. These findings are consistent with the baseline scenario, indicating a reduction in the negative impact of MP shocks on GDP growth following IT implementation.

6.2 Change in Domestic Variables

The second robustness exercise involves estimating two different specifications that modify the domestic variables. In the first specification, total GDP is replaced with non-primary GDP, and in the second, total inflation is substituted with core inflation. Mendoza and Collantes Goicochea (2017) argue that in Peru, aggregate GDP is heavily influenced by mining projects. Thus, considering non-primary GDP, which includes construction, commerce, and non-primary industry, provides a clearer picture of GDP growth. Similarly, they contend that core inflation, which excludes transitory shocks, is a better indicator of the percentage change in prices.

Table 4 shows that the RS-VAR-SV-R1 and RS-VAR-SV-R3 models have BFs of 1.58×10^{17} and 5.45×10^{2} respectively, in comparison to the CVAR model, with the RS-VAR-SV-R1 model continuing to be the best fit followed by the RS-VAR-SV-R3 model. The reduction in the volatilities of domestic variables, particularly the interest rate, indicates that MP shocks are no longer a significant source of macroeconomic volatility in Peru since IT adoption.

The IRFs suggest that when GDP is replaced with non-primary GDP, the response of GDP growth to MP shocks is 0.4% in the third quarter. The response of the interest rate to AD, AS, and external shocks shows the expected and significant direction, although the confidence bands are broader compared to the baseline model.

The analysis of the FEVDs indicates that MP shocks contribute 40% to the variability of GDP growth in the first regime, while in the second regime, their contribution is non-existent. Compared to the baseline model, the contribution of MP shocks to the FEVD of GDP growth is higher by 10% in both regimes. For inflation, the FEVD shows a contribution of MP shocks close to 12% in the first regime, which is 3% less than in the main scenario, while in the second regime, their contribution is nil. In the case of the CVAR model, the contribution of MP shocks is close to 10%. The FEVD of GDP growth, inflation, and the interest rate are similar to those in the main scenario.

The HD of GDP growth shows an increase from 3.10% in the first regime to 5.16% in the second. During the pre-IT period, the contribution of MP shocks to GDP growth was -106.84%, while post-IT, it was -3.07%. These results also demonstrate a reduction in the negative impact of MP shocks on GDP growth in the second regime. This finding aligns with Winkelried (2013), who shows that MP shocks have a minimal contribution (between -2% and +2%) to the output gap between 2002 and 2013.

Regarding the specification that replaces total inflation with core inflation, Table 4 indicates that the RS-VAR-SV-R1 model has the highest log-ML, with a BF of 2.87×10^{18} compared to the CVAR model. The RS-VAR-SV-R3 model follows closely with a BF of 2.68×10^{5} in comparison to the CVAR model, suggesting that these models remain the best fit for the data.

Table 5 shows that the RS-VAR-SV-R1 and RS-VAR-SV-R3 models present a reduction in the volatility of domestic variables in the second regime. From the IRFs, the response of GDP growth to MP shocks is of similar magnitude as that in the baseline model in both regimes (-0.3%). Additionally, the inclusion of core inflation instead of total inflation eliminates the *price puzzle*. The interest rate's response to AD shocks is similar to the primary specification. However, the response to AS shocks is abrupt and of greater magnitude (0.6%) compared to the baseline model (0.35%), peaking in the third quarter. Thus, the BCRP's response to AS shocks has become more effective following the implementation of a countercyclical policy and anchoring inflation expectations. The interest rate remains unchanged in response to external shocks in this exercise. This is consistent with findings in Winkelried (2013), which show that the BCRP does not respond to temporary terms-of-trade shocks.

The HD of GDP growth indicates that this variable's growth increased from 4.12% pre-IT to 5.27% post-IT. The contribution of MP shocks was -48.26% in the first regime and -0.91% in the second regime. These results demonstrate a reduction in the negative impact of MP shocks on GDP growth post-IT implementation.

6.3 Change in Ordering

As the third robustness exercise, we first present the results of the specification that changes the ordering of money growth and inflation. Mishkin and Savastano (2002) argue that the relationship between the monetary aggregate and inflation is often unstable, making the use of this variable as a policy instrument problematic. Therefore, in the first specification, we make the monetary aggregate more exogenous by swapping its order with inflation. The RS-VAR-SV-R1 and RS-VAR-SV-R3 models show BFs of 2.14×10^{15} and 8.10×10^{3}, respectively, compared to the CVAR model.

The IRFs for GDP growth in both regimes, in response to MP and MG shocks, maintain the contractive behavior of the main specification. The interest rate's response to AD shocks reaches a maximum of 0.3% in the second quarter, gradually decreasing thereafter. In contrast, the response to AS shocks shows a maximum increase of 0.06% in the interest rate, less than the 0.34% increase observed in the baseline specification pre-IT. However, in the second regime, the interest rate's response to AS shocks is non-significant. This specification indicates a greater response by the BCRP to AD shocks compared to AS shocks in the first regime, contrary to the baseline specification where the BCRP responds more aggressively to AS shocks. Both the FEVDs and HDs show a similar contribution of MP shocks as in the main specification.

Secondly, a specification changing the ordering of money growth and the interest rate is estimated. The RS-VAR-SV-R1 and RS-VAR-SV-R3 models show BFs of 5.27×10^{15} and 1.47×10^{6}, respectively, compared to the CVAR model. Table 5 indicates a reduction in the volatility of domestic variables in the second regime, suggesting that using the interest rate as a policy instrument leads to a reduction in macroeconomic risk.

In terms of the IRFs, there is a slight reduction in the GDP growth rate in response to MP shocks in the second regime compared to the first. A significant reduction in GDP growth and inflation is observed in response to MG shocks in both regimes. The interest rate's response to AD shocks fades by the 10th quarter, in line with findings in Winkelried (2013). The response to AS and external shocks is similar to the main specification.

The FEVD of GDP growth shows that MP shocks contribute 30% to its variability under the first regime in the RS-VAR-SV-R1 model, compared to 20% in the RS-VAR-SV-R3 pre-IT. However, the contribution of MP shocks is null in both specifications in the second regime. The FEVD of inflation shows a contribution of around 20% in the first regime for the RS-VAR-SV-R1 and RS-VAR-SV-R3 models, but it is nonexistent in the second regime. Regarding the HDs, the HD of GDP growth indicates an increase from 3.39% pre-IT to 4.98% post-IT. The contribution of MP shocks is -88.58% in the first state and -3.30% in the second, findings that are similar to those for the baseline model.

6.4 Models with Different Dimensions

As the fourth robustness exercise, we explore specifications with varying dimensions: first, a four-variable model excluding money growth, and then a six-variable model including exchange rate growth.

In the four-variable model, the RS-VAR-SV-R1 and RS-VAR-SV-R3 models exhibit BFs of 7.03×10^{19} and 1.05×10^{18}, respectively, in relation to the CVAR model, making the RS-VAR-SV-R1 model the preferred choice.

The response of GDP growth to MP shocks is as expected and similar in magnitude to the baseline model (-0.2%). The interest rate's response to AD shocks remains persistent, with the increase sustained even after three years in both states, while the response to AS shocks dissipates after two years. In this case, even though the maximum increase in the interest rate for both shocks is similar (0.3%), the BCRP's response is more enduring in the face of AD shocks. This is contrary to other robustness exercises where the interest rate's response diminishes after the 10th quarter. The response to external shocks is non-significant.

Excluding the monetary aggregate leads to a greater contribution of AS shocks in the FEVD of GDP growth and inflation. The HD of GDP growth shows an increase from 4.07% pre-IT to 5.07% post-IT. The contribution of MP shocks is -63.37% in the first state and -2.33% in the second.

Regarding the six-variable model, Table 4 shows that the RS-VAR-SV-R1 model is the best fit, followed by the CVAR and RS-VAR-SV-R3 models. Thus, the BFs for the RS-VAR-SV-R1 and RS-VAR-SV-R3 models are 1.07×10^{12} and 1.12×10^{-6} in relation to the CVAR model, respectively.

Table 5 indicates a reduction in the volatility of GDP growth, inflation, and the interest, as well as an increase in the volatility of the terms of trade and the exchange rate, in the second state. The IRFs show that the response of GDP growth and inflation to MP and MG shocks does not differ from the baseline specification; i.e., the inclusion of the exchange rate does not resolve the *price puzzle*. In response to exchange rate shocks, IRFs show a significant contraction in GDP growth and a non-significant response in inflation, consistent with findings in Castillo et al. (2011). The interest rate's response to AD and AS shocks is similar to the main model, and the response to external shocks, while initially non-significant, becomes positive and significant from the 5th quarter onward, indicating a more aggressive response by the BCRP to external shocks over time.

The contribution of the exchange rate to the FEVD of GDP growth and inflation is slightly higher in the second regime than in the first (approximately 10% in the long-term horizon) in the RS-VAR-SV-R1 and RS-VAR-SV-R3 models. The HDs of GDP growth and inflation also show a significant contribution of MP shocks in the first regime and a reduced contribution in the second.

6.5 Change in External Variables

Estimations with different variables reflecting external activity were conducted, including growth of the Export Price Index (EPI) and the Standard & Poor's Index (S&P500). These specifications are similar to those estimated in Chávez and Rodríguez (2023) and Rodríguez et al. (2024).

The BF results indicate that the RS-VAR-SV-R1 model is the best fit for Peru's data. For instance, the BFs for the RS-VAR-SV-R1 and RS-VAR-SV-R3 models are 3.5×10^{18} and 6.5×10^{7}, respectively, in relation to the CVAR model when using the growth of the EPI index.

In this context, a positive shock results in increased export revenues and higher mining returns, which in turn encourages other investors to develop mining projects in Peru. Higher revenues lead to improved income tax revenues (mainly mining royalties), creating more fiscal space to finance investment; see Mendoza Bellido and Anastacio Clemente (2021) and Jiménez et al. (2023).

The IRFs show that MP and MG shocks reduce economic activity in both RS-VAR-SV-R1 and RS-VR-SV-R3 models across all regimes. The interest rate's response to AD shocks is positive, peaking at 0.2% in the 5th quarter and gradually decreasing by year 3. The interest rate's response to AS, AD, and external shocks is similar to that in the main specification.

The contribution of MP shocks to the FEVD of GDP growth is 40% in the first regime and non-existent in the second. For inflation, this contribution is 20% pre-IT and non-existent post-IT. External shocks have an increased contribution to the FEVD of GDP growth, nearly 60% in the second state (25% higher than in the main scenario), similar to findings in Chávez and Rodríguez (2023). The HD of GDP growth shows that it increased from 3.55% pre-IT to 5.37% post-IT. The contribution of MP shocks was -85.92% in the first state and -0.60% in the second regime.

In the model that substitutes terms-of-trade growth with growth of the S&P 500 Index, the BFs obtained were 3.2×10^{14} and 2.9×10^{6} compared to the CVAR model. The interest rate's response to AS shocks is more immediate and of greater magnitude compared to the response to AD shocks. The response to external shocks is not significant. In the CVAR model, the interest rate's response to AD shocks is close to 1%, and the response to AD and external shocks is non-significant in the initial quarters.

The participation of MP shocks in the FEVD of GDP growth is substantial in the first regime and non-existent in the second. Notably, in this robustness exercise, external shocks increase their contribution by 20% in the FEVD of GDP growth and by 30% in the FEVD of inflation in the second regime compared to the main model. The HD of GDP growth indicates that it increased from 3.38% pre-IT to 5.24% post-IT. The contribution of MP shocks was -90.97% in the first regime and -1.06% in the second,in line with the baseline scenario, showing a reduction in the negative impact of MP shocks on GDP growth post-IT.

These results demonstrate that the main estimations remain robust against changes in priors, ordering, and dimensions. Moreover, the same conclusions are maintained when altering the external variable or domestic variables. The impacts on GDP growth and inflation from each of the shocks also retain similar magnitude and direction when calculating the IRFs, FEVDs, and HDs.

6.6 Change in the Number of Regimes

In the final robustness exercise, the RS-VAR-SV-R1 model was estimated with three and four regimes. For both specifications, transition probabilities indicate the presence of only two distinct regimes. Regarding MP shocks, the response of GDP growth and inflation is consistent across both regimes, mirroring findings in the main model. In the case of MG shocks, the response of these variables across the three regimes differs but is as expected for GDP growth and inflation and is of similar magnitude in both specifications.

MP shocks in the three-regime model are notably relevant for explaining the FEVD of GDP growth, money growth, and the interest rate, especially in the first regime, to a lesser extent in the third, and almost nil in the second. In contrast, these shocks have minimal participation in the FEVD of inflation across all regimes, aligning with findings in the base model. The HD results are generally robust relative to the baseline scenario.

In the four-regime model, similar to the baseline model, MP shocks are significant in the FEVD of GDP growth and money growth primarily in the first regime, while their contribution is almost nonexistent in the third and low in the second. Regarding the FEVD of the interest rate, MP shocks explain over 80% in the first, second, and fourth regimes and almost nothing in the third. In contrast, these shocks have minimal participation in the FEVD of inflation in all states. The HD results are generally similar to those in the baseline scenario.

7 Conclusions

This study employs the RS-VAR-SV model approach as proposed by Chan and Eisenstat (2018) to analyze the impact and evolution of monetary policy shocks and their contribution to the dynamics of GDP growth, inflation, and the interest rate in Peru for the period from 1994Q3 to 2019Q4. The variables considered for the estimations are the terms of trade growth, real GDP growth, inflation, money growth, and the interest rate.

The findings reveal temporal variations in coefficients and volatilities. According to the log-ML criterion, the model that includes only SV fits the Peruvian economy better than a homoscedastic model. Transition probabilities also indicate the existence of two distinct regimes, covering 1994Q3-2002Q3 and 2002Q4-2019Q4, respectively. This regime change is a result of IT implementation by the BCRP. It is also noted that the volatility of GDP growth, inflation, and the interest rate significantly diminishes in the second regime (up to 41.4%, 33.5%, and 88.7% respectively), which can be attributed to greater monetary stability following IT adoption.

An unexpected 100-basis point increase in the interest rate leads to a contraction of 0.3% in real output growth in both regimes. In the first regime, MP shocks explain 15%, 30%, and 90% of the long-term FEVD for inflation, GDP growth, and the interest rate, respectively, while in the second regime, the contribution of MP shocks is almost negligible, losing significance in comparison to external shocks. Furthermore, MP shocks have a significant participation in the HD of domestic variables in the pre-IT period while decreasing considerably after 2002.

Regarding the impact of other shocks on the interest rate, in response to AD, AS, and external shocks, the monetary authority raises the interest rate to keep inflation within the target band. Changing priors, the domestic economic activity variable, the inflation variable, the ordering of some variables, as well as including nominal exchange rate growth as an additional variable, generally yield findings similar to those of the baseline scenario, validating the robustness of the results obtained.

As economic policy recommendations, the BCRP should continue operating under the IT scheme and make decisions focused on mitigating the influence of other shocks, particularly external ones, that have become significant in explaining the volatility of key domestic variables in recent years. Additionally, in line with Rodríguez et al. (2018), the recent high participation of external variables in the variance of GDP growth highlights the need for greater diversification of Peru's domestic production as a mechanism to reduce uncertainty in medium- and long-term economic growth.

Finally, as a future research agenda, it would be interesting to incorporate long-term or sign restrictions. Another possible extension, in line with Rodríguez et al. (2023), would be to change the foreign variable to the growth rate of Peru's main trading partners (China and the US) or the Fed interest rate. Lastly, given the role of banks in amplifying or reducing the effects of MP shocks through credit, variables associated with bank loans could be included within an RS-VAR-SV approach (Carrera, 2011).

References

[1] Aleem, A., and Lahiani, A. (2014). Monetary policy credibility and exchange rate pass-through: Some evidence from emerging countries. *Economic Modelling* **43,** 21-29. https://doi.org/10.1016/j.econmod.2014.06.020

[2] Allen, N., and Robinson, J. (2015). Monetary Policy Effects in a Regime Switching Model. Working Paper Bank of Jamaica.

[3] Angeriz, A., and Arestis, P. (2006). Has inflation targeting had any impact on inflation? *Journal of Post Keynesian Economics* **28(4)**, 559-571. doi: https://doi.org/10.2753/PKE0160-3477280402

[4] Anguyo, F., Gupta, R., and Kotze, K. (2020). Monetary policy, financial frictions and structural changes in Uganda: a Markov-switching DSGE approach. *Economic Research-Ekonomska Istraživanja* **33(1)**, 1538-1561. doi: https://doi.org/10.1080/1331677X.2020.1757480

[5] Armas, A., and Grippa, F. (2008). Metas de inflación en una economía dolarizada: La experiencia del Perú. *Revista de Análisis del BCB* **10(1)**, 7-44.

[6] Armas, A., Grippa, F., Quispe, Z., and Valdivia, L. (2001). De metas monetarias a metas de inflación en una economía con dolarización parcial: el caso peruano. *Revista Estudios Económicos* **7,** 7-23.

[7] Arratibel, O., and Michaelis, H. (2014). The Impact of Monetary Policy and Exchange Rate Shocks in Poland: Evidence from a Time-Varying VAR. ECB Working Paper **1636**. doi: 10.5282/ubm/epub.21088

[8] Ball, L. M., and Sheridan, N. (2004). Does inflation targeting matter? In Bernanke, B. and M. Woodford (Ed.), *The Inflation-Targeting Debate*, University of Chicago Press, 249-282.

[9] Batini, N., and Laxton, D. (2007). Under what conditions can inflation targeting be adopted? The experience of emerging markets. Series on Central Banking, Analysis, and Economic Policie, **11**.

[10] Bernanke, B., Boivin, J. and Eliazs, P. (2005). Measuring the Effects of Monetary Policy: a Factor-augmented Vector Autoregressive (FAVAR) Approach. *The Quarterly Journal of Economics* **120**, 387-422.

[11] BCRP (2008). La correlación entre el crecimiento del dinero y la inflación. *Reporte de Inflación: Panorama Actual y Proyecciones Macroeconómicas,* Setiembre 2008.

[12] BCRP. (2018). El rol de los términos de intercambio en la actividad económica del Perú. *Reporte de Inflación: Panorama Actual y Proyecciones Macroeconómicas*, Marzo 2018.

[13] BCRP (2021). El mandato del Banco Central. *Reporte de Inflación: Panorama Actual y Proyecciones Macroeconómicas,* Marzo 2021.

[14] Bernanke, B., and Blinder, A. (1992). The Federal Funds Rate and the Channels of Monetary Transmission. *American Economic Review* **82(4)**, 901-921.

[15] Bernanke, B., and Mihov, I. (1998). Measuring monetary policy. *The Quartely Journal of Economics* **113(3)**, 869-902. doi: https://doi.org/10.1162/003355398555775

[16] Bianchi, F., and Melosi, L. (2017). Escaping the Great Recession. *American Economic Review* **107(4)**, 1030-58. https://doi.org/10.1016/j.jimonfin.2015.02.013

[17] Bijsterbosch, M., and Falagiarda, M. (2015). The macroeconomic impact of financial fragmentation in the euro area: Which role for credit supply? *Journal of International Money and Finance* **54**, 93-115. doi: https://doi.org/10.1016/j.jimonfin.2015.02.013

[18] Bittencourt, M., Mwabutwa C., and Viegi, N. (2016). Evolution of Monetary Policy Transmission Mechanism in Malawi TVP-VAR approach. *Journal of Economic Development* **41(1)** 33-55.

[19] Brito, R. D., and Bystedt, B. (2010). Inflation targeting in emerging economies: Panel evidence. *Journal of Development Economics* **91(2)**, 198-210. doi: https://doi.org/10.1016/j.jdeveco.2009.09.010

[20] Carrera, C. (2011). El canal del crédito bancario en el Perú: evidencia y mecanismo de transmisión. *Revista Estudios Económicos* **22**, 63-82.

[21] Castillo, P., Montoro, C., and Tuesta, V. (2007). Hechos estilizados de la economía peruana. *Revista Estudios Económicos* **14**, 33-75.

[22] Castillo, P., Montoya, J., and Quineche, R. (2015). Cambios en la volatilidad del PBI en el Perú: el rol de la estabilidad monetaria. *Revista Moneda* **162**, 4-8.

[23] Castillo, P., Montoya, J., and Quineche, R. (2016). From the "Great Inflation" to the "Great Moderation" in Peru: A Time Varying Structural Vector Autoregressions Analysis. Working Paper **3,** Banco Central de Reserva del Perú.

[24] Castillo, P., Peréz, F., and Tuesta, V. (2011). Los mecanismos de transmisión de la política monetaria en Perú. *Revista Estudios Económicos* **21**, 41-63.

[25] Cadavid, S. (2018). Monetary policy and structural changes in Colombia, 1990-2016: A Markov Switching approach. Working Paper **60,** Universidad de los Andes.

[26] Chan, C., and Eisenstat, E. (2015). Marginal likelihood estimation with the cross-entropy method. *Econometric Reviews* **34(3)**, 256-285. doi: https://doi.org/10.1080/07474938.2014.944474

[27] Chan, C., and Eisenstat, E. (2018). Bayesian Model Comparison for Time Varying Parameter VARs with Stochastic Volatility. *Journal of Applied Econometrics* **33(4)**, 509-532. doi: https://doi.org/10.1002/jae.2617

[28] Chávez, P., and Rodríguez., G. (2023). Time changing effects of external shocks on macroeconomic fluctuations in Peru: empirical application using regime-switching VAR Models with stochastic volatility. *Review of World Economics* **159**, 505-544. doi: https://doi.org/10.1007/s10290-022-00474-1

[29] Chib, S. (1996). Calculating posterior distributions and modal estimates in Markov mixture models. *Journal of Econometrics* **75(1)**, 79-97. doi: https://doi.org/10.1016/0304-4076(95)01770-4

[30] Christiano, L., Eichenbaum, M., and Evans, C. (1996). The effects of Monetary Policy Shocks: Evidence from the Flow of Funds. *The Review of Economics and Statistics* **78(1)**, 16-34. doi: https://doi.org/10.2307/2109845

[31] Christiano, L., Eichenbaum, M., and Evans, C. (1999). Monetary policy shocks: What have we learned and to what end? In Taylor, J. and M. Woodford (Ed.), *Handbook of Macroeconomics,* Chapter **2**, 65-148. doi: https://doi.org/10.1016/S1574-0048(99)01005-8

[32] Cogley, T., and Sargent, T. (2001). Evolving Post-World War II U.S. Inflation Dynamics. *NBER Macroeconomic Annual* **16**, 331-373. doi: https://doi.org/10.1086/654451

[33] Cogley, T., and Sargent, T. (2005). Drifts and Volatilities: Monetary Policies and Outcomes in the Post WWII US. *Review of Economic Dynamics* **8**, 262-302. doi: https://doi.org/10.1016/j.red.2004.10.009

[34] Eichenbaum, M. (1992). Interpreting Macroeconomic Time Series Facts: the effects of Monetary Policy Shocks: Comments. *European Economic Review* **36**, 1001-1011.

[35] Finck, D., and Tillmann, P. (2022). The Role of Global and Domestic Shocks for Inflation Dynamics: Evidence from Asia. *Oxford Bulletin of Economics and Statistics* **84(5)**, 1181-1208. doi: https://doi.org/10.1111/obes.12495

[36] Franta, M., Horvath R., and Rusnak, M. (2014). Evaluating Changes in the Monetary Transmission Mechanism in the Czech Republic. *Empirical Economics* **46(3)**, 827-842.

[37] Fujiwara, I. (2006). Evaluating monetary policy when nominal interest rates are almost zero. *Journal of the Japanese and International Economies* **20(3)**, 434-453. doi: https://doi.org/10.1016/j.jjie.2006.02.001

[38] Gerlach, S., and Smets, F. (1995). The monetary transmission mechanism: evidence from the G-7 countries. BIS Working Paper **26**.

[39] Gillitzer, C., and Simon, J. (2015). Inflation Targeting: A Victim of Its Own Success?. *International Journal of Central Banking* **11(4)**, 259-287.

[40] Gómez, V., and Maravall, A. (1996). Programs TRAMO and SEATS: Instructions for the User. Departamento de Investigación, Working Paper **9628**, Banco de España.

[41] Gordon, D., and Leeper, E. (1994). The Dynamic Impacts of Monetary Policy: An Exercise in Tentative Identification. *Journal of Political Economy* **102(6)**, 1228-1247. doi: https://doi.org/10.1086/261969

[42] Hendricks, W., and Kempa, B. (2008). Asymmetric Transmission of Monetary Policy in Europe: a Markov-switching Approach. *Journal of Economic Integration* **23**, 873-895.

[43] Jiménez, A., Rodríguez, G., and Ataurima Arellano, M. (2023). Time-Varying Impact of Fiscal Shocks over GDP Growth in Peru: An Empirical Application using Hybrid TVP-VAR-SV Models. *Structural Change and Economic Dynamics* **64**, 314-332.

[44] Kim, C. J. and Nelson, C. R. (1999). State-Space Models with Regime Switching. MIT Press, London, England and Cambridge, Massachusetts. doi: 10.7551/mitpress/6444.001.0001

[45] Klingelhöfer, J. and Sun, R. (2018). China's regime-switching monetary policy. *Economic Modelling* **68**, 32-40. doi: https://doi.org/10.1016/j.econmod.2017.04.017

[46] Koop, G., Leon-Gonzalez, R., and Strachan, R. (2009). On the evolution of the monetary policy transmission mechanism. *Journal of Economic Dynamics and Control* **33**, 997-1017. doi: https://doi.org/10.1016/j.jedc.2008.11.003

[47] Lahura, E. (2012). Midiendo los efectos de la política monetaria a través de las expectativas de mercado. *Revista Estudios Económicos* **23**, 39-52.

[48] Lakwadala, A. (2015). Modeling Monetary Policy Dynamics: A Comparison of Regime Switching and Time Varying Parameter Approaches.Unpublished Manuscript, Michigan State University.

[49] Lange, R. (2016). The Monetary Transmission Mechanism and Inflation Targeting: A Regime-Switching VAR Approach for Canada. *Applied Economics and Finance* **3(2)**, 263-279.

[50] Leeper, E., Sims, C. A., and Zha, T. (1996). What does monetary policy do?. *Brookings Papers on Economic Activity* **2**, 1-63. doi: https://doi.org/10.2307/2534619

[51] Lo, M. C., and Piger, J. (2005). Is the response of output to monetary policy asymmetric? Evidence from a regime-switching coefficients model. *Journal of Money, Credit and Banking*, **37(5)**, 865-886.

[52] Lodge, D., and Manu, A. S. (2022). EME financial conditions: Which global shocks matter?. *Journal of International Money and Finance* **120**, 102479.

[53] Mendoza, W. (2013). Contexto internacional y desempeño macroeconómico en América Latina y el Perú: 1980-2012. Working Paper **351,** Pontificia Universidad Católica del Perú.

[54] Mendoza Bellido, W., and Anastacio Clemente, Y. (2021). *La historia fiscal del Perú: 1980-2020. Colapso, estabilización, consolidación y el golpe de la COVID-19*. Lima, Perú: Fondo Editorial PUCP.

[55] Mendoza, W., and Collantes Goicochea, E. (2017). La economía de PPK. Promesas y resultados: la distancia que los separa. Working Paper **440**, Department of Economics, Pontificia Universidad Católica del Perú.

[56] Mishkin, F. S., and Schmidt-Hebbel, K. (2007). Does inflation targeting make a difference? National Bureau of Economic Research, Working Paper **12876**. doi: 10.3386/w12876

[57] Mishkin, F. S., and Savastano, M. A. (2002). Monetary Policy Strategies For Emerging Market Countries: Lessons From Latin America. *Comparative Economic Studies* **44(2-3)**, 45-82.

[58] Nakajima, J. (2011). Monetary Policy Transmission under Zero Interest Rates: An Extended Time-Varying Parameter Vector Autoregression Approach. *The B.E. Journal of Macroeconomics* **11(1)**, 1-24. doi: https://doi.org/10.2202/1935-1690.2323

[59] Pérez Forero, F. (2015). Comparing the Transmission of Monetary Policy Shocks in Latin America: A Hierarchical Panel VAR. Working Paper **2015-15**, Banco Central de Reserva del Perú.

[60] Pérez Rojo, F., and Rodríguez, G. (2023). Impact of Monetary Policy Shocks in the Peruvian Economy Over Time. Working Paper **523**, Department of Economics, Pontificia Universidad Católica del Perú.

[61] Plante, M. (2014). How should monetary policy respond to changes in the relative price of oil? Considering supply and demand shocks. *Journal of Economic Dynamics and Control* **44**, 1-19.

[62] Portilla, J., Rodríguez, G. and Castillo B., P. (2022). Evolution of Monetary Policy in Peru: An Empirical Application Using a Mixture Innovation TVP-VAR-SV Model. *CESifo Economic Studies* **68(1)**, 98-126. doi: https://doi.org/10.1093/cesifo/ifab013

[63] Primiceri, G. (2005). Time Varying Structural Vector Autoregressions and Monetary Policy. *Review of Economic Studies* **72**, 821-852. doi: https://doi.org/10.1111/j.1467-937X.2005.00353.x

[64] Quispe, Z. (2000). Monetary policy in a dollarized economy: The case of Peru. In Sterne, G. and L. Mahadeva (Ed.), *Monetary Policy Framework in a Global Context*, London: Routledge and Bank of England, 330-353.

[65] Rodríguez, G., Villanueva Vega, P. and Castillo Bardalez, P. (2018). Driving economic fluctuations in Peru: The role of the terms of trade. *Empirical Economics* **53(3)**, 1089-1119. doi: https://doi.org/10.1007/s00181-017-1318-2

[66] Rodríguez., G., Castillo B., P. and Ojeda Cunya, J. A. (2024). Time-Varying Effects of Foreign Shocks on Macroeconomic Fluctuations in Peru: Empirical Application using TVP-VAR-SV Models. Forthcoming in *Open Economies Review*.

[67] Rodríguez, G**.**, Vassallo, R. and Castillo B., P. (2023). Effects of External Shocks on Macroeconomic Fluctuations in Pacific Alliance Countries. *Economic Modelling* **124**, 106302.

[68] Rossini, R., and Vega, M. (2007). El mecanismo de transmisión de la política monetaria en un entorno de dolarización financiera: el caso de Perú entre 1996 y 2006. Working Paper **17,** Banco Central de Reserva del Perú.

[69] Ryuzo, M., and Tatsuyoshi, O. (2017). The Macroeconomic Effects of Japan's Unconventional Monetary Policies. *Research Institute of Economy, Trade and Industry* **17(65)**, 1-26.

[70] Sims, C. A. (1972). Money, Income and Causality. *American Economic Review* **62**, 540-552.

[71] Sims, C. A. (1980). Macroeconomics and Reality. *Econometrica* **48**, 1-47. doi: https://doi.org/10.2307/1912017

[72] Sims, C. A. (1986). Are Forecasting Models Usable for Policy Analysis? *Minneapolis Federal Reserve Bank Quarterly Review* **10**, 2-16.

[73] Sims, C. A. (1992). Interpreting the macroeconomic time series fact: the effects of monetary policy. *European Economic Review* **36**, 975-1000. doi: https://doi.org/10.1016/0014-2921(92)90041-T

[74] Sims, C. A. (2001). Comment on Sargent and Cogley's Evolving post World War II US inflation dynamics. *NBER Macroeconomics Annual* **16**, 373-379. doi: https://doi.org/10.1086/654451

[75] Sims, C. A., and Zha, T. (2006). Were There Regime Switches in U.S. Monetary Policy? *American Economic Review* **96(1)**, 54-81. doi: 10.1257/000282806776157678

[76] Sousa, J., and Zaghini, A. (2008). Monetary policy shocks in the euro area and global liquidity spillovers. *International Journal of Finance and Economics*, **13(3)**, 205-218.

[77] Stock, J. H. (2001). Discussion of Cogley and Sargent's Evolving post World War II US inflation dynamics. *NBER Macroeconomics Annual* **16**, 379-387. doi: https://doi.org/10.1086/654451

[78] Winkelried D. (2004). Tendencias comunes y análisis de la política monetaria en el Perú, *Revista de Estudios Económicos* **11**.

[79] Winkelried, D. (2013). Modelo de Proyección Trimestral del BCRP: Actualización y novedades. *Revista de Estudios Económicos* **26**, 9-60.

[80] Zha, T., and Chen, K. (2017). The Asymmetric Transmission of China's Monetary Policy. *Society for Economic Dynamics,* Meeting Papers **516**.

Table 1. Tests for Time Variation in Coefficients and Volatilities

Trace test			
Trace	16% percentil	50% percentil	84% percentil
0.16	0.1852	0.2806	0.4285
Kolmogorov-Smirnov Test			
$\boldsymbol{\gamma}_t$			
1994Q3-2002Q1	2002Q2-2019Q4	1994Q3-2006Q4	2007Q1-2019Q4
8/10	8/10	8/10	8/10
$\boldsymbol{\beta}_t$			
1994Q3-2002Q1	2002Q2-2019Q4	1994Q3-2006Q4	2007Q1-2019Q4
41/55	47/55	44/55	44/55
$\mathbf{h}_t$			
1994Q3-2002Q1	2002Q2-2019Q4	1994Q3-2006Q4	2007Q1-2019Q4
5/5	5/5	5/5	5/5
Two sample t-test			
$\boldsymbol{\gamma}_t$			
1994Q3-2002Q1	2002Q2-2019Q4	1994Q3-2006Q4	2007Q1-2019Q4
10/10	10/10	10/10	10/10
$\boldsymbol{\beta}_t$			
1994Q3-2002Q1	2002Q2-2019Q4	1994Q3-2006Q4	2007Q1-2019Q4
44/55	44/55	38/55	46/55
$\mathbf{h}_t$			
1994Q3-2002Q1	2002Q2-2019Q4	1994Q3-2006Q4	2007Q1-2019Q4
5/5	5/5	5/5	5/5

γ_t is a vector of time-varying coefficients that characterize the contemporary relationships between variables, β_t is a vector of time-varying intercepts and coefficients associated with lagged variables, and $\mathbf{h}_t$ are time-varying variances of innovations.

Table 2. Model Selection

Model	Log-ML	Rank
CVAR	−1376.9 (0.015)	5
RS-VAR-SV ($r = 2$)	−1426.5 (0.119)	13
RS-VAR-SV-R1 ($r = 2$)	−1341.4 (0.045)	1
RS-VAR-R2 ($r = 2$)	−1423.7 (0.151)	12
RS-VAR-SV-R3 ($r = 2$)	−1369.3 (0.922)	4
RS-VAR-SV-R4 ($r = 2$)	−1441.2 (0.526)	16
RS-VAR-SV-R5 ($r = 2$)	−1388.6 (0.381)	7
RS-VAR-SV ($r = 3$)	−1436.4 (0.067)	15
RS-VAR-SV-R1 ($r = 3$)	−1348.2 (0.071)	2
RS-VAR-R2 ($r = 3$)	−1433.2 (0.267)	14
RS-VAR-SV-R3 ($r = 3$)	−1381.7 (1.056)	6
RS-VAR-SV-R4 ($r = 3$)	−1451.6 (0.419)	18
RS-VAR-SV-R5 ($r = 3$)	−1398.1 (0.363)	9
RS-VAR-SV ($r = 4$)	−1444.9 (0.103)	17
RS-VAR-SV-R1 ($r = 4$)	−1354.8 (0.149)	3
RS-VAR-R2 ($r = 4$)	−1422.3 (0.408)	11
RS-VAR-SV-R3 ($r = 4$)	−1389.1 (1.499)	8
RS-VAR-SV-R4 ($r = 4$)	−1460.1 (0.708)	19
RS-VAR-SV-R5 ($r = 4$)	−1406.3 (0.405)	10

For each model, the log likelihood marginal estimates are based on 10,000 evaluations of the integrated likelihood, where the importance sampling density is constructed using the 10,000 posterior draws. The order of the variables in the estimation is the following: Terms of Trade Growth, Real GDP Growth, Inflation Rate, Money Growth and Interest Rate. Values in parenthesis denote standard deviations. In this tablerdenotes the number of lags.

Table 3. Normalized Standard Deviations with respect to First Regime (Models with $r = 2$)

Model	TOT	GDP	INF	MON	INT
RS-VAR-SV	1.583	0.701	0.917	0.772	0.179
RS-VAR-SV-R1	1.131	0.618	0.681	0.628	0.117
RS-VAR-SV-R3	1.108	0.586	0.665	0.596	0.129
RS-VAR-SV-R4	1.601	0.672	0.824	0.603	0.180
RS-VAR-SV-R5	1.143	0.608	0.734	0.514	0.113

TOT, GDP, INF, MON and INT are abbreviations for Terms of Trade Growth, Real GDP Growth, Inflation Rate, Money Growth and Interest Rate, respectively.

Table 4. Robustness Analysis: Model Selection

	(i) Change in Priors		(ii) Non-Primary GDP Growth		(iii) Core Inflation		(iv) Alternative Order 1		(v) Alternative Order 2		(vi) Four Variables		(vii) Six Variables		(viii) EPI Growth		(ix) S&P500 Growth	
Model	Log-ML	Rank	Log-ML	Rank	Log-ML	Rank	Log-ML	Rank	Log-ML	Rank	Log-ML	Rank	Log-ML	Rank	Log-ML	Rank	Log-ML	Rank
CVAR	−1313.9 (0.021)	8	−1375.9 (0.015)	4	−1316.2 (0.016)	4	−1382.6 (0.012)	4	−1375.5 (0.054)	5	−1029.6 (0.154)	6	−1721.9 (0.014)	3	−1351.8 (0.741)	5	−1420.9 (0.254)	5
RS-VAR-SV ($r=2$)	−1310.8 (0.308)	5	−1420.5 (0.128)	9	−1367.9 (0.104)	9	−1435.4 (0.074)	13	−1422.6 (0.087)	9	−1034.2 (0.857)	8	−1822.0 (0.648)	9	−1391.1 (0.852)	8	−1491.9 (0.144)	9
RS-VAR-SV-R1 ($r=2$)	−1276.1 (0.062)	1	−1336.4 (0.038)	1	−1273.7 (0.043)	1	−1347.2 (0.039)	1	−1339.3 (0.021)	1	−938.90 (0.365)	1	−1694.2 (0.106)	1	−1309.1 (0.963)	1	−1387.5 (0.652)	1
RS-VAR-R2 ($r=2$)	−1311.7 (0.267)	7	−1418.0 (0.225)	8	−1373.5 (0.096)	10	−1438.7 (0.550)	7	−1419.4 (1.450)	8	−1030.9 (0.147)	7	−1825.6 (1.186)	10	−1402.3 (0.114)	9	−1429.4 (0.852)	6
RS-VAR-SV-R3 ($r=2$)	−1300.0 (0.805)	3	−1367.8 (1.544)	3	−1303.8 (1.588)	3	−1375.5 (0.839)	3	−1361.3 (0.941)	3	−988.10 (1.241)	3	−1736.2 (1.515)	4	−1331.5 (1.574)	3	−1406.0 (0.162)	3
RS-VAR-SV-R4 ($r=2$)	−1331.3 (0.487)	12	−1441.2 (0.384)	12	−1385.3 (0.583)	12	−1442.0 (0.485)	15	−1434.6 (0.324)	11	−1039.7 (0.587)	9	−1834.8 (0.536)	12	−1404.0 (1.354)	11	−1499.4 (0.641)	10
RS-VAR-SV-R5 ($r=2$)	−1311.1 (0.477)	6	−1382.1 (0.374)	6	−1320.6 (0.368)	5	−1393.8 (0.387)	8	−1382.6 (0.178)	6	−1007.9 (0.124)	5	−1752.5 (0.489)	6	−1358.1 (0.954)	6	−1435.2 (0.847)	7
RS-VAR-SV ($r=3$)	−1321.1 (0.305)	11	−1430.8 (0.201)	11	−1377.1 (0.154)	11	−1445.1 (0.107)	16	−1432.3 (0.814)	10	−1045.4 (0.951)	11	−1829.1 (0.652)	11	−1400.7 (0.537)	10	−1501.4 (0.931)	11
RS-VAR-SV-R1($r=3$)	−1282.9 (0.059)	2	−1342.6 (0.086)	2	−1280.9 (0.108)	2	−1353.8 (0.203)	2	−1345.8 (0.715)	2	−990.10 (0.454)	2	−1702.3 (0.084)	2	−1315.6 (0.852)	2	−1392.9 (1.114)	2
RS-VAR-R2 ($r=3$)	−1320.0 (0.124)	9	−1427.2 (0.242)	10	−1341.6 (0.047)	8	−1401.7 (0.200)	9	−1428.4 (0.425)	10	−1039.9 (0.247)	10	−1816.3 (0.146)	9	−1411.7 (0.247)	12	−1524.3 (0.647)	13
RS-VAR-SV-R3 ($r=3$)	−1310.0 (0.851)	4	−1378.0 (1.103)	5	−1329.7 (1.698)	6	−1384.7 (0.958)	4	−1371.2 (1.541)	4	−1004.4 (1.022)	4	−1744.9 (1.553)	5	−1338.9 (0.957)	4	−1412.9 (0.897)	4
RS-VAR-SV-R4 ($r=3$)	−1340.6 (0.529)	13	−1450.6 (0.457)	13	−1395.7 (0.350)	13	−1451.2 (0.538)	11	−1444.1 (1.087)	12	−1050.4 (0.781)	13	−1855.5 (0.825)	13	−1413.5 (1.264)	13	−1510.8 (1.247)	12
RS-VAR-SV-R5 ($r=3$)	−1320.2 (0.688)	10	−1391.5 (0.325)	7	−1329.9 (0.384)	7	−1403.3 (0.421)	10	−1392.1 (0.984)	7	−1049.9 (0.173)	12	−1762.1 (0.516)	8	−1367.8 (0.011)	7	−1445.7 (0.965)	8

For each model, the log likelihood marginal estimates are based on 10,000 evaluations of the integrated likelihood, where the importance sampling density is constructed using the 10,000 posterior draws. The robustness exercises are the following: (i) use of more diffuse priors; (ii) use of Non Primary GDP Growth instead of Total GDP Growth; (iii) use of core inflation instead of total inflation; (iv) alternative order 1; (v) alternative order 2; and (vi) estimation of a four-variable model. Values in parenthesis denote standard deviations.

Table 5. Robustness Analysis: Normalized Standard Deviation with respect to First Regime (Models with $r = 2$)

	TOT	GDP	INF	MON	INT	TOT	GDP	INF	MON	INT	TOT	GDP	INF	MON	INT
Model	(i) Change in Priors					(ii) Non-Primary GDP Growth					(iii) Core Inflation				
RS-VAR-SV	2.035	0.750	0.905	1.050	0.184	2.355	0.930	0.849	1.505	0.288	2.518	0.842	0.522	1.896	0.318
RS-VAR-SV-R1	1.158	0.611	0.680	0.609	0.116	1.142	0.760	0.638	0.592	0.118	1.298	0.623	0.589	0.535	0.108
RS-VAR-SV-R3	1.146	0.585	0.669	0.594	0.117	1.092	0.692	0.633	0.571	0.129	1.230	0.598	0.590	0.530	0.125
RS-VAR-SV-R4	1.640	0.664	0.809	0.620	0.170	1.600	0.896	0.806	0.577	0.160	1.497	0.678	0.626	0.585	0.171
RS-VAR-SV-R5	1.168	0.596	0.729	0.506	0.113	1.152	0.735	0.744	0.518	0.113	1.337	0.613	0.589	0.469	0.099
Model	(iv) Alternative Order 1					(v) Alternative Order 2					(vi) Four Variables				
RS-VAR-SV	1.588	0.616	0.875	0.819	0.176	1.571	0.702	0.916	0.834	0.166	2.047	0.342	0.451	1.086	0.184
RS-VAR-SV-R1	1.134	0.620	0.734	0.567	0.117	1.127	0.618	0.679	0.609	0.115	1.753	0.689	0.749	0.609	0.754
RS-VAR-SV-R3	1.110	0.598	0.694	0.545	0.128	1.103	0.587	0.677	0.582	0.115	1.721	0.743	0.341	0.541	0.221
RS-VAR-SV-R4	1.576	0.673	0.816	0.597	0.178	1.652	0.672	0.828	0.662	0.167	1.223	0.789	0.876	0.753	0.532
RS-VAR-SV-R5	1.139	0.608	0.711	0.516	0.112	1.141	0.607	0.734	0.115	0.553	1.943	0.471	0.671	0.489	0.183
Model	(vii) Six Variables					(viii) EPI Growth					(ix) S&P 500 Growth				
RS-VAR-SV	2.716	1.389	0.792	1.469	0.461	2.210	2.355	0.939	0.849	1.222	0.290	2.591	0.663	0.555	1.896
RS-VAR-SV-R1	1.193	0.606	0.663	0.609	0.119	1.146	1.721	0.777	0.639	0.592	0.119	1.298	0.623	0.571	0.535
RS-VAR-SV-R3	1.122	0.575	0.657	0.588	0.131	1.135	1.790	0.421	0.521	0.568	0.129	1.430	0.598	0.590	0.671
RS-VAR-SV-R4	2.825	1.342	0.814	0.835	0.247	2.501	1.699	0.890	0.436	0.577	0.160	1.511	0.679	0.854	0.596
RS-VAR-SV-R5	1.269	0.601	0.736	0.669	0.122	1.178	1.152	0.755	0.213	0.566	0.165	1.396	0.231	0.589	0.665

The robustness exercises are the following: (i) use of more diffuse priors; (ii) use of Non Primary GDP Growth instead of Total GDP Growth; (iii) use of core inflation instead of total inflation; (iv) alternative order 1; (v) alternative order 2; (vi) estimation of a four-variable model; (vii) use of a six-variables model; (viii) use of EPI Growth instead of Terms of Trade Growth and (ix) use of S&P500 Growth instead of Terms of Trade Growth.. TOT, GDP, INF, MON and INT are abbreviations for Terms of Trade Growth, Real GDP Growth, Inflation Rate, Money Growth and Interest Rate, respectively.

Table 6. Model Selection with Covid-19 Sample

Model	Log-ML	Rank
CVAR	−1691.5 (0.011)	14
RS-VAR-SV($r = 2$)	−1651.5 (0.062)	9
RS-VAR-SV-R1 ($r = 2$)	−1582.2 (0.798)	2
RS-VAR-R2 ($r = 2$)	−1640.1 (0.022)	8
RS-VAR-SV-R3 ($r = 2$)	−1609.7 (0.807)	4
RS-VAR-SV-R4 ($r = 2$)	−1735.2 (0.522)	19
RS-VAR-SV-R5 ($r = 2$)	−1620.6 (0.597)	6
RS-VAR-SV ($r = 3$)	−1680.3 (0.3711)	11
RS-VAR-SV-R1 ($r = 3$)	−1576.0 (0.098)	1
RS-VAR-R2 ($r = 3$)	−1687.1 (1.446)	12
RS-VAR-SV-R3 ($r = 3$)	−1620.5 (1.064)	5
RS-VAR-SV-R4 ($r = 3$)	−1696.7 (0.704)	16
RS-VAR-SV-R5 ($r = 3$)	−1720.0 (1.539)	18
RS-VAR-SV ($r = 4$)	−1687.5 (0.256)	13
RS-VAR-SV-R1 ($r = 4$)	−1583.8 (0.163)	3
RS-VAR-R2 ($r = 4$)	−1694.6 (0.7273)	15
RS-VAR-SV-R3 ($r = 4$)	−1632.0 (1.439)	7
RS-VAR-SV-R4 ($r = 4$)	−1703.4 (0.682)	17
RS-VAR-SV-R5 ($r = 4$)	−1666.7 (0.659)	10

For each model, the log likelihood marginal estimates are based on 10,000 evaluations of the integrated likelihood, where the importance sampling density is constructed using the 10,000 posterior draws. The order of the variables in the estimation is the following: Terms of Trade Growth, Real GDP Growth, Inflation Rate, Money Growth and Interest Rate. Values in parenthesis denote standard deviations. In this table rdenotes the number of lags.

Table 7. Normalized Standard Deviations with respect to First Regime with COVID Sample (Models with $r = 3$)

Model	Regime	TOT	GDP	INF	MON	INT
RS-VAR-SV	2	2.719	0.424	0.946	0.759	0.035
	3	0.098	0.207	1.425	0.086	0.147
RS-VAR-SV-R1	2	1.065	0.353	0.586	0.323	0.013
	3	0.120	32.150	0.649	0.066	0.058
RS-VAR-SV-R3	2	1.063	0.341	0.524	0.296	0.016
	3	0.114	27.885	0.814	0.097	0.063
RS-VAR-SV-R4	2	2.279	0.699	0.770	0.425	0.026
	3	0.085	0.261	1.067	0.041	0.101
RS-VAR-SV-R5	2	1.051	0.580	0.794	0.557	0.112
	3	0.323	9.503	1.081	0.568	1.976

TOT, GDP, INF, MON and INT are abbreviations for Terms of Trade Growth, Real GDP Growth, Inflation Rate, Money Growth and Interest Rate, respectively.

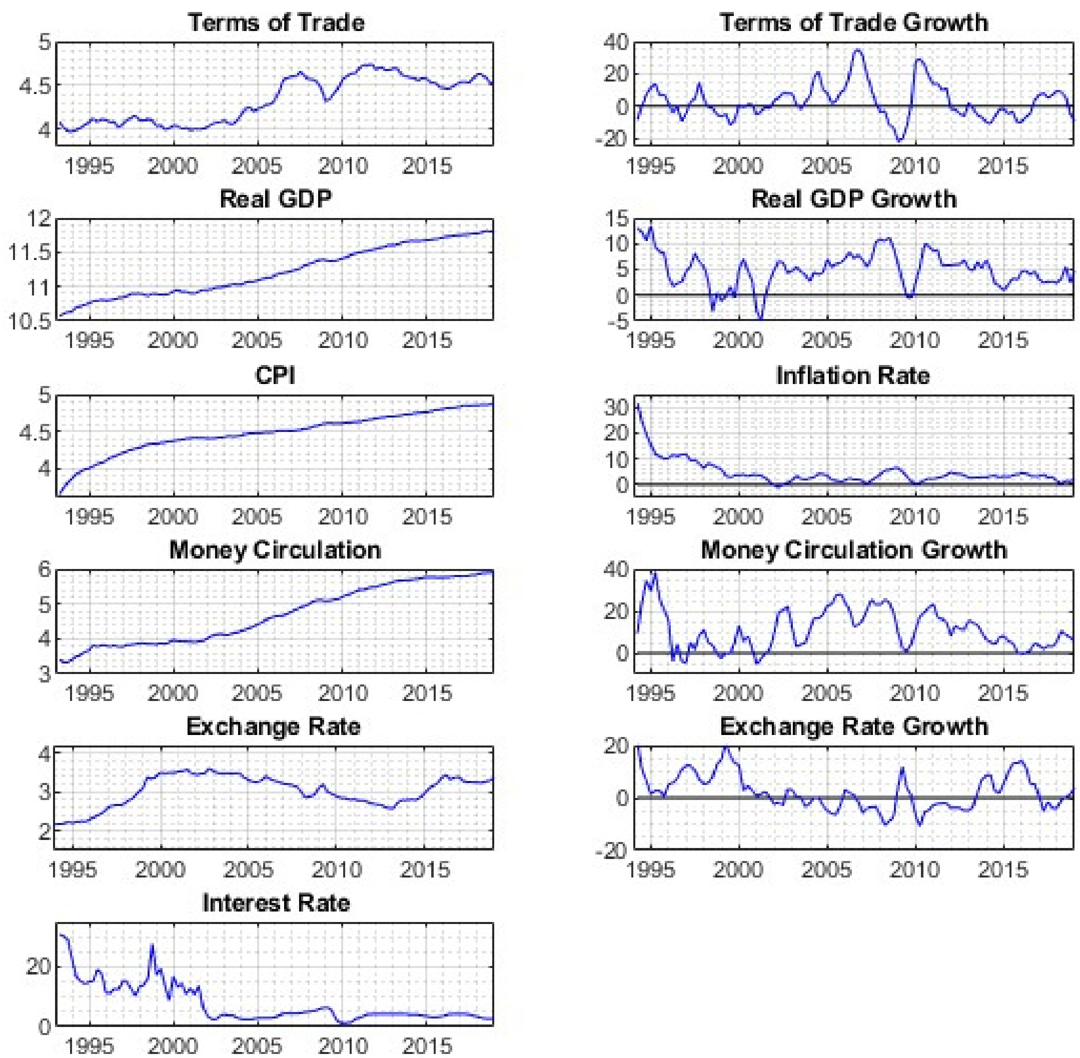

Figure 1. Time Series in Levels (Left) and Annual Growth Rates (Right).

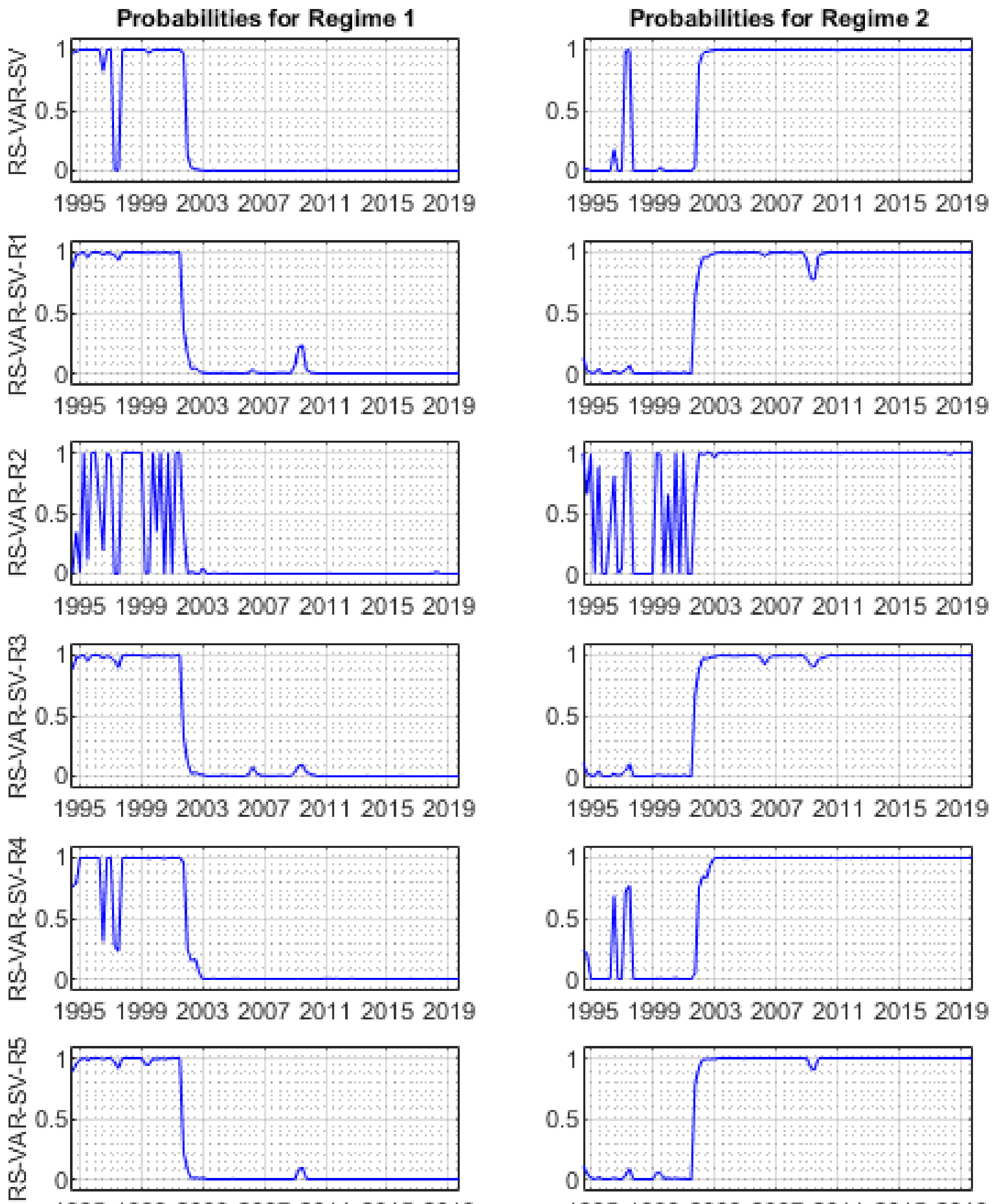

Figure 2. Regime Probabilities for Models with $r = 2$.

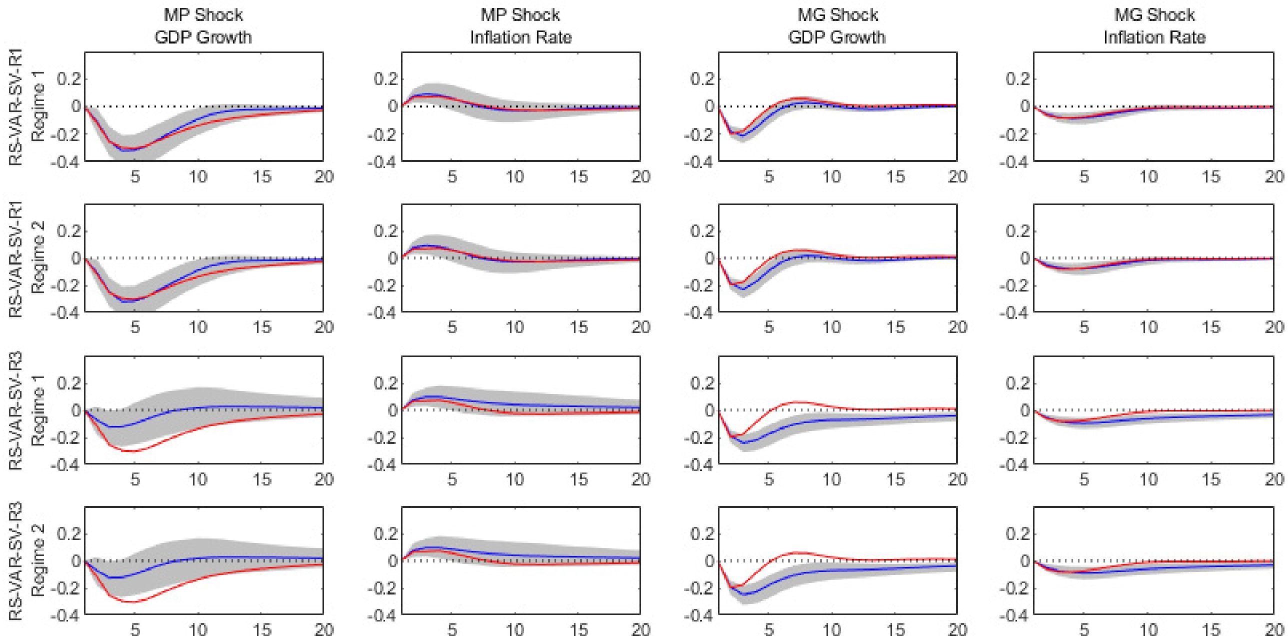

Figure 3. Median IRFs of GDP Growth and Inflation to a MP Shock and a MG Shock for Regimes 1 and 2. The shocks are normalized to an increase of 1% in the Interest Rate and a 1% in Money Growth for both regimes, respectively. The blue line represents the RS-VAR-SV-R1 ($r = 2$) and RS-VAR-SV-R3 ($r = 2$) Models and the shaded area, its 68% error band. The red line represents the CVAR Model.

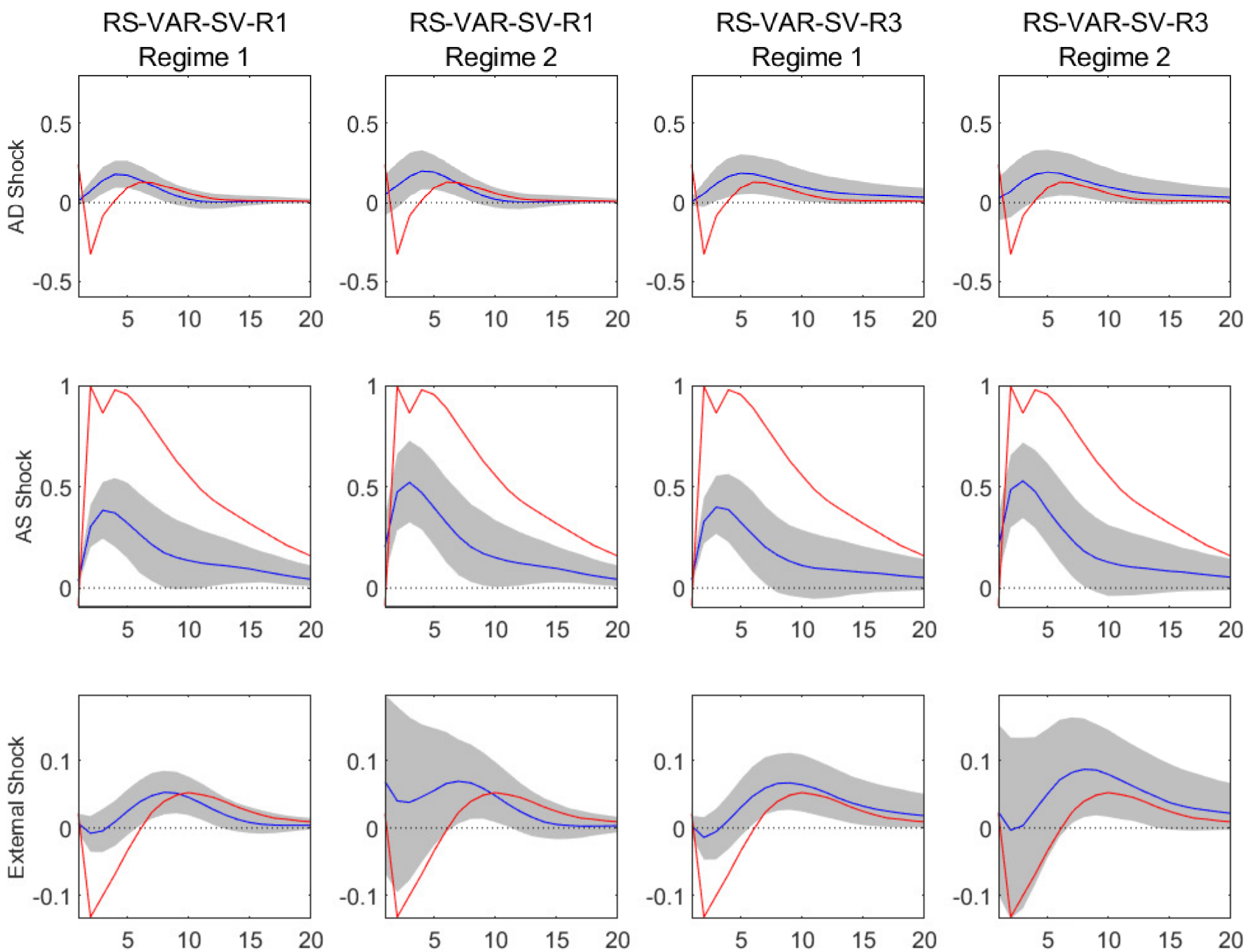

Figure 4. Median IRFs of Interest Rate to an AD, an AS and an External Shock. The shocks are normalized to an increase of 1% in GDP Growth, Inflation Rate and Terms of Trade Growth, respectively. The blue line represents the RS-VAR-SV-R1 ($r = 2$) and RS-VAR-SV-R3 ($r = 2$) Models and the shaded area, its 68% error band. The red line represents the CVAR Model.6

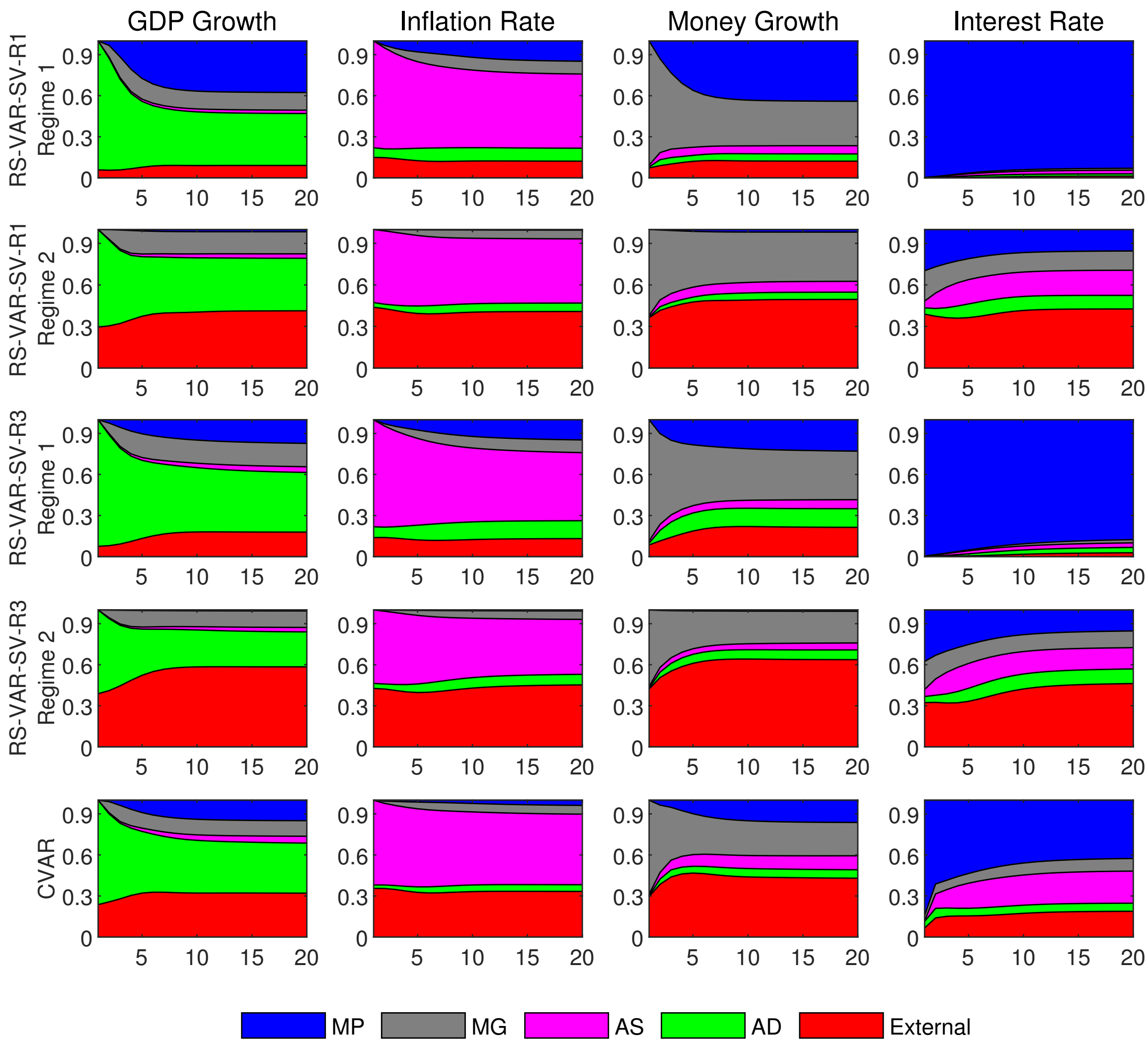

Figure 5. FEVD of GDP Growth, Inflation Rate, Money Growth and Interest Rate for RS-VAR-SV-R1 ($r = 2$), RS-VAR-SV-R3 ($r = 2$) and CVAR Models at $h = 20$.

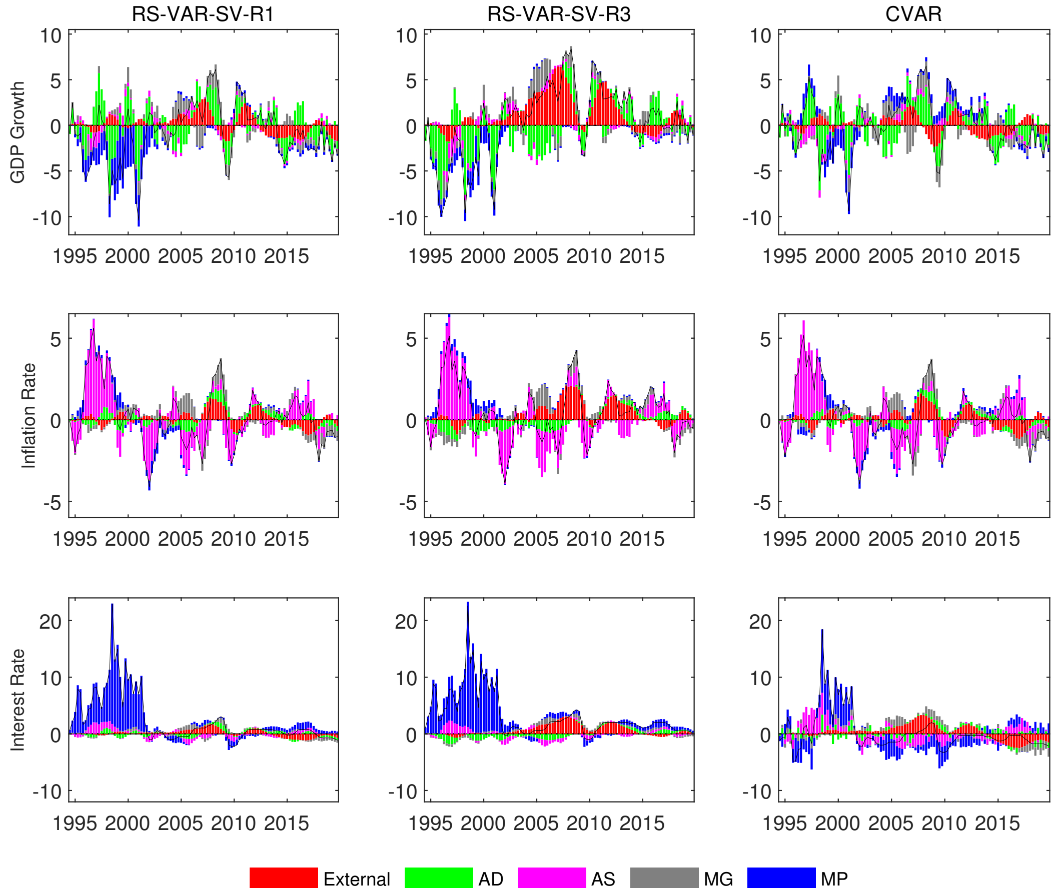

Figure 6. HD of GDP Growth, Inflation Rate, Money Growth and Interest Rate for RS-VAR-SV-R1 ($r = 2$), RS-VAR-SV-R3 ($r = 2$) and CVAR Models.

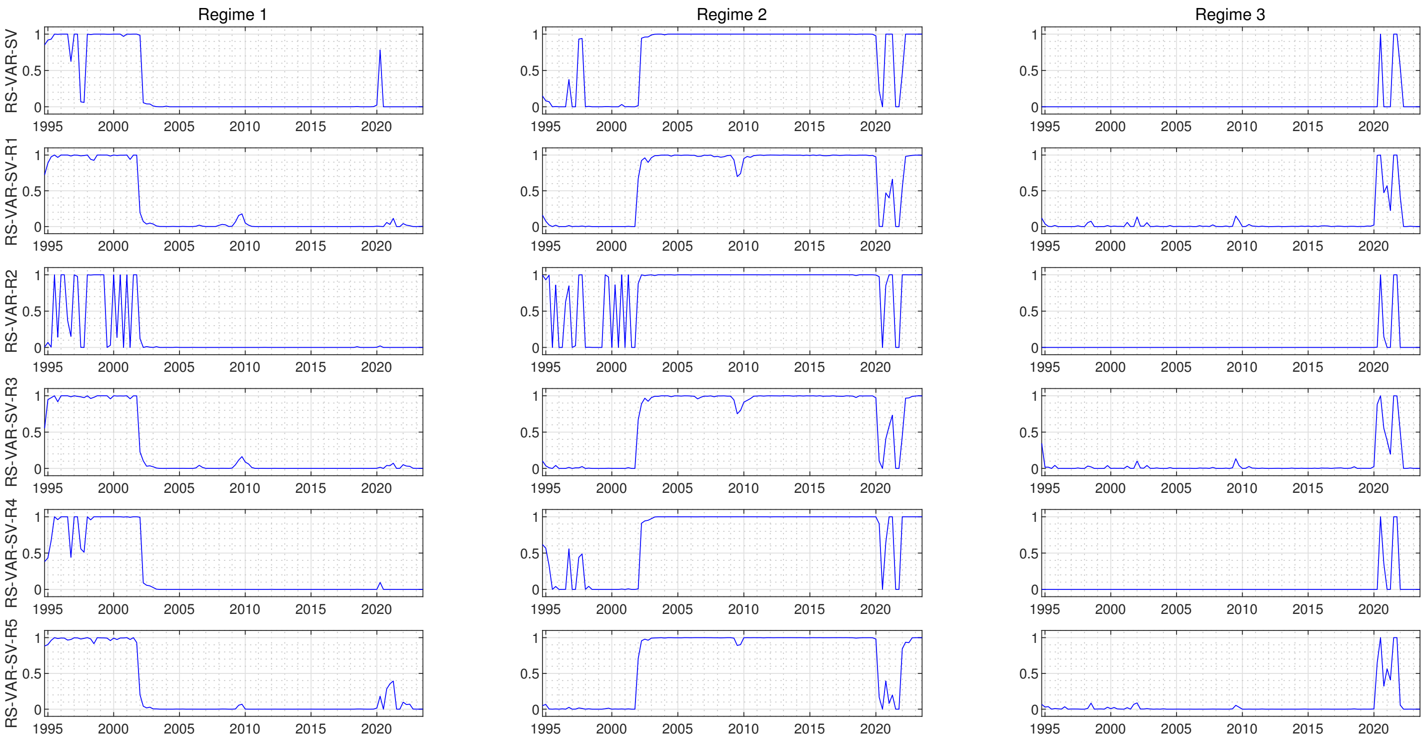

Figure 7. Regime Probabilities for RS-VAR-SV-R1 Model with $r = 3$ with Covid-19 Sample

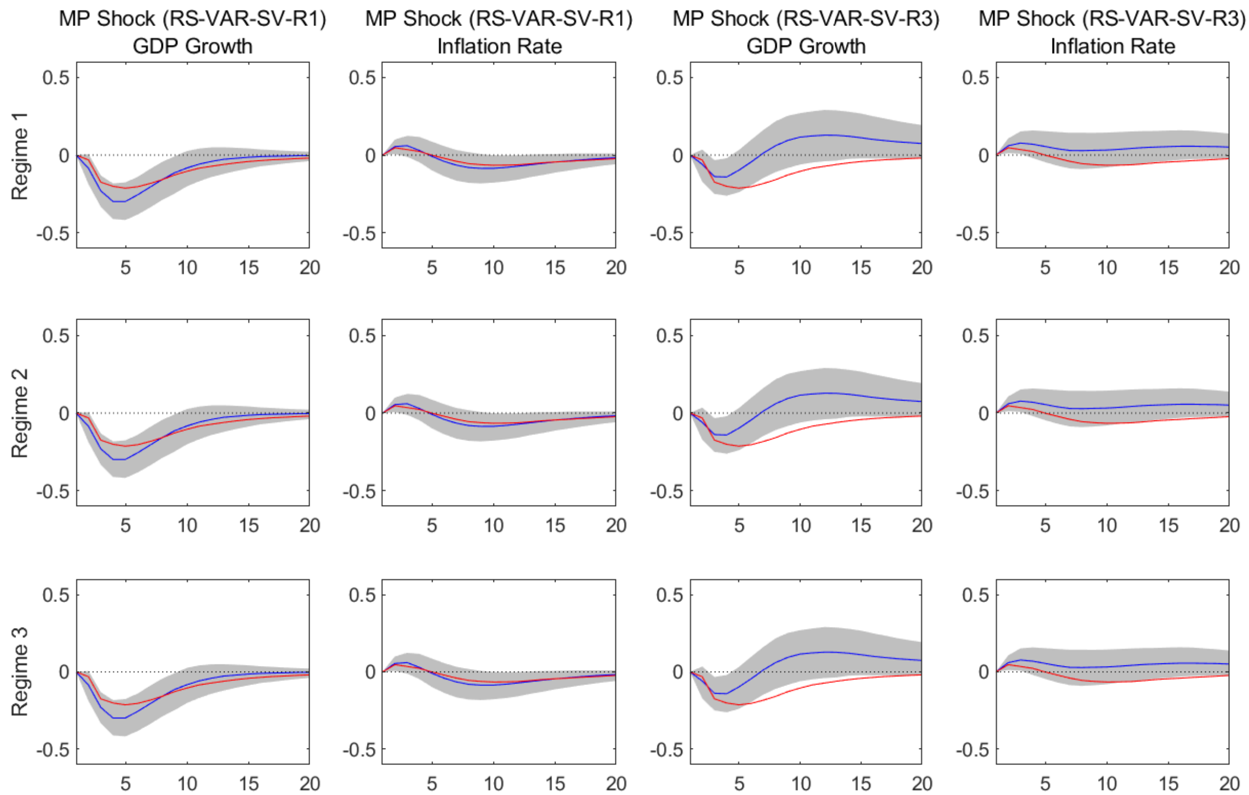

Figure 8. Median IRFs of GDP Growth and Inflation to a MP Shock for Regimes 1, 2 and 3 with Covid-19 Sample. The shocks are normalized to an increase of 1% in the Interest Rate for all regimes. The blue line represents the RS-VAR-SV-R1 ($r = 3$) Model and the shaded area, its 68% error band. The red line represents the CVAR Model.

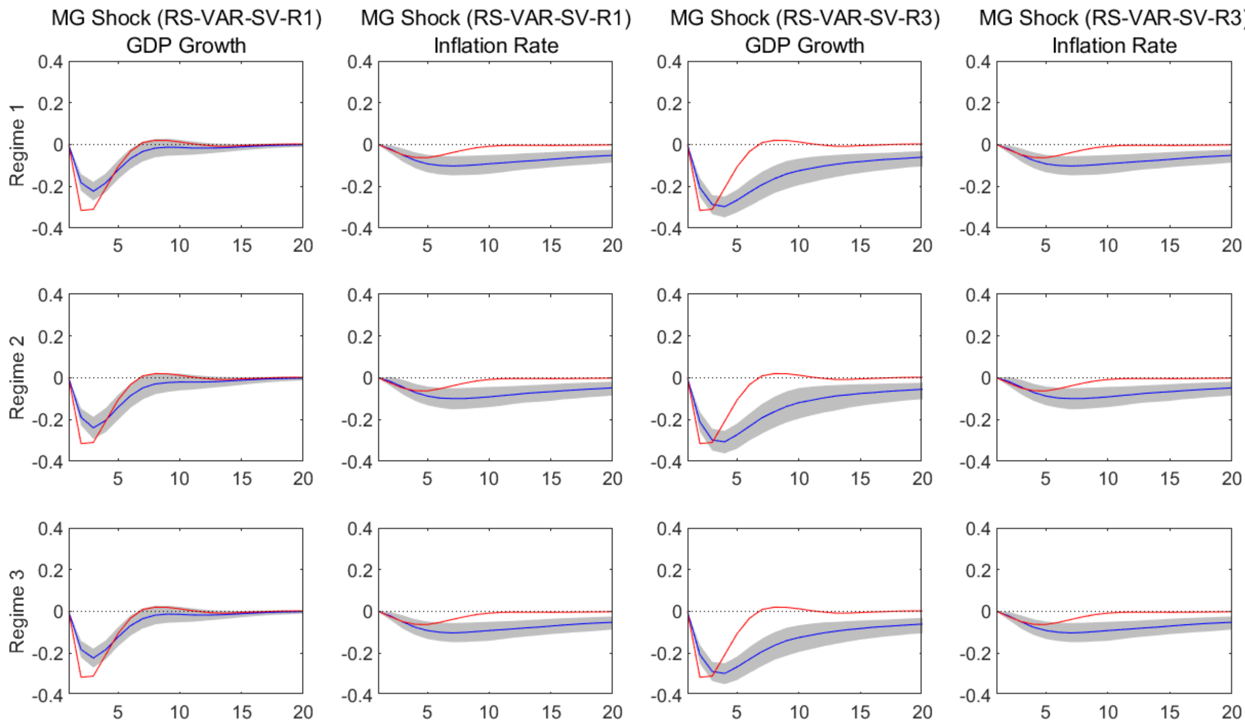

Figure 9. Median IRFs of GDP Growth and Inflation to a MG Shock for Regimes 1, 2 and 3 with Covid-19 Sample. The shocks are normalized to an increase of 1% in Money Growth for all regimes. The blue line represents the RS-VAR-SV-R1 ($r = 3$) Model and the shaded area, its 68% error band. The red line represents the CVAR Model.

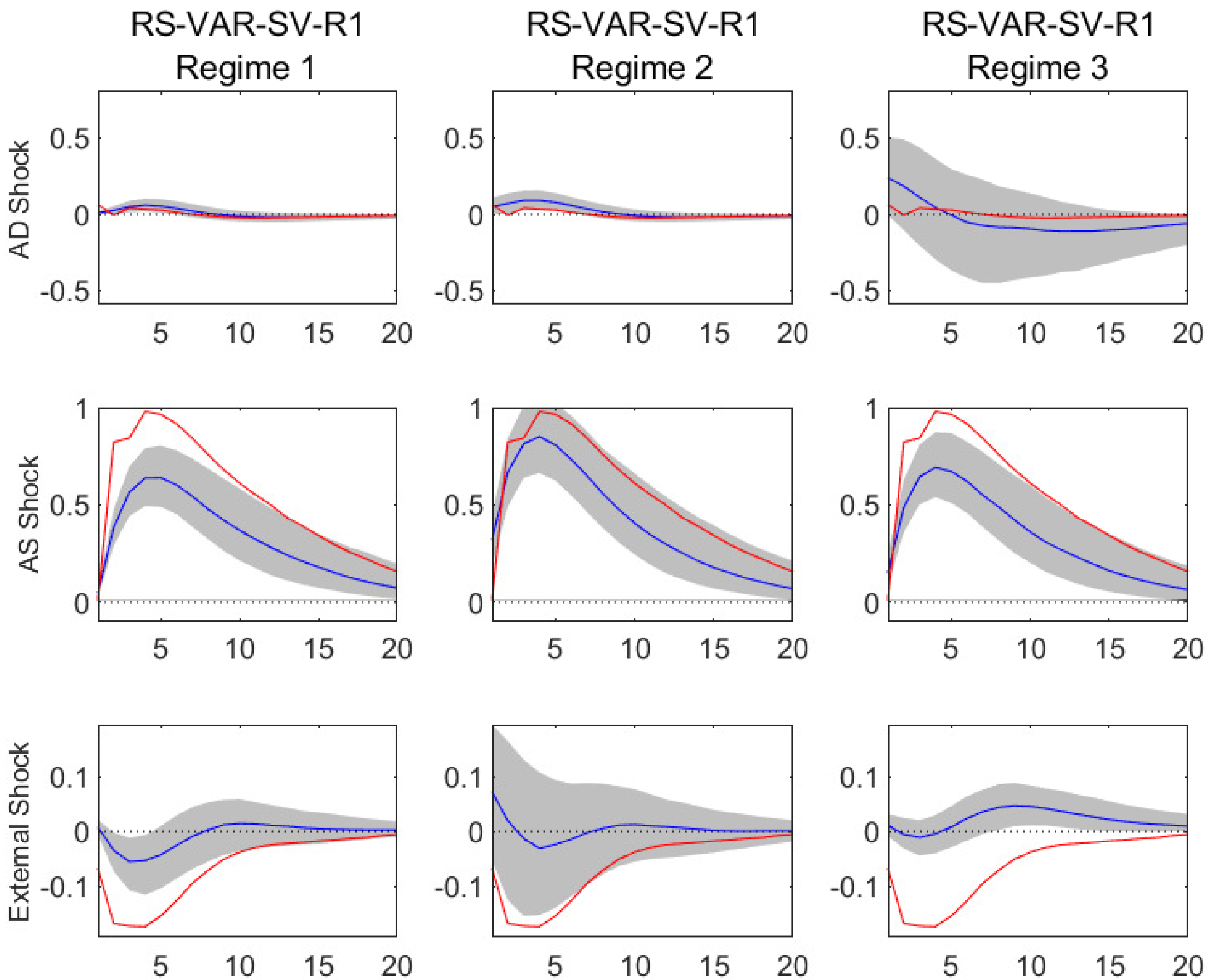

Figure 10. Median IRFs of Interest Rate to an AD, an AS and an External Shock with Covid-19 Sample. The shocks are normalized to an increase of 1% in GDP Growth, Inflation Rate and Terms of Trade Growth, respectively. The blue line represents the RS-VAR-SV-R1 ($r = 3$) Model and the shaded area, its 68% error band. The red line represents the CVAR Model.

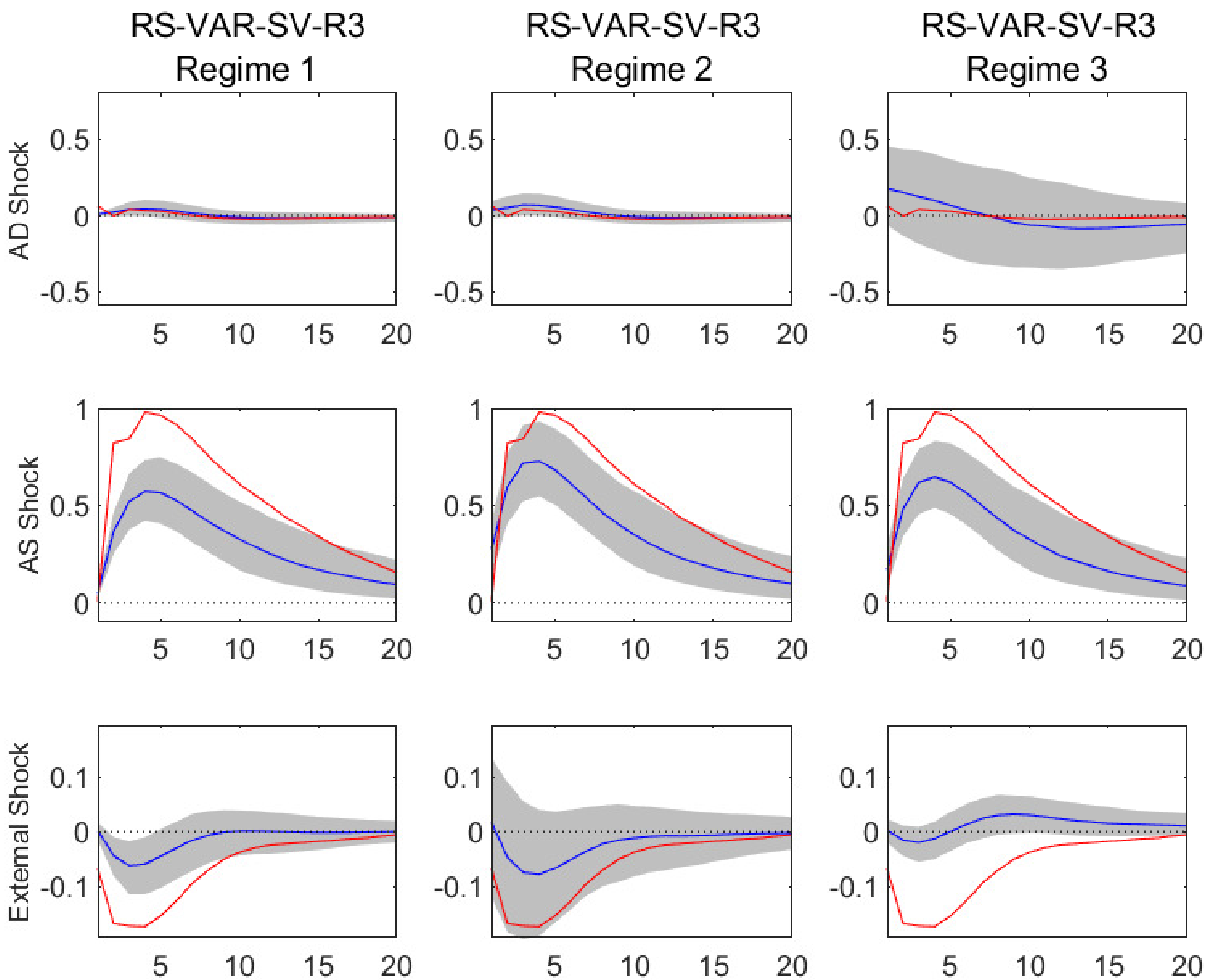

Figure 11. Median IRFs of Interest Rate to an AD, an AS and an External Shock with Covid-19 Sample. The shocks are normalized to an increase of 1% in GDP Growth, Inflation Rate and Terms of Trade Growth, respectively. The blue line represents RS-VAR-SV-R1 ($r = 3$) Model and the shaded area, its 68% error band. The red line represents the CVAR Model.

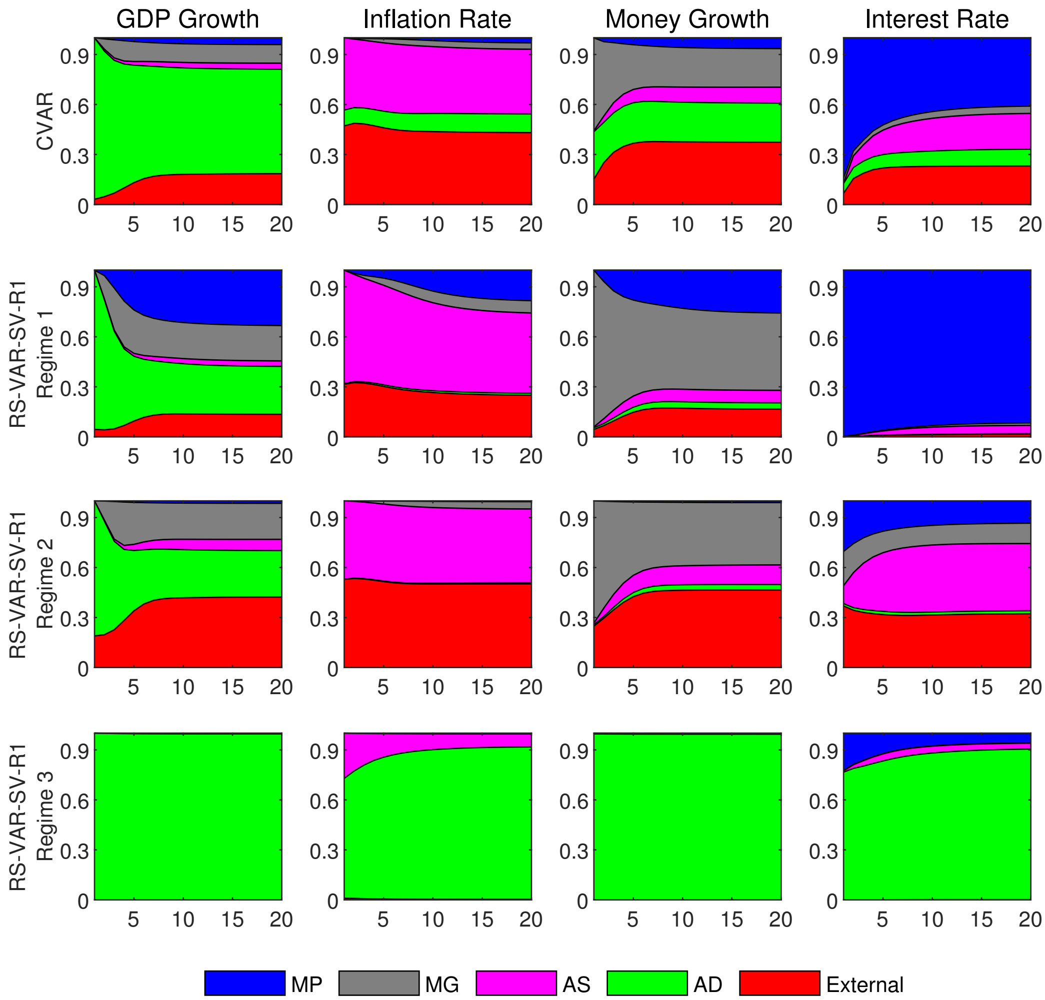

Figure 12. FEVD of GDP Growth, Inflation Rate, Money Growth and Interest Rate for RS-VAR-SV-R1 ($r = 3$) and CVAR Models at $h = 20$ with Covid-19 Sample

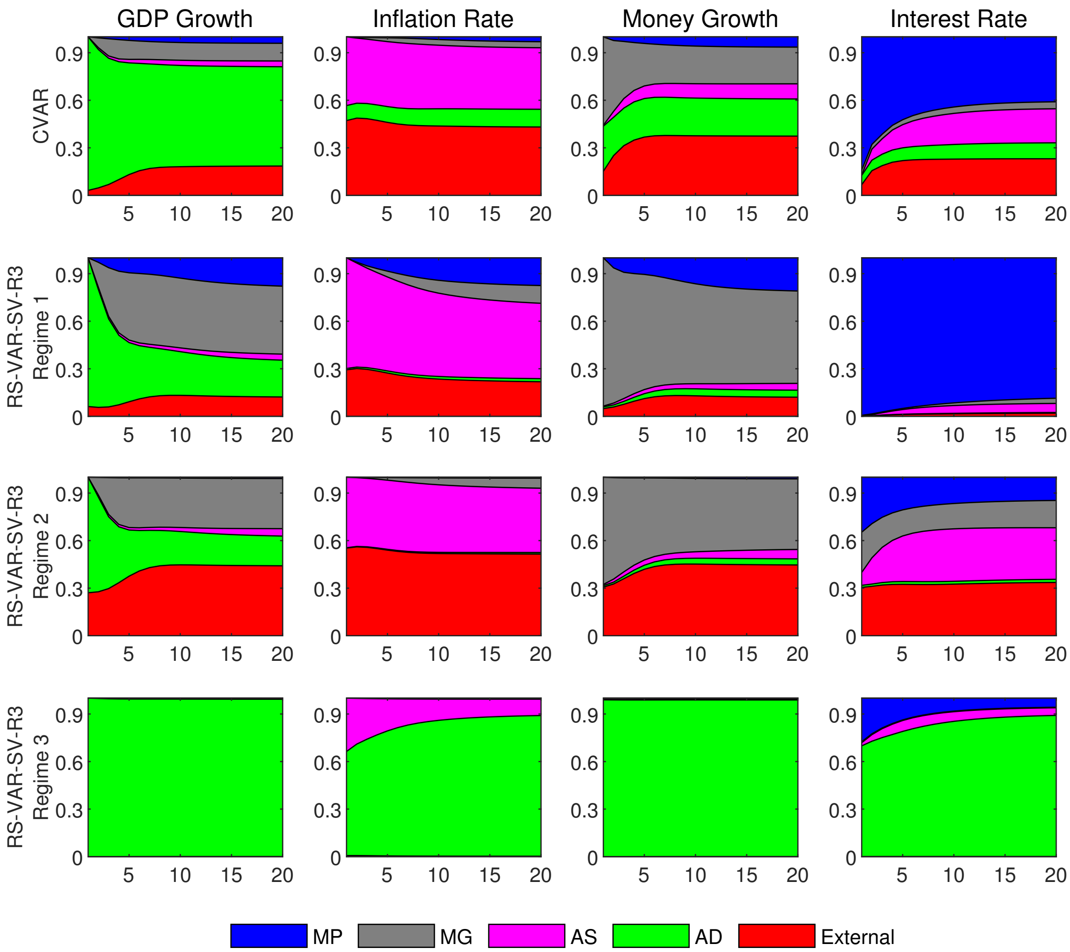

Figure 13. FEVD of GDP Growth, Inflation Rate, Money Growth and Interest Rate for RS-VAR-SV-R3 ($r = 3$) and CVAR Models at $h = 20$ with Covid-19 Sample

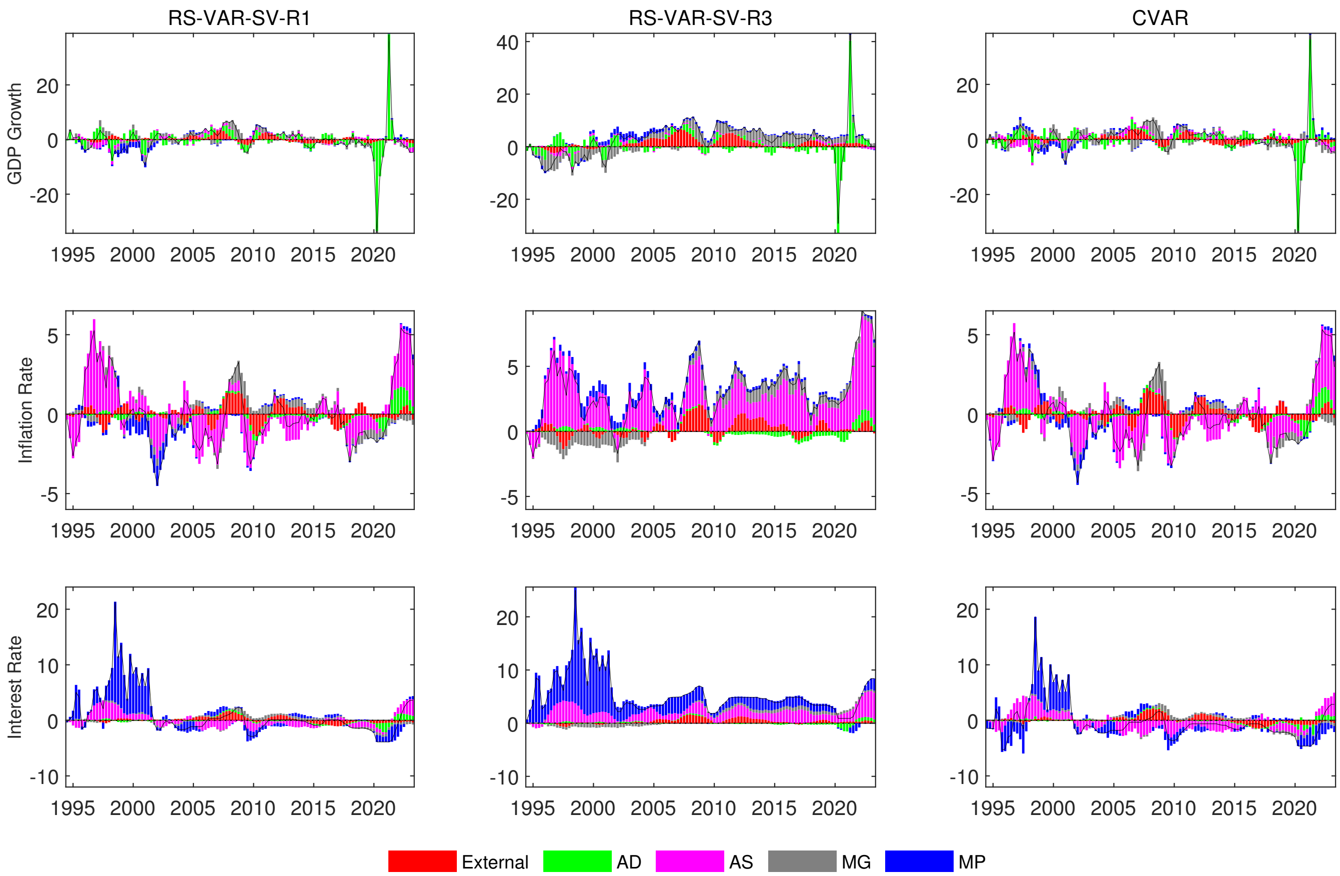

Figure 14. HD of GDP Growth, Inflation Rate, Money Growth and Interest Rate for RS-VAR-SV-R1 ($r = 3$), RS-VAR-SV-R3 ($r = 3$) and CVAR Models with Covid-19 Sample

ÚLTIMAS PUBLICACIONES DE LOS PROFESORES
DEL DEPARTAMENTO DE ECONOMÍA

- *Libros*

Alan Fairlie Reinoso y Ariana Figueroa
2024 *Programas de posgrado en crecimiento verde y desarrollo sostenible en América Latina: una aproximación comparativa*. Lima, INTE PUCP.

Félix Jiménez
2024 *La economía peruana del periodo 1950-2020.* Lima, Fondo Editorial PUCP.

Roxana Barrantes y José I. Távara (editores)
2023 *Perspectivas sobre desarrollo y territorio en el nuevo contexto. Homenaje a Efraín Gonzales de Olarte.* Lima, Fondo Editorial PUCP.

Efraín Gonzales de Olarte
2023 *La descentralización pasmada. Desconcentración y desarrollo regional en el Perú 2003-2020*. Lima, Fondo Editorial PUCP.

Adolfo Figueroa
2023 *The Quality of Society, Volume III. Essays on the Unified Theory of Capitalism.* New York, Palgrave Macmillan

Efraín Gonzales de Olarte
2023 *El modelo de Washington, el neoliberalismo y el desarrollo económico. El caso peruano 1990-2020. L*ima, Fondo Editorial PUCP.

Máximo Vega Centeno.
2023 *Perú: desarrollo, naturaleza y urgencias Una mirada desde la economía y el desarrollo humano.* Lima, Fondo Editorial PUCP.

Waldo Mendoza
2023 *Constitución y crecimiento económico: Perú 1993-2021*. Lima, Fondo Editorial PUCP.

Oscar Dancourt y Waldo Mendoza (Eds.)
2023 *Ensayos macroeconómicos en honor a Félix Jiménez*. Lima, Fondo Editorial PUCP.

Carlos Contreras Carranza (ed.)
2022 *Historia económica del Perú central. Ventajas y desafíos de estar cerca de la capital*. Lima, Banco Central de Reserva del Perú e Instituto de Estudios Peruanos.

Alejandro Lugon
2022 *Equilibrio, eficiencia e imperfecciones del mercado.* Lima, Fondo Editorial PUCP.

Waldo Mendoza Bellido
2022 *Cómo investigan los economistas. Guía para elaborar y desarrollar un proyecto de investigación. Segunda edición aumentada*. Lima, Fondo Editorial PUCP.

Elena Álvarez (Editor)
2022 *Agricultura y desarrollo rural en el Perú: homenaje a José María Caballero.* Lima, Departamento de Economía PUCP.

Aleida Azamar Alonso, José Carlos Silva Macher y Federico Zuberman (Editores)
2022 *Economía ecológica latinoamericana.* Buenos Aires, México. CLACSO, Siglo XXI Editores.

Efraín Gonzales de Olarte
2021 *Economía regional y urbana. El espacio importa.* Lima, Fondo Editorial PUCP.

Alfredo Dammert Lira
2021 *Economía minera*. Lima, Fondo Editorial PUCP.

Adolfo Figueroa
2021 *The Quality of Society, Volume II – Essays on the Unified Theory of Capitalism*. New York, Palgrave Macmillan.

Carlos Contreras Carranza (Editor)
2021 *La Economía como Ciencia Social en el Perú. Cincuenta años de estudios económicos en la Pontificia Universidad Católica del Perú.* Lima, Departamento de Economía PUCP.

José Carlos Orihuela y César Contreras
2021 *Amazonía en cifras: Recursos naturales, cambio climático y desigualdades.* Lima, OXFAM.

Alan Fairlie
2021 *Hacia una estrategia de desarrollo sostenible para el Perú del Bicentenario.* Arequipa, Editorial UNSA.

Waldo Mendoza e Yuliño Anastacio
2021 *La historia fiscal del Perú: 1980-2020. Colapso, estabilización, consolidación y el golpe de la COVID-19.* Lima, Fondo Editorial PUCP.

Cecilia Garavito
2020 *Microeconomía: Consumidores, productores y estructuras de mercado. Segunda edición.* Lima, Fondo Editorial de la Pontificia Universidad Católica del Perú.

Adolfo Figueroa
2019 *The Quality of Society Essays on the Unified Theory of Capitalism.* New York. Palgrave MacMillan.

Carlos Contreras y Stephan Gruber (Eds.)
2019 *Historia del Pensamiento Económico en el Perú. Antología y selección de textos*. Lima, Facultad de Ciencias Sociales PUCP.

Barreix, Alberto Daniel; Corrales, Luis Fernando; Benitez, Juan Carlos; Garcimartín, Carlos; Ardanaz, Martín; Díaz, Santiago; Cerda, Rodrigo; Larraín B., Felipe; Revilla, Ernesto; Acevedo, Carlos; Peña, Santiago; Agüero, Emmanuel; Mendoza Bellido, Waldo; Escobar Arango y Andrés.
2019 *Reglas fiscales resilientes en América Latina*. Washington, BID.

José D. Gallardo Ku

2019 *Notas de teoría para para la incertidumbre*. Lima, Fondo Editorial de la Pontificia Universidad Católica del Perú.

Úrsula Aldana, Jhonatan Clausen, Angelo Cozzubo, Carolina Trivelli, Carlos Urrutia y Johanna Yancari

2018 *Desigualdad y pobreza en un contexto de crecimiento económico*. Lima, Instituto de Estudios Peruanos.

Séverine Deneulin, Jhonatan Clausen y Arelí Valencia (Eds.)

2018 *Introducción al enfoque de las capacidades: Aportes para el Desarrollo Humano en América Latina*. Flacso Argentina y Editorial Manantial. Fondo Editorial de la Pontificia Universidad Católica del Perú.

Mario Dammil, Oscar Dancourt y Roberto Frenkel (Eds.)

2018 *Dilemas de las políticas cambiarias y monetarias en América Latina*. Lima, Fondo Editorial de la Pontificia Universidad Católica del Perú.

- *Documentos de trabajo*

No. 536 La dinámica de la inversión en una economía primario exportadora: un modelo. Waldo Mendoza. Julio 2024.

No. 535 Perú 1895-2019: Continuidad de la Dependencia Externa y Desindustrialización Prematura. Félix Jiménez. Junio 2024.

No. 534 'Bonos': Lecciones de las transferencias monetarias no condicionadas durante la pandemia de COVID-19 en Perú. Pedro Francke y Josue Benites. Abril 2024.

No. 533 Modeling the Trend, Persistence, and Volatility of Inflation in Pacific Alliance Countries: An Empirical Application Using a Model with Inflation Bands. Gabriel Rodríguez y Luis Surco. Febrero 2024.

No. 532 Regional Financial Development and Micro and Small Enterprises in Peru. Jennifer de la Cruz. Enero 2024.

No. 531 Time-Varying Effects of Financial Uncertainty Shocks on Macroeconomic Fluctuations in Peru. Mauricio Alvarado y Gabriel Rodríguez. Enero 2024.

No. 530 Experiments on the Different Numbers of Bidders in Sequential Auctions. Gunay, Hikmet y Ricardo Huamán-Aguilar. Enero 2024.

No. 529 External Shocks and Economic Fluctuations in Peru: Empirical Evidence using Mixture Innovation TVP-VAR-SV Models.
Brenda Guevara, Gabriel Rodríguez y Lorena Yamuca Salvatierra. Enero, 2024.

No. 528 COVID-19 y el mercado laboral de Lima Metropolitana y Callao: Un análisis de género.
Tania Paredes. Noviembre, 2023.

No. 527 COVID-19 y el alza de la inseguridad alimentaria de los hogares rurales en Perú durante 2020-2021.
Josue Benites y Pedro Francke. Noviembre, 2023.

No. 526 Globalización Neoliberal y Reordenamiento Geopolítico.
Jorge Rojas. Octubre, 2023.

No. 525 The effects of social pensions on mortality among the extreme poor elderly.
Jose A. Valderrama y Javier Olivera. Setiembre, 2023.

No. 524 Jane Haldimand Marcet: Escribir sobre economía política en el siglo XVIII.
Cecilia Garavito. Setiembre, 2023.

No. 523 Impact of Monetary Policy Shocks in the Peruvian Economy Over Time
Flavio Pérez Rojo y Gabriel Rodríguez. Agosto, 2023.

No. 522 Perú 1990-2021: la causa del "milagro" económico ¿Constitución de 1993 o Superciclo de las materias primas?
Félix Jiménez, José Oscátegui y Marco Arroyo. Agosto, 2023.

No. 521 Envejeciendo desigualmente en América Latina.
Javier Olivera. Julio, 2023.

No. 520 Choques externos en la economía peruana: un enfoque de ceros y signos en un modelo BVAR.
Gustavo Ganiko y Álvaro Jiménez. Mayo, 2023

No. 519 Ley de Okun en Lima Metropolitana 1970 – 2021.
Cecilia Garavito. Mayo, 2023

No. 518 Efectos 'Spillovers' (de derrame) del COVID-19 Sobre la Pobreza en el Perú: Un Diseño No Experimental de Control Sintético.
Mario Tello. Febrero, 2023

No. 517 Indicadores comerciales de la Comunidad Andina 2002-2021: ¿Posible complementariedad o convergencia regional?
Alan Fairlie y Paula Paredes. Febrero, 2023.

No. 516 Evolution over Time of the Effects of Fiscal Shocks in the Peruvian Economy: Empirical Application Using TVP-VAR-SV Models.
Alexander Meléndez Holguín y Gabriel Rodríguez. Enero, 2023.

No. 515 COVID-19 and Gender Differences in the Labor Market: Evidence from the Peruvian Economy.
Giannina Vaccaro, Tania Paredes. Julio 2022.

No. 514 Do institutions mitigate the uncertainty effect on sovereign credit ratings?
Nelson Ramírez-Rondán, Renato Rojas-Rojas y Julio A. Villavicencio. Julio 2022.

No. 513 Gender gap in pension savings: Evidence from Peru's individual capitalization system. Javier Olivera y Yadiraah Iparraguirre. Junio 2022.

No. 512 Poder de mercado, bienestar social y eficiencia en la industria microfinanciera regulada en el Perú. Giovanna Aguilar y Jhonatan Portilla. Junio 2022.

No. 511 Perú 1990-2020: Heterogeneidad estructural y regímenes económicos regionales ¿Persiste la desconexión entre la economía, la demografía y la geografía? Félix Jiménez y Marco Arroyo. Junio 2022.

No. 510 Evolution of the Exchange Rate Pass-Throught into Prices in Peru: An Empirical Application Using TVP-VAR-SV Models. Roberto Calero, Gabriel Rodríguez y Rodrigo Salcedo Cisneros. Mayo 2022.

No. 509 Time Changing Effects of External Shocks on Macroeconomic Fluctuations in Peru: Empirical Application Using Regime-Switching VAR Models with Stochastic Volatility. Paulo Chávez y Gabriel Rodríguez. Marzo 2022.

No. 508 Time Evolution of External Shocks on Macroeconomic Fluctuations in Pacific Alliance Countries: Empirical Application using TVP-VAR-SV Models. Gabriel Rodríguez y Renato Vassallo. Marzo 2022.

No. 507 Time-Varying Effects of External Shocks on Macroeconomic Fluctuations in Peru: An Empirical Application using TVP-VARSV Models. Junior A. Ojeda Cunya y Gabriel Rodríguez. Marzo 2022.

No. 506 La Macroeconomía de la cuarentena: Un modelo de dos sectores. Waldo Mendoza, Luis Mancilla y Rafael Velarde. Febrero 2022.

No. 505 ¿Coexistencia o canibalismo? Un análisis del desplazamiento de medios de comunicación tradicionales y modernos en los adultos mayores para el caso latinoamericano: Argentina, Colombia, Ecuador, Guatemala, Paraguay y Perú. Roxana Barrantes Cáceres y Silvana Manrique Romero. Enero 2022.

No. 504 "Does the Central Bank of Peru Respond to Exchange Rate Movements? A Bayesian Estimation of a New Keynesian DSGE Model with FX Interventions". Gabriel Rodríguez, Paul Castillo B. y Harumi Hasegawa. Diciembre, 2021

No. 503 "La no linealidad en la relación entre la competencia y la sostenibilidad financiera y alcance social de las instituciones microfinancieras reguladas en el Perú". Giovanna Aguilar y Jhonatan Portilla. Noviembre, 2021.

No. 502 "Approximate Bayesian Estimation of Stochastic Volatility in Mean Models using Hidden Markov Models: Empirical Evidence from Stock Latin American Markets". Carlos A. Abanto-Valle, Gabriel Rodríguez, Luis M. Castro Cepero y Hernán B. Garrafa-Aragón. Noviembre, 2021.

No. 501 "El impacto de políticas diferenciadas de cuarentena sobre la mortalidad por COVID-19: el caso de Brasil y Perú". Angelo Cozzubo, Javier Herrera, Mireille Razafindrakoto y François Roubaud. Octubre, 2021.

No. 500 "Determinantes del gasto de bolsillo en salud en el Perú". Luis García y Crissy Rojas. Julio, 2021.

No. 499 "Cadenas Globales de Valor de Exportación de los Países de la Comunidad Andina 2000-2015". Mario Tello. Junio, 2021.

No. 498 "¿Cómo afecta el desempleo regional a los salarios en el área urbana? Una curva de salarios para Perú (2012-2019)". Sergio Quispe. Mayo, 2021.

No. 497 "¿Qué tan rígidos son los precios en línea? Evidencia para Perú usando Big Data". Hilary Coronado, Erick Lahura y Marco Vega. Mayo, 2021.

No. 496 "Reformando el sistema de pensiones en Perú: costo fiscal, nivel de pensiones, brecha de género y desigualdad". Javier Olivera. Diciembre, 2020.

No. 495 "Crónica de la economía peruana en tiempos de pandemia". Jorge Vega Castro. Diciembre, 2020.

No. 494 "Epidemia y nivel de actividad económica: un modelo". Waldo Mendoza e Isaías Chalco. Setiembre, 2020.

No. 493 "Competencia, alcance social y sostenibilidad financiera en las microfinanzas reguladas peruanas". Giovanna Aguilar Andía y Jhonatan Portilla Goicochea. Setiembre, 2020.

No. 492 "Empoderamiento de la mujer y demanda por servicios de salud preventivos y de salud reproductiva en el Perú 2015-2018". Pedro Francke y Diego Quispe O. Julio, 2020.

No. 491 “Inversión en infraestructura y demanda turística: una aplicación del enfoque de control sintético para el caso Kuéalp, Perú”. Erick Lahura y Rosario Sabrera. Julio, 2020.

No. 490 “La dinámica de inversión privada. El modelo del acelerador flexible en una economía abierta”. Waldo Mendoza Bellido. Mayo, 2020.

No. 489 “Time-Varying Impact of Fiscal Shocks over GDP Growth in Peru: An Empirical Application using Hybrid TVP-VAR-SV Models”. Álvaro Jiménez y Gabriel Rodríguez. Abril, 2020.

No. 488 “Experimentos clásicos de economía. Evidencia de laboratorio de Perú”. Kristian López Vargas y Alejandro Lugon. Marzo, 2020.

No. 487 “Investigación y desarrollo, tecnologías de información y comunicación e impactos sobre el proceso de innovación y la productividad”. Mario D. Tello. Marzo, 2020.

No. 486 “The Political Economy Approach of Trade Barriers: The Case of Peruvian’s Trade Liberalization”. Mario D. Tello. Marzo, 2020.

No. 485 “Evolution of Monetary Policy in Peru. An Empirical Application Using a Mixture Innovation TVP-VAR-SV Model”. Jhonatan Portilla Goicochea y Gabriel Rodríguez. Febrero, 2020.

No. 484 “Modeling the Volatility of Returns on Commodities: An Application and Empirical Comparison of GARCH and SV Models”. Jean Pierre Fernández Prada Saucedo y Gabriel Rodríguez. Febrero, 2020.

No. 483 “Macroeconomic Effects of Loan Supply Shocks: Empirical Evidence”. Jefferson Martínez y Gabriel Rodríguez. Febrero, 2020.

No. 482 “Acerca de la relación entre el gasto público por alumno y los retornos a la educación en el Perú: un análisis por cohortes”. Luis García y Sara Sánchez. Febrero, 2020.

No. 481 “Stochastic Volatility in Mean. Empirical Evidence from Stock Latin American Markets”. Carlos A. Abanto-Valle, Gabriel Rodríguez y Hernán B. Garrafa-Aragón. Febrero, 2020.

No. 480 “Presidential Approval in Peru: An Empirical Analysis Using a Fractionally Cointegrated VAR2”. Alexander Boca Saravia y Gabriel Rodríguez. Diciembre, 2019.

No. 479 “La Ley de Okun en el Perú: Lima Metropolitana 1971 – 2016.” Cecilia Garavito. Agosto, 2019.

No. 478 “Peru´s Regional Growth and Convergence in 1979-2017: An Empirical Spatial Panel Data Analysis”. Juan Palomino y Gabriel Rodríguez. Marzo, 2019.

- *Materiales de Enseñanza*

No. 10 "Boleta o factura: el impuesto general a las ventas (IGV) en el Perú". Jorge Vega Castro. Abril, 2023

No. 9 "Economía Pública. Segunda edición". Roxana Barrantes Cáceres, Silvana Manrique Romero y Carla Glave Barrantes. Febrero, 2023.

No. 8 "Economía Experimental Aplicada. Programación de experimentos con oTree". Ricardo Huamán-Aguilar. Febrero, 2023

No. 7 "Modelos de Ecuaciones Simultáneas (MES): Aplicación al mercado monetario". Luis Mancilla, Tania Paredes y Juan León. Agosto, 2022

No. 6 "Apuntes de Macroeconomía Intermedia". Felix Jiménez. Diciembre, 2020

No. 5 "Matemáticas para Economistas 1". Tessy Váquez Baos. Abril, 2019.

No. 4 "Teoría de la Regulación". Roxana Barrantes. Marzo, 2019.

No. 3 "Economía Pública". Roxana Barrantes, Silvana Manrique y Carla Glave. Marzo, 2018.

No. 2 "Macroeconomía: Enfoques y modelos. Ejercicios resueltos". Felix Jiménez. Marzo, 2016.

No. 1 "Introducción a la teoría del Equilibrio General". Alejandro Lugon. Octubre, 2015.

Departamento de Economía - Pontificia Universidad Católica del Perú
Av. Universitaria 1801, San Miguel, 15008 – Perú
Telf. 626-2000 anexos 4950 – 4951
https://departamento-economia.pucp.edu.pe/