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Macroeconomic vs. Financial Uncertainty in the Euro Area: Regime-Dependent Transmission and the Volatility–Risk Premium Channel

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Abstract

In recent years, the euro area has experienced an unusual sequence of shocks, including the pandemic disruption, the energy-driven inflation surge, and the rapid monetary tightening cycle. This paper studies whether macroeconomic uncertainty (MEU), expected financial volatility (FU), and priced volatility risk (VRP) represent distinct uncertainty channels in the euro area, and whether their effects depend on the prevailing macro-financial regime. Local projections are estimated using innovations in MEU, FU, and the VRP along with complementary LP-IV and state-dependent specifications. The results suggest that the three components have different transmission profiles. MEU is associated with a broad real-activity channel, FU is associated with the clearest contractionary financial-stress response, and the VRP behaves as a distinct priced-risk component; its inflation response is episode-dependent and concentrated in supply shock periods, while in normal macro-financial conditions it transmits primarily through financial stress with more delayed real effects. State-dependent estimates show component-specific amplification where FU transmission intensifies through credit conditions under financial stress, while recessionary periods amplify MEU through demand compression and VRP through on-impact financial stress. These findings suggest that treating uncertainty indicators as interchangeable can obscure the relevant macro-financial transmission mechanism. For euro area policy analysis, distinguishing between macroeconomic uncertainty, expected financial volatility, and priced volatility risk is therefore important for assessing the effects of uncertainty shocks across different regimes.

Keywords: macroeconomic uncertainty, financial uncertainty, variance risk premium, local projections, euro area, state-dependent transmission.

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1 Introduction

Volatility is not fundamentally an enemy of prosperity. The financial turbulence preceding the 2008 collapse of Lehman Brothers and the turbulence that accompanied the technology boom a decade earlier were, in market terms, similar phenomena with opposite economic meanings. What really distinguishes them is not the level of volatility but what it represents; either genuine unpredictability about economic fundamentals, or a shift in the price markets demand for bearing that uncertainty. These two are different economic objects that activate different expectations, transmit through different channels, and call for different policy responses.

Since the Global Financial Crisis, uncertainty has become central to explaining fluctuations in output, investment, and employment. Existing work has separated macroeconomic from financial uncertainty and identified their distinct transmission channels (Ludvigson et al., 2021; Caldara et al., 2016), yet for the euro area, not much work has extended this to a unified framework that jointly identifies macroeconomic uncertainty, expected financial volatility, and priced volatility risk across the business cycle. This gap is particularly relevant due to the heterogeneity of the region's uncertainty episodes, for instance, between 2003 and 2024, the euro area passed through four structurally distinct uncertainty episodes. The Global Financial Crisis (2008-2009) was a financial-system shock that only gradually became a macroeconomic one. Years later, the sovereign debt crisis (2011-2012) elevated financial stress and institutional uncertainty without a comparable rise in conventional macroeconomic uncertainty. In 2020, the COVID-19 was the reverse case, macroeconomic uncertainty reached its highest recorded level as output collapsed, while ECB asset purchases rapidly stabilized financial markets. More recently, the 2022 energy and geopolitical shock mixed commodity-price volatility, policy uncertainty, and genuine ambiguity about Europe's medium-term supply capacity. Treating these episodes as instances of the same shock risks blurring the relevant transmission channel.

This paper asks whether macroeconomic and financial uncertainty are genuinely distinct shocks for the Euro Area, if they transmit through different channels, and whether a third component, the variance risk premium, operates as a separate risk-pricing component with macro-financial effects distinct from expected financial volatility. These questions matter for multiple reasons that existing work on the euro area has not *jointly* addressed. First, the dominant empirical approach for the euro area usually focuses on a single aggregate uncertainty measure or studies macro and financial uncertainty in parallel without a unified framework that directly compares their dynamic effects across the business cycle. This leaves unanswered which type of uncertainty dominates the euro-area cycle, under which conditions, and whether the two act as substitutes or complements. Second, the variance risk premium has received substantial theoretical attention, Caballero and Simsek (2024a) develop a risk-centric New Keynesian framework in which risk premia tighten financial conditions and contract aggregate demand independently of the policy rate, yet this is still to be tested empirically as a separate shock for the euro area within an identified local projection framework. Third, the euro area's bank-based transmission structure and the ECB's single monetary policy rate generate specific prior expectations about how each type of uncertainty should propagate, expectations that existing US-based evidence cannot answer.

The distinction between these three components is conceptually grounded. Macroeconomic uncertainty, measured by the Comunale and Nguyen (2023) conditional volatility index, captures genuine unpredictability about real economic outcomes and reflects the state of agent expectations about fundamental macroeconomic dynamics. Financial uncertainty, extracted from the VSTOXX using the decomposition following Bekaert et al. (2013), measures the physical conditional expectation of future equity market variance, that is, how volatile financial markets are rationally expected to be given current return dynamics. Additionally, the variance risk premium is the residual between the risk-neutral implied variance priced in options markets and the physical expectation. It does not measure how uncertain the future is, but how expensive that uncertainty has become to insure against. When the VRP rises, investors are demanding compensation not because they expect volatility to be higher, but because they are less willing to bear it, a change in preferences and expectations about the distribution of risk that is logically prior to, and distinct from, any change in fundamental economic uncertainty.(Carr and Wu, 2009). Following this distinction, the Caballero-Simsek framework predicts that VRP shocks transmit through a specific mechanism: elevated risk premia require asset prices to fall to clear the risk balance condition, reducing aggregate wealth and contracting demand through the balance sheet channel. This prediction holds when the monetary policy can absorb the shock, but may be modified when supply disturbances simultaneously elevate both risk premia and inflation (Caballero and Simsek, 2024a).

In the euro area, this transmission must pass through bank lending standards rather than direct market repricing. This suggests that VRP effects may materialize with longer lags in the euro area, and that short-run responses may partially be offset by ECB accommodation or ambiguous when market repricing, policy expectations, and delayed credit transmission operate simultaneously. It may amplify most strongly when bank balance sheets are already under stress. MEU, by contrast, operates through the real options channel (Dixit and Pindyck, 1994; Bloom, 2009): it is the unpredictability of fundamentals that freezes investment, and this mechanism is most sensitive to the state of the business cycle. FU sits between the two, genuine financial volatility uncertainty that tightens conditions through risk perceptions and lending standards, but without the pure pricing-of-risk character of the VRP. These different mechanisms generate testable predictions about the shape, timing, and state-dependence of each component's impulse response predictions that form the empirical backbone of this paper.

To test these predictions, local projections are estimated (Jordà, 2005) over 2003M6–2024M7, introducing MEU, FU, and VRP jointly as autoregressive innovations. Outcome variables span real activity,industrial production, unemployment, capital goods production, prices, and financial conditions[1]. This is then complemented with LP-IV specifications that instrument FU using a signed gold-return narrative index (Piffer and Podstawski, 2018) and VRP using a six-month implied variance end-of-month measure,sharpening identification of the two financial channels. State-dependent local projections (Gonçalves et al., 2024) examine whether transmission amplifies under financial stress, recession, a weak output gap, and the zero lower bound, the conditions under which the financial accelerator and the risk-premium channel are expected to be most operative. The findings speak to three open questions in the euro area uncertainty literature: whether macroeconomic, financial uncertainty and the variance risk premium are empirically separable channels; whether the variance risk premium operates as an independent macroeconomic channel in a bank-based economy; and whether uncertainty transmission is state-dependent in ways that matter for the ECB's reaction function.

The paper contributes to these questions in three ways. First, it provides a local-projection-based decomposition of MEU, FU, and VRP for the euro area, extending the framework of Ludvigson et al. (2021) beyond the United States without the parametric dynamic restrictions of a structural VAR. Second, it provides LP-based empirical assessment of the Caballero-Simsek second-moment transmission channel in the euro area, a bank-based economy where lag structure,inflation response, and financial amplification are theoretically relevant. Third, it provides state-dependent LP evidence on the differential amplification of MEU, FU, and VRP across financial stress and monetary policy regimes, extending the non-linear VAR evidence of Nalban and Smădu (2021) to a more flexible estimator that separately identifies three distinct uncertainty channels.

The remainder of the paper is organized as follows. Section 2 reviews the related literature. Section 3 develops the theoretical framework. Section 4 describes the data and variable construction. Section 5 presents the empirical strategy. Section 6 reports the results. Section 7 discusses results and findings. Section 8 mentions limitations and directions for further research. Section 9 concludes.

2 Literature Review

The modern literature on uncertainty and the business cycle begins with Bloom (2009), who shows that large uncertainty shocks proxied by stock market volatility cause firms to

[1]CISS, credit spreads, NFC loan growth

temporarily freeze hiring and investment, producing sharp short-lived recessions followed by rapid rebounds. This mechanism shows that when the future is sufficiently opaque, the option value of waiting dominates the return to irreversible decisions (Dixit and Pindyck, 1994). But this foundational result rests on a measurement choice that conflates two distinct objects: how uncertain the future is, and how expensive that uncertainty is to insure against. Separating them is not just a refinement, it changes the economic interpretation of what uncertainty shocks actually are.

Jurado et al. (2015) construct Macroeconomic Uncertainty as the conditional volatility of the unforecastable component of a large panel of time series, where they remove the predictable component that earlier volatility-based measures included. To separate macroeconomic and Financial Uncertainty empirically Ludvigson et al. (2021) extend this, finding that financial uncertainty is more likely a causal driver of output fluctuations while macroeconomic uncertainty tends to rise endogenously in recessions regardless of their origin. This asymmetry is highly relevant as it suggests that the two types of uncertainty are not interchangeable, and that identifying which is driving a downturn requires a framework that consider them separately rather than aggregating into a single index. Caldara et al. (2016) show that financial conditions and uncertainty shocks are substantially more contractionary when they coincide with tighter financial conditions and that their interaction determines the severity of the contraction. Both contributions are grounded in SVAR frameworks and focused on the United States, leaving open whether the same patterns hold in a bank-based economy with a single monetary policy rate across heterogeneous member states.

For the euro area, Comunale and Nguyen (2023) construct the most comprehensive macroeconomic uncertainty index to date, built from nearly 1,500 variables following the Jurado et al. (2015) methodology and adapted for the monetary union's cross-country structure. Their key finding is that macroeconomic uncertainty substantially outperforms market-based financial uncertainty proxies in explaining the COVID-19 contraction, motivates the use of their index as the primary MEU measure in this paper and illustrates that the two types of uncertainty do not always move together. According to Nalban and Smădu (2021), uncertainty shocks in the euro area have substantially larger real effects during financial distress than in normal times, providing non-linear VAR evidence of state-dependent amplification for this region. Their work treats uncertainty as a single object, however, leaving open how the amplification differs across the macro, financial, and risk-pricing components that this paper separates. The bank based nature of the euro area transmissions is further documented by Altavilla et al. (2020), who show that heterogeneous bank balance sheet conditions create systematic differences in how financial shocks propagate across the monetary union, a feature that motivates the prior expectation in this paper that uncertainty shocks operating through credit conditions may transmit differently in the euro area than in more market based financial systems.

While this literature establishes the euro area relevance of macroeconomic uncertainty and its state-dependent amplification, a parallel strand suggests that the pricing of volatility risk operates as a distinct channel that neither the Comunale and Nguyen (2023) index nor standard financial uncertainty measures capture. The variance risk premium is not a measure of how uncertain the future is, but of how expensive that uncertainty has become to insure against. Bekaert and Hoerova (2014) show that the physical variance predicts future IP while the VRP predicts future stock returns, a finding that is the empirical starting point for the FU-VRP separation in this paper. Bollerslev et al. (2009) establish that the VRP is time-varying, counter cyclical, and leads business cycle turning points, while Carr and Wu (2009) provide the no-arbitrage foundation for its interpretation as compensation for bearing variance risk, and Drechsler and Yaron (2011) show in a general equilibrium setting that the VRP is driven by time-varying macroeconomic uncertainty, providing a structural link between risk compensation and real economic conditions. The theoretical mechanism through which the VRP affects the real economy is formalized by Caballero and Simsek (2024a), who show in a risk-centric New Keynesian model that elevated risk premia tighten financial conditions through the risk balance condition independently of the policy rate, with amplification when arbitrageur capacity is constrained. This mechanism has been developed for the United States and whether it operates in the euro area, where transmission runs through bank lending rather than market repricing, and where the ECB's accommodation signals may partially offset near-term VRP spikes, is an open empirical question that this paper address.

On identification, a recurring challenge in the uncertainty literature is that standard recursive approaches combine genuine exogenous uncertainty innovations with endogenous responses to the business cycle while, following Ludvigson et al. (2021), uncertainty rises in recessions regardless of whether it caused them. To address this, Piffer and Podstawski (2018) propose the use of gold prices as an external instrument, exploiting the safe-haven demand for gold that arises specifically during episodes of genuine exogenous uncertainty, when investors seek protection against tail risks that are orthogonal to the business cycle rather than driven by it. Bobasu et al. (2021) apply this strategy to euro area data, finding that instrumented global uncertainty shocks have substantially larger real effects than recursive VAR estimates suggest, consistent with attenuation bias from endogeneity in standard identification approaches. This paper adopts a similar narrative instrument logic for the FU shock, constructing a signed gold-return weighted index of financial stress episodes, and extends it to the LP-IV setting where the contrast between OLS and instrumented responses directly quantifies the attenuation that recursive identification produces. On methodology, the local projection framework of Jordà (2005) is used throughout because it extends naturally to instrumental variable and state-dependent specifications without requiring the parametric dynamic structure of a SVAR, as established by Plagborg-Møller and Wolf (2021), Montiel Olea and Plagborg-Møller (2021), and Gonçalves et al. (2024).

This paper brings these strands together in a unified euro area framework. It extends the MEU-FU decomposition of Ludvigson et al. (2021) beyond the United States to a bank-based monetary union. It operationalizes the FU-VRP separation of Bekaert and Hoerova (2014) within an identified LP framework rather than a return-prediction exercise. It provides an empirical assessment of the Caballero and Simsek (2024a) risk-centric transmission channel in a bank-based economy. Additionally, it moves beyond the single-object state-dependent evidence of Nalban and Smădu (2021) to separately identify how financial stress and recession regimes amplify three distinct uncertainty channels. The result is a framework that can speak to which type of uncertainty matters for euro area transmission, under what conditions, and through which channel; questions that the existing literature has addressed individually but not jointly.

3 Theoretical Framework

3.1 Uncertainty: Definitions and Distinctions

Modern macroeconomics operationalizes uncertainty through second-moment shocks: unexpected increases in the conditional variance of economic outcomes (Bloom, 2009). Beyond the conceptual distinction drawn in the Introduction, MU and FU also differ in their dynamics: MU is slow-moving and persistent, rising in recessions and dissipating gradually as the outlook clarifies (Jurado et al., 2015; Comunale and Nguyen, 2023), while FU is faster-moving, capable of spiking and collapsing within days or weeks, and may originate in financial markets independently of real fundamentals (Bekaert and Hoerova, 2014). The central hypothesis of this paper is that MU and FU are not interchangeable: they represent distinct shocks with distinct transmission mechanisms, regime-dependencies, and real-economy effects, as developed below.

3.2 The Caballero–Simsek Risk-Centric Framework

The theoretical anchor of this paper is the risk-centric macroeconomic framework developed by Caballero and Simsek (2024a). In contrast to conventional New Keynesian models, which trace aggregate demand dynamics to the expected path of real interest rates, the risk-centric framework places the *risk premium*, at the center of the transmission mechanism between financial conditions and the real economy.

A representative investor holding risky assets (equities) and a safe asset must be compensated for the volatility borne on the risky portfolio. The equilibrium risk premium ρ_t satisfies:

$$\rho_t = \frac{1}{2}\sigma_t^2 + \rho_t^{\text{pol}} \tag{1}$$

where σ_t^2 denotes the conditional variance of market returns, the key second-moment variable, and ρ_t^{pol} is a policy risk premium arising from disagreements between the central bank and financial markets about the appropriate level of asset prices (Caballero and Simsek, 2024a, equation 34). Equation (1) encapsulates the **volatility risk premium (VRP) channel** where an increase in the variance of market returns directly raises the risk premium, tightening financial conditions even in the absence of any change in policy rates.

The link to aggregate output runs through asset prices. Defining output y_t as increasing in asset prices p_t and the money supply m_t via the output-asset price relation, a rise in ρ_t depresses p_t, contracting aggregate demand y_t:

$$\uparrow \sigma_t^2 \;\longrightarrow\; \uparrow \rho_t \;\longrightarrow\; \downarrow p_t \;\longrightarrow\; \downarrow y_t \tag{2}$$

Critically, this channel is operative *independently* of the conventional interest rate channel. Even if monetary policy holds the short rate constant, a spike in financial uncertainty tightens financial conditions through the risk premium. This is the second-moment channel: it is the *variance* of returns that matters, not their mean.

3.3 Decomposing Financial Uncertainty: The Bekaert-Hoerova Structure

To operationalize the VRP channel empirically, this paper adopts the structural decomposition of implied volatility proposed by Bekaert and Hoerova (2014). The VSTOXX index measures the risk-neutral expectation of the variance of the EURO STOXX 50 over a 30-day horizon, it contains two economically distinct components:

$$\underbrace{\left(\frac{VSTOXX_t}{100}\right)^2}_{\text{Risk-neutral implied variance}} = \underbrace{\mathbb{E}_t[\sigma_{t+1}^2]}_{\text{Expected variance (FU)}} + \underbrace{\left[\left(\frac{VSTOXX_t}{100}\right)^2 - \mathbb{E}_t[\sigma_{t+1}^2]\right]}_{\text{Variance Risk Premium (VRP)}} \tag{3}$$

The expected physical variance $\mathbb{E}_t[\sigma_{t+1}^2]$ is estimated via a GARCH(1,1) model fitted to EURO STOXX 50 returns, following the implementation logic of Bekaert and Hoerova (2014)[2]. This component captures the conditional expectation of future equity market variance under the physical probability measure, reflecting how volatile financial markets are rationally expected to be, given the unpredictability of future market volatility based on past return dynamics. The residual constitutes the **Variance Risk Premium(VRP)**. It reflects the additional compensation investors demand for bearing variance risk, and corresponds directly to ρ_t^{vol} in equation (1).

[2] The choice of GARCH(1,1) over alternative physical variance forecasts is validated through an in-sample forecast comparison reported in Appendix A

This decomposition is theoretically superior to simple residualization approaches because it isolates the component of financial conditions that corresponds to the VRP channel in (Caballero and Simsek, 2024a), where VRP is the risk premium, not merely a measure correlated with it.

3.4 Transmission in the Euro Area

The theoretical mechanisms described above, the real options channel for MEU, the credit and volatility channel for FU, and the risk balance condition for VRP, are each modified by the institutional structure of the euro area.

For MEU, the wait-and-see mechanism of Bloom (2009) and Dixit and Pindyck (1994) is expected to operate as in the US but with greater persistence, given rigid labour market institutions and the slower adjustment of investment in bank-dependent firms facing higher external finance costs when uncertainty rises.

For the financial Uncertainty, the credit channel is the primary transmission vehicle. Unlike the US, where financial conditions transmit rapidly through capital markets, the euro area relies on bank-based intermediation. Elevated expected financial volatility could raise intermediation costs and tighten lending standards, with real effects accumulating through bank balance sheet rather than direct market repricing (Altavilla et al., 2020).

Lastly, for VRP, the C&S wealth channel is attenuated by the euro area's lower household equity ownership; the empirically relevant route is instead the bank balance sheet channel, where asset price declines impair bank capital and collateral values and tighten credit supply through intermediary constraints. This implies a different lag structure than in US evidence: short-run responses may be muted or ambiguous as market repricing, policy expectations, and delayed investment decisions operate simultaneously, while medium-horizon effects accumulate as bank balance sheet constraints bind and credit conditions tighten. The empirical analysis therefore treats VRP responses as potentially delayed and state-dependent rather than imposing the sharper timing found in US-based evidence.

3.5 State Dependence: Why Regimes Matter for Uncertainty Transmission

Uncertainty shocks do not operate in a vacuum. The same VRP spike that causes a modest contraction in an economy with healthy bank balance sheets, ample liquidity, and expansionary monetary policy may cause a severe and protracted contraction in an economy where banks are capital-constrained, sovereign spreads are elevated, and the monetary policy space is limited. This is the essence of *state-dependent transmission*: the response to a shock depends on the state of the economy at the time of impact (Gonçalves et al., 2024).

This paper examines two main theoretically motivated regimes. The **financial stress**

regime, identified by the Composite Indicator of Systemic Stress (CISS, Holló et al., 2012), captures episodes in which the financial system is under strain: elevated interbank spreads, falling equity prices, widening corporate credit spreads, and deteriorating liquidity conditions. In this regime, the VRP channel is expected, as a prior, to be amplified. The rising variance risk premia feed back into bank funding costs, which tighten credit supply, which further depresses asset prices, generating the endogenous volatility feedback loop modeled by Caballero and Simsek (2024b). The **recession regime**, identified by CEPR Euro Area recession dates, captures contractionary phases of the business cycle. In this regime, MU effects are expected to amplify more strongly than FU effects, as macro uncertainty is intrinsically tied to cyclical dynamics. Existing evidence confirms this asymmetry: Gupta et al. (2019) find that uncertainty shocks during Euro Area recessions produce materially stronger contractions in output than during expansions.

A key theoretical distinction is that the CISS and CEPR regimes are not equivalent. The European sovereign debt crisis of 2010-2012 is the canonical example of a high-CISS, non-recessionary episode: financial stress was extreme while the Euro Area economy, though weak, had technically exited the post-Lehman recession. The two regime variables therefore capture orthogonal dimensions of "bad times", and the interaction between them is necessary to trace the full heterogeneity of uncertainty transmission.

3.6 Testable Predictions

The theoretical framework implies four main predictions that organize the results in Section 6. First, MEU, FU, and VRP should not produce identical impulse responses, with MEU expected to operate mainly through expectation revision and FU transmitting more quickly through financial stress and credit conditions. Second, the VRP channel should display a distinct dynamic profile from FU, with real activity responses potentially more delayed and less sharply contractionary on impact given the role of bank credit in euro area transmission. Third, effects should be state dependent: FU amplified under financial stress, MEU more sensitive to recessionary or weak-demand regimes. Fourth, LP-IV estimates should reveal whether externally instrumented FU and VRP components differ from reduced-form OLS, addressing the endogeneity concern raised in Section 2.

4 Data

The analysis uses a monthly Euro Area aggregate sample starting on June 2003 until July 2024. The sample is determined by the availability of the macroeconomic uncertainty index developed by Comunale-Nguyen which serves this thesis as baseline MEU measure. Additionally, the monthly frequency is appropriate for the analysis because the transmission of uncertainty shocks to real activity, prices, unemployment, and credit conditions is expected to unfold over several months rather than only at high frequency. The sample spans the four euro-area uncertainty heterogeneous episodes introduced in the previous section. Detailed variable definitions, transformations, and sources are reported in Appendix D, Table 12.

The baseline **macroeconomic uncertainty measure**, Comunale-Nguyen Euro Area MEU index, captures uncertainty about aggregate macroeconomic conditions rather than financial-market volatility or risk pricing, which makes it a suitable proxy for the unpredictability of fundamentals that drives through the real options channel. In the local projections, MEU is used through its standardized autoregressive innovation, so the estimated shock corresponds to the unexpected component of macroeconomic uncertainty. This heterogeneity allows the regime-dependent estimator to identify how transmission differs across structurally distinct episodes. As a robustness check, a PCA-based macro-uncertainty measure is also constructed from MEU, European economic policy uncertainty, and CESIEUR.

Financial uncertainty and the variance risk premium are obtained from a decomposition of the squared VSTOXX index, converted into annualized implied variance, following Bekaert et al. (2013) and Bekaert and Hoerova (2014). This object is a market-based proxy for the risk-neutral expectation of near-term equity-market variance and is split into a physical expected variance component and a residual risk premium; the full decomposition and its components are detailed in Appendix A (Table 14).

The physical expected variance, FU_t, is the financial uncertainty measure used in this thesis, it reflects how volatile markets are rationally expected to be given current return dynamics, and relates to real-options and wait-and-see mechanisms through which uncertainty delays investment (Dixit and Pindyck, 1994; Bloom, 2009). The residual, VRP_t, is the variance risk premium, commonly interpreted as compensation for bearing variance risk (Carr and Wu, 2009; Bollerslev et al., 2009; Drechsler and Yaron, 2011). Although both are extracted from the same option-implied variance, FU_t measures *expected* future volatility, while VRP_t measures how expensive that volatility is to insure against, a distinction central to the risk-centric mechanisms studied here (Caballero and Simsek, 2024a).

4.1 Regime Variables

State-dependent local projections are estimated using regime variables $F_t \in [0, 1]$, which allow the response to an uncertainty shock to differ between low- and high-regime states by interacting the shock with $(1 - F_t)$ and F_t. For each horizon h, the estimated equation includes both $shock_t(1 - F_t)$ and $shock_t F_t$ where the coefficient on the first term measures the low-regime response, the coefficient on the second measures the high-regime response, and F_t itself is included separately to absorb average level differences across states.

The main financial-stress regime is based on the Composite Indicator of Systemic Stress (CISS) of Holló et al. (2012), which aggregates information across segments of the financial system to capture systemic rather than isolated stress. CISS is the central regime variable because the thesis's theoretical mechanism emphasizes financial amplification and risk-premium transmission during stressed conditions. To avoid contemporaneous reverse causality, the regime is constructed as a smooth transition of lagged, standardized CISS (z_{t-1}^{CISS}). Values near zero indicate low stress and values near one indicate high stress; this avoids imposing a hard threshold and lets stress intensity vary continuously across months. (Appendix B.6)

The business-cycle regime is a binary CEPR-style euro-area recession indicator, which yields separate expansion (β_h^{exp}) and recession (β_h^{rec}) coefficients whose difference $\beta_h^{rec} - \beta_h^{exp}$ measures differential amplification during recessions.

Two additional regimes serve as robustness checks: a policy-constraint regime and an output-gap regime, both treated as robustness given their sensitivity to filtering choices and endpoint behavior.(See Appendix B.6)

4.2 Outcome Variables and Controls

The main macroeconomic outcomes are industrial production growth (the primary real activity measure), inflation, and unemployment. To study financial and real transmission channels more directly,capital-goods production growth,NFC loan growth,CISS, and credit spreads are considered as additional outcomes.

The control set includes the change in the policy rate, the output gap, CISS, credit spreads, and inflation, with industrial production growth additionally included as a control for outcomes other than IP itself. Controls that coincide mechanically with the dependent variable are excluded [3].

4.3 Descriptive Overview

Figure 1 plots the standardized levels of macroeconomic uncertainty, financial uncertainty, and the variance risk premium. The three series increase around major stress episodes but do not move one-for-one: FU displays sharp spikes around episodes of market volatility, MEU is more persistent and rises gradually around broad macroeconomic disruptions, and VRP is visibly more volatile than FU, spiking sharply at the onset of stress episodes and mean-reverting quickly, consistent with its character as a compensation-for-risk measure rather than a slow-moving uncertainty state.

Descriptive correlations between the uncertainty measures and the main macro-financial variables (Table 13, Appendix D) confirm this separation: FU is strongly related to financial-stress indicators such as CISS and credit spreads, MEU is more closely associated with macroeconomic conditions, and VRP displays weaker and less uniform correlations,

[3] In the LP regressions, the dependent variable and the controls enter with two monthly lags. The other uncertainty shocks enter contemporaneously as conditioning shocks.A COVID dummy is included as an exogenous control

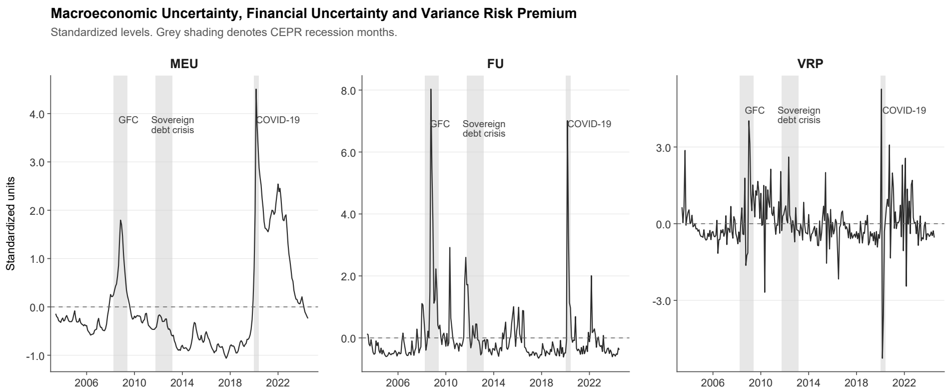


Figure 1. Macroeconomic Uncertainty, Financial Uncertainty and Variance Risk Premium.

supporting its treatment as a separate risk-pricing component.

Table 1 summarizes the central regimes used in the state-dependent analysis. High-stress periods are associated with higher average MEU, FU, and VRP, weaker industrial production growth, and tighter financial conditions; CEPR recession months display a similar pattern, with especially elevated FU and substantially lower industrial production growth. Full summary statistics and additional regime diagnostics are reported in Appendix D.

Table 1. Regime Summary Statistics

State	Regime	N	MEU	FU	VRP	IP_growth	CISS	CS
CISS stress	High stress	91	0.27	0.48	0.30	-1.66	0.37	7.64
CISS stress	Low stress	163	-0.15	-0.27	-0.17	1.48	0.06	3.70
CEPR recession	Expansion	215	-0.11	-0.19	-0.04	1.67	0.13	4.26
CEPR recession	Recession	39	0.60	1.05	0.21	-6.88	0.42	9.79

5 Empirical Strategy

5.1 Baseline local projections

A large share of the empirical literature on uncertainty shocks has relied on VAR or SVAR models to trace dynamic macroeconomic effects. Local projections (Jordà, 2005) are used because they estimate impulse responses directly through horizon-specific regressions rather than an estimated dynamic system. This specification is suited to compare the conditional transmission of three distinct uncertainty components rather than characterizing the full macro-financial system; while LP's and VAR's estimate the same impulse-response objects under comparable identifying assumptions, they differ in finite samples through a bias-variance trade-off, short-lag VAR's can be more precise but may impose restrictive dynamic extrapolation when the underlying system is misspecified, whereas LP's estimate each horizon directly without propagating specification error across the response path, at the cost of some parsimony (Plagborg-Møller and Wolf, 2021; Montiel Olea and Plagborg-Møller, 2021; Montiel Olea et al., 2025). Additionally the horizon-by-horizon structure extends naturally to the instrumental-variable and state-dependent specifications used below (Ramey and Zubairy, 2018; Gonçalves et al., 2024).

For each horizon $h = 0, 1, \dots, 24$ months, the baseline specification is:

$$y_{t+h} = \alpha_h + \beta_h^{MEU} u_t^{MEU} + \beta_h^{FU} u_t^{FU} + \beta_h^{VRP} u_t^{VRP} + \Gamma_h' X_{t-1:t-p} + \Phi_h' Z_t + \varepsilon_{t+h}. \quad (4)$$

Here y_{t+h} is the outcome at horizon h, related to contemporaneous innovations in MEU (u_t^{MEU}), FU (u_t^{FU}), and VRP (u_t^{VRP}), together with lagged controls and outcome dynamics. The outcome set, described in Section 4.2, spans real activity, prices, and financial conditions, so the estimated coefficients trace how each uncertainty component is associated with the subsequent path of real, nominal, and financial variables. Local projections respond to unexpected movements in each shock rather than its predictable component, so the MEU, FU, and VRP series are transformed into autoregressive innovations (Appendix A.4). The response to each shock is therefore conditional, holding fixed the contemporaneous innovations in the other two components and the macro-financial controls; this does not make the shocks fully structural, but provides a disciplined reduced-form baseline for comparing the three channels.

The control vector $X_{t-1:t-p}$ contains lagged macro-financial variables and outcome dynamics: the change in the policy rate, the output gap, CISS, changes in credit spreads, and inflation, with industrial production growth additionally included in non-output equations. Variables that coincide mechanically with the dependent variable are excluded from the controls. A COVID-19 dummy absorbs the exceptional pandemic disruption. The baseline uses two monthly lags, balancing parsimony and dynamic adjustment in a relatively short monthly sample, with a six-lag specification retained as a robustness check (Appendix C, Figure 8).

Inference uses Newey-West HAC standard errors with a horizon-dependent bandwidth $\max(h, p)$, accounting for the serial correlation that the horizon-specific dependent variable y_{t+h} induces in LP residuals (Montiel Olea and Plagborg-Møller, 2021). Impulse responses are reported with 68% and 90% point wise confidence bands: the 68% band is conventional in the LP literature for cross-study comparison (Gertler and Karadi, 2015), while the 90% band provides the standard significance threshold.

Two additional specifications are reported in Appendix C as robustness and presentation devices. An ordered recursive specification orthogonalize the uncertainty innovations as MEU $\rightarrow$ FU $\rightarrow$ VRP, following the convention of treating MEU as the most predetermined innovation and the VRP as the most immediately responsive financial-pricing component (Ludvigson et al., 2021). Bayesian local projections smooth the horizon-by-horizon response path via a prior penalizing excessive variation across adjacent horizons, assessing whether the main dynamic patterns survive when noisy horizon-specific movements are regularized.

5.2 LP-IV identification

The baseline local projections use reduced-form uncertainty innovations which, while useful for describing conditional dynamic responses, may still reflect reverse causality, omitted contemporaneous shocks, or measurement error. This specification is therefore complemented with instrumental-variable local projections that keep the same horizon-by-horizon structure but instrument the targeted uncertainty innovation using an external source of variation. For a given component s_t^j, $j \in \{FU, VRP\}$, the LP-IV regression is estimated as:

$$y_{t+h} = \alpha_h + \beta_h^j \widehat{s}_t^j + \Psi_h' R_t + \varepsilon_{t+h}, \qquad h = 0, \ldots, 24. \tag{5}$$

Here $\widehat{s}_t^j$ is the fitted first-stage component, and R_t contains the remaining uncertainty innovations, lagged controls and outcome dynamics, and contemporaneous exogenous controls (same control set as the baseline). Standard errors use Newey-West HAC covariance matrices, following the external-instrument logic of Stock and Watson (2018).

For FU, the preferred instrument is a signed gold-based financial-event index, exploiting safe-haven gold demand during financial-stress events as external variation in expected financial volatility. As for the VRP, the preferred instrument is the six-month implied-variance end-of-month measure, conceptually aligned with the variance-based construction of the VRP. Alternative FU event-window definitions and VRP instruments (the six-month volatility-spread measure and the short-end VSTOXX slope) are retained as robustness checks (Appendix B.5).

Exclusion restriction for the signed gold-based FU instrument requires that the selected gold-return movements affect euro-area macro-financial outcomes primarily through expected financial volatility, conditional on the controls, the other uncertainty innovations, and the COVID dummy. The identifying logic is that these events generate safe-haven gold demand during externally timed financial-stress episodes, providing variation orthogonal to euro-area output, inflation, and credit conditions; the main threat is that gold may also respond to broader risk-off sentiment, geopolitical news, or monetary-policy expectations. The instrumented FU estimates are accordingly interpreted as evidence from externally timed financial-stress variation rather than a fully structural shock.

As for the six-month variance EOM VRP instrument, the exclusion restriction requires that movements in this longer-horizon implied-variance measure affect outcomes through the VRP innovation, after conditioning on FU, MEU, and the macro-financial controls. The instrument is relevant precisely because it is closely linked to option-market pricing of future variance risk, but this proximity also means the exclusion restriction is less clean than for a purely narrative instrument. The VRP-IV results are therefore interpreted as evidence on the risk-pricing component isolated by option-market variation, not as definitive proof of a fully exogenous VRP shock.

Differences between OLS-LP and LP-IV responses do not mechanically imply that one estimate is preferable: they may reflect removal of endogenous variation, but also the specific variation isolated by the instrument and first-stage strength. Relevance is evaluated using HAC first-stage F-statistics; full first-stage diagnostics are reported in Appendix C.

5.3 State-dependent local projections

The baseline LP estimates an average response over the full sample, which may hide heterogeneity if uncertainty shocks transmit differently during financial stress, recessions, or policy constraints. State-dependent local projections are estimated in the spirit of the nonlinear LP literature (Auerbach and Gorodnichenko, 2012; Ramey and Zubairy, 2018).

For each target shock s_t^j, with $j \in \{MEU, FU, VRP\}$, the following specification is estimated:

$$y_{t+h} = \alpha_h + \beta_{h,L}^j (1 - F_t) s_t^j + \beta_{h,H}^j F_t s_t^j + \Theta_h' s_{-j,t} + \delta_h F_t + \Gamma_h' X_{t-1:t-p} + \Phi_h' Z_t + \varepsilon_{t+h} \quad (6)$$

for horizons $h = 0, \ldots, 24$. Here $F_t \in [0, 1]$ is the regime variable defined in Section 4.1, and $\beta_{h,L}^j$, $\beta_{h,H}^j$ measure the low- and high-regime responses to shock j, as in the general $(1 - F_t)/F_t$ interaction framework introduced there. For binary regimes (CEPR recession) these correspond directly to the two states; for smooth regimes (CISS) they are endpoint responses implied by the transition function rather than averages over observed periods (Section 8). Only the target shock is interacted with the regime; the other uncertainty innovations enter contemporaneously as conditioning shocks, and F_t enters separately so that the interaction terms capture differences in transmission rather than level differences across states. Lagged controls, outcome lags, the COVID dummy, lag length, and HAC inference follow the baseline specification.

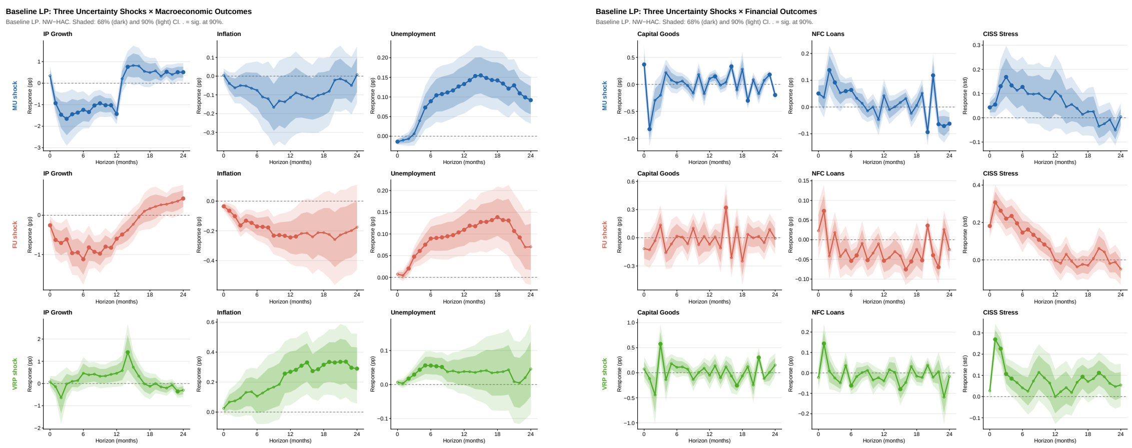
The main state variable is the financial-stress regime F_t^{CISS} based on lagged CISS (Section 4.1), with high values corresponding to elevated financial stress. A CEPR recession dummy serves as the central business-cycle regime. The ZLB/policy-constraint and output-gap regimes are reported as robustness checks in Appendix C.

The key object of interest is $\Delta_h^j = \beta_{h,H}^j - \beta_{h,L}^j$, with the null hypothesis of no state dependence at horizon h given by $H_0 : \Delta_h^j = 0$. This is assessed using the high-minus-low response and its Newey-West HAC confidence bands. State-dependent estimates are conditional heterogeneity exercises rather than a separate identification strategy: differences relative to the baseline may reflect that the baseline averages over regimes, while state-dependent LPs estimate responses separately across states with fewer effective observations and additional interaction terms.

6 Results

6.1 Local Projections: Do MEU,FU & VRP Display Distinct Dynamic Responses?

The baseline local projections show that the three uncertainty components are empirically distinct disturbances that transmit through different channels, supporting the premise that FU and MEU should not be treated as equivalent. The MEU and FU shocks are associated with clear contractionary macroeconomic responses, while the VRP shock behaves less like a standard "uncertainty contraction" and more like a risk-pricing disturbance with stronger effects on inflation, unemployment, and financial stress.



(a) Macroeconomic outcomes **(b)** Financial outcomes

Figure 2. Baseline IRF's: Macroeconomic and Financial Outcomes

The MEU shock is consistent with a broad macroeconomic-uncertainty channel, Figure 2a identifies a fall in IP growth for the first year while unemployment rises gradually and persistently at medium-to-long horizons, aligned with demand-side contraction through delayed expenditure and weaker labour-market conditions. Capital goods production falls sharply and in large magnitude on impact, consistent with the real-options "wait-and-see" mechanism of Bloom (2009) linking macroeconomic uncertainty to postponed investment. On the other side, Financial variables react less dramatically than under FU or VRP (Figure 2b) where CISS rises only modestly and NFC loan growth weakens and remains mostly negative thereafter.

The second row of Figure 2a shows the responses after an FU shock, a sequence that suggest financial stress precedes real contraction as the IP growth declines and unemployment rises (Figure 2a), but the most immediate and pronounced response is in CISS (Figure 2b), which rises sharply on impact and remains elevated for several months before mean-reverting. There is also a visible response aligned with demand compression through tighter financial conditions rather than a direct price-expectation channel as inflation falls persistently and NFC loan growth weakens in the same way, following a channel where elevated expected financial volatility reduces credit supply through the bank-based transmission mechanism.

The capital goods response also contracts, though less sharply than after a MEU shock, consistent with Bekaert and Hoerova (2014)'s finding that the physical variance component, not the risk premium, most robustly predicts real activity at medium horizons.

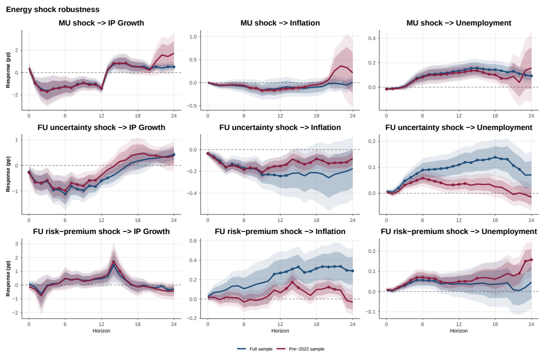
Showing a different transmission pattern, not consistent with the standard contractionary uncertainty shocks, VRP responses shows an immediate and sharp rise in the CISS (Figure 2b), indicating that the VRP is closely linked to financial market stress at short horizons, which is aligned with Caballero and Simsek (2024a)'s risk premium channel which states that when investors demand elevated compensation for bearing variance risk, financial conditions tighten accordingly.

The macro responses to a VRP shock show a divergence from the MEU and FU patterns (Figure 2a). First, inflation rises persistently, more aligned with a financial-conditions channel operating through asset prices and the exchange rate than through aggregate demand compression. Second, the unemployment response is weaker and less precisely estimated, and IP growth is volatile across horizons and positive at some medium-horizon windows, possibly reflecting the bank-based lag structure (Section 3.4) where the initial financial stress spike may be partially offset by ECB accommodation signals at short horizons, before the bank credit channel propagates real effects at longer horizons.

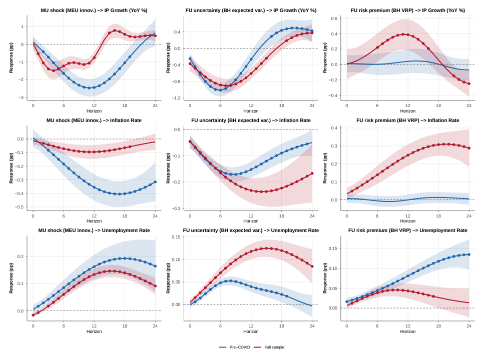
The baseline results show evidence of different transmission mechanisms among the three measures. MEU and FU both generate contractionary real effect, yet MEU's pattern suggest its primary transmission is through direct real-side effects, on the other hand, FU transmission mechanism is more through financial conditions rather than real side expectation revision, transmitting more immediately through financial stress and credit dynamics. Despite being derived alongside FU from option-implied financial volatility VRP shows an empirically distinct, more episodic and less consistently contractionary responses than FU. This last finding supports the idea that treating FU as a single homogeneous object would limit the relevant transmission mechanism. These patterns are robust to lag length, the choice of MEU proxy, the recursive ordering, and the inclusion of a sentiment indicator (Appendix C).

One concern is that the positive VRP-inflation response may reflect supply-shock contamination from the 2022 energy and geopolitical episode, during which risk premia and commodity prices moved simultaneously. Re-estimating the baseline LP on a pre-energy-shock sample ending December 2021 (Figure 3a) shows the positive VRP-inflation response is reduced but retains its sign and direction throughout, indicating the 2022 episode carried a substantial share of the estimated effect without being its sole source.

Although a COVID-19 dummy controls for the pandemic period in the baseline, a pre-COVID robustness exercise (Figure 3b) tests directly whether the pandemic drives the estimated effects. For MEU, the pre-COVID sample shows a more pronounced and persistent IP contraction and more clearly negative inflation than the full sample, consistent with the large MEU spike during COVID having been partially cushioned by extraordinary ECB communication. FU transmission is similarly stable or stronger pre-COVID, with the IP contraction and inflation decline preserved and a larger CISS response, suggesting ECB unconventional interventions partially compressed financial stress indicators even in high-FU environments. The VRP shows the most striking sample dependence: the pre-COVID inflation response is essentially zero throughout, with confidence bands spanning zero at all horizons, while the full sample produces the persistent positive response documented above.



(a) Pre-2022 energy shock sample



(b) Pre-COVID sample

Figure 3. Sub-sample Robustness: Excluding the 2022 Energy Shock and Pre-COVID Sample

Together, these results indicate that the positive VRP-inflation response is concentrated in the COVID and post-2022 supply-shock periods, when risk-premium spikes coincided with extraordinary inflationary pressure from supply disruptions and unconventional policy accommodation; in normal macro-financial conditions outside these episodes, VRP shocks produce no visible inflation response. This finding complies with the Caballero-Simsek framework, under which elevated risk premia should be neutral to disinflationary when transmission operates through wealth and credit effects rather than supply-side channels.

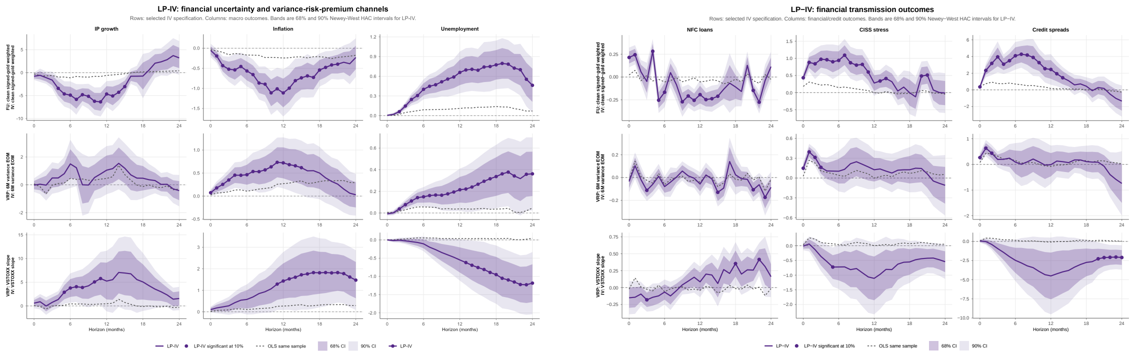
6.2 Local Projections - Instrumental Variables: Identifying the FU and VRP Channels

The baseline local projections estimate average conditional responses to FU and VRP innovations but do not address the residual endogeneity concern that both series may co-move with latent financial conditions not fully absorbed by the controls. The LP-IV specifications instrument each shock with an external variable whose identifying assumption restricts the channel of influence, sharpening the assessment of each component's causal content by isolating the variation predicted by the instrument.

6.2.1 *Instrument selection*

For Financial Uncertainty, the selected instrument is a signed gold-return weighted financial-event index exploiting safe-haven gold demand during arguably exogenous financial-stress episodes, intended to isolate movements in expected financial volatility less likely to reflect contemporaneous macroeconomic conditions, following the strategy of Piffer and Podstawski (2018) (events and weights in Appendix C). Additionally, a six-month implied variance at end-of-month (6M variance EOM) is used as instrument for VRP, the difference between the six-month risk-neutral variance priced in VSTOXX options and the expected physical variance from the GARCH decomposition, where both are expressed in annualized variance units; variation in the six-month risk premium exceeding the conditional physical variance forecast should affect outcomes only through the risk-pricing channel (Caballero and Simsek, 2024a). Alternative instrument specifications, first-stage diagnostics, and the cross-outcome OLS-versus-IV comparison are reported in Appendix B.5 and Appendix C.5 respectively.

6.2.2 *FU channel: Financial Uncertainty Amplification Mechanism*



(a) Macroeconomic outcomes **(b)** Financial outcomes

Figure 4. LP-IV IRFs: Macroeconomic and Financial Outcomes

Figure 4 presents the LP-IV responses to the instrumented FU shock alongside same-sample OLS responses, for both macroeconomic (panel a) and financial (panel b) outcomes. The IV estimate corrects for the modest results on the OLS baseline (Attenuation bias as documented by Bobasu et al. (2021)), in this specification, IP growth falls sharply, reaching approximately −5 percentage points around horizons 6 to 12 before recovering, a magnitude substantially larger than OLS and consistent with the finance uncertainty multiplier of Alfaro et al. (2024), where financially constrained firms amplify uncertainty shocks through precautionary liquidity motives that compound the standard wait-and-see mechanism.

The inflation response is persistently negative (Figure 4a), reaching approximately −1.1 p.p. at horizon 12, consistent with demand-side contraction as FU depresses investment and consumption through the credit channel and in line with Bekaert and Hoerova (2014)'s finding that the physical variance component (FU's conceptual counterpart) robustly predicts IP declines, distinct from the price-raising effect of the VRP discussed below. Unemployment rises gradually and remains significantly elevated through the medium horizon which aligns with labour-market adjustment lagging the initial contraction and with the euro area's rigid labour-market institutions producing a delayed but durable employment effect (Nalban and Smădu, 2021).

The financial-outcome responses (Figure 4b) reinforce the credit-channel interpretation: CISS rises sharply on impact, peaking around horizon 6 before gradually reverting, and credit spreads widen substantially at short-to-medium horizons, confirming that the signed-gold instrument isolates variation in FU associated with genuine financial-stress episodes rather than ordinary market-volatility fluctuations. NFC loan growth is more volatile and less precisely estimated, reflecting the slower quantity adjustment of bank credit supply relative to spread pricing, so the credit-channel evidence is interpreted primarily through CISS and spreads. Together, these responses are consistent with the tightening of bank credit standards documented by the ECB Bank Lending Survey, under which banks tighten credit standards for enterprise loans at a lag of roughly five to six quarters following a rise in perceived uncertainty (European Central Bank, 2023).

The LP-IV responses to the instrumented VRP shock shown in Figure 4a are clearly distinct from the FU-IV results. Industrial production does not display the sharp, persistent contraction seen after the FU shock; instead the response is hump-shaped and imprecise, with a modest positive movement at short horizons and a gradual return toward zero, suggesting the VRP does not transmit through the same direct contractionary channel as expected financial volatility. This difference is also visible with the inflation response (Figure 4a), which reaches approximately +0.7 p.p. at horizon 11. As the sub-sample evidence in Section 6.1 shows, however, this positive inflation effect reflects co-movement with supply shocks that the instrument does not fully orthogonalize away, a limitation acknowledged in Section 8.

These VRP responses are broadly consistent with the bank-based lag structure discussed in Section 3.4 where the initial stress spike may be partially offset by ECB accommodation at short horizons, before the bank credit channel tightens conditions at medium horizons. As well as with risk-centric models in which a shift in the price of risk generates inflationary pressure through the exchange rate and import prices.The imprecision of the IP response, however, means this interpretation remains suggestive rather than conclusive.

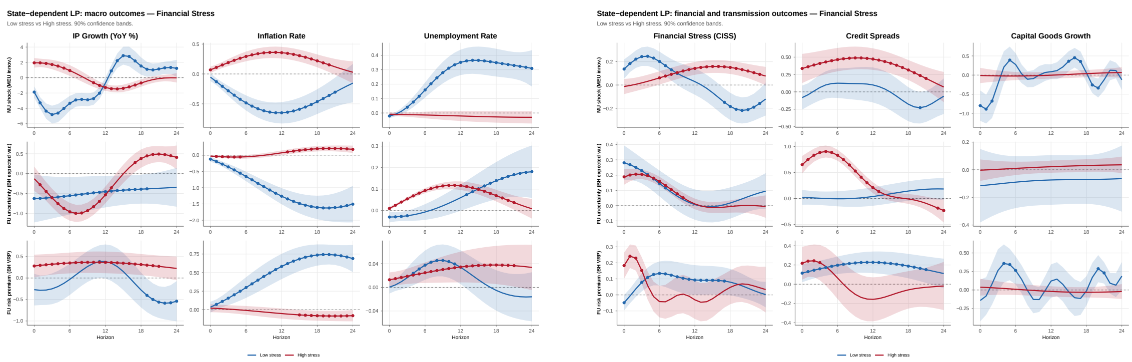
The labour-market response is more clearly adverse. Unemployment increases gradually and remains elevated at medium horizons, indicating persistent macroeconomic effects even without a sharp short-run IP contraction. The financial outcomes (Figure 4b) likewise support VRP's role as a risk-pricing shock as CISS rises on impact but fades faster than after FU, while credit and investment-related responses are more volatile and less precisely estimated.

6.2.3 Overall assessment

Together, the LP-IV evidence sharpens the distinction established in the baseline: FU instrumented with the gold-based index produces the clearest contractionary financial-stress transmission, with the OLS-IV gap confirming attenuation bias in the reduced-form estimates, while the VRP instrumented with the 6M variance EOM measure behaves as a genuinely distinct risk-pricing disturbance, its positive inflation response aligning with the cost-push mechanism of Caballero and Simsek (2024a) but attenuating toward zero outside crisis episodes, consistent with the theoretical distinction between expected volatility and the compensation required for bearing it.

6.3 State-dependent transmission: Bayesian-smoothed LP evidence

Previous findings show how the uncertainty measures under this specification have distinct average transmission profiles, this section evaluates whether these profiles change with the macro-financial environment in which the shock occurs. Bayesian-smoothed local projections are used only to improve the readability of the regime-specific impulse responses; they should therefore be interpreted as evidence on heterogeneous transmission rather than as a separate identification strategy.

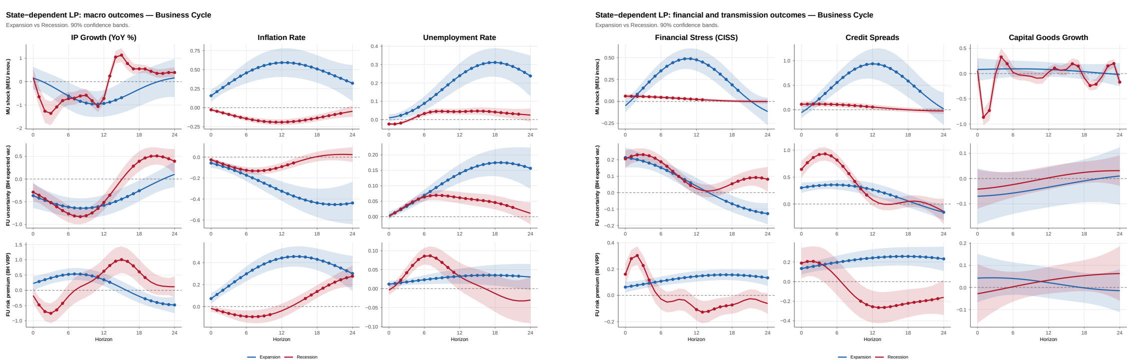


(a) Macroeconomic outcomes **(b)** Financial outcomes

Figure 5. State-dependent LP: Macroeconomic and Financial Outcomes under Financial Stress

Financial stress regime (CISS). Financial stress regimes shown in (Figure 5) suggest broader real effects under financial stress for both FU and MEU, though the formal Δ tests indicate the most robust amplification operates through financial conditions rather than real activity directly evidencing that under high financial stress, FU shocks show significantly larger credit-spread responses across horizons 0-7 (Δ significant at $p < 0.01$ to $p < 0.05$). While MEU also displays stronger real effects under high CISS, its amplification is broader and less specifically tied to financial variables. Conversely, the VRP shock produces a significantly larger on-impact CISS response under high stress ($\Delta = 0.245$, $p = 0.005$), confirming that priced volatility risk amplifies financial market stress when conditions are already elevated, and is associated with significantly more disinflationary pressure at long horizons (h = 18-24), consistent with the risk-premium demand-depression channel of Caballero and Simsek (2024a) operating most forcefully when financial fragility constrains the monetary policy offset.

Business cycle regime (CEPR recession). The CEPR recession split provides a complementary perspective (Figure 6). MEU produces significantly more disinflation during recessions than expansions, with the inflation Δ negative and significant from $h = 0$ through $h = 9$, aligning with demand compression amplifying when slack is already high and expectations are fragile. VRP shocks produce significantly more disinflation during recessions, with Δ negative and significant from $h = 1$ through $h = 17$, consistent with the Caballero-Simsek demand-recession mechanism: when the economy is already in a downturn, the risk-premium channel is not offset by monetary accommodation, and asset-price depression translates into persistent demand and price compression. VRP also produces a significantly larger IP contraction during recessions at short horizons (Δ negative and significant at h = 1-4), reinforcing this interpretation, while FU shocks show credit-spread amplification during recessions at short horizons (h = 0-6, $p < 0.05$), similar to the CISS regime.



(a) Macroeconomic outcomes **(b)** Financial outcomes

Figure 6. State-dependent LP: Macroeconomic and Financial Outcomes on Recessions

The unemployment response is particularly informative showing that labour-market effects are stronger and more persistent when the shock occurs in a downturn and suggesting uncertainty shocks are not linear disturbances with constant effects over the cycle, firms and households may be less able to absorb uncertainty without adjusting production, investment, or hiring when slack is already high and expectations are fragile.

The financial side of the transmission is also state-dependent over the business cycle as shown in Figure 6, though the mechanism is less directly financial than in the CISS regime: the CISS regime captures amplification operating inside the financial system through stress and credit conditions, while the recession regime captures broader macroeconomic vulnerability, where weak demand, labour-market slack, and fragile expectations increase the persistence of uncertainty shocks. The two regimes are therefore complementary rather than redundant.

Additional regimes The output-gap and zero-lower-bound regimes, reported in Appendix C, reinforce these conclusions: the output-gap split confirms that real-side weakness amplifies uncertainty effects through demand channels, while the ZLB split suggests stronger responses when conventional policy space is limited, especially for MEU, consistent with monetary accommodation cushioning uncertainty shocks in normal times while policy constraints make them more costly during ZLB periods.

The state-dependent results reinforce the baseline distinction between MEU, FU, and VRP. FU displays the clearest financial-state dependence, with stronger credit-spread responses under stress and recession regimes. MEU is more closely linked to recessionary demand conditions, while VRP differs from FU by showing sharper recession-state real effects and more short-lived financial-stress amplification. These results should be interpreted cautiously because some regimes, especially CEPR recessions, contain relatively few observations, but they support the central claim that uncertainty transmission in the euro area depends on both the type of uncertainty shock and the macro-financial state at the time of impact[4].

7 Discussion

The results of this paper are, in a way, a story about what volatility means: whether a surge in financial volatility contracts output because agents face genuine unpredictability about fundamentals, or because the price of bearing that uncertainty has risen. The empirical evidence suggests both mechanisms are present in the euro area, operating through different channels and responding differently to the state of the financial system.

The broadness and persistence of the Macroeconomic uncertainty contraction demonstrates the signature of a wait-and-see pause in irreversible decisions predicted by Bloom (2009) and Dixit and Pindyck (1994), with inflation declining moderately, consistent with demand compression rather than supply disruption. This channel is not financial in the first instance: it operates mainly through expectations about future fundamentals, and amplifies most strongly during recessions and when monetary policy space is constrained, the two conditions under which it has the least institutional capacity to be offset.

The Financial uncertainty evidence points most clearly towards a bank based financial accelerator path. Credit spreads widen, CISS rises persistently, NFC loan growth contracts, and inflation falls, showing a mechanism where elevated expected volatility raises inter-

[4]These patterns are formally confirmed by Delta test reported in Table 9 (Appendix C)

mediation costs, tightens credit supply, and amplifies the initial shock through balance sheet dynamics. Evidence across specifications is the most consistent through this channel, where the LP-IV estimates confirm attenuation bias in the OLS responses, consistent with the finance uncertainty multiplier of Alfaro et al. (2024), and the high-CISS regime shows the clearest and most persistent state-dependent amplification of all three components.

The variance risk premium tells a different and more ambiguous story. Financial stress spikes immediately but dissipates faster than under FU, the real activity response is delayed and imprecise, with the inflation response being episode-dependent following the cost-push extension of Caballero and Simsek (2024a) where elevated risk compensation tightens financial conditions through a common driver, rather than through direct VRP to inflation causation. The prediction that VRP transmission would be slower and more bank-mediated than in the US finds partial support in the delayed real activity profile. However, it is crucial to acknowledge that the imprecision of the IP response limits stronger claims.

Together, the three channels are complements in bad times: a shock that simultaneously elevates MEU, FU, and VRP, as in September 2008 and March 2020, activates three reinforcing mechanisms, investment postponement through wait-and-see, credit tightening through the financial accelerator, and risk-compensation pressure through the variance risk premium channel, operating with longer lags in the bank-based euro area transmission structure. The aggregate euro area data likely attenuates each effect individually, blending the faster market-based transmission of Germany and France with the slower bank-dependent adjustment of Italy and Spain. Decomposing these aggregate patterns into country-specific channels remains an important direction for further work.

8 Limitations and Further Research

The analysis is subject to several limitations that qualify the interpretation of the results and motivate further work.

Aggregate identification and cross-country heterogeneity. The empirical analysis is conducted on Euro Area aggregate data. This is useful for studying the Euro Area as a single monetary-policy area, but it masks important cross-country differences in financial structure, banking dependence, external exposure, and policy transmission. The estimated impulse responses therefore average economies where uncertainty shocks may operate through different channels and at different speeds. This is especially relevant for the VRP, whose transmission may differ between economies with deeper financial markets and economies where bank credit plays a larger role.

Measurement and identification. The VRP is constructed as the difference between risk-neutral implied variance and a GARCH-based forecast of physical variance. This residual construction introduces measurement uncertainty, since any error in the physical variance forecast enters mechanically into the VRP. Monthly aggregation may also smooth over high-frequency movements in the variance risk premium, reducing the precision with which its macroeconomic effects can be estimated. The LP-IV results face an important limitation as the exclusion restrictions are plausible but not directly testable. The gold-based FU instrument may capture broader risk-off movements around financial stress events. On the MEU side, candidate instruments based on geopolitical event indices, gold safe-haven and CB communication surprises were explored but failed to achieve adequate first-stage relevance without violating plausible exclusion restrictions. The MEU channel therefore rests on reduced-form identification, and the results for MEU should be interpreted as conditional correlations rather than causal estimates, consistent with Ludvigson et al. (2021) who similarly note the identification challenge for macroeconomic uncertainty.

The robustness exercises reported in Section 6.1 provide direct evidence that the VRP inflation response is concentrated in the COVID and post-2022 energy periods, meaning that supply-shock co-movement partially contaminates the full-sample IV estimate. Additionally, the change in the policy rate controls for conventional monetary policy accommodation but does not capture accommodation operating through forward guidance or asset purchase programmes, which were the primary ECB tools during the 2013–2022 period and may have partially offset uncertainty shocks in ways the control vector does not absorb.

Regime scarcity and linearity. The state-dependent results are constrained by the limited number of recession, financial-stress, and ZLB episodes in the sample. These episodes are heterogeneous in origin and policy response, including the Global Financial Crisis, the sovereign debt crisis, and the COVID-19 recession. Pooling them under smooth or binary regime indicators is useful for detecting broad heterogeneity, but it cannot completely identify episode-specific mechanisms. The baseline LP's also impose linearity, treating positive and negative innovations symmetrically. This may be restrictive for the VRP, which is right-skewed and characterized by large positive spikes during stress episodes. Because the CISS regime is smooth rather than binary, the reported low- and high-stress responses are endpoint responses implied by the transition function, not simple averages over observed low- and high-stress months. This makes the coefficients useful for describing the direction and magnitude of regime-dependent transmission, but limits their direct comparability with responses obtained from a binary high/low sample split.

Further research. Future research could extend the analysis in three directions. First, a country-level panel LP for major Euro Area economies would allow the aggregate responses to be decomposed into national transmission channels and would test whether bank-dependent economies react differently to FU and VRP shocks. Second, higher-frequency realized variance data or a HAR-based decomposition, as in Bekaert and

Hoerova (2014), could improve the measurement of the physical variance component and sharpen the VRP estimates. Third, richer external instruments or data on institutional investor flows and ECB-market expectation disagreements could move the analysis closer to a structural identification of the risk-pricing channel. Extending the sample beyond 2024 would also allow future work to evaluate whether the VRP channel changes during the ECB rate-normalization period, when conventional monetary policy space is no longer constrained by the ZLB.

9 Conclusion

This paper studies whether macroeconomic uncertainty, expected financial volatility, and priced volatility risk transmit differently to the Euro Area economy, or whether they are better understood as different names for the same underlying disturbance. The evidence presented in this paper points towards the former. MEU drives a broad, slow-moving real contraction weakening IP and inflation; FU operates mainly through credit and financial stress, with lower response from real activity and inflation; and VRP, despite being extracted from the same option-implied variance as FU, its effect behaves more like a risk-pricing shock than a conventional uncertainty shock, with effects sharper on impact, more episodic and harder to observe at long horizons.

The LP-IV evidence sharpens this distinction. When FU is instrumented using the signed gold-based index it produces substantially larger contraction than in the same-sample OLS estimates, supporting prior claims and suggesting that the baseline understates how disruptive FU shocks are once the endogenous component is stripped away. The VRP instrumented with the six-month variance EOM measure shows a different transmission profile, it shows a less persistent IP contraction, episode-dependent inflation, gradually rising unemployment, and a more short-lived on-impact financial stress than FU. This results strengthen the claim that VRP moves through a distinct channel and shouldn't be considered as just another measure of expected financial uncertainty.

The state-dependent results confirm that uncertainty transmission depends on the prevailing macro-financial regime. Transmission operates through the credit channel for FU under financial stress, through demand and inflation for MEU during recessions, and for VRP through on-impact financial stress with recession-period real and inflation effects. Uncertainty shocks are therefore not linear disturbances with constant effects, but depend on the economy's initial condition, particularly its financial fragility and cyclical position.

These findings have important implications for policy analysis. The ECB and observers of euro area macro-financial conditions, must be aware that the use of a single uncertainty index is likely to miss part of the picture. Monitoring uncertainty requires distinguishing between macroeconomic uncertainty, expected financial volatility, and priced volatility risk.

A rise in FU may signal a financial-stress shock with contractionary consequences through the credit channel, while a rise in the VRP may instead reflect a repricing of volatility risk whose macroeconomic consequences may depend heavily on what else is happening at that time, particularly if the economy is already in a downturn or financial strain. Treating all uncertainty indicators as equivalent can therefore obscure the relevant transmission channel and lead to an incomplete assessment of macro-financial risks.

The aggregate, euro area-wide framework used here is also its main limitation, and the most natural next step. If FU and VRP transmit partly through bank balance sheets, then countries with different banking structures and different exposure to market-based finance plausibly experience these shocks differently. A country-level extension of this framework,would be the most direct way to test whether the bank-based transmission story told here for the euro area as a whole actually holds at the national level, and for which countries it holds most strongly.

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A Construction of Financial Uncertainty and Variance Risk Premium Measures

This appendix describes the construction of the financial uncertainty and variance risk premium measures used in the local projection exercises. The objective is to separate the option-implied variance of the euro-area equity market into two components: an expected physical variance component and a variance risk premium component. The construction follows the logic of the variance decomposition used by Bekaert et al. (2013) and Bekaert and Hoerova (2014), adapted to the euro-area setting using the VSTOXX index and EURO STOXX 50 returns.

A.1 Conceptual decomposition

Let IV_t^{ann} denote the annualized risk-neutral implied variance of the euro-area equity market. The VSTOXX index is quoted as annualized implied volatility in percentage points. Therefore, monthly VSTOXX series are converted into annualized implied variance as:

$$IV_t^{ann} = \left(\frac{VSTOXX_t}{100}\right)^2 .$$

This object is interpreted as a market-based proxy for the risk-neutral expectation of near-term future realized variance. This follows the model-free implied variance logic developed in the option-pricing literature, where option prices can be used to recover risk-neutral expectations of future variance. In practice, this is only an approximation because it depends on the index methodology, option-market liquidity, strike availability, interpolation, and measurement conventions. Therefore, IV_t^{ann} is not treated as a perfectly observed theoretical object, but as an empirical proxy for risk-neutral expected variance. The physical counterpart is the conditional expectation of future realized variance under the objective probability measure P:

$$E_t^P\left(RV_{t,t+22}^{ann}\right),$$

where the 22-trading-day horizon corresponds approximately to the 30-calendar-day horizon of volatility indices such as VSTOXX. The financial uncertainty component is defined as this expected physical variance:

$$FU_t = E_t^P\left(RV_{t,t+22}^{ann}\right)$$

The variance risk premium is defined as the wedge between risk-neutral and physical expected variance:

$$VRP_t = IV_t^{ann} - E_t^P\left(RV_{t,t+22}^{ann}\right).$$

Hence the implied variance is decomposed as

$$IV_t^{ann} = FU_t + VRP_t.$$

In this thesis, FU_t is interpreted as expected physical financial uncertainty, while VRP_t captures the pricing wedge between risk-neutral and physical expectations of variance. This decomposition is exact once IV_t^{ann} and FU_t are constructed, but its economic interpretation depends on the quality of the implied-variance proxy and the physical-variance forecast.

A.2 Physical variance forecast: GARCH(1,1)

To construct FU_t, a GARCH(1,1) model is estimated using daily EURO STOXX 50 log returns. Let

$$r_d = \log(P_d) - \log(P_{d-1})$$

denote the daily log return. The return equation is

$$r_d = \mu + \varepsilon_d, \qquad \varepsilon_d|\mathcal{F}_{d-1} \sim (0, h_d),$$

with conditional variance

$$h_d = \omega + \alpha\varepsilon_{d-1}^2 + \beta h_{d-1}.$$

The GARCH model is appropriate in this context because equity returns display volatility clustering: large shocks tend to be followed by periods of elevated conditional variance. ARCH and GARCH models were developed precisely to model time-varying conditional variance in financial time series, with GARCH extending ARCH by allowing conditional variance to depend both on past squared innovations and past conditional variance.

The one-step-ahead conditional variance forecast after observing day d is:

$$h_{d+1|d} = \omega + \alpha\varepsilon_d^2 + \beta h_d.$$

If $\alpha + \beta < 1$, the model is covariance stationary and has long-run variance:

$$\bar{h} = \frac{\omega}{1 - \alpha - \beta}.$$

The j-step-ahead conditional variance forecast is then:

$$E_d(h_{d+j}) = \bar{h} + (\alpha + \beta)^{j-1}\left(h_{d+1|d} - \bar{h}\right), \qquad j = 1, \ldots, 22.$$

Therefore, the expected cumulative variance over the next 22 trading days is:

$$\sum_{j=1}^{22} E_d(h_{d+j}) = 22\bar{h} + \frac{1 - (\alpha + \beta)^{22}}{1 - \alpha - \beta}\left(h_{d+1|d} - \bar{h}\right).$$

This 22-day expected variance is annualized as:

$$\widehat{RV}^{P,ann}_{d,d+22} = \frac{252}{22} \sum_{j=1}^{22} E_d(h_{d+j}).$$

The resulting daily annualized physical variance forecast is then aggregated to monthly frequency by taking the monthly average of the daily 22-day forecasts.

$$FU_t = \frac{1}{n_t} \sum_{d \in t} \widehat{RV}^{P,ann}_{d,d+22},$$

where n_t is the number of trading days in month t. This monthly average is the baseline physical variance proxy used in the decomposition.

A.3 Risk-neutral variance, physical variance and VRP

The empirical implementation works in annualized variance units throughout. The risk-neutral implied variance is

$$implied\_var\_q_t = \left(\frac{VSTOXX_t}{100}\right)^2.$$

The preferred physical expected variance is

$$garch\_var\_p\_22_t = \left(\frac{garch\_vol\_22\_ann_t}{100}\right)^2.$$

The main financial uncertainty component is then

$$fu\_uncertainty_t = garch\_var\_p\_22_t,$$

and the variance risk premium is

$$fu\_riskpremium_t = implied\_var\_q_t - garch\_var\_p\_22_t.$$

A.4 Innovation extraction for local projections

The local projections use innovations, not the raw levels, as shocks. The raw components FU_t and VRP_t are persistent financial variables. To extract unexpected movements, I estimate autoregressive innovation equations. For the financial uncertainty component,

$$FU_t = a_0 + \sum_{\ell=1}^{p} a_\ell FU_{t-\ell} + \sum_{\ell=1}^{p} b_\ell VRP_{t-\ell} + u_t^{FU}.$$

The residual is the FU uncertainty innovation:

$$fu\_uncertainty\_innov_t = \widehat{u}_t^{FU}.$$

For the risk-premium component,

$$VRP_t = c_0 + \sum_{\ell=1}^{q} c_\ell VRP_{t-\ell} + \sum_{\ell=1}^{q} d_\ell FU_{t-\ell} + u_t^{VRP}.$$

The residual is the VRP innovation:

$$fu\_riskpremium\_innov_t = \widehat{u}_t^{VRP}.$$

In the implementation, $fu\_uncertainty\_innov_t$ is extracted using an AR specification selected by information and residual-correlation diagnostics. For $fu\_riskpremium\_innov_t$, I use six monthly lags. This choice is not arbitrary: shorter lag specifications left more residual persistence in the risk-premium component, while $p = 6$ produced acceptable Ljung-Box diagnostics. The risk-premium component is less predictable than the physical variance component, consistent with the idea that it captures changes in market risk pricing and sentiment.

A.5 Validation of the physical variance proxy

I compare the baseline 22-day GARCH physical variance forecast with three alternatives: a low-frequency HAR approximation, a GARCH-X model including MEU, and a GARCH-X model including macro-financial controls. This is an internal in-sample validation exercise, not a pseudo-out-of-sample forecasting exercise. The goal is to assess whether the baseline GARCH-22 day measure is empirically adequate in this dataset and whether adding macro uncertainty or macro controls substantially improves the physical variance proxy. The comparison uses three criteria: mean squared forecast error (MSFE), QLIKE, and correlation with realized variance. The results are: In this implementation, the GARCH-22

Table 2. In-sample comparison of physical variance forecasts

Model	MSFE	QLIKE	Corr(RV)
GARCH-22 day (main)	0.0006	0.1065	0.9693
HAR	0.0030	0.2771	0.5285
GARCH-X MEU	0.0007	0.1155	0.9590
GARCH-X Macro	0.0007	0.1087	0.9650

day model obtains the lowest MSFE, the lowest QLIKE, and the highest correlation with realized variance. The GARCH-X models do not improve forecast accuracy relative to the parsimonious GARCH-22 day benchmark. The low-frequency HAR approximation performs substantially worse in this monthly implementation. This should not be interpreted as evidence that GARCH dominates HAR-type models in general. HAR models were developed for realized-volatility forecasting and are often used with richer high-frequency realized-variance data. In this application, the HAR specification is a low-frequency approximation based on monthly realized-variance lags. Therefore, the result only supports the use of GARCH-22 day as the baseline physical variance proxy in this dataset.

A.6 Correlation diagnostics with macroeconomic uncertainty and financial stress

As a further validation check, I compare the VRP series generated by alternative physical-variance forecasts with MEU and CISS. The results are

Table 3. Correlation of VRP measures with CISS and MEU

Model	Corr(CISS)	Corr(MEU)	N
VRP GARCH-22 day	0.143	-0.070	248
VRP HAR	0.320	0.524	248
VRP GARCH-X MEU	0.185	-0.0256	248
VRP GARCH-X Macro	0.220	-0.029	248

These correlations support the baseline GARCH-22 day decomposition. The GARCH-based VRP has a low correlation with MEU, while the HAR-based VRP is strongly correlated with MEU. It suggests that the GARCH-22 day decomposition better preserves the empirical separation between macroeconomic uncertainty and the financial risk-premium component. This reduces the concern that the VRP measure mechanically reproduces macroeconomic uncertainty.

A.7 GARCH-X robustness

The GARCH-X MEU exercise maps monthly MEU observations to daily EURO STOXX 50 returns. This allows the GARCH-X model to be estimated over the full daily sample, but it also means that the GARCH-X MEU exercise should be interpreted cautiously. The key result is that adding MEU or macro-financial controls to the variance equation does not improve the forecasting performance of the physical variance proxy relative to the baseline GARCH-22 day model.

A.8 Diagnostic tests

The GARCH(1,1) model is evaluated using standard residual diagnostics. The relevant tests are:

$$H_0 : \text{no serial correlation in standardized residuals,}$$

$$H_0 : \text{no serial correlation in squared standardized residuals,}$$

and

$$H_0 : \text{no remaining ARCH effects.}$$

The estimated model has persistence $\alpha + \beta < 1$, indicating covariance stationarity. The Ljung-Box test on standardized residuals, the Ljung-Box test on squared standardized residuals, and the ARCH-LM test do not indicate major remaining serial correlation or ARCH effects at conventional levels.

$$\alpha = 0.107, \qquad \beta = 0.875, \qquad \alpha + \beta = 0.983.$$

$$p_{\text{LB residuals}} = 0.79, \qquad p_{\text{LB squared residuals}} = 0.15, \qquad p_{\text{ARCH-LM}} = 0.12$$

These diagnostics indicate that the GARCH(1,1) model is adequate for constructing a parsimonious physical variance forecast in this application.

A.9 Final empirical choice

Based on the variance-unit consistency, the 22-trading-day horizon alignment with VSTOXX, the diagnostic tests, the in-sample forecast comparison, and the lower overlap with MEU, GARCH-22 day physical variance forecast is used as the main measure of financial uncertainty:

$$FU_t = garch\_var\_p\_22_t.$$

The main variance risk premium measure is:

$$VRP_t = implied\_var\_q_t - garch\_var\_p\_22_t.$$

The decomposition is empirically motivated and internally validated, but it is not a unique decomposition of uncertainty and risk premia.

B LP Methodology

B.1 Baseline local projection methodology

For each outcome y_t, I estimate impulse responses using local projections. For horizons $h = 0, \dots, H$, with $H = 24$, the baseline regression is

$$y_{t+h} = \alpha_h + \boldsymbol{\beta}_h' \mathbf{u}_t + \Gamma_h' \mathbf{W}_{t-1:t-p} + \Phi_h' \mathbf{Z}_t + \varepsilon_{t+h},$$

where

$$\mathbf{u}_t = \begin{bmatrix} u_t^{MEU} \\ u_t^{FU} \\ u_t^{VRP} \end{bmatrix}.$$

The coefficient vector

$$\boldsymbol{\beta}_h = \begin{bmatrix} \beta_h^{MEU} \\ \beta_h^{FU} \\ \beta_h^{VRP} \end{bmatrix}$$

contains the horizon-h responses to the three uncertainty innovations. The control vector $\mathbf{W}_{t-1:t-p}$ includes p lags of the dependent variable and p lags of the macro-financial controls. The baseline uses $p = 2$. The vector $\mathbf{Z}_t$ contains contemporaneous exogenous controls, in particular the COVID-19 dummy.

The local projection estimator is obtained horizon by horizon by ordinary least squares:

$$\widehat{\boldsymbol{\theta}}_h = \left(\mathbf{R}_h'\mathbf{R}_h\right)^{-1}\mathbf{R}_h'\mathbf{y}_h,$$

where $\mathbf{R}_h$ is the matrix collecting the shock innovations, lagged controls, lagged outcome terms, and exogenous dummy variables for horizon h. The relevant impulse response is the component of $\widehat{\boldsymbol{\theta}}_h$ corresponding to the shock of interest.

The shocks used in the baseline are reduced-form innovations. For a generic uncertainty measure q_t, the innovation is obtained from an autoregressive specification of the form:

$$q_t = a_0 + \sum_{\ell=1}^{p_q} a_\ell q_{t-\ell} + \mathbf{b}'\mathbf{M}_{t-1} + u_t^q,$$

where $\mathbf{M}_{t-1}$ denotes additional lagged macro-financial predictors when included. The resulting residual u_t^q is standardized and used as the shock in the LP. In the baseline implementation, u_t^{MEU} is the innovation of the MEU composite, u_t^{FU} is the innovation of the expected physical financial-variance component, and u_t^{VRP} is the innovation of the variance risk premium. This construction removes predictable own dynamics from each measure before estimating impulse responses. The innovation should not be interpreted as unconditionally exogenous; it is a reduced-form shock conditional on the lag structure and controls used in the specification.

The baseline LP includes the three innovations jointly. Therefore, the coefficient β_h^{FU}, for example, measures the response to an innovation in financial uncertainty conditional on contemporaneous innovations in MEU and VRP. This avoids attributing all common uncertainty variation to a single measure, but it does not by itself impose a structural contemporaneous ordering.

Because y_{t+h} overlaps across horizons, local projection residuals are serially correlated. Therefore Newey–West HAC standard errors are computed (Newey and West, 1987). For each horizon h, the HAC bandwidth is set to:

$$L_h = \max(h, p),$$

which ensures that the covariance estimator allows for the moving-average structure induced by the h-period-ahead dependent variable. Confidence intervals are constructed as:

$$\widehat{\beta}_h \pm c_\alpha \widehat{\text{se}}(\widehat{\beta}_h),$$

with $c_\alpha = 1$ for approximately 68 percent intervals and $c_\alpha = 1.645$ for 90 percent intervals.

Lag length is selected using a parsimonious macro-financial VAR lag-selection exercise. BIC selected one lag, while AIC selected a much longer lag length. Since one lag is likely too restrictive for monthly macro-financial dynamics, the baseline imposes a minimum of two lags. Six lags are used as a robustness specification. This preserves a balance between dynamic flexibility and finite-sample precision.

B.2 Recursive ordered LP robustness

The baseline LP estimates conditional responses but does not impose a contemporaneous causal ordering among the uncertainty shocks. As a robustness check, I estimate a recursive ordered specification. The ordering is

$$MEU \rightarrow FU \rightarrow VRP.$$

This ordering treats macroeconomic uncertainty as the most predetermined monthly innovation, financial uncertainty as an intermediate financial-volatility component, and the variance risk premium as the most immediately responsive risk-pricing component.

Let the original innovation vector be

$$\mathbf{u}_t = \begin{bmatrix} u_t^{MEU} \\ u_t^{FU} \\ u_t^{VRP} \end{bmatrix}.$$

The ordered shocks are constructed sequentially. First,

$$\widetilde{u}_t^{MEU} = u_t^{MEU}.$$

Second, financial uncertainty is residualized on the ordered MEU shock:

$$u_t^{FU} = \delta_0 + \delta_1 \widetilde{u}_t^{MEU} + \widetilde{u}_t^{FU}.$$

Third, the variance risk premium is residualized on the preceding ordered shocks:

$$u_t^{VRP} = \eta_0 + \eta_1 \widetilde{u}_t^{MEU} + \eta_2 \widetilde{u}_t^{FU} + \widetilde{u}_t^{VRP}.$$

The residuals $\widetilde{u}_t^{MEU}$, $\widetilde{u}_t^{FU}$, and $\widetilde{u}_t^{VRP}$ are standardized and then used in the same LP specification as the baseline. This recursive procedure assigns contemporaneous covariance according to the imposed ordering. Since the ordering is not directly testable, the ordered LP results are interpreted as robustness evidence rather than as the main identification strategy.

B.3 Bayesian local projection smoothing

As an additional robustness exercise, Bayesian local projections that smooth the impulse-response path across horizons are estimated. The starting point is the sequence of horizon-by-horizon LP estimates,

$$\widehat{\boldsymbol{\beta}} = \left(\widehat{\beta}_0, \widehat{\beta}_1, \ldots, \widehat{\beta}_H\right)'.$$

The Bayesian specification treats the true impulse-response path as an unknown smooth function over horizons:

$$\boldsymbol{\beta} \sim \mathcal{N}(0, K),$$

where K is a Gaussian-process covariance matrix. In the implementation, the covariance between two horizons h and h' is

$$K(h, h') = \sigma_f^2 \exp\left[-\frac{(h-h')^2}{2\ell^2}\right].$$

The LP estimates are treated as noisy observations of the underlying impulse-response path:

$$\widehat{\boldsymbol{\beta}} \mid \boldsymbol{\beta} \sim \mathcal{N}\left(\boldsymbol{\beta}, \Lambda\right),$$

where Λ is a diagonal matrix containing the squared frequentist standard errors from the LP estimates. The posterior distribution is

$$\boldsymbol{\beta} \mid \widehat{\boldsymbol{\beta}} \sim \mathcal{N}\left(\boldsymbol{\mu}_{post}, \Sigma_{post}\right),$$

with

$$\Sigma_{post} = \left(K^{-1} + \Lambda^{-1}\right)^{-1},$$

and

$$\boldsymbol{\mu}_{post} = \Sigma_{post}\Lambda^{-1}\widehat{\boldsymbol{\beta}}.$$

This approach regularizes noisy horizon-by-horizon LP estimates by borrowing information across adjacent horizons. I use it as a presentation and robustness device, not as a replacement for the baseline frequentist LP estimates.

B.4 LP-IV methodology and instrument construction

The LP-IV specification instruments one uncertainty innovation at a time. Let s_t^j denote the targeted uncertainty shock, where $j \in \{FU, VRP\}$, and let Z_t^j denote the corresponding instrument. The vector R_t contains all included exogenous regressors: the non-instrumented uncertainty innovations, contemporaneous exogenous controls, lagged outcome terms, and lagged macro-financial controls.

For each horizon $h = 0, \ldots, H$, the structural LP equation is

$$y_{t+h} = \alpha_h + \beta_h^j s_t^j + \Psi_h' R_t + \varepsilon_{t+h}.$$

The concern is that s_t^j may be correlated with ε_{t+h}. This can happen if the measured uncertainty innovation reacts contemporaneously to expected future macro-financial conditions, if it contains measurement error, or if omitted financial shocks affect both uncertainty and the outcome. The LP-IV estimator therefore uses an external instrument Z_t^j satisfying

$$\mathrm{Cov}(Z_t^j, s_t^j \mid R_t) \neq 0,$$

and

$$\mathbb{E}\left[Z_t^j \varepsilon_{t+h} \mid R_t\right] = 0.$$

The first condition is relevance. The second condition is the conditional exclusion restriction.

The first-stage equation is:

$$s_t^j = \pi_0 + \pi_1 Z_t^j + \Pi' R_t + v_t^j.$$

The fitted value from this first stage is:

$$\widehat{s}_t^j = \widehat{\pi}_0 + \widehat{\pi}_1 Z_t^j + \widehat{\Pi}' R_t.$$

Then, the second-stage local projection is:

$$y_{t+h} = \alpha_h + \beta_h^j \widehat{s}_t^j + \Psi_h' R_t + \varepsilon_{t+h}.$$

Equivalently, defining $X_t = [s_t^j, R_t]$ and $Q_t = [Z_t^j, R_t]$, the two-stage least squares estimator at horizon h is:

$$\widehat{\theta}_h^{IV} = \left(X' P_Q X\right)^{-1} X' P_Q Y_h,$$

where:

$$P_Q = Q(Q'Q)^{-1}Q',$$

and Y_h stacks the observations of y_{t+h}. The coefficient of interest is the element of $\widehat{\theta}_h^{IV}$ corresponding to s_t^j.

The implementation estimates this equation separately for each horizon. The same control logic as in the baseline LP is used: the policy-rate change, output gap, CISS, credit-spread changes, and inflation enter as lagged controls; the dependent variable itself is not included as a control when it is the outcome; industrial production growth is added to non-output equations; and the COVID dummy enters contemporaneously. The baseline uses two lags, while six lags are retained for robustness. HAC standard errors are computed using a Newey–West covariance estimator with horizon-dependent bandwidth.

For each instrument, First-stage diagnostics are reported. The first-stage relevance statistic is computed from the HAC t-statistic on the instrument:

$$F_{HAC} = t_{HAC}^2.$$

Because these are time-series LP-IV regressions with HAC inference, the F-statistic is used as a practical relevance diagnostic rather than as a mechanical Stock–Yogo weak-instrument test. Instruments with stronger and correctly signed first stages are preferred, but relevance alone is not sufficient for validity. The exclusion restriction is assessed through the economic construction of the instrument and through robustness checks.

For the FU innovation, the preferred instrument comes from the gold-financial event family. The candidate instruments are built from a curated set of financial-stress events. In the signed-window version, adverse financial events enter positively, and the event month receives weight one while the following month receives a smaller weight to account for monthly timing mismatch. The logic is that adverse financial-stress events that generate safe-haven reactions in gold should predict increases in expected physical financial volatility. The expected first-stage sign is therefore positive:

$$\pi_1^{FU} > 0.$$

Table 4. Construction of the Signed-Gold Financial-Event Instruments

Date	Event	Gold (%)	Wgt.	Rationale	IV
2007-08-01	BNP Paribas freezes subprime funds	-0.688	2.0	Major banking/market stress	C
2007-09-01	Northern Rock liquidity support	0.319	2.0	Major banking/market stress	C
2008-03-01	Bear Stearns rescue	1.993	2.0	Major banking/market stress	C
2008-09-01	Lehman bankruptcy / AIG rescue	3.865	3.0	Global systemic event	C
2008-09-01	US House rejects TARP	-0.884	2.0	Major banking/market stress	B
2009-10-01	Greece reveals larger deficit	0.095	2.0	Major banking/market stress	B
2009-11-01	Dubai World debt standstill	0.275	1.5	Medium stress event	C
2010-05-01	Flash Crash	1.211	1.5	Medium stress event	C
2010-05-01	EFSF agreed	-1.164	2.0	Major banking/market stress	N
2011-08-01	US sovereign downgrade, market day	3.075	2.0	Major banking/market stress	B
2011-11-01	Berlusconi announces resignation	-0.836	1.0	Ambiguous/smaller event	B
2012-09-01	ECB OMT announcement	-0.439	2.5	Very large systemic event	N
2012-09-01	German Constitutional Court approves ESM	0.345	1.5	Medium stress event	N
2013-03-01	Cyprus bail-in, market day	0.251	2.0	Major banking/market stress	B
2015-01-01	SNB removes EUR/CHF floor	0.020	1.0	Ambiguous/smaller event	B
2015-07-01	Greek referendum, market day	-0.317	1.5	Medium stress event	B
2015-08-01	China RMB devaluation	1.481	1.0	Ambiguous/smaller event	B
2016-01-01	China market stress / trading halt	0.421	2.0	Major banking/market stress	B
2018-02-01	Volmageddon	0.829	2.0	Major banking/market stress	C
2018-05-01	Italian constitutional crisis	NA	1.0	Ambiguous/smaller event	B
2018-08-01	Turkish lira crisis	-0.222	1.5	Medium stress event	B
2018-10-01	EC rejects Italy budget	0.028	1.0	Ambiguous/smaller event	B
2018-10-01	Global equity selloff	1.052	2.0	Major banking/market stress	C
2018-12-01	Christmas crash / US government shutdown	0.246	1.5	Medium stress event	B
2020-03-01	COVID / oil price war crash	-0.419	1.0	Ambiguous/smaller event	B
2022-09-01	UK mini-budget	-0.622	2.0	Major banking/market stress	C
2023-03-01	SVB collapse	1.120	2.0	Major banking/market stress	C
2023-03-01	Credit Suisse rescue, market day	NA	2.5	Very large systemic event	C
2024-06-01	Macron calls snap French elections	-0.569	1.0	Ambiguous/smaller event	B

Note: C = clean and broad; B = broad only; N = neither (policy relief/stabilization events).

Broader event sets and alternative gold-reaction weights are retained only as robustness checks because increasing the number of events may improve relevance but can weaken the exclusion argument.

For the VRP innovation, the main instrument is the six-month variance EOM:

$$Z_t^{VRP,2} = IV_t^{6M} - \widehat{RV}_t^{6M},$$

As robustness checks, the short-end VSTOXX term-structure slope is tested:

$$Z_t^{VRP,1} = V1X_t - V3X_t,$$

standardized over the estimation sample. This instrument captures whether short-maturity option-implied volatility is elevated relative to the medium horizon. Such movements are expected to be informative about near-term variance-risk pricing pressures, and hence about the VRP innovation.

These alternatives capture risk-pricing variation over a longer horizon and are therefore not expected to produce numerically identical responses to the short-end slope instrument.

Overall, the LP-IV results are interpreted as identification checks for the FU and VRP channels. They are not meant to replace the baseline LP estimates. Instead, they ask whether the main conclusions are robust when the targeted uncertainty innovation is isolated using external variation rather than using the full reduced-form innovation.

B.5 Instrumental Variable Election and Diagnostics

Two main instruments were tested for VRP. The short-slope instrument produces very large responses, especially for industrial production, inflation, unemployment, and CISS. However, these responses come with very wide confidence bands and appear more sensitive to the specific maturity structure being used. Economically, this is plausible because the short-end VSTOXX slope captures near-term volatility repricing relative to medium-horizon expectations. That variation may be highly episodic and closely tied to acute market stress. By contrast, the 6-month variance EOM instrument produces more stable medium-horizon responses and is closer to the variance-based definition of the VRP used in the thesis. The fact that the 6-month variance and 6-month volatility-spread instruments deliver broadly similar patterns strengthens the interpretation that the main VRP-IV results are not driven by a single arbitrary proxy.

Table 5. FU Instrument First-Stage Diagnostics

Instrument	Coef	HAC t	HAC F	p-value	Sign OK
iv_fu_goldfin_clean_signed_w_std	0.188	4.947	24.476	0.000	TRUE
iv_fu_goldfin_ea_signed_w_std	0.151	7.361	54.190	0.000	TRUE
iv_fu_goldfin_clean_signed_window_std	0.364	4.142	17.158	0.000	TRUE
iv_fu_goldfin_signed_policy_gold_window_std	0.432	5.415	29.319	0.000	TRUE
iv_fu_goldfin_clean_signed_std	0.194	3.902	15.229	0.000	TRUE
iv_fu_goldfin_ea_signed_std	0.126	2.518	6.338	0.012	TRUE
iv_fu_goldfin_broad_signed_w_std	0.239	5.129	26.312	0.000	TRUE
iv_fu_goldfin_broad_signed_window_std	0.422	5.024	25.241	0.000	TRUE

Table 6. VRP Instrument First-Stage Diagnostics

Instrument	Coef	HAC t	HAC F	p-value	Sign OK
iv_vrp6m_var_eom_std	0.682	4.943	24.433	0.000	TRUE
iv_vrp6m_volspread_eom_std	0.672	5.282	27.895	0.000	TRUE
instrument_slope	0.335	3.785	14.325	0.000	TRUE
iv_vrp6m_volspread_innov_std	0.329	3.204	10.263	0.002	TRUE
iv_vrp6m_volspread_std	0.291	2.843	8.083	0.005	TRUE
iv_vrp6m_var_std	0.269	2.173	4.722	0.031	TRUE
iv_vrp6m_var_innov_std	0.263	1.560	2.435	0.120	TRUE

B.5.1 Comparison of VRP instruments

Figure 7 compares the three VRP instruments. The VSTOXX short-end slope instrument produces substantially larger responses in every outcome — industrial production, inflation, unemployment and CISS — but accompanied by very wide confidence bands that in many cases span zero throughout the full horizon. The extreme magnitude of the point estimates under the slope instrument is most plausibly explained by the instrument's exposure to acute near-term volatility repricing events, including brief episodes of market dislocation that are episodic rather than persistent and whose real effects are transitory. This makes the slope instrument unsuitable as the main specification but informative as an upper bound on the plausible magnitude of VRP effects under extreme near-term stress.

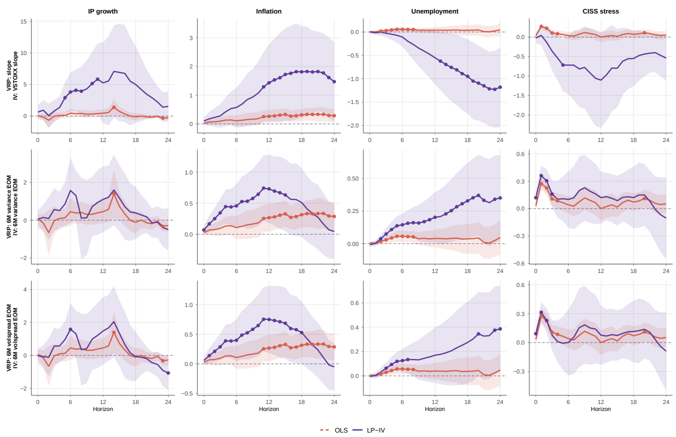

Figure 7. Variance Risk Premium Instrument Comparison

B.6 State-dependent local projection methodology

The state-dependent specification extends the baseline LP by allowing the response to a target uncertainty shock to vary with a regime variable F_t. Let s_t^j denote the target shock and $s_{-j,t}$ the vector of the remaining uncertainty shocks. For each horizon $h = 0, \ldots, H$:

$$y_{t+h} = \alpha_h + \beta_{h,L}^j s_{t,L}^j + \beta_{h,H}^j s_{t,H}^j + \Theta_h' s_{-j,t} + \delta_h F_t + \Gamma_h' W_{t-1:t-p} + \Phi_h' Z_t + \varepsilon_{t+h},$$

where:

$$s_{t,L}^j = (1 - F_t) s_t^j,$$

and

$$s_{t,H}^j = F_t s_t^j.$$

Thus, the response to shock j at a given state value $F_t = f$ is

$$IRF_h^j(f) = (1 - f)\beta_{h,L}^j + f\beta_{h,H}^j.$$

When $F_t = 0$, the response is $\beta_{h,L}^j$. When $F_t = 1$, the response is $\beta_{h,H}^j$. For binary regimes, this directly gives the low- and high-state impulse responses. For smooth regimes, the coefficients represent endpoint responses implied by the transition function.

The state variable enters the regression separately through $\delta_h F_t$. This is important because the high state may have a different average level of the outcome even in the absence of a shock. Including F_t separately helps distinguish average regime differences from differences in the transmission of the uncertainty shock.

The high-minus-low response is

$$\Delta_h^j = \beta_{h,H}^j - \beta_{h,L}^j.$$

Its variance is computed using the covariance matrix of the LP estimates:

$$\widehat{\text{Var}}(\widehat{\Delta}_h^j) = \widehat{\text{Var}}(\widehat{\beta}_{h,H}^j) + \widehat{\text{Var}}(\widehat{\beta}_{h,L}^j) - 2\widehat{\text{Cov}}(\widehat{\beta}_{h,H}^j, \widehat{\beta}_{h,L}^j).$$

The corresponding standard error is

$$\widehat{\text{se}}(\widehat{\Delta}_h^j) = \sqrt{\widehat{\text{Var}}(\widehat{\Delta}_h^j)}.$$

The test statistic is

$$t_h = \frac{\widehat{\Delta}_h^j}{\widehat{\text{se}}(\widehat{\Delta}_h^j)}.$$

The null hypothesis is

$$H_0 : \beta_{h,H}^j = \beta_{h,L}^j,$$

or equivalently,

$$H_0 : \Delta_h^j = 0.$$

In the implementation, Newey–West HAC standard errors are used with bandwidth $\max(h, p)$, as in the baseline LP. The reported difference plots show $\widehat{\Delta}_h^j$ with 90 percent confidence bands.

The main financial-stress regime is based on lagged CISS: it captures systemic stress across different pats of the financial system, it allows to observe financial amplification and risk-premium transmission during stressed conditions.To avoid contemporaneous reverse causality, the regime is constructed using lagged standardized CISS meaning that the state is predetermined with respect to the uncertainty shock at time t.

$$F_t^{CISS} = \frac{1}{1 + \exp(-\gamma z_{t-1}^{CISS})}, \qquad \gamma = 1.5.$$

The smooth transition function maps lagged CISS into a value between zero and one, where a value close to zero corresponds to low financial stress, while a value close to one corresponds to high financial stress. This construction makes the interpretation as model implied endpoint responses rather than simple averages across the two observed samples.

The second main regime studied is the business-cycle regime is a binary CEPR-style euro-area recession indicator:

$$F_t^{REC} = \mathbf{1}\{t \in \text{CEPR recession month}\}.$$

$F_t^{rec} = D_t^{rec}$ substitutes directly for F_t in the specification above, yielding separate expansion (β_h^{exp}) and recession (β_h^{rec}) coefficients whose difference $\beta_h^{rec} - \beta_h^{exp}$ measures differential amplification during recessions. For this regime, the low-state coefficient corresponds to expansions and the high-state coefficient corresponds to recession months.Since the recession dummy is interacted with the uncertainty shock, the specification estimates expansion-specific and recession-specific responses rather than simply controlling for recessions.

Policy-constraint regime. The policy-constraint regime is defined as a binary indicator,

$$F_t^{ZLB} = \mathbf{1}\{i_t \leq 0.25\},$$

where i_t is the ECB deposit facility rate. Since $F_t^{ZLB} \in \{0, 1\}$, the interaction terms $s_t(1 - F_t^{ZLB})$ and $s_t F_t^{ZLB}$ directly estimate unconstrained-policy and constrained-policy responses, respectively. This regime is treated as a robustness split because it captures a specific monetary-policy environment rather than a continuous macro-financial state.

The policy-constraint regime is defined as

$$F_t^{ZLB} = \mathbf{1}\{i_t \leq 0.25\},$$

where i_t is the ECB policy rate. This regime captures periods in which conventional policy is close to the lower bound.

Output-gap regime. The output-gap regime is constructed as a smooth transition function of the lagged output gap:

$$F_t^{GAP} = \frac{1}{1 + \exp(\gamma z_{t-1}^{GAP})}, \qquad \gamma = 1.5.$$

The sign convention implies that lower values of the standardized output gap are mapped into high-regime values, so $F_t^{gap} \approx 1$ corresponds to weak or below-potential activity. In the final dataset, the output gap is the recursive one-sided HP-filtered measure. Therefore, this regime is used as a robustness check because output-gap estimates are sensitive to filtering choices.

The state-dependent estimates are not interpreted as a replacement for the baseline LP, instead, it asks whether this average masks systematic differences across regimes. Because interacted specifications require more variation and effectively split the sample across states, their estimates may be less precise than the baseline estimates.

C Robustness

Robustness figures report alternative specifications used to assess whether the baseline transmission patterns are sensitive to lag length, uncertainty-measure construction, recursive ordering, sub-sample exclusions, Bayesian smoothing, or alternative regime definitions. These exercises are not treated as separate baseline estimates. Their purpose is to evaluate whether the main qualitative distinction between MEU, FU, and VRP survives reasonable changes in measurement, timing, and sample composition.

C.1 Robustness: Lag-length

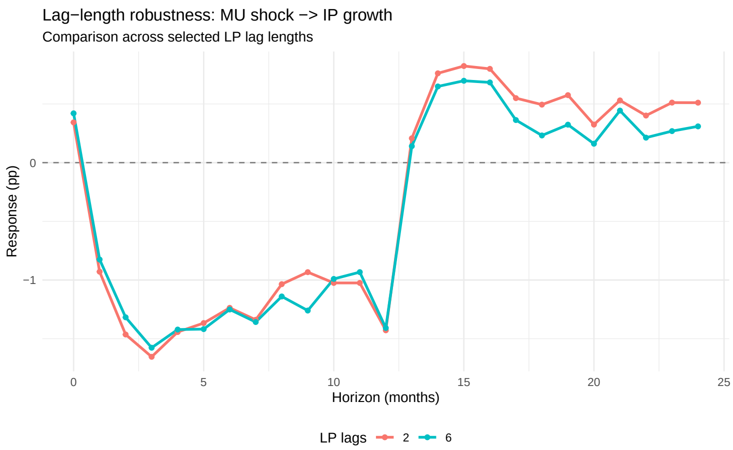

Figure 8. Lag-length Robustness

C.2 Robustness: Baseline PCA IRF's and Sentiment Indicator

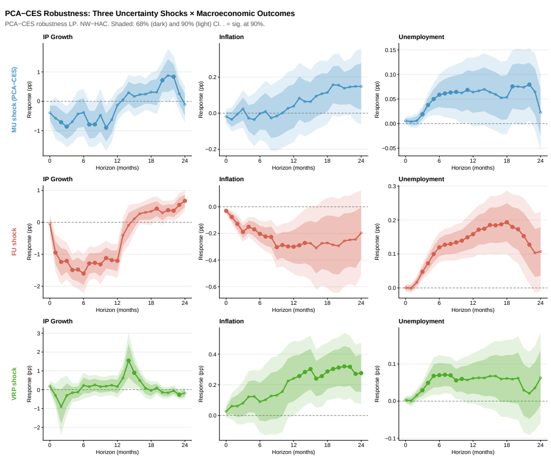

Figure 9. Baseline PCA IRFs

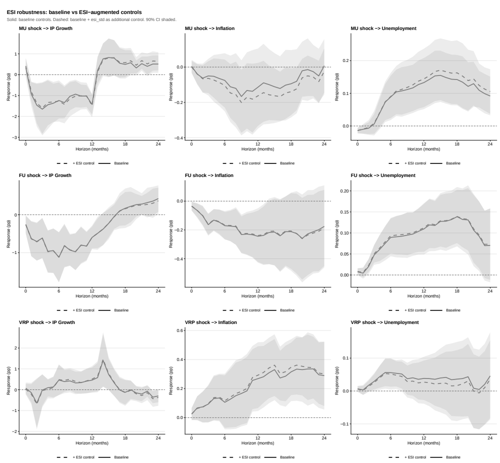

Figure 10. Baseline with ESI Control

C.3 Robustness - Cholesky-style Ordered Local Projections

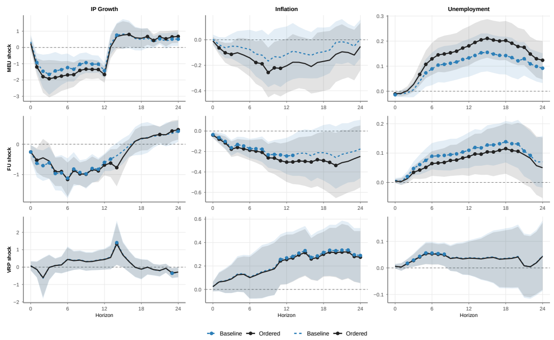

Figure 11. Ordered vs. Baseline LPs — Macroeconomic Outcomes

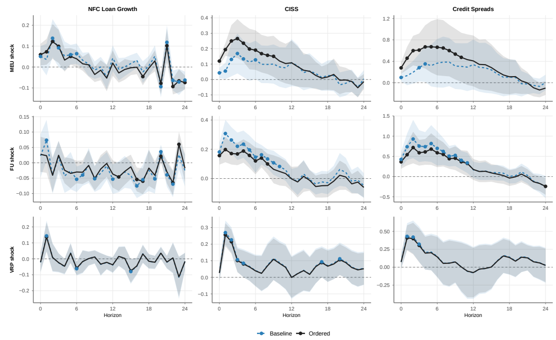

Figure 12. Ordered vs. Baseline LPs — Financial Outcomes

C.4 Robustness: Energy Shock and COVID-19 Sub-samples — Financial Outcomes

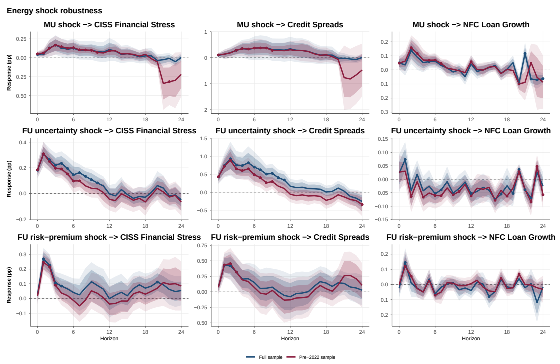

Figure 13. Excluded Energy Shock — Financial Outcomes

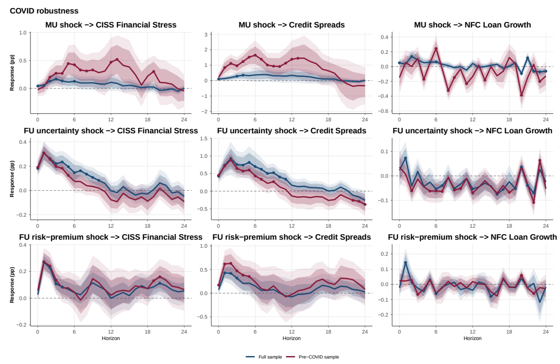

Figure 14. Pre-COVID Sample — Financial Outcomes

C.5 Robustness: LP-IV

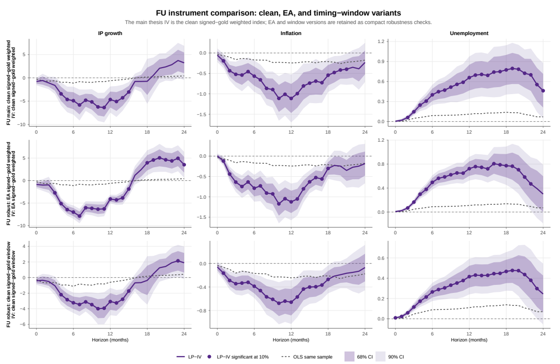

Figure 15. Top-3 FU Instruments: IRF Comparison

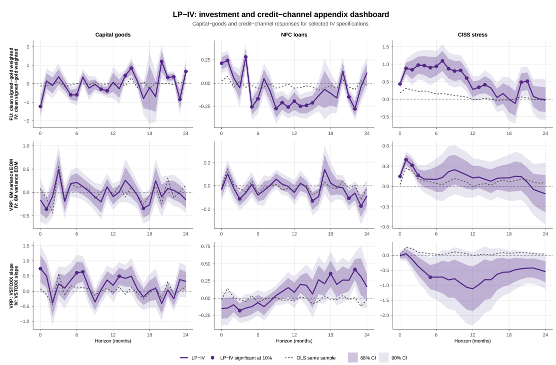

Figure 16. LP-IV: Investment & Credit

Table 7. First-Stage Diagnostics by Instrument and Outcome

Instrument	Outcome	Min F	Median F	Max F	Weakest h
FU: clean signed-gold weighted	Capital goods	12.007	24.164	26.011	23
FU: clean signed-gold weighted	CISS stress	12.066	22.877	24.476	24
FU: clean signed-gold weighted	Credit spreads	13.711	29.983	32.111	24
FU: clean signed-gold weighted	Inflation	12.066	22.877	24.476	24
FU: clean signed-gold weighted	IP growth	12.066	22.877	24.476	24
FU: clean signed-gold weighted	NFC loans	11.545	22.412	23.823	24
FU: clean signed-gold weighted	Unemployment	11.813	22.390	24.122	23
VRP: 6M variance EOM	Capital goods	25.273	28.122	28.539	23
VRP: 6M variance EOM	CISS stress	21.919	24.533	24.832	24
VRP: 6M variance EOM	Credit spreads	21.528	24.161	24.591	24
VRP: 6M variance EOM	Inflation	21.919	24.533	24.832	24
VRP: 6M variance EOM	IP growth	21.919	24.533	24.832	24
VRP: 6M variance EOM	NFC loans	22.672	25.827	26.217	23
VRP: 6M variance EOM	Unemployment	30.841	33.568	34.394	23
VRP: VSTOXX slope	Capital goods	12.080	14.389	14.654	24
VRP: VSTOXX slope	CISS stress	11.980	14.251	14.456	24
VRP: VSTOXX slope	Credit spreads	11.453	13.710	13.893	24
VRP: VSTOXX slope	Inflation	11.980	14.251	14.456	24
VRP: VSTOXX slope	IP growth	11.980	14.251	14.456	24
VRP: VSTOXX slope	NFC loans	11.420	14.328	14.571	24
VRP: VSTOXX slope	Unemployment	11.433	13.784	13.990	24

Table 8. Cross-Outcome Classification of Selected LP-IV Impulse Responses

Instrument	Outcome	Peak h	Peak coef.	Sig. h (n)	Classification
FU: clean signed-gold	Capital goods	0	−1.225	12	Contractionary
FU: clean signed-gold	CISS stress	7	1.092	16	Stress-increasing
FU: clean signed-gold	Credit spreads	7	4.275	15	Stress-increasing
FU: clean signed-gold	Inflation	12	−1.113	21	Disinflationary
FU: clean signed-gold	IP growth	11	−6.374	12	Contractionary
FU: clean signed-gold	NFC loans	4	0.282	14	Expansionary
FU: clean signed-gold	Unemployment	19	0.796	23	Stress-increasing
VRP: 6M variance EOM	Capital goods	3	0.489	2	Expansionary
VRP: 6M variance EOM	CISS stress	1	0.396	4	Stress-increasing
VRP: 6M variance EOM	Credit spreads	24	−0.740	3	Easing
VRP: 6M variance EOM	Inflation	11	0.733	16	Inflationary
VRP: 6M variance EOM	IP growth	14	1.544	0	No significant horizon
VRP: 6M variance EOM	NFC loans	23	−0.174	4	Contractionary
VRP: 6M variance EOM	Unemployment	20	0.378	22	Stress-increasing
VRP: VSTOXX slope	Capital goods	0	0.746	4	Expansionary
VRP: VSTOXX slope	CISS stress	12	−1.110	1	Easing
VRP: VSTOXX slope	Credit spreads	12	−4.503	5	Easing
VRP: VSTOXX slope	Inflation	19	1.825	14	Inflationary
VRP: VSTOXX slope	IP growth	14	7.068	6	Expansionary
VRP: VSTOXX slope	NFC loans	22	0.416	3	Expansionary
VRP: VSTOXX slope	Unemployment	23	−1.229	12	Easing

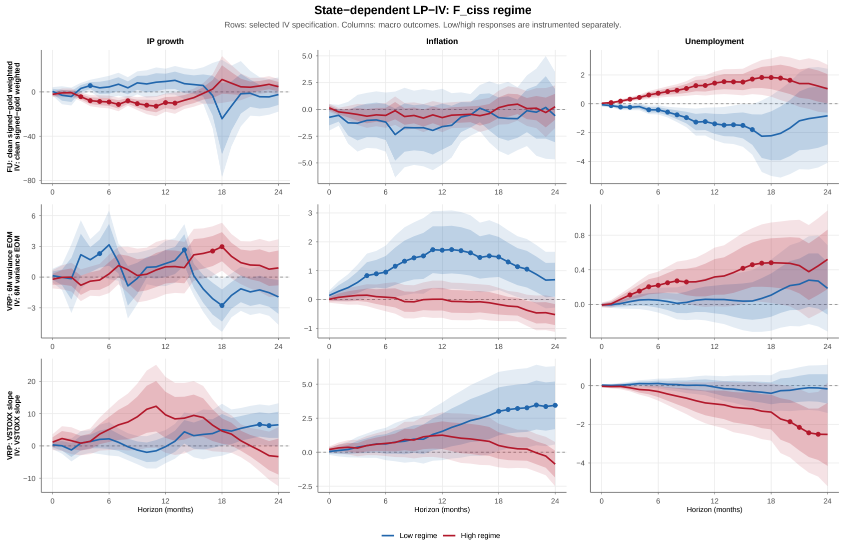

Figure 17. State-dependent LP-IV: Financial Stress - Macro Outcomes

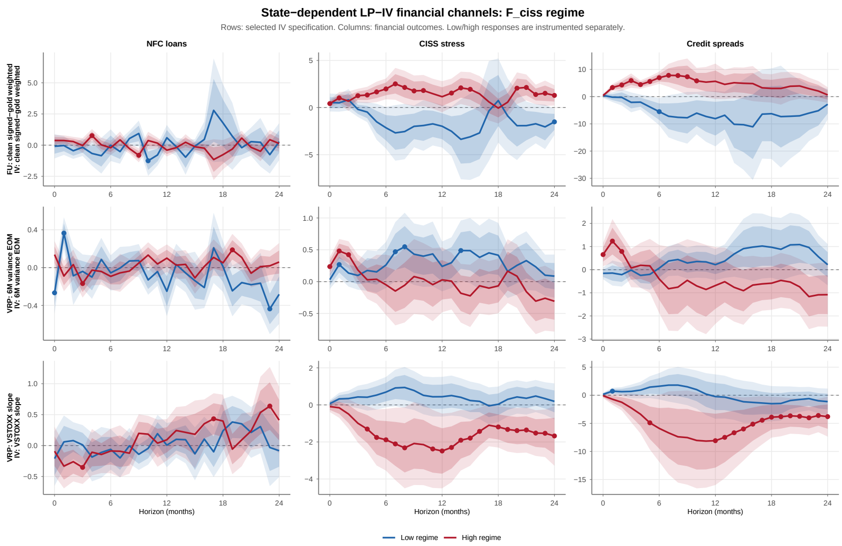

Figure 18. State-dependent LP-IV: Financial Stress - Financial Outcomes

Table 9. Formal Δ Tests: High-Low Regime Differences

Regime	Outcome	h=0	h=6	h=12	h=18	h=24	Sig.
Panel A: MEU shock							
Financial Stress	IP Growth	+4.003***	+3.973*	−0.916	−1.843	−1.096	13/25
Financial Stress	Inflation	+0.066	+0.748**	+1.033*	+0.935	−0.146	14/25
Financial Stress	Unemployment	+0.003	−0.337	−0.366	−0.227	−0.450**	3/25
Financial Stress	Capital Goods	+2.270***	−0.661	−0.077	+0.540	+0.289	5/25
Financial Stress	NFC Loan Growth	−0.052	−0.179*	+0.082	−0.093	+0.217	8/25
Financial Stress	CISS	−0.122	−0.044	+0.043	+0.295	−0.029	4/25
Financial Stress	Credit Spreads	+0.483	+0.656	+0.182	+0.769	−0.472	2/25
Business Cycle (CEPR)	IP Growth	+0.385	+1.825	+0.034	+0.879	−0.240	5/25
Business Cycle (CEPR)	Inflation	−0.155**	−0.696**	−0.833	−0.605	−0.364	10/25
Business Cycle (CEPR)	Unemployment	−0.034**	−0.045	−0.219	−0.317*	−0.228	7/25
Business Cycle (CEPR)	Capital Goods	+0.783*	−0.219	−0.099	+0.617	+0.085	6/25
Business Cycle (CEPR)	NFC Loan Growth	+0.249	−0.233**	+0.347***	+0.002	+0.102	5/25
Business Cycle (CEPR)	CISS	+0.114*	−0.231	−0.580**	−0.235	+0.144	8/25
Business Cycle (CEPR)	Credit Spreads	+0.161	−0.420	−1.370	−0.938	−0.069	3/25
Panel B: FU shock							
Financial Stress	IP Growth	+0.926	−1.117	−0.681	+1.333	+1.043	1/25
Financial Stress	Inflation	+0.104	+0.614**	+1.404*	+2.090*	+1.651*	18/25
Financial Stress	Unemployment	+0.033	+0.098	+0.057	−0.086	−0.408	3/25
Financial Stress	Capital Goods	+0.283	+0.504	−0.446	+0.197	+0.549	3/25
Financial Stress	NFC Loan Growth	+0.144	−0.021	−0.180	+0.020	−0.065	2/25
Financial Stress	CISS	−0.159	−0.001	+0.032	−0.137	−0.213	1/25
Financial Stress	Credit Spreads	+0.566**	+1.031**	+0.384	−0.300	−0.950*	9/25
Business Cycle (CEPR)	IP Growth	−0.219	−0.087	+0.099	+0.954	+0.143	1/25
Business Cycle (CEPR)	Inflation	+0.039	+0.032	+0.236	+0.551	+0.515	0/25
Business Cycle (CEPR)	Unemployment	−0.006	−0.009	−0.072	−0.146	−0.140	0/25
Business Cycle (CEPR)	Capital Goods	+0.038	+0.217	−0.020	+0.160	+0.163	3/25
Business Cycle (CEPR)	NFC Loan Growth	+0.155	−0.004	+0.019	+0.027	+0.055	7/25
Business Cycle (CEPR)	CISS	+0.028	+0.057	−0.043	−0.021	+0.215*	2/25
Business Cycle (CEPR)	Credit Spreads	+0.368**	+0.571**	−0.224	−0.104	−0.001	6/25
Panel C: VRP shock							
Financial Stress	IP Growth	+0.603	+0.288	−0.160	+1.641	+0.798	0/25
Financial Stress	Inflation	−0.023	−0.337	−0.729	−0.881*	−0.892***	7/25
Financial Stress	Unemployment	+0.003	−0.058	−0.008	+0.135	+0.303*	1/25
Financial Stress	Capital Goods	+0.235	−0.179	−0.231	+0.379	−0.412	5/25
Financial Stress	NFC Loan Growth	+0.195**	−0.113	+0.186*	+0.076	+0.232**	6/25
Financial Stress	CISS	+0.245***	−0.150	−0.143	−0.058	+0.071	1/25
Financial Stress	Credit Spreads	+0.130	−0.378	−0.578	−0.312	+0.057	0/25
Business Cycle (CEPR)	IP Growth	−0.200	−1.150*	+0.059	+1.255*	+0.783*	10/25
Business Cycle (CEPR)	Inflation	−0.068	−0.388**	−0.535*	−0.290	+0.060	16/25
Business Cycle (CEPR)	Unemployment	−0.013	+0.073*	+0.005	−0.096	−0.171	2/25
Business Cycle (CEPR)	Capital Goods	−0.186	−0.343**	−0.162	−0.120	−0.109	5/25
Business Cycle (CEPR)	NFC Loan Growth	+0.036	−0.021	+0.044	−0.064	+0.118**	5/25
Business Cycle (CEPR)	CISS	+0.060	−0.118	−0.238**	−0.255*	−0.221***	16/25
Business Cycle (CEPR)	Credit Spreads	−0.024	−0.201	−0.479	−0.620	−0.411*	4/25

Notes: Each cell reports $\Delta_h = \beta_{h,H} - \beta_{h,L}$, the high-regime minus low-regime impulse response difference at horizon h. Significance stars refer to the HAC Newey–West test of $H_0 : \Delta_h = 0$: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. The *Sig.* column reports the number of horizons at which Δ_h is significant at the 10 percent level. .

C.6 Robustness: Frequentist vs Bayesian LP

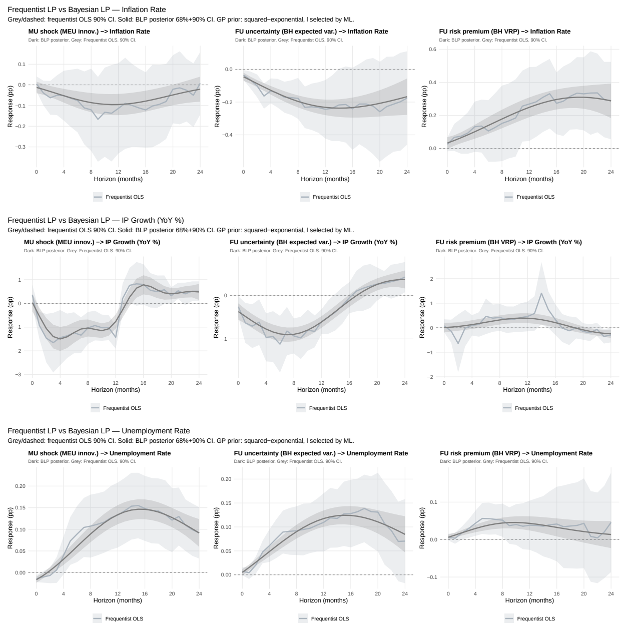

Figure 19. Bayesian Local Projections vs. Baseline LPs

C.7 Robustness: Additional State-Dependent Regimes

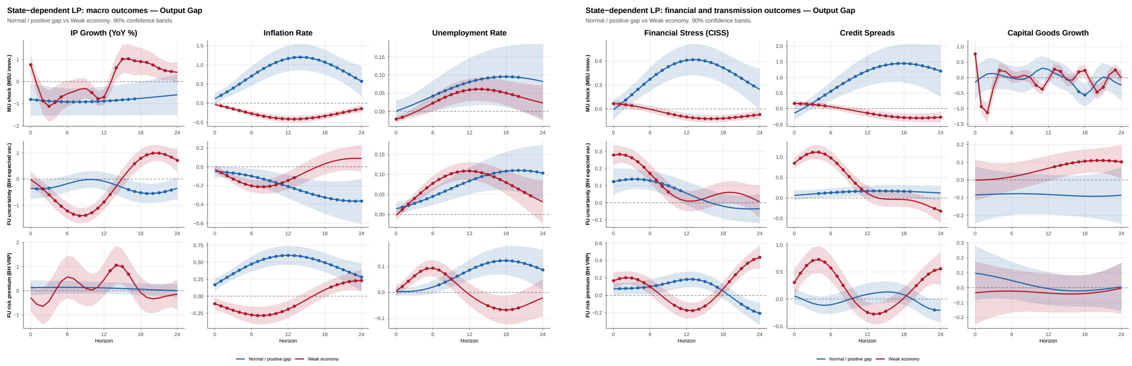

Figure 20. State-Dependent IRFs: Output Gap Regime

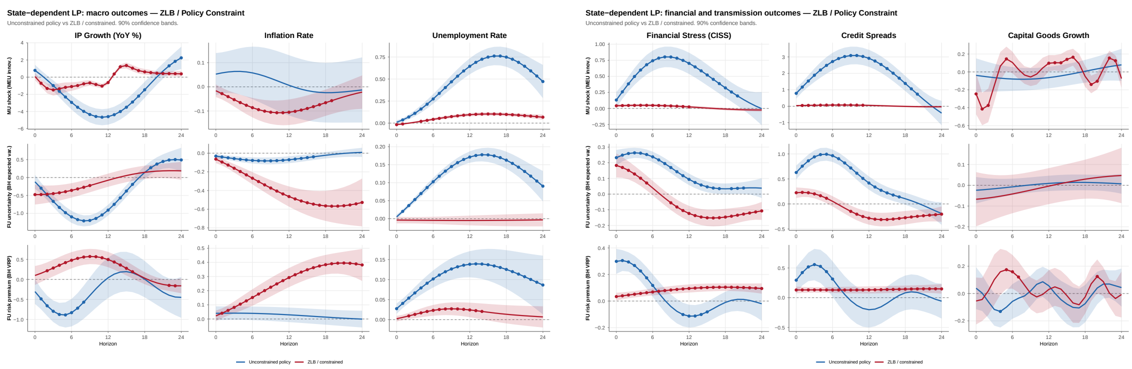

Figure 21. State-Dependent IRFs: Policy-Constrained (ZLB) Regime

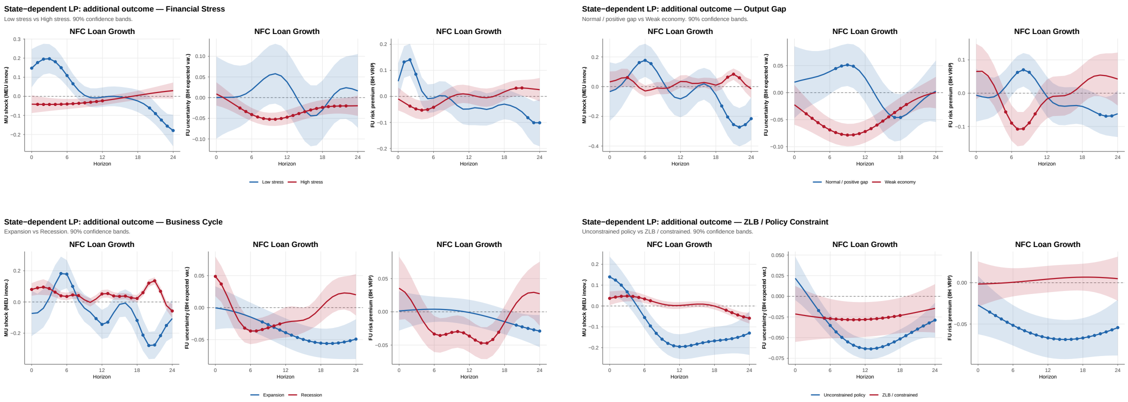

Figure 22. State-Dependent IRFs: NFC Loans Across All Regimes

Table 10. Formal Δ Tests: High-Low Regime Differences, Output Gap Regime

Outcome	$h = 0$	$h = 6$	$h = 12$	$h = 18$	$h = 24$	Sig. h
Panel A: MEU shock						
IP Growth	+2.113*	+1.835	-1.339	+2.972	+1.348	1/25
Inflation	-0.169	-0.952	-1.866*	-1.529*	-0.571	13/25
Unemployment	-0.019	-0.022	-0.067	-0.108	-0.197	0/25
Capital Goods	+2.794***	+0.039	-0.336	+2.673***	+0.588	5/25
NFC Loans	+0.313	-0.521***	+0.474**	-0.333*	+0.198	7/25
CISS	+0.186	-0.099	-1.061**	-0.814	-0.440	3/25
Credit Spreads	+0.370*	-0.321	-2.270	-2.364	-1.839	1/25
Panel B: FU shock						
IP Growth	+0.101	-1.182	-0.916	+2.041	+1.061	4/25
Inflation	+0.055	-0.139	+0.052	+0.548	+0.712	0/25
Unemployment	-0.028	+0.035	+0.040	-0.024	-0.130	0/25
Capital Goods	+0.180	-0.206	+0.184	-0.057	+0.199	4/25
NFC Loans	+0.071	-0.127	-0.190**	+0.034	-0.154	5/25
CISS	+0.210	+0.059	-0.219	-0.038	+0.009	0/25
Credit Spreads	+0.953***	+0.960**	-0.364	-0.212	-0.692	6/25
Panel C: VRP shock						
IP Growth	-0.351	+2.060	-0.110	-0.245	+0.130	0/25
Inflation	-0.229*	-0.825*	-0.987*	-0.218	+0.017	10/25
Unemployment	+0.002	+0.106	-0.097	-0.321	-0.085	3/25
Capital Goods	-0.681	-0.243	-0.604	+0.008	+0.139	2/25
NFC Loans	+0.143	-0.086	+0.187	+0.161	+0.263*	4/25
CISS	-0.011	+0.031	-0.315	-0.005	+0.752***	5/25
Credit Spreads	-0.193	+0.856	-0.435	-0.221	+1.305**	5/25

Each cell reports Δ: high-regime minus low-regime response.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$ (HAC Newey–West test of $\Delta = 0$).
Sig. h = number of horizons $h \in [0, 24]$ significant at the 10% level.

Table 11. Formal Δ Tests: High-Low Regime Differences, ZLB Regime

Outcome	$h = 0$	$h = 6$	$h = 12$	$h = 18$	$h = 24$	Sig. h
Panel A: MEU shock						
IP Growth	-0.526	+2.254	+3.675**	+1.897	-1.744	9/25
Inflation	-0.043	-0.343	-0.121	-0.043	-0.063	0/25
Unemployment	-0.030**	-0.231*	-0.522***	-0.777***	-0.250	21/25
Capital Goods	+0.132	+0.130	+0.021	+0.664	-0.517	4/25
NFC Loans	-0.152	-0.137	+0.131	+0.064	-0.086	10/25
CISS	-0.007	-0.813**	-0.661**	-0.300	+0.024	16/25
Credit Spreads	-0.586***	-3.284**	-2.666***	-1.495**	+0.478	20/25
Panel B: FU shock						
IP Growth	-0.204	+0.990*	+0.937**	-0.134	-0.298	7/25
Inflation	-0.042	-0.226	-0.369	-0.617	-0.587	0/25
Unemployment	-0.011	-0.110***	-0.190***	-0.211**	-0.027	20/25
Capital Goods	+0.124	-0.473**	+0.189	-0.065	-0.117	6/25
NFC Loans	-0.129	-0.027	+0.003	+0.079	+0.029	1/25
CISS	-0.000	-0.189**	-0.256**	-0.046	-0.067	13/25
Credit Spreads	-0.394***	-1.008***	-0.798***	-0.312	+0.122	16/25
Panel C: VRP shock						
IP Growth	+0.228	+1.664**	+0.447	-0.333	+0.737	6/25
Inflation	-0.042	+0.179	+0.212	+0.359*	+0.475**	7/25
Unemployment	-0.020**	-0.072	-0.095	-0.156	-0.107	3/25
Capital Goods	-0.057	-0.113	-0.164	+0.018	-0.023	5/25
NFC Loans	-0.128**	+0.076	-0.002	+0.046	-0.090	11/25
CISS	-0.257***	-0.041	+0.172	+0.099	+0.198	5/25
Credit Spreads	-0.111	-0.333	+0.318	+0.040	+0.345	4/25

Each cell reports Δ: high-regime minus low-regime response.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$ (HAC Newey–West test of $\Delta = 0$).
Sig. h = number of horizons $h \in [0, 24]$ significant at the 10% level.

D Data

This appendix summarizes the data sources, transformations, and empirical role of each variable used in the thesis. The purpose is to keep the main Data section focused on the conceptual role of the variables, while reporting the mechanical construction details in one place. Variables are grouped into uncertainty measures, regime indicators, outcomes, controls, and LP-IV instruments. Unless otherwise stated, the empirical analysis uses monthly euro-area aggregate data from June 2003 to July 2024. Variables entering the local projections as shocks are transformed into autoregressive innovations, so the estimated responses correspond to unexpected movements rather than persistent raw levels. Details on the construction and validation of the financial uncertainty and variance risk premium measures are provided in Appendix A.

Table 12. Variables, Transformations, and Data Sources

Variable	Transformation / Construction	Source
Panel A: Uncertainty Measures		
MEU	Euro-area MEU index; standardized AR innovation used as LP shock.	Comunale–Nguyen
FU	Expected physical variance from EURO STOXX 50 returns, GARCH-based.	Bloomberg; own decomp.
VRP	$VRP_t = Var_t^Q - Var_t^P$, $Var_t^Q = (VSTOXX_t/100)^2$, $Var_t^P =$ GARCH physical variance.	Bloomberg; own decomp.
PCA macro-uncertainty (robustness)	First PC of standardized uncertainty/surprise indicators; AR innovations.	Comunale and Nguyen (2023); Baker et al. (2016); Caldara and Iacoviello (2022)
Panel B: Macroeconomic Outcomes		
IP growth	YoY log growth: $100[\log(IP_t) - \log(IP_{t-12})]$.	Eurostat
Inflation	YoY log growth of HICP.	Eurostat
Unemployment	Monthly euro-area rate.	Eurostat
Capital goods growth	MoM log growth of capital goods IP.	Eurostat
Panel C: Financial Outcomes		
CISS	Composite Indicator of Systemic Stress; monthly, standardized.	ECB SDW
Credit spreads	Daily series aggregated monthly; levels (outcome) / differences (control).	FRED
NFC loan growth	MoM log growth of loans to euro-area NFCs.	ECB BSI dataset
Panel D: Controls		
ECB policy rate	Deposit facility rate, mainly in first differences.	FRED
Output gap	One-sided HP-filter gap from IP, standardized.	Own constr. (Eurostat)
Inflation	Control in non-inflation equations.	Eurostat
ESI	Monthly sentiment indicator, levels/standardized.	European Commission
COVID dummy	=1 in March–May 2020.	Own construction
Panel E: Regime Variables		
CISS regime	$F_t^{CISS} = 1/[1 + \exp(-1.5 z_{t-1}^{CISS})]$.	Own constr. (ECB CISS)
CEPR recession	Binary recession indicator, monthly.	CEPR/EABCN
ZLB regime	=1 if ECB policy rate $\leq 0.25\%$.	Own constr. (FRED)
Output-gap regime	$F_t^{gap} = 1/[1 + \exp(1.5 z_{t-1}^{gap})]$.	Own construction
Panel F: External Instruments		
Gold financial-event IV	Signed, weighted, standardized gold-price moves around stress events.	Bloomberg; own event list
6M variance EOM IV	End-of-month 6M implied variance from VSTOXX 6M, standardized.	Bloomberg; own constr.
VSTOXX slope IV	V1X − V3X, standardized.	Bloomberg

Notes: VSTOXX, EURO STOXX 50, CESIEUR, V1X, V3X, and gold prices from Bloomberg. YoY and MoM variables are in their own units; response magnitudes are not directly comparable across outcomes.

Table 13. Main variables correlations

Variable	MEU	FU	VRP
Industrial production growth	-0.25	-0.37	-0.04
Inflation	0.36	-0.02	0.03
Unemployment	-0.49	-0.01	0.08
CISS	0.33	0.71	0.13
Credit spreads	0.23	0.62	0.22
Capital goods production growth	-0.04	-0.22	0.22
NFC loan growth	0.17	0.19	-0.23

Table 14. Decomposition of Risk-Neutral Implied Variance into FU and VRP

$$\underbrace{\left(\frac{VSTOXX_t}{100}\right)^2}_{\text{risk-neutral implied variance}} = \underbrace{\mathbb{E}_t^P\left[RV_{t,t+22}^{ann}\right]}_{\text{financial uncertainty } (FU)} + \underbrace{\left[\left(\frac{VSTOXX_t}{100}\right)^2 - \mathbb{E}_t^P\left[RV_{t,t+22}^{ann}\right]\right]}_{\text{variance risk premium } (VRP)}$$

Term	Description	Variable
$\left(\frac{VSTOXX_t}{100}\right)^2$	Risk-neutral implied variance: annualized, option-implied expectation of near-term euro-area equity-market variance.	IV_t
$\mathbb{E}_t^P\left[RV_{t,t+22}^{ann}\right]$	Physical expected variance: conditional expectation of realized variance over the next 22 trading days under the physical measure, estimated via GARCH(1,1) (Appendix A).	FU_t
$\left(\frac{VSTOXX_t}{100}\right)^2 - \mathbb{E}_t^P\left[RV_{t,t+22}^{ann}\right]$	Residual wedge between risk-neutral and physical variance: compensation demanded for bearing variance risk.	VRP_t

Additional note. Generative AI was used during the preparation of this thesis to assist with debugging and logic-checking of `R` scripts, as well as to provide language editing and proofreading of the text.