Everybody Adjusts to Big Neighbor's Policy — But How Much? Measuring Monetary Adjustment to ECB Monetary Policy Shocks across Monetary Regimes

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Abstract

How much do small open economies adjust to the monetary policy of a dominant neighbor when their monetary regimes and policy instruments differ fundamentally? We develop the Central Bank Monetary Adjustment Metric (CMAM), a hierarchical dynamic-factor measure of effective monetary adjustment that combines regime-specific information from policy rates, reserve requirements, reserve remuneration, liquidity operations, and external adjustment. Applying CMAM to six European economies spanning inflation targeting, managed exchange rates, a currency board, and unilateral euroization reveals a striking result: everybody adjusts to ECB monetary policy, but not by the same amount or through the same mechanisms. Under the benchmark specification, ECB-attributable adjustment is strongest under hard monetary anchors, intermediate in managed regimes, and lowest on average under inflation targeting; Bayesian inference assigns a 94.5% posterior probability to this regime ordering. The mechanisms differ even more sharply. Hard-anchor economies adjust overwhelmingly through external and balance-sheet mechanisms, managed regimes rely heavily on external adjustment and liquidity management, while inflation targeters use a broader instrument mix in which the policy rate remains only one component. Local-projection validation and alternative specifications confirm pervasive ECB-related adjustment, although exact country and regime rankings are more sensitive to shock measurement. The results demonstrate that monetary autonomy and monetary adjustment are distinct: greater policy discretion does not imply insulation from external monetary conditions, while limited conventional autonomy does not automatically imply the largest adjustment. CMAM provides a framework for comparing effective monetary adjustment across otherwise institutionally incomparable monetary systems.

Keywords: Monetary adjustment; ECB monetary policy; International monetary spillovers; Monetary regimes; Monetary-policy transmission; Latent-factor models

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1. Introduction

Monetary policy in large economies rarely stops at national borders. Changes in the monetary stance of major central banks propagate internationally through financial conditions, capital flows, exchange rates, bank funding, trade, and expectations, affecting economic activity and prices well beyond the jurisdiction in which the original policy decision is taken. A large empirical literature has documented these international monetary-policy spillovers, with particularly strong implications for small open economies that are financially and economically integrated with a dominant currency area (e.g., Rey, 2015; Miranda-Agrippino and Rey, 2020; Georgiadis, 2016). For European economies outside the euro area, monetary policy of the European Central Bank (ECB) represents an especially important external force (Babecká Kucharčuková et al., 2016; Potjagailo, 2017; Kovacevic, 2026). Yet establishing that ECB policy matters leaves a related question largely unanswered: how much do domestic monetary systems themselves adjust when ECB monetary policy changes?

This distinction between monetary-policy spillovers and monetary adjustment is central to this paper. Most of the existing literature examines how foreign monetary shocks affect domestic macroeconomic or financial outcomes—output, inflation, credit, interest rates, exchange rates, asset prices, or financial conditions—or studies the response of individual monetary-policy instruments. Such responses necessarily contain information about domestic adjustment, but they do not provide a unified measure of it. In particular, comparing monetary adjustment across monetary regimes is difficult because there is no single policy instrument that performs the same function everywhere. An inflation-targeting central bank may respond through its policy rate and liquidity operations while allowing substantial exchange-rate flexibility, but it may also seek to contain exchange-rate fluctuations through foreign-exchange intervention. A central bank operating a managed exchange-rate regime may rely more heavily on foreign-exchange and liquidity management. Under a currency board or unilateral euroization, conventional interest-rate policy is severely constrained or absent, and adjustment instead operates through external monetary flows, balance-sheet mechanisms, liquidity conditions, and required reserve and remuneration policies. Consequently, neither the formal monetary regime nor the behavior of any single policy instrument is sufficient to characterize the overall monetary adjustment taking place in an economy.

This paper addresses that measurement problem by introducing a Central Bank Monetary Adjustment Metric (CMAM), a latent measure of the intensity with which domestic monetary conditions adjust to ECB monetary-policy shocks. Rather than defining monetary adjustment by the behavior of any single instrument, CMAM treats observable policy and adjustment channels as different manifestations of an underlying common process. Depending on the institutional framework, these channels include policy rates, liquidity operations, reserve requirements, remuneration of reserves, and external adjustment mechanisms—the latter reflected in exchange-rate changes, foreign-exchange intervention, and/or changes in external financial flows. The empirical manifestation of the external channel therefore differs across monetary regimes:

exchange-rate movements and foreign-exchange intervention are informative where exchange-rate discretion exists, whereas under a currency board or unilateral euroization adjustment is necessarily reflected primarily in external monetary and financial flows and the associated balance-sheet and liquidity dynamics. Importantly, their inclusion does not imply that every instrument is expected to move with every ECB policy shock. Individual instruments continue to serve domestic policy objectives and may remain unchanged, reinforce the externally induced adjustment, or move against it at different points in time. The object of interest is therefore not the mechanical synchronization of individual policy instruments with the ECB, but the joint adjustment of monetary conditions through the instruments and mechanisms available within each monetary framework. We refer to this joint adjustment as effective monetary adjustment. CMAM provides a latent measure of its intensity.

The empirical setting provides an unusually useful laboratory for identifying this distinction. We study six Western Balkan and closely integrated regional economies—Albania, Bosnia and Herzegovina, Croatia before euro adoption, Montenegro, North Macedonia, and Serbia—which share strong economic and financial links with the euro area but operate, or operated during the sample, under markedly different monetary arrangements. Albania and Serbia provide inflation-targeting regimes with comparatively greater monetary-policy autonomy; North Macedonia and pre-euro Croatia represent managed exchange-rate arrangements with stronger exchange-rate considerations; Bosnia and Herzegovina operates a currency board; and Montenegro is unilaterally euroized. These institutional differences imply different sets of available policy instruments and adjustment mechanisms while exposing all six economies to a common dominant external monetary force. The comparison therefore allows us to ask not simply whether ECB monetary policy spills over to the region, but how monetary adjustment to the same external policy impulse differs systematically with the monetary regime.

To recover this otherwise unobservable adjustment process, we develop a hierarchical dynamic factor framework in which country-specific monetary-policy and adjustment variables load on a latent CMAM factor. The hierarchical structure permits common information to discipline estimation while retaining country-specific heterogeneity, an important feature in a relatively short and heterogeneous regional panel. Our preferred specification allows the importance of individual adjustment channels to vary smoothly over time and around major monetary-policy episodes, rather than imposing constant channel weights throughout the sample. The model further separates overall monetary adjustment from the component statistically attributable to identified ECB monetary-policy shocks, allowing domestic macroeconomic conditions, external financial conditions, and idiosyncratic innovations to influence the same adjustment process. This distinction is important: CMAM is not intended to imply that all monetary actions in these economies are responses to Frankfurt. Instead, it provides a common framework for determining how much of observed monetary adjustment can be associated with ECB policy and through which channels that adjustment occurs.

The paper makes three main contributions. First, it shifts the focus of the international monetary-spillover literature from the consequences of foreign monetary shocks to an intermediate

mechanism that is often implicit in those consequences: the effective adjustment of domestic monetary conditions. This complements evidence—including our recent work on ECB spillovers across the Western Balkans—showing that ECB shocks affect domestic output and prices and that transmission differs across monetary and exchange-rate regimes (Kovacevic, 2026). If that literature establishes that these economies are affected by ECB policy, the present paper asks the natural next question: if everybody is affected, how much does everybody adjust? Second, the paper provides a measurement framework capable of comparing monetary adjustment across regimes whose available instruments are fundamentally different. By treating policy rates, reserve policies, liquidity management, remuneration, and external adjustment as regime-dependent manifestations of a common latent construct, CMAM avoids equating monetary-policy autonomy with the behavior of a single observable instrument. Third, the framework distinguishes the intensity of monetary adjustment from both its underlying drivers and the channels through which it is implemented. This allows the analysis to move beyond whether one country adjusts more than another toward the economically more informative questions of how much adjustment is attributable to ECB policy, where within the monetary system that adjustment occurs, and how its composition varies across monetary frameworks.

Our estimates point to a clear organizing pattern. ECB monetary-policy shocks generate measurable effective monetary adjustment across all three monetary regimes, but neither its intensity nor its composition is uniform. Hard monetary anchors exhibit the strongest ECB-attributable adjustment, managed exchange-rate regimes occupy an intermediate position, and inflation-targeting economies adjust less strongly on average. Bayesian posterior inference assigns a 94.5 percent probability to this complete regime ordering, while uncertainty surrounding several individual-country rankings is considerably greater. The mechanisms underlying adjustment differ just as markedly. Hard-anchor adjustment is overwhelmingly concentrated in external monetary and financial mechanisms; managed regimes rely predominantly on external adjustment and liquidity operations; and inflation-targeting economies exhibit a more diversified adjustment mix across policy-rate, liquidity, and external channels. Considerable heterogeneity nevertheless remains within regimes. The central result is therefore not a rigid league table of individual countries, but a systematic relationship between the monetary framework and both the intensity and composition of adjustment to ECB policy. Monetary regimes shape the feasible adjustment architecture, but do not uniquely determine how strongly or through which mechanisms individual economies adjust.

These results also provide a different perspective on monetary-policy independence in small open economies. Monetary autonomy and monetary adjustment are not opposites. An economy may retain discretion over its domestic policy rate while nevertheless experiencing substantial external monetary influence through financial, exchange-rate, liquidity, or balance-sheet channels. Conversely, under a hard peg or euroization, the absence of an independently set policy rate does not mechanically imply stronger effective monetary adjustment; it changes how that adjustment occurs, shifting its composition toward external monetary flows, balance-sheet and liquidity mechanisms, and reserve-related policies. The relevant empirical question is therefore

not simply whether domestic interest rates follow the ECB, but where the adjustment occurs, how large it is, and how the institutional monetary framework shapes its transmission.

The credibility of a latent measure necessarily depends on whether its conclusions survive alternative ways of defining, measuring, and estimating the underlying adjustment process. We therefore subject the results to an extensive set of validation and robustness exercises. These include alternative measures of ECB monetary-policy shocks, constant- and time-varying-loading specifications, alternative treatments of country-specific measurement issues, complementary local-projection evidence constructed separately from the ECB-conditioned CMAM specification, and formal evaluation of the stability of country and regime comparisons across specifications. The validation exercises also examine whether cross-country comparisons are mechanically affected by differences in the number, structural availability, or frequency of use of monetary instruments. In addition, we complement the benchmark maximum a posteriori estimation (MAP) estimates with MAP-anchored Bayesian inference that quantifies posterior uncertainty around the empirically validated benchmark-associated region of the model. This allows uncertainty surrounding CMAM paths, channel contributions, regime differences, and country comparisons to be assessed explicitly rather than inferred solely from point estimates. The Bayesian exercise is therefore used as uncertainty and robustness analysis rather than as an independent diffuse-prior re-estimation of the model. Together, these exercises distinguish findings that are robust at the structural level—particularly cross-regime patterns and broad adjustment mechanisms—from exact country orderings and individual channel estimates that are subject to greater specification or posterior uncertainty.

The remainder of the paper is organized as follows. Section 2 reviews the related literature and develops the conceptual framework. Section 3 describes the institutional setting and monetary adjustment channels across the different monetary regimes. Section 4 presents the data and measurement approach. Section 5 develops the CMAM framework and discusses identification, estimation, and inference. Section 6 examines the magnitude of overall and ECB-attributable monetary adjustment across countries and regimes. Section 7 analyzes the channels through which that adjustment is implemented and their evolution over time. Section 8 provides complementary dynamic evidence using local projections. Section 9 examines robustness, identification, and Bayesian posterior uncertainty. Section 10 discusses the implications for monetary autonomy and cross-regime monetary adjustment. Section 11 concludes.

2. Related Literature and Conceptual Framework

The concept of effective monetary adjustment developed in this paper lies at the intersection of several strands of monetary and international macroeconomic research. The first concerns attempts to summarize monetary conditions using information from multiple observable variables rather than a single policy instrument. The second examines pressure and adjustment in foreign-exchange markets when monetary authorities can accommodate external pressures through different combinations of exchange-rate movements and intervention. A third, much larger

literature studies the international transmission of monetary-policy shocks and the constraints that monetary and financial integration impose on policy autonomy in small open economies. These literatures approach the problem from different directions, but they share an important insight: monetary conditions and monetary adjustment are multidimensional, and their observable manifestation depends on the institutional environment in which monetary policy operates. CMAM builds on this insight while addressing a different measurement problem—the intensity and composition of effective monetary adjustment to a common external monetary-policy impulse across heterogeneous monetary regimes.

An important antecedent is the literature on monetary conditions indices (MCIs). Traditional MCIs emerged from the recognition that the monetary stance of an open economy cannot necessarily be summarized by the domestic short-term interest rate alone. In their conventional form, MCIs combine changes in a short-term interest rate and an exchange rate, with weights intended to capture their relative effects on aggregate demand or inflation. The approach became particularly associated with the conduct and analysis of monetary policy in Canada and was subsequently applied to other open economies (Freedman, 1995; Eika et al., 1996; Batini and Turnbull, 2002). The central idea is directly relevant to the present analysis: different observable variables can jointly convey information about an underlying monetary condition that no individual variable adequately represents.

At the same time, the MCI literature demonstrates the difficulties involved in constructing such composite measures. Fixed weights may be sensitive to the underlying empirical model, transmission coefficients may change over time, and the interpretation of an index can become problematic when its components respond to shocks for reasons unrelated to monetary policy. Eika et al. (1996), in particular, emphasize the importance of model constancy, dynamics, exogeneity, and omitted variables for the usefulness of an MCI. Later approaches sought to accommodate some of these concerns through richer econometric models and dynamic weighting schemes (Batini and Turnbull, 2002). These limitations are especially consequential in the present setting. A conventional MCI presumes that interest rates and exchange rates constitute broadly comparable indicators of monetary conditions across observations. Such an assumption is difficult to sustain when comparing inflation targeting, managed exchange rates, a currency board, and unilateral euroization. Some countries possess an independently set policy rate; others do not. Exchange rates can adjust substantially in some regimes, are actively managed in others, and are institutionally fixed or absent as an adjustment margin in still others. A common fixed-weight combination of the same observable variables would therefore impose precisely the cross-regime homogeneity that the present paper seeks to avoid.

CMAM retains the broader intuition of the MCI literature—that monetary conditions should be assessed jointly rather than inferred from a single instrument—but changes both the object being measured and the method of aggregation. It is not an index of the stance of domestic monetary policy and does not seek to determine whether monetary conditions are tight or loose in an absolute sense. Instead, it measures the intensity of effective monetary adjustment, defined as the joint adjustment of monetary conditions through the instruments and mechanisms available

within a given monetary framework. Moreover, the weights assigned to these manifestations are not imposed from estimated output or inflation equations. They are recovered within a hierarchical latent-factor model and, in the preferred specification, are allowed to evolve over time. This distinction is important because the relative importance of the policy rate, liquidity operations, reserve policies, remuneration, and external adjustment need not be constant either across countries or through time.

A second conceptual antecedent is provided by the literature on exchange-market pressure (EMP). Beginning with Girton and Roper (1977), this literature recognized that pressure on a currency need not be observed exclusively through changes in the exchange rate. When monetary authorities intervene to resist exchange-rate movements, the same underlying pressure may instead be reflected in changes in international reserves. Subsequent contributions generalized the measurement of exchange-market pressure and applied EMP indicators extensively to the identification of speculative pressure and currency crises (Weymark, 1998; Kaminsky et al., 1998). Although specific constructions differ, the underlying principle is highly relevant for cross-regime monetary analysis: an underlying external pressure may manifest itself differently depending on the degree to which the exchange rate is allowed to adjust and the extent to which the monetary authority offsets that pressure through intervention.

This insight is particularly useful for the external-adjustment channel of CMAM. In economies with meaningful exchange-rate flexibility, external monetary adjustment can be reflected in exchange-rate movements; where authorities actively manage the exchange rate, foreign-exchange intervention provides an additional manifestation of the same adjustment margin. In regimes where the domestic currency is rigidly tied to the euro, or where the euro itself is used as legal tender, adjustment cannot occur through a conventional bilateral exchange-rate movement against the anchor currency and is instead reflected more strongly in external monetary and financial flows and associated balance-sheet and liquidity dynamics. The empirical implementation therefore draws on the intuition of the EMP literature without treating CMAM itself as an exchange-market-pressure index. EMP is one component of the measurement architecture where institutionally appropriate; CMAM is a broader latent construct encompassing external adjustment alongside the other monetary channels available under each regime.

The distinction is also important for interpreting foreign-exchange intervention under more flexible regimes. Formal inflation targeting does not imply that the exchange rate is irrelevant to monetary policy or that intervention is absent. The well-known “fear of floating” literature shows that economies classified as floaters frequently stabilize exchange rates more actively than their formal regime labels would suggest (Calvo and Reinhart, 2002). For small and highly open economies, exchange-rate movements can affect inflation, balance sheets, expectations, and financial stability, giving policymakers reasons to react even when the exchange rate is not an explicit intermediate target. Thus, the operative monetary framework is better understood as determining the set and relative importance of available adjustment mechanisms than as prescribing a single instrument through which adjustment must occur.

The third and most extensive strand of relevant research concerns the international transmission of monetary policy. Monetary-policy decisions in major economies affect financial conditions well beyond their borders through interest rates, asset prices, bank leverage, international credit, capital flows, exchange rates, trade, and expectations. The global financial-cycle literature emphasizes the ability of monetary conditions in major financial centers to generate common movements in global asset prices, credit, leverage, and capital flows (Rey, 2015; Bruno and Shin, 2015; Miranda-Agrippino and Rey, 2020). This evidence has sharpened the traditional debate over the extent of monetary-policy autonomy in financially integrated economies. Whereas the classical monetary-policy trilemma emphasizes the trade-off among exchange-rate stability, capital mobility, and monetary independence (Obstfeld et al., 2005), the global-financial-cycle argument suggests that international financial integration may constrain domestic monetary conditions even under flexible exchange rates (Rey, 2015).

For the economies considered here, the relevant external monetary center is primarily the euro area. A growing empirical literature documents significant spillovers from ECB monetary policy to European economies outside the monetary union. Babecká Kucharčuková et al. (2016) find that both conventional and unconventional ECB policies generate macroeconomic spillovers to non-euro-area EU economies. Potjagailo (2017) documents heterogeneous ECB spillovers across Europe and relates their strength to country characteristics, including exchange-rate arrangements and economic and financial integration. More recent evidence emphasizes the transmission of euro-area monetary policy through financial euroization and domestic retail interest rates in Central, Eastern, and Southeastern Europe (Moder, 2023). Kovacevic (2026), focusing directly on the Western Balkan economies, finds significant ECB-induced responses of output and prices and systematic heterogeneity in transmission across monetary and exchange-rate regimes. Taken together, this literature establishes both the relevance of ECB monetary policy for neighboring economies and the importance of institutional heterogeneity for its transmission.

Yet the existence of spillovers and the existence of domestic monetary adjustment are not the same empirical object. Spillover studies typically trace the effect of an external monetary-policy shock to domestic macroeconomic or financial outcomes. Their purpose is to establish whether foreign policy matters, through which transmission channels, and with what consequences for variables such as output, inflation, credit, interest rates, or exchange rates. From the perspective of the present paper, however, an intermediate stage remains only partially observed. Between the external policy impulse and its ultimate domestic consequences, monetary conditions adjust through the mechanisms permitted by the domestic institutional framework. Individual elements of this adjustment appear throughout the existing literature—policy-rate co-movement, exchange-rate responses, foreign-exchange intervention, reserve movements, bank funding and capital flows—but they are generally examined separately rather than as manifestations of a common latent adjustment process.

This distinction also changes the interpretation of monetary-policy autonomy. Greater autonomy does not imply insulation from external monetary conditions. An inflation-targeting central bank may retain discretion over its policy rate while allowing exchange-rate movements,

intervening selectively in foreign-exchange markets, adjusting liquidity provision, or accommodating externally induced financial flows. Conversely, a currency board or euroized economy has little or no conventional policy-rate autonomy, but effective monetary adjustment continues to occur through external monetary flows, balance-sheet and liquidity mechanisms, and reserve-related policies. Monetary autonomy and monetary adjustment are therefore distinct rather than opposing concepts. The relevant difference across regimes is therefore not whether adjustment exists, but how much adjustment occurs and through which combination of mechanisms. The monetary regime shapes the feasible adjustment set and the relative importance of its components.

This perspective provides the conceptual basis for CMAM. Let an ECB monetary-policy shock constitute a common external impulse confronting economies that differ in their monetary institutions. The shock need not induce a contemporaneous or mechanically proportional movement in every domestic instrument. Policy instruments retain domestic objectives; some may remain unchanged for long periods, some may reinforce the externally induced adjustment, and others may temporarily offset it. Required-reserve ratios, for example, are changed relatively infrequently, yet changes in them can materially alter monetary conditions when they occur. Similarly, an inflation-targeting policy rate need not mechanically follow the ECB because its primary calibration reflects domestic inflation and activity, while external adjustment may simultaneously occur through the exchange rate, intervention, liquidity, or financial flows. Effective monetary adjustment is therefore a joint property of the operative channels, not the synchronization of any individual instrument with the external policy rate.

This conceptualization has three implications for measurement. The observable variables entering CMAM should be regime-specific manifestations of a common economic construct, rather than an identical set of instruments imposed on every country. Structural absence of an instrument is therefore different from zero use of an available instrument. The contribution of individual channels should also be allowed to differ across countries and, where supported by the data, over time. Monetary frameworks may be institutionally stable while the relative importance of the mechanisms operating within them changes across episodes. Finally, overall effective monetary adjustment must be distinguished from the part attributable specifically to ECB policy. Domestic inflation and activity, external financial conditions, institutional changes, and country-specific disturbances can all induce monetary adjustment independently of an identified ECB shock.

These principles distinguish CMAM from both conventional composite monetary indicators and standard spillover measures. Relative to an MCI, CMAM broadens the information set beyond interest and exchange rates, accommodates structurally different instrument sets across monetary regimes, and estimates rather than imposes the relative importance of the constituent channels. Relative to an EMP index, it treats external adjustment as one component of a wider monetary-adjustment process rather than as the object of interest itself. Relative to the international spillover literature, it shifts attention from the ultimate consequences of an external monetary shock toward the effective adjustment of domestic monetary conditions that occurs between the

external impulse and those consequences. Finally, by separating overall CMAM from its ECB-attributable component, the framework does not equate domestic monetary behavior with passive following of the ECB.

The conceptual framework also provides clear empirical expectations for the analysis that follows. Effective monetary adjustment should be observable across all monetary regimes considered here. The absence of an independent policy rate does not automatically imply the most intensive adjustment, just as greater policy autonomy does not insulate an economy from external monetary conditions. ECB monetary-policy shocks should therefore be reflected somewhere within the operative monetary and financial adjustment mechanisms of each economy. At the same time, the intensity of ECB-attributable adjustment should vary systematically with the monetary constraints imposed by the institutional framework. Hard monetary anchors provide the least scope for domestic monetary conditions to diverge persistently from those of the anchor currency area, while managed exchange-rate regimes retain more adjustment margins and inflation-targeting regimes possess greater conventional policy discretion. This suggests an organizing regime gradient in which ECB-attributable adjustment is strongest under hard monetary anchors, intermediate under managed exchange-rate regimes, and weaker on average under inflation targeting. This ordering is an empirical implication of the institutional framework rather than a restriction imposed in estimation.

The composition of adjustment need not follow the same cross-country pattern as its intensity. Hard-anchor regimes can be expected to rely disproportionately on external monetary, balance-sheet, liquidity, and reserve-related mechanisms, while managed exchange-rate regimes combine external adjustment with active liquidity management and other domestic instruments. Inflation-targeting regimes permit a more diversified combination of policy-rate, liquidity, exchange-rate, and external adjustment. These expectations concern broad institutional patterns rather than deterministic country-specific outcomes. Economies operating under the same formal regime may differ substantially in both the intensity of their adjustment and the instruments and mechanisms through which it is realized.

3. Institutional Setting and Monetary Adjustment Channels

The Western Balkan region provides an unusually informative setting for studying effective monetary adjustment because economies that are geographically close, strongly integrated with the euro area, and exposed to a common external monetary environment operate under markedly different monetary arrangements. During the period considered in this paper, these arrangements span inflation targeting with managed exchange-rate flexibility, exchange-rate-oriented monetary strategies, a currency board, and unilateral euroization. The resulting differences are not merely institutional labels. They shape which monetary-policy instruments are available, which margins can absorb external monetary impulses, and consequently how effective monetary adjustment to ECB policy can manifest itself. The same ECB monetary-policy shock may therefore be accommodated through policy rates and liquidity operations in one economy,

foreign-exchange intervention and exchange-rate movements in another, and external monetary flows, bank liquidity, or reserve-related policies in a third.

For the purposes of the analysis, the six economies are grouped into three broad monetary-regime categories: inflation targeting in Albania and Serbia; managed exchange-rate regimes in North Macedonia and Croatia prior to euro adoption; and hard monetary anchors, comprising the currency-board arrangement in Bosnia and Herzegovina and unilateral euroization in Montenegro. These categories necessarily abstract from important country-specific institutional features. In particular, inflation targeting does not imply indifference to the exchange rate, while the two hard-anchor arrangements impose monetary constraints through fundamentally different institutional mechanisms. The classification is therefore intended to organize the cross-regime comparison rather than to imply identical monetary-policy implementation within each group.

3.1. Inflation-Targeting Economies: Albania and Serbia

Albania and Serbia possess the greatest conventional monetary-policy autonomy among the economies considered. In both countries, price stability is pursued within an inflation-targeting framework and the policy interest rate provides the principal signal of the monetary-policy stance. The availability of an independently determined policy rate creates a direct adjustment margin that does not exist under the hard-anchor regimes. Open-market and liquidity operations support implementation by steering short-term market rates and managing banking-system liquidity, while reserve requirements provide an additional, less frequently adjusted instrument.

Albania operates an inflation-targeting regime centered on the Bank of Albania's price-stability objective. The policy rate applied to its main refinancing operations provides the principal monetary-policy signal, while liquidity management is implemented through open-market operations and standing facilities. The banking system's structural liquidity position and reserve requirements are integral to this operational framework. At the same time, the lek is not institutionally fixed to the euro, allowing the exchange rate itself to absorb part of an external monetary impulse. The Bank of Albania can nevertheless operate in the foreign-exchange market, so exchange-rate adjustment and foreign-exchange intervention should be regarded as complementary rather than mutually exclusive manifestations of the external adjustment channel.

Serbia likewise operates an inflation-targeting framework, formally implemented since 2009 following the gradual introduction of its main elements from 2006. The key policy rate, applied in the National Bank of Serbia's main open-market operations, is the principal monetary-policy instrument. Serbia nevertheless represents an important reminder that inflation targeting and freely floating exchange rates are not synonymous. The dinar operates under a managed floating arrangement, and the National Bank of Serbia may intervene in the foreign-exchange market to moderate excessive short-term exchange-rate fluctuations, preserve price and financial stability, and maintain adequate foreign-exchange reserves. The Serbian monetary framework therefore combines substantial policy-rate autonomy with active use of the foreign-exchange adjustment margin.

This distinction is particularly relevant for CMAM. The policy-rate channel in Albania and Serbia is available as a potentially important component of effective monetary adjustment to ECB policy, but neither central bank is expected to mechanically follow ECB interest-rate decisions. Their policy rates remain primarily directed toward domestic inflation and macroeconomic conditions. An ECB shock can therefore be accommodated through several margins simultaneously: domestic policy rates, liquidity operations, reserve policies, exchange-rate movements, and foreign-exchange intervention. Some of these channels may reinforce the ECB-induced adjustment while others may offset it. Consequently, relatively weak synchronization of the domestic policy rate with ECB rates need not imply weak effective monetary adjustment overall.

3.2. Managed Exchange-Rate Regimes: North Macedonia and pre-euro Croatia

North Macedonia and Croatia prior to euro adoption occupy an intermediate institutional position. Both retained national currencies and domestic monetary-policy instruments during the sample considered here, but exchange-rate stability vis-à-vis the euro played a substantially greater role in their monetary frameworks than in the inflation-targeting economies. As a result, foreign-exchange management, international reserves, and domestic liquidity conditions become particularly important components of adjustment.

North Macedonia has pursued an exchange-rate-oriented monetary strategy since the mid-1990s, initially against the Deutsche Mark and subsequently against the euro. Stability of the denar against the euro serves as the intermediate monetary-policy objective supporting the ultimate objective of price stability. This arrangement gives the National Bank of the Republic of North Macedonia access to domestic monetary instruments while placing exchange-rate considerations at the center of policy implementation. Interest-rate instruments, central-bank bills and other liquidity operations, reserve requirements, and foreign-exchange intervention can therefore interact in maintaining monetary and exchange-rate stability.

The implications for adjustment to ECB policy are different from those under inflation targeting. Because the exchange rate against the euro constitutes an explicit nominal anchor, changes in euro-area monetary conditions create stronger incentives for domestic monetary and liquidity conditions to remain compatible with exchange-rate stability. Adjustment can consequently occur through foreign-exchange intervention and reserve movements, liquidity absorption or provision, domestic interest-rate conditions, and reserve-related measures. The exchange-rate objective constrains the degree to which domestic monetary conditions can diverge persistently from those prevailing in the anchor currency area without generating pressure elsewhere in the system.

Croatia provides an especially important case because its monetary framework evolved during the sample toward full participation in the euro area. Prior to euro adoption, the Croatian National Bank operated a tightly managed exchange-rate framework in a highly euroized financial

system. Stability of the kuna against the euro was a central feature of monetary policy, and foreign-exchange intervention played a major role in influencing domestic liquidity and limiting exchange-rate fluctuations. Reserve requirements and liquidity-management instruments complemented this framework. The high degree of financial euroization strengthened the relevance of euro-area monetary conditions even before formal monetary integration.

Croatia's path toward euro adoption progressively reduced the institutional distance between domestic and euro-area monetary conditions. The kuna entered the Exchange Rate Mechanism II (ERM II) in July 2020. Participation in ERM II formalized the exchange-rate relationship with the euro as part of the convergence process, while close cooperation between the ECB and the Croatian National Bank also brought significant Croatian banks under ECB supervision from October 2020. The Council of the European Union subsequently approved Croatia's accession to the euro area at the fixed conversion rate of HRK 7.53450 per euro, and Croatia adopted the euro on 1 January 2023.

This transition has an important consequence for the empirical design of the paper. Croatia is included only through December 2022. Euro adoption is not treated as another observation within the same Croatian monetary regime because it eliminates the independent national monetary framework whose adjustment CMAM is intended to measure. From January 2023 onward, ECB monetary policy is no longer an external monetary-policy impulse to which a Croatian national monetary system adjusts; Croatia participates directly in the common monetary policy of the euro area. Extending the Croatian CMAM beyond this point would therefore change the economic meaning of the latent construct rather than simply extend the sample. Croatia's pre-euro experience is nevertheless especially informative because it represents the endpoint of increasing monetary integration with the anchor currency area.

3.3. Hard Monetary Anchors: Bosnia and Herzegovina and Montenegro

Bosnia and Herzegovina and Montenegro form the hard-anchor group, but their institutional arrangements are distinct. Bosnia and Herzegovina retains a national currency under a statutory currency board, whereas Montenegro has no national currency and uses the euro unilaterally. What unites the two cases is the absence of a conventional independently determined policy-rate channel and the correspondingly greater importance of external monetary flows, balance-sheet adjustment, banking-system liquidity, and reserve-related mechanisms.

The Central Bank of Bosnia and Herzegovina operates under a currency-board arrangement in which the convertible mark is fixed to the euro at KM 1.95583 per euro and domestic monetary liabilities must be backed by foreign-exchange reserves in accordance with the statutory currency-board rules. The arrangement sharply restricts discretionary monetary policy. The central bank cannot alter the exchange rate to absorb shocks, create uncovered domestic money, conduct conventional open-market operations, or provide ordinary lender-of-last-resort financing. Required reserves and remuneration policies constitute its principal discretionary monetary-policy instruments.

The currency-board architecture implies a fundamentally different mechanism of monetary adjustment from that operating under inflation targeting. With the exchange rate fixed and an independent policy rate unavailable, external monetary and balance-sheet flows become central to the adjustment process. Changes in foreign assets and liabilities are transmitted into domestic monetary conditions through the currency-board balance sheet and the banking system. Required-reserve policy and the remuneration of required and excess reserves can modify banks' liquidity incentives and the distribution of monetary adjustment, but they operate within rather than override the currency-board constraint. Consequently, adjustment to ECB monetary conditions should not be sought in a domestic policy rate that does not exist as an independent instrument. It is reflected instead in the interaction among external flows, reserve money and banking-system liquidity, required reserves, and reserve remuneration.

Montenegro represents an even more complete surrender of conventional monetary autonomy. Following the earlier use of the Deutsche Mark, Montenegro adopted the euro unilaterally and does not issue a national currency. The Central Bank of Montenegro therefore neither determines an exchange rate against the euro nor sets an independent reference policy rate. The quantity of euros available to the domestic economy depends importantly on external transactions and financial flows, including trade, capital movements, remittances and other balance-of-payments flows. In this sense, changes in euro-area monetary conditions are transmitted into an economy in which the currency of the external monetary authority is already the domestic means of payment.

The absence of a national currency does not imply an absence of domestic monetary adjustment. Rather, it shifts the adjustment toward other margins. External monetary and financial flows affect the liquidity available to the banking system, while reserve requirements provide the Central Bank of Montenegro with an instrument for influencing bank liquidity, credit conditions, and the money-multiplication process. Reserve remuneration and other liquidity-related measures can further affect banks' incentives and liquidity management. The reserve requirement is consequently particularly important as a policy instrument under Montenegro's institutional constraints, even though changes in the reserve ratio are relatively infrequent.

For the purposes of CMAM, Montenegro also illustrates why external adjustment cannot be represented identically across monetary regimes. There is no EUR/Montenegrin-currency exchange rate whose movement could reveal external monetary pressure, and conventional foreign-exchange intervention against the euro is conceptually absent. External adjustment must instead be inferred from monetary and financial flows that change the domestic availability of euro liquidity. This motivates the use of banking-system excess reserves as the principal observable manifestation of Montenegro's external adjustment channel in the empirical analysis. Excess reserves are not interpreted as a direct measure of cross-border flows themselves, but as a balance-sheet manifestation of the euro liquidity generated or absorbed by those flows within a unilaterally euroized monetary system. Because excess reserves can also respond to domestic reserve policies and other banking-system liquidity developments, their use as an external-adjustment proxy is

treated as a measurement choice whose robustness is evaluated explicitly in the empirical analysis.[1] The precise construction and robustness of this measure are discussed in Section 4.

3.4. Monetary Adjustment Channels Across Regimes

The institutional comparison makes clear why effective monetary adjustment cannot be measured by imposing an identical set of observable instruments on every country. CMAM instead organizes the available mechanisms into five economically common channels—the policy rate, liquidity operations, reserve requirements, reserve remuneration, and external adjustment—while allowing the empirical manifestation and structural availability of these channels to differ across monetary regimes.

The policy-rate channel is most directly relevant for Albania and Serbia, where the central bank can independently set a policy interest rate in pursuit of its domestic inflation objective. Interest-rate instruments also matter in the implementation of managed exchange-rate strategies, although their freedom to diverge from euro-area monetary conditions is constrained by the exchange-rate objective. By contrast, an independently determined policy-rate channel is structurally absent under the Bosnian currency board and Montenegrin euroization. Structural absence is conceptually different from an available instrument that happens not to change during a particular period.

The liquidity-operations channel captures central-bank operations affecting the amount and price of short-term banking-system liquidity. Its institutional form varies considerably—from refinancing and open-market operations under inflation targeting to central-bank securities and liquidity-management operations under exchange-rate-oriented frameworks. Where a policy rate provides the primary signal of monetary stance, liquidity operations should not be interpreted as a second, independent stance decision: they operationalize that stance by adjusting reserve supply and helping keep short-term monetary conditions consistent with the intended policy setting. At the same time, liquidity operations can perform a distinct implementation and balance-sheet function by absorbing or supplying liquidity generated by foreign-exchange intervention, external flows, and other autonomous liquidity factors. In this latter role they may constitute an operational extension of the external-adjustment process, particularly in exchange-rate-oriented frameworks. CMAM therefore treats liquidity operations as an observable adjustment channel while distinguishing their implementation role from the underlying policy-rate stance decision.

The required-reserve channel captures changes in the quantity of funds that banks must maintain with the central bank. Reserve requirements can influence structural liquidity, the cost of intermediation, lending capacity, and—in systems with differentiated reserve ratios—the composition or maturity of bank funding. Their economic importance is not proportional to the frequency with which the statutory rate changes. Reserve requirements may remain unchanged

[1] As a robustness check, we residualized changes in excess reserves with respect to reserve-requirement and reserve-remuneration policy changes. The residual-based measure provided no improvement over the directly observed excess-reserves series, which is therefore retained as the benchmark measure.

through many ECB policy decisions and then generate a material monetary adjustment when altered. This is precisely why CMAM does not equate channel importance with simple contemporaneous co-movement with the ECB shock.

The reserve-remuneration channel is analytically distinct from the reserve requirement itself. While the required-reserve ratio determines how much liquidity must be immobilized, remuneration determines the return earned on required or excess balances and therefore affects the opportunity cost of holding reserves. Changes in remuneration can alter banks' incentives to maintain liquidity at the central bank relative to alternative assets and can consequently reinforce or offset changes generated through other channels. This distinction is particularly relevant for hard-anchor economies, where reserve-related policies represent some of the limited discretionary instruments available to the monetary authority.

Finally, the external-adjustment channel captures the margin through which external monetary pressure is absorbed by the exchange rate, foreign-exchange operations, or cross-border monetary and financial flows. Its empirical manifestation is necessarily regime dependent. Under greater exchange-rate flexibility, changes in the exchange rate against the euro convey part of the adjustment. Under managed exchange rates, foreign-exchange intervention and associated reserve movements become more important. Under a currency board, external flows interact mechanically with the central-bank balance sheet and domestic monetary base, while under unilateral euroization the domestic stock of monetary liquidity is intrinsically dependent on euro inflows and outflows. The external channel is therefore economically common across regimes even though no single observable variable can represent it in all of them.

These channels should not be interpreted as mutually independent policy levers. They interact. Foreign-exchange intervention changes domestic liquidity and may require sterilization; reserve requirements alter the liquidity consequences of external flows; remuneration changes banks' incentives to hold reserves; and policy-rate decisions can influence both capital flows and exchange rates. Liquidity operations are especially important in this respect because the same operation may simultaneously implement the intended policy-rate stance and manage liquidity consequences originating elsewhere in the monetary system. The channel decomposition should therefore be interpreted as identifying economically meaningful manifestations of adjustment rather than five orthogonal policy decisions. The purpose of the channel classification is not to impose a sequence of isolated policy actions, but to organize the observable manifestations through which effective monetary adjustment is realized.

The institutional setting also clarifies why monetary adjustment to ECB policy should not be interpreted as passive policy imitation. Albania and Serbia can choose domestic policy rates in response to their own inflation outlooks while external adjustment occurs elsewhere in the monetary system. North Macedonia and pre-euro Croatia place greater weight on maintaining exchange-rate conditions compatible with the euro anchor. Bosnia and Herzegovina and Montenegro lack an independently determined policy-rate margin altogether, causing adjustment

to be concentrated more heavily in external, balance-sheet, liquidity, and reserve-related mechanisms. The common ECB impulse therefore confronts different feasible adjustment sets.

This cross-regime heterogeneity is the central institutional motivation for the CMAM framework. An empirical comparison based solely on policy-rate synchronization would mechanically understate adjustment in hard-anchor regimes; one based solely on exchange-rate movements would create the opposite distortion, because the exchange rate is deliberately stabilized or institutionally unavailable precisely where external monetary dependence is greatest. Effective monetary adjustment can only be compared meaningfully by allowing different observable mechanisms to represent a common latent adjustment process. The following section therefore turns from the institutional logic of these channels to their empirical measurement and construction.

4. Data and Measurement

The empirical analysis uses a monthly country-level panel for Albania, Bosnia and Herzegovina, Croatia, Montenegro, North Macedonia, and Serbia. The baseline sample begins in January 2005 and extends through June 2026, yielding 1,506 country-month observations before model-specific availability restrictions. Croatia is observed through December 2022, immediately before euro adoption, so that its observations refer exclusively to the pre-euro monetary regime. For the remaining economies, the sample extends to 2026, although the starting and ending dates of individual monetary-adjustment indicators differ according to data availability. The resulting panel combines monetary-policy instruments, central-bank balance-sheet operations, exchange-rate and external-liquidity indicators, domestic macroeconomic controls[2], and common external variables.

The central measurement problem is that the same economic concept—effective monetary adjustment—is not observed through the same instrument in every monetary regime. Accordingly, the dataset is constructed around five economically defined adjustment channels rather than a uniform set of instruments: the policy rate, reserve requirements, reserve remuneration, liquidity operations, and external adjustment. The observable variables representing these channels differ across countries according to their institutional arrangements. This is intentional. Imposing an identical set of observed instruments on all six economies would exclude important adjustment margins in constrained regimes and, conversely, assign nonexistent instruments to countries in which they are structurally unavailable. The measurement strategy therefore holds *the economic interpretation of each channel constant while allowing its observable implementation to vary across monetary systems*.

[2] Domestic macroeconomic controls comprise CPI inflation and the available measure of economic activity – the index of industrial production or GDP. For Albania and Serbia, which operate inflation-targeting regimes, one year ahead expected inflation is used instead of contemporaneous CPI inflation.

4.1 Monetary-Adjustment Channels

The *policy-rate channel* is measured by changes in the principal domestic policy rate in the four economies possessing an operative policy-rate instrument during the sample: the Bank of Albania policy rate, the Croatian policy rate in the pre-euro period, the National Bank of the Republic of North Macedonia policy rate, and the National Bank of Serbia policy rate. An increase in the relevant rate is coded as monetary tightening. No policy-rate series is artificially assigned to Bosnia and Herzegovina or Montenegro. Under the currency-board arrangement in Bosnia and Herzegovina and unilateral euroization in Montenegro, an independent domestic policy rate of the type observed in the other four economies is structurally absent.

The *reserve-requirement channel* requires a more elaborate construction because statutory reserve requirements frequently differ by currency denomination, liability maturity, or type of reservable liability. Using any single statutory rate would therefore misrepresent the effective policy change whenever several rates coexist. We construct an effective reserve-requirement policy-change measure by combining changes in the applicable statutory rates using lagged exposure weights. The principle is to measure the change in the effective reserve burden that would have resulted from the policy decision while holding the relevant composition of the reserve base predetermined. In general form,

$$\Delta RR_{it}^{eff} = \sum_{k=1}^{K_i} \omega_{ik,t-1} \Delta rr_{ik,t}, \qquad (1)$$

where $rr_{ik,t}$ denotes statutory reserve-requirement rate k in country i, and $\omega_{ik,t-1}$ is the corresponding lagged share of the relevant reserve base or liability category. The use of lagged rather than contemporaneous weights is important because it prevents changes in the composition of bank liabilities following a policy action from being mechanically interpreted as an additional policy change.

The precise weighting structure reflects the institutional reserve system in each country. Albania combines the applicable reserve rates across maturity and foreign-currency categories using liability-based weights. Bosnia and Herzegovina combines reserve-requirement rates using lagged reserve-base exposures. Montenegro uses the corresponding liability structure, while North Macedonia employs currency and reserve-composition weights. Serbia combines the dinar and foreign-currency reserve requirements across relevant maturity categories; the baseline construction is restricted to the reserve-requirement system itself rather than incorporating the giro-account proxy. Croatia requires a somewhat different construction reflecting its more complex pre-euro reserve framework: changes in the general, marginal, special and foreign-currency-related reserve requirements are combined using the relevant exposure amounts, with official monthly amounts serving as weights. In every case, a positive effective change denotes an increase in the reserve burden and therefore monetary tightening.

The *reserve-remuneration channel* is constructed analogously. Where different categories of required or excess reserves were remunerated at different rates, the effective change in

remuneration is calculated using lagged shares of the reserve categories to which those rates applied:

$$\Delta REM_{it}^{eff} = \sum_{m=1}^{M_i} v_{im,t-1} \Delta r_{im,t}^{rem}. \quad (2)$$

This produces a single economically interpretable remuneration-policy measure rather than treating several administratively distinct remuneration rates as independent monetary instruments. The construction combines the relevant domestic- and foreign-currency remuneration arrangements in Bosnia and Herzegovina, Croatia, North Macedonia, Montenegro and Serbia and the corresponding remuneration arrangements in Albania. For Albania, the benchmark specification retains the *full observed effective remuneration change*, including changes mechanically associated with movements in the policy rate. An alternative measure removing mechanically indexed changes is retained as a diagnostic rather than used in the benchmark. This choice avoids imposing ex ante that policy-rate-linked remuneration changes are economically irrelevant simply because they share a common policy origin. Throughout the benchmark dataset, an increase in effective reserve remuneration is oriented as a tightening adjustment.

The *liquidity-operations channel* captures changes in central-bank operations that absorb or provide banking-system liquidity. Its observable composition necessarily varies substantially across monetary frameworks. For Albania, the measure is based on monthly changes in the constructed open-market-operations balance rather than its level. This distinction prevents a persistently large stock of outstanding operations from being interpreted as repeated monetary adjustment when no new liquidity action has occurred. For pre-euro Croatia, liquidity provision through reverse-repo operations, collateralized credit and securities purchases is combined into the liquidity measure. North Macedonia's measure incorporates the relevant central-bank bills, repo operations, six-month bills, seven-day and overnight deposits, and overnight credit, with each component oriented according to whether it absorbs or injects liquidity. Serbia's measure similarly combines repo sales and purchases and the deposit-facility balance. Operations supplying liquidity are assigned an easing sign, while liquidity absorption is assigned a tightening sign. Bosnia and Herzegovina and Montenegro are not assigned a separate liquidity-operations channel because no comparable independent operational instrument satisfying the channel definition is structurally available in the benchmark architecture.

The *external-adjustment channel* is deliberately broader than the exchange rate alone. In economies in which the central bank manages the exchange rate, adjustment may occur through a combination of price adjustment—the movement of the domestic currency against the euro—and quantity adjustment through foreign-exchange intervention. Concentrating exclusively on the exchange rate would therefore understate adjustment precisely where intervention is successful in limiting exchange-rate movements. Conversely, intervention alone may fail to capture adjustment that is permitted to occur through the exchange rate.

For Albania, Croatia, North Macedonia and Serbia, the external channel consequently combines the exchange-rate and foreign-exchange-intervention margins. Exchange rates are expressed as domestic currency per euro, so an increase represents depreciation and is oriented as

easing, whereas appreciation is oriented as tightening. Foreign-exchange transactions are oriented according to their domestic monetary-liquidity implication: foreign-currency purchases accompanied by domestic-currency provision are expansionary, while foreign-currency sales and the associated withdrawal of domestic liquidity are contractionary. After the individual margins have been transformed and standardized, the external-adjustment measure is constructed as the equal-weight average of the available exchange-rate and quantity margins and is subsequently standardized again within country. Equal weighting avoids allowing a component to dominate the external measure merely because it is expressed in larger physical units.

The hard-anchor regimes require different observable manifestations of the same external-adjustment concept. Under the Bosnian currency board, the exchange rate itself provides essentially no useful variation. The external channel is therefore represented by the balance of transactions that create or withdraw convertible-mark liquidity through the currency-board mechanism. The raw series is sign-oriented so that liquidity creation associated with external inflows is expansionary and liquidity withdrawal is tightening.

Montenegro presents an even more distinctive measurement problem because unilateral euroization eliminates both a domestic exchange rate against the euro and conventional domestic foreign-exchange intervention. The benchmark therefore uses changes in banking-system *excess reserves held with the Central Bank of Montenegro* as the observable balance-sheet manifestation of external euro-liquidity adjustment. The series is available from January 2007, with monthly changes beginning in February 2007. An increase in excess reserves represents accumulation of immediately available banking-system euro liquidity and is therefore oriented as easing; a decline represents liquidity withdrawal and is oriented as tightening. Excess reserves are not interpreted as a direct observation of cross-border capital flows. Rather, they provide a balance-sheet manifestation of euro liquidity generated or absorbed within a monetary system in which the conventional exchange-rate and foreign-exchange-intervention margins do not exist. Because excess reserves may also respond to domestic reserve policies and other banking-system liquidity developments, this construction is subjected to separate robustness and channel-validity analysis.
This treatment also illustrates a general feature of the measurement architecture. *A structurally unavailable channel is recorded as unavailable, not as zero***.** A zero observation means that an available instrument did not change in that month; a missing structural channel means that the corresponding adjustment mechanism does not exist in that monetary framework. Conflating these two cases would incorrectly treat the absence of a policy instrument as a sequence of deliberate zero policy actions and could mechanically disadvantage countries operating with fewer instruments.

4.2 Transformation, Scaling and Sign Normalization

The raw monetary variables are heterogeneous in units, scale and frequency of policy adjustment. Interest-rate changes are measured in percentage points, reserve-policy changes can be discrete and infrequent, liquidity operations and foreign-exchange interventions are expressed

in monetary quantities, and exchange-rate movements are proportional changes. Directly combining these variables would make the resulting factor depend on measurement units rather than economic co-movement. The raw series are therefore transformed into comparable adjustment indicators before estimation.

Rate-based policy variables enter primarily as changes rather than levels. Policy-rate changes are first differences of the corresponding policy rate. Reserve-requirement and remuneration measures are changes in the weighted effective policy rates described above. Exchange-rate adjustment is measured using changes in the logarithm of the domestic-currency price of the euro. Liquidity variables are transformed according to their institutional interpretation: balance-sheet stocks are differenced where the monetary action is represented by a change in the outstanding position, whereas transaction-flow measures can enter directly. This distinction is particularly important for the Albanian OMO series, for which the benchmark uses the monthly change in the OMO balance.

A common sign convention is imposed after these transformations:

$$\textit{positive channel observation} \Leftrightarrow \textit{monetary tightening}.$$

Thus, increases in policy rates and effective reserve requirements are positive; liquidity injections are negative and liquidity absorption positive; depreciation against the euro is negative and appreciation positive; and foreign-exchange operations that inject domestic liquidity are negative while operations withdrawing liquidity are positive. The same convention is imposed on the ECB shock and, subsequently, on CMAM itself. This orientation is essential for the factor model: positive co-movement across otherwise heterogeneous instruments then has the common interpretation of tighter monetary conditions rather than reflecting arbitrary signs inherited from the original statistical series.

For continuously varying channel measures, transformed components are standardized within country so that differences in units do not determine their contribution to the latent factor. Where several observable components belong to the same channel, the sign-aligned standardized components are combined and the resulting channel composite is standardized again. The normalization therefore preserves the timing and relative intensity of adjustment within a country while placing heterogeneous instruments on comparable statistical scales.

Reserve requirements and remuneration require special treatment because policy changes are *sparse event series*. In many months the statutory rate is genuinely unchanged, so zero is economically meaningful: it denotes no policy action. Conventional mean-centered or median-centered standardization can distort this property. In particular, when more than half of the observations are zero, the median absolute deviation may collapse to zero; falling back mechanically to mean/standard-deviation normalization would then map an original zero into a small nonzero value. A month in which the central bank took no action would consequently appear as either a tightening or easing observation.

The benchmark construction avoids this problem. Effective reserve-requirement changes are scaled using *a common pooled root-mean-square magnitude of nonzero policy events*, rather than country-specific mean-centered z-scores:

$$RR_{it}^{*} = \frac{\Delta RR_{it}^{eff}}{\sqrt{N_{RR}^{-1} \sum_{\Delta RR^{eff} \neq 0} (\Delta RR^{eff})^2}}. \tag{3}$$

The same principle is applied to reserve-remuneration changes using the pooled nonzero remuneration events. The resulting scaling constants are approximately 3.37 percentage points for reserve-requirement events and 0.236 percentage points for remuneration events. This approach has two advantages. It preserves a genuine policy zero *exactly at zero*, and it places a policy action of a given absolute magnitude on the same scale across countries rather than normalizing each country's relatively few policy events separately. The latter is particularly important for cross-country comparison: a rare small reserve-requirement change should not be transformed into an apparently large monetary action merely because that country exhibits little variation in the instrument.

The same zero-preservation principle is applied inside the estimator to sparse ECB policy-change shocks. The benchmark ECB impulse is the monthly change in the ECB main refinancing operations (MRO) rate. Because the MRO rate is unchanged in most months, conventional robust standardization encounters the same zero-mass problem. The final specification therefore uses scale-only standardization whenever zero observations dominate or the median absolute deviation collapses in the presence of genuine zeros. If s^tdenotes the raw monthly policy-rate change,

$$s_t^{*} = \frac{s^t}{\sigma^s}, \quad s_t^{*} = 0 \Rightarrow s^t = 0. \tag{4}$$

The estimator explicitly enforces this zero-preserving treatment: sparse change-based shocks are divided by their scale without subtracting a nonzero location parameter, and raw zeros are reset exactly to zero. The MRO benchmark shock is constructed from the monthly first difference of the ECB MRO rate and then subjected to this normalization. Alternative ECB measures—including the deposit-facility rate, shadow rate, three-month Euribor, an externally identified shock and the composite shadow-rate/deposit-facility measure—are constructed under the same orientation and used in robustness analysis rather than replacing the MRO benchmark.

Negative observations are therefore *not treated as a data problem*. Once all series have been economically oriented, their sign carries substantive information: positive values represent tightening, negative values represent easing, and exact zeros in discrete policy-change variables represent inactivity. The transformation procedure is designed to preserve precisely this distinction. What is avoided is not negativity, but artificial nonzero observations generated by centering sparse series.

4.3 Macroeconomic Controls and Sample Construction

The state equation additionally conditions on domestic inflation, domestic activity and a common external financial control. Because the availability and relevance of domestic macroeconomic indicators differ across countries, the domestic controls are selected from country-specific source hierarchies while retaining the same economic concepts. Albania uses projected CPI inflation and real GDP growth; Bosnia and Herzegovina and pre-euro Croatia use CPI inflation and industrial production; North Macedonia uses CPI and industrial production; Montenegro uses the available CPI and industrial-production indicators; and Serbia uses inflation expectations together with industrial production. The VIX is included as the parsimonious common external control capturing changes in global risk and financial conditions. Before entering the model, the controls are interpolated over internal missing observations where necessary and standardized within country.

The final estimation dataset therefore contains five conceptually common monetary-adjustment channels but does not require all five to exist in every country. Albania, Croatia, North Macedonia and Serbia can be represented through all five channels, subject to individual series availability. Bosnia and Herzegovina and Montenegro contain reserve requirements, reserve remuneration and external adjustment, while policy-rate and separate liquidity-operation channels are structurally absent. This architecture follows the monetary institutions described in Section 3 rather than imposing statistical symmetry for its own sake.

An important implication is that CMAM is *not constructed by mechanically averaging the available channel indicators*. The transformed series constitute the measurement system from which the latent common adjustment factor and its country- and channel-specific loadings are estimated. Countries with fewer operative channels are therefore not mechanically assigned smaller CMAM values simply because fewer observed series enter their measurement equations. Structural absence, temporary missingness and genuine zero policy actions remain distinct throughout the construction and estimation procedure. This distinction is central to the objective of the paper: achieving comparability across monetary regimes without pretending that those regimes conduct monetary adjustment through identical instruments.

5. CMAM Framework, Identification, Estimation and Inference

The empirical framework is designed to recover a common concept—effective monetary adjustment—from policy variables whose observable manifestations differ across monetary regimes. The central premise is that monetary adjustment is latent: no single instrument provides a comparable measure across countries because the set of instruments through which monetary conditions adjust depends on the institutional framework. CMAM therefore treats the observed policy-rate, reserve-requirement, reserve-remuneration, liquidity-operations and external-adjustment indicators described in Section 4 as noisy manifestations of an underlying country-specific monetary-adjustment process. A hierarchical dynamic factor structure provides the link

between these heterogeneous observable variables and the common economic concept of effective monetary adjustment.

5.1 The Hierarchical Dynamic Factor Model

Let $y_{i,j,t}$ denote the standardized observation for monetary-adjustment channel j in country i at month t, where j belongs to the set of channels that is institutionally available in country i. The measurement equation is

$$y_{i,j,t} = \lambda_{i,j,t} f_{i,t} + \varepsilon_{i,j,t}, \qquad \varepsilon_{i,j,t} \sim \mathrm{N}(0, \sigma_{i,j}^2), \tag{5}$$

where $f_{i,t}$ is the latent country-specific monetary-adjustment factor and $\lambda_{i,j,t}$ is the loading of channel j on that factor. Because all observed monetary variables are oriented so that positive values represent tightening, positive realizations of $f_{i,t}$ have the same economic interpretation: a tightening of effective monetary conditions. The measurement-error term $\varepsilon_{i,j,t}$ allows individual instruments to contain idiosyncratic movements that need not represent broad monetary adjustment.

The measurement system is country specific. Albania, Croatia, North Macedonia and Serbia contain five potential measurement equations—policy rate, reserve requirements, reserve remuneration, liquidity operations and external adjustment—whereas Bosnia and Herzegovina and Montenegro contain three: reserve requirements, reserve remuneration and external adjustment. A channel that is structurally unavailable under a country's monetary framework does not enter its measurement system. This is distinct from an available instrument recording a zero change in a particular month.

The latent factor evolves dynamically according to

$$f_{i,t} = \phi_i f_{i,t-1} + \beta_i s_t^{ECB} + \gamma_i' x_{i,t} + \eta_{i,t} \qquad \eta_{i,t} \sim \mathrm{N}(0, q_i), \tag{6}$$

where ϕ_i captures persistence in monetary adjustment, s_t^{ECB} is the common ECB monetary-policy shock, and $x_{i,t}$ contains the domestic inflation and activity controls and the common external financial control described in Section 4. The coefficient β_i measures the contemporaneous association between the ECB shock and the latent monetary-adjustment process after conditioning on these controls, while $\eta_{i,t}$ captures innovations in monetary adjustment not explained by the ECB shock or included controls.

This distinction is important for interpretation. The latent factor $f_{i,t}$ represents *overall effective monetary adjustment*, not ECB-induced adjustment alone. Conditional on the estimated model, the ECB-attributable component can be isolated from the state equation. The direct ECB contribution at t is $\beta_i s_t^{ECB}$, while the dynamic structure propagates previous ECB innovations through ϕ_i. Defining the ECB-attributable state recursively as

$$f_{i,t}^{ECB} = \phi_i f_{i,t-1}^{ECB} + \beta_i s_t^{ECB}, \tag{7}$$

separates the portion of the latent adjustment path associated with ECB monetary-policy innovations from the contributions of domestic and global controls and the remaining state innovation. This decomposition permits two related but conceptually different comparisons: the total intensity of monetary adjustment in each country and the part of that adjustment attributable to ECB monetary-policy shocks.

The benchmark MRO specification is complemented by alternative ECB shock measures described in Section 4. These alternative shocks change the measurement of the external monetary impulse rather than the structure or economic interpretation of CMAM.

The loadings $\lambda_{i,j,t}$ determine how strongly individual monetary channels manifest the underlying adjustment process. A constant-loading specification, denoted M0, assumes

$$\lambda_{i,j,t} = \bar{\lambda}_{i,j}, \tag{8}$$

providing a stable country-specific mapping between the latent factor and the observed instruments. The preferred M1 specification relaxes this restriction by allowing channel importance to vary over time around country-specific baseline loadings. The time variation is regularized around those baselines and permits persistent deviations associated with economically important monetary-policy episodes rather than requiring a continuously drifting relationship. M1 can therefore capture changes in the way a country implements monetary adjustment while preserving a stable long-run country-specific channel architecture. The comparison between M0 and M1 provides a direct assessment of whether allowing the transmission structure to evolve materially changes the estimated intensity and composition of adjustment.

This formulation also separates two dimensions that are economically distinct. The latent factor measures *how much* effective monetary adjustment occurs, whereas the estimated loadings and associated channel contributions describe *how that adjustment is implemented*. A country may consequently exhibit substantial monetary adjustment without relying primarily on its policy rate, and two countries displaying similar adjustment intensity may achieve it through very different combinations of instruments.

5.2 Identification and Normalization

Identification of CMAM combines economic orientation of the observable variables with explicit statistical normalization of the latent-factor system. As described in Section 4, every monetary-adjustment indicator is oriented before estimation so that positive values consistently represent tightening and negative values easing. This removes the otherwise arbitrary sign indeterminacy of a conventional factor model and gives the latent state a common economic interpretation across countries.

Factor models additionally exhibit a scale indeterminacy because multiplying the latent factor by a constant and dividing its loadings by the same constant leaves the measurement equation unchanged. CMAM resolves this indeterminacy through an exact loading normalization. For each country and sample, the geometric mean of the relevant positive channel loadings is normalized to unity,

$$\left(\prod_{j\in\mathcal{J}_i}\lambda_{i,j,t}\right)^{1/|\mathcal{J}_i|}=1, \tag{9}$$

where $\mathcal{J}_i$ denotes the set of structurally available channels for country *i*. The normalization fixes the scale of the latent state while preserving relative differences in channel importance. In the time-varying specification, the parameterization is constructed so that changes in relative loadings cannot introduce an additional unidentified common loading direction.

Cross-country identification does not require countries to possess the same number of monetary instruments. The model is estimated from the joint behavior of the channels that actually exist in each monetary system, and the normalization prevents the scale of the latent factor from mechanically increasing with the number of measurement equations. Consequently, Bosnia and Herzegovina and Montenegro are not assigned lower CMAM values merely because three rather than five channels are structurally operative. This property is subsequently examined directly through channel-count and measurement-fairness diagnostics.

The framework should not, however, be interpreted as identifying every channel as an independent structural monetary-policy shock. The measurement equations identify the observable manifestations associated with a common monetary-adjustment process. These manifestations can interact institutionally: liquidity operations may implement a policy-rate decision or sterilize liquidity created by foreign-exchange intervention, while reserve policies may themselves respond to changes in external liquidity conditions. The channel decomposition therefore describes the *structure through which effective adjustment is manifested*, rather than five mutually orthogonal policy decisions.

A related distinction concerns identification of the ECB component. Conditioning the latent-state equation on an externally measured ECB monetary-policy shock permits decomposition of estimated CMAM into ECB-attributable and other components, but this does not by itself establish unrestricted causal identification of every domestic response mechanism. The interpretation instead rests on the ECB shock being external to the monetary-policy decisions of the six relatively small economies, together with the conditioning variables and alternative shock specifications used to assess the robustness of the estimated relationship. The separate local-projection analysis in Section 8 provides an additional dynamic validation that does not construct its dependent variable from an ECB-conditioned CMAM specification, thereby addressing the potential generated-regressor and circularity concern from a different empirical direction.

5.3 Estimation and Model Specifications

The model is estimated in two nested forms. *M0* imposes constant country-channel loadings and provides the parsimonious benchmark for the long-run measurement structure. *M1* retains the same latent-factor and state-equation architecture but permits country-specific channel loadings to deviate over time from their baseline values, including deviations associated with major monetary-policy episodes. Importantly, the regimes themselves do not determine these loadings: countries are estimated individually, and the inflation-targeting, managed-exchange-rate and hard-anchor classifications are used only for ex-post interpretation and comparison.

The primary benchmark parameters are obtained by *maximum a posteriori (MAP) estimation* of the hierarchical dynamic factor model. Regularization is particularly important because the model combines persistent latent states, heterogeneous measurement equations, time-varying loadings and monetary instruments with very different frequencies of adjustment. Reserve-requirement and reserve-remuneration variables are especially sparse, with policy actions concentrated in relatively few months. Their zero observations are retained as genuine periods of policy inactivity, while channel-specific measurement variances allow the model to distinguish infrequent policy movements from more continuously varying adjustment indicators.

The likelihood is evaluated through the state-space representation of the model. Conditional on the parameters and loading structure, the latent monetary-adjustment states are integrated through the Kalman-filter likelihood rather than treated as unrestricted additional parameters at every date. This exploits the dynamic structure of CMAM while keeping the distinction between the latent monetary-adjustment process and noisy channel-specific observations explicit.

The time-varying *M1* specification is not intended to generate unconstrained month-to-month fluctuations in channel importance. Country-channel loadings remain centered on their baseline structure, while the model permits sufficiently persistent departures when supported by the data. This formulation reflects the economic proposition that monetary institutions tend to generate relatively stable channel architectures, although the relative importance of particular instruments may change during episodes such as financial crises, unconventional monetary-policy periods or major tightening cycles.

Model adequacy is assessed at several levels. The estimation diagnostics examine convergence and parameter stability; measurement diagnostics evaluate the ability of the latent factor to represent the observed channels; reconstruction and additivity tests verify the numerical decomposition of CMAM; and channel-availability and fairness tests examine whether comparisons are affected mechanically by differences in the number or frequency of available monetary instruments. The purpose of this diagnostic structure is not to select a specification that reproduces a predetermined country ranking, but to establish that the resulting cross-regime comparison is not an artifact of scale normalization, sparse instruments or heterogeneous monetary architectures.

5.4 Bayesian Inference and Posterior Uncertainty

The MAP estimates provide the benchmark point estimates, while Bayesian estimation is used to quantify uncertainty surrounding the preferred M1 specification. Because unrestricted posterior exploration of the high-dimensional latent model reveals weakly identified alternative combinations of latent states, loadings and measurement variances, the Bayesian exercise is deliberately formulated as *MAP-anchored Bayesian inference around the empirically validated benchmark-associated region of the model*, rather than as an independent diffuse-prior re-estimation.

Prior locations for the relevant model parameters are centered on the corresponding benchmark MAP estimates, with finite prior variances allowing the likelihood to update those parameters. The Bayesian specification therefore retains uncertainty in the latent CMAM paths, ECB-attributable components, channel loadings, measurement variances and cross-country comparisons rather than fixing the MAP solution. No prior restriction is imposed on the ordering of countries or monetary regimes, and regime classifications do not enter the estimation of country parameters.

Posterior sampling is conducted within the benchmark-associated posterior basin using independently perturbed initial values around the MAP-local region. This initialization addresses the computational multimodality associated with weakly identified alternative parameter combinations; it does not alter the posterior density within the specified Bayesian model. Conditional on the sampled parameters, latent-state trajectories are subsequently recovered using forward-filtering backward-sampling. Standard Markov-chain diagnostics—including R^, effective sample sizes, divergences, tree-depth behavior and energy diagnostics—are used to assess the reliability of posterior inference.

The Bayesian results are consequently interpreted as a *local uncertainty analysis conditional on the empirically preferred benchmark mode*, rather than evidence that an unrestricted global posterior uniquely identifies the same solution. This distinction is important because the same data are used to obtain the MAP estimates that provide the locations of the Bayesian priors. The Bayesian exercise therefore does not constitute an independent confirmation of the MAP results; its purpose is to determine whether the substantive conclusions of the benchmark survive parameter and latent-state uncertainty around the validated empirical solution.

Posterior draws nevertheless permit considerably richer inference than point estimates alone. For any country *i*, the posterior distribution of overall and ECB-attributable CMAM provides credible intervals for adjustment intensity. Cross-country comparisons can be expressed as posterior probabilities such as:

$$P(CMAM_i^{ECB} > CMAM_k^{ECB} \mid D), \tag{10}$$

rather than relying exclusively on point-estimate rankings. Similarly, after estimation, countries can be grouped according to their observed monetary regimes and posterior draws used to calculate

regime-level adjustment distributions and ordering probabilities. Because these regime classifications are applied only after country-level estimation, evidence that hard anchors, managed exchange-rate regimes and inflation-targeting economies differ systematically in ECB-attributable adjustment is an empirical result rather than a consequence of regime-specific priors.

This combination of the hierarchical measurement system, explicit factor identification, MAP benchmark estimation and posterior uncertainty analysis provides the basis for the empirical comparisons that follow. Section 6 turns first to the magnitude of overall and ECB-attributable monetary adjustment across the six economies, before Section 7 examines the channels through which that adjustment is realized.

6. Benchmark Results: How Much Does Everybody Adjust?

The benchmark estimates distinguish between two related but conceptually different measures of monetary adjustment. *Overall CMAM* measures the total effective monetary adjustment taking place in each economy. It should not be interpreted as adjustment to a particular shock. Rather, it represents the common monetary-adjustment component embodied in the set of policy instruments and adjustment channels available to each country As formalized in Equation (6), its evolution reflects persistence in monetary adjustment, ECB monetary-policy shocks, domestic macroeconomic conditions, common external financial conditions, and country-specific innovations. Overall CMAM therefore provides the reference monetary-adjustment process against which the role of ECB policy can be evaluated.

The central empirical object of the paper is the *ECB-attributable component of CMAM*. As defined in Equation (7), this component isolates the part of the latent monetary-adjustment process generated by ECB monetary-policy shocks, while preserving the estimated persistence of domestic monetary adjustment. It allows us to ask whether, and by how much, monetary conditions in economies operating under fundamentally different monetary regimes adjust to ECB policy. Comparing ECB-attributable adjustment with overall CMAM additionally reveals how important ECB-induced adjustment is relative to the total effective monetary adjustment taking place within each economy.

The benchmark results reported in this section are obtained from the MAP estimates of the preferred M1 specification, which allows the importance of individual monetary-adjustment channels to vary over time, using changes in the ECB main refinancing operations (MRO) rate as the monetary-policy shock. Alternative model specifications, ECB shock measures, and Bayesian inference are considered subsequently in the robustness analysis.

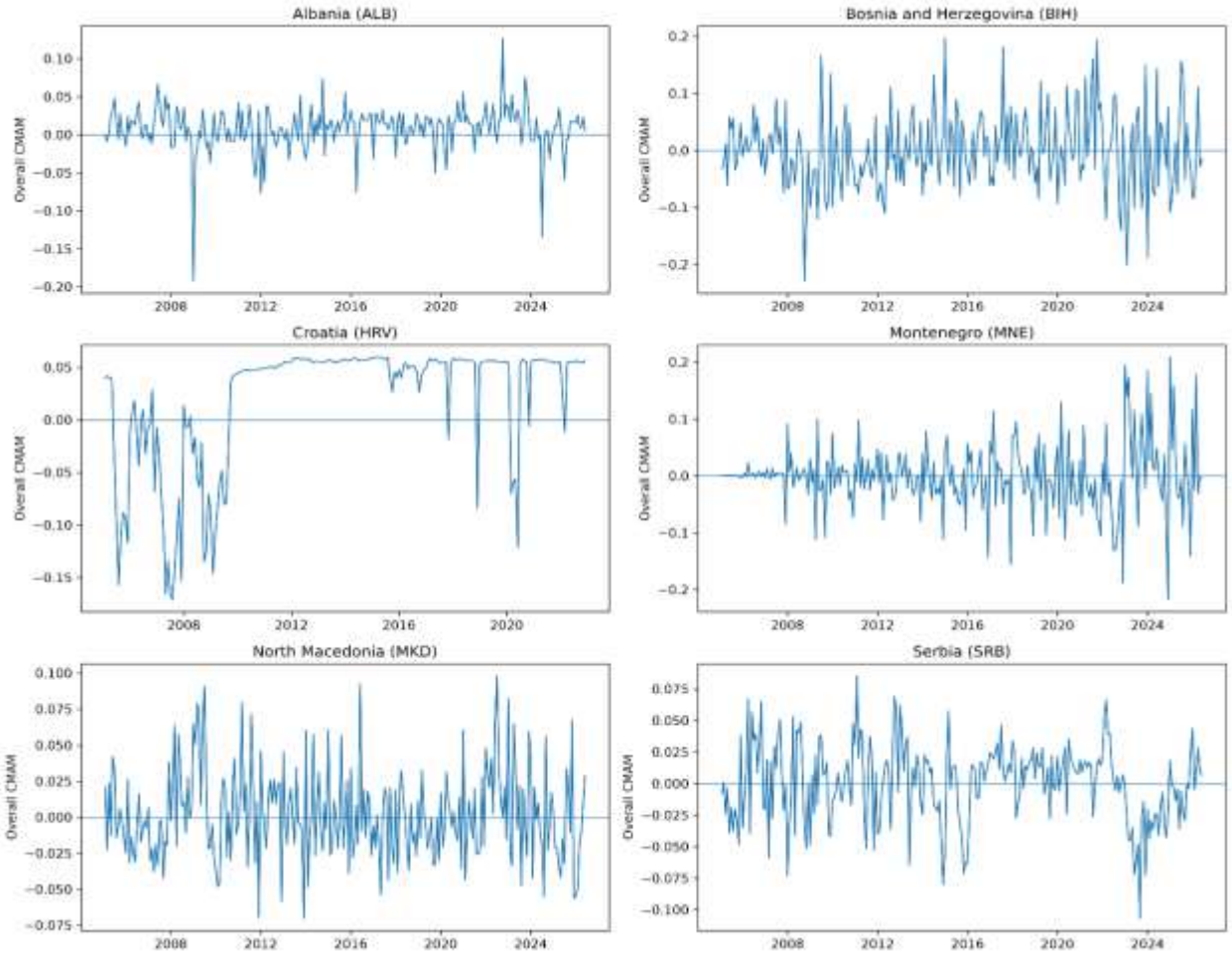
6.1 Overall CMAM: The Reference Measure of Effective Monetary Adjustment

Overall CMAM summarizes the *effective movement in monetary conditions generated through the set of adjustment mechanisms available to each economy*. Rather than identifying monetary adjustment with the movement of any single instrument, it captures the common stance

signal revealed jointly by policy rates, reserve policies, liquidity operations, and external adjustment, depending on which channels are institutionally available in each country. The resulting measure should therefore be interpreted as the *intensity and direction of effective monetary adjustment*, rather than as the stance of any individual policy instrument. Positive CMAM values indicate a common movement of the available adjustment channels toward tighter monetary conditions, while negative values indicate movement toward easier conditions. The magnitude of CMAM captures the intensity of that common adjustment.

Figure 1 presents the estimated overall CMAM paths for the six economies. The figure establishes the broader monetary-adjustment environment within which the ECB-attributable component is subsequently evaluated. In all six countries, the latent factor exhibits economically meaningful variation over time, indicating that the different policy instruments and adjustment mechanisms contain a discernible common monetary-adjustment signal.

Figure 1. Overall Monetary Adjustment across Countries



Notes: The figure reports benchmark MAP M1 estimates of overall CMAM using the ECB MRO-rate-change specification. Overall CMAM measures the total latent monetary-adjustment process and is not attributable to the ECB alone. Positive values denote monetary tightening and negative values monetary easing. Croatia is observed through December 2022, prior to euro adoption.

The estimated paths differ considerably across countries in both their magnitude and temporal behavior. Croatia and Bosnia and Herzegovina display the largest mean absolute overall adjustment, while Montenegro also exhibits substantial monetary variation. North Macedonia and Serbia occupy an intermediate range, whereas Albania records the lowest average magnitude of overall CMAM. These differences are summarized in Table 1.

Table 1. Magnitude of Overall and ECB-Attributable Monetary Adjustment by Country

Country	Monetary regime	Overall CMAM	ECB-attributable CMAM	ECB share (%)	Overall rank	ECB rank
Bosnia and Herzegovina	Hard peg	0.0527	0.0094	17.9	2	1
Montenegro	Hard peg	0.0401	0.0076	18.9	3	3
Croatia	Managed exchange rate	0.0566	0.0091	16.0	1	2
North Macedonia	Managed exchange rate	0.0249	0.0067	26.7	4	4
Serbia	Inflation targeting	0.0246	0.0061	24.9	5	5
Albania	Inflation targeting	0.0210	0.0061	28.8	6	6

Notes: Overall CMAM is measured as the mean absolute value of the estimated overall monetary-adjustment factor. ECB-attributable CMAM is the mean absolute value of the component attributable to ECB MRO-rate-change shocks. The ECB share is the ratio of mean absolute ECB-attributable CMAM to mean absolute overall CMAM, expressed as percentage. Rankings are based on the corresponding mean absolute CMAM measures, with rank 1 indicating the largest adjustment magnitude. Results are based on the benchmark MAP M1 specification. Croatia is observed through December 2022.

The cross-country ordering of overall CMAM is useful primarily as a description of the monetary-adjustment processes against which ECB-induced adjustment will be evaluated. It is not, by itself, a ranking of countries according to their responsiveness to ECB monetary policy. A country can experience substantial overall monetary adjustment for reasons that are only partly related to ECB policy, while another can exhibit lower total adjustment but have a larger proportion of that adjustment associated with ECB shocks.

This distinction is especially important given the institutional heterogeneity of the sample. Relatively large overall adjustment is observed in economies with very different monetary arrangements: Croatia operated a managed exchange-rate regime during the sample, Bosnia and Herzegovina operates a currency board, and Montenegro is unilaterally euroized. Conversely, the inflation-targeting economies retain conventional policy rates and greater formal monetary-policy discretion but do not exhibit the largest overall CMAM values. The estimates therefore illustrate an important conceptual distinction: *monetary autonomy and effective monetary adjustment are not opposites*. Greater monetary autonomy does not imply weaker effective monetary adjustment, just as more constrained monetary autonomy does not mechanically imply stronger effective adjustment. Thus, economies with limited conventional monetary-policy autonomy can undergo substantial adjustment through reserve policies, liquidity conditions, external flows, and other balance-sheet mechanisms, while the possession of a conventional policy rate does not itself determine the total intensity of monetary adjustment.

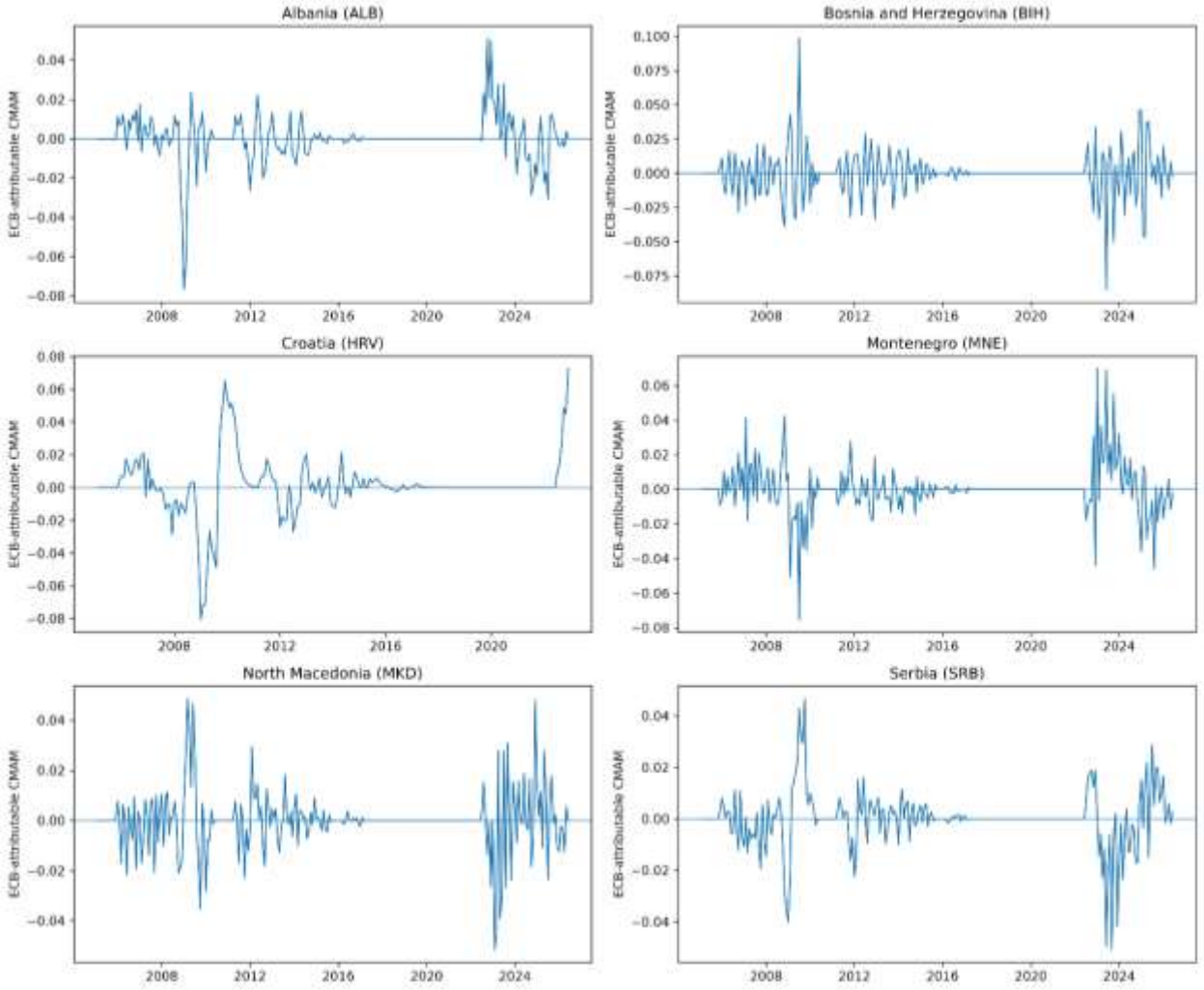
The purpose of overall CMAM in the present analysis is consequently not to identify the source of monetary adjustment but to measure its total effective intensity. The next step is to isolate

from this broader process the component specifically associated with ECB monetary-policy shocks.

6.2 ECB-Attributable Monetary Adjustment

Having established the overall monetary-adjustment process, we now turn to the principal empirical object of the paper: *the component of monetary adjustment attributable to ECB monetary-policy shocks*. Figure 2 reports the estimated ECB-attributable CMAM for each country.

Figure 2. ECB-Attributable Monetary Adjustment across Countries



Notes: The figure reports the component of benchmark MAP M1 CMAM attributable to ECB MRO-rate-change shocks, conditional on the domestic and common external controls included in the state equation. Positive values indicate ECB-induced tightening of domestic monetary conditions and negative values ECB-induced easing. Croatia is observed through December 2022.

The central result is immediately visible: *ECB monetary-policy shocks are associated with effective monetary adjustment in all six economies*, despite fundamental differences in their monetary regimes and available instruments. ECB-attributable adjustment is observed not only in the currency-board and euroized economies or in countries actively managing their exchange rates against the euro, but also in Albania and Serbia, which operate inflation-targeting frameworks and retain formally independent monetary policies.

This result is central to the motivation for constructing CMAM. Conventional comparisons based on domestic policy rates alone would capture only one possible margin through which economies respond to ECB monetary policy and would be particularly uninformative for regimes in which a conventional domestic policy rate is absent or plays a limited role. The latent-adjustment framework instead identifies the common monetary response manifested across the set of instruments and adjustment mechanisms actually available in each economy.

The temporal behavior of ECB-attributable CMAM also supports its economic interpretation. The estimated component becomes particularly visible during episodes of substantial changes in the ECB monetary-policy environment, including the global financial crisis and the subsequent European monetary-policy cycle, while becoming comparatively small during periods in which changes in the benchmark MRO rate provide little monetary-policy impulse. ECB-attributable adjustment becomes pronounced again during the post-2022 tightening cycle. The estimated component therefore does not simply reproduce the broader volatility of overall CMAM; it isolates a more specific pattern associated with variation in ECB policy.

The magnitude of ECB-attributable adjustment nevertheless differs across countries. Bosnia and Herzegovina exhibits the largest mean absolute ECB-attributable CMAM in the benchmark MAP estimates, closely followed by Croatia. Montenegro ranks third, followed by North Macedonia, Serbia, and Albania. Importantly, this ordering is not identical to the ordering based on overall CMAM. Croatia displays the largest overall adjustment, whereas Bosnia and Herzegovina exhibits the largest ECB-attributable component. This difference is precisely why the two concepts need to be distinguished: *overall CMAM measures the total effective monetary-adjustment process, whereas ECB-attributable CMAM measures the portion of that process associated specifically with ECB monetary-policy shocks***.**

The exact country ordering should nevertheless be interpreted as a benchmark point-estimate result rather than as a structural ranking. Subsequent Bayesian analysis evaluates the uncertainty surrounding these cross-country comparisons, while alternative ECB shock specifications examine their sensitivity to monetary-policy identification.

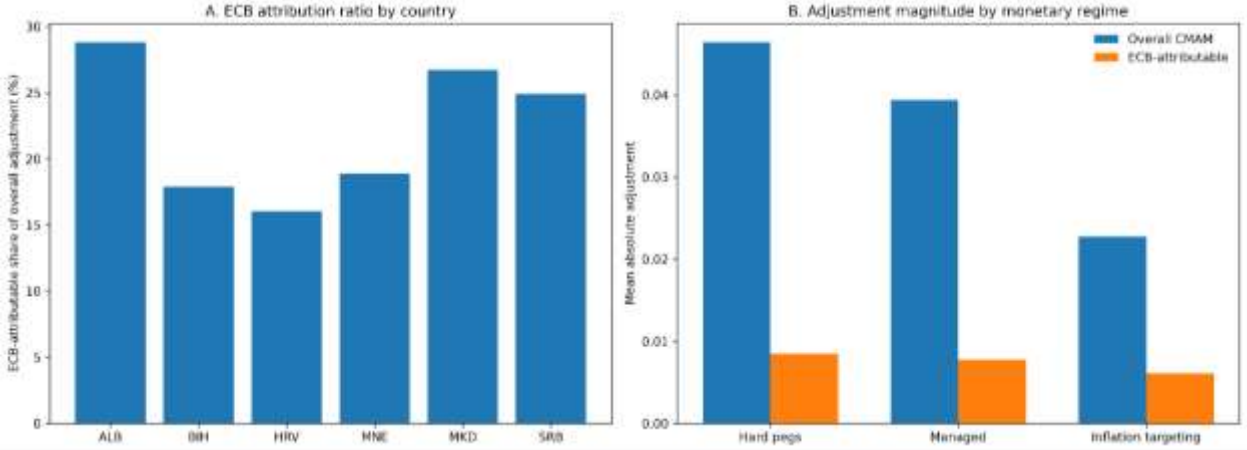
6.3 The Importance of ECB Policy within Overall Monetary Adjustment

Absolute ECB-attributable CMAM answers how much effective monetary adjustment is associated with ECB shocks, but it does not reveal how important this component is relative to all monetary adjustment occurring within a country. We therefore complement the absolute measure with the ratio of mean absolute ECB-attributable CMAM to mean absolute overall CMAM:

$$ECB\ Attribution\ Ratio_i = \frac{mean_t|CMAM_{i,t}^{ECB}|}{meant|CMAM_{i,t}|}. \quad (11)$$

Panel A of Figure 3 reports this ratio for each country. Panel B provides the complementary comparison of absolute overall and ECB-attributable adjustment across the three broad monetary-regime groups.

Figure 3. Magnitude and ECB Attribution of Monetary Adjustment



Notes: Panel A reports mean absolute ECB-attributable CMAM relative to mean absolute overall CMAM for each country. Panel B reports mean absolute overall and ECB-attributable CMAM for hard-peg, managed exchange-rate, and inflation-targeting regimes. Regime classifications are used for ex-post comparison and do not enter model estimation.

The attribution ratios reveal a different cross-country pattern from the absolute ECB-attributable magnitudes. Albania has the lowest mean absolute ECB-attributable CMAM, but ECB shocks account for approximately 28.8% of its overall monetary adjustment, the largest relative share among the six countries. North Macedonia and Serbia follow at approximately 26.7% and 24.9%, respectively. The corresponding ratios are approximately 18.9% in Montenegro, 17.9% in Bosnia and Herzegovina, and 16.0% in Croatia.

There is no contradiction between these results and the absolute ECB-attributable ranking. They capture two different dimensions of monetary adjustment. A country can exhibit substantial ECB-induced adjustment in absolute terms while that component represents a relatively small proportion of a much larger overall monetary-adjustment process. Conversely, a country with lower absolute monetary adjustment can have a larger proportion of that adjustment associated with ECB policy. Bosnia and Herzegovina and Croatia illustrate the former case, whereas Albania illustrates the latter.

This distinction also places an important boundary on the interpretation of the attribution ratio. It should not be interpreted mechanically as a measure of formal monetary dependence or as an inverse measure of monetary autonomy. Rather, it quantifies the *relative empirical importance of ECB-induced adjustment within the total effective monetary adjustment captured by the CMAM*.

Formal monetary autonomy, the absolute magnitude of adjustment to ECB policy, and the share of overall adjustment attributable to ECB policy are related but conceptually distinct objects.

The distinction is economically useful precisely because it separates two questions that conventional policy-rate comparisons tend to conflate: *how strongly does the domestic monetary system adjust to ECB policy* and *how important is ECB policy relative to the other forces generating domestic monetary adjustment.*

6.4 ECB-Attributable Adjustment across Monetary Regimes

The country-level results can be aggregated into three broad monetary frameworks to examine whether the intensity of adjustment is systematically related to institutional arrangements. Table 2 reports the corresponding regime-level estimates, while Panel B of Figure 3 provides their graphical representation.

Table 2. Overall and ECB-Attributable Monetary Adjustment across Monetary Regimes

Monetary regime	Overall CMAM	ECB-attributable CMAM	ECB attribution ratio (%)	Overall rank	ECB rank
Hard pegs	0.0464	0.0085	18.3	1	1
Managed exchange-rate regimes	0.0393	0.0078	19.7	2	2
Inflation targeting	0.0228	0.0061	26.7	3	3

Notes: Overall CMAM is measured as the mean absolute value of the estimated overall monetary-adjustment factor. ECB-attributable CMAM is the mean absolute value of the component attributable to ECB MRO-rate-change shocks. The ECB attribution ratio is the ratio of mean absolute ECB-attributable CMAM to mean absolute overall CMAM, expressed as percentage. It measures the relative magnitude of ECB-attributable adjustment withing the overall monetary-adjustment process and should not be interpreted as a variance-decomposition share or as a direct measure of monetary dependence on the ECB. Rankings are based on the corresponding mean absolute CMAM measures, with rank 1 indicating the largest adjustment magnitude. Regime classifications are used for ex-post comparison and do not enter model estimation. Results are based on the benchmark MAP M1 specification.

The benchmark estimates reveal a clear ordering in the *absolute magnitude of ECB-attributable monetary adjustment*. Adjustment is strongest among the hard-peg economies, followed by the managed exchange-rate regimes and then the inflation-targeting economies. Mean absolute ECB-attributable CMAM is approximately 0.0085 for hard pegs, 0.0078 for managed regimes, and 0.0061 for inflation targeters.[3]

The same ordering is observed for overall monetary adjustment, but the differences are considerably larger. Mean absolute overall CMAM is approximately 0.0464 for hard pegs, 0.0393

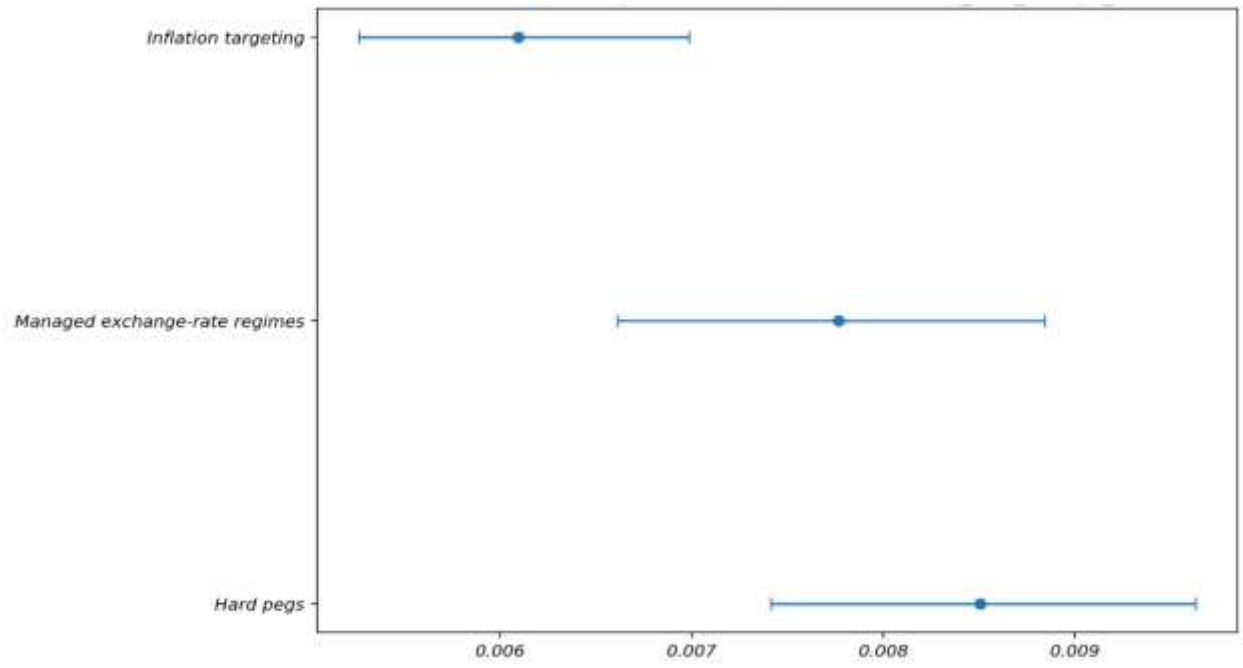
[3] These values are mean absolute CMAM magnitudes rather than percentages or policy-rate changes. They summarize the average intensity of effective monetary adjustment on the standardized latent CMAM scale, where larger values indicate stronger adjustment but have no direct interpretation in basis points or percentage points. The comparison is therefore fundamentally ordinal and intensity-based: the CMAM magnitudes allow monetary adjustment to be compared across countries and regimes operating with different policy instruments, but they should not be interpreted as conventional monetary-policy units.

for managed exchange-rate regimes, and 0.0228 for inflation-targeting economies. The benchmark therefore suggests a regime-related gradient in the intensity of effective monetary adjustment: economies operating under harder external monetary constraints display the strongest adjustment, managed regimes occupy an intermediate position, and inflation targeters exhibit lower adjustment on average.

The absolute ECB-attributable differences across regimes are nevertheless much smaller than the corresponding differences in overall adjustment. This is reflected in the regime-level attribution ratios. ECB shocks account for approximately 18.3% of overall monetary adjustment among hard pegs and 19.7% among managed regimes, compared with approximately 26.7% among the inflation-targeting economies.

The regime ordering is also visible when uncertainty around the benchmark estimates is taken into account. Figure 4 reports the regime-level mean absolute ECB-attributable CMAM together with bootstrap confidence intervals. Inflation-targeting economies are clearly located at the lower end of the adjustment distribution, while hard pegs and managed exchange-rate regimes exhibit stronger ECB-attributable adjustment. The intervals also indicate, however, that uncertainty around the latter two regime estimates is substantial and partially overlapping, cautioning against interpreting their point-estimate difference as mechanically sharp.

Figure 4. ECB-Attributable Monetary Adjustment across Monetary Regimes: Bootstrap Intervals



Notes: Points report mean absolute ECB-attributable CMAM for each monetary regime under the benchmark MAP M1 specification. Horizontal bars report 95% non-parametric bootstrap intervals based on 1,000 replications, obtained by resampling with replacement the pooled country-month observations of absolute ECB-attributable CMAM within each regime and taking the 2.5th and 97.5th percentiles of the resulting distribution of regime means. Monetary regimes are used for ex-post comparison and do not enter model estimation.

This result provides an important qualification to a simple monetary-regime interpretation. Hard-peg economies experience the greatest *absolute* effective adjustment and the largest absolute ECB-attributable adjustment, but ECB shocks constitute a larger *relative share* of the smaller overall monetary-adjustment process among inflation targeters. The regime ordering therefore depends on the dimension being considered: absolute adjustment intensity and relative ECB attribution are not the same empirical object.

More generally, the estimates do not imply that monetary regimes mechanically determine the magnitude of adjustment. Institutional arrangements constrain the instruments available and shape the mechanisms through which external monetary impulses are absorbed, but the resulting adjustment also reflects country-specific policy implementation, financial structures, external exposure, and domestic conditions. The benchmark regime comparison should therefore be interpreted as evidence of systematic differences across monetary frameworks rather than as a deterministic mapping from regime classification to monetary adjustment.

6.5 Benchmark and Comparability Diagnostics

A central measurement issue in comparing monetary adjustment across heterogeneous monetary regimes is that countries do not operate the same number of policy channels. Bosnia and Herzegovina and Montenegro have three structurally active channels in the benchmark specification, whereas Albania, Croatia, North Macedonia, and Serbia have five. Without appropriate normalization, a multidimensional measure of monetary adjustment could therefore mechanically assign greater adjustment to countries for which more observable channels enter the measurement system. This concern is particularly important for the cross-regime comparisons above: differences in CMAM should reflect differences in the intensity of effective monetary adjustment rather than differences in the dimensionality of the instrument set.

Figure 5: Channel-Count Comparability of Benchmark CMAM Magnitudes

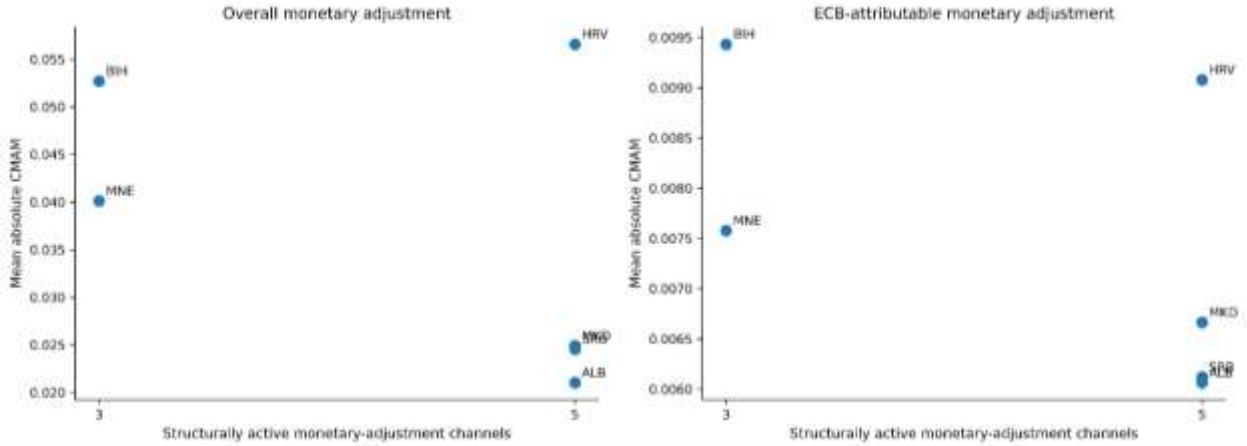
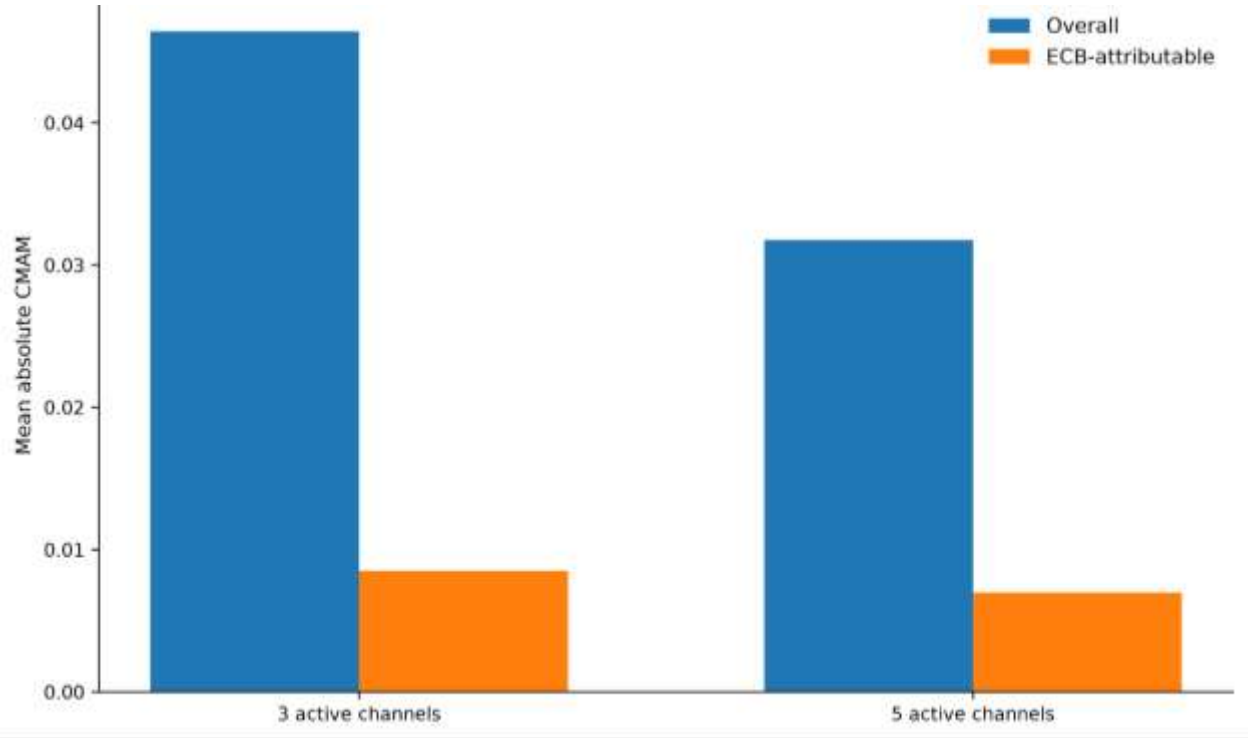


Figure 5 examines this issue directly by relating the number of structurally active channels to the benchmark magnitude of CMAM at the country level. Panel A reports mean absolute overall

CMAM, while Panel B reports mean absolute ECB-attributable CMAM. The results provide no indication that countries with fewer active channels are mechanically assigned lower monetary adjustment. Bosnia and Herzegovina and Montenegro, despite having only three active channels, lie in the upper part of the distribution for both measures. Bosnia and Herzegovina records the second-highest mean absolute overall CMAM and the highest ECB-attributable CMAM, while Montenegro also exceeds several of the five-channel economies on both dimensions. Conversely, the availability of five channels does not systematically translate into larger measured adjustment: Albania, North Macedonia, and Serbia have comparatively low overall CMAM despite their broader observable instrument sets.

Figure 6: Average CMAM Magnitude by Number of Active Channels



The same result is evident when countries are grouped according to the number of structurally active channels. As shown in Figure 6 and summarized in Table 3, mean absolute overall CMAM equals 0.0464 among the three-channel economies, compared with 0.0318 among the five-channel economies. The corresponding mean absolute ECB-attributable values are 0.0085 and 0.0070. Thus, rather than being compressed by the smaller number of observable channels, the three-channel economies exhibit average overall and ECB-attributable adjustment approximately 46 and 22 percent higher, respectively, than the corresponding averages for the five-channel economies.

Simple diagnostic statistics reinforce this conclusion. Across the six countries, the correlation between the number of active channels and mean absolute CMAM is negative for both overall adjustment (−0.49) and ECB-attributable adjustment (−0.53). Exact permutation comparisons between the three- and five-channel groups yield p-values of 0.40 and 0.33,

respectively. These statistics should be interpreted descriptively rather than as tests of a causal effect of channel availability. With only six countries, the number of active channels is closely associated with the underlying monetary regime, and the purpose of the exercise is therefore narrower: to determine whether the benchmark comparisons display the mechanical positive relationship with measurement dimensionality that would arise if countries with richer instrument sets were systematically advantaged by construction. They do not.

Table 3. Channel-Count Comparability of Benchmark CMAM

Country / group	Active channels	Mean absolute overall CMAM	Mean absolute ECB-attributable CMAM	ECB-attributable share (%)
Albania	5	0.0210	0.0061	28.8
Bosnia and Herzegovina	3	0.0527	0.0094	17.9
Croatia	5	0.0566	0.0091	16.0
Montenegro	3	0.0401	0.0076	18.9
North Macedonia	5	0.0249	0.0067	26.7
Serbia	5	0.0246	0.0061	24.9
Three-channel economies	**3**	**0.0464**	**0.0085**	**18.3**
Five-channel economies	**5**	**0.0318**	**0.0070**	**22.1**
Three-/five-channel ratio	–	**1.46**	**1.22**	–

Notes: The table reports benchmark MAP M1 estimates using the ECB MRO-rate shock. Active channels refer to channels that are structurally available in the country-specific measurement system. Overall and ECB-attributable magnitudes are measured as mean absolute CMAM. The ECB-attributable share is the ratio of mean absolute ECB-attributable CMAM to mean absolute overall CMAM. Croatia is included through December 2022.

The comparability result is also consistent with the normalization embedded in the measurement model. Additional diagnostics based on common-channel representations, country-specific loading scales, and adjustment normalized by the number of active channels are reported in the Appendix. These diagnostics provide complementary checks on the sensitivity of the latent measure to differences in the composition of the country-specific measurement systems rather than alternative estimates of the benchmark model. The underlying accounting identities are considerably stronger: the historical decomposition of the latent state and the additive allocation of CMAM across implementation channels both reconcile to their respective CMAM components to numerical precision, with maximum absolute discrepancies below $3\times10-17$.

These diagnostics support the interpretation of the cross-country and cross-regime differences reported above as substantive differences in estimated monetary adjustment rather than mechanical consequences of the number of observable policy channels. This is particularly important for the comparison of hard-peg economies with managed and inflation-targeting regimes. The relatively strong adjustment recorded for countries operating narrower instrument sets is not generated by giving them more opportunities to register policy action; if anything, the descriptive relationship runs in the opposite direction. The benchmark evidence can therefore be compared across monetary frameworks while allowing the *mechanisms through which adjustment occurs* to differ across countries. Section 7 turns precisely to those mechanisms.

6.6 Summary of the Benchmark Evidence

The benchmark results provide a clear answer to the first part of the paper's empirical question. *ECB monetary-policy shocks are associated with effective monetary adjustment across all three monetary-regime types represented in the sample.* This adjustment does not require the presence of a conventional domestic policy rate and is not confined to economies that formally surrender monetary-policy autonomy. Once monetary adjustment is measured across the full set of relevant instruments and balance-sheet mechanisms, ECB policy is reflected in domestic monetary conditions throughout the sample.

The intensity of that adjustment is heterogeneous. At the regime level, the benchmark MAP estimates indicate stronger absolute ECB-attributable adjustment under hard pegs, intermediate adjustment under managed exchange-rate regimes, and lower adjustment among inflation targeters. At the country level, however, substantial heterogeneity remains, and the exact point-estimate ordering should not be interpreted as an immutable structural ranking. The robustness and Bayesian analyses subsequently examine how strongly these comparisons survive alternative specifications and parameter uncertainty.

Overall CMAM provides essential context for these findings but serves a different purpose from the ECB-attributable measure. It characterizes the total effective monetary-adjustment process from which the ECB-associated component is isolated. Comparing the two shows that the *absolute magnitude of adjustment to ECB policy and the relative importance of ECB policy within domestic monetary adjustment need not coincide*. This distinction allows external monetary exposure to be characterized more precisely than would be possible from conventional comparisons of policy rates or formal monetary regimes alone.

Establishing that ECB shocks generate effective monetary adjustment, however, leaves open an equally important question. The countries in the sample possess very different monetary-policy instruments and institutional arrangements, so similar aggregate adjustment need not be implemented in similar ways. A currency board, a managed exchange-rate regime, and an inflation-targeting central bank can absorb the same external monetary impulse through fundamentally different combinations of external adjustment, liquidity operations, policy rates, reserve requirements, and reserve remuneration. *Section 7 therefore turns from the magnitude of ECB-attributable monetary adjustment to the channels through which that adjustment is implemented and how their importance evolves over time.*

7. How Does Everybody Adjust? Channels and Mechanisms

The benchmark results establish that monetary adjustment to ECB policy is not confined to any particular monetary regime. The next question is how that adjustment is implemented. This distinction is central to the CMAM framework because focusing on policy rates alone would provide an incomplete—and for some monetary regimes largely inappropriate—description of monetary adjustment. Central banks can alter monetary conditions through policy rates, reserve

requirements, reserve remuneration, liquidity operations, and external adjustment, with the relative importance of these channels depending on the institutional and operational characteristics of the monetary regime.

This section therefore focuses primarily on *the channel composition of ECB-attributable monetary adjustment*. The decomposition allocates the ECB-attributable CMAM component across the monetary-adjustment channels that are structurally available in each country. Because the allocations are additive, the channel contributions sum to the corresponding ECB-attributable CMAM at each point in time. Structural absence of an instrument is treated as absence rather than as zero use of an available instrument. Overall monetary adjustment is considered subsequently as a reference against which the ECB-attributable channel structure can be assessed.

7.1 Channels of ECB-Attributable Monetary Adjustment

Figure 7 reports the channel composition of ECB-attributable monetary adjustment across countries. The results reveal substantial differences in the mechanisms through which ECB policy is transmitted into domestic monetary conditions. At the same time, a striking common feature emerges: *ECB monetary-policy spillovers should not be equated with domestic policy-rate pass-through*. Across the six economies, external adjustment and liquidity operations account for most ECB-attributable monetary adjustment, while the policy rate plays a quantitatively dominant role in none of them.

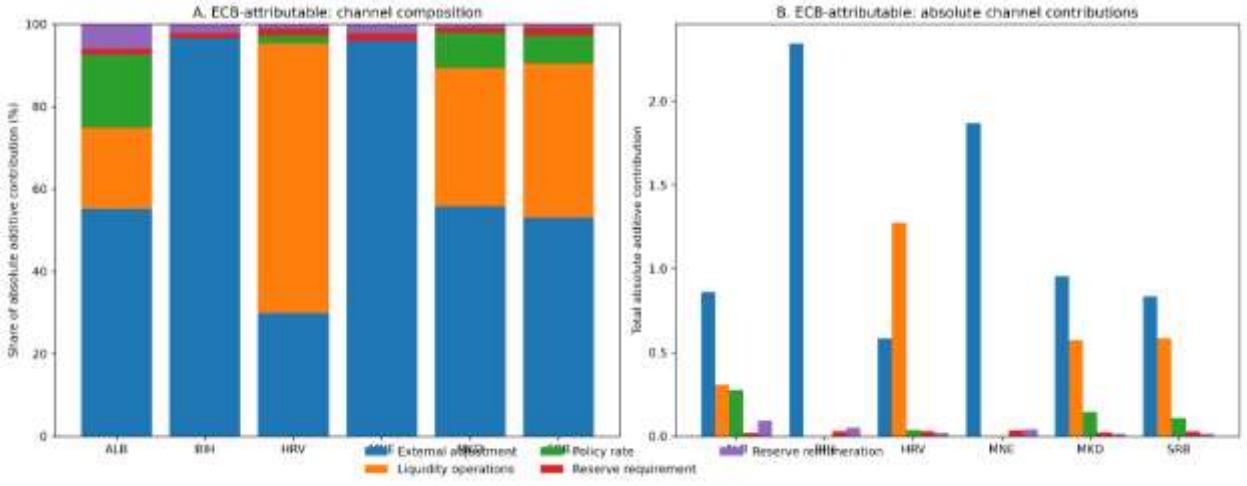
The distinction is clearest in the two hard-anchor regimes. In Bosnia and Herzegovina, the external-adjustment channel accounts for approximately 96.6% of ECB-attributable monetary adjustment, with reserve remuneration and reserve requirements contributing about 2.1% and 1.3%, respectively. Montenegro exhibits an almost identical structure: approximately 96.0% of ECB-attributable adjustment occurs through the external channel, while reserve remuneration and reserve requirements account for only small remaining shares. These results are consistent with the institutional logic of the two regimes. Neither economy possesses a conventional independent policy-rate instrument comparable to that of an inflation-targeting central bank. Adjustment to changes in euro-area monetary conditions therefore becomes visible predominantly through external and banking-system liquidity mechanisms rather than through an administratively announced domestic policy rate.

The managed regimes display a markedly different implementation structure. Croatia's ECB-attributable adjustment is dominated by *liquidity operations, with a share of approximately 65.4%*, followed by external adjustment at about 29.9%. The policy-rate channel accounts for only around 2.0%. North Macedonia exhibits a more balanced combination of external and liquidity adjustment: the external channel contributes approximately 55.8%, liquidity operations 33.5%, and the policy rate about 8.5%. These results illustrate why the monetary response of a managed exchange-rate regime cannot be inferred from policy-rate movements alone. Monetary conditions can adjust substantially through central-bank balance-sheet operations and management of

domestic and external liquidity even when changes in the reference policy rate are comparatively limited.

The two inflation-targeting economies employ a broader instrument mix, but here too the policy rate represents only part of the response. In Albania, external adjustment accounts for approximately 55.2% of ECB-attributable adjustment, liquidity operations for 19.6%, and the policy-rate channel for 17.8%, with reserve remuneration and reserve requirements accounting for the remainder. Serbia similarly relies predominantly on external adjustment (53.1%) and liquidity operations (37.2%), while the policy-rate channel contributes approximately 6.9%. Inflation targeting therefore increases the role of the conventional interest-rate instrument without making monetary adjustment reducible to that instrument (see Table A1 in the Appendix).

Figure 7: ECB-Attributable Monetary Adjustment by Implementation Channel



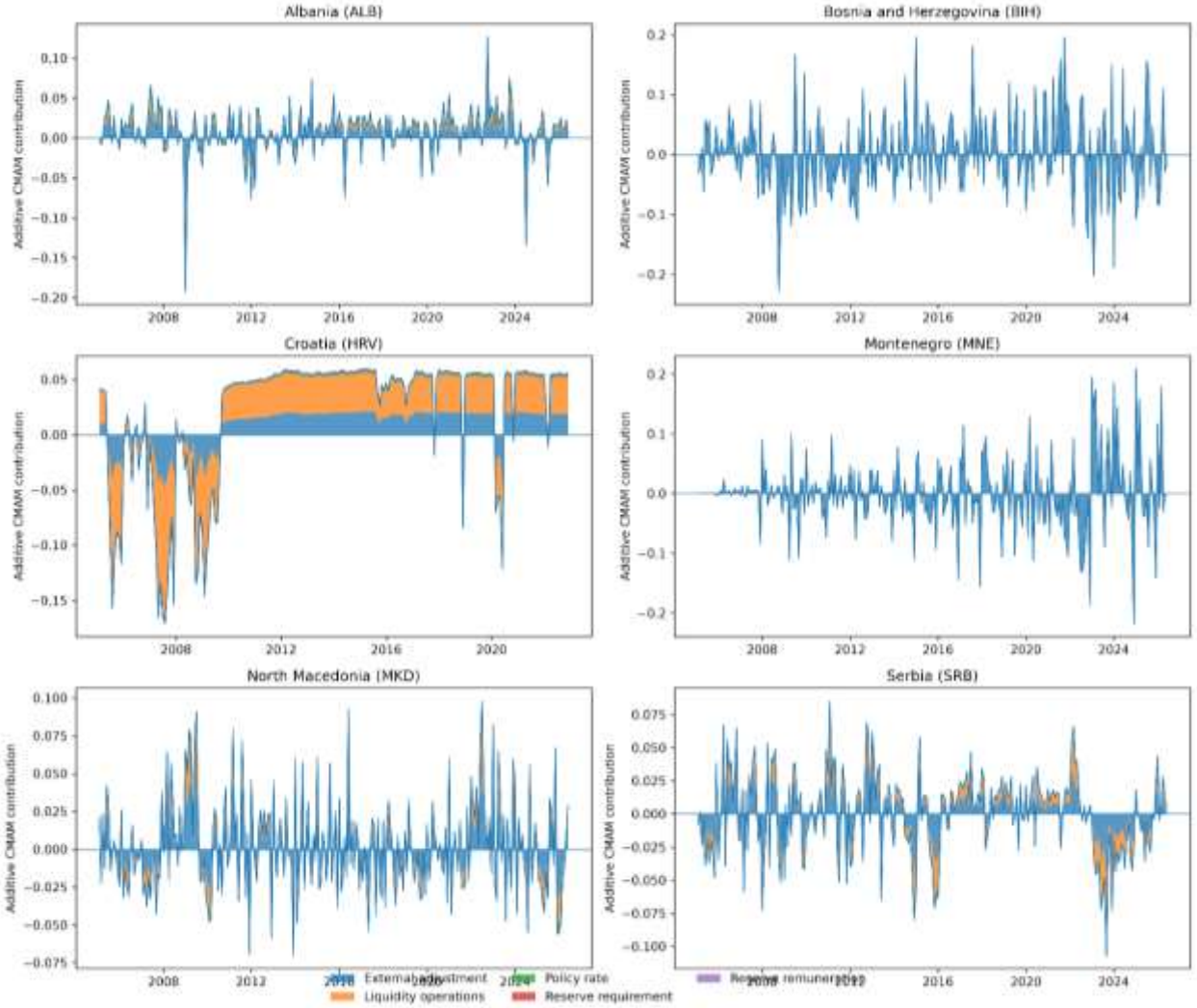
Taken together, these country results point to an important distinction between monetary-policy decisions and the mechanisms through which ECB monetary-policy shocks are transmitted into domestic monetary conditions. Where a domestic policy rate exists, it may provide the principal signal of the intended policy stance, but the response to an ECB shock need not occur primarily through that rate. Liquidity operations can transmit the shock by adjusting reserve supply and short-term banking-system liquidity, either in support of the policy-rate stance or as a source of monetary impulse in their own right. External adjustment can transmit the same shock through exchange-rate management, foreign-exchange operations, and the associated effects of external flows on domestic liquidity. The ECB-attributable CMAM decomposition therefore captures the broader set of mechanisms through which an ECB monetary-policy shock is absorbed into domestic monetary conditions, rather than treating domestic policy-rate adjustment as a sufficient statistic for monetary adjustment.

7.1.1 The Instrument Mix over Time

The cross-country averages conceal meaningful variation in the instrument/channels mix over time. The dynamic channel decomposition presented in Figure 8 therefore provides an

additional perspective on how ECB-attributable adjustment is implemented across different monetary-policy episodes. Although the relative importance of individual channels varies through time, the principal country-specific patterns are persistent rather than being driven by a small number of isolated observations.

Figure 8: Evolution of ECB-Attributable Monetary Adjustment by Implementation Channel



In the hard-anchor economies, external adjustment remains the predominant mechanism across the sample. This persistence is particularly informative because it indicates that the high external-channel shares reported above are not simply averages generated by a few unusually large episodes. Instead, external and associated liquidity adjustment appear to constitute the normal mechanism through which changes in euro-area monetary conditions are absorbed under these institutional arrangements.

The instrument mix is more variable in the managed and inflation-targeting regimes. In Croatia, the relative importance of liquidity and external adjustment changes across monetary-policy and financial-stress episodes, while liquidity operations remain a central component of the

adjustment mechanism. North Macedonia likewise exhibits variation in the balance between external adjustment and liquidity operations. Albania and Serbia show broader combinations of instruments, with the relative contributions of policy rates, liquidity operations, and external adjustment changing over time.

This temporal variation provides an economically important qualification to the average channel shares. Monetary regimes create relatively persistent institutional structures within which adjustment takes place, but they do not imply a fixed instrument mix. Central banks can alter the intensity with which available instruments are used as domestic and external conditions change. The time-varying specification of the CMAM framework is intended precisely to accommodate such changes in the relative importance of monetary-adjustment channels without requiring the underlying monetary regime itself to change.

The dynamic evidence therefore suggests a combination of *institutional persistence and operational flexibility*. Countries tend to rely on channels consistent with their monetary frameworks, but the relative intensity of those channels changes across episodes. What remains comparatively stable is not the exact monthly allocation across instruments, but the broader architecture through which monetary adjustment is implemented.

7.1.2 Channel Composition across Monetary Regimes

Aggregating the country-level decomposition by monetary regime makes these differences particularly transparent. Figure 9 reports the composition of absolute ECB-attributable monetary adjustment for the three broad monetary frameworks. The regimes are used solely for ex-post comparison and do not enter the estimation of the country models.

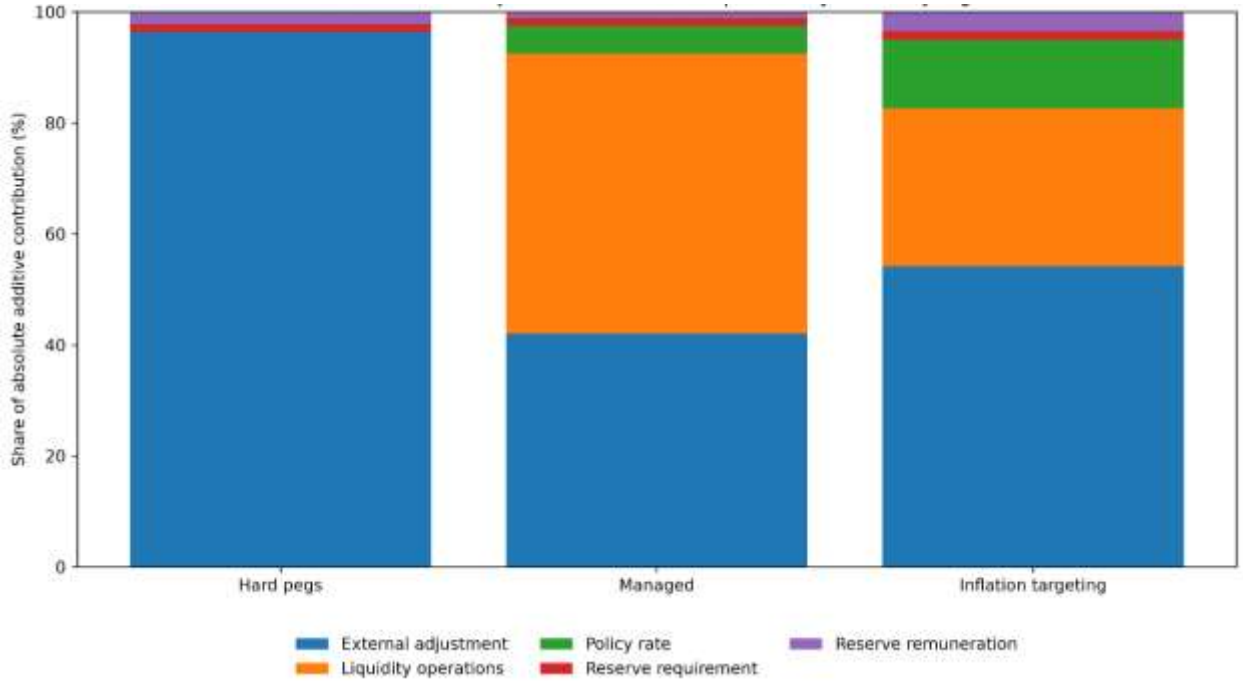
Hard-anchor regimes exhibit the most concentrated channel structure. Approximately 96.4% of ECB-attributable monetary adjustment occurs through the external-adjustment channel, with reserve remuneration accounting for around 2.1% and reserve requirements for 1.5%. The result is consistent with the institutional constraints imposed by currency-board and euroized arrangements: adjustment to ECB policy occurs primarily through the external monetary environment and the associated balance-sheet and liquidity mechanisms rather than through an independent domestic interest-rate response.

Managed regimes exhibit a substantially more diversified structure. Liquidity operations account for approximately 50.5% of ECB-attributable adjustment and external adjustment for about 42.0%, while the policy-rate channel contributes around 5.0%. The managed regimes are therefore not simply an intermediate quantitative case between hard anchors and inflation targeting. They exhibit a qualitatively distinctive implementation mechanism in which liquidity management and external adjustment jointly perform much of the adjustment that might otherwise be attributed to the policy rate.

Inflation-targeting regimes display the broadest instrument mix. External adjustment remains the largest channel, accounting for approximately 54.2**%** of ECB-attributable adjustment, followed by liquidity operations at 28.5% and the policy rate at 12.3%. Reserve remuneration and

reserve requirements account for relatively small remaining shares. Thus, even where central banks possess an explicit policy rate and greater formal monetary autonomy, most measured adjustment to ECB policy occurs outside the policy-rate channel (see Table A3 in the Appendix).

Figure 9: ECB-Attributable Channel Composition across Monetary Regimes



The regime comparison consequently reveals more than differences in the *amount* of adjustment documented in Section 6. It shows that monetary regimes are associated with different *mechanisms of adjustment*. Hard anchors transmit ECB policy overwhelmingly through external adjustment; managed regimes combine external adjustment with intensive liquidity management; and inflation targeters use a broader instrument set in which the policy rate assumes a larger role but does not displace external and liquidity channels.

This distinction is important for interpreting monetary autonomy. Greater formal discretion over domestic monetary instruments does not imply insulation from ECB policy, just as the absence of an independent policy rate does not imply the absence of monetary adjustment. The institutional regime instead shapes the *channels through which adjustment is expressed*.

7.2 ECB-Attributable Channels in the Context of Overall Monetary Adjustment

The preceding analysis establishes how the ECB-attributable component is implemented. A related question is whether ECB-induced adjustment generates a distinctive channel structure or is transmitted predominantly through the same mechanisms that countries use in their broader monetary adjustment. To assess this, Figure 7 can be compared with the decomposition of overall CMAM reported in Appendix Figure A1. The resulting comparison suggests the latter. The normalized channel composition of ECB-attributable adjustment is remarkably similar to the

composition of overall monetary adjustment in most countries. Bosnia and Herzegovina and Montenegro are externally dominated in both decompositions. Croatia is characterized primarily by liquidity operations and external adjustment in both cases. North Macedonia and Serbia combine external adjustment with substantial liquidity operations, while Albania exhibits the broadest combination of external adjustment, liquidity operations, and policy-rate adjustment.

The similarity is also visible quantitatively. For example, the external channel accounts for approximately **55.2%** of Albania's ECB-attributable adjustment compared with **55.2%** of overall adjustment. In Serbia the corresponding shares are 53.1% and 53.2%, while in Montenegro they are **96.0%** and **96.3%**. Croatia displays a somewhat greater concentration of the ECB-attributable component in liquidity operations—approximately 65.4%, compared with 62.6% in overall adjustment—but the underlying hierarchy remains unchanged.

This similarity should not be interpreted as implying that ECB policy explains most overall monetary adjustment. As shown in Section 6, the ECB-attributable component represents only a fraction of total measured monetary adjustment, and its importance differs substantially across countries. The comparison here concerns the *mechanism through which adjustment is implemented*, not the fraction of overall adjustment explained by the ECB.

The result instead suggests that ECB policy is generally transmitted through the *existing monetary-adjustment architecture* of each economy. When ECB policy generates domestic adjustment, countries do not appear to switch systematically to an entirely different set of instruments. Rather, the ECB impulse is absorbed through the institutional and operational mechanisms that already characterize monetary adjustment in the respective economy.

This finding helps connect the external origin of the shock with domestic monetary implementation. The ECB determines neither the domestic instrument mix nor the institutional structure through which adjustment occurs. Those structures are country specific. What differs across regimes is therefore not simply the strength with which an ECB shock is transmitted, but the mechanism through which domestic monetary conditions accommodate that shock.

Overall CMAM is useful in this context precisely as a benchmark. It identifies the broader monetary-adjustment architecture against which the ECB-attributable component can be evaluated. The central empirical object remains the ECB-attributable component; the overall decomposition establishes whether the channels through which ECB policy is transmitted are exceptional or instead reflect the country's more general monetary-adjustment mechanism.

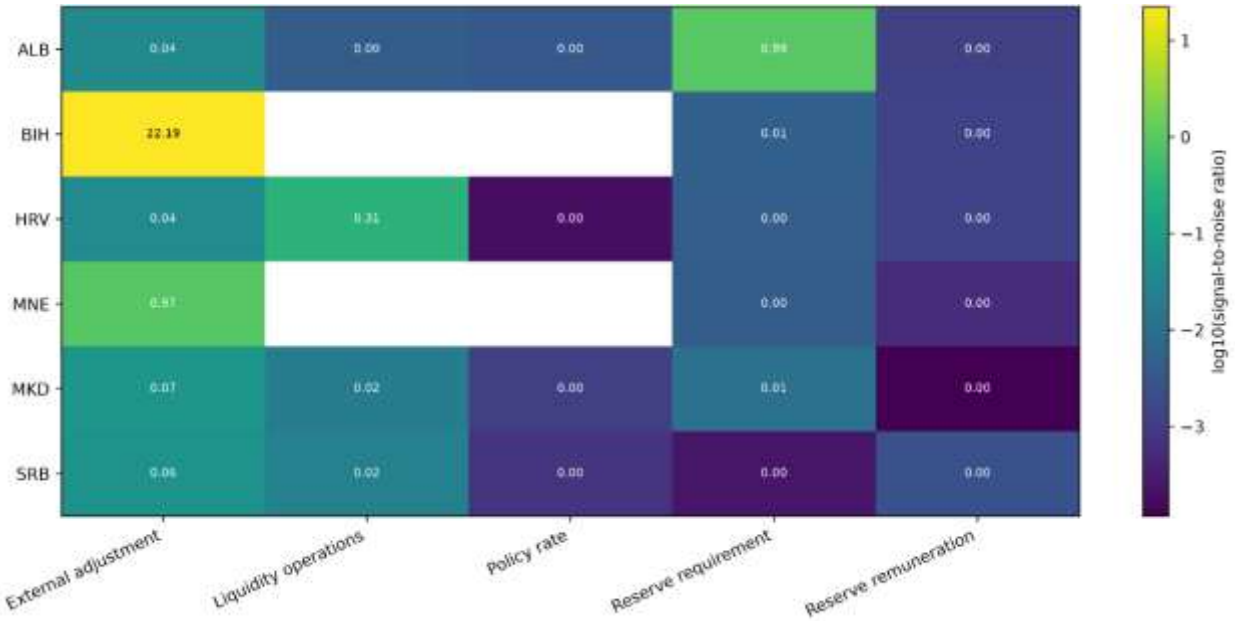
7.3 Channel-Decomposition Diagnostics

The interpretation of the channel decomposition requires that the underlying channel measurements contain economically meaningful signal and that the results are not driven by mechanical redundancy across observed instruments. We therefore examine two complementary diagnostics for the benchmark M1/MRO specification: channel-level signal-to-noise ratios and pairwise correlation among the observed monetary-adjustment channels.

Figure 10 reports the signal-to-noise ratios of the individual channel measurements. The results indicate substantial heterogeneity in the precision with which different channels reveal the common monetary-adjustment signal. Several of the economically dominant channels display comparatively strong signal content. The external-adjustment channel is particularly well measured in Bosnia and Herzegovina and Montenegro, with signal-to-noise ratios of approximately 22.2 and 1.0, respectively, while Croatia's liquidity-operations channel also exhibits a comparatively strong ratio of about 0.31. These are precisely the channels that account for particularly large shares of ECB-attributable adjustment in those countries.

At the same time, many individual channel measurements exhibit low signal-to-noise ratios. This is especially evident for policy-rate, reserve-requirement, and reserve-remuneration series, several of which consist of relatively infrequent policy changes embedded in otherwise inactive monthly observations. Low signal-to-noise ratios therefore caution against interpreting every small channel contribution with the same degree of precision as the dominant channels. They do not, however, imply that the corresponding instruments should be excluded from the measurement system. The purpose of the hierarchical factor structure is precisely to extract the common monetary-adjustment component from observables that differ substantially in frequency, volatility, and idiosyncratic noise. Accordingly, the substantive interpretation in this section emphasizes broad channel hierarchies and economically material contributions rather than small differences among weakly informative channels.

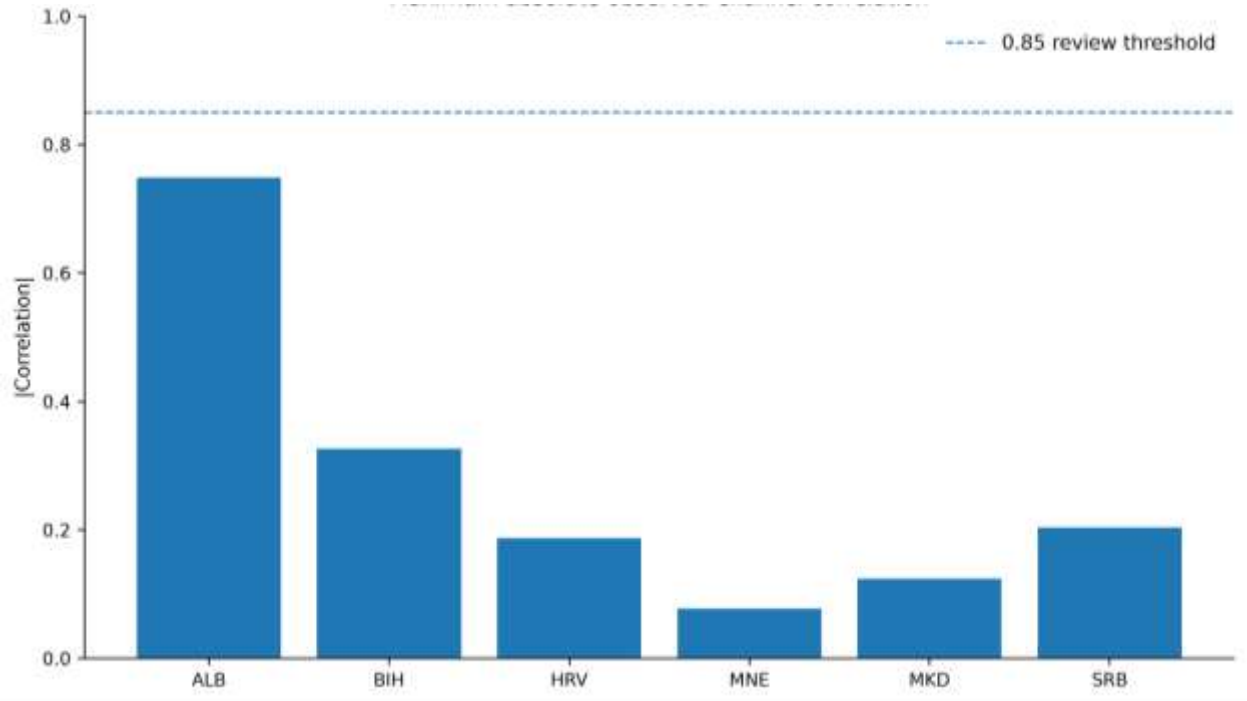
Figure 10: Channel Measurement Signal-to-Noise Ratios — Benchmark M1/MRO



Notes: Cell entries report signal-to-noise ratios (SNRs) in levels. Colors represent log10 (SNR) to accommodate the wide dispersion in signal strength across channels; consequently, the values shown on the color scale differ from the cell entries. Values displayed as 0.00 represent small positive SNRs rounded to two decimal places, not necessarily zero signal. Blank cells denote structurally unavailable channels.

A separate concern is that apparently distinct channels might capture essentially the same observed monetary action, thereby mechanically inflating the contribution of particular implementation mechanisms. Figure 11 therefore reports, for each country, the maximum absolute pairwise correlation among the observed active channels. None of the countries exceeds the prespecified review threshold of 0.85. The largest correlation occurs in Albania, at approximately 0.75, between the policy-rate and reserve-remuneration measures. The corresponding maxima are considerably lower elsewhere, ranging from approximately 0.08 in Montenegro to 0.33 in Bosnia and Herzegovina. The benchmark channel decomposition therefore does not appear to be driven by near-duplicate observed channel series.

Figure 11: Maximum Absolute Observed-Channel Correlation



The additive decomposition itself also satisfies the accounting identities exactly to numerical precision. In particular, the ECB-attributable channel allocations reproduce the corresponding ECB-attributable CMAM component without residual discrepancy. The associated cancellation diagnostic is identically zero across all six countries and is therefore not reported graphically. This reflects the additive construction of the decomposition rather than providing an independent test of economic identification.

The reported diagnostics support a qualified interpretation of the channel results. The observed monetary instruments are not highly redundant, and the additive allocation is internally exact, but the information content of individual channel measurements is uneven. The strongest conclusions should therefore concern the broad transmission architecture documented above—such as the dominance of external adjustment under hard anchors, the central role of liquidity operations in Croatia, and the joint importance of external and liquidity channels in the managed and inflation-targeting economies—rather than very small differences among secondary channels.

7.4 The Structure of Monetary Adjustment

The channel results provide a more complete interpretation of the central finding that countries operating under very different monetary arrangements nevertheless adjust to ECB policy. They show that this common adjustment does **not** imply a common transmission mechanism.

Under hard anchors, ECB-attributable adjustment is overwhelmingly external. Under managed regimes, external adjustment interacts with liquidity operations, with the latter assuming a particularly important role. Inflation-targeting economies employ a broader instrument mix and make greater use of the policy rate, but external adjustment and liquidity operations still account for most measured ECB-attributable adjustment. The differences across regimes therefore concern not only the intensity of adjustment but also its institutional implementation.

This result also explains why comparisons based exclusively on domestic policy rates can be misleading. Such comparisons implicitly privilege the monetary instrument characteristic of conventional inflation-targeting frameworks. They can consequently understate adjustment in economies where monetary conditions respond through foreign-exchange operations, banking-system liquidity, reserve policies, or other balance-sheet mechanisms. The CMAM framework places these different mechanisms on a common measurement basis and thereby makes adjustment comparable across monetary regimes without requiring the same instruments to be available in every country.

The evidence thus points to a distinction between *the degree of monetary adjustment and the mechanism of monetary adjustment*. Monetary regimes influence both, but neither dimension can be inferred mechanically from the formal exchange-rate or monetary-policy arrangement alone. Institutional constraints determine which instruments are available, while operational choices and country-specific financial structures determine how intensively those instruments are used.

The central implication is therefore stronger than the observation that all six economies respond to ECB policy. *Everybody adjusts, but they do so through different combinations of instruments consistent with their monetary and institutional frameworks.* The next section examines whether the resulting CMAM measure also exhibits the dynamic response to ECB monetary-policy shocks expected of a meaningful measure of monetary adjustment.

8. Dynamic Validation: Does CMAM Respond to ECB Monetary-Policy Shocks?

The benchmark results establish that a component of monetary adjustment can be attributed to ECB policy innovations within the hierarchical dynamic-factor model. Because the ECB shock enters the state equation in that specification, however, the resulting ECB-attributable component is mechanically linked to the shock used to identify it. This does not invalidate the decomposition—the purpose of the state equation is precisely to separate the contribution associated with ECB policy from other determinants of monetary adjustment—but it raises a

distinct validation question. A convincing measure of monetary adjustment should respond systematically to ECB policy shocks even when those shocks are not used in constructing the measure itself.

We address this issue through a separate local-projection exercise designed to break this mechanical link. For this exercise, the CMAM model is re-estimated after excluding the ECB shock from the latent-state equation. The resulting shock-free CMAM therefore reflects the common monetary-adjustment signal extracted from the observed domestic policy channels, conditional on the remaining model structure, but its estimated path is not directly conditioned on ECB policy innovations. We subsequently estimate the dynamic response of this independently constructed CMAM measure to the benchmark ECB MRO shock. The exercise consequently asks a deliberately different question from the benchmark decomposition: *having constructed monetary adjustment without using ECB shocks, does the resulting measure subsequently respond to an ECB tightening in an economically meaningful way?*

8.1 Local-Projection Design

For each country i, local projections relate the shock-free CMAM measure to the contemporaneous ECB monetary-policy shock over horizons extending from impact to 24 months. The estimated specification can be represented as:

$$CMAM_{i,t+h}^{SF} = \alpha_{i,h} + \theta_{i,h} s_t^{ECB} + \sum_{l=1}^{L_f} \rho_{i,h,l} CMAM_{i,t-l}^{SF} + \sum_{l=0}^{L_x} \delta'_{i,h,l} x_{i,t-l} + v_{i,t+h}, \quad (11)$$

where $CMAM_{i,t+h}^{SF}$ denotes the monetary-adjustment factor obtained from the shock-free specification, s_t^{ECB} is the standardized ECB MRO tightening shock, and $x_{i,t}$ contains the domestic macroeconomic and common external controls used in the benchmark framework. The coefficient $\theta_{i,h}$ traces the response of independently constructed monetary adjustment at horizon *h* to an ECB tightening shock.

The preferred specification uses the time-varying-loading M1 measure and retains the second-stage controls. Inference is based on the block-bootstrap procedure implemented for the local projections, thereby allowing uncertainty around the dynamic response to vary across horizons. In addition to the horizon-specific responses, we report cumulative responses,

$$\Theta_{i,H} = h = \sum_{h=0}^{H} \theta_{i,h}, \quad (12)$$

which summarize the adjustment accumulated during the first H months following the ECB shock. The cumulative responses are particularly informative where monetary adjustment is implemented gradually through liquidity and external channels rather than through an immediate discrete change in a domestic policy rate.

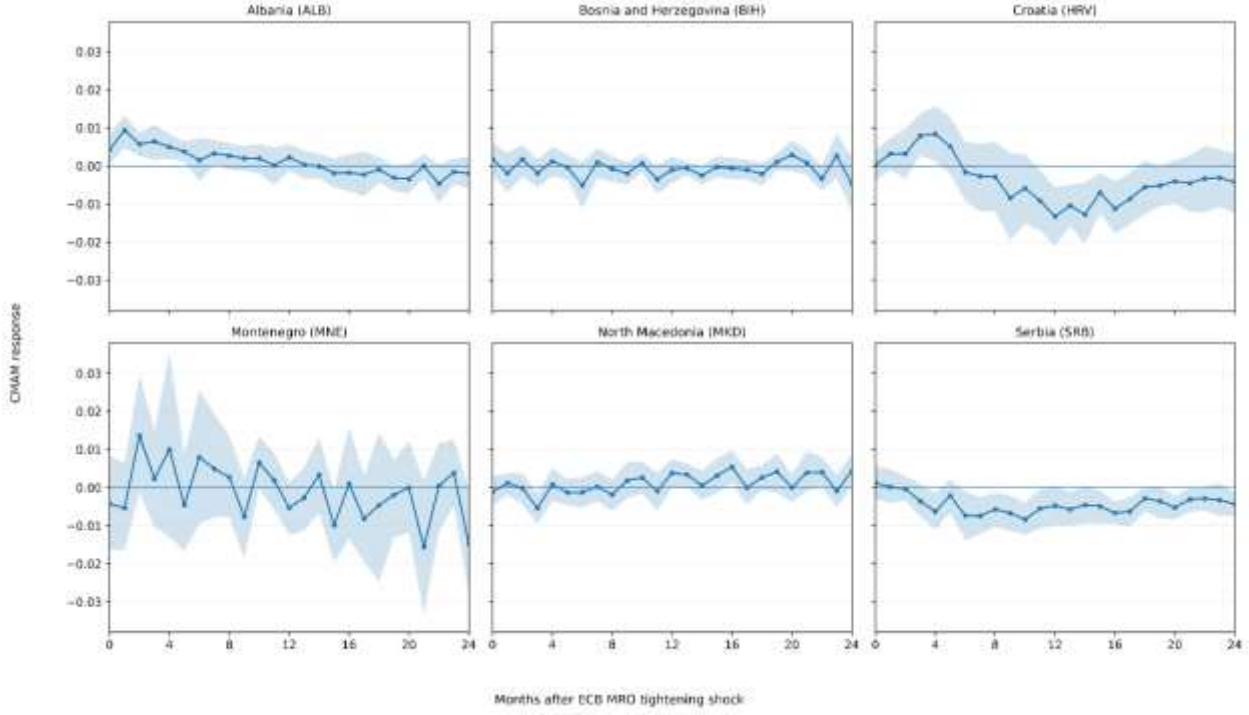
This design provides a direct diagnostic for the potential generated-regressor or circularity concern. The dependent variable in the local projections is itself estimated, but the ECB shock

whose dynamic effect is being evaluated is deliberately excluded from the first-stage state equation. A positive response therefore cannot arise simply because the same ECB shock was mechanically embedded in the construction of the dependent variable.

8.2 Dynamic Responses of Monetary Adjustment

Figure 12 reports the horizon-by-horizon responses of shock-free CMAM to a positive ECB MRO shock. The results reveal substantial cross-country heterogeneity. Most importantly, they do not display a mechanically uniform response across the six economies. Instead, the sign, magnitude, timing, and persistence of adjustment differ considerably across countries, as would be expected if the local projections were recovering the interaction between a common external monetary impulse and heterogeneous domestic monetary systems.

Figure 12. Dynamic Response of Shock-Free CMAM to an ECB MRO Tightening Shock



Albania exhibits the clearest sustained positive response. Monetary adjustment increases almost immediately following the ECB tightening and continues to strengthen over subsequent months. The response rises gradually rather than discontinuously, reaching its largest magnitude around the middle of the projection horizon before declining moderately thereafter. Importantly, the response remains positive throughout the 24-month horizon. This pattern is consistent with a gradual accommodation of the external monetary impulse through the broader set of adjustment mechanisms identified in Section 7 rather than with a one-off synchronization of policy rates.

Montenegro also exhibits an initially positive response, although considerably less persistent and more weakly estimated. After modest fluctuations at very short horizons, the response becomes positive and increases during approximately the first year following the ECB shock. It subsequently diminishes and approaches zero at longer horizons. Given Montenegro's unilateral euroization and the predominance of external adjustment documented above, such a pattern is consistent with adjustment occurring through banking-system liquidity and external financial conditions rather than through a conventional domestic policy-rate reaction.

North Macedonia displays a different temporal profile. The initial response is small and mildly negative, but it subsequently reverses and becomes positive at medium and longer horizons. This delayed response is economically plausible for a managed exchange-rate regime in which adjustment to external monetary conditions can operate through foreign-exchange management and liquidity operations rather than through an immediate policy-rate response alone.

The responses for Bosnia and Herzegovina, Croatia, and Serbia are less supportive of a uniformly persistent tightening interpretation. Bosnia and Herzegovina remains close to zero over much of the horizon before becoming moderately negative at longer horizons. Croatia initially responds positively, with the response building over the first several months, but subsequently reverses sign and becomes increasingly negative after approximately one year. Serbia similarly develops a progressively negative response after the first few months.

These reversals are important rather than merely inconvenient for the validation exercise. The local projections do *not* imply that an ECB tightening produces a permanently positive monetary-adjustment response in every country. Nor should the validation criterion require such a result. The CMAM captures realized effective monetary adjustment rather than a mechanically imposed policy-reaction coefficient. Subsequent domestic macroeconomic developments, liquidity conditions, exchange-rate pressures, and policy responses can attenuate or reverse the initial adjustment as the horizon lengthens. The relevant validation question is therefore whether the independently measured CMAM exhibits economically structured dynamics following ECB shocks, rather than whether every country produces a positive and statistically significant coefficient at every horizon.

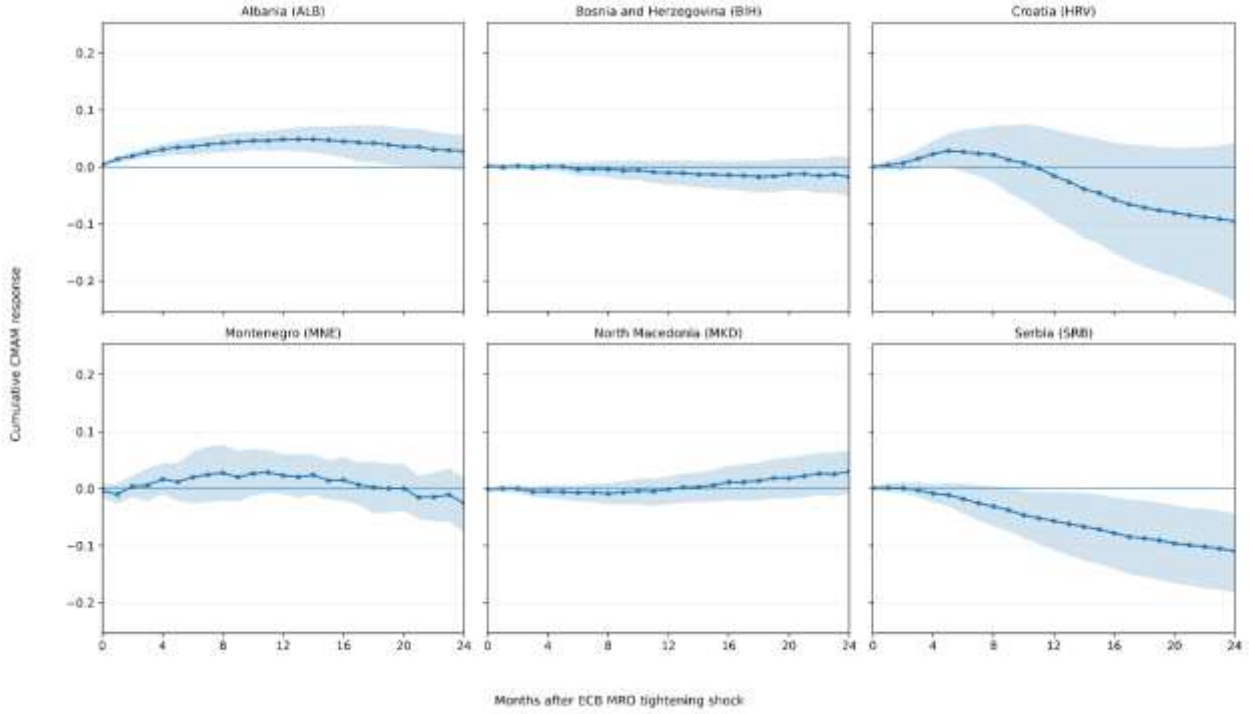
At the same time, the heterogeneous responses impose an important qualification on the benchmark findings. The strong contemporaneous association between ECB policy and monetary adjustment documented in Sections 6 and 7 should not be interpreted as implying homogeneous or permanently reinforcing dynamic transmission. The response to a common ECB innovation can evolve differently once domestic adjustment mechanisms and subsequent economic conditions begin to operate.

8.3 Cumulative Monetary Adjustment

Figure 13 reports the corresponding cumulative responses. These provide a complementary perspective because temporary but persistent horizon-specific effects can generate economically

meaningful accumulated adjustment even when individual monthly responses are imprecisely estimated.

Figure 13. Cumulative Response of Shock-Free CMAM to an ECB MRO Tightening Shock



The cumulative evidence reinforces the heterogeneity apparent in the horizon-specific responses, while also revealing some evidence of an initially positive adjustment following the ECB tightening. Several economies exhibit positive cumulative responses over the early horizons, although the magnitude and statistical precision of these responses differ considerably across countries and the initial adjustment is subsequently reversed in some cases. Albania exhibits the strongest and most persistent positive cumulative adjustment. The accumulated response increases steadily through approximately the first year and remains clearly positive thereafter, declining only moderately toward the end of the 24-month horizon. The shape of the response suggests that adjustment to ECB tightening is distributed over time rather than concentrated at impact.

Montenegro records a smaller positive cumulative response over much of the first year and a half, before the effect gradually dissipates toward zero at longer horizons. North Macedonia initially shows little accumulated adjustment but moves progressively into positive territory during the second year. These patterns are consistent with the possibility that balance-sheet, liquidity, and external-adjustment mechanisms transmit common monetary impulses more gradually than a conventional policy-rate reaction function would suggest.

The cumulative responses for Croatia and Serbia eventually become negative. In Croatia, an initially positive cumulative response reverses around the middle of the projection horizon and becomes increasingly negative thereafter. Serbia exhibits a more persistent downward cumulative

trajectory. Bosnia and Herzegovina remains much closer to zero, with only a modest negative cumulative response emerging at longer horizons. Confidence bands widen substantially with the horizon in several cases, however, so the magnitude of these longer-run reversals should not be interpreted with the same precision as the more clearly identified shorter- and medium-horizon patterns.

These results therefore reinforce an important distinction between the initial monetary response to an ECB shock and the subsequent evolution of domestic monetary adjustment. A country may initially adjust in the direction of an ECB tightening but subsequently attenuate or reverse that response as domestic conditions evolve. Conversely, adjustment may emerge only gradually where institutional transmission operates through external or liquidity mechanisms. A 24-month horizon is useful precisely because it reveals these dynamics; restricting the analysis to the first year would conceal economically meaningful reversals and delayed responses.

8.4 Implications for CMAM Validation

The local-projection evidence provides a deliberately demanding validation of CMAM. The monetary-adjustment measure used in this exercise is constructed without including the ECB shock in its state equation. Nevertheless, subsequent ECB innovations generate systematic dynamic responses in the independently estimated latent adjustment factor. The responses are neither identical across countries nor mechanically positive at every horizon. Instead, they display differences in timing, persistence, and eventual reversal that are consistent with the heterogeneous monetary institutions and implementation mechanisms documented in the preceding sections.

This evidence addresses the circularity concern from a different empirical direction than the benchmark decomposition. The benchmark model asks how much of realized monetary adjustment can be attributed to ECB policy conditional on the state equation. The local projections instead ask whether a measure of monetary adjustment constructed independently of that ECB conditioning subsequently responds to ECB policy shocks. The two exercises are therefore complementary rather than redundant.

The validation is not unqualified. Several country responses are imprecisely estimated, and the longer-horizon responses in Croatia and Serbia eventually reverse sign. Its more important implication is that the central CMAM results are not solely an artifact of embedding the ECB shock in the latent-state equation. Once ECB policy is excluded from the construction of the latent adjustment measure, subsequent ECB shocks continue to generate economically structured movements in CMAM, although *the sign, timing, persistence, and precision of those responses differ substantially across countries*. The LP evidence therefore provides independent support for the existence of ECB-related monetary adjustment, while leaving the magnitude and cross-regime ordering of that adjustment to be established by the benchmark and posterior evidence.

The next section examines whether the principal benchmark conclusions remain robust to alternative ECB shock measures and model specifications and evaluates the uncertainty

surrounding cross-country and cross-regime comparisons using the Bayesian posterior distribution.

9. Robustness, Identification and Bayesian Uncertainty

The benchmark results are obtained from the preferred M1 specification with time-varying channel loadings and changes in the ECB main refinancing operations rate as the monetary-policy shock. The preceding analysis has shown that this specification produces economically interpretable differences in the magnitude and composition of monetary adjustment across countries and regimes, while the shock-free local-projection exercise provides an independent dynamic validation of the CMAM construct. The remaining question is whether the central conclusions depend materially on particular modelling or identification choices.

This section examines that question along three dimensions. We first assess the role of time variation in the measurement system by comparing the benchmark M1 estimates with the constant-loading M0 specification. We then use Bayesian estimation of the preferred M1/MRO model to quantify uncertainty around the benchmark estimates and, in particular, around cross-country and cross-regime comparisons. Finally, we replace the MRO-rate innovation with alternative measures of ECB monetary-policy shocks to assess whether the substantive results depend on the particular shock used in the benchmark specification.

These exercises serve different purposes and should therefore not be interpreted as interchangeable robustness checks. The M0–M1 comparison evaluates sensitivity to the specification of the measurement system; the Bayesian analysis evaluates uncertainty conditional on the empirically preferred benchmark model and its associated posterior mode; and the alternative-shock analysis evaluates sensitivity to monetary-policy identification. Taken together, they assess whether the principal conclusions of the paper—widespread adjustment to ECB policy, systematic differences across monetary regimes, and substantial heterogeneity in the mechanisms through which that adjustment occurs—survive changes in the principal modelling and identification assumptions.

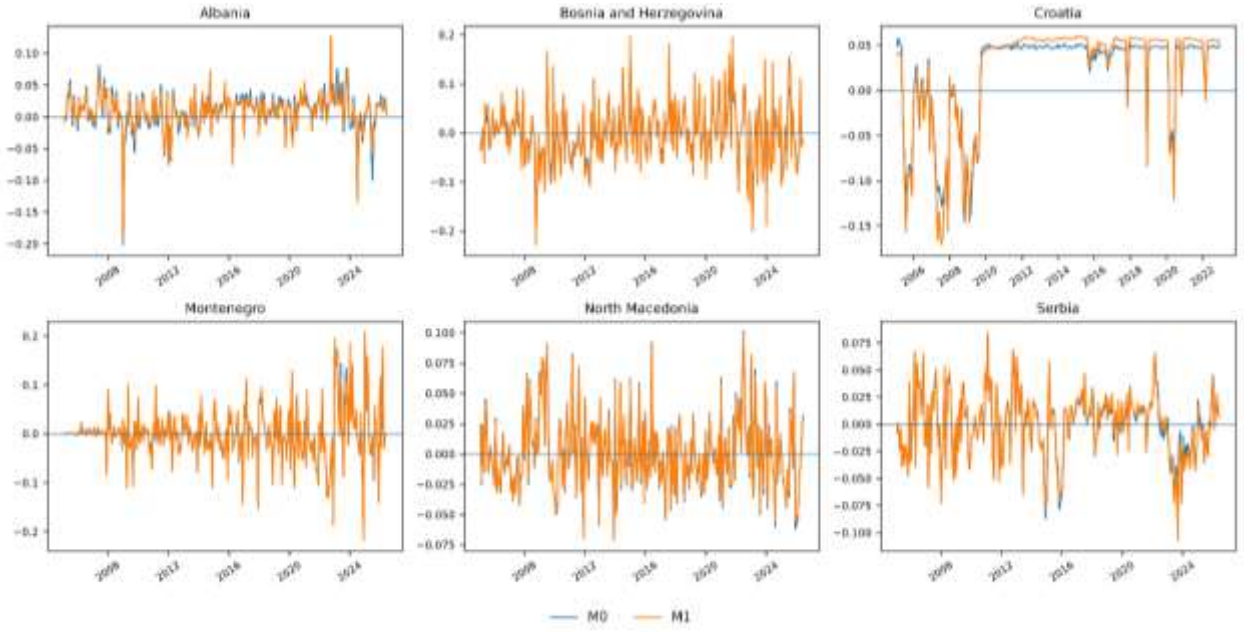
9.1 Constant versus Time-Varying Channel Loadings

The benchmark M1 specification allows the importance of individual monetary-adjustment channels to vary over time. This flexibility is economically attractive because the relevance of policy rates, reserve instruments, liquidity operations and external adjustment need not remain constant across episodes such as the global financial crisis, the period of unconventional ECB monetary policy, the pandemic, and the subsequent tightening cycle. At the same time, introducing time-varying loadings creates a natural robustness question: are the substantive CMAM results driven by this additional flexibility, or do they also emerge when the measurement relationship is restricted to remain constant over time?

To address this question, we compare the benchmark M1 specification with M0, which retains the same underlying CMAM architecture and ECB MRO shock but imposes constant channel loadings. This is therefore a particularly informative specification comparison. Unlike the alternative-shock exercises considered below, it leaves the monetary-policy innovation unchanged and varies the way in which observed monetary-adjustment channels map into the latent factor. Similar results across M0 and M1 would indicate that the principal conclusions are not generated by the time-varying-loading structure itself, while differences between the two specifications reveal where allowing the monetary-adjustment mechanism to evolve over time is empirically consequential.

Figure 14 compares the estimated paths of overall CMAM under M0 and M1 for the six economies. The purpose of this comparison is primarily diagnostic. Overall CMAM represents the complete latent monetary-adjustment process and therefore provides a direct indication of how much the introduction of time-varying loadings changes the estimated adjustment path. The comparison should be interpreted in terms of both co-movement and economically meaningful deviations rather than requiring the two specifications to generate identical monthly estimates.

Figure 14: Overall CMAM under Constant and Time-Varying Channel Loadings: M0 versus M1

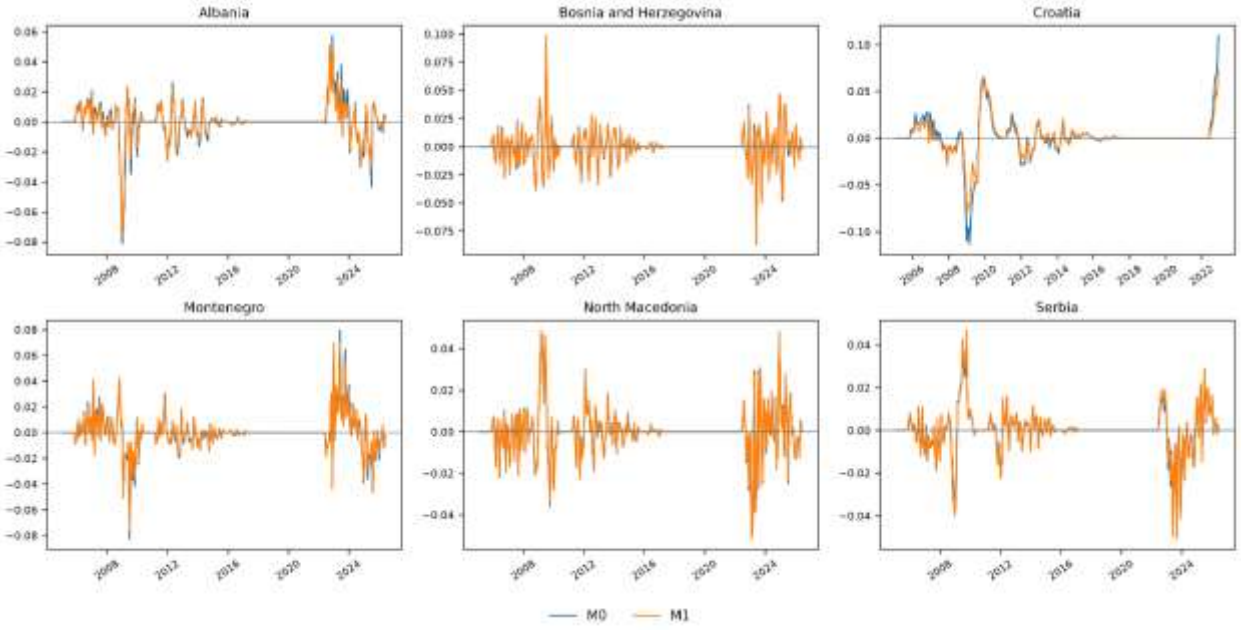


The more important comparison for the paper concerns ECB-attributable adjustment. Figure 15 therefore reports the corresponding M0 and M1 paths for the component of CMAM attributed to ECB monetary-policy shocks. The broad similarity of these paths indicates whether the estimated transmission of ECB policy is preserved when the measurement system is restricted to constant loadings, while departures between them show where allowing channel importance to evolve changes the estimated intensity or timing of adjustment.

The broad similarity of these paths indicates whether the estimated transmission of ECB policy is preserved when the measurement system is restricted to constant loadings, while departures between them show where allowing channel importance to evolve changes the estimated intensity or timing of adjustment. This visual similarity is confirmed by the formal path diagnostics reported in Appendix Table A4. Correlations between the M0 and M1 overall-CMAM paths range from approximately 0.96 to almost unity across countries, while correlations for ECB-attributable CMAM range from approximately 0.97 to almost unity. The corresponding mean absolute and root mean squared differences reported in Table A4 provide additional evidence that the two specifications preserve the principal temporal patterns despite allowing for economically meaningful differences in magnitude.

Table 4 summarizes the economically relevant differences in ECB-attributable adjustment. The comparison indicates substantial stability in the magnitude of the ECB component. Moving from M0 to M1 changes mean absolute ECB-attributable adjustment by less than 1 percent in North Macedonia, by about 5 percent in Bosnia and Herzegovina, and by about 8 percent in Montenegro. The differences are somewhat larger in Albania and Croatia, where the M1 estimate is approximately 15 and 19 percent lower, respectively, while Serbia moves in the opposite direction, with ECB-attributable adjustment approximately 12 percent higher under M1. Thus, allowing the loadings to vary over time affects the estimated magnitude of adjustment in some countries, but does not produce a systematic upward or downward shift across the sample.

Figure 15: ECB-Attributable CMAM under Constant and Time-Varying Channel Loadings: M0 versus M1



The comparison of the ECB-attributable component with overall CMAM leads to a similar conclusion. The ECB-to-overall adjustment ratio changes relatively little in Albania and North Macedonia, while the M1 specification reduces the ratio more noticeably in Bosnia and

Herzegovina, Croatia and Montenegro and increases it modestly in Serbia. The fuller country-level results reported in Appendix Table A5 also show that introducing time-varying loadings produces some changes in exact country rankings, even though the broad cross-country structure of adjustment remains recognizable. This reinforces the interpretation of individual country ranks as specification-dependent point estimates rather than immutable structural orderings. These differences are economically useful rather than problematic: they indicate that time-varying channel importance affects the magnitude and decomposition of total monetary adjustment in a country-specific manner. Crucially, however, the ECB-attributable component remains present under both specifications in every economy. The central result that ECB policy is reflected in effective domestic monetary adjustment is therefore not dependent on allowing channel loadings to vary over time.

Table 4: ECB-Attributable Monetary Adjustment under Constant and Time-Varying Channel Loadings

Country	ECB-attributable CMAM		Change	ECB/overall CMAM (%)	
	M0	M1	M1 vs. M0 (%)	M0	M1
Albania	0.0071	0.0061	-14.6	29.5	28.8
Bosnia and Herzegovina	0.0099	0.0094	-4.8	21.5	17.9
Croatia	0.0112	0.0091	-18.9	20.6	16.0
Montenegro	0.0082	0.0076	-7.7	22.2	18.9
North Macedonia	0.0067	0.0067	-0.4	27.1	26.7
Serbia	0.0055	0.0061	11.8	23.2	24.9

Notes: M0 denotes the constant-loading specification and M1 the time-varying-loading specification. ECB-attributable CMAM is reported as the mean absolute ECB-attributable adjustment over the estimation sample. The change column reports the percentage difference in mean absolute ECB-attributable CMAM between M1 and M0. ECB/overall CMAM reports ECB-attributable adjustment as a percentage of mean absolute overall CMAM. Both specifications use changes in the ECB main refinancing operations (MRO) rate as the monetary-policy shocks.

The M0–M1 exercise consequently supports the use of M1 as the benchmark without making the paper's main conclusions conditional on it. The constant-loading specification reproduces the broad ECB-adjustment pattern, whereas M1 permits the measurement system to accommodate changes in the relative importance of monetary-adjustment channels over time. The benchmark results should therefore be interpreted as a refinement of a pattern already present under the more restrictive specification, rather than as a consequence of the additional flexibility introduced by time-varying loadings.

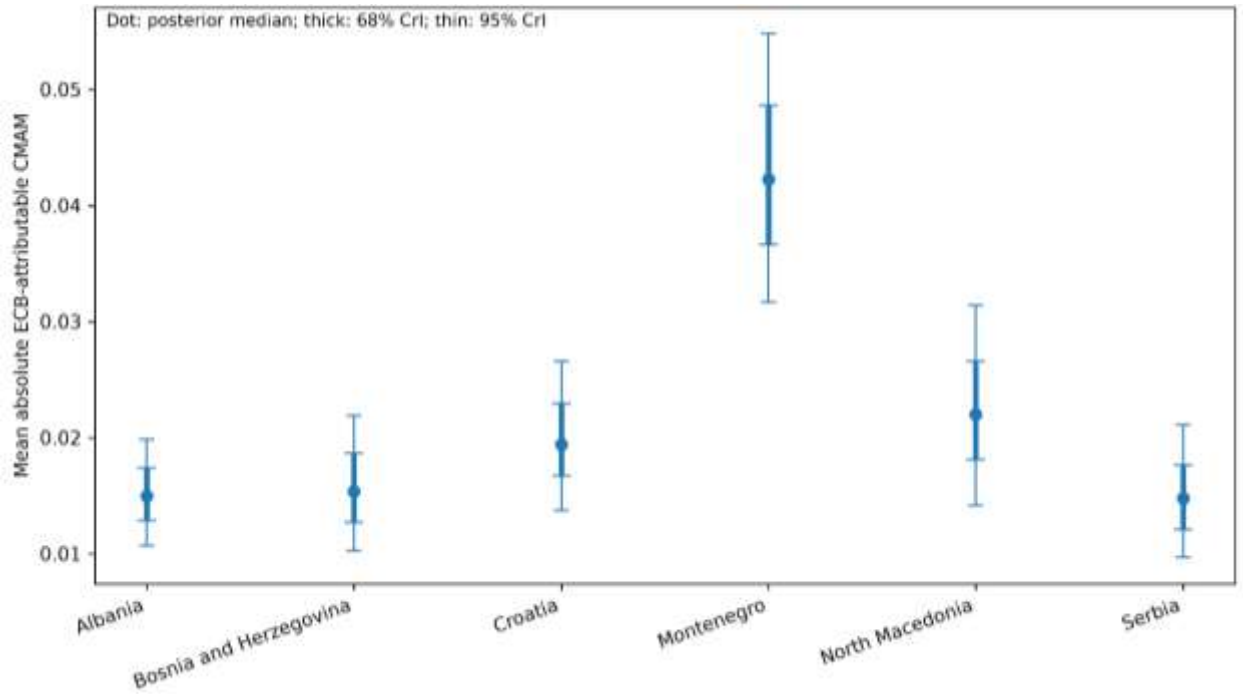
9.2 Bayesian Posterior Uncertainty around the MRO Benchmark

The MAP estimates reported above provide a convenient benchmark for comparing the magnitude and composition of monetary adjustment, but they do not by themselves quantify uncertainty surrounding the estimated latent states and model parameters. We therefore

complement the benchmark with Bayesian estimation of the M1 specification under the same MRO-rate shock. As discussed in Section 5.4, this exercise is deliberately anchored around the empirically validated MAP solution. It should consequently be interpreted as posterior uncertainty analysis around the benchmark-associated mode rather than as an independent diffuse-prior Bayesian identification exercise. Its purpose is to assess whether the principal substantive conclusions obtained from the benchmark remain supported once parameter and latent-state uncertainty are propagated through the model. The results reported below use the final Stage-B posterior of the preferred time-varying-loading specification.

Figure 16 reports the posterior distribution of mean absolute ECB-attributable CMAM for each country. The dots represent posterior medians, the thicker intervals the 68 percent credible intervals, and the thinner intervals the 95 percent credible intervals. This representation is particularly informative for the cross-country comparison because it distinguishes differences in posterior central tendency from the uncertainty surrounding exact country positions.

Figure 16: Posterior ECB-Attributable Monetary Adjustment by Country: M1/MRO Benchmark



The posterior evidence confirms that ECB-related monetary adjustment is economically meaningful across all six economies, but it also qualifies any interpretation based on a rigid country ranking. Montenegro stands out clearly, with a posterior median of mean absolute ECB-attributable CMAM of approximately 0.042 and a 95 percent credible interval of roughly 0.032–0.055. North Macedonia and Croatia occupy an intermediate range, with posterior medians of approximately 0.022 and 0.019, respectively, whereas Albania, Bosnia and Herzegovina and Serbia have posterior medians close to 0.015. At the same time, the credible intervals overlap substantially among several of these economies. The Bayesian evidence therefore provides much

stronger support for broad differences in adjustment intensity than for a deterministic ordering of all six countries. Figure 16 makes this distinction explicit: Montenegro is clearly separated from the remainder of the sample, while uncertainty about the relative positions of several other economies remains considerable.

Table 5 reports the corresponding country-level posterior summaries for overall CMAM, ECB-attributable CMAM and the ratio of ECB-attributable to overall adjustment. Reporting these quantities jointly is useful because the posterior magnitude of the ECB component need not coincide with its relative importance in total monetary adjustment. The results therefore preserve the distinction emphasized in Section 6 between the absolute intensity of ECB-related adjustment and the share of overall adjustment associated with ECB monetary-policy shocks.

Table 5: Posterior Distribution of Monetary Adjustment by Country: M1/MRO Benchmark

Country	Overall CMAM	ECB-attributable CMAM	ECB/Overall ratio
Albania	0.079 (0.060–0.101)	0.015 (0.011–0.020)	0.189 (0.143–0.243)
Bosnia and Herzegovina	0.077 (0.056–0.102)	0.015 (0.010–0.022)	0.199 (0.141–0.270)
Croatia	0.117 (0.087–0.153)	0.019 (0.014–0.027)	0.167 (0.122–0.222)
Montenegro	0.174 (0.135–0.220)	0.042 (0.032–0.055)	0.244 (0.190–0.307)
North Macedonia	0.134 (0.096–0.181)	0.022 (0.014–0.031)	0.164 (0.111–0.228)
Serbia	0.110 (0.080–0.148)	0.015 (0.010–0.021)	0.134 (0.092–0.185)

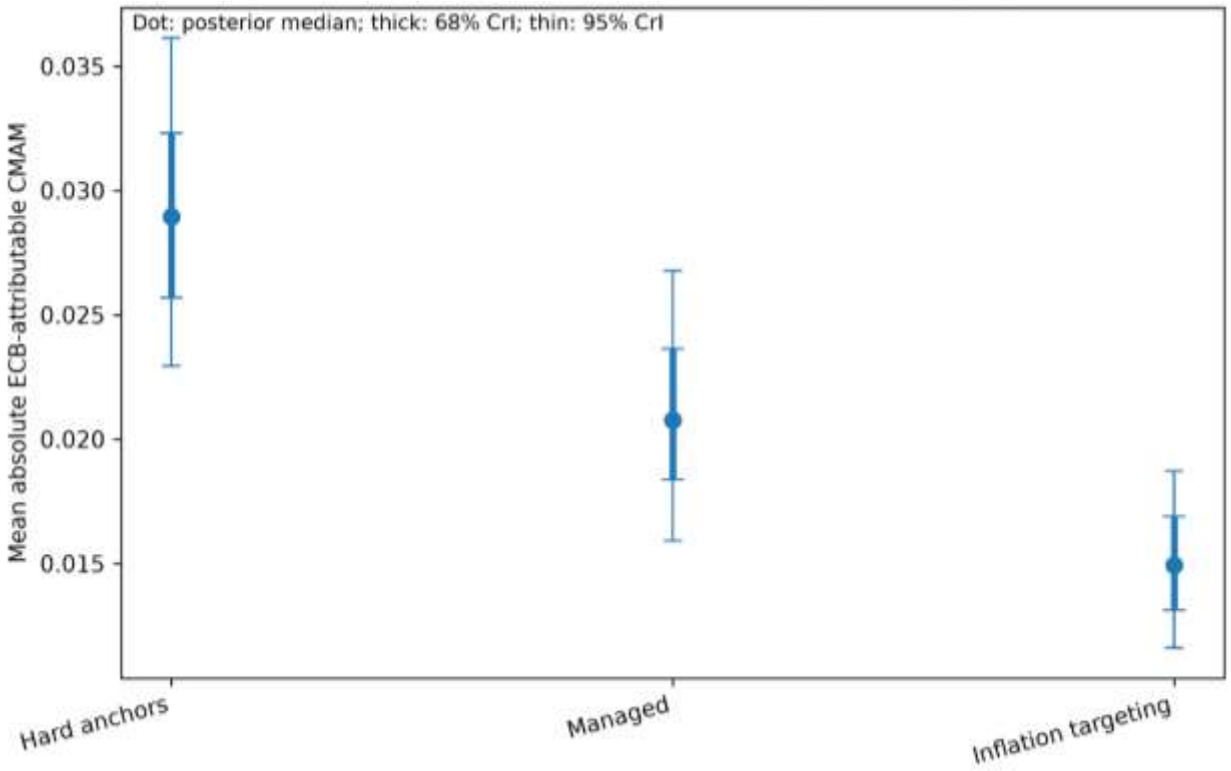
Notes: Entries in the first row for each country are posterior medians; figures in parentheses report the corresponding 95% credible intervals. Overall CMAM measures total effective monetary adjustment, while ECB-attributable CMAM denotes the component associated with ECB monetary-policy shocks. The ECB/Overall ratio is the posterior ratio of mean absolute ECB-attributable CMAM to mean absolute overall CMAM. Results are based on the preferred Bayesian M1 specification with time-varying channel loadings and the ECB MRO-rate shock. Bayesian inference characterizes uncertainty around the validated benchmark-associated posterior mode.

The posterior country results reinforce rather than overturn the central benchmark finding that all six monetary systems exhibit adjustment associated with ECB policy. They nevertheless place an important qualification on the exact country ordering obtained from point estimates. Posterior rank probabilities, reported in Appendix Table A8, show that the position of Montenegro at the upper end of the distribution is particularly robust, whereas considerably greater posterior uncertainty characterizes the ordering of the remaining countries. Exact country ranks should therefore be interpreted as convenient summaries of posterior central tendencies rather than as sharply identified structural positions. This distinction is consistent with the broader purpose of

the Bayesian exercise: uncertainty propagation should determine which comparisons are strongly supported by the data rather than simply attach intervals to an otherwise unchanged point-estimate ranking.

The regime-level evidence is considerably sharper. Figure 17 aggregates the country posterior draws according to the three monetary-framework groups used throughout the paper. As in the country figure, the dots denote posterior medians and the inner and outer intervals represent the 68 and 95 percent credible intervals, respectively. Importantly, regime classifications are imposed only after country-level estimation; the posterior hierarchy is therefore not generated by regime-specific priors or restrictions. This follows the inferential strategy set out in Section 5.4, under which regime-level distributions and ordering probabilities are calculated from posterior country draws after estimation.

Figure 17: Posterior ECB-Attributable Monetary Adjustment by Monetary Regime: M1/MRO Benchmark



The posterior medians exhibit a clear monotonic ordering. Mean absolute ECB-attributable adjustment is approximately 0.029 for hard-anchor economies, 0.021 for managed exchange-rate regimes and 0.015 for inflation-targeting economies. The corresponding 95 percent credible intervals are approximately 0.023–0.036, 0.016–0.027 and 0.012–0.019, respectively. Thus, although the marginal credible intervals overlap to some extent, the posterior distributions shift systematically downward as monetary arrangements move from hard external anchors toward greater formal monetary-policy autonomy.

The overlap of marginal credible intervals should not, however, be used as a test of the regime ordering. The Bayesian framework permits the relevant comparisons to be evaluated directly from the joint posterior distribution. Table 6 therefore reports the regime-level posterior summaries together with the probabilities of the economically relevant pairwise and complete orderings. The posterior probability that hard-anchor economies exhibit greater ECB-attributable adjustment than managed regimes is approximately 96.9 percent, while the probability that managed regimes adjust more strongly than inflation-targeting economies is approximately 97.6 percent. The posterior probability that hard anchors exceed inflation targeters is effectively 100 percent. Most importantly, the joint posterior probability of the complete ordering:

Hard anchors > Managed > Inflation targeting

is approximately *94.5 percent*.

Table 6: Posterior Monetary-Regime Comparisons and Ordering Probabilities: M1/MRO Benchmark

Panel A: Posterior monetary adjustment by regime

Monetary regime	Overall CMAM	ECB-attributable CMAM	ECB/Overall ratio
Hard anchors	0.126 (0.099–0.157)	0.029 (0.023–0.036)	0.230 (0.185–0.282)
Managed exchange-rate regimes	0.126 (0.095–0.164)	0.021 (0.016–0.027)	0.166 (0.128–0.214)
Inflation targeting	0.095 (0.071–0.124)	0.015 (0.012–0.019)	0.158 (0.123–0.195)

Panel B: Posterior ordering probabilities

Posterior comparison	Probability
Hard anchors > Managed exchange-rate regimes	0.969
Hard anchors > Inflation targeting	1.000
Managed exchange-rate regimes > Inflation targeting	0.976
Hard anchors > Managed exchange-rate regimes > Inflation targeting	**0.945**

Notes: Entries in the first row for each country are posterior medians; figures in parentheses report the corresponding 95% credible intervals. Overall CMAM measures total effective monetary adjustment, while ECB-attributable CMAM denotes the component associated with ECB monetary-policy shocks. The ECB/Overall ratio is the posterior ratio of mean absolute ECB-attributable CMAM to mean absolute overall CMAM. Results are based on the preferred Bayesian M1 specification with time-varying channel loadings and the ECB MRO-rate shock. Bayesian inference characterizes uncertainty around the validated benchmark-associated posterior mode.

This result is stronger than a comparison of posterior medians alone. It indicates that the regime hierarchy observed in the benchmark estimates remains highly probable after uncertainty in the parameters and latent adjustment processes is propagated through the model. At the same

time, it should not be interpreted as implying that institutional regime classification mechanically determines monetary adjustment. The substantial country-level heterogeneity visible in Figure 16 remains important. Rather, the posterior evidence indicates that the monetary framework contains systematic information about the intensity with which ECB policy is reflected in effective domestic monetary adjustment, even though country-specific institutional structures, instrument use and adjustment mechanisms continue to matter within each regime.

The constant-loading Bayesian results provide an additional check on this conclusion. Appendix Tables A6 and A7 compare the posterior country and regime distributions obtained under the constant-loading Stage-A specification with those from the preferred time-varying-loading Stage-B specification. Allowing loadings to vary over time affects posterior magnitudes in several cases, as would be expected when the relative importance of monetary-adjustment channels is permitted to evolve. The regime pattern, however, is not created by this flexibility. Under the constant-loading Bayesian specification, posterior median ECB-attributable adjustment is approximately 0.042 for hard anchors, 0.028 for managed regimes and 0.017 for inflation targeters, compared with approximately 0.029, 0.021 and 0.015 under M1. Moreover, the posterior probability of the complete hard-anchor–managed–inflation-targeting ordering is approximately 98.9 percent under the constant-loading specification, compared with 94.5 percent under M1. The Bayesian M0–M1 comparison therefore reaches the same qualitative conclusion as the MAP robustness exercise in Section 9.1: time variation refines the estimated magnitude of adjustment but is not responsible for generating the central cross-regime result.

Finally, posterior inference is supported by generally satisfactory sampling diagnostics. The preferred M1 estimation produces no divergent transitions or maximum-tree-depth violations, while effective sample sizes remain substantial. The maximum R^ is 1.02, marginally above the deliberately strict 1.01 diagnostic threshold used in the estimation workflow, and the run is therefore conservatively flagged for review rather than mechanically classified as an unconditional pass. The minimum bulk and tail effective sample sizes are approximately 893 and 771, respectively, and the minimum chain-level BFMI is approximately 0.89. The constant-loading posterior displays similarly satisfactory diagnostics. Full convergence and energy diagnostics are reported in Appendix Table A9. Given the MAP-centered nature of the Bayesian exercise, these diagnostics should be considered together with the identification qualification already discussed in Section 5.4: the posterior characterizes uncertainty around the validated benchmark-associated mode and does not establish uniqueness of that mode in an unrestricted global posterior.

The Bayesian results sharpen the interpretation of the benchmark evidence in two important respects. They counsel against placing excessive weight on the exact six-country ranking, since posterior uncertainty leaves several country positions only weakly differentiated. At the same time, they provide considerably stronger support for the broader monetary-regime pattern. The finding that hard-anchor economies exhibit the greatest ECB-attributable monetary adjustment, managed regimes occupy an intermediate position, and inflation-targeting economies adjust less strongly on average survives posterior uncertainty and the alternative constant-loading Bayesian specification. The substantive conclusion is therefore not that institutional arrangements

uniquely determine how much an economy adjusts to ECB policy, but that the degree of monetary anchoring is systematically associated with the intensity of effective adjustment even after uncertainty surrounding the latent monetary-adjustment process is explicitly taken into account.

9.3 Robustness across Alternative ECB Monetary-Policy Shock Measures

The benchmark analysis uses changes in the ECB main refinancing operations rate as the monetary-policy shock. Although the MRO rate provides a transparent measure of conventional ECB policy changes and preserves a direct interpretation of tightening and easing episodes, no single indicator captures all dimensions of the ECB monetary-policy stance over a sample that includes the global financial crisis, the effective-lower-bound period, unconventional monetary policy, the pandemic, and the subsequent tightening cycle. We therefore examine whether the principal CMAM results depend on the particular measure used to represent the external monetary-policy impulse. The MRO specification remains the benchmark throughout this exercise; the alternative shocks are used to evaluate the sensitivity of the estimated magnitude and cross-country distribution of ECB-attributable adjustment rather than to select ex post the specification producing the strongest regime ordering.

The robustness analysis considers five alternative measures: the composite ECB shock, the externally identified monetary-policy shock[4], changes in the shadow rate (Wu and Xia, 2016 and Wu and Xia, 2020), changes in the deposit-facility rate (DFR), and changes in three-month Euribor. Each shock is introduced separately into the same CMAM architecture and estimated under both the constant-loading M0 and time-varying-loading M1 specifications. This design separates two sources of specification uncertainty. Variation between M0 and M1 for a given shock reflects sensitivity to the measurement structure, whereas variation across shock measures reflects sensitivity to the representation or identification of the ECB monetary-policy impulse. Table 7 reports mean absolute ECB-attributable CMAM by country for the benchmark MRO specification and each alternative shock, with the M0 and M1 estimates reported alongside one another.

The first result from Table 7 is that ECB-attributable adjustment is not specific to the benchmark MRO shock. Every alternative specification produces a quantitatively non-zero ECB-attributable component in all six economies. The magnitude of that component varies across shock measures, sometimes substantially, but the basic result that ECB monetary conditions are reflected in effective domestic monetary adjustment is preserved throughout the exercise. This is particularly important because the alternative measures capture different dimensions of euro-area monetary conditions and differ in their behavior across conventional and unconventional policy periods. The existence of ECB-related monetary adjustment is therefore considerably more robust than the precise magnitude assigned to it by any individual shock specification.

[4] The externally identified ECB monetary-policy shock follows Jarociński and Karadi (2020), who use high-frequency financial-market responses around ECB announcements to distinguish monetary-policy shocks from central-bank information shocks based on the joint response of interest rates and stock prices. The resulting shock series is transformed to monthly frequency and standardized consistently with the other ECB shock measures used in the CMAM specifications.

The comparison also confirms the relative stability of the measurement architecture conditional on a given ECB shock. For most country–shock combinations, moving from M0 to M1 changes the magnitude of ECB-attributable adjustment considerably less than replacing the ECB shock itself. The corresponding M0–M1 path correlations, reported in Appendix Table A10, are generally very high. Under the benchmark MRO specification they range from approximately 0.97 to virtually unity across the six countries. Similarly high correlations characterize most of the alternative specifications, although larger differences emerge for Croatia under the composite, shadow-rate and Euribor specifications and for a small number of other country–shock combinations. These results reinforce the conclusion of Section 9.1: allowing channel loadings to vary over time can affect the estimated magnitude and temporal profile of adjustment, but the underlying ECB-related signal is generally recognizable under the more restrictive constant-loading model as well.

Table 7: ECB-Attributable Monetary Adjustment across Alternative ECB Shock Measures and Model Specifications

	MRO		Composite		Identified		Shadow		DFR		Euribor 3M	
Country	**M0**	**M1**	M0	M1	M0	M1	M0	M1	M0	M1	M0	M1
Albania	**0.00717**	**0.00607**	0.00811	0.00846	0.00901	0.00864	0.00711	0.00858	0.00900	0.01300	0.01294	0.01377
Bosnia and Herzegovina	**0.00897**	**0.00944**	0.00472	0.00510	0.00662	0.00798	0.01037	0.01066	0.01057	0.00970	0.00513	0.00475
Croatia	**0.01116**	**0.00908**	0.01005	0.01086	0.01216	0.01524	0.01536	0.01117	0.01118	0.00922	0.01102	0.00691
Montenegro	**0.00825**	**0.00758**	0.00902	0.00862	0.00498	0.00538	0.01311	0.01312	0.00726	0.00647	0.00734	0.00637
North Macedonia	**0.00669**	**0.00667**	0.00883	0.00897	0.01022	0.01012	0.00662	0.00854	0.00629	0.00655	0.00905	0.00954
Serbia	**0.00545**	**0.00612**	0.00586	0.00660	0.00635	0.00661	0.00384	0.00462	0.00520	0.00639	0.00791	0.00962

Notes: Entries report mean absolute ECB-attributable CMAM. M0 denotes the constant-loading specification and M1 the time-varying-loading specification. The MRO-rate shock is the benchmark specification and it is shown first in bold. The remaining columns report results obtained using the composite ECB shock, the identified monetary-policy shock, changes in the shadow rate, changes in the ECB deposit-facility rate (DFR) and changes in three-month Euribor. Each shock is estimated separately under the same CMAM architecture. The table is intended to assess the sensitivity of the magnitude of ECB-attributable monetary adjustment to both the loading specification and to the measure of the ECB monetary-policy impulse.

The alternative shocks nevertheless reveal greater sensitivity in the *relative* magnitude of ECB-attributable adjustment across countries. Croatia displays the strongest average ranking stability, occupying the highest country position in seven of the twelve shock–model combinations and one of the top two positions in ten. Serbia is most frequently located toward the lower end of the distribution, with a median rank of five and a top-three position in only one of the twelve specifications. The positions of Albania, Bosnia and Herzegovina, Montenegro and North Macedonia vary more substantially across alternative shock definitions. Table A11 reports the corresponding rank-stability diagnostics. This variation reinforces rather than contradicts the Bayesian evidence in Section 9.2: exact six-country rankings contain considerably more uncertainty than the existence of ECB-attributable adjustment itself and should not be interpreted as immutable structural positions.

The regime-level comparison makes the consequences of shock choice particularly transparent. Table 8 reports mean absolute ECB-attributable CMAM for hard-anchor, managed

exchange-rate and inflation-targeting economies under each shock and both loading specifications. Under the preferred M1/MRO benchmark, the estimated ordering is the one emphasized in the main results: hard anchors exhibit the strongest ECB-attributable adjustment, managed regimes occupy an intermediate position, and inflation-targeting economies exhibit the lowest average adjustment. The corresponding mean absolute values are approximately 0.0085, 0.0079 and 0.0061, respectively. Under M0/MRO, the distinction between hard anchors and managed regimes becomes very small and their order reverses, while both continue to exceed the inflation-targeting group.

Table 8: ECB-Attributable Monetary Adjustment and Regime Ordering across Alternative ECB Shock Measures

ECB shock	Model	Hard anchors	Managed	Inflation targeting	Regime ordering
MRO	**M0**	**0.00861**	**0.00892**	**0.00631**	**Managed > Hard > IT**
MRO	**M1**	**0.00851**	**0.00787**	**0.00610**	**Hard > Managed > IT**
Composite	M0	0.00687	0.00944	0.00699	Managed > IT > Hard
Composite	M1	0.00686	0.00991	0.00753	Managed > IT > Hard
Identified	M0	0.00580	0.01119	0.00768	Managed > IT > Hard
Identified	M1	0.00668	0.01268	0.00763	Managed > IT > Hard
Shadow	M0	0.01174	0.01099	0.00547	Hard > Managed > IT
Shadow	M1	0.01189	0.00986	0.00660	Hard > Managed > IT
DFR	M0	0.00891	0.00873	0.00710	Hard > Managed > IT
DFR	M1	0.00809	0.00788	0.00970	IT > Hard > Managed
Euribor 3M	M0	0.00623	0.01004	0.01043	IT > Managed > Hard
Euribor 3M	M1	0.00556	0.00823	0.01170	IT > Managed > Hard

Notes: Entries report mean absolute ECB-attributable CMAM aggregated by monetary regime. Hard anchors comprise Bosnia and Herzegovina and Montenegro; managed regimes comprise pre-euro Croatia and North Macedonia; and inflation-targeting (IT) regimes comprise Albania and Serbia. M0 denotes the constant-loading specification and M1 the time-varying-loading specification. The MRO-rate shock is the benchmark and is shown first in bold. The remaining rows report robustness results using the composite ECB shock, the externally identified monetary-policy shock, changes in the shadow rate, changes in the ECB deposit facility rate (DFR), and changes in three-month Euribor. Regime classifications are used only for ex-post comparison and do not enter model estimation. The final column orders regimes from the highest to the lowest mean absolute ECB-attributable adjustment within each shock-model specification.

The complete benchmark ordering is reproduced under both M0 and M1 when the shadow-rate shock is used and under M0 with the DFR shock. Other measures alter the relative regime positions, although the country-level results indicate that some of these changes are disproportionately associated with particular economies rather than representing uniform shifts among all countries belonging to a regime. The composite and identified shocks assign the largest ECB-attributable adjustment to the managed regimes under both M0 and M1, while the DFR results reveal greater cross-country heterogeneity within the regime groups. These results therefore

suggest greater uncertainty about the exact relative magnitude of adjustment across regimes than about the pervasive presence of ECB-attributable adjustment itself.

The Euribor results warrant a somewhat different interpretation. Unlike the administered MRO and DFR rates, Euribor is a market rate and therefore reflects not only current ECB policy but also expectations of future policy, money-market conditions, liquidity and risk premia, and other market developments. Its reversal of the benchmark regime ordering, with inflation-targeting economies exhibiting the largest ECB-attributable adjustment under both M0 and M1, should consequently not be interpreted simply as a failure of the benchmark regime result. Rather, it suggests that countries with active interest-rate-based monetary frameworks may display particularly strong adjustment to euro-area market-rate conditions, whereas the transmission of administered ECB policy to hard-anchor economies operates more strongly through the external and balance-sheet mechanisms documented in Section 7.

More generally, the alternative indicators are not interchangeable observations of an identical monetary-policy impulse. The MRO and DFR measures capture changes in administered ECB policy rates; the Wu--Xia shadow rate extends the measurement of the monetary stance into periods in which conventional policy rates are constrained; the composite measure links policy information across different monetary-policy environments; the identified shock seeks to isolate exogenous monetary-policy innovations; and Euribor captures the market transmission of ECB policy together with other determinants of short-term euro-area interest rates. Differences in estimated CMAM magnitudes across these specifications are therefore economically informative: they show that the measured intensity and cross-regime distribution of adjustment depend partly on the dimension of ECB policy or euro-area monetary conditions through which the external impulse is measured.

The robustness exercises in this section sharpen the central empirical conclusion of the paper. Effective monetary adjustment to ECB policy is not an artifact of allowing channel loadings to vary over time, nor does it disappear when the MRO-rate shock is replaced by alternative measures of euro-area monetary conditions. What is less robust—and should accordingly receive less structural interpretation—is the precise ranking of individual economies and the exact regime ordering under every alternative shock definition. The evidence therefore supports a broader conclusion than a fixed league table: *all six monetary systems adjust to ECB monetary conditions, but the measured intensity of that adjustment and its distribution across monetary regimes depend on both domestic monetary architecture and the dimension of ECB policy through which the external impulse is identified***.**

9.4 Channel-Exclusion Robustness and the Role of Liquidity Operations

The benchmark specification combines monetary-policy instruments and adjustment mechanisms that can be institutionally related. This is particularly relevant for liquidity operations. Where an independently determined policy rate is available, liquidity operations can implement the chosen stance by adjusting reserve supply and supporting the transmission of the policy signal to short-term monetary conditions. At the same time, they can absorb or supply liquidity associated

with foreign-exchange intervention, external monetary flows, and other autonomous liquidity factors. Their inclusion in CMAM therefore raises an important measurement question: do liquidity operations provide distinct information about effective monetary adjustment, or do they merely duplicate information already contained in the policy-rate or external-adjustment channels?

We examine this issue within a broader genuine leave-one-channel-out (LOCO) robustness exercise based on the *benchmark M1 specification estimated by MAP using the ECB MRO-rate shock*. For each channel, the model is re-estimated after that channel is excluded, allowing the remaining measurement relationships and the latent adjustment process to adapt to the reduced information set. This differs importantly from mechanically removing an estimated channel contribution from the benchmark decomposition. Genuine LOCO re-estimation instead asks whether the ECB-attributable adjustment process recovered by the model remains similar when the information supplied by a particular monetary-adjustment mechanism is no longer available.

Figure 18: Stability of ECB-Attributable CMAM under Genuine Leave-One-Channel-Out Re-Estimation, Benchmark M1/MRO MAP Specification

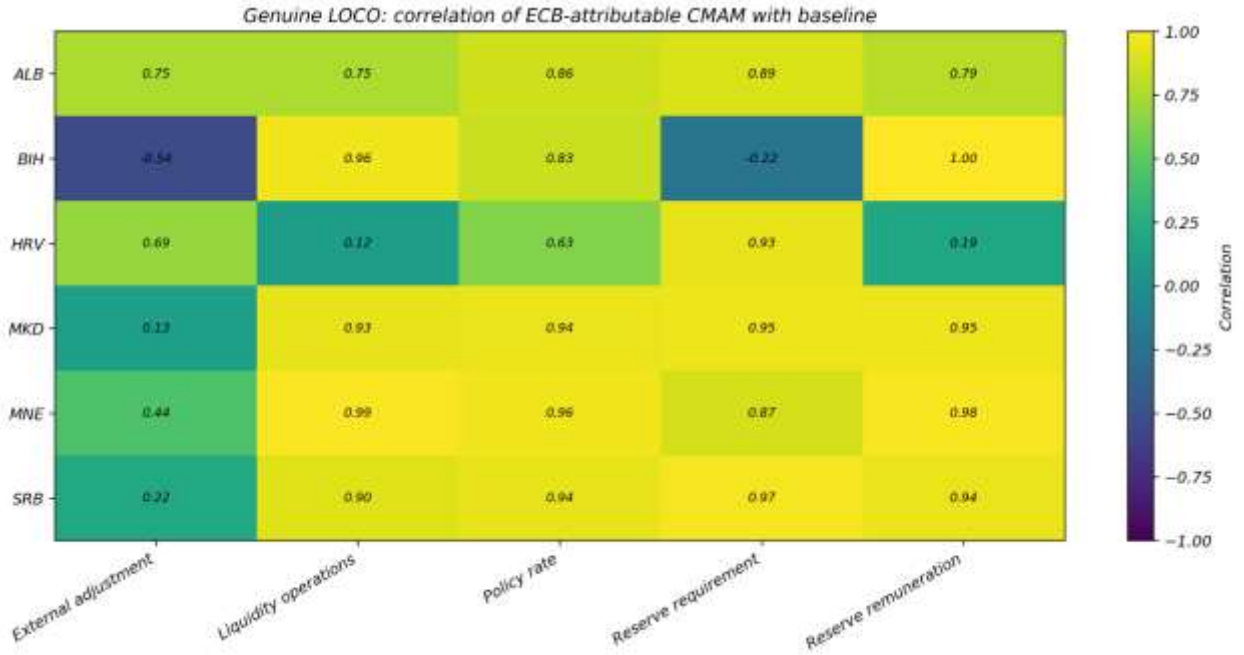


Figure 18 summarizes the exercise by reporting, for each country and omitted channel, the correlation between ECB-attributable CMAM obtained from the reduced model and its benchmark counterpart. The results show that the importance of individual channels is strongly country dependent. In several cases, omission of a channel leaves the ECB-attributable path highly correlated with the benchmark, indicating that the principal adjustment signal can be recovered from the remaining information. Other exclusions produce substantially larger changes. Most notably, removing the external-adjustment channel strongly alters the recovered ECB component in several economies, whereas omission of the policy-rate channel generally has a more limited effect. The latter result is particularly informative in light of the channel decomposition in Section

7: ECB-related monetary adjustment is not reducible to domestic policy-rate pass-through, and other adjustment mechanisms contain substantial information about the transmission of ECB policy into domestic monetary conditions.

The heterogeneous pattern in Figure 18 is also consistent with the central measurement premise of CMAM. If the different channels were merely interchangeable indicators of a common observable policy signal, removing individual channels should have relatively similar consequences across countries. Instead, the effect of channel exclusion depends substantially on the monetary architecture of the economy and on the role played by the omitted mechanism within that architecture. The LOCO results therefore provide additional evidence that effective monetary adjustment cannot be represented by imposing a single observable instrument on institutionally different monetary systems.

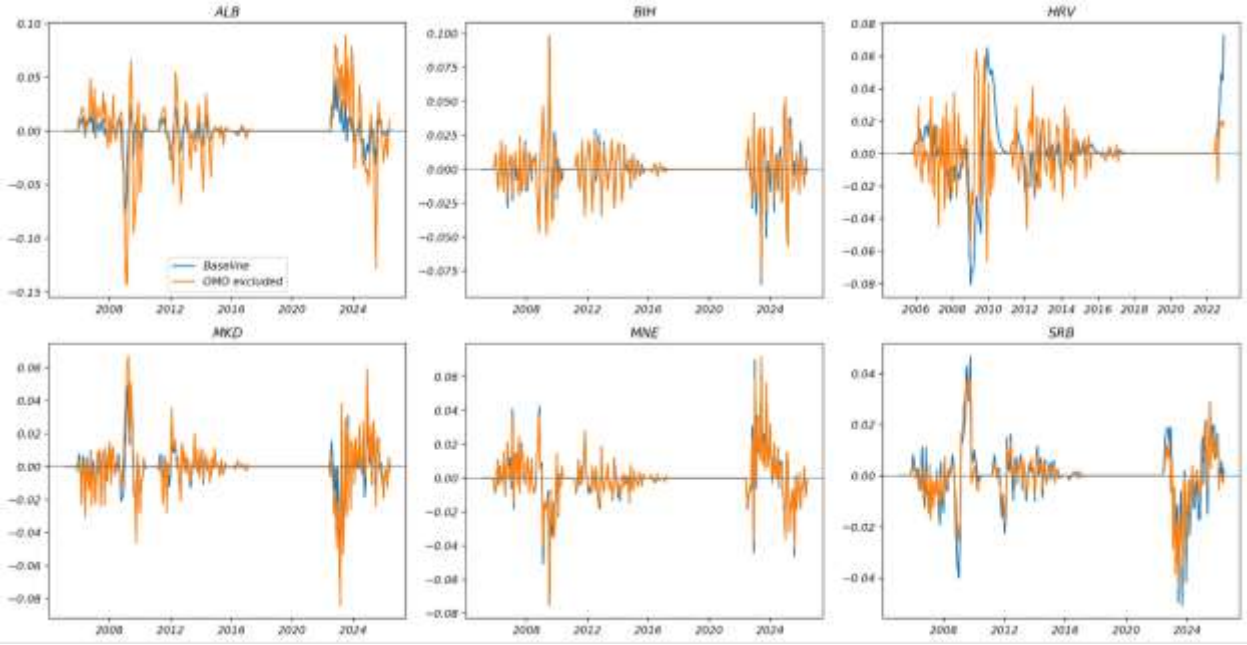
Within this general exercise, the liquidity-operations channel deserves particular attention because its inclusion alongside both the policy-rate and external-adjustment channels could raise a question of conceptual overlap. Figure 18 shows that omitting liquidity operations has very different consequences across countries. The effect is especially pronounced in Croatia, where the correlation between the benchmark and liquidity-operations-excluded ECB-attributable CMAM falls to approximately 0.12, and is also economically meaningful in Albania. In other economies the benchmark ECB component is considerably more stable. The evidence therefore does not suggest that liquidity operations provide an identical amount of independent information everywhere; rather, their importance depends on the role that liquidity management plays within the country's monetary framework.

Figure 19 examines this issue more directly by comparing the complete ECB-attributable CMAM paths from the benchmark M1/MRO MAP specification with those obtained after liquidity operations are excluded and the model is re-estimated. The comparison confirms that removing the channel does not simply subtract a liquidity-operations contribution from an otherwise unchanged CMAM series. In Croatia, the timing and dynamics of ECB-attributable adjustment change substantially, while Albania also exhibits pronounced differences between the two specifications. Differences are more moderate in the other economies. Moreover, omission does not systematically reduce the magnitude of ECB-attributable adjustment: the remaining measurement system can generate either larger or smaller movements as the latent state and the contributions of the remaining channels adjust to the reduced information set.

This result helps clarify why liquidity operations are retained as a separate CMAM channel. Their empirical contribution cannot be characterized simply as duplication of the policy-rate stance. At the same time, the re-estimation indicates an important connection with the external-adjustment mechanism: when liquidity operations are omitted, part of the adjustment is substantially reallocated toward the external channel in the countries most affected by the exclusion. This is consistent with their institutional role. Liquidity operations can operationalize a policy-rate decision, but they can also absorb or supply banking-system liquidity generated by foreign-exchange intervention, external flows, and other balance-sheet developments. In this latter

capacity, they can constitute a liquidity-management counterpart of external adjustment without being observationally equivalent to it.

Figure 19: ECB-Attributable CMAM under the Benchmark and Liquidity-Operations-Excluded M1/MRO MAP Specifications



The LOCO evidence therefore rejects two overly restrictive interpretations of the liquidity-operations channel. Treating liquidity operations as a second independent stance decision would overstate their separation from the policy-rate and external mechanisms, but excluding them because they are presumed to be redundant would remove information that is empirically consequential for the recovered adjustment process in several economies. More broadly, the channel-exclusion results reinforce the paper's central argument that the mechanisms through which monetary adjustment becomes observable differ across monetary architectures. *The relevant question is therefore not whether every channel is equally important in every country, but whether the measurement system captures the mechanisms through which effective adjustment actually occurs under each monetary framework.*

10. Discussion

The results of this paper provide a consistent answer to the question posed at the outset. Monetary systems operating under very different institutional arrangements all adjust to ECB monetary-policy conditions, but they do not adjust to the same extent and, just as importantly, they do not adjust through the same mechanisms. Once monetary adjustment is measured across the full set of channels available within each monetary framework rather than inferred from movements in a single policy instrument, a common external monetary impulse becomes visible

across inflation targeting, managed exchange-rate regimes, a currency board, and unilateral euroization. The central empirical regularity is therefore broader than conventional policy-rate pass-through: proximity to a dominant monetary area is reflected in the effective adjustment of domestic monetary conditions even when the institutional mechanism carrying that adjustment differs fundamentally across countries.

Under the preferred M1 specification with the ECB MRO-rate shock, the benchmark estimates reveal a clear regime gradient. ECB-attributable adjustment is strongest among the hard-anchor economies, intermediate under managed exchange-rate regimes, and lower on average among inflation-targeting economies. The Bayesian posterior evidence reinforces this result: conditional on the empirically preferred benchmark-associated posterior mode, the probability of the complete hard-anchor > managed > inflation-targeting ordering is approximately 94.5 percent. The regime result is considerably sharper than the exact ordering of individual economies. Posterior uncertainty overlaps substantially for several countries, and the alternative-shock exercises show that country positions and, in some cases, the exact regime ordering can change when the external monetary impulse is measured differently. The evidence therefore supports a systematic relationship between monetary architecture and adjustment intensity, but not an immutable six-country league table.

This distinction is important for interpreting what monetary regimes do. A monetary regime does not mechanically determine a country's response to ECB policy. Rather, it defines the set of adjustment margins available to the economy and changes the relative cost and feasibility of using them. Hard anchors provide little scope for persistent divergence from monetary conditions in the anchor currency area, but that constraint need not appear in a domestic policy rate. Managed regimes retain more instruments while simultaneously devoting substantial attention to exchange-rate and liquidity conditions. Inflation-targeting central banks possess greater discretion over domestic interest rates, but this does not insulate their monetary systems from ECB-related adjustment. Country-specific financial structures, euroization, intervention practices, liquidity-management arrangements, bank behavior, and the intensity with which available instruments are actually used all operate within these broader regime constraints. Monetary regimes consequently organize adjustment without completely determining it.

The channel decomposition makes this point especially clear. In the hard-anchor economies, ECB-attributable adjustment is overwhelmingly manifested through the external-adjustment channel. Under managed exchange-rate regimes, external adjustment and liquidity operations jointly dominate, with liquidity management especially important in pre-euro Croatia. Inflation-targeting economies exhibit the most diversified adjustment architecture: the policy rate plays a larger role than under the other regimes, but external adjustment and liquidity operations remain quantitatively more important. The implication is not that policy rates are unimportant for monetary policy. It is that *international monetary adjustment should not be equated with domestic policy-rate synchronization*. A central bank can retain an independent policy-rate decision while a substantial part of the effective response to external monetary conditions is absorbed elsewhere in its monetary and financial system.

This finding also clarifies the interpretation of liquidity operations. Where an independently chosen policy rate is present, open-market and liquidity operations frequently operationalize that stance by supplying or absorbing reserves so that short-term monetary conditions remain consistent with the policy decision. But they can simultaneously perform a broader balance-sheet role, including absorbing or supplying liquidity generated by foreign-exchange intervention and other external flows. In exchange-rate-oriented frameworks, liquidity operations may therefore act partly as an operational extension of external adjustment. Treating policy rates and liquidity operations as two independent stance decisions would be misleading; excluding liquidity operations altogether would be equally problematic because an important observable manifestation of effective adjustment would disappear from the measurement system.

A broader conceptual implication follows. *Effective monetary adjustment is not synonymous with discretionary monetary-policy action***.** Some CMAM channels represent deliberate decisions by the monetary authority, including changes in policy rates, reserve requirements, remuneration policies, or discretionary liquidity operations. Others reflect endogenous or partly automatic responses embedded in the monetary regime, particularly external monetary flows and their balance-sheet and liquidity consequences under hard anchors. This distinction is indispensable for meaningful cross-regime comparison. Restricting monetary adjustment to discretionary policy actions would mechanically make a currency board or a unilaterally euroized economy appear inactive precisely because the institutional arrangement transfers much of the adjustment away from independently chosen conventional instruments. CMAM instead measures the effective adjustment of monetary conditions through the mechanisms available under the prevailing framework, irrespective of whether a particular movement originates in an explicit policy decision or in an endogenous institutional adjustment mechanism.

Seen from this perspective, *monetary autonomy and monetary adjustment are not opposites*. Formal autonomy concerns the discretion an authority retains over its own monetary-policy decisions. Effective adjustment concerns how much domestic monetary conditions move through the available monetary mechanisms. An inflation-targeting central bank may retain substantial discretion while nevertheless adjusting strongly to euro-area financial conditions. Conversely, a hard-anchor economy may possess very little conventional monetary-policy autonomy while adjustment takes place automatically through external flows and liquidity conditions. The benchmark results therefore caution against using either policy-rate synchronization or the absence of an independent policy rate as a sufficient statistic for effective monetary dependence. What matters empirically is both the magnitude of the adjustment and where within the monetary system that adjustment occurs.

The distinction between absolute ECB-attributable adjustment and its importance relative to overall CMAM reinforces the same point. The benchmark hard-anchor economies exhibit comparatively strong absolute adjustment to ECB policy, yet the ECB-attributable component represents a larger proportion of overall CMAM in the inflation-targeting group. These are not contradictory results. The former asks how much effective adjustment is associated with ECB policy; the latter asks how large that component is relative to all other forces generating domestic

monetary adjustment. Neither statistic, by itself, is a measure of monetary autonomy. In particular, the ECB-to-overall ratio should not be interpreted as a welfare measure, a causal variance decomposition, or a direct index of dependence on Frankfurt. Its value lies in distinguishing the absolute intensity of externally associated adjustment from its relative importance within the country's broader monetary-adjustment process.

The validation and robustness evidence supports this interpretation while also defining its limits. CMAM constructed without the ECB shock in its state equation subsequently responds to ECB innovations in the local-projection exercise, which reduces the concern that the benchmark ECB component is merely a mechanical consequence of conditioning the latent state on the same shock. The M0-M1 comparison shows that the main ECB-related signal does not depend on allowing channel loadings to vary over time, even though time variation refines its magnitude and implementation. Bayesian inference shows strong posterior support for the benchmark regime pattern but more uncertainty surrounding exact country ranks. Finally, replacing the MRO shock with alternative measures of the ECB monetary impulse preserves ECB-attributable adjustment throughout the sample but changes some relative country and regime positions. The strongest inference is therefore the existence and heterogeneous implementation of adjustment; exact ranks are a more specification-dependent object and warrant correspondingly less structural interpretation.

The alternative-shock evidence also suggests that this sensitivity is not merely statistical noise. Administered ECB rates, shadow rates, identified policy innovations, composite measures, and market rates such as Euribor do not represent identical dimensions of euro-area monetary conditions. Their differing results indicate that domestic monetary systems can be exposed differently to changes in official policy settings, unconventional monetary conditions, exogenous policy innovations, and euro-area money-market conditions. In this sense, robustness does not require every indicator to reproduce an identical ordering. What matters is whether the principal economic phenomenon survives and whether differences across specifications can be reconciled with the mechanisms through which the external impulse is transmitted. The evidence in this paper supports the former while cautioning against treating the benchmark regime hierarchy as identification invariant.

The measurement perspective introduced here may also have uses beyond the particular country ranking studied in this paper. A measure of effective monetary adjustment can provide a common empirical language for comparing economies in which conventional policy indicators are institutionally non-comparable. In applied surveillance, it could help distinguish periods in which domestic monetary systems are adjusting strongly from periods of relative inertia, identify whether that adjustment is concentrated in interest rates, liquidity management, reserve policies, or external mechanisms, and compare the relative importance of domestic and external drivers over time. It may also be useful for studying regime transitions or changes in monetary implementation, where the disappearance or emergence of particular instruments makes comparisons based on a fixed policy-rate indicator especially problematic. More generally, the framework could be adapted to

other groups of small open economies exposed to a dominant foreign monetary center, provided that the relevant adjustment channels can be measured in an institutionally coherent way.

These potential applications should not be taken to imply that CMAM is a sufficient statistic for monetary policy. It does not measure the welfare consequences of adjustment, the optimality of policy, or the level of monetary tightness or accommodation at a particular date. Nor should the estimated channel contributions be interpreted as mutually orthogonal structural policy shocks. They are manifestations of a common adjustment process and can interact institutionally. The resulting index also necessarily depends on the quality of the observables used to represent channels that are not directly observed, with the external adjustment mechanism under highly constrained monetary arrangements presenting a particularly demanding measurement problem. The small number of economies within each regime group and the sensitivity of some rankings to the measure of the ECB impulse provide additional reasons for restraint. The Bayesian analysis, moreover, characterizes uncertainty around the empirically validated benchmark-associated mode rather than establishing unique global posterior identification.

These limitations define the appropriate contribution of CMAM rather than negate it. The metric is most useful when treated as *a measurement framework for an otherwise difficult-to-compare economic object*: the effective adjustment of monetary conditions across institutional environments in which the same adjustment cannot be observed through the same instrument. Its contribution is therefore not to replace conventional monetary-policy indicators, structural spillover models, or institutional analysis, but to connect them. Policy rates, reserve policies, liquidity operations, exchange-rate adjustment, and external monetary flows remain economically distinct. CMAM asks what they reveal jointly about the intensity of the underlying adjustment process and how that process changes when the feasible monetary architecture changes.

The broader lesson from the six economies studied here is consequently more nuanced than either complete monetary dependence or complete monetary autonomy. All six monetary systems adjust to the policy of the dominant neighboring monetary area. Harder monetary constraints are associated, in the benchmark and posterior evidence, with stronger effective adjustment, but greater formal autonomy does not eliminate that adjustment. Instead, institutional arrangements redistribute it across mechanisms. The relevant distinction across monetary regimes is therefore not between countries that adjust and countries that do not. It is between *how much they adjust, through which mechanisms they adjust, and how much discretion they retain over the composition and timing of that adjustment.*

11. Conclusion

How much do domestic monetary systems adjust when the dominant neighboring central bank changes policy? Answering this question is difficult when the economies being compared conduct monetary policy through fundamentally different institutional arrangements. A policy rate provides a natural observable measure in some countries but is unavailable or economically secondary in others; exchange-rate movements are informative under greater flexibility but

deliberately suppressed under hard pegs; and liquidity operations, reserve policies, intervention, and external monetary flows can perform roles that conventional interest-rate comparisons do not capture. This paper addresses that measurement problem by developing the Central Bank Monetary Adjustment Metric, a hierarchical latent-factor measure of *effective monetary adjustment* constructed from the policy instruments and adjustment mechanisms actually available within each monetary framework.

Applying CMAM to Albania, Bosnia and Herzegovina, pre-euro Croatia, Montenegro, North Macedonia, and Serbia yields a simple headline result: *everybody adjusts to the big neighbor's monetary policy, but not by the same amount and not in the same way*. Under the preferred MRO/M1 benchmark, ECB-attributable adjustment is strongest among the hard-anchor economies, intermediate in the managed exchange-rate regimes, and lower on average among the inflation-targeting economies. Bayesian inference assigns a 94.5 percent posterior probability to this complete regime ordering conditional on the preferred benchmark specification. The evidence is less supportive of a rigid ranking of individual countries, however. Posterior uncertainty and alternative ECB shock measures show that exact country positions are more fragile than the broader presence of ECB-related adjustment and its systematic association with monetary architecture.

The channel results are at least as important as the differences in adjustment intensity. Hard-anchor economies adjust overwhelmingly through external monetary and balance-sheet mechanisms. Managed regimes combine external adjustment with intensive liquidity management. Inflation-targeting economies employ a broader mix in which the policy rate has a larger role, but external and liquidity channels still account for most measured ECB-attributable adjustment. The international transmission of monetary policy therefore cannot be adequately characterized by asking whether domestic policy rates follow the ECB. The same external monetary impulse can be absorbed through very different parts of the monetary system depending on the institutional framework.

This leads to the paper's broader conceptual conclusion. *Monetary autonomy and monetary adjustment are distinct dimensions.* Greater discretion over domestic monetary-policy decisions does not imply insulation from external monetary conditions, while the absence of an independent policy rate does not mechanically translate into the strongest monetary adjustment. Moreover, effective adjustment is broader than discretionary policy action: under constrained monetary systems, part of the adjustment occurs through endogenous external, balance-sheet, and liquidity mechanisms embedded in the regime itself. Cross-regime comparison therefore requires measuring the effective movement of monetary conditions rather than counting discretionary policy decisions or imposing the same observable instrument on every economy.

The empirical exercises also indicate where the conclusions should be drawn more cautiously. The shock-free local projections provide independent evidence that CMAM responds dynamically to subsequent ECB shocks, and the constant-loading model reproduces the broad signal contained in the preferred time-varying specification. Alternative measures of the ECB impulse preserve ECB-attributable adjustment across all six economies, but some alter exact

country and regime rankings. The strongest finding is consequently not a fixed ordering valid under every conceivable monetary-policy indicator. It is that ECB-related effective monetary adjustment is pervasive, quantitatively heterogeneous, and implemented through systematically different monetary architectures.

CMAM is intended as a contribution to measurement rather than as a universal index of monetary-policy quality, dependence, or optimality. Its potential value lies in making an otherwise difficult comparison possible: tracing the intensity and composition of monetary adjustment across economies whose institutional frameworks make conventional single-instrument comparisons misleading. With appropriate adaptation of the observable channels, the same logic could be applied to other small open economies exposed to a dominant regional or global monetary center, to changes in monetary regimes, or to surveillance of how the composition of adjustment evolves through major policy episodes. Such applications would need to preserve the central principle of the approach—that comparable economic adjustment need not have identical observable manifestations across monetary systems.

The results ultimately suggest a different way of thinking about monetary spillovers in small open economies. External monetary influence does not simply cross borders and appear in domestic output, inflation, or interest rates. It is absorbed through a domestic monetary architecture that determines where the adjustment can occur and how it is distributed across instruments and balance-sheet mechanisms. Formal regimes matter because they structure that architecture, but country-specific institutions and implementation practices continue to matter within regimes. *Everybody adjusts; the economically consequential questions are how much, through which mechanisms, and with how much discretion over the adjustment process.*

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Appendix

Table A1: Variables, Transformations and Data Sources

Variable / channel	Country	Underlying variable(s)	Transformation and construction	Source
Panel A. ECB monetary-policy shock specifications				
ECB MRO shock (`ecb_mro_change_z`)	All	ECB main refinancing operations (MRO) rate	Monthly first difference of the MRO rate. Because policy-rate changes contain a large mass of genuine zeros, the final specification applies zero-preserving scale normalization rather than location-centering when sparsity requires it. Positive values denote ECB tightening. This is the benchmark shock specification.	European Central Bank
ECB deposit-facility shock (`ecb_dfr_change_z`)	All	ECB deposit facility rate (DFR)	Monthly first difference of the DFR followed by the same zero-preserving normalization used for sparse policy-change shocks. Positive values denote ECB tightening.	European Central Bank
ECB shadow-rate shock (`ecb_shadow_change_z`)	All	Euro-area monetary-policy shadow rate	Monthly first difference of the shadow rate, followed by robust standardization. Positive values denote tighter euro-area monetary conditions. The measure is used to capture monetary-policy variation when conventional policy rates are constrained by the effective lower bound.	External shadow-rate database; original source to verify
Composite ECB shock (`ecb_composite_z`)	All	Shadow rate and ECB deposit facility rate	Monthly shadow-rate change through June 2021 and monthly DFR change thereafter. The resulting series is subjected to the same zero-preserving robust normalization and oriented so that positive values denote tightening.	Shadow-rate database and European Central Bank
Identified ECB shock (`ecb_identified_z`)	All	Externally identified ECB monetary-policy shock (`Ident_shocks`)	Externally identified monetary-policy shock used directly rather than first-differenced. Robustly standardized and oriented so that positive values denote ECB tightening.	External high-frequency identification series; original source to verify
Euribor shock (`ecb_euribor_change_z`)	All	Three-month Euribor	Monthly first difference of three-month Euribor followed by zero-preserving robust normalization where required. Positive values denote tighter euro-area monetary conditions.	European Money Markets Institute / ECB data
Panel B. Monetary-adjustment measurement variables				

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Variable / channel	Country	Underlying variable(s)	Transformation and construction	Source
Policy rate (`policy_rate_adjustment_z`)	Albania	Bank of Albania policy rate	Monthly first difference of the policy rate followed by within-country normalization. Policy-rate increases are positive and therefore represent tightening.	Bank of Albania
Policy rate	Bosnia and Herzegovina	No independent domestic policy rate	Structurally unavailable under the currency-board arrangement. The channel is excluded from the measurement equation rather than coded as a sequence of zeros.	N/A
Policy rate	Croatia	Croatian National Bank policy rate	Monthly first difference followed by within-country normalization. Policy-rate increases are positive. The Croatian estimation sample ends in December 2022, before euro adoption.	Croatian National Bank
Policy rate	Montenegro	No independent domestic policy rate under unilateral euroization	Structurally unavailable. The channel is excluded rather than coded as zero.	N/A
Policy rate	North Macedonia	National Bank policy rate	Monthly first difference followed by within-country normalization. Policy-rate increases are positive.	National Bank of the Republic of North Macedonia
Policy rate	Serbia	National Bank of Serbia policy rate	Monthly first difference followed by within-country normalization. Policy-rate increases are positive.	National Bank of Serbia
Reserve requirement (`rr_policy_adjustment_z`)	Albania	Statutory reserve-requirement rates differentiated by relevant liability, maturity and currency categories	Effective reserve-requirement policy change constructed as the weighted sum of changes in applicable statutory RR rates, using predetermined lagged liability shares. The construction isolates the policy-rate change from contemporaneous changes in the composition of the reserve base. Positive effective RR changes denote tightening. Sparse zero-action months remain exactly zero after normalization.	Bank of Albania
Reserve requirement	Bosnia and Herzegovina	Statutory RR rates applied to relevant reserve-base categories	Effective RR change constructed from changes in statutory rates using lagged reserve-base or liability-category weights. Positive changes denote tightening. Genuine zero-policy months are preserved under sparse-event normalization.	Central Bank of Bosnia and Herzegovina

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Variable / channel	Country	Underlying variable(s)	Transformation and construction	Source
Reserve requirement	Croatia	General and differentiated pre-euro reserve-requirement arrangements, including relevant FX-related reserve requirements	Changes in applicable statutory reserve-requirement rates are aggregated using corresponding predetermined reserve-base or exposure weights. Positive effective changes denote tightening. Sparse-event normalization preserves exact zero-policy months.	Croatian National Bank
Reserve requirement	Montenegro	Statutory reserve-requirement rates	Effective policy change based on changes in the applicable RR structure combined using predetermined liability weights. Positive changes denote tightening; genuine zero-policy months remain zero after normalization.	Central Bank of Montenegro
Reserve requirement	North Macedonia	RR rates on denar, FX-clause and foreign-currency liabilities	Changes in relevant statutory RR rates are combined using lagged liability or reserve-composition weights. Positive effective changes denote tightening. Sparse-event scaling is applied to retain exact policy zeros.	National Bank of the Republic of North Macedonia
Reserve requirement	Serbia	RR rates on dinar and foreign-currency liabilities differentiated by maturity and relevant liability category	Effective RR change constructed from changes in statutory rates weighted by lagged liability-category shares. Positive changes denote tightening. Sparse zero-action months remain exactly zero after normalization.	National Bank of Serbia
Reserve remuneration (`rr_renuneration_adjustment_m`)	Albania	Remuneration rate(s) applicable to reserve balances	Effective remuneration-policy change based on the applicable remuneration arrangements. The benchmark retains the full observed effective remuneration change, including mechanically policy-rate-linked remuneration changes where applicable. Higher effective remuneration is oriented as tightening. Sparse-event normalization preserves exact zeros.	Bank of Albania
Reserve remuneration	Bosnia and Herzegovina	Remuneration rates applicable to required and relevant excess reserve balances	Changes in applicable remuneration rates are aggregated using lagged shares of the reserve categories to which the rates apply. Higher effective remuneration is coded as tightening; genuine zero-change months remain zero.	Central Bank of Bosnia and Herzegovina

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Variable / channel	Country	Underlying variable(s)	Transformation and construction	Source
Reserve remuneration	Croatia	Remuneration rates applicable to relevant reserve components	Effective remuneration change constructed by weighting changes in applicable remuneration rates by the predetermined composition of remunerated reserve balances. Positive values denote tightening.	Croatian National Bank
Reserve remuneration	Montenegro	Reserve-remuneration arrangements	Monthly changes in applicable remuneration rates, combined where necessary using the relevant reserve-composition weights. Higher effective remuneration is oriented as tightening.	Central Bank of Montenegro
Reserve remuneration	North Macedonia	Remuneration rates on relevant denar and foreign-currency reserve components	Effective remuneration change obtained from component remuneration-rate changes and lagged reserve-composition weights. Higher effective remuneration is positive.	National Bank of the Republic of North Macedonia
Reserve remuneration	Serbia	Remuneration rates applicable to relevant reserve and deposit components	Changes in component remuneration rates are combined using lagged reserve-composition weights. Higher effective remuneration is positive; exact zero-policy months are preserved.	National Bank of Serbia
Liquidity operations (`liquidity_adjustment_z`)	Albania	Constructed monthly OMO balance	Monthly first difference of the OMO balance rather than its level. Liquidity provision is oriented as easing and liquidity absorption as tightening; the resulting series is normalized within country. This prevents a persistent stock of outstanding operations from being interpreted as repeated policy adjustment.	Bank of Albania
Liquidity operations	Bosnia and Herzegovina	No separate comparable discretionary liquidity-operations instrument in the benchmark architecture	Structurally unavailable; excluded from the measurement equation rather than coded as zero.	N/A
Liquidity operations	Croatia	Reverse-repo operations, collateralized credit, securities purchases and other relevant pre-euro liquidity operations	Liquidity-providing and liquidity-absorbing operations are sign-aligned so that positive values represent tighter liquidity conditions. Standardized components are combined into a country-level liquidity-adjustment indicator.	Croatian National Bank
Liquidity operations	Montenegro	No separate comparable liquidity-operations channel in the benchmark architecture	Structurally unavailable; excluded from the measurement equation rather than coded as zero.	N/A

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Variable / channel	Country	Underlying variable(s)	Transformation and construction	Source
Liquidity operations	North Macedonia	Central-bank bills, repo operations, six-month bills, seven-day deposits, overnight deposits and overnight credit	Monthly changes in relevant balance-sheet positions. Liquidity-absorbing instruments retain a positive orientation, whereas liquidity-providing instruments are sign-reversed. Sign-aligned standardized components are combined into the liquidity-adjustment channel.	National Bank of the Republic of North Macedonia
Liquidity operations	Serbia	Repo securities sold, repo securities purchased and deposit-facility balances	Monthly changes in the relevant liquidity-operation positions. Liquidity absorption is assigned a positive sign and liquidity provision a negative sign. Standardized components are combined into the liquidity-adjustment measure.	National Bank of Serbia
External adjustment (`external_adjustment_z`)	Albania	Lek/euro exchange rate and foreign-exchange intervention	Exchange-rate component based on the change in the domestic-currency price of the euro and oriented so that appreciation represents tightening. FX operations are sign-oriented according to their domestic-liquidity effect: domestic-liquidity withdrawal is positive and liquidity provision negative. Standardized available components are combined into a single external-adjustment indicator and re-standardized within country.	Bank of Albania
External adjustment	Bosnia and Herzegovina	Convertible-mark liquidity balance associated with currency-board foreign-exchange transactions (`Buy_sell_KM_balance`)	Quantity-based external-adjustment measure. The raw sign is reversed once so that withdrawal of domestic KM liquidity represents tightening. No exchange-rate component is required because the KM/euro exchange rate is institutionally fixed.	Central Bank of Bosnia and Herzegovina
External adjustment	Croatia	Kuna/euro exchange rate and foreign-exchange intervention	Exchange-rate movement and FX-intervention quantity adjustment are sign-aligned so that appreciation and domestic-liquidity withdrawal represent tightening. Standardized components are combined into a single external-adjustment indicator and re-standardized within country.	Croatian National Bank

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Variable / channel	Country	Underlying variable(s)	Transformation and construction	Source
External adjustment	Montenegro	Banking-system excess reserves held with the Central Bank of Montenegro	Monthly change in excess reserves, used as the principal observable balance-sheet manifestation of external euro-liquidity adjustment under unilateral euroization. An increase in excess reserves represents greater immediately available banking-system euro liquidity and is therefore oriented as easing; a decline is tightening. The extended benchmark series begins in 2007.	Central Bank of Montenegro
External adjustment	North Macedonia	Denar/euro exchange rate and foreign-exchange intervention	Exchange-rate and FX-intervention margins are sign-aligned so that appreciation and liquidity withdrawal represent tightening. Standardized components are combined into the external-adjustment measure and re-standardized within country.	National Bank of the Republic of North Macedonia
External adjustment	Serbia	Dinar/euro exchange rate and foreign-exchange intervention	Exchange-rate and intervention margins are sign-aligned so that appreciation and domestic-liquidity withdrawal represent tightening. Standardized components are combined into a single external-adjustment indicator and re-standardized within country.	National Bank of Serbia
Panel C. Domestic and common external controls				
Inflation control (`inflation_control`)	Albania	Forward-looking inflation projection	Country-specific forward-looking inflation indicator. Internal missing observations are interpolated where necessary and the resulting series is standardized within country before entering the state equation.	Bank of Albania
Inflation control	Bosnia and Herzegovina	Consumer-price inflation	Year-on-year CPI inflation used as the domestic inflation control and standardized within country.	Agency for Statistics of Bosnia and Herzegovina / national data source
Inflation control	Croatia	Consumer-price inflation	Year-on-year CPI inflation, standardized within country.	Croatian Bureau of Statistics / national data source
Inflation control	Montenegro	Consumer-price inflation	Available CPI inflation indicator, standardized within country.	MONSTAT / national data source

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Variable / channel	Country	Underlying variable(s)	Transformation and construction	Source
Inflation control	North Macedonia	Consumer-price inflation	CPI inflation indicator, standardized within country.	State Statistical Office of the Republic of North Macedonia / national data source
Inflation control	Serbia	Inflation expectations	Forward-looking inflation-expectations indicator used as the inflation control and standardized within country.	National Bank of Serbia
Activity control (`activity_control`)	Albania	Monthly activity proxy / real GDP-based activity indicator	Country-specific real-activity measure. Internal missing observations are interpolated where necessary and the series is standardized within country.	INSTAT / national data source
Activity control	Bosnia and Herzegovina	Industrial production	Monthly industrial-production indicator used as the real-activity control and standardized within country.	Agency for Statistics of Bosnia and Herzegovina
Activity control	Croatia	Industrial production	Monthly industrial-production indicator, standardized within country.	Croatian Bureau of Statistics
Activity control	Montenegro	Industrial production	Available industrial-production indicator, standardized within country.	MONSTAT
Activity control	North Macedonia	Industrial production	Monthly industrial-production indicator, standardized within country.	State Statistical Office of the Republic of North Macedonia
Activity control	Serbia	Industrial production	Monthly industrial-production indicator, standardized within country.	Statistical Office of the Republic of Serbia
Global financial conditions (`ext_vix`)	All	CBOE Volatility Index (VIX)	Common external financial-control variable aligned to the monthly country panel. The series is standardized within each country sample before entering the state equation.	CBOE / FRED

Notes: All monetary-adjustment variables are oriented so that positive values denote monetary tightening and negative values monetary easing. Δ denotes the monthly first difference and $\Delta\ln(.)$ the monthly log change. RR denotes reserve requirements; OMO denotes open-market operations; FX denotes foreign exchange. For sparse policy-change variables, exact zero denotes no policy action and is preserved under the final normalization. "N/A" denotes a structurally unavailable channel rather than a zero observation. National monetary-policy and central bank balance-sheet series are obtained from the respective national central banks unless otherwise indicated.

Table A2: Channel Composition of ECB-Attributable Monetary Adjustment

Country	External adjustment	Liquidity operations	Policy rate	Reserve requirement	Reserve remuneration
Albania	55.2	19.6	17.8	1.4	6.0
Bosnia and Herzegovina	96.6	–	–	1.3	2.1
Croatia	29.9	65.4	2.0	1.6	1.1
Montenegro	96.0	–	–	1.8	2.1
North Macedonia	55.8	33.5	8.5	1.3	0.8
Serbia	53.1	37.2	6.9	1.8	0.9

Notes: The table reports the channel composition of ECB-attributable monetary adjustment under the benchmark MAP M1 specification using the ECB MRO-rate shock. Entries are shares of total absolute additive ECB-attributable channel contributions for each country, expressed in percent. Channel contributions are additive and sum to the corresponding ECB-attributable CMAM component at each point in time. Dashes denote channels that are structurally unavailable under the respective country's monetary framework. Croatia is included through December 2022.

Table A3: Channel Composition of ECB-Attributable Monetary Adjustment by Monetary Regime

Monetary regime	External adjustment	Liquidity operations	Policy rate	Reserve requirement	Reserve remuneration
Hard anchors	96.4	–	–	1.5	2.1
Managed regimes	42.0	50.5	5.0	1.5	1.0
Inflation targeting	54.2	28.5	12.3	1.6	3.5

Notes: The table reports the channel composition of ECB-attributable monetary adjustment by monetary regime under the benchmark MAP M1 specification using the ECB MRO-rate shock. Entries are shares of total absolute additive ECB-attributable channel contributions, expressed in percent. Hard-anchor regimes comprise Bosnia and Herzegovina and Montenegro; managed regimes comprise Croatia and North Macedonia; and inflation-targeting regimes comprise Albania and Serbia. Dashes denote channels that are structurally unavailable under the respective monetary frameworks. Monetary regimes are used solely for ex-post comparison and do not enter model estimation. Croatia is included through December 2022.

Figure A1: Overall Monetary Adjustment by Implementation Channel

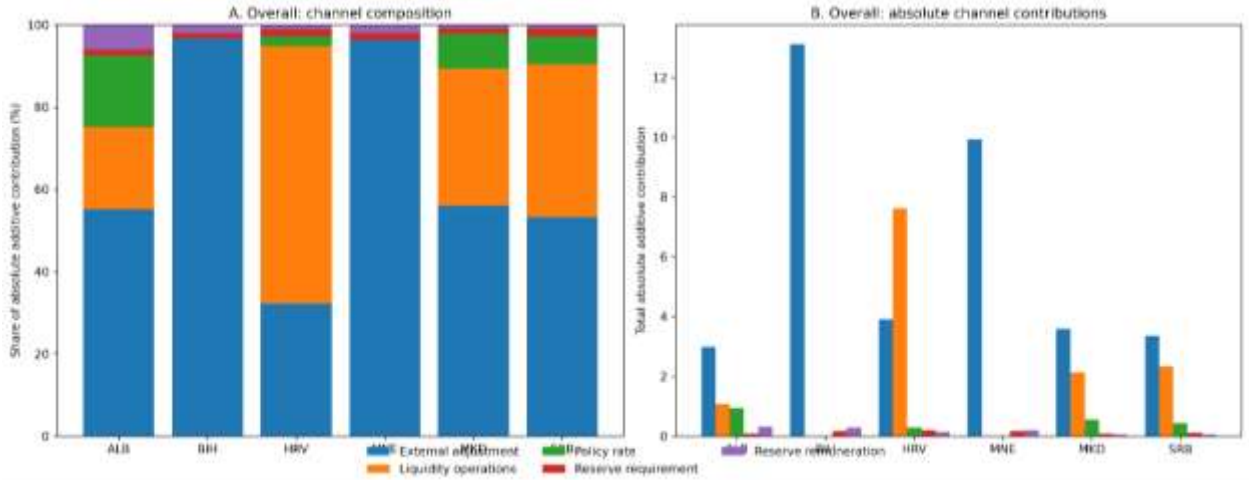


Table A4: M0-M1 CMAM Path Similarity Diagnostics under the Benchmark MRO shock

	Correlation		MAE		RMSE	
Country	Overall	ECB	Overall	ECB	Overall	ECB
Albania	0.9586	0.9802	0.0067	0.0017	0.0089	0.0030
Bosnia and Herzegovina	0.9841	0.9916	0.0118	0.0013	0.0190	0.0022
Croatia	0.9899	0.9700	0.0082	0.0034	0.0107	0.0072
Montenegro	0.9811	0.9861	0.0067	0.0014	0.0138	0.0027
North Macedonia	0.9989	0.9988	0.0013	0.0003	0.0018	0.0006
Serbia	0.9924	0.9949	0.0029	0.0009	0.0041	0.0016

Notes: The table reports path-similarity diagnostics comparing the constant-loading (M0) and time-varying-loading (M1) specifications under the benchmark ECB main refinancing operations (MRO) rate shock. "Overall" refers to the complete CMAM path, while "ECB" refers to the ECB-attributable CMAM component. Correlation measures the temporal co-movement of the corresponding M0 and M1 paths. MAE denotes the mean absolute difference between the two specifications, and RMSE denotes the root mean squared difference. Higher correlations and smaller MAE and RMSE indicate greater similarity between the M0 and M1 estimates.

Table A5: Full Country-Level M0-M1 CMAM Metrics under the Benchmark MRO Shock

Country	Model	Overall CMAM	ECB CMAM	ECB/Overall (%)	Overall Rank	ECB Rank
Albania	M0	0.0241	0.0072	29.7	5	4
	M1	0.0210	0.0061	28.8	6	6
Bosnia and Herzegovina	M0	0.0419	0.0090	21.4	2	2
	M1	0.0527	0.0094	17.9	2	1
Croatia	M0	0.0503	0.0112	22.2	1	1
	M1	0.0566	0.0091	16.0	1	2
Montenegro	M0	0.0348	0.0083	23.7	3	3
	M1	0.0401	0.0076	18.9	3	3
North Macedonia	M0	0.0257	0.0067	26.0	4	5
	M1	0.0249	0.0067	26.7	4	4
Serbia	M0	0.0231	0.0054	23.6	6	6
	M1	0.0246	0.0061	24.9	5	5

Notes: M0 denotes the constant-loading specification and M1 the time-varying-loading specification. Overall CMAM is the mean absolute overall monetary-adjustment index, while ECB CMAM is the mean absolute ECB-attributable component. ECB/Overall reports the ratio of mean absolute ECB-attributable CMAM to mean absolute overall CMAM, expressed as a percentage. Overall Rank and ECB Rank rank countries from highest to the lowest mean absolute overall and ECB-attributable adjustment, respectively. Both specifications use changes in the ECB main refinancing operations (MRO) rate as the monetary-policy shock. The estimation sample contains 257 monthly observations for Albania, Bosnia and Herzegovina, Montenegro, North Macedonia and Serbia, and 215 observations for Croatia, whose sample ends in December 2022 prior to euro adoption.

Table A6: Bayesian M0-M1 Comparison of Country-Level Monetary Adjustment

Country	M0: Constant loadings	M1: Time-varying loadings
Albania	0.069 (0.060–0.080)	0.079 (0.070–0.091)
Bosnia and Herzegovina	0.096 (0.087–0.106)	0.077 (0.068–0.086)
Croatia	0.131 (0.114–0.148)	0.117 (0.102–0.133)
Montenegro	0.237 (0.209–0.265)	0.174 (0.155–0.194)
North Macedonia	0.131 (0.116–0.148)	0.134 (0.121–0.148)
Serbia	0.129 (0.113–0.146)	0.110 (0.095–0.124)

Panel B: ECB-attributable CMAM

Country	M0: Constant loadings	M1: Time-varying loadings
Albania	0.016 (0.011–0.021)	0.015 (0.011–0.020)
Bosnia and Herzegovina	0.021 (0.014–0.029)	0.015 (0.010–0.022)
Croatia	0.024 (0.017–0.031)	0.019 (0.014–0.027)
Montenegro	0.063 (0.045–0.085)	0.042 (0.032–0.055)
North Macedonia	0.032 (0.021–0.044)	0.022 (0.014–0.031)
Serbia	0.017 (0.011–0.025)	0.015 (0.010–0.021)

Panel C: ECB-attributable adjustment as a share of overall CMAM

Country	M0: Constant loadings	M1: Time-varying loadings
Albania	0.233 (0.161–0.318)	0.189 (0.134–0.256)
Bosnia and Herzegovina	0.216 (0.151–0.297)	0.199 (0.137–0.279)
Croatia	0.184 (0.135–0.240)	0.167 (0.120–0.220)
Montenegro	0.266 (0.193–0.349)	0.244 (0.186–0.304)
North Macedonia	0.245 (0.163–0.340)	0.164 (0.108–0.237)
Serbia	0.135 (0.084–0.190)	0.134 (0.089–0.187)

Notes: Entries in the first row for each country are posterior medians: figures in parentheses report the corresponding 95% credible intervals. M0 imposes constant channel loadings, whereas M1 allows channel loadings to vary over time. Panel A reports mean absolute overall CMAM. Panel B reports mean absolute ECB-attributable CMAM, and panel C reports the posterior ratio of ECB-attributable to overall adjustment. Both specifications use changes in the ECB main refinancing operations (MRO) rate as the monetary-policy shocks. The M0 results correspond to the constant-loading Bayesian Stage-A specifications, while M1 corresponds to the preferred time-varying-loading Stage-B specification.

Table A7: Bayesian M0-M1 Comparison of Monetary Adjustment by Monetary Regimes

Panel A: Overall CMAM

Monetary regime	M0: Constant loadings	M1: Time-varying loadings
Hard anchors	0.167 (0.148–0.188)	0.126 (0.112–0.141)
Managed exchange-rate regimes	0.131 (0.119–0.143)	0.126 (0.115–0.138)
Inflation targeting	0.099 (0.089–0.110)	0.095 (0.086–0.105)

Panel B: ECB-attributable CMAM

Monetary regime	M0: Constant loadings	M1: Time-varying loadings
Hard anchors	0.042 (0.032–0.053)	0.029 (0.023–0.036)
Managed exchange-rate regimes	0.028 (0.021–0.036)	0.021 (0.016–0.027)
Inflation targeting	0.017 (0.012–0.022)	0.015 (0.012–0.019)

Panel C: ECB-attributable adjustment as a share of overall CMAM

Monetary regime	M0: Constant loadings	M1: Time-varying loadings
Hard anchors	0.251 (0.194–0.316)	0.230 (0.185–0.282)
Managed exchange-rate regimes	0.215 (0.163–0.276)	0.166 (0.128–0.214)
Inflation targeting	0.170 (0.122–0.224)	0.158 (0.123–0.195)

Panel D: Posterior probability of the complete regime ordering

Posterior ordering	M0	M1
Hard anchors > Managed exchange-rate regimes > Inflation targeting	0.989	0.945

Notes: Panels A-C report posterior medians, with corresponding 95% credible intervals in parentheses. M0 imposes constant channel loadings, whereas M1 allows channel loadings to vary over time. Panel A reports mean absolute overall CMAM. Panel B reports mean absolute ECB-attributable CMAM, and panel C reports the posterior ratio of ECB-attributable to overall adjustment. Panel D reports the posterior probability of the complete ordering of mean absolute ECB-attributable adjustment across the three monetary regimes. Regime comparisons are constructed ex post from country-level posterior draws and are not imposed through regime-specific priors or ordering restrictions. Both specifications use changes in the ECB main refinancing operations (MRO) rate as the monetary-policy shock. M0 corresponds to the constant-loading Bayesian Stage-A specifications and M1 to the preferred time-varying-loading Stage-B specification.

Table A8: Posterior Rank Probabilities for ECB-Attributable Monetary Adjustment

Country	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Rank 6
Albania	0.000	0.011	0.080	0.253	0.338	0.318
Bosnia and Herzegovina	0.000	0.038	0.149	0.272	0.294	0.247
Croatia	0.002	0.280	0.446	0.183	0.070	0.019
Montenegro	**0.997**	0.003	0.000	0.000	0.000	0.000
North Macedonia	0.001	**0.630**	0.284	0.069	0.014	0.002
Serbia	0.000	0.038	0.041	0.223	0.284	0.414

Notes: Entries report posterior probabilities that a country occupies the indicated rank in mean absolute ECB-attributable CMAM, with Rank 1 denoting the highest adjustment intensity and Rank 6 the lowest. Probabilities are calculated draw by draw from the joint country posterior and therefore sum to one across ranks for each country, subject to rounding. Results are based on the preferred Bayesian M1 specification with time-varying channel loadings and changes in the ECB main refinancing operations (MRO) rate as the monetary-policy shock. The table illustrates the posterior uncertainty surrounding exact country rankings and should be interpreted jointly with the posterior country distributions reported in Figure 16 and Table 5.

Table A9: Bayesian Sampling and Convergence Diagnostics

Diagnostic	M0: Constant loadings	M1: Time-varying loadings
Maximum $\widehat{R}$	1.01	1.02
Minimum bulk ESS	1,021	893
Minimum tail ESS	769	771
Divergent transitions	0	0
Maximum tree-depth hits	0	0
Minimum BFMI	0.834	0.887

Notes: The table reports standard Markov-chain Monte Carlo diagnostics for the Bayesian M0 and M1 specifications using changes in the ECB main refinancing operations (MRO) rate as the monetary-policy shock. M0 corresponds to the constant-loading Stage-A specification and M1 to the preferred time-varying-loading Stage-B specification. $\hat{R}$ denotes the potential scale-reduction statistics, ESS denotes effective sample size, and BFMI denotes the Bayesian fraction of missing information. For M1, the maximum $\hat{R}$ is 1.02, marginally above the stringent 1.01 threshold used in the computational audit. The minor exceedance is considered alongside the broader diagnostic evidence: no divergent transitions or maximum-tree-depth hits are observed, effective sample size remains substantial and the minimum BFMI is 0.887.

Table A10: M0-M1 Path Stability of ECB-Attributable CMAM across Alternative ECB Shock Measures

ECB shock	Albania	Bosnia and Herzegovina	Croatia	Montenegro	North Macedonia	Serbia
MRO	**0.980**	**0.992**	**0.970**	**0.986**	**0.999**	**0.995**
Composite	0.980	0.941	0.820	0.986	0.998	0.976
Identified	0.995	0.976	0.972	0.981	0.999	0.998
Shadow	0.969	0.994	0.864	0.999	0.960	0.986
DFR	0.920	0.992	0.961	0.956	0.986	0.948
Euribor 3M	0.967	0.989	0.760	0.977	0.999	0.973

Notes: Entries report correlations between the monthly ECB-attributable CMAM paths estimated under the constant-loading M0 specifications and the time-varying-loading M1 specification of each country and ECB shock measure. Values closer to one indicate greater stability of the estimated temporal pattern of ECB-attributable monetary adjustment to the introduction of time-varying channel loadings. The MRO-rate shock is the benchmark specification and is shown in bold. The remaining rows report results for the composite ECB measure, the externally identified monetary-policy shock, the shadow rate, the ECB deposit-facility rate (DFR), and three-month Euribor.

Table A11: Stability of Country Rankings across ECB Shock Measures and Model Specifications

Country	Mean rank	Median rank	Min. rank	Max. rank	SD of rank	Rank 1 frequency	Top 2 frequency	Top 3 frequency
Albania	3.17	3.50	1	6	1.46	25.0%	25.0%	50.0%
Bosnia and Herzegovina	3.75	3.50	1	6	1.79	8.3%	33.3%	50.0%
Croatia	1.67	1.00	1	4	0.94	58.3%	83.3%	91.7%
Montenegro	3.75	3.50	1	6	1.59	8.3%	25.0%	50.0%
North Macedonia	3.58	3.50	2	5	1.19	0.0%	25.0%	50.0%
Serbia	5.08	5.00	2	6	1.11	0.0%	8.3%	8.3%

Notes: The table summarizes the stability of country rankings by mean absolute ECB-attributable CMAM across 12 specifications, obtained from six alternative measures of the ECB monetary-policy impulse estimated under both the constant-loading M0 and time-varying-loading M1 models. A rank of 1 denotes the highest mean absolute ECB-attributable monetary adjustment and a rank of 6 the lowest. “Rank 1 frequency” reports the share of specifications in which a country occupies the highest rank: “Top 2 frequency” and “Top 3 frequency” report the shares in which the country belongs to the two and three highest-ranked economies, respectively. Rank dispersion across specifications captures sensitivity to both the measurement of the ECB monetary-policy impulse and the loading specification; it should therefore not be interpreted as posterior uncertainty conditional on the benchmark MRO model.