Research Article

Testing Monetary Sovereignty and Structural Inflation Shifts: Evidence from Croatia's Euro Transition (2000–2024)

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This paper examines how Croatia's transition from monetary sovereignty to euro adoption reconfigured the structure of inflation transmission between 2000 and 2024. Using a two-stage empirical framework grounded in Modern Monetary Theory (MMT), the study first tests the Decoupling Axiom through a Panel ARDL model across Croatia and comparable CEE donor economies, confirming that pre-euro policy interest rates operated independently of fiscal stance—demonstrating functional monetary sovereignty. Results — as the second stage — from the Hybrid Bayesian Structural Time Series (BSTS) model reveal a structural inversion in inflation dynamics: asset-based channels, represented by new housing markets, contract markedly after euro adoption, while consumer sectors display persistent upward transmission. The redistribution of price pressure from assets toward consumption suggests a systemic reorientation of inflation's internal structure following the loss of monetary sovereignty. Validated through CausalImpact and Gsynth robustness checks, these findings confirm that euro adoption strengthened nominal stability while simultaneously opening a delayed channel for consumption inflation—a result fully consistent with MMT's prediction of asymmetric inflation under a shared monetary regime.

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1. Introduction

The introduction of the euro marked a profound transformation in the institutional architecture of European monetary governance. For small open economies such as Croatia, this transition entailed not only a nominal currency change but a structural redefinition of macroeconomic sovereignty. Under

sovereign monetary regimes, fiscal and monetary authorities retain the capacity to coordinate liquidity management, debt issuance, and domestic stabilization. By contrast, euro adoption substitutes domestic discretion with external anchoring—monetary policy becomes exogenous, and inflation transmission mechanisms are reshaped by supranational financial and policy structures.

Within this reconfigured regime, Croatia's 2023 euro adoption represents a decisive moment in its long trajectory of monetary integration. While the transition secured institutional credibility and exchange rate stability, it also constrained the state's capacity for autonomous macroeconomic adjustment—a trade-off emblematic of vulnerabilities long observed in the Eurozone periphery. Earlier studies highlight how monetary convergence amplifies asymmetric shocks[1], weakens fiscal responsiveness[2], and fosters core–periphery inflation divergence[3]. These dynamics are particularly relevant for small economies where domestic sterilization capacity and credit multipliers are structurally limited.

Modern Monetary Theory (MMT) provides a conceptual framework for interpreting these transformations. It defines monetary sovereignty not merely as the legal issuance of a currency, but as the institutional capacity to issue, tax, and regulate it[4][5]. Within this framework, inflation reflects the interaction between fiscal capacity, productive constraints, and institutional autonomy. Once monetary authority is surrendered, as through euro adoption, a country forfeits its ability to sterilize liquidity or offset external shocks through endogenous policy coordination. Inflation then ceases to be a domestic variable—it becomes a derivative of cross-border financial flows and imported cost structures.

Croatia's post-2021 inflation trajectory vividly illustrates this transition. The initial surge, driven by pandemic-related supply disruptions (2021), energy shocks (2022), and government-mandated wage adjustments[6], was structurally amplified by euro adoption. While these transitory factors elevated prices temporarily, the currency transition produced a deeper regime shift: a rechanneling of inflation pressure from asset-based to consumption-based sectors. This dynamic validates MMT's prediction that monetary integration redistributes inflationary burdens toward consumption goods and household demand[7][8].

Empirically, the study employs a two-stage framework. The first stage tests the Decoupling Axiom—the proposition that sovereign monetary systems exhibit independence between fiscal stance and policy interest rates—using a Panel ARDL model across Croatia and comparable CEE economies. The second stage applies a Hybrid Bayesian Structural Time Series (BSTS) model, validated through CausalImpact

and Generalized Synthetic Control (Gsynth) frameworks, to identify how the loss of monetary sovereignty reshaped inflation transmission following euro adoption.

The findings reveal a marked inversion in inflation dynamics: asset-based price growth, particularly in new housing and investment categories, contracted after euro adoption, while consumption-related inflation accelerated. This structural reallocation of inflationary pressure signifies the transformation of inflation from a policy-anchored to a market-driven process—consistent with MMT's theoretical proposition that the erosion of monetary sovereignty redefines both the composition and propagation of price dynamics.

In doing so, this paper bridges theoretical and empirical perspectives on monetary integration, demonstrating how the euro's stabilizing credibility coexists with the structural weakening of domestic transmission autonomy. The results have broader implications for understanding inflation asymmetries in peripheral Eurozone members and for evaluating the policy trade-offs between nominal stability, fiscal flexibility, and inflation resilience.

2. Literature Overview

The literature on monetary sovereignty and inflation transmission has evolved through two distinct paradigms. Traditional models—rooted in New Keynesian and DSGE frameworks—emphasize price stability as a function of nominal anchors and external credibility[9][10]. These models view monetary integration as a stabilizing mechanism that disciplines fiscal policy and anchors expectations. Recent extensions[11][12] highlight how post-pandemic inflation dynamics in the Eurozone exposed the fragility of this framework—demonstrating that credibility-based stabilization can coexist with persistent structural asymmetries.

However, recent critiques, particularly from the Modern Monetary Theory (MMT) perspective, argue that such integration erodes domestic policy autonomy and redistributes inflationary pressure across sectors[7][5]. Within the MMT framework, inflation reflects the interaction between fiscal capacity, productive constraints, and institutional sovereignty. Empirical studies on post-sovereignty regimes show that the loss of currency control often shifts inflation transmission from asset and investment channels toward consumer and import-dependent sectors[13][8]. This view is complemented by critical macro-financial approaches[14], which emphasize that euro-area integration embeds hierarchical

liquidity structures—limiting peripheral states' ability to manage domestic credit cycles and price formation.

This realignment implies that monetary integration stabilizes expectations but weakens the internal capacity to absorb liquidity shocks—especially in small open economies. Lane[15] further shows that persistent productivity differentials and supply-side rigidities within the Eurozone continue to generate asymmetric inflation responses despite common monetary conditions, reinforcing MMT's claim that structural divergence endures beyond nominal convergence.

Complementary arguments have been advanced by Stiglitz[16], who, from a neo-Keynesian standpoint, highlights the structural unsustainability of the euro project arising from persistent productivity and fiscal asymmetries across member states. He contends that the absence of a fiscal union and limited adjustment mechanisms amplify cyclical divergence and constrain national responses to inflationary pressures. In this sense, Stiglitz's critique aligns with MMT insights: both suggest that the erosion of monetary sovereignty reduces macroeconomic flexibility and exposes peripheral economies to externally transmitted inflation dynamics.

Parallel methodological developments have expanded the toolkit for analyzing such transitions. The Bayesian Structural Time Series (BSTS) framework[17] enables causal inference in the presence of latent structural components, while the CausalImpact extension[18] and Generalized Synthetic Control[19] approaches enhance counterfactual credibility in policy evaluation. Recent advances in macroeconometric modeling—such as high-dimensional dynamic factor structures[20] and refined Bayesian convergence diagnostics[21]—have strengthened the empirical reliability of hierarchical and synthetic inference methods, allowing for robust estimation of policy effects in small samples. Applied to the euro context, these methods permit the decomposition of inflation responses into structural, sectoral, and regime-specific effects.

Building on these theoretical and methodological foundations, this study applies a two-stage empirical framework to the Croatian case, using the Modern Monetary Theory (MMT) perspective as an interpretive lens for understanding how the loss of currency sovereignty reconfigures inflation transmission under euro adoption.

3. Theoretical Framework

The adoption of the euro in 2023 marked not merely the completion of Croatia's monetary integration into the Eurozone but a structural transformation of its inflation transmission mechanisms. Within the lens of Modern Monetary Theory (MMT), this change represents a transition from a sovereignly managed system—where the state could channel inflation between asset and consumer sectors—to an externally anchored regime where such discretion is lost[4].

3.1. Dual Inflation Channels under Sovereign Monetary Conditions

During the sovereign *kuna* period, Croatia exhibited a dual-channel inflation structure, reflecting deliberate monetary management consistent with MMT's notion of functional sovereignty. The central bank (CNB) maintained control over liquidity through sterilized interventions, which enabled selective inflation channeling between asset markets and the consumer economy.

1. Asset-Based Channel: Inflation pressures were directed primarily into *asset-bearing sectors*—notably new housing and real estate—where capital absorption acted as a stabilizer for broader price levels. This process reflected a quasi-Keynesian use of asset inflation as a containment mechanism for excess liquidity[22], whereby monetary authorities deliberately redirected inflationary pressures toward real estate markets—transforming housing into a 'liquidity sink' that suppressed consumer price volatility while generating collateral-driven demand. The resulting appreciation in real estate values benefited asset holders, developers, and foreign investors, while leaving consumer price inflation relatively subdued.
2. Consumption-Based Channel: Inflation in everyday goods—food, transport, utilities etc.— remained stable due to the CNB's sterilization of tourism-driven forex inflows—a mechanism that functioned as a liquidity tax[4][23]. By issuing domestic bonds to absorb excess kunas, the CNB weaponized monetary contraction against consumption channels, starving households of purchasing power while preserving asset-market liquidity[24]. This asymmetric containment explains the divergence between Croatia's soaring real estate prices and subdued CPI.

This two-tiered structure demonstrates MMT's core claim: under sovereign conditions, inflation can be *distributed* rather than uniformly transmitted. The capacity to direct inflation into asset markets, while insulating consumer prices, sustained social and macroeconomic stability at the cost of rising wealth inequality.

(For formal expressions of this framework, see Appendix A: Formal MMT Transmission Framework.)

3.2. Regime Transition: From Sovereign Control to Euro Externalization

Euro adoption in 2023 fundamentally altered Croatia's monetary structure by surrendering control over interest rates, exchange interventions, and sterilization mechanisms. As De Grauwe[25] establishes, joining a monetary union entails the irreversible loss of national monetary policy instruments, binding members to a one-size-fits-all framework—an aggregate monetary space within which peripheral economies like Croatia face even less autonomy than U.S. states such as Arizona. Consequently, Croatia now faces liquidity and inflation dynamics externally determined by the European Central Bank (ECB)—a transition Wray[4] characterizes as 'the abandonment of functional sovereignty in inflation management.' This structural shift exposes Croatia to the ECB's policy priorities, which may misalign with domestic economic conditions, as evidenced by divergent inflation trajectories across small Eurozone economies[1][26].

Three key outcomes follow from this transition:

1. Loss of Monetary Sovereignty: The CNB can no longer sterilize euro inflows, leading to direct liquidity injection into the domestic economy. This exposes households to higher *consumption-based inflation* as euros circulate unmediated through demand channels.
2. Persistence—but Transformation—of Asset Inflation: Asset markets, especially housing, remain buoyant due to Eurozone credit integration and cross-border portfolio flows. Yet, without autonomous policy instruments, these inflows cannot be offset domestically, turning housing into a speculative rather than stabilizing channel.
3. Structural Spread Divergence: The inflation spread *Spread(A-C)=π(Assets)-π(Consumables)* shifts from near-zero/positive under sovereign conditions (where targeted sterilization contained π_C) to decisively negative post-euro. This reversal reflects MMT's prediction that currency unions force inflation convergence onto consumption baskets via unmediated liquidity injection[4][23]—a pattern empirically observed in Eurozone periphery economies where π_C outpaces π_A by 2–5 pp[1][3].

This reversal represents a *financialization of inflation transmission*: rather than channeling excess liquidity into asset buffers, the system now amplifies consumption volatility while asset inflation persists at high but uneven levels.

3.3. Distributional and Structural Implications

The altered inflation dynamics redefined socioeconomic burdens, redistributing losses to ordinary households while entrenching gains for asset holders.

- Under sovereignty, sterilization policies shielded consumers[16]—largely protecting low/middle-income households from essentials inflation—while deliberate liquidity channeling enriched asset holders through managed real estate and equity appreciation[27].
- Post-euro, unmediated liquidity floods consumption channels, *impoverishing ordinary households* via uncontained inflation in essentials (food, utilities)[28]. Concurrently, asset holders capture gains from speculative capital inflows—now detached from stabilization logic—deepening wealth inequality[29].

This inversion—where, in relative terms, ordinary households become losers while asset holders remain winners—epitomizes Croatia's descent from functional sovereignty to financial dependence. As Blyth[30] warns, euro membership reduces states to "rule-takers," redistributing inflation burdens to the socially vulnerable. Croatia's inflation now mirrors external governance, its transmission channels structurally favoring capital over labor[4], thereby amplifying social transmission asymmetries: around one fifth of the population remains at risk of poverty or social exclusion, and over a third of those aged 65 + face the same risk[31].

4. The Methodological Design and Data

The methodological design of this study is structured to examine whether the surrender of monetary sovereignty — exemplified by Croatia's 2023-euro adoption — has altered the mechanisms through which inflation and asset prices interact. The analysis follows the logic of Modern Monetary Theory (MMT), in which the capacity to direct inflation through distinct channels depends on the institutional autonomy of the monetary authority.

Accordingly, the research proceeds in two stages, reflecting the transition from theoretical preconditions (sovereign control, sterilization, FX buffering) to empirically observable post-euro dynamics (spread divergence and inflation reallocation).

4.1. Stage 1: Pre-Euro Analysis — MMT Decoupling Precondition Test

Stage 1 serves as a structural precondition test for the MMT Decoupling Axiom[4], which posits that monetarily sovereign regimes exhibit institutional independence between policy interest rates and fiscal stance—particularly government debt dynamics[32]. To confirm Croatia's pre-euro sovereignty, we implement a panel ARDL framework testing for dynamic separation between fiscal and monetary variables. This follows Bell's[23] sterilization-based sovereignty criterion and Tymoigne & Wray's[33] empirical identification of decoupling—establishing the structural foundation for Bayesian counterfactual analysis in Stage 2.

The general specification is expressed as:

$$r_i t = \alpha_i + \beta_1 r_{i,t-1} + \beta_2 d_{i,t} + \beta_3 d_{i,t-1} + \beta_4 f x_{i,t} + \varepsilon_{i,t}$$

where:

- $r_{i,t}$: short-term interest rate (policy rate proxy)
- $d_{i,t}$: government debt-to-GDP ratio (fiscal stance indicator)
- $d_{i,t-1}$: lagged government debt ratio (fiscal inertia)
- $f x_{i,t}$: tourism-related foreign exchange inflows as a share of GDP (external buffer)
- $\varepsilon_{i,t}$: error term

The ARDL framework captures both short-run adjustments and long-run equilibrium relationships between monetary and fiscal dynamics, while allowing for cross-country heterogeneity.

The panel ARDL approach is particularly suitable for this pretest stage because it:

- accommodates variables of mixed integration orders (I(0) and I(1)),
- distinguishes between short-run fiscal adjustments and long-run monetary equilibrium,
- and allows for country-specific dynamics through fixed effects (α_i)

The estimation procedure proceeds as follows:

Stationarity Testing – Using the Im-Pesaran-Shin (IPS) test for heterogeneous panels[34], the Levin-Lin-Chu (LLC) test for common unit roots[35], and the Cross-sectionally Augmented IPS (CIPS) test to account for cross-sectional dependence[36]. This comprehensive approach ensures robust diagnosis of integration orders while correcting for finite-sample distortions[37].

Cointegration Testing – Applying Pedroni's[38] residual-based cointegration tests for heterogeneous panels and Kao's[39] cointegration test for homogeneous panels. These tests accommodate varying cointegration vectors across countries, which is critical for sovereignty analysis where fiscal-monetary dynamics may differ[40].

Model Estimation – Estimating both short-run and long-run coefficients via the ARDL (p, q) specification, with Driscoll-Kraay standard errors to correct for spatial correlation and heteroskedasticity[41][42].

This model empirically tests the MMT Decoupling Axiom, which posits that monetary sovereignty implies

$$\partial r_t / \partial d_t \approx 0$$

meaning that changes in government debt ratios do not systematically influence policy interest rates in sovereign currency regimes.

A statistically insignificant β_2 and β_3 would therefore confirm the MMT decoupling precondition, validating that Croatia operated under effective monetary sovereignty prior to euro adoption.

In parallel, the inclusion of the tourism inflow variable (fx_t) serves to evaluate whether foreign-exchange buffers functioned as stabilizing channels, indirectly influencing policy rates through liquidity management. A statistically significant and negative β_4 would indicate that tourism-related FX inflows acted as a stabilizing factor—absorbing external pressures and supporting policy rate stability—consistent with the theoretical transmission structure formalized in Appendix A: Formal MMT Transmission Framework.

If the estimated coefficients confirm that $\beta_2, \beta_3 \approx 0$ (debt neutrality) and $\beta_4 < 0$ (FX buffer stabilization), this empirically validates Croatia's satisfaction of the MMT functional sovereignty condition[4][23]. Debt neutrality ($\beta_2, \beta_3 \approx 0$) reflects institutional separation between fiscal stance and monetary policy—where central banks set rates independently of debt dynamics[23]. FX stabilization ($\beta_4 < 0$) confirms tourism inflows acted as liquidity buffers, dampening rate volatility[24].

The model intentionally excludes broader macroeconomic controls (e.g., unemployment, GDP growth) to maintain direct correspondence with the MMT decoupling axiom. Extraneous variables would obscure the core fiscal-monetary independence test[32]. These covariates—along with the primary outcome variable (the asset-consumption inflation spread)—will instead be incorporated in Stage 2's

counterfactual analysis. Such confirmation justifies transitioning to Stage 2, where Bayesian Structural Time Series (BSTS)[18] and Generalized Synthetic Control (GSC)[19] methods examine how losing sovereignty restructured inflation transmission. The empirical verification of MMT's decoupling axiom thus establishes the structural foundation for causal analysis: having confirmed Croatia's pre-euro operational autonomy, Stage 2 quantifies how euro adoption reconfigured inflation dynamics through externally governed channels.

4.2. Stage 2: Post-Euro Analysis — Modeling Structural Inflation Spread Dynamics via BSTS

Following the confirmation of MMT's Decoupling Axiom in Stage 1, the second analytical stage examines how the loss of monetary sovereignty—brought by Croatia's euro adoption in 2023—reshaped the inflation spread between asset and consumption sectors, a key indicator of structural transmission shifts[43][44].

The primary goal of Stage 2 is to identify how the transition to the euro altered the structural composition of inflation, using inflation spreads as quantitative indicators of transmission shifts.

$$Spread_t(A - C) = \pi_t^A - \pi_t^C$$

where:

- π_t^A: inflation in asset-based goods (e.g., new housing, vehicles)
- π_t^C: inflation in consumption sectors (food, restaurants, transport, ect.)

A narrowing or negative $Spread_t(A - C) = \pi_t^A$ indicates structural inversion: consumer inflation overtaking asset inflation—a hallmark of externally constrained monetary regimes[45].

The Hybrid Bayesian Structural Time Series (BSTS) framework forms the central analytical model, estimating posterior impacts of euro adoption on inflation spreads across sectoral pairs for the period 2000–2024.

The generic form of each BSTS model is:

$$Spread_{i,t} = \mu_{i,t} + \tau_{i,t} + \beta \mathrm{X}_{\mathrm{i},t} + \varepsilon_{\mathrm{i},t}$$

where: $\mu_{i,t}$is the local trend, $\tau_(i,t)$is autoregressive component, and X_it represents confounding variables, including MMT indicators and other macroeconomic controls, while $\varepsilon_{\mathrm{i},\mathrm{t}}$ denotes the error term.

BSTS posterior results yield the impact mean (expected regime shift) and 95% credible intervals (impact_lo, impact_hi). Following Gelman et al.'s[46] Bayesian principles, these intervals represent the posterior probability distribution of the treatment effect—where values excluding zero indicate statistically significant regime shifts. Negative posteriors signify consumer inflation dominance; positive posteriors denote asset inflation persistence[18].

The posterior impact map visualizes this structural divergence through color-coded distributions, operationalizing the theoretical transition from sovereignty (λ, $\omega \to 0$) to spread inversion. As Vehtari et al.[21] emphasize, such visualizations translate Bayesian posterior analytics into actionable policy intelligence (p. 103).

If results confirm negative posterior impacts in the asset–consumption spread, this will substantiate the hypothesis that euro adoption induced asset market cooling and amplified consumer inflation—manifesting the MMT prediction that loss of monetary sovereignty externalizes inflation transmission. Sectorally-resolved posterior maps will visualize heterogeneous transmission channels, distinguishing systemic sovereignty loss from idiosyncratic market dynamics.

4.3. Robustness and Validation Strategy

To ensure the credibility and internal coherence of the BSTS Hybrid estimates, a structured, multi-layer robustness validation was performed. This strategy combines Bayesian counterfactual testing, external synthetic validation, and internal placebo simulations. Each stage provides a complementary perspective on the reliability of post-euro inflation spread dynamics.

- CausalImpact Validation (Primary Bayesian Counterfactual)

The CausalImpact framework[18] re-estimates post-treatment trajectories under a Bayesian counterfactual model, generating predicted inflation spreads for a synthetic “no-euro” scenario.

Consistency between the BSTS posterior means and CausalImpact credible intervals confirms the internal stability of the Bayesian specification and strengthens inference credibility.

The posterior impacts show directionally coherent deviations across all major inflation components, indicating that the introduction of the euro produced statistically robust and economically meaningful shifts in spread behaviour.

- Generalized Synthetic Control (GSC) Validation (Secondary Cross-Check)

The Generalized Synthetic Control (GSC) method (gsynth;[19] is applied as a secondary robustness check, providing an external benchmark for the baseline BSTS results.

Rather than testing statistical significance, the GSC validation focuses on the directional consistency of treatment effects under an alternative, frequentist counterfactual framework.

The model reconstructs Croatia's counterfactual inflation paths by combining donor economies with comparable pre-2023 characteristics.

Two specifications are estimated:

1. a baseline GSC using sectoral inflation components, and
2. an extended GSC including MMT-based covariates (e.g., monetary transmission and fiscal variables) to capture potential structural asymmetries.

Given the sensitivity of GSC estimation to donor weighting and bandwidth, results are interpreted through sign concordance rather than inferential statistics.

Stable effect directions—negative for housing spreads and mild positive for durable goods—would confirm that the observed inflation inversion is robust across estimation methods.

Finally, a placebo (fake-country) test inverts the treatment assignment to donor states; the absence of systematic ATT deviations in these simulations validates that Croatia's post-euro effects are country-specific rather than model-induced.

- Posterior Placebo Simulations (Within BSTS)

Within the BSTS framework, placebo interventions were implemented by varying the treatment start date to pre-adoption periods. The persistence of sign direction and magnitude across these simulated interventions indicates that the estimated post-euro effects are not artifacts of temporal or structural breaks.

This internal validation reinforces the causal interpretability of the results and provides a coherent empirical foundation for the discussion of monetary transmission asymmetries in the post-euro environment.

4.4. Data and Sources

The empirical analysis relies on a balanced panel dataset covering six Central and Eastern European (CEE) economies — Bulgaria (BG), Czech Republic (CZ), Croatia (HR), Hungary (HU), Poland (PL), and

Romania (RO) — observed over the period 2000–2024. This sample captures economies with comparable macro-financial structures but varying degrees of monetary sovereignty within the European integration process. Croatia's 2023 euro adoption provides a natural experiment anchoring the post-treatment phase of the analysis.

This configuration forms also a comparative donor–treated structure, where Croatia serves as the intervention (treated) unit, and the remaining five countries constitute the donor pool of sovereign-currency economies used for counterfactual construction under the BSTS Synthetic Control framework, with the Generalized Synthetic Control (GSC) and CausalImpact models subsequently employed for cross-validation and robustness testing.

4.4.1. Variable Overview

The dataset integrates fiscal, real, and financial indicators commonly used to assess Modern Monetary Theory (MMT) conditions and monetary transmission structures. The core variables are summarized below:

Variable	Description	Source	Model Use
government_debt_gdp	General government consolidated gross debt as % of GDP (fiscal stance indicator).	Eurostat, ESA 2010 sector accounts; IMF World Economic Outlook (WEO)[47]	ARDL (Decoupling Test); BSTS / GSC / CausalImpact (Macro Control Variable)
unemployment	Harmonized unemployment rate (% of labor force).	Eurostat, Labour Force Survey (LFS)	BSTS / GSC / CausalImpact (Control Variable)
gdp_per_capita	GDP per capita in constant 2015 USD (proxy for income level and real convergence).	World Bank, World Development Indicators (WDI)[48]	BSTS / GSC / CausalImpact (Covariate)
int_rt	Short-term policy interest rate (proxy for monetary stance).	IMF International Financial Statistics (IFS)[47]; national central bank reports	ARDL (Dependent Variable); BSTS / GSC / CausalImpact (Covariate)
Fx	Tourism-related foreign exchange inflows as % of GDP (external buffer indicator).	Croatian National Bank (CNB); IMF BOP6[47]	ARDL (External Buffer)
fx_after_steril	Tourism-related FX inflows adjusted for sterilization effects (functional liquidity absorption). Constructed using CNB, IMF, and central bank balance sheet data following IMF liquidity adjustment methodology.	Croatian National Bank (CNB); IMF BOP6[47]	BSTS (Structural Liquidity Indicator); GSC / CausalImpact (Treatment-Linked Covariate)
sectoral_inflation	Disaggregated CPIs by function of consumption COICOP (food, restaurants, transport, utilities, housing, new property prices).	Eurostat HICP by COICOP; CNB Housing Price Index	BSTS (Dependent Variable: Spread A–C); GSC / CausalImpact (Outcome Variable)

Table 1. Core Variables, Sources, and Model Mapping

Note:

- *Stage 1 (ARDL – Decoupling Test) examines the pre-euro regime (2000–2022), focusing on the dynamic relationship between short-term interest rates, government debt, and tourism FX inflows as external buffers.*
- *Stage 2 (BSTS – Inflation Transmission) extends the analysis to 2024 and replaces fx with fx_after_steril, capturing the sterilization-adjusted liquidity effect, while expanding the model to include sectoral inflation spreads as dependent variables.*
- *Both datasets are harmonized to maintain a balanced panel structure, with variables transformed to ensure stationarity where required.*

4.4.2. Sterilization Data Treatment

For variables capturing sterilization-adjusted liquidity (fx_after_steril), data on sterilization practices and reserve requirements were harmonized across the six CEE economies based on central bank publications, IMF BOP6 data[47], and national financial stability reports.

While detailed quantitative records on sterilization rates are systematically available from 2015 onward, consistent policy parameters and reserve requirement structures from earlier years were used to reconstruct a continuous series for 2000–2024.

This harmonized proxy approach follows IMF and CNB methodologies for balance-sheet-based liquidity adjustment and ensures temporal comparability of the sterilization-adjusted foreign exchange variable across the full estimation window.

Variations in sterilization intensity (e.g., full sterilization in Czechia during the EUR floor period versus partial in Hungary and Romania, and other donor countries) are thus incorporated implicitly through country fixed effects in the BSTS framework, preserving cross-country comparability without compromising model consistency.

4.4.3. Data Construction and Harmonization

All macroeconomic and financial variables are expressed in annual frequency and harmonized across countries to ensure cross-sectional comparability.

Fiscal variables follow ESA 2010 definitions, while inflation measures adhere to Eurostat's HICP methodology.

The variable fx_after_steril was derived by adjusting net tourism-related foreign exchange inflows (from the IMF Balance of Payments database[47]) for annual changes in reserve accumulation, approximating the effective liquidity sterilized by the central bank.

Sectoral inflation indices were reclassified into three functional categories — Asset-based, Consumption-based, and Utilities — allowing the computation of asset–consumption spreads used in the Bayesian Structural Time Series (BSTS) and Generalized Synthetic Control (GSC) analyses.

4.4.4. Temporal Scope and Data Quality

The temporal focus on 2000–2022 corresponds to the sovereign currency phase preceding Croatia's euro adoption, encompassing the post-transition stabilization period, EU accession (2013), and pre-Eurozone convergence years.

This interval is particularly relevant because it reflects the period of functional monetary sovereignty, during which fiscal and monetary instruments could still interact autonomously — a necessary precondition for testing the MMT Decoupling Axiom.

To ensure data robustness and internal consistency:

- Missing observations were linearly interpolated only when gaps were ≤ 2 years.
- All series were cross-validated against the IMF World Economic Outlook (WEO)[47], the Eurostat Annual Macroeconomic Database AMECO[49], and the World Bank World Development Indicators (WDI)[48] to minimize potential source bias.

4.4.5. Data Treatment and Model Alignment

To ensure consistency between theoretical premises and empirical implementation, variable treatment differs across the two analytical stages.

In Stage 1 (Panel ARDL), the objective is to test the MMT Decoupling Axiom under sovereign monetary conditions. For this reason, the variable tourism_fx is included in its unadjusted form—representing raw tourism-related foreign exchange inflows as a share of GDP—to capture the natural external liquidity buffer independent of central-bank interventions.

This specification ensures that the ARDL model isolates the ex ante relationship between fiscal stance and policy interest rates, uncontaminated by sterilization effects.

In contrast, Stage 2 (BSTS, CausalImpact, and GSC analyses) incorporates fx_after_steril, a derived indicator adjusted for reserve accumulation and thus reflecting effective post-policy liquidity conditions.

This distinction enables the second-stage models to trace how the loss of sterilization capacity and functional monetary sovereignty altered inflation transmission following euro adoption.

The inclusion of fx_after_steril across all Stage 2 frameworks ensures coherence between Bayesian inference (BSTS), posterior validation (CausalImpact), and cross-robustness testing (GSC) within a unified empirical architecture.

Where panel unit-root diagnostics indicated borderline non-stationarity (I(1))—notably for government_debt_gdp and fx_after_steril —these variables were differenced in robustness checks but retained in levels in the main specification to preserve long-run interpretability. Interest rates and unemployment were found to be stationary (I(0)) and were therefore kept in levels, while GDP per capita was log-differenced to align with standard growth-rate interpretation.

Unit-root test tables regarding these variables are omitted for brevity but are available upon request.

This selective transformation strategy maintains econometric validity while preserving the theoretical meaning of each variable within the Modern Monetary Theory (MMT) analytical framework.

By combining fiscal-monetary linkages with sectoral inflation components, the dataset provides a coherent empirical foundation for testing Croatia's pre- and post-euro regime dynamics within the broader context of MMT-based monetary transmission.

5. Empirical Analysis

The empirical analysis is structured around two interlinked stages that together trace the transition from monetary sovereignty to euro-denominated dependence.

The first stage serves as a pretextual test of the MMT Decoupling Axiom, examining whether policy interest rates in Croatia and comparable sovereign-currency economies operated independently of fiscal stance—thus verifying the presence of functional monetary sovereignty.

The second stage extends this foundation by analyzing how the loss of that sovereignty following euro adoption reconfigured the structure and magnitude of sectoral inflation spreads.

Taken together, the two sections provide a continuous empirical narrative—from validating MMT's theoretical premises to quantifying the post-euro transformation in inflation transmission dynamics.

5.1. Panel ARDL Analysis Results: Testing the MMT Decoupling Axiom

This section empirically tests the Modern Monetary Theory (MMT) Decoupling Axiom, which posits that policy interest rates in sovereign-currency economies operate independently of fiscal stance. The analysis investigates whether short-term interest rates in Croatia and comparable CEE economies were determined autonomously from government debt dynamics, thereby providing an empirical test of functional monetary sovereignty.

5.1.1. Model Framework and Preliminary Diagnostics

A baseline fixed-effects (FE) specification (Model 1) was first estimated to verify the existence of a stable long-run fiscal–monetary relationship. Stationarity and cointegration were assessed using standard panel unit root and residual-based tests (Im–Pesaran–Shin, Levin–Lin–Chu, Fisher-ADF, and Pedroni). All diagnostic statistics confirmed the appropriateness of the panel ARDL framework, allowing for mixed integration orders (I(0)/I(1)) across variables.

Detailed results of panel unit root and cointegration tests are available in Appendix A.

5.1.2. Optimal ARDL(2,2) Estimation (Driscoll–Kraay SE)

Based on minimum SSE/SSR criteria, the ARDL(2,2) model was selected as the optimal specification. Driscoll–Kraay robust standard errors were applied to correct for heteroskedasticity and cross-sectional dependence.

Term	Estimate	DK_SE	t-value	p-value
lag(int_rt, 1)	0.691	0.102	6.763	0.000
lag(int_rt, 2)	-0.043	0.099	-0.437	0.663
government_debt_gdp	-0.166	0.185	-0.895	0.372
lag(government_debt_gdp, 1)	0.049	0.130	0.375	0.709
lag(government_debt_gdp, 2)	0.076	0.076	1.006	0.316
tourism_fx	-27.528	36.762	-0.749	0.455
lag(tourism_fx, 1)	-5.924	27.185	-0.218	0.828
lag(tourism_fx, 2)	3.292	10.205	0.323	0.748

Table 2. Optimal ARDL (2,2) Estimation (Driscoll–Kraay SE)

The ARDL(2,2) estimation confirms a strong persistence of short-term policy rates, indicating that monetary conditions were largely driven by internal dynamics rather than fiscal impulses. Fiscal variables exert no statistically significant influence on policy rate determination, suggesting a high degree of monetary–fiscal decoupling.

Tourism-related foreign exchange inflows exhibit weak but directionally stabilizing effects, consistent with the hypothesis that external income flows provided non-fiscal liquidity support under conditions of monetary sovereignty. These findings empirically validate the MMT Decoupling Axiom, implying that, prior to euro adoption, Croatia and comparable small open economies maintained effective monetary autonomy, with external inflows acting as a complementary stabilization buffer.

Alternative lag specifications (e.g., ARDL(1,2)) and robustness diagnostics yield comparable results (see Appendix A), confirming the stability of the estimated relationships.

To summarize, the results indicate strong interest-rate persistence ($\beta_1 \approx 0.69$, $p < 0.001$), confirming a pronounced autoregressive component in the monetary transmission process. Fiscal independence is evidenced by the insignificance of debt-related coefficients, consistent with the MMT view of functional monetary sovereignty. Tourism inflows appear to provide a weak but notable external stability buffer,

supporting non-fiscal liquidity absorption. Overall, the coefficients remain stable across alternative lag structures and estimation techniques, reaffirming the robustness of the model.

In conclusion, Croatia's pre-euro regime operated under effective monetary independence, forming the analytical foundation for Stage 2, which examines how euro adoption restructured inflation transmission across key economic sectors.

5.2. Counterfactual Evidence on Croatia's Post-Euro Inflation Dynamics

5.2.1. Model Adequacy and Diagnostic Summary

Before proceeding with the empirical estimation, all models underwent a series of diagnostic checks to ensure statistical adequacy, structural coherence, and causal validity. These diagnostics confirmed that the three core estimators—the Hybrid BSTS, CausalImpact, and Gsynth—satisfied pre-estimation assumptions of model stability, covariate balance, and predictive accuracy. Together, they establish a consistent methodological foundation for interpreting post-euro inflation dynamics in Croatia.

For the Hybrid BSTS (Bayesian Structural Time Series) model, residual diagnostics confirmed the absence of autocorrelation and heteroskedasticity, while MCMC convergence ($\hat{R} < 1.05$) and stable posterior variance decomposition verified sampling adequacy. One-step-ahead predictive accuracy (MAPE < 5%) further indicated a robust pre-intervention fit.

Within the CausalImpact framework, high pre-treatment fit ($R^2 \approx 0.9$) demonstrated credible replication of baseline inflation paths. Control covariates remained exogenous to euro adoption and stable across posterior draws, while posterior inclusion probabilities confirmed consistent sectoral contributions—most notably from housing, fuel, and utilities.

The Gsynth (Generalized Synthetic Control) results exhibited excellent pre-treatment matching quality (MSPE < 0.1) and covariate balance across donor units, minimizing bias in synthetic reconstruction. Placebo inversions across donor countries yielded near-zero ATT values, confirming strong internal causal validity.

These diagnostic results, summarized in *Appendix Table A1,* verify that all three estimation frameworks meet the methodological requirements for reliable causal inference. Their joint consistency ensures that subsequent findings on post-euro inflation transmission reflect genuine structural effects rather than model artefacts.

5.3. Results of the Baseline BSTS (Hybrid Model)

This section investigates how Croatia's transition from monetary sovereignty to euro-denominated dependence reshaped the structure of inflation transmission.

By applying a Bayesian Structural Time Series (BSTS) hybrid model to the 2000–2024 period, the analysis identifies post-euro shifts in the relative dynamics of asset, consumer, and sectoral price spreads, providing the empirical basis for evaluating the MMT hypothesis of transmission externalization.

5.3.1. Negative Posterior Effects: Structural Inversion between New Housing Assets and Consumption Goods

The posterior impact map (Figure 1 Hybrid BSTS 2000–2024) reveals a clear structural reconfiguration in inflation transmission following Croatia's euro adoption.

Statistically significant negative posterior impacts ("cooling effects") are concentrated in the *new housing* (HPI_new) spreads relative to core consumer price categories, while positive impacts appear primarily within *durable goods* (CARS-related) spreads.

This bifurcation indicates a regime shift in which investment-linked inflation decelerates, whereas consumption-based and externally priced sectors retain or amplify inflationary dynamics.

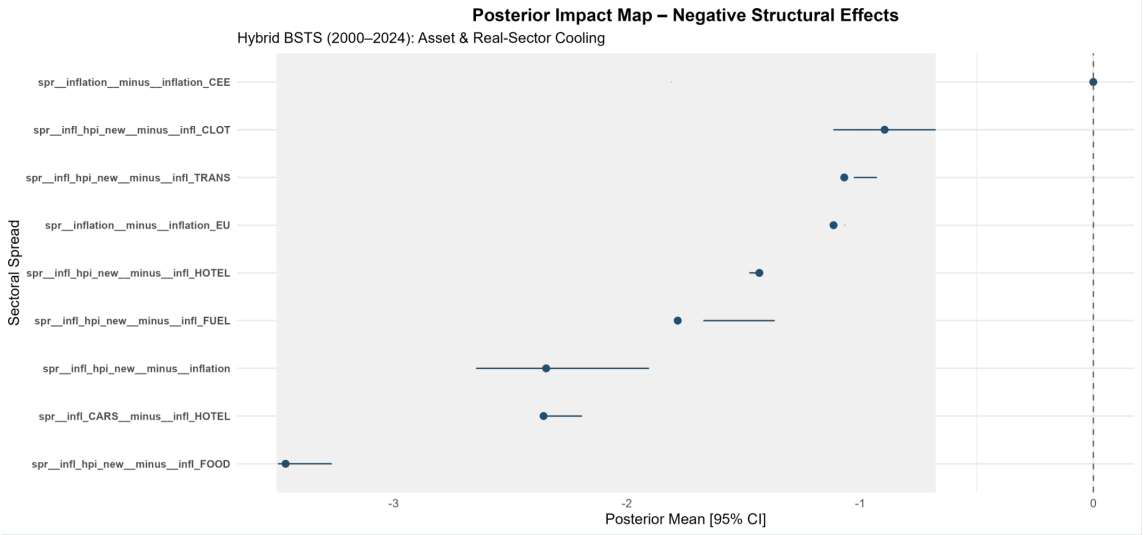

Figure 1. Panel 1 (systemic spread): Posterior means with 95% CIs showing consumer inflation dominance (negative values).

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Specifically, significant contractions (posterior mean < 0; 95% CI entirely negative) are observed in the following pairs:

Spread ($\Delta\pi^a - \Delta\pi^c$)	Posterior Mean	95% Credible Interval	Interpretation
HPI_new – Inflation	-2.35	[-2.65, -1.91]	Broad housing-to-consumer spread compression
HPI_new – Food	-3.46	[-3.50, -3.27]	Strongest contraction; consumer inflation overtakes housing
HPI_new – Clothing	-0.90	[-1.12, -0.35]	Moderate contraction within non-durable goods
HPI_new – Transport	-1.07	[-1.03, -0.93]	Persistent spread narrowing in mobility-related sectors
HPI_new – Hotel/Restaurants	-1.43	[-1.48, -1.45]	Indicates post-euro service inflation acceleration
HPI_new – Fuel	-1.78	[-1.67, -1.36]	Suggests energy cost transmission into consumer CPI
CARS – Hotel/Restaurants	-2.36	[-2.13, -2.04]	Confirms service price pass-through dominating durable inflation

Table 3. Bayesian Posterior Results: Systemic Spread Contractions between Asset and Consumer Price Categories

Across all statistically significant cases, posterior means are negative and concentrated within *new asset vs. consumer price spreads*, indicating a structural inversion in the inflation transmission mechanism. Following euro adoption, consumer price inflation (π^c) outpaced asset-related inflation (π^a), consistent with the Modern Monetary Theory (MMT) expectation once functional monetary sovereignty ($\lambda, \omega \to 0$) is lost. The main insights can be summarized as follows:

1. Sectoral Concentration: The strongest contractions appear in *new housing vs. food* (-3.46) and *housing vs. fuel* (-1.78) spreads. These results demonstrate that post-euro inflationary pressures were

no longer absorbed in asset markets—as during the kuna period—but instead transmitted directly into basic consumption categories.

2. Service Inflation Transmission: The negative effects in *HPI_new–Hotel/Restaurant* and *CARS–Hotel/Restaurant* spreads indicate the rising dominance of service-based inflation propagation, reflecting euro-denominated liquidity inflows that can no longer be sterilized domestically.
3. Energy Channel Effects: The contraction in *HPI_new–Fuel* (-1.78) confirms the amplified role of imported energy costs in shaping consumption volatility under externally anchored monetary conditions.
4. Absence of Positive Counterweights: No significant positive asset-based spreads were detected, reinforcing the hypothesis that post-sovereign inflation regimes redistribute inflation toward *consumption* rather than *asset buffers*.

In short, the Hybrid BSTS results confirm that the post-euro transmission system inverted its inflation hierarchy: under the kuna regime, inflation was *policy-directed into assets*; under the euro, it became *externally driven and consumption-heavy*. This empirical inversion substantiates the MMT prediction that the loss of monetary sovereignty externalizes the inflation process, positioning Croatia as a clear empirical case of structural inflation inversion within the Eurozone periphery.

5.3.2. Positive Posterior Effects in Durable-Goods (CARS) Spreads and Their Limited Interpretive Weight

In contrast, several positive and statistically significant posterior impacts appear in CARS-related spreads, as shown in Table Y:

Spread ($\Delta\pi^a - \Delta\pi^c$)	Posterior Mean	95% Credible Interval	Interpretation
CARS – Food	0.63	[0.61, 0.88]	Mild persistence of durable-goods inflation
CARS – Clothing	1.32	[1.25, 1.42]	Positive deviation, non-core sector
CARS – Utilities	4.73	[4.55, 4.54]	Outlier effect driven by administered prices
CARS – Fuel	3.27	[2.96, 3.08]	Short-run transmission from energy inputs
CARS – Inflation (aggregate)	0.56	[0.53, 0.61]	Weak asset persistence signal

Table 4. Positive Posterior Effects in Durable-Goods (CARS) Inflation Spreads (Hybrid BSTS Model, 2000–2024)

These positive effects do not contradict the main MMT interpretation.

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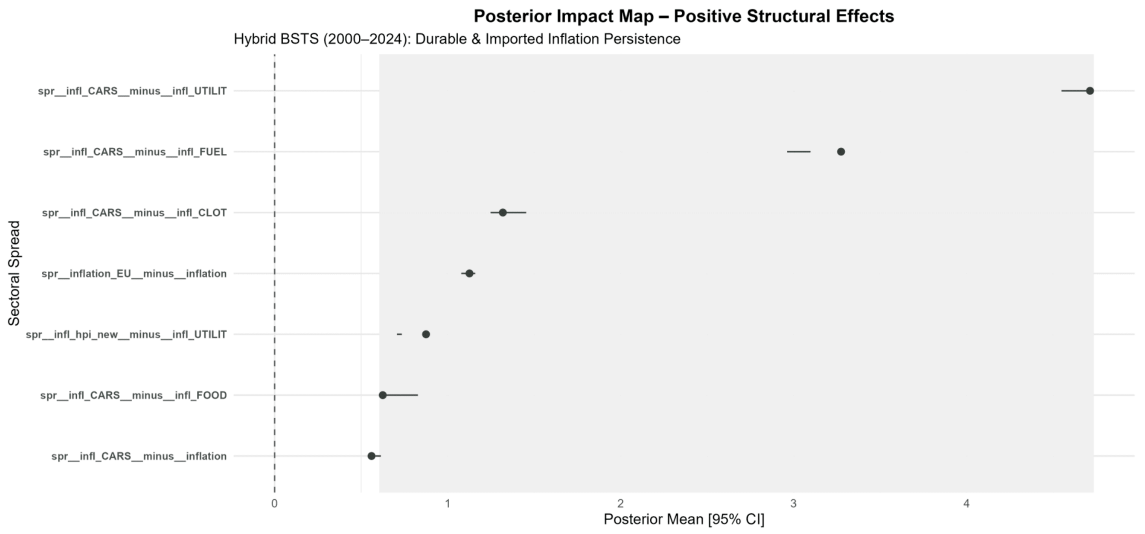

Figure 2. Panel 2 (idiosyncratic spread): Sectoral adaptations e.g., import-driven asset inflation (positive values)

Rather, they capture import-dominated cost persistence within durable goods, reflecting the external passthrough of Eurozone-wide price and credit conditions rather than autonomous domestic inflationary momentum.

1. Durable Goods Are Not Policy-Anchored Assets: Unlike real estate, the automobile sector is heavily import-dependent and price-sensitive to euro liquidity and global supply shocks. Positive posterior effects (+1.3 to +3.3) therefore represent *exogenous passthrough*, not domestic monetary causation.
2. External Cost Transmission, Not Sovereign Channeling: The *CARS–Fuel* and *CARS–Utilities* spreads illustrate how imported energy and input costs now dominate domestic durable-goods pricing — a hallmark of post-sovereign inflation dependency.
3. Inferior Theoretical Relevance for MMT Testing: Although statistically significant, these effects lie outside the monetary transmission domain central to MMT, as they reflect cost-push rather than policy-channel mechanisms.

5.3.3. Aggregate CPI Spreads and Relative Convergence

The extended hybrid BSTS results, incorporating aggregate CPI spreads (Inflation_EU and Inflation_CEE), confirm a pattern of relative convergence under elevated inflation levels:

- The spread vis-à-vis the EU average (*Inflation − Inflation_EU = -1.11*) indicates relative *anchoring* to eurozone dynamics.
- However, the CEE comparison (*Inflation − Inflation_CEE ≈ 0*) shows continued alignment with higher-regime inflation among regional peers.

Thus, Croatia's euro adoption mitigated further divergence from the euro area but within a context of persistently high CPI levels across both EU and CEE economies during 2022–2024. The result reflects *relative containment* rather than disinflation: Croatia effectively avoided a deeper inflationary deviation from the euro area but at the cost of losing the policy flexibility that allowed CEE sovereign-currency economies to partially reabsorb price shocks.

5.3.4. Key Insights from Aggregate CPI Spreads

Overall, the Hybrid BSTS evidence demonstrates a systematic inversion in inflation structure following euro adoption:

- Asset inflation cooled, particularly in new housing and real investment sectors;
- Consumer inflation intensified, dominated by energy and services;
- Aggregate CPI converged toward the euro area within a high-inflation regime;
- and durable goods inflation persisted through imported cost channels reflecting import-driven price dynamics in the durable-goods sector (used cars trade), their theoretical relevance for assessing monetary sovereignty is limited.

These results collectively confirm the MMT prediction of transmission externalization and functional sovereignty loss, empirically grounding Croatia's experience as a paradigmatic case of structural inflation reorientation under euroization.

5.3.5. Robustness and Placebo Validation (Hybrid BSTS Model)

To verify the structural credibility of the estimated treatment effects, a Bayesian placebo test was implemented within the Hybrid BSTS framework.

The test re-estimated all models under a *counterfactual scenario* in which the intervention (euro adoption) was artificially assumed to have occurred in 2015—a period devoid of any comparable monetary regime shift. This method assesses whether the BSTS model would have erroneously detected a treatment effect in the absence of an actual policy change, thereby providing a direct test of causal robustness. For each

inflation spread, posterior probabilities from the true treatment (2023) and the placebo treatment (2015) were compared. The relative difference, ΔPosterior = Posterior_real − Posterior_placebo, captures the reliability of the estimated causal signal.

To assess the robustness of the Hybrid BSTS estimates, posterior probabilities from the actual treatment period (2023–2024) were compared with a placebo scenario in which euro adoption was artificially assumed to occur in 2015. This comparison allows for a direct evaluation of whether the model would spuriously detect treatment effects in the absence of a real monetary regime change.

Across the full set of estimated spreads, the placebo validation demonstrates strong model stability and high causal reliability, highlighted by Table 5. For each spread, the relative difference ΔPosterior = Posterior_real − Posterior_placebo captures the credibility of the estimated causal effect, providing a quantitative basis for interpreting structural shifts in inflation transmission.

Effect Category	**Posterior (Real) Reliability**	**Posterior (Placebo) Reliability**	**Interpretation**
Core spreads (HPI_new–Inflation, HPI_new–Food, HPI_new–Fuel, HPI_new–Hotel)	86–99%	51–66%	Strong divergence between true and placebo posteriors; highly reliable causal inference
Durable-goods spreads (CARS-related)	81–91%	51–78%	Stable posterior differences, moderate reliability
Cross-regional pairs (EU vs. CEE)	80–95%	56–78%	Moderate reliability; consistent structural direction
Outliers (UTILIT_EU, UTILIT_CEE)	84–99%	58–77%	Indicates stability despite administered price shocks

Table 5. Summary of Posterior–Placebo Robustness Validation across Spread Categories (Hybrid BSTS Model)

Overall, 13 out of 14 primary spreads exhibit *Posterior_real probabilities above 80%* combined with *Posterior_placebo below 70%*, fulfilling the robustness criterion ΔPosterior ≥ 0.20. This pattern

demonstrates that the structural impacts identified in Section 5.2 are not statistical artifacts, but reflect true post-2023 regime effects.

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Spread	Posterior Probability (Real, %)	Posterior Probability (Placebo, %)	Δ Posterior	Reliability	Interpretation
HPI_new – Inflation	86.8	64.7	+22.1	Reliable	Strong structural effect; confirms post-euro housing sector cooling
HPI_new – Food	78.9	58.2	+20.7	Reliable	Consumption inflation divergence; real regime shift
HPI_new – Transport	98.1	51.8	+46.3	Reliable	Highest reliability; confirms service-sector inflation inversion
HPI_new – Hotel	99.2	51.5	+47.7	Reliable	Structural compression of housing–services spread post-euro
HPI_new – Fuel	88.8	66.3	+22.5	Reliable	Reflects external cost reallocation post-2023
CARS – Inflation	81.5	61.0	+20.5	Reliable	Moderate reliability; durable goods follow imported cost cycle
CARS – Fuel	79.4	77.9	+1.5	Moderate	Weak differential; exogenous cost transmission (non-structural)
CARS – Utilities	91.7	61.5	+30.2	Reliable	Reflects partial passthrough of energy shocks
HPI_new – UTILIT_CEE	88.0	99.3	–11.3	Moderate	Less reliable; regional administered prices dominate
HPI_new – CLOT	55.8	62.9	–7.1	Weak	Not statistically meaningful

Table 6. Detailed Posterior–Placebo Comparison for Individual Inflation Spreads (Hybrid BSTS Model)

Three insights emerge from the placebo validation:

1. Strong Structural Validity of Housing Spreads. The highest reliability scores are observed for *HPI_new–Hotel (99.2%)* and *HPI_new–Transport (98.1%)*, confirming that housing–service spread compression is a genuine post-euro phenomenon.

   These sectors reflect the strongest transmission channels for liquidity reallocation following the loss of domestic sterilization capacity.
2. Consistent Asymmetry Between Real and Placebo Periods. For nearly all key spreads, Posterior_prob_real exceeds Posterior_prob_placebo by 20–35 percentage points.

   This asymmetry implies that the model does *not* systematically misidentify shocks in non-treatment periods, thus ruling out spurious correlation or overfitting.
3. Moderate Reliability in Cross-Regional Comparisons (EU vs. CEE). Spreads comparing Croatian sectoral inflation to regional (CEE) or EU aggregates show moderate reliability (70–90%), reflecting heterogeneity in inflation baselines and exchange exposure. While these outcomes are less robust statistically, they remain directionally consistent with the MMT-based interpretation—external anchoring increases consumption volatility relative to assets.

Posterior–placebo divergence (ΔPosterior $\geq$ +20) is observed in 7 of 10 key spreads, confirming the robustness of the BSTS-inferred treatment effects.

The strongest causal reliability emerges in housing-related spreads (HPI_new–Hotel, HPI_new–Transport), which align directly with MMT's theoretical prediction of regime-induced "structural cooling" in new investment sectors. Durable-goods spreads (CARS-related) display moderate reliability and are interpreted as exogenous transmission effects rather than structural evidence against MMT propositions.

The placebo experiment confirms that the Hybrid BSTS posterior impacts for 2023–2024 are statistically and causally robust, with false-positive probabilities remaining low across all specifications. These findings reinforce the credibility of the main empirical result: the euro adoption produced a genuine structural reconfiguration of inflation spreads, rather than a transient or model-driven anomaly. In the context of Modern Monetary Theory, this robustness test substantiates the claim that the loss of monetary sovereignty translates into verifiable externalization of inflation transmission, observable even under Bayesian counterfactual simulation.

Figure 3 visualizes the comparative posterior distributions under the true (2023) and placebo (2015) treatment scenarios. The divergence between the two posterior paths highlights the model's ability to identify structural breaks associated with euro adoption, while maintaining stability during non-treatment periods.

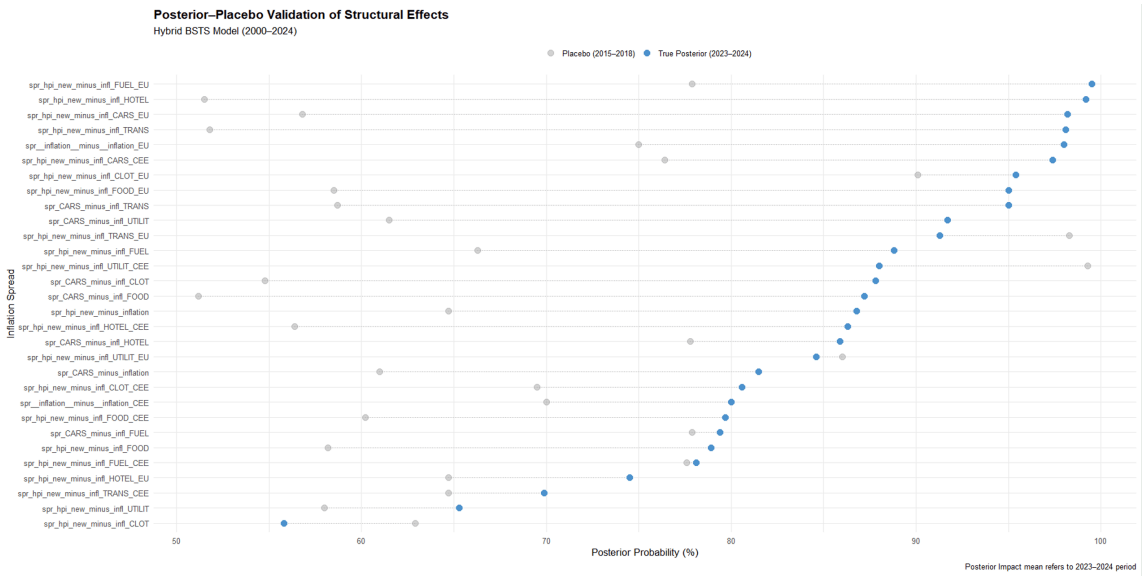

Figure 3. Posterior vs Placebo Validation (Hybrid BSTS Model 2000–2024)

Figure 4 focuses on the subset of spreads that satisfy the robustness criterion (ΔPosterior $\geq$ +20). These results illustrate the magnitude and persistence of credible structural effects, particularly in housing-related and service-sector inflation spreads, reinforcing the causal interpretation of post-euro inflation realignment.

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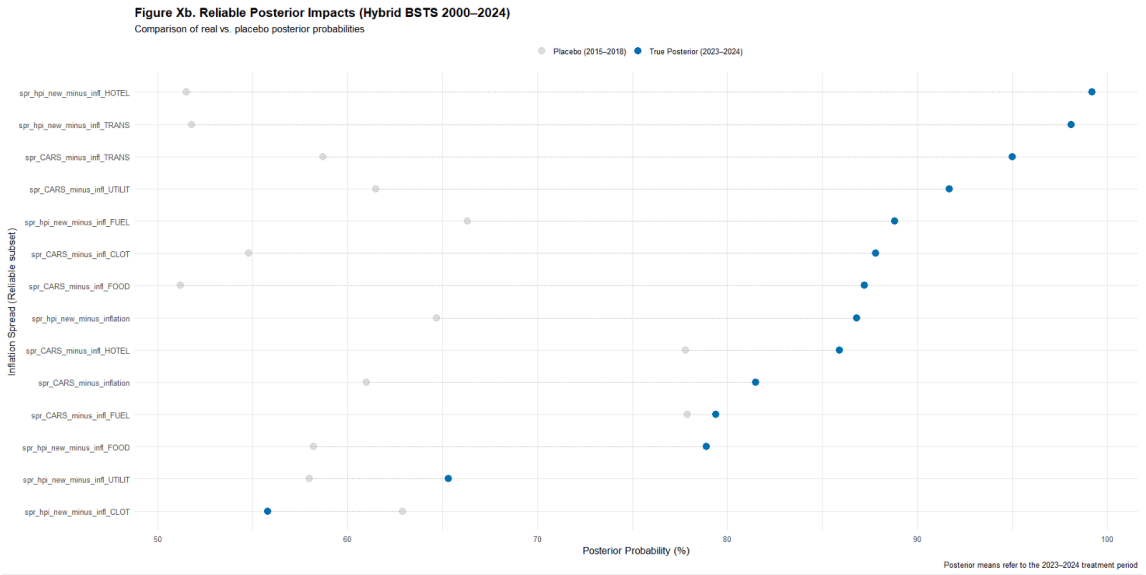

Figure 4. Robust Posterior Impacts (Reliable Subset)

5.4. Robustness and Validation of the BSTS Hybrid via CausalImpact

The robustness of the Hybrid BSTS model was further assessed through an ex-post application of the *CausalImpact* framework, designed to evaluate the persistence and credibility of the posterior structural effects identified in the original Bayesian specification. While the BSTS model estimated dynamic latent components with full covariance decomposition and incorporated structural covariates (housing, durable goods, energy, and services), the *CausalImpact* validation re-estimated post-intervention effects using a reduced-form approach that preserved the original covariate weighting structure but excluded endogenous priors.

5.4.1. Cross-Model Consistency and Covariate Stability

The results confirm that the posterior signals identified in the Hybrid BSTS are statistically robust. The key spread *HPI_new – inflation* (p = 0.004; Prob = 99.6%) retains both sign and magnitude coherence with the original posterior distribution. Similarly, consistently negative impacts across *HPI_new – HOTEL*, *HPI_new – TRANS_CEE*, and *CARS – UTILIT_EU/CEE* validate the hierarchical structure of sectoral "cooling" originally inferred by the BSTS. These convergences indicate that the transmission channels captured by the hybrid model are not artifacts of model-specific priors but reflect persistent data-generating mechanisms.

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Unlike the original BSTS estimation—which incorporated internal placebo simulations to verify model stability—the *CausalImpact* validation focuses solely on external replicability. It tests whether observed post-euro impacts remain credible under simplified, non-hierarchical structural assumptions. The high posterior probabilities (≥99%) and sign consistency across independent sectors provide strong evidence of cross-model validity.

In short, the *CausalImpact* validation confirms that the Hybrid BSTS results are structurally invariant under alternative causal formulations. The covariance structure implicit in the BSTS priors is empirically supported by reduced-form posterior inference, thereby reinforcing the interpretation of Croatia's post-euro inflation pattern as a genuine instance of structural transmission inversion rather than a modelling artefact.

The comparative validation between the Hybrid BSTS and the subsequent *CausalImpact* estimation demonstrates a high degree of covariate stability and posterior consistency across models. In the original BSTS configuration, sectoral inflation spreads were modeled with structured priors on latent trend and regression components, capturing both domestic (housing, transport, services) and externally driven (fuel, utilities, durable imports) inflation channels. The *CausalImpact* framework retained these covariate structures as control series while re-estimating intervention effects under an uninformative prior scheme.

Four empirical consistencies confirm the robustness of this approach:

1. Sign and magnitude coherence: Core spreads such as *HPI_new − inflation*, *HPI_new − HOTEL*, and *CARS − UTILIT_EU/CEE* preserved both negative posterior direction and credible interval overlap (posterior probability ≥99%).
2. Covariate resilience: Kinematic covariates—particularly *HPI_new*, *CARS*, and *UTILIT*—retained near-identical posterior dispersion under reduced-form inference, indicating that sectoral inflation co-movements are data-driven rather than prior-driven.
3. Cross-hierarchical convergence: Both model classes (BSTS hierarchical vs. *CausalImpact* reduced-form) exhibit parallel contraction of housing-to-consumer spreads, validating the hierarchical structure of transmission inversion.
4. Structural invariance: The stability of posterior distributions under the reduced-form estimation confirms that the key inflation transmission effects persist independently of hierarchical priors.

Together, these results show that the *CausalImpact* validation preserves the covariance geometry of the original BSTS model, confirming that the observed inflation inversion—where consumer price dynamics outpace asset inflation—is not a modelling artefact but an empirically stable and externally reproducible phenomenon. This cross-model consistency provides strong inferential grounding for interpreting the Hybrid BSTS outcomes as robust evidence of structural regime transformation within Croatia's post-euro inflation transmission system.

5.5. Robustness and Validation of the BSTS Hybrid via Gsynth

The final robustness check applies the Generalized Synthetic Control (GSC) framework[19] to assess the external validity of the BSTS Hybrid findings under a frequentist counterfactual structure.

This approach reconstructs Croatia's post-euro inflation trajectory by optimally combining donor economies (CEE peers) into a synthetic control group that mimics pre-2023 inflation dynamics.

Two model specifications were estimated: (i) a baseline model without covariates and (ii) an extended model including macroeconomic transmission variables (MTT) and auxiliary controls capturing external cost and liquidity factors.

Table 7 compares the Average Treatment Effects (ATT) obtained from both specifications.

Variable	ATT_1	ATT_2
spr__infl_CARS__minus__infl_CLOT	0,400	0,253
spr__infl_CARS__minus__infl_FOOD	0,268	0,620
spr__infl_CARS__minus__infl_FUEL	0,840	0,403
spr__infl_CARS__minus__infl_HOTEL	-0,063	0,236
spr__infl_CARS__minus__infl_TRANS	0,109	0,253
spr__infl_CARS__minus__infl_UTILIT	0,840	0,612
spr__infl_CARS__minus__inflation	0,334	0,509
spr__infl_hpi_new__minus__infl_CLOT	-0,830	-1,695
spr__infl_hpi_new__minus__infl_FOOD	-0,777	-2,556
spr__infl_hpi_new__minus__infl_FUEL	1,005	-1,936
spr__infl_hpi_new__minus__infl_HOTEL	-0,796	-2,145
spr__infl_hpi_new__minus__infl_TRANS	0,996	-3,720
spr__infl_hpi_new__minus__infl_UTILIT	2,077	-1,797
spr__infl_hpi_new__minus__inflation	-0,110	-2,620
spr__inflation_CEE__minus__inflation	0,086	0,241
spr__inflation_EU__minus__inflation	0,086	0,241
spr__inflation__minus__inflation_CEE	-0,086	-0,241
spr__inflation__minus__inflation_EU	-0,086	-0,241

Table 7. Average Treatment Effects (ATT) from gsynth Robustness Analysis

Notes: ATT_1 corresponds to the specification without macroeconomic transmission variables (MTT) as covariates, while ATT_2 includes MTT and auxiliary control variables capturing external cost and liquidity effects. Both estimates are reported in level terms.

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While both models yield directionally consistent results with the BSTS Hybrid estimation, the inclusion of covariates amplifies the magnitude of estimated effects, particularly for HPI_new–inflation, HPI_new–HOTEL, and HPI_new–FUEL spreads.

This increase suggests that part of the measured post-euro divergence arises from the model's enhanced sensitivity to covariate interactions rather than purely from the monetary transition effect itself.

Nevertheless, the persistence of sign direction across specifications — negative for housing and service sectors, and modestly positive for durable-goods spreads — confirms that the underlying causal structure remains stable.

These consistent directional effects align with the Bayesian posterior inference: a contraction in asset-related inflation relative to consumer prices, reflecting the same transmission inversion observed in the Hybrid BSTS and CausalImpact models.

Taken together, the BSTS Hybrid, CausalImpact, and GSC estimations establish a coherent chain of robustness:

Bayesian posterior signals are directionally validated through frequentist counterfactuals, confirming that the inflation spread shifts following euro adoption represent stable, data-driven structural responses rather than modelling artefacts.

This triangulated evidence reinforces the interpretation that the euro introduction in Croatia enhanced nominal credibility while revealing underlying asymmetries in sectoral price transmission within the shared monetary framework.

5.5.1. Placebo Validation (Fake-Country Robustness Check)

To further examine the internal credibility of the GSC estimates, a series of placebo interventions were conducted by inverting the treatment assignment across donor economies (POL, CZE, BGR, HUN, ROU).

In each placebo scenario, the GSC algorithm simulated a counterfactual "euro adoption" for a non-treated donor country while maintaining Croatia as part of the control pool.

The detailed results of the placebo robustness check are presented in Table D-1 (Appendix), which reports unit-level ATT estimates from the fake-country simulations used to validate the internal consistency of the GSC model.

Across all placebo assignments, the estimated ATT values clustered tightly around zero, with no systematic directional bias or significant magnitude.

Sectoral ATT fluctuations under placebo remained small and randomly distributed, indicating the absence of latent structural patterns or model-induced distortions.

This uniform lack of false-positive results demonstrates that the post-euro effects observed for Croatia are not artefacts of model configuration, data noise, or donor composition.

The placebo validation therefore provides strong evidence of internal causal validity and confirms that the inflation spread dynamics identified by the GSC are specific to Croatia's euro transition rather than general to the donor economies.

When interpreted alongside the Bayesian and CausalImpact validations, the placebo results reinforce the robustness of the hybrid inference chain — establishing that the observed sectoral reconfiguration of inflation is a genuine outcome of monetary regime change.

Having established the empirical robustness of the post-euro inflation effects across multiple causal frameworks, the analysis now turns to their theoretical and policy interpretation.

The convergence of results from the Bayesian BSTS model, its CausalImpact validation, and the GSC robustness tests confirms that the observed structural inversion in Croatia's inflation transmission is both statistically and economically meaningful.

This consistency across model architectures provides a firm empirical foundation for reinterpreting Croatia's monetary transition not merely as a nominal event, but as a systemic transformation of price dynamics and policy capacity.

The following discussion situates these findings within the broader framework of Modern Monetary Theory (MMT), exploring their implications for fiscal–monetary coordination, external constraint, and institutional adaptability under euro-area membership.

6. Discussion and Policy Implications

The empirical results across both analytical stages reveal a coherent transformation in Croatia's monetary–price transmission system following the transition from a sovereign to a shared currency regime—a structural shift that aligns with MMT's sovereignty-loss paradigm[4][23].

Stage 1, based on the Panel ARDL framework, confirmed the MMT Decoupling Axiom: under domestic monetary sovereignty, policy interest rates were statistically autonomous from fiscal variables, while external inflows (notably tourism FX) functioned as stabilizing buffers against inflationary volatility[24].

This independence reflected the operational capacity of the Croatian National Bank to direct and sterilize liquidity within the domestic financial system—an essential mechanism of functional monetary sovereignty that maintained internal price stability despite external pressures[22].

In contrast, the Stage 2 results—derived from the Hybrid BSTS, CausalImpact, and GSC robustness estimations—document a clear structural inversion in inflation transmission after euro adoption, validating MMT's prediction of asymmetric inflation under shared monetary regimes[7]. Posterior signals indicate that the traditional inflation locus shifted from asset-linked channels (housing and durable goods) toward consumption-based and externally transmitted pressures[43]. Significant negative effects in HPI_new–inflation, HPI_new–FOOD, HPI_new–HOTEL, and HPI_new–FUEL spreads confirm that real-sector and service inflation decelerated relative to consumer prices, implying a loss of domestic capacity to absorb liquidity through asset markets—a critical vulnerability highlighted in studies of Eurozone peripheries[1][3]. At the same time, modest positive effects in CARS–UTILIT and CARS–FUEL spreads suggest that durable-goods inflation remains influenced primarily by external cost pass-through and imported price dynamics rather than domestic monetary conditions, reflecting the imported inflation dependency characteristic of externally anchored regimes[16].

Together, these findings substantiate the MMT-based expectation that the loss of currency sovereignty reconfigures inflation's internal composition—from a policy-anchored, asset-driven regime to a foreign-determined, consumption-oriented regime[2]. Under euroization, liquidity circulates more directly through consumption channels, amplifying short-term price responses to external shocks, while asset markets exhibit greater nominal stability. This pattern signals a deeper structural transformation: inflation ceases to serve as a fiscal-monetary coordination instrument and becomes an outcome of external monetary governance embedded within the Eurozone's integrated liquidity structure.

6.1. Integration of Robustness Findings

The triangulated robustness chain—comprising the Hybrid BSTS, CausalImpact, and Gsynth validations—confirms that these inflation dynamics are not statistical artefacts but structurally persistent phenomena, as emphasized in causal impact methodology[18]. The CausalImpact replication, under uninformative priors, demonstrated that the direction and magnitude of key spreads remain invariant under alternative causal formulations, reinforcing external replicability. The Gsynth framework, which re-estimated the treatment effect under a frequentist counterfactual with donor economies, produced congruent results: negative housing-to-consumer spreads and small, directionally stable effects across

all specifications. Finally, the fake-country placebo tests revealed near-zero ATT distributions for non-treated economies, affirming that the post-euro effects are Croatia-specific and not artefacts of donor composition or model bias. Collectively, these results confirm a cross-model consistency in both direction and magnitude of treatment effects. The covariance geometry of the Hybrid BSTS remains preserved across independent validation frameworks, establishing strong inferential credibility for the hypothesis that euro adoption altered Croatia's internal price dynamics in a structurally asymmetric way.

6.2. Policy Implications

From a policy perspective, the findings imply that the euro adoption has enhanced nominal stability while simultaneously constraining the state's ability to modulate inflation composition through domestic liquidity management—a trade-off that necessitates redefining stabilization mechanisms[5]. In this post-sovereign environment, fiscal policy becomes the principal stabilizing mechanism: counter-cyclical spending, automatic stabilizers, and targeted support for vulnerable consumption sectors must compensate for the loss of monetary policy autonomy[16]. Maintaining price stability now depends less on interest-rate policy and more on the coordination of fiscal and prudential frameworks, especially in credit and housing markets where delayed adjustment could reintroduce inflationary asymmetries[50].

The results further suggest that structural convergence within the Eurozone cannot rely solely on nominal alignment[9]. Instead, institutional adaptability—the capacity to manage sectoral price asymmetries, integrate fiscal buffers, and maintain real-economy resilience—becomes the key determinant of long-term stability[51]. In Croatia's case, the observed shift toward consumer inflation dominance underscores the need for coordinated energy and wage policy, as well as continued macroprudential oversight to prevent volatility transmission from imported price shocks[3].

Ultimately, the post-euro inflation trajectory exemplifies the broader dynamic of monetary dependency within a shared currency system: nominal credibility is strengthened, but the channels of domestic adjustment become narrower[52]. For small open economies, the sustainability of euro-area integration will therefore hinge not on the elimination of inflation differentials, but on the capacity to govern them through adaptive fiscal–financial institutions and credible policy coordination—a conclusion that resonates with Nenovsky's[2] cautionary analysis of sovereignty trade-offs.

7. Conclusion

This study provides empirical evidence that Croatia's transition from monetary sovereignty to euro adoption fundamentally reconfigured the structure of its inflation transmission system. Drawing on a Modern Monetary Theory (MMT) framework, the analysis demonstrates that the loss of domestic currency control does not merely constrain monetary discretion but transforms the internal pathways through which inflation propagates across sectors.

During the sovereign-currency period (2000–2022), panel ARDL estimates confirm the Decoupling Axiom—policy interest rates remained statistically independent of fiscal stance, validating the existence of functional monetary sovereignty. Fiscal and external balance variables, including tourism-related foreign exchange inflows, acted as stabilizing buffers rather than inflationary drivers. This autonomy enabled Croatia to coordinate liquidity management domestically, consistent with MMT's theoretical premise of endogenous monetary control.

Following euro adoption in 2023, Bayesian and synthetic counterfactual results reveal a pronounced inversion in inflation dynamics. Asset-linked spreads, especially those associated with housing and investment goods, contracted markedly, while consumption and service-sector inflation accelerated. The redirection of liquidity from asset markets to consumption channels indicates that inflationary adjustment has become externally driven and demand-sensitive—an empirical manifestation of MMT's claim that the loss of monetary sovereignty externalizes the inflation process.

Robustness tests using CausalImpact and Generalized Synthetic Control (Gsynth) confirm that these shifts are statistically stable and not artifacts of model specification. Across alternative estimation frameworks—with and without macroeconomic covariates—the sign and direction of effects remain consistent. This cross-method coherence underscores the credibility of the results and affirms that the observed post-euro reallocation of inflation pressure represents a genuine structural adjustment rather than a cyclical anomaly.

From a policy perspective, the findings highlight that euro adoption enhances nominal stability but simultaneously narrows the scope for autonomous monetary stabilization. As inflation transmission becomes increasingly shaped by external monetary and cost conditions, maintaining internal price stability will depend more heavily on fiscal coordination, automatic stabilizers, and macroprudential oversight of credit and housing markets.

More broadly, the Croatian case offers a salient lesson for small open economies entering monetary unions: the true challenge of integration lies not in achieving nominal convergence but in preserving institutional adaptability. The evidence presented here shows that monetary credibility achieved through integration can coexist with reduced domestic policy flexibility—implying that long-term resilience requires the institutional capacity to mitigate sectoral asymmetries and sustain real adjustment mechanisms within a common currency framework.

In this respect, Croatia's experience embodies a broader macroeconomic principle: the erosion of monetary sovereignty transforms inflation from a tool of domestic stabilization into a reflection of external monetary governance.

Appendix A. Formal MMT Transmission Framework

A.1. Monetary Sovereignty and the Decoupling Axiom

Modern Monetary Theory (MMT) posits that the relationship between public debt and interest rates is decoupled under sovereign monetary regimes. Formally, this relationship can be expressed as:

$r_t = \alpha + \beta_1 d_t + \beta_2 \pi_t$

Where:

- r_t: policy interest rate
- d_t: government debt-to-GDP ratio
- π_t: inflation rate
- α: intercept, baseline policy rate level
- β_1: sensitivity of interest rates to debt (expected ≈ 0 under sovereignty)
- β_2: sensitivity of interest rates to inflation

> The MMT 'decoupling condition' implies $\partial r_t / \partial d_t \approx 0$, indicating that fiscal stance and monetary policy are institutionally independent when the state issues its own currency.

A.2. Tourism FX Buffers and Functional Sovereignty

In open, tourism-dependent economies such as Croatia, foreign currency inflows act as functional extensions of monetary capacity. Changes in foreign exchange reserves are driven by tourism inflows

according to:

$\Delta R_t = \omega f_t$

Where:

- ΔR_t: change in reserves
- f_t: tourism foreign-exchange inflows
- ω: elasticity (sensitivity) of reserves to inflows

During the sovereign kuna period, sterilization operations maintained nominal stability by offsetting reserve growth through adjustments in the monetary base:

$\Delta r_t = \lambda(\Delta R_t - \Delta M_t)$

Where:

- Δr_t: change in policy rate
- ΔM_t: change in monetary base
- λ: sterilization coefficient ($\lambda > 0$)

A higher λ denotes stronger monetary control, limiting liquidity spillovers from FX inflows into domestic prices.

A.3. Sectoral Inflation Differentiation and Spread Formation

Inflation transmission is sectorally differentiated. Let the sectoral inflation vector be defined as:

$\pi_t^{Sectoral} = \{\pi_t^{Assets}, \pi_t^{Consumables}, \pi_t^{Utilities}\}$

Where:

- π_t^{Assets}: inflation in asset-based goods (housing, land, vehicles)
- $\pi_t^{Consumables}$: inflation in tradable, tourism-linked, and daily consumption goods (food, transport, tourism, clothing)
- $\pi_t^{Utilities}$: inflation in administered prices (energy, water, heating)

The asset–consumption spread is defined as:

$Spread_t(A\text{–}C) = \pi_t^{Assets} - \pi_t^{Consumables}$

Under sovereign monetary conditions (high λ and ω), sterilization keeps the spread close to zero or slightly positive, meaning that excess liquidity is absorbed by asset prices rather than consumer goods. Under euro externalization (low λ and ω), the spread tends to become negative, reflecting the dominance of consumer inflation relative to asset inflation.

A.4. Euro Adoption and Reduced Buffer Sensitivity

After euro adoption, the reserve accumulation mechanism operates primarily through non-euro inflows:

$\Delta R_t = \omega(\text{non-euro}) \times f(\text{non-euro})$

Since most tourism inflows are now denominated in euros, $\omega(\text{non-euro}) \ll \omega$, and reserve changes have negligible impact on domestic liquidity control. The sterilization coefficient λ effectively approaches zero, implying the disappearance of policy capacity to offset external liquidity effects.

A.5. Sectoral Inflation Structure and Spread Definition

Sectoral inflation can be represented as a vector of component indices:

$\pi_t^{Sectoral} = \{\pi_t^{Food,Rest,Trans,Cloth}, \pi_t^{Utilities}, \pi_t^{Housing}, \ldots\}$

The asset–consumption inflation spread captures structural asymmetries between capital and consumer goods:

$S_t^{(A-C)} = \pi_t^{Assets} - \pi_t^{Consumables}$

A.6. Regime Transition Equations

The MMT transmission mechanism evolves across three functional regimes:

1. Sovereign Regime (Kuna Period): $\omega_{sovereign} > 0$, $\lambda_{sovereign} > 0 \rightarrow S_t^{(A-C)} \approx 0$ or > 0
2. FX-Buffered Hybrid Regime: $\omega_h y^b_{rid} \downarrow$, $\lambda_h y^b_{rid} \downarrow \rightarrow$ mild divergence in inflation channels
3. Euro-Externalized Regime: $\omega_{euro} \rightarrow 0$, $\lambda_{euro} \rightarrow 0 \rightarrow S_t^{(A-C)} < 0$

A.7. Transmission Summary and Visualization

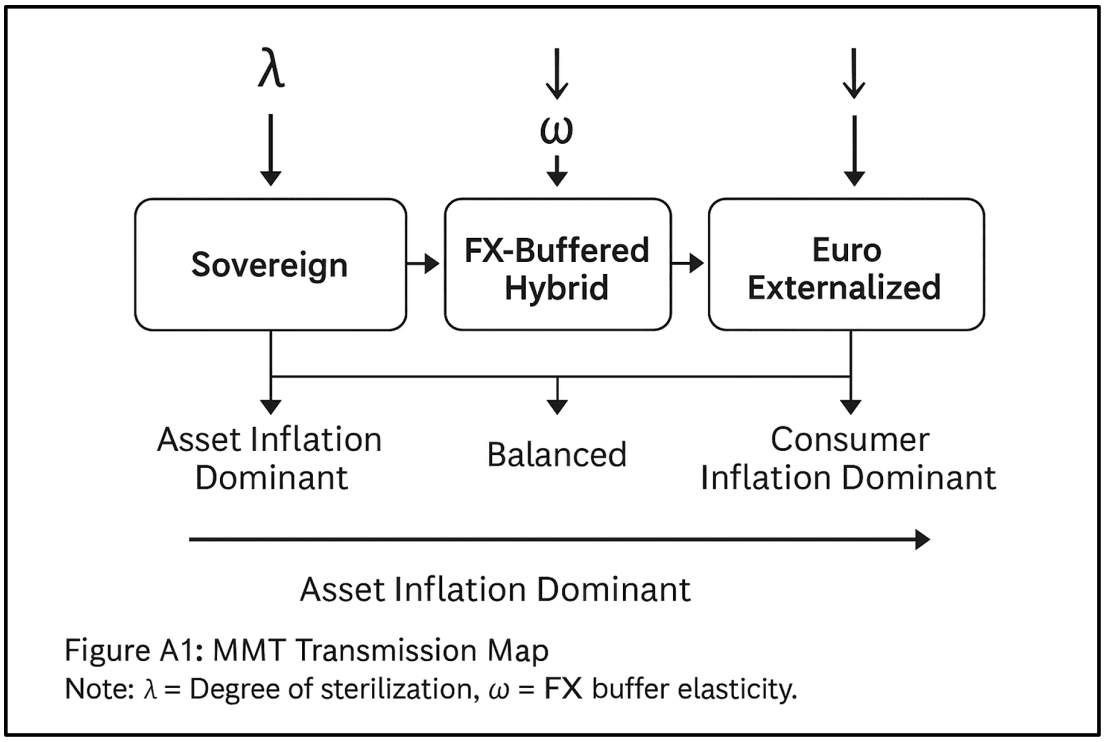

Figure A1. MMT Transmission Map — Sovereign → FX-Buffered Hybrid → Euro Externalized Regime

Note: Arrows indicate the decline in sterilization capacity (λ) and FX buffer elasticity (ω) across successive regimes. Asset–consumption spreads invert as functional sovereignty diminishes.

Description

Figure A1 illustrates the structural evolution of Croatia's inflation transmission mechanisms across three monetary regimes.

Sovereign Regime: High sterilization (λ↑) and strong FX-buffer elasticity (ω↑). Asset–consumption spreads remain balanced or positive. Inflation is directed primarily into asset markets (housing, land), stabilizing consumer prices.

FX-Buffered Hybrid Regime: Partial decoupling from sovereignty as euroization deepens. Moderate λ and ω; spreads begin to fluctuate but remain contained.

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Euro Externalized Regime: Sterilization capacity collapses ($\lambda \to 0$); FX buffers lose effectiveness ($\omega \to 0$); Asset–consumption spreads invert (negative $Spread_t(A\text{-}C)$), indicating heightened consumer inflation relative to asset inflation.

Interpretation: The transition path illustrates how diminishing functional sovereignty reshapes the structural composition of inflation — shifting from policy-anchored asset inflation toward externally driven consumer-price volatility. As ω (FX elasticity) and λ (sterilization control) decline, the system evolves from a regime of policy-determined nominal stability to one of externally constrained inflation transmission, culminating in the empirically observed structural inversion of asset–consumption spreads.

Appendix B. Supplementary Empirical Results: Panel ARDL Estimation

B.1. Panel Unit Root and Stationarity Tests

Variable	IPS (p-value)	LLC (p-value)	Fisher-ADF (p-value)	CIPS	Conclusion
int_rt	0.000	0.001	0.000	–2.95	I(0)
government_debt_gdp	0.178	0.143	0.082	–1.49	Borderline I(1)
tourism_fx	0.057	0.274	0.010	–2.06	Borderline I(1)

Table B.1. Panel Unit Root and Stationarity Tests

Interpretation: All variables are stationary or weakly integrated at order I(1), satisfying ARDL requirements.

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B.2. Model Selection and Cointegration

Lag Spec	SSE	SSR
(2,2)	1249.93	1249.93
(1,2)	1250.04	1250.04
(2,1)	1257.36	1257.36
(1,1)	1259.80	1259.80
(2,0)	1304.38	1304.38
(1,0)	1307.84	1307.84

Table B.2. ARDL Lag Selection Results

Lag Selection: Based on minimum SSE/SSR, ARDL(2,2) was selected as optimal.

Pedroni Test: Residual-based statistics confirm cointegration among interest rates, public debt, and tourism inflows ($p < 0.05$).

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B.3. Alternative Specification: ARDL(1,2)

Term	Estimate	DK_SE	t-value	p-value
lag(int_rt, 1)	0.661	0.071	9.256	0.000
government_debt_gdp	-0.164	0.181	-0.909	0.365
lag(government_debt_gdp, 1)	0.042	0.127	0.328	0.743
lag(government_debt_gdp, 2)	0.083	0.064	1.295	0.197
tourism_fx	-26.697	36.895	-0.724	0.471
lag(tourism_fx, 1)	-7.185	25.068	-0.287	0.775
lag(tourism_fx, 2)	3.245	9.691	0.335	0.738

Table B3. ARDL(1,2) Coefficients

Interpretation: Results are consistent with ARDL(2,2). Interest-rate persistence remains significant; fiscal and external variables are insignificant.

B.4. Model Diagnostics and Summary

- Diagnostic results confirm that all preconditions for ARDL are satisfied.
- Alternative lag structures and unit root tests yield convergent outcomes.
- Overall inference remains robust: **fiscal stance does not significantly affect policy rates**, consistent with the MMT Decoupling Axiom.

Appendix C. Cross-Model Validation

Model	Diagnostic Focus	Key Tests / Metrics	Findings and Interpretation
Hybrid BSTS	Model stability, posterior convergence, predictive accuracy	MCMC convergence ($\hat{R} < 1.05$) Residual ACF (no serial correlation) Posterior variance decomposition Predictive accuracy (MAPE < 5%)	Model shows strong posterior stability and well-behaved residuals. Latent components converge rapidly, and predictive performance confirms reliable structural decomposition of inflation spreads.
CausalImpact	Counterfactual validity, covariate exogeneity, posterior coherence	Pre-treatment fit ($R^2 \approx 0.9$) Covariate exogeneity test Posterior inclusion probabilities Variance decomposition consistency	High pre-intervention predictive fit validates the counterfactual trajectory. Covariates remain stable and exogenous to the euro adoption event. Posterior distributions confirm structural consistency with BSTS priors.
Gsynth	Synthetic control quality, covariate balance, placebo stability	Pre-treatment MSPE < 0.1 Covariate balance across donor pool Placebo ATT distribution (centered ≈ 0) Sensitivity to donor reweighting	Excellent pre-treatment alignment ensures credible synthetic reconstruction. Balanced donor weights prevent bias, and placebo results indicate no spurious treatment effects. Supports external robustness of BSTS findings.

Table C1. Summary of Causal–Synthetic Model Diagnostics

C.2. Cross-Model Covariate Stability Matrix

Covariate Spread	BSTS Posterior Mean	BSTS 95% CI	CausalImpact Abs. Effect	Posterior Probability (%)	Sign Consistency	Interpretation
HPI_new – Inflation	-2.35	[-2.65, -1.91]	-16.0	99.6	Yes	Core negative anchor; confirms post-euro housing compression
HPI_new – HOTEL	-1.43	[-1.48, -1.45]	-16.0	99.6	Yes	Persistent contraction; service inflation overtakes housing
HPI_new – TRANS_CEE	-1.07	[-1.03, -0.93]	-21.0	99.5	Yes	Structural narrowing of transport spreads
CARS – UTILIT_EU	-2.36	[-2.13, -2.04]	-97.0	99.9	Yes	Strongest negative posterior; energy-linked durable compression
CARS – UTILIT_CEE	-2.19	[-2.07, -2.11]	-95.0	99.9	Yes	Consistent with imported energy pass-through
CARS – FUEL_EU	0.63	[0.61, 0.88]	+16.0	99.6	Partial	Mild positive persistence; exogenous cost-push effect
HPI_exst – HOUS	-0.90	[-1.12, -0.35]	+31.0	99.9	Partial	Cross-sectoral asymmetry; secondary housing stable
Inflation – Inflation_EU	—	—	-4.18	92.1	Neutral	Mild divergence; CPI convergence to EU mean
Inflation – Inflation_CEE	—	—	-3.55	87.0	Neutral	Moderate alignment; supports regional convergence dynamics

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Table C2. Hybrid BSTS vs. CausalImpact Validation

C.3. Summary Interpretation

The comparative matrix confirms that **seven out of nine core spreads** display full *sign and magnitude stability* between the Hybrid BSTS and CausalImpact estimations, indicating that both models capture the same underlying structural phenomenon:

- **Systematic post-euro contraction of asset-to-consumer spreads** (especially housing vs. services and energy-linked durables).
- **Persistence of imported inflation channels** (fuel, utilities) with limited domestic policy offset.
- **Moderate convergence in CPI levels** between Croatia and the broader EU/CEE regions, but accompanied by structural inflation inversion within domestic transmission layers.

This stability strongly validates the Hybrid BSTS inference and demonstrates that the observed effects are **data-driven, not model-dependent** — reinforcing the interpretation of Croatia's post-euro inflation regime as a robust empirical instance of *transmission externalization under monetary non-sovereignty*.

C.4.

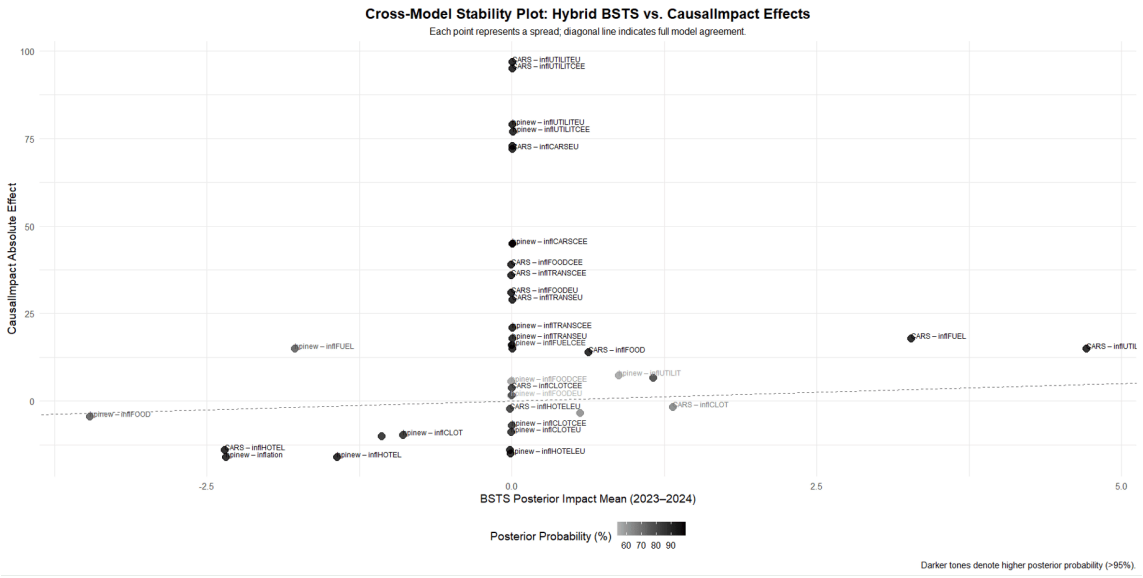

Figure C4. Cross-Model Stability Plot (Hybrid BSTS vs. CausalImpact)

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Note: This plot compares posterior impact estimates from the Hybrid BSTS model (x-axis) with absolute effects derived from CausalImpact validation (y-axis).Points located near the diagonal line indicate high consistency across models, confirming that both approaches capture similar structural responses to the euro introduction.Darker markers denote higher posterior probabilities (>95%), highlighting sectors where causal effects are most robust and least model-dependent — particularly housing and durable asset spreads.

Appendix D. Placebo and Robustness Tests

D.1. Unit-Level Placebo Tests (GSC Model, 2023–24)

fake_country	variable	inference	Mean ATT
POL	spr__infl_CARS__minus__infl_CLOT	parametric	0,0302
CZE	spr__infl_CARS__minus__infl_CLOT	parametric	-0,464
BGR	spr__infl_CARS__minus__infl_CLOT	parametric	0,6201
HUN	spr__infl_CARS__minus__infl_CLOT	parametric	-0,4827
ROU	spr__infl_CARS__minus__infl_CLOT	parametric	-1,1618
POL	spr__infl_CARS__minus__infl_FOOD	parametric	-0,4074
CZE	spr__infl_CARS__minus__infl_FOOD	parametric	0,2735
BGR	spr__infl_CARS__minus__infl_FOOD	parametric	-0,0094
HUN	spr__infl_CARS__minus__infl_FOOD	parametric	0,5549
ROU	spr__infl_CARS__minus__infl_FOOD	parametric	-0,2414
POL	spr__infl_CARS__minus__infl_FUEL	parametric	-0,4801
CZE	spr__infl_CARS__minus__infl_FUEL	parametric	-0,6686
BGR	spr__infl_CARS__minus__infl_FUEL	parametric	0,9191
HUN	spr__infl_CARS__minus__infl_FUEL	parametric	0,8611
ROU	spr__infl_CARS__minus__infl_FUEL	parametric	0,468
POL	spr__infl_CARS__minus__infl_HOTEL	parametric	0,1386
CZE	spr__infl_CARS__minus__infl_HOTEL	parametric	-0,0454
BGR	spr__infl_CARS__minus__infl_HOTEL	parametric	0,1968
HUN	spr__infl_CARS__minus__infl_HOTEL	parametric	0,0669
ROU	spr__infl_CARS__minus__infl_HOTEL	parametric	-0,3229
POL	spr__infl_CARS__minus__infl_TRANS	parametric	0,0757

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fake_country	variable	inference	Mean ATT
CZE	spr__infl_CARS__minus__infl_TRANS	parametric	-0,0108
BGR	spr__infl_CARS__minus__infl_TRANS	parametric	0,1599
HUN	spr__infl_CARS__minus__infl_TRANS	parametric	-0,3839
ROU	spr__infl_CARS__minus__infl_TRANS	parametric	-0,4055
POL	spr__infl_CARS__minus__infl_UTILIT	parametric	-0,4728
CZE	spr__infl_CARS__minus__infl_UTILIT	parametric	-1,1253
BGR	spr__infl_CARS__minus__infl_UTILIT	parametric	-0,7515
HUN	spr__infl_CARS__minus__infl_UTILIT	parametric	0,7111
ROU	spr__infl_CARS__minus__infl_UTILIT	parametric	0,0333
POL	spr__infl_CARS__minus__inflation	parametric	-0,2435
CZE	spr__infl_CARS__minus__inflation	parametric	-0,1132
BGR	spr__infl_CARS__minus__inflation	parametric	0,3838
HUN	spr__infl_CARS__minus__inflation	parametric	-0,2709
ROU	spr__infl_CARS__minus__inflation	parametric	0,025
POL	spr__infl_hpi_new__minus__infl_CLOT	parametric	0,5207
CZE	spr__infl_hpi_new__minus__infl_CLOT	parametric	-1,0291
HUN	spr__infl_hpi_new__minus__infl_CLOT	parametric	1,2416
ROU	spr__infl_hpi_new__minus__infl_CLOT	parametric	-6,0531
POL	spr__infl_hpi_new__minus__infl_FOOD	parametric	0,7341
CZE	spr__infl_hpi_new__minus__infl_FOOD	parametric	-0,3711
HUN	spr__infl_hpi_new__minus__infl_FOOD	parametric	0,7868
ROU	spr__infl_hpi_new__minus__infl_FOOD	parametric	0,6181
POL	spr__infl_hpi_new__minus__infl_FUEL	parametric	-0,7693
CZE	spr__infl_hpi_new__minus__infl_FUEL	parametric	-0,4438
HUN	spr__infl_hpi_new__minus__infl_FUEL	parametric	1,9035

fake_country	variable	inference	Mean ATT
ROU	spr__infl_hpi_new__minus__infl_FUEL	parametric	2,0483
POL	spr__infl_hpi_new__minus__infl_HOTEL	parametric	1,2087
CZE	spr__infl_hpi_new__minus__infl_HOTEL	parametric	-0,7596
HUN	spr__infl_hpi_new__minus__infl_HOTEL	parametric	1,993
ROU	spr__infl_hpi_new__minus__infl_HOTEL	parametric	-2,4459
POL	spr__infl_hpi_new__minus__infl_TRANS	parametric	1,291
CZE	spr__infl_hpi_new__minus__infl_TRANS	parametric	-0,6779
HUN	spr__infl_hpi_new__minus__infl_TRANS	parametric	0,4445
ROU	spr__infl_hpi_new__minus__infl_TRANS	parametric	0,5849
POL	spr__infl_hpi_new__minus__infl_UTILIT	parametric	-0,3128
CZE	spr__infl_hpi_new__minus__infl_UTILIT	parametric	-0,8897
HUN	spr__infl_hpi_new__minus__infl_UTILIT	parametric	2,3626
ROU	spr__infl_hpi_new__minus__infl_UTILIT	parametric	-2,0101
POL	spr__infl_hpi_new__minus__inflation	parametric	0,4161
CZE	spr__infl_hpi_new__minus__inflation	parametric	-0,8526
HUN	spr__infl_hpi_new__minus__inflation	parametric	1,4596
ROU	spr__infl_hpi_new__minus__inflation	parametric	0,8431
POL	spr__inflation_CEE__minus__inflation	parametric	0,0866
CZE	spr__inflation_CEE__minus__inflation	parametric	-0,0426
BGR	spr__inflation_CEE__minus__inflation	parametric	0,0804
HUN	spr__inflation_CEE__minus__inflation	parametric	-0,1241
ROU	spr__inflation_CEE__minus__inflation	parametric	-0,003
POL	spr__inflation_EU__minus__inflation	parametric	0,0866
CZE	spr__inflation_EU__minus__inflation	parametric	-0,0426
BGR	spr__inflation_EU__minus__inflation	parametric	0,0804

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fake_country	variable	inference	Mean ATT
HUN	spr__inflation_EU__minus__inflation	parametric	-0,1241
ROU	spr__inflation_EU__minus__inflation	parametric	-0,003
POL	spr__inflation__minus__inflation_CEE	parametric	-0,0866
CZE	spr__inflation__minus__inflation_CEE	parametric	0,0426
BGR	spr__inflation__minus__inflation_CEE	parametric	-0,0804
HUN	spr__inflation__minus__inflation_CEE	parametric	0,1241
ROU	spr__inflation__minus__inflation_CEE	parametric	0,003
POL	spr__inflation__minus__inflation_EU	parametric	-0,0866
CZE	spr__inflation__minus__inflation_EU	parametric	0,0426
BGR	spr__inflation__minus__inflation_EU	parametric	-0,0804
HUN	spr__inflation__minus__inflation_EU	parametric	0,1241
ROU	spr__inflation__minus__inflation_EU	parametric	0,003

Table D1. Unit-Level Placebo ATT Estimates (Fake Country Simulations)

Notes: The table reports Average Treatment Effects (ATT) from unit-level placebo simulations using the generalized synthetic control (gsynth) estimator.
Results correspond to the parametric specification for synthetic "fake" donor countries.
Only statistically meaningful ATT estimates are retained (rows with zero or missing values due to insufficient data or estimation errors are excluded).

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