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# Collateral Policy Surprises*

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**Abstract**

Central bank collateral policy specifies which assets banks can pledge as collateral to obtain central bank funding and is an important determinant of liquidity in the banking system. We propose a high-frequency identification approach to study the systematic effects of central bank collateral policy on banks, financial markets, and asset prices. We identify collateral policy surprises using intraday bank stock price changes around Eurosystem collateral policy announcements. Expansionary collateral policy surprises lead to excess returns of bank stocks, a decline in common volatility measures, and a reduction in bank default risk, in particular for riskier banks. They also compress core-periphery government bond spreads, even for policy changes that are unrelated to the collateral treatment of government bonds. The uneven transmission of collateral policy through banks to sovereign bond markets is distinct from both central bank asset purchases and conventional monetary policy.

**Keywords:** Central Bank Collateral Framework, Bank Stocks, Government Bond Market, High Frequency Identification, Intermediary Asset Pricing
**JEL Codes:** E44, E58, G12, G21

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# 1 Introduction

Central banks implement monetary policy by lending to banks against collateral. Central bank collateral policy specifies which assets banks can pledge as collateral and the valuation haircut applied to each asset. Importantly, collateral frameworks are not static, but both respond to and shape the macro-financial environment. For example, during the Great Financial Crisis in 2008, many central banks reduced the minimum rating requirements on government and corporate bonds to ensure that all banks could access central bank funding and that monetary policy transmission remained intact. In doing so, collateral policy also affects banks' liquidity risk, their pricing of eligible assets, and the prices of securities that can be pledged as collateral. In this paper, we quantify these effects and illustrate the transmission channels at play, using changes to the Eurosystem collateral framework as a laboratory.

Establishing causal effects of central bank collateral policy on asset prices is challenging for two main reasons. First, the stance of collateral policy varies over time and endogenously responds to the macro-financial environment. Thus, it is difficult to separate the systematic from the surprise (unanticipated) component of a collateral policy change, which is essential for establishing causal effects. Second, the Eurosystem accepts a wide range of assets as collateral, some of which are illiquid, and policy announcements often affect multiple asset classes simultaneously. This makes the choice of an appropriate asset class to study the systematic effects of collateral policy nontrivial.

We propose a novel identification strategy based on high-frequency bank stock price reactions that overcomes both challenges. We motivate our approach using a stylized intermediary asset pricing model (He and Krishnamurthy, 2013). Banks receive liquidity shocks that they have to settle by borrowing from the central bank against collateral, in the spirit of Bianchi and Bigio (2022) and De Fiore et al. (2024). A relaxation of collateral policy reduces the probability that banks' liquidity shocks exceed the collateral value of their assets. This stylized model predicts that expansionary collateral policy increases bank stock prices and reduces bank credit default swap (CDS) spreads, in particular for riskier, less liquid banks.

Guided by the model, we exploit intraday changes in bank stock prices around Eurosystem collateral policy announcements. Focusing on the users of collateral rather than the eligible assets themselves allows us to include the broadest possible set of collateral policy events. In particular, we can include events concerning non-marketable assets, such as asset-backed securities or credit claims, for which market prices are not available, at least not at a sufficiently high frequency. Moreover, the high-frequency approach enables us to separate the surprise component of collateral policy from systematic responses to macro-financial conditions, similar to the identification of monetary policy shocks using high-frequency asset price data, see Kuttner (2001) for an early reference.

We compile a comprehensive list of ECB collateral policy announcements from the introduction of a harmonized Eurosystem collateral framework in January 2007 to December 2022, building on Bindseil et al. (2017). There are 98 events in total, 55 of which attracted suf-

ficient attention in financial markets to be reported by Thomson Reuters News. Excluding announcements that coincide with ECB monetary policy decision dates leaves a final sample of 44 events. We compute stock price changes of the largest euro area banks over a narrow intraday (45-minute) window around these announcements and extract the first principal component to isolate the common factor in bank stock reactions. Price reactions are often sizable, exceeding two percent for some announcements. To illustrate that collateral policy surprises have a macroeconomically relevant effect, it is helpful to compare them to conventional monetary policy surprises. While the standard deviation of bank stock returns is close to one percent for a collateral policy surprise, conventional monetary policy surprises move bank stocks on average by about 0.4 percent. We interpret positive (negative) reactions as expansionary (contractionary) collateral policy surprises.

Our identification strategy has three additional advantages. First, we avoid many judgment calls on the choice of assets when multiple asset classes are affected by a policy change. Second, extracting the common factor from individual responses does not require information on individual banks' exposure to targeted assets, which cannot be measured at sufficiently high frequency, even with confidential securities holdings data. Third, using market data to classify events into expansionary or contractionary surprises is less susceptible to biases than a purely narrative classification, which would not take into account market participants' expectations about Eurosystem collateral policy changes. Reassuringly, the market-based classification generally aligns with narrative evidence.

The identified high-frequency collateral policy surprise series exhibits no significant autocorrelation and is not predictable based on information available to financial markets prior to the announcements. In particular, we show that it is not predicted by conventional monetary policy surprises or by indicators of financial market stress, such as the EURIBOR-OIS spread, implied equity market volatility (V2X), sovereign CDS spreads, and bank CDS spreads. We do not find significant evidence for central bank information effects (Jarociński and Karadi (2020)), as bank stocks and CDS spreads move in opposite directions for the majority of events, including all large ones. Furthermore, we show that bank stock prices are much more volatile on days with a collateral policy event than on control days without such announcements, indicating that these announcements trigger significant market reactions. To further validate our empirical approach, we demonstrate that illiquid and less capitalized banks respond more strongly to changes in collateral policy. This finding is in line with our model and with a large body of literature on the bank lending channel of conventional monetary policy (Kashyap and Stein, 2000), further corroborating the validity of the high-frequency collateral policy surprise (CPS) series.

Using local projections (Jordà, 2005) estimated on daily data, we find that banks outperform the overall stock market after an expansionary collateral policy surprise. An expansionary one standard deviation CPS lowers the most commonly traded equity market volatility index (V2X) by around four percent, suggesting a dampening effect on financial market uncertainty. Moreover, expansionary collateral policy lowers bank CDS spreads by 4 basis points on average. This points towards a reduction in perceived bank default risk and is consistent with our stylized

model. This effect is particularly strong for banks located in the euro area periphery, where it exceeds 10 basis points for some banks. Generally, the effects are strongest for events affecting the collateral treatment of government bonds, in particular those that changed the treatment of individual countries, such as minimum rating requirement exemptions for Greece in 2012 and 2015.

We then examine how expansionary collateral policy affects the government bond market. The spreads of all major euro area sovereigns over the overnight index swap (OIS) decline significantly and persistently following an expansionary collateral policy surprise. The decline is around 10 basis points for periphery bonds (Italy, Ireland, Portugal, Spain) but only about 2 basis points for core bonds (Austria, Belgium, Finland, France, Netherlands, Germany). Accordingly, the periphery-core government bond spread narrows substantially. Collateral policy also affects the pricing of sovereign risk more generally. We observe a decline in sovereign credit default swap (CDS) spreads, which is again much stronger for periphery borrowers, in particular for events related to the collateral treatment of government bonds. We also examine the CDS-bond basis, which is defined as the difference between the government bond yield and a replication portfolio of CDS-spread and the risk-free rate. The CDS-bond basis is often used as a measure of convenience yields. Interestingly, the CDS-bond basis does not respond significantly for any country, suggesting that the transmission of central bank collateral policy is more nuanced than changes in commonly used measures of convenience yield.

To reconcile the heterogeneous transmission of collateral policy to the government bond market and the absence of effects on the CDS-bond basis, we revisit our stylized intermediary asset pricing framework. The model predicts that lower bank default risk raises government bond prices, since banks receive the payoff from their investment with a larger probability. This effect is more pronounced for riskier banks. This novel transmission mechanism of collateral policy through bank default risk can rationalize why periphery bond and CDS spreads are more responsive to collateral policy, and why the CDS-bond basis is not responsive.

The home bias of European banks' holdings of domestic sovereign debt and its adverse consequences are documented in Acharya and Steffen (2015) and Ongena et al. (2019). We argue that home bias is a key determinant of the uneven transmission of collateral policy. The most responsive banks are located in periphery countries, exhibit higher CDS spreads, lower balance sheet liquidity, and poorer capitalization. Since these banks also have a larger home bias, any changes in their default risk and, hence, in their stochastic discount factor are arguably more relevant for the pricing of periphery sovereign bonds and credit default swaps. Consequently, the core-periphery spread narrows.

To further illustrate the transmission mechanism of collateral policy, we explore its effects in different sub-samples. Collateral policy has particularly pronounced effects during recessions, where the demand for central bank liquidity is arguably higher than in expansions. By contrast, during periods of excess liquidity, especially after the Eurosystem began large-scale asset purchases in 2015, the effects of collateral policy are less pronounced, but not zero. As a last step, we benchmark the effects of collateral policy surprises, an "unconventional" central bank instru-

ment after all, against conventional monetary policy surprises (Jarociński and Karadi, 2020). We find that monetary policy surprises affect equity markets, but there is no notable excess return for the banking sector. We observe no significant heterogeneous effects on government bond yields or on bank and sovereign CDS spreads. These findings point to a markedly different transmission mechanism of collateral policy to banks and asset prices than that of conventional monetary policy.

**Related Literature** Our paper relates to two strands of literature. First, from a methodological perspective, it is closely related to the large literature on high-frequency identification. The key insight of this literature is that the unexpected (surprise) component of policy announcements can be identified using asset price movements within narrow time windows surrounding these announcements, which has been used extensively in the empirical monetary policy literature (Kuttner, 2001, Gürkaynak et al., 2005, Altavilla et al., 2019, Swanson, 2021).

More broadly, this approach has been extended beyond monetary policy to identify a wide range of macroeconomic and financial shocks. In this paper, we introduce a novel high-frequency identification approach to measure collateral policy surprises, based on changes in bank stock prices around Eurosystem collateral announcements. To the best of our knowledge, we are the first to do so. Bianchi et al. (2023) study the effects of threats to central bank independence, while Känzig (2021) identifies oil supply news shocks using OPEC announcements. Phillot (2025) identifies Treasury supply shocks in bond markets, Cardamone (2026) studies U.S. debt-ceiling episodes, and Diebold and Hack (2026) considers sovereign rating changes. Boneva et al. (2023) analyze FOMC announcements related to lender-of-last-resort policy, and Bluwstein and Patozi (2024) examine macroprudential policy announcements. Finally, Drechsel and Miura (2024) and Ottonello and Song (2025) use intraday bank stock data to construct high-frequency surprises from regulatory speeches and earnings announcements, respectively.

Second, our paper relates to the empirical banking literature on central bank collateral policy. Building on our novel high-frequency identification of collateral policy surprises, we contribute to this literature by providing a systematic analysis of collateral policy's macro-financial effects using the full set of policy changes. In contrast to the existing literature, which typically focuses on individual policy changes and exploits security- or loan-level variation, our approach allows us to study the aggregate effects of collateral policy across a broad set of outcomes. This literature shows that central bank collateral frameworks have economically meaningful effects on banks (the users of collateral) as well as on non-financial firms and sovereigns (the issuers of collateral). Expansionary collateral policy reduces bank funding costs (Cassola and Koulischer, 2019; Fang et al., 2025), affects the prices of eligible assets (Mésonnier et al., 2021; Chen et al., 2023), increases bank credit supply (Bekkum et al., 2018), and has real effects on the non-financial sector (Delatte et al., 2025; Hüttl and Kaldorf, 2026). For example, Pelizzon et al. (2024) show that the inclusion of corporate bonds as eligible collateral lowers yields and improves secondary market liquidity. For sovereign bonds, Nissinen and Sihvonen (2024) document that yields respond to discrete changes in collateral haircuts across maturity buckets, while Nguyen (2020)

shows that investors demand higher yields for bonds with higher collateral haircuts.

**Outline** The remainder of the paper is structured as follows. Section 2 reviews the Eurosystem collateral framework and introduces a stylized intermediary asset pricing model to illustrate our identification strategy. We describe our data, measurement, and provide a series of diagnostic tests on the identified surprise series in Section 3. Section 4 examines the transmission of collateral policy at the micro level. In Section 5, we discuss the effects of collateral policy surprises on financial variables and on the government bond market. Section 6 concludes.

# 2 Collateral Policy: Institutional Background and Theory

In this section, we provide some institutional background of the Eurosystem collateral framework on which our empirical results are based. Furthermore, we introduce a highly stylized model of collateral policy and banks, which delivers predictions of the relationship between collateral policy, bank stock returns, and the government bond market. Guided by the institutional background and the model, we then describe our identification strategy and its advantages.

## 2.1 Institutional Background

Central banks implement monetary policy by lending to commercial banks against collateral. Unlike the interbank market, there is no unsecured funding option. A sufficiently large pool of eligible collateral is therefore necessary to give all euro area banks access to central bank facilities and to ensure the smooth implementation of monetary policy. The Eurosystem collateral framework is exceptionally broad. While the Federal Reserve predominantly lends against highly liquid US Treasury bonds, euro area banks can pledge a wide variety of asset classes, including non-marketable assets and BBB-rated bonds, see Bindseil et al., 2017 for an overview. The main reason for operating such a broad framework is that the amount of euro-denominated high-quality liquid assets, such as AAA-rated government bonds, is small relative to the size and regional heterogeneity of the euro area banking sector. Establishing the causal effects of collateral policy on asset prices is therefore challenging. Announcements may affect multiple asset classes simultaneously, and collateral policy operates along two distinct dimensions: eligibility requirements and valuation haircuts.

Additionally, when accepting financial assets as collateral, the Eurosystem sets minimum quality requirements on assets and applies valuation haircuts to the market value of the pledged asset.[1] This reduces losses from exposure to low-quality collateral in the case of a counterparty default. Accepting risky collateral can be costly either because setting up and operating a credit risk management facility is costly for the central bank (Bindseil and Papadia, 2006; Hall and

[1] Importantly, collateral eligibility requirements and valuation haircuts in the Eurosystem only depend on the pledged collateral and not on the borrowing bank. This means that the collateral framework cannot be used to discriminate directly between banks.

Reis, 2015), or because central banks are loss-averse (Goncharov et al., 2023). Therefore, the Eurosystem sets its collateral framework sufficiently wide to facilitate a smooth implementation of monetary policy, but tight enough to limit expected losses to an acceptable level.

The macro-financial environment shapes how this trade-off is optimally resolved. In times of financial market stress, banks' demand for central bank funding rises while the availability of high-quality collateral typically declines, as rating downgrades affect issuers in both the private and public sectors. It is then generally optimal for the central bank to expand its collateral framework, both by easing minimum eligibility requirements and by reducing valuation haircuts. Such a systematic reaction of collateral policy complicates identification, since asset prices already reflect anticipated policy responses. For instance, an easing of minimum rating requirements may have contractionary price effects if market participants had expected an even larger relaxation during a period of elevated stress. A careful empirical investigation must therefore account for this endogeneity by employing a suitable instrument for collateral availability.

## 2.2 A Stylized Model of Collateral Policy

Based on the preceding considerations, one might argue that the collateral framework is essentially a function that maps the characteristics of bank assets (asset class, default risk, liquidity, size) into their collateral value. Hence, banks appear to be a well-suited candidate to measure collateral policy, as they are the direct users of central bank facilities and the primary channel through which collateral policy transmits to financial markets.

To illustrate the transmission mechanisms at play and to microfound our identification strategy, we present a stylized intermediary asset pricing model (He and Krishnamurthy, 2013). There are two periods indexed by $t = 0, 1$. The risk-free rate is normalized to zero. Banks raise funds by issuing debt to investors $d_1$ at price $q_0^D$ and invest into fixed income securities $b_1$, such as government bonds, corporate bonds, and non-marketable assets including bank loans to the corporate sector. Their price is denoted by $q_0^B$, and their expected per-unit payoff is denoted by $\mathcal{R}_1$. Banks cannot raise outside equity in period 0, which translates into a non-negativity constraint on $div_0$, and they maximize expected dividends in the next period, $\mathbb{E}_0[div_1]$. Dividends in period 0 are given by:

$$div_0 = q_0^D d_1 - q_0^B b_1 \ . \tag{1}$$

Since banks only value dividend payouts in period 1, they will not raise more debt than necessary to finance their investment, such that $div_0 = 0$ and equation (1) essentially becomes a balance sheet constraint. At the beginning of period 1, banks draw a liquidity deficit $\delta_1 \cdot d_1$, where $\delta_1$ is a random variable with cdf $F(\delta_1)$, in the spirit of Bianchi and Bigio (2022) and De Fiore et al. (2024). We do not impose a specific distributional assumption, but merely require that the pdf is positive and decreasing over $\delta_1$, i.e., it is less likely to draw very large liquidity deficits. Banks settle their liquidity with the central bank against eligible collateral. The collateral value of

bank assets depends on the central bank's collateral policy:

$$\bar{b}_1 = (1-\kappa)\mathcal{R}_1 b_1 \ , \tag{2}$$

where $\kappa \in [0,1]$ is the central bank collateral parameter. In this simplified setting, $\kappa$ should be interpreted as the stance of collateral policy, which encompasses both eligibility criteria and valuation haircuts. Specifically, $\kappa$ reflects the weighted average haircut on all bank assets, where $\kappa = 1$ corresponds to a 100% haircut on ineligible assets. We assume that banks default if their collateral is insufficient to replace the withdrawn funds by central bank borrowing, i.e., if $\bar{b}_1 < \delta_1 \cdot d_1$.[2]

**Bank Stocks and Bank CDS** We obtain the bank default probability $D^{bank}\Big(\bar{b}_1/d_1\Big)$ from evaluating the cdf of the liquidity deficit at $\bar{b}_1/d_1$:

$$D^{bank}\Big(\frac{\bar{b}_1}{d_1}\Big) = 1 - F\Big(\frac{\bar{b}_1}{d_1}\Big) \ . \tag{3}$$

Importantly, the bank default probability can be measured by bank CDS spreads in the data. All else equal, removing the collateral eligibility of specific asset classes or raising the applicable collateral haircut increases the bank failure probability. This directly follows from differentiating the default probability with respect to $\kappa$:

$$\frac{\partial D^{bank}(\bar{b}_1/d_1)}{\partial \kappa} = \frac{\partial \bar{b}_1}{\partial \kappa}\frac{1}{d_1} f\big(\frac{\bar{b}_1}{d_1}\big) \ . \tag{4}$$

The first partial derivative $\frac{\partial \bar{b}_1}{\partial \kappa}$ measures how much a change in collateral policy changes collateral availability. The second term measures how much a change in collateral availability affects the default risk, which corresponds to the pdf of the liquidity shock distribution $f\big(\frac{\bar{b}_1}{d_1}\big)$. The effect of collateral policy is more pronounced for riskier banks. Holding collateral $\bar{b}$ fixed, this is the case for banks with a more dispersed liquidity shock distribution. Formally, the derivative of equation (3) satisfies $\frac{\partial^2 F^{bank}(\bar{b}_1/d_1)}{\partial \kappa \partial \sigma} > 0$. Furthermore, holding the liquidity distribution fixed, the effects are larger for banks with a smaller share of eligible assets $\bar{b}_1/d_1$, since we have $\frac{\partial^2 F^{bank}(\bar{b}_1/d_1)}{\partial \kappa \partial b_1/d_1} > 0$.

To link collateral policy to bank stock prices $s_0$, we consider expected dividends in period 1. Dividends in period 1 depend on bank survival $div_1 = \mathbb{1}\{\bar{b}_1 > \delta_1 d_1\}\big(\mathcal{R}_1 b_1 - d_1\big)$, such that we can write expected dividends as

$$s_0 \equiv \mathbb{E}_0[div_1] = F\Big(\frac{\bar{b}_1}{d_1}\Big)\big(\mathcal{R}_1 b_1 - d_1\big) \tag{5}$$

It immediately follows that stock prices are negatively related to $\kappa$, i.e., they fall if the collateral haircut parameter $\kappa$ rises. Again, effects are more pronounced for riskier banks or for banks

[2] Ashcraft et al. (2010) study central bank haircut policies in a model where banks face collateral constraints. Our model delivers similar predictions and also allows us to link central bank collateral policy directly to bank CDS spreads.

with a smaller share of eligible assets.

**Model Implication Ia.** Expansionary collateral policy increases bank stock prices and reduces bank CDS-spreads.
**Model Implication Ib.** The effects are stronger for banks with poor capitalization, higher liquidity risk, and generally higher default risk.

We exploit these implications for our identification strategy, and posit that a positive bank stock price reaction to a collateral policy announcement signals an expansionary surprise.

**Government Bonds and CDS** Our stylized framework can also be used to study how collateral policy changes affect the pricing of eligible assets. To do so, we solve the shareholder value maximization problem, which yields a pricing condition for government bonds. We assume that bank liabilities $d_1$ are priced competitively at their expected repayment probability, such that we can write the maximization problem as:

$$\max_{d_1,b_1} \mathbb{E}_0[div_1] \quad \text{s.t.} \quad div_0 = 0 \quad \text{and} \quad q_0^D = 1 - D^{bank}\big(\bar{b}_1/d_1\big) \; . \tag{6}$$

Using equations (1) and (3), this can be written as

$$\max_{d_1,b_1} \Big(1 - D^{bank}\big(\bar{b}_1/d_1\big)\Big)\big(\mathcal{R}_1 b_1 - d_1\big) \quad \text{s.t.} \; \Big(1 - D^{bank}\big(\bar{b}_1/d_1\big)\Big) d_1 = q_0 b_1$$

Plugging in the constraint, this can be expressed as

$$\max_{b_1} \Big(1 - D^{bank}\big(\bar{b}_1/d_1\big)\Big)\mathcal{R}_1 b_1 - q_0 b_1$$

The first-order conditions with respect to asset holdings $b_1$ are given by

$$q_0 = \Big( \underbrace{F\Big(\frac{\bar{b}_1}{d_1}\Big)}_{\text{Discounting}} + \underbrace{\frac{\bar{b}_1}{d_1} f\Big(\frac{\bar{b}_1}{d_1}\Big)}_{\text{Coll. premium}} \Big) \cdot \mathcal{R}_1 \; . \tag{7}$$

The possibility of bank failure affects asset prices in two ways. First, the expected payoff from purchasing *any* asset is discounted more strongly since banks receive the payoff from their investment in fewer states of the world. Second, holding pledgeable securities reduces the bank default probability, since they increase the likelihood that the collateral value of their assets is sufficient to cover the liquidity shock $\delta_1 d_1$. We refer to this willingness to pay for collateral services as the *collateral premium*, which in turn depends on the amount of collateral services provided by the asset $\frac{\bar{b}_1}{d_1}$, and the marginal default probability $f\Big(\frac{\bar{b}_1}{d_1}\Big)$.

How does collateral policy affect banks' pricing of assets? Since we assume that collateral policy does not affect each asset's expected payoff, we can write the partial derivatives of the

asset pricing condition with respect to the collateral parameter $\kappa$:

$$\frac{\partial q_0}{\partial \kappa} = \Big( \underbrace{-f\big(\frac{\bar{b}_1}{d_1}\big)\frac{b_1 \mathcal{R}_1}{d_1}}_{\text{More bank failure}} - \underbrace{\frac{\mathcal{R}_1 b_1}{d_1} f(\bar{b}_1/d_1)}_{\text{Smaller coll. amount}} - \underbrace{\frac{\mathcal{R}_1 b_1 \bar{b}_1}{d_1^2} f'(\bar{b}_1/d_1)}_{\text{Larger coll. valuation}} \Big) \cdot \mathcal{R}_1 \ , \tag{8}$$

The first part of equation (8) is unambiguously negative and captures that a collateral policy tightening depresses banks' valuation of government bonds by raising expected bank failure. The second part is also unambiguously negative and captures that the amount of collateral services provided by the bond is smaller if collateral policy is tightened. The third term is positive, since $f'(\bar{b}_1/d_1) < 0$ by assumption. Intuitively, banks' valuation of collateral increases, which counteracts the negative effect of bank failure on the pricing of government debt. Without placing additional structure on the model, the sign of equation (8) is unclear. To the extent that such collateral valuation effects are comparatively small, the model implies that collateral easing lowers government bond spreads over the risk-free rate.

To understand the transmission of collateral policy to sovereign CDS, it is helpful to note that we can price an asset that reflects the payoff profile of a sovereign CDS in our stylized model:

$$q_0^{CDS} = F\big(\bar{b}_1/d_1\big)\mathcal{R}_1^{CDS} \ . \tag{9}$$

While the CDS price is also negatively affected by the bank failure rate, it does not contain the second term related to the *marginal* bank failure rate, since a CDS is an insurance against sovereign default, and is not pledgeable as collateral. The partial derivative of the CDS price with respect to the collateral parameter reads

$$\frac{\partial q_0^{CDS}}{\partial \kappa} = -f(\bar{b}_1/d_1)\frac{\mathcal{R}_1 b_1}{d_1}\mathcal{R}_1^{CDS} \ . \tag{10}$$

Intuitively, a lower bank failure rate increases banks' willingness to pay for protection against a sovereign default event, since they receive the payoff from such an asset with a larger probability. The model also predicts a larger response of government bond spreads and CDS spreads if these assets are held and priced by riskier banks, since the marginal effect of collateral availability on bank failure is larger. We test these predictions when estimating the effects of our identified collateral policy surprise series on a panel of government bond and CDS spreads. We provide supporting evidence for this mechanism by comparing the capitalization, liquidity proxies, and the share of domestic government bonds for banks located in euro area core and periphery countries.

### 2.3 Identifying Collateral Policy Surprises

Based on the implications of our simple model, we use bank stock returns around collateral policy announcements to identify collateral policy surprises. Several advantages arise from such

a set-up. First, by focusing on banks as the *users* of collateral, rather than the issuers of collateral, allows us to examine the largest possible set of collateral policy events. In particular, we can include events concerning non-marketable assets, such as asset-backed securities or credit claims, for which market prices are not available, at least not at a sufficiently high frequency. Second, we avoid many judgment calls on the choice of which asset price to examine whenever an event affects multiple asset classes simultaneously.

Third, by employing high-frequency bank stock price data within a narrow window around collateral policy announcements, we isolate the unexpected component of the policy change. In doing so, we exclude the systematic responses of the central bank to macro-financial conditions, which is essential for a causal interpretation of the effect of collateral policy surprises on the macroeconomy. Fourth, extracting the common factor from individual responses does not require information on the exposure of individual banks to targeted assets, which are often very opaque, even with detailed securities holdings data.

We interpret a collateral policy event with a stock price increase (decline) as expansionary (contractionary). The advantage of this classification is that it is purely driven by market data. Hence, it comes at a low informational burden about the technical details of each announcement. It also renders events affecting very different asset classes, such as government bonds, covered bank bonds, or non-marketable assets comparable. Such a comparability across events is crucial for a systematic analysis of the transmission of collateral policy to banks' liquidity risk and asset prices. Lastly, there is one practical advantage to using bank stocks to identify collateral policy surprises, instead of bank CDS spreads. Bank stocks of all major European banks are traded at very high frequencies on centralized, liquid markets. By contrast, bank CDS are less liquid and are not available for all banks in our sample.

# 3 Measuring Collateral Policy Surprises

To measure collateral policy surprises, we use high-frequency bank stock price changes in a short window around collateral policy changes.

## 3.1 Data

Our measurement relies on three data sources. These are related to bank stock prices, the Eurosystem collateral framework for the list of policy announcements and press releases, and historical news archives, which provide additional information on the events.

**Bank Stock Prices** We obtain high-frequency tick-by-tick data of stock prices of the largest euro area banks contained in the EURO STOXX Banks Index from Thomson Reuters. We have full coverage for BBVA, Caixa Bank, and Santander (Spain); Banco Comercial Portugues (Portugal); BNP Paribas and Societe Generale (France); Intensa Sanpaolo and Unicredit (Italy); and Deutsche Bank (Germany) for our sample period, from 1 January 2007 to 31 December 2022.

For ING Group (Netherlands), Nordea Bank (Finland), and Bank of Ireland Group (Ireland), the high-frequency data are only available for a more recent sub-sample.

**ECB Collateral Policy Announcements** We obtain a comprehensive list of collateral policy announcements by the ECB since the establishment of the Eurosystem-wide single list in January 2007 until December 2022, extending the list of framework changes contained in Bindseil et al. (2017). We do not include announcements concerning the so-called Additional Credit Claims" programs by different national central banks during the Great Financial Crisis. Over this period, we identify 98 distinct collateral-related announcements - far from being an exceptionally rigid part of the plumbing of the financial system, collateral policy undergoes six changes per year on average.

Collateral policy announcements are spread across the year and do not systematically coincide with the regular governing council meetings. Unlike monetary policy announcements, which are tied to regular meetings by the ECB governing council, collateral policy changes are often announced in a standalone press release. As an illustration, consider the following excerpt from a press release concerning a collateral policy change on June 22, 2012:

> **PRESS RELEASE, 22 June 2012** ECB takes further measures to increase collateral availability for counterparties
> *On 20 June 2012 the Governing Council of the European Central Bank (ECB) decided on additional measures to improve the access of the banking sector to Eurosystem operations in order to further support the provision of credit to households and non-financial corporations. The Governing Council has reduced the rating threshold and amended the eligibility requirements for certain asset-backed securities (ABSs). It has thus broadened the scope of the measures to increase collateral availability [...]*[3]

**Historical News Archive** Based on the list of ECB collateral announcements, we make use of the LSEG Historical News Archive to uncover the precise time when news about ECB collateral policy announcements is disseminated to financial market participants. While ECB press releases provide the publication date, they do not include a precise timestamp, making the news archive essential for constructing accurate event windows in our high-frequency analysis.

In addition to timing, the archive provides valuable qualitative insights into market perceptions and commentary surrounding each announcement. For example, following up on the press release 22 June 2012 shown in the previous section, the market reaction for this announcement was the following: *"It just means that they are willing to take as collateral lower-quality credit, which is probably why the periphery is getting a bit of a bid against Germany"*, a trader said. This suggests that markets pay close attention and asset prices responded accordingly; the government bond and stock markets reacted positively.

[3]The full announcement is accessible under https://www.ecb.europa.eu/press/pr/date/2012/html/pr120622.en.html

We restrict our sample to events that received press coverage in the LSEG Historical News Archive, excluding announcements without any headline as insufficiently salient to financial market participants. This gives us 54 events, a complete list of which can be found in Appendix Appendix A.1. We further classify events into those affecting the collateral treatment of government bonds and those exclusively affecting the collateral treatment of privately issued assets. Out of 54 events, 20 are sovereign-related. Finally, we exclude collateral policy announcements coinciding with ECB monetary policy decisions, as well as the EU summit on 28 June 2012, since on these days price movements in the narrow event window cannot be cleanly attributed to the collateral policy change alone. This leaves a final sample of 44 collateral policy announcement events.

### 3.2 Collateral Policy Surprise Series

By using high-frequency asset price data around collateral policy announcements, we isolate the surprise component of each announcement. Akin to the large literature that identifies monetary policy surprises with high-frequency financial data (Kuttner, 2001; Gürkaynak et al., 2005), we assume that bank stock prices already reflect all relevant information about the macro-financial environment, in particular systematic changes in collateral policy. Thus, any immediate price change in a narrow window around an announcement reflects new information.

We measure the surprise component of each announcement using the bank stock price changes of the largest banks in the Euro STOXX Banks Index in a 45-minute time window around the announcements. Since our focus is on aggregate effects of collateral policy, we extract the first principal component of individual bank stock price reactions, which essentially absorbs all bank-specific characteristics. We will revisit the role of bank heterogeneity in the next section. All events with a positive stock price reaction are interpreted as "expansionary", i.e., the collateral framework was relaxed more aggressively or tightened less aggressively than expected by market participants.

Figure 1 graphically shows the time series of our collateral policy surprises (CPS). While there are more events during times of high financial stress, in particular during the European sovereign debt crisis, each year contains at least one event. Notably, the magnitude of the bank stock price reaction is quite evenly distributed across the sample, suggesting that collateral policy has relevant effects on banks outside of crisis times. There are several large positive and large negative events; the shock series has no visible skewness, there is no significant autocorrelation, and we find no heteroskedasticity in the surprise series. Red dots indicate events affecting the collateral treatment of government bonds. Importantly, these events are not clustered around the euro area debt crisis. By contrast, orange events indicate events that exclusively affect the collateral treatment of assets issued by private agents. Some of these events also induced large bank stock price reactions. We run a battery of robustness checks in Section 3.4.

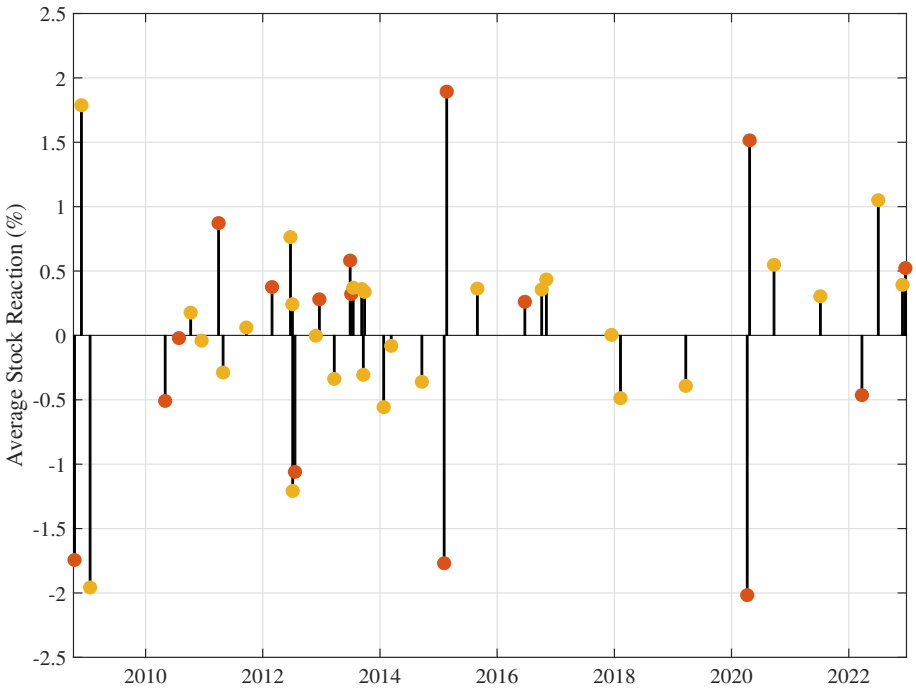


**Figure 1: Collateral Policy Surprise Series**: This figure plots the Collateral Policy Surprises, displayed in terms of the mean stock price reaction. Events coinciding with ECB governing council meetings and the 2012 euro summit are excluded, leaving a final sample of 44 events. Red dots indicate events affecting the collateral treatment of government bonds, while orange dots indicate events that exclusively affect the collateral treatment of assets issued by private agents.

### 3.3 Narrative Evidence

Our interpretation of collateral policy surprises as expansionary or contractionary relies on the direction of the bank stock response. The advantage of this approach is that we do not need to impose any interpretation on the direction of the surprise, but instead follow the assessment of market participants. To further corroborate the plausibility of this interpretation, we present a narrative assessment of selected episodes in the spirit of Drechsel and Miura (2024). We focus on a set of expansionary and contractionary events that are particularly relevant, as they are associated with average stock price reactions exceeding one percent in absolute value. These events correspond to the largest spikes observed in Figure 1.

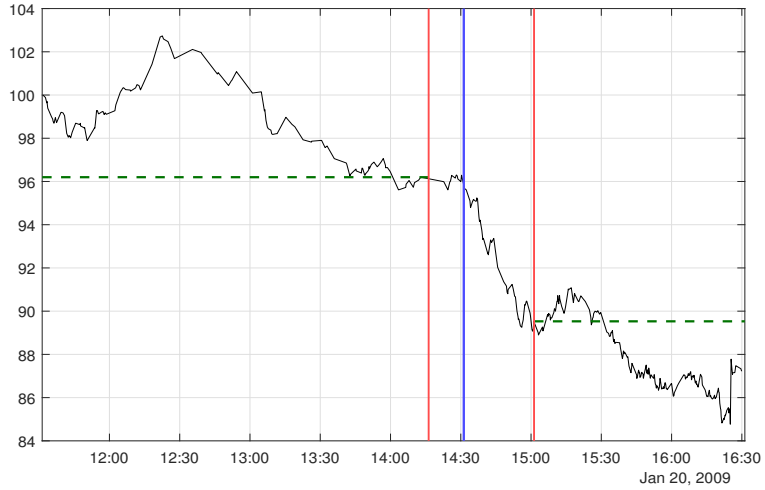


**Figure 2: Negative high-frequency reaction**: This figure plots the intraday first principal component of bank stock prices across all banks in our sample around a contractionary collateral policy surprise on Jan 20, 2009, normalized to 100 at the start of the window. The vertical blue line indicates the timing of the collateral policy announcement (press release). The vertical red lines mark the pre- and post-announcement windows. The horizontal dashed green lines indicate the median price levels within the pre- and post-announcement windows, expressed relative to the normalization at the start of the window. The horizontal axis reports time in UTC.

For example, on January 20, 2009, the ECB raised the minimum rating on asset-backed securities to AAA. This was accompanied by generally negative market commentary, stressing that it does not contribute to an improvement in market liquidity but rather results in greater financial stress. As Figure 2 shows, the aggregate bank stock return exhibits a sharp decline after the press release at 14:30, while there is very little movement in the 15 minutes prior to the event. Similarly, the ECB excluded Greek government bonds from the list of eligible collateral on July 20, 2012, which was accompanied by a strongly negative bank stock reaction and negative market commentary emphasizing the effect on bank funding cost. A similar pattern emerges on February 4, 2015. The ECB again removed Greek bonds from the list of eligible collateral, which had become eligible again in the meantime. The market commentary was again negative, mentioning concerns about runs on Greek government bonds.

Conversely, two important expansionary events concerning the treatment of Greek government bonds on February 20, 2015, and the Eurosystem's response to the Covid-19 pandemic on April 22, 2020, are associated with a large positive bank stock reaction. Figure 3 shows the positive market reaction, the aggregate bank stock return exhibits a sharp jump after the press release in the late afternoon, and the stocks started trading again on a higher level the next day. In Appendix A.1, we provide a comprehensive assessment of the market commentary for each event, as well as the mean stock price reaction of the banks in our sample. This illustrates that the classification of collateral policy surprises into "expansionary" and "contractionary" events is generally consistent with the stock market response.


**Figure 3: Positive high-frequency reaction**: This figure plots the first principal component of bank stock prices across all banks in our sample around an expansionary collateral policy surprise on April 22, 2020, normalized to 100 at the start of the window. The vertical blue line indicates the timing of the collateral policy announcement (press release). The vertical red lines mark the pre- and post-announcement windows. The horizontal dashed green lines indicate the median price levels within the pre- and post-announcement windows, expressed relative to the normalization at the start of the window. The horizontal axis reports time in UTC.

- On January 20, 2009, the ECB says to require a rating of AAA/Aaa for ABS as collateral as of March 1st. Market commentary: *"From the banks' perspective, it's more restrictive, but it's not so drastic that it will shrink the mortgage market," said an analyst specialising in structured credit at a German bank. RBS economist Silvio Peruzzo said the announcement was minor compared to other changes announced to the ECB's collateral rules. "It provides an additional control on the quality of assets," he said. But Tullett Prebon economist Lena Komileva said the move sent the wrong signal at a time when the Bank of England and the U.S. Federal Reserve were stepping in to support illiquid markets. "Rather than responding to an underlying improvement in market liquidity conditions, the ECB's collateral tightening reflects quite the opposite – poor asset quality and insufficient market transparency – resulting in greater financial stresses," she said.* The bank stock reaction was unanimous and negative, and exceeded one percent in absolute terms.

- On July 20, 2012 the ECB announces that Greek government bonds become ineligible as collateral from July 25. Market commentary: *Greek bankers took the decision in their stride. "It's something we were expecting," one banker speaking on the condition of anonymity said. "The only difference is the borrowing cost for the banks."* The bank stock reaction was unanimous and negative, and exceeded one percent in absolute terms.

- On February 4, 2015, the ECB lifts waiver on credit rating requirements for Greek bonds. Market commentary: *ECB move rekindled safe-haven demand for low-risk U.S. and German government debt as it stoked worries about runs at Greek banks and concerns the new*

*Greek government would have trouble renegotiating debt terms with its euro zone partners, analysts said.* The bank stock reaction was unanimous and negative, and exceeded one percent in absolute terms.

- On February 20, 2015, the ECB is ready to reintroduce waiver for Greek collateral once it assesses that program likely to be concluded. The bank stock reaction was positive for every bank, and exceeded one percent in absolute terms.
- On April 22, 2020 the ECB says it takes steps to mitigate impact of possible rating downgrades on collateral availability. The bank stock reaction was unanimous and positive, and exceeded one percent in absolute terms.

### 3.4 Diagnostics

In this section, we present a large battery of plausibility checks for the collateral policy surprise series. We address concerns regarding the measurement of the surprise component, which are related to macro-financial confounders, predictability of the surprises, bank heterogeneity, and information effects.

**Macro-Financial Confounders and Predictability** The measured CPS series would be biased if bank stock price reactions captured not only the pure surprise component of collateral policy changes, but also the systematic response of collateral policy to the macro-financial environment. This bias would arise if financial market participants fail to anticipate the systematic component; that is, if they do not account for how collateral policy predictably responds to macroeconomic and financial conditions. Market commentary suggests that participants do track these systematic responses, implying that asset prices already reflect them and that the surprise component is isolated correctly. Nevertheless, it is instructive to contrast the CPS with established measures of financial market stress as an additional check.

The upper left panel of Figure 4 demonstrates graphically that the measured CPS does not correlate with the EURIBOR-OIS spread, which is a common measure of interbank market stress. Specifically, we plot the baseline CPS against the residual of regressing the CPS on the EURIBOR-OIS spread. The second row of Figure 4 repeats the same exercise using the EUROSTOXX volatility index as a common measure of uncertainty in wider financial markets. In both cases, the purged surprise series, i.e., the fitted residual, is highly correlated with the baseline CPS, while the residual exhibits no significant correlation. The picture does not change for the lagged series of EURIBOR-OIS spreads or of the EUROSTOXX volatility index. In the bottom row, we use bank and sovereign CDS spreads on the trading day before the announcement, respectively, to purge the shock series. Again, the residuals are essentially located along the 45-degree line, suggesting that these measures of financial stress do not predict our measured collateral policy surprises.

To ensure that our event window is not contaminated by other major economic news, we check for overlapping data releases using the Bloomberg economic calendar. We find no significant

macroeconomic announcements or monetary policy decisions in the United States, the euro area, or the United Kingdom on those dates. Lastly, we test whether monetary policy surprises predict our collateral policy surprises. We regress our surprise series on the monetary policy surprise factors identified by Altavilla et al. (2019) and find no statistically significant relationship.

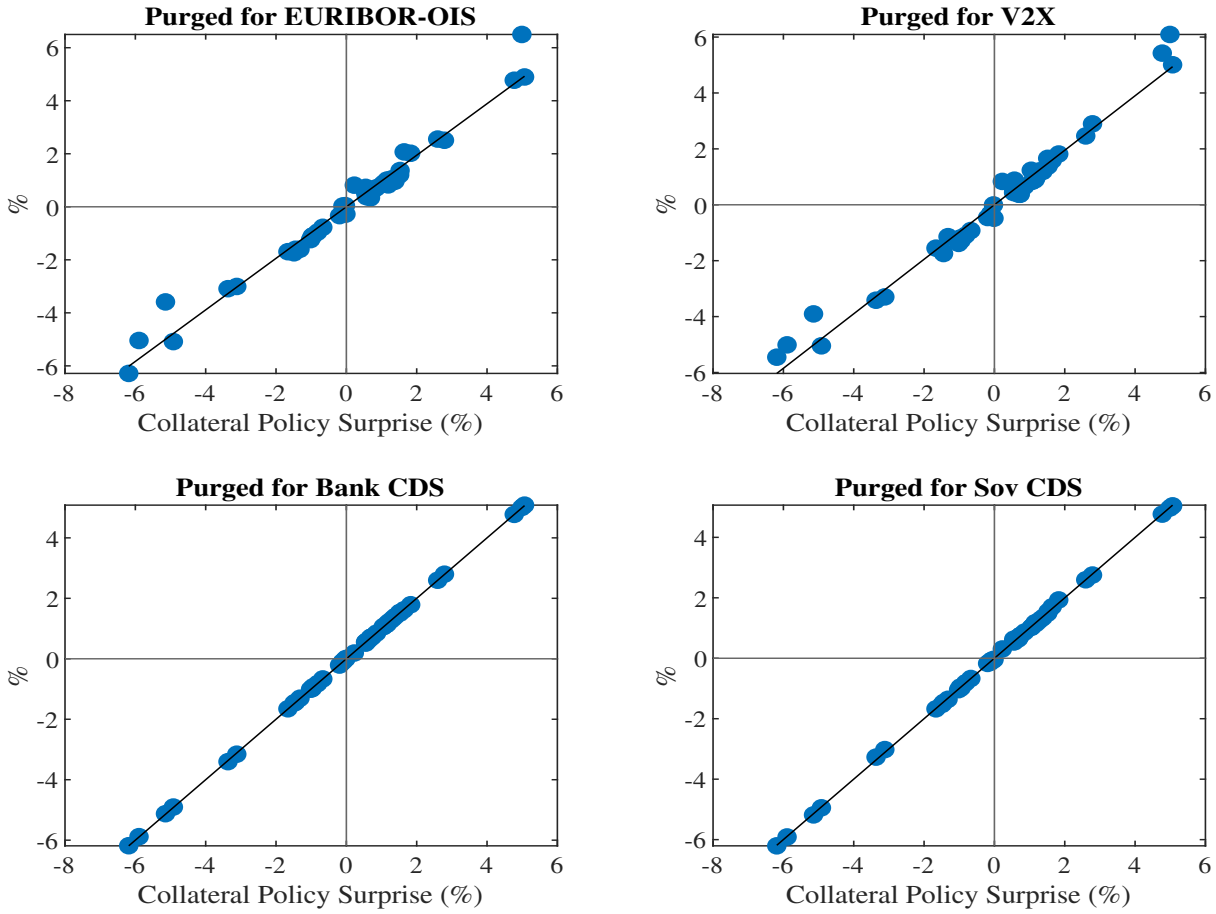


**Figure 4: Purged Collateral Policy Surprises**. The left column compares our collateral policy surprise, i.e. the first principal component of all bank stock price reactions (in %) to the residual $\nu_t$ from regressing $cps_t$ on potential confounders: $cps_t = \beta_0 + \beta_1 y_t + \nu_t$. The right column plots the fitted value $\widehat{eps}_t$ against the original collateral policy surprise. The EURIBOR-OIS spread is expressed in basis points, the V2X is an implied volatility expressed in percentage points and the return dispersion is expressed in percent.

**Information Effects** As a next step, we address the potential role of central bank "information effects", which have been suggested as a confounding factor in high-frequency monetary policy surprise measures (see Nakamura and Steinsson, 2018; Jarociński and Karadi, 2020; Miranda-Agrippino and Ricco, 2021). In our context, it is also important to highlight that ECB announcements are typically of a rather technical nature, as illustrated by the comprehensive list of collateral announcements provided in Appendix A.1. Nevertheless, market participants might uncover valuable information from such a policy announcement, for instance, about the quality of eligible assets or the role they play in the liquidity status of specific banks. Drechsel and Miura (2024) discuss information effects in the context of high-frequency bank stock prices to identify macroprudential policy shocks.

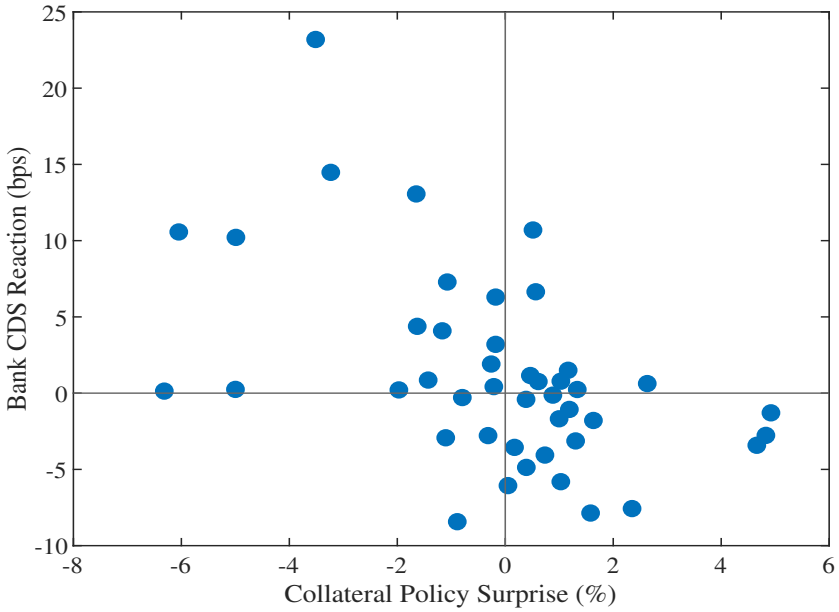


**Figure 5: Information Effects: Bank Stocks and CDS Spreads**. The figure plots the baseline collateral policy surprise based on the first principal component of high-frequency bank stock price reactions (x-axis) against the aggregate daily bank CDS reaction, measured in basis points.

To shed light on this issue, we exploit the fact that our stylized model implies that a "pure" expansionary CPS should move both bank stocks and CDS-spreads in opposite directions, as it reduces the risk of bank failure due to liquidity shocks. In Figure 5, we compare the high-frequency identified collateral policy surprises to the aggregate bank CDS reaction. On most events, bank stocks and CDS spreads indeed move in opposite directions. There are around 10 events in the southwest and northeast quadrant, but the stock price reactions are generally comparatively small, rarely exceeding one percent. Manually inspecting these events, it turns out that around half of them are of a very technical nature. For instance, five events concern information disclosure requirements on asset-backed securities or the introduction of a new collateral management system. Furthermore, there is hardly any market commentary on those event days, suggesting that information effects are not a concern. Excluding all events during which bank stocks and CDS spreads move in the same direction does not change the results.

**Placebo Test** A potential concern regarding the high-frequency approach can be that other news might affect the bank stock price during the event window, even if it is intraday. To test this, we conduct a "placebo" test by measuring intraday changes in bank stock prices using the same event window, but shifted to 7 days before each collateral policy announcement. These days serve as a proxy for comparable days without any actual collateral policy announcements. We do not find any significant changes in financial variables in response to these "placebo" surprise series. This can be illustrated graphically via probability density functions similar to Känzig (2021). Figure 6 plots the kernel density estimate for our baseline surprise series against the kernel density estimate for the "placebo" surprise series. The bank stock return distribution on event days (solid black line) shows increased variance and fatter tails on announcement event

windows as opposed to control dates (dashed black line).

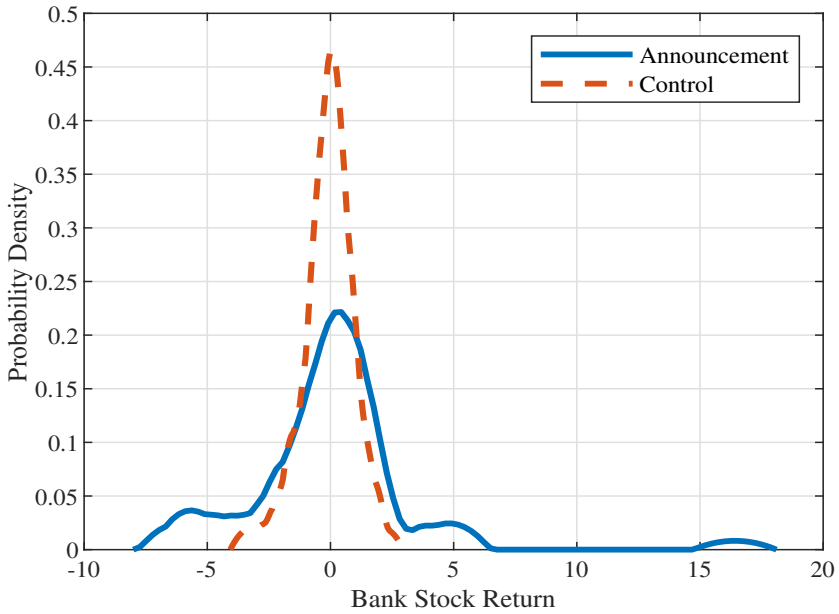


**Figure 6: Announcement versus Control Event Window**. The figure plots the Epanechnikov kernel density estimate of aggregate bank stock returns on our 44 event dates (solid black line). As a control group, we report the Epanechnikov kernel density estimate for a placebo surprise series that is based on the same intraday 45-minute event window, but 7 trading days before each actual collateral announcement.

# 4 The Transmission at the Micro Level

While our measured collateral policy surprise series has appealing properties from a macro-econometric point of view, there might be concerns about bank selection and heterogeneity as potential confounders of our measurement of collateral policy surprises. We address these concerns in Section 4.1. Furthermore, we exploit bank heterogeneity to better understand the transmission of collateral policy surprises in Section 4.2.

## 4.1 Bank Heterogeneity and Measurement

As a first step, we demonstrate that our measure of collateral policy surprises, based on high-frequency stock price data, is robust to the selection of banks. In Appendix A.2, we show that excluding any one bank at a time does not affect our shock series. We also illustrate that for most events with a positive (negative) first principal component, the maximum and minimum stock price reactions were also positive (negative). By contrast, the dispersion in bank stock reactions is not visibly correlated with the aggregate response. This implies that purging the CPS by the bank return dispersion has no relevant effect on the measurement of collateral policy.

**Bank Balance Sheet Characteristics** To explore cross-sectional heterogeneity in a more structural fashion, we obtain balance sheet data from CapitalIQ for all banks included in our intraday sample, spanning the period from Q1 2007 until Q4 2024. We estimate the following regression at the bank-quarter level:

$$\Delta\text{Stock}_{i,t} = \alpha + \beta\ \text{weak}_{i,t-1} + \gamma \mathbf{X}_{i,t} + \phi_i + \tau_t + \epsilon_{i,t} \tag{11}$$

where $\Delta$ Stock is the (high-frequency) stock price reaction around a collateral policy change of bank $i$, cumulated over all events in quarter $t$. We define "weak" in terms of liquidity and solvency, respectively. First, we define a bank to be weak in terms of liquidity if its securities-over-assets-ratio is below the median of all the banks in the sample. Second, we define a bank to be weakly capitalized if its tier-one equity ratio is below the median of all banks in the sample. We expect that $\beta > 0$ as collateral policy changes are stronger for banks with less liquid / less capitalized banks, following Kashyap and Stein (2000). We also include a vector of time-varying control variables at the bank level $\mathbf{X}_{i,t}$. Here, ln(Assets) is the log of total assets; Loans Ratio is the loans-over-assets ratio; ROE is the return on equity; Debt Ratio is the total debt-over-assets ratio; Deposits Ratio is the deposits-over-assets ratio of bank $i$ in quarter $t$. We further include bank $\phi_i$ and quarter $\tau_t$ fixed effects.

| | (1) $\Delta$ Stock$_i$ | (2) $\Delta$ Stock$_i$ | (3) $\Delta$ Stock$_i$ | (4) $\Delta$ Stock$_i$ | (5) $\Delta$ Stock$_i$ | (6) $\Delta$ Stock$_i$ |
|---|---|---|---|---|---|---|
| Illiquid $(0/1)_{i,t-1}$ | 0.286 | 0.237 | 0.396** | | | |
| | (0.240) | (0.322) | (0.176) | | | |
| Low Capital $(0/1)_{i,t-1}$ | | | | 0.328 | 0.304 | 0.192* |
| | | | | (0.220) | (0.406) | (0.095) |
| ln(Assets) | -0.009 | -0.131 | -0.921* | -0.047 | -0.287 | -0.865* |
| | (0.062) | (0.447) | (0.496) | (0.080) | (0.436) | (0.411) |
| Loans Ratio | 0.006 | -0.021 | -0.016 | 0.007 | -0.023 | -0.015 |
| | (0.013) | (0.023) | (0.011) | (0.012) | (0.025) | (0.009) |
| ROE | -0.038 | -0.039 | -0.021 | -0.036 | -0.036 | -0.019 |
| | (0.028) | (0.031) | (0.023 | (0.028) | (0.031) | (0.023) |
| Debt Ratio | 0.014 | 0.066** | 0.003 | 0.017 | 0.066** | 0.003 |
| | (0.011) | (0.023) | (0.006) | (0.010) | (0.024) | (0.007) |
| Deposits Ratio | -0.005 | 0.033* | -0.008 | -0.005 | 0.029 | -0.008 |
| | (0.012) | (0.016) | (0.012) | (0.011) | (0.018) | (0.012) |
| Observations | 231 | 231 | 231 | 231 | 231 | 231 |
| R-squared | 0.035 | 0.085 | 0.824 | 0.040 | 0.088 | 0.820 |
| Bank FE | No | Yes | Yes | No | Yes | Yes |
| Quarter FE | No | No | Yes | No | No | Yes |
| Cluster | Bank | Bank | Bank | Bank | Bank | Bank |

**Table 1: Collateral Policy Surprises and Bank Heterogeneity**. This table presents the results from estimating (11) over all collateral policy events. ***, **, * indicate significance at the 1, 5, and 10% level.

Table 1 presents the results from estimating (11) over all collateral policy events. Summary Statistics can be found in Table A.3 in Appendix A.2. Columns (1)-(3) show that less liquid banks react more to collateral policy surprises. Importantly, the variation in individual stock price reactions seems to be driven by the common aggregate response to each event, which is reflected by an $R^2$ of more than 0.8 once quarter fixed effects are included. By contrast, the $R^2$ is less than 0.1 in specifications without quarter fixed effects. Furthermore, significant cross-sectional differences emerge only after partialling out the common component. Similarly, columns (4)-(6) show that less capitalized banks also seem to react more to collateral policy changes, albeit with a lower magnitude. Since collateral policy is primarily associated with banks' short-term funding needs, it is reasonable to expect that bank liquidity is a more important characteristic than bank capitalization. Overall, these results are in line with Kashyap and Stein (2000) who find similar results for changes in monetary policy. Collateral policy surprises predominantly affect aggregate liquidity and that the cross-sectional variation appears to be of second-order importance for the *measurement* of collateral policy surprises.

### 4.2 Bank CDS

We have already shown that aggregate bank CDS spreads generally respond negatively to an expansionary CPS. In this section, we exploit bank heterogeneity to uncover potential *transmission* mechanisms of collateral policy. Following the literature on the financial market effects of monetary policy (Swanson, 2021; Bauer et al., 2023), we estimate local projections

$$y_{t+h} - y_{t-1} = \alpha + \beta_h cps_t + \epsilon_t \ , \tag{12}$$

where $t$ indexes collateral policy announcements, $h$ is the number of days after the announcement and ranges from $h = -4$ to $h = 10$, $cps_t$ is the high-frequency collateral policy surprise series measured using intraday data, $y_{t+h}$ is the asset price $h$ days after the announcement, $y_{t-1}$ is the asset price one day before the announcement, and $\epsilon_t$ is the residual. As customary in the local projections literature, each time horizon is estimated separately. Standard errors are adjusted for serial correlation and heteroskedasticity. To test for pre-trends, we extend the local projection horizon to include four days prior to collateral policy announcements and find no meaningful evidence of such pre-trend patterns. While asset prices prior to the announcements should already reflect all publicly available information, controlling for pre-trends allows us to account for other relevant news that may have occurred shortly before collateral policy announcements and could generate pre-event price drifts correlated with our surprise measure.

Figure 7 displays the response of bank CDS spreads to an expansionary CPS, where we subset banks into "Core" and "Periphery" based on their headquarters' location. We display the results on individual bank CDS spreads in Figure A.3 in Appendix B. While the effect is significantly negative for all banks, it is much more pronounced for banks located in the periphery. Importantly, core and periphery banks differ along several dimensions. Periphery banks have higher CDS spreads, a smaller share of liquid assets, less tier 1 capital, and a larger home bias in their government bond holdings. Information on European banks' home bias can be obtained from publicly available data from the European Banking Authority's transparency exercise in 2013.[4] Summary statistics for all banks in our sample are presented in Table 2. Consequently, a similar picture emerges when splitting banks at the median for each of these dimensions. These characteristics are also significant in specifications where we interact the shock with the respective bank characteristic.

[4]More details on the EU-wide transparency exercise can be found under this link.

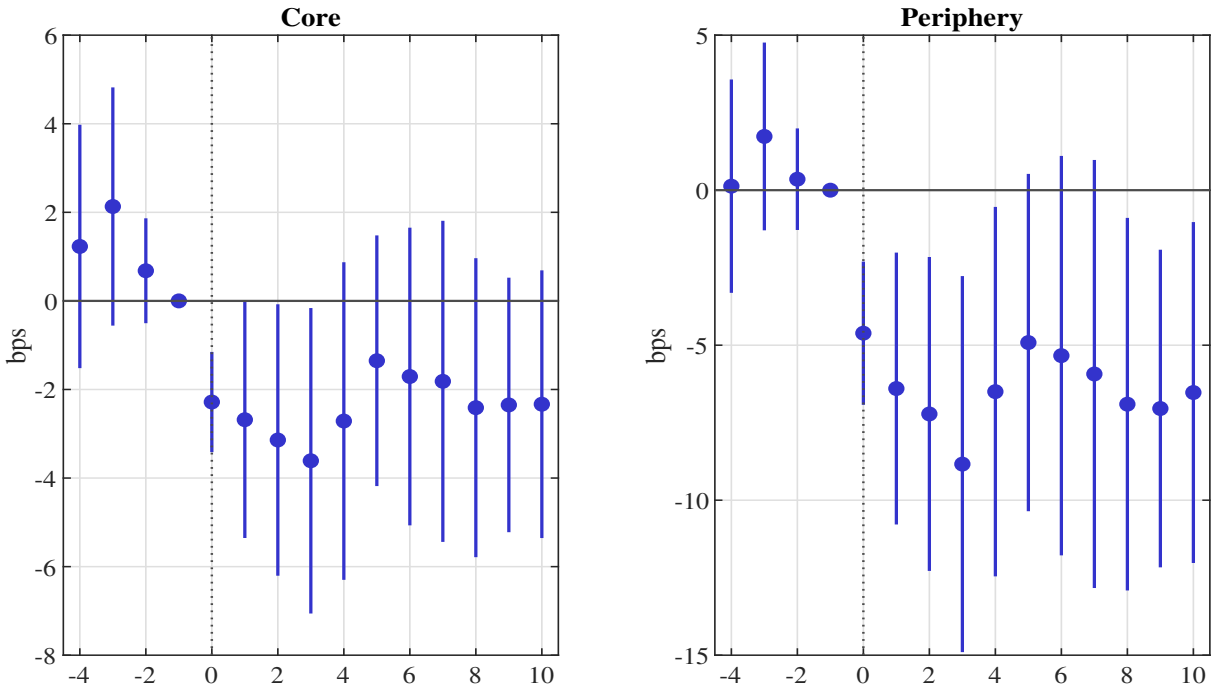


**Figure 7: Bank CDS**: Results from estimating (12) using all collateral policy surprises. The dependent variables are 5 Year senior CDS written on single-name banks, expressed in basis points. Dots represent estimated coefficients, and vertical lines denote 90% confidence intervals based on heteroskedasticity- and autocorrelation-consistent (Newey-West) standard errors. The horizontal axis reports event time in days relative to the policy announcements, with $t = 0$ marking the announcement dates.

| Variable | Full Sample | Core | Periphery |
|---|---|---|---|
| CDS Spread (bps) | 177.11 | 136.00 | 228.49 |
| Securities Ratio (%) | 41.76 | 53.18 | 27.49 |
| Tier-1 Ratio (%) | 9.30 | 9.73 | 8.75 |
| Home Bias (%) | 63 | 51 | 78 |

**Table 2: Bank Heterogeneity in the Euro Area**. The CDS spread refers to the full sample average from 2008-2022. The home bias in sovereign bond holdings is based on publicly available data from the 2013 EBA stres test. The securities and Tier 1 capital ratios are computed over total assets, using data from Compustat in 2013.

# 5 Macroeconomic Effects

In this section, we use our high-frequency collateral policy surprise (CPS) series to study the transmission of collateral policy to general financial markets and the euro area government bond market. Using the local projection framework introduced above (Equation 12), we estimate the dynamic responses of asset prices to collateral policy surprises at daily frequency.

## 5.1 Financial Markets

Figure 8 presents the effects of an expansionary one-standard deviation collateral policy surprise (CPS) on key financial market indicators. Bank stock returns are persistently positive for several trading days and exceed those of the wider stock market by a considerable margin. To put the numbers into perspective, a one-standard-deviation monetary policy surprise (Jarociński and Karadi, 2020) raises stock market returns by 0.4 percentage points, with no differential effect on bank stocks relative to the broader market.

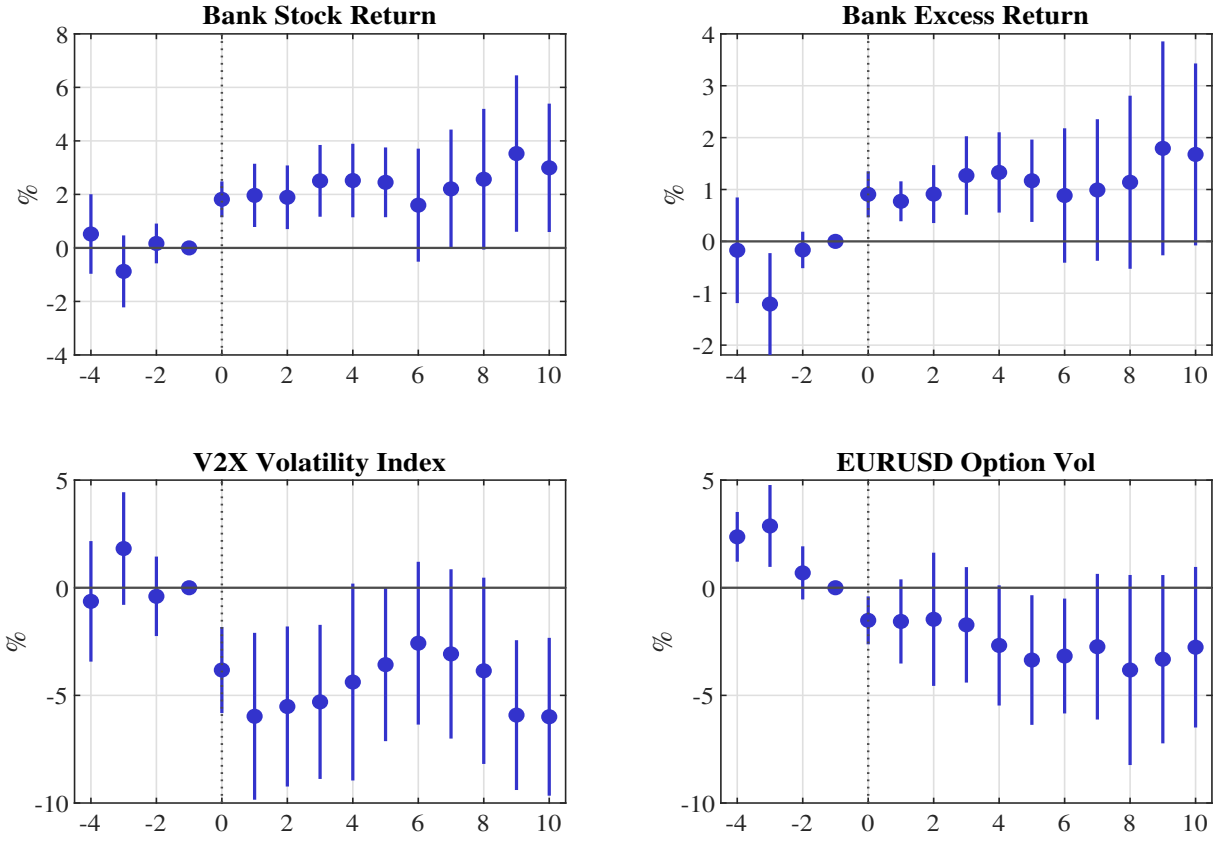


**Figure 8: Key Financial Indicators**: Results from estimating (12) using all collateral policy surprises. The dependent variables in the top row are the EuroSTOXX Banks Index and the excess return of EuroSTOXX Banks over the overall index. The dependent variables in the bottom row are the implied volatility of EuroSTOXX50 options and the option-implied volatility of the EUR-USD exchange rate. Dots represent estimated coefficients, and vertical lines denote 90% confidence intervals based on heteroskedasticity- and autocorrelation-consistent (Newey-West) standard errors. The horizontal axis reports event time in days relative to the policy announcements, with $t = 0$ marking the announcement dates.

Turning to variables that capture aggregate risk in financial markets, we find that expansion-

ary collateral policy significantly reduces the V2X index, a common proxy for European equity market uncertainty, across all event horizons. Similarly, the implied volatility of EUR/USD currency options (EURUSDVOL) declines following an expansionary CPS, although the effects are somewhat less significant. the magnitude of both effects remains stable or even strengthens over time, suggesting a persistent dampening of financial market uncertainty.

## 5.2 Government Bond Markets

We now turn to the government bond market effects of an expansionary CPS. We examine responses of 5-year government bond spreads over the risk-free rate, proxied by the Overnight Index Swap, for the eight largest euro area sovereign borrowers. We divide countries into two groups. These are Germany, Belgium, France, and the Netherlands (the "core" countries), as well as Italy, Spain, Ireland, and Portugal (the "periphery"). The responses of each individual country are presented in B.

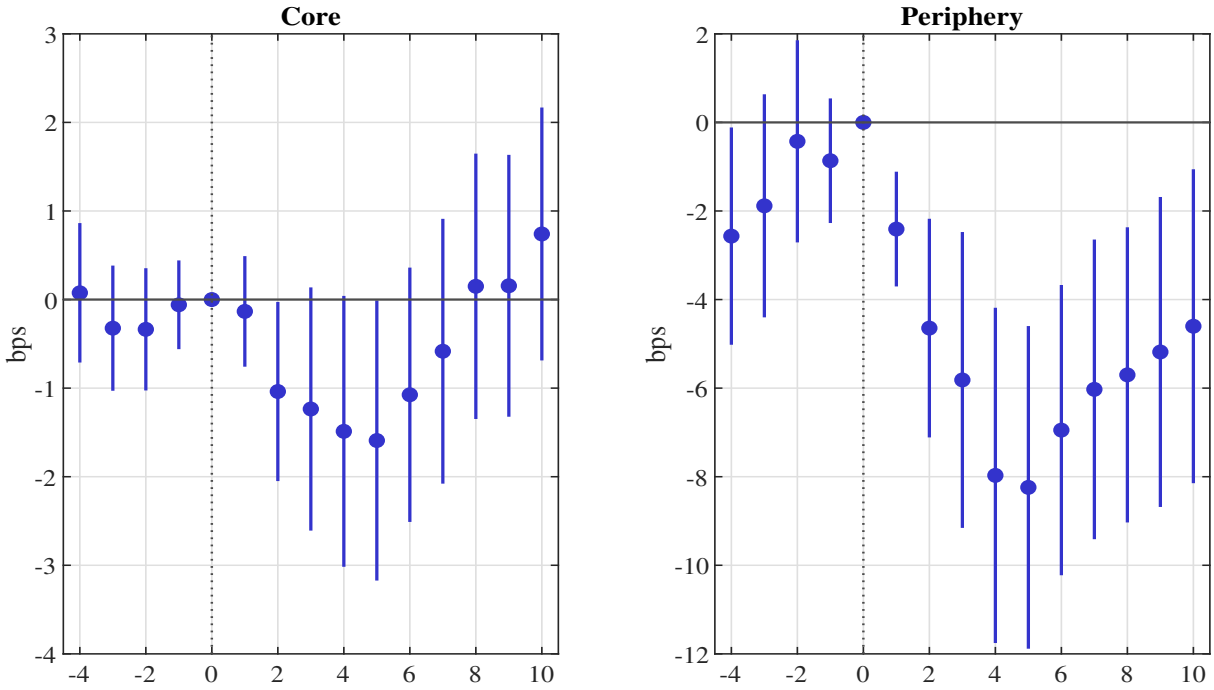


**Figure 9: Collateral Policy Surprises and 5Y Bond Spreads over OIS**: Results from estimating (12) for 5-year government bond yield spreads relative to OIS for core versus periphery euro area countries. Core countries are Germany, Belgium, France and the Netherlands. Periphery countries are Italy, Spain, Ireland and Portugal. Dots represent estimated coefficients and vertical lines denote 90% confidence intervals based on heteroskedasticity- and autocorrelation-consistent (Newey-West) standard errors. The horizontal axis reports event time in days relative to the policy announcements, with $t = 0$ marking the announcement dates.

Figure 9 shows the results. The periphery-core spread declines significantly after an expansionary CPS for every estimation horizon and both bond maturities. The effect is quite sizable and peaks at around -5 basis points several trading days after the shock. Examining core and periphery yields separately, we find that the effect on the periphery–core spread primarily reflects changes in periphery yields, both in magnitude and statistical significance. By contrast,

core yields exhibit smaller and less consistent responses. The fully dynamic responses for 10-year bonds are presented in the Appendix in Figure B.1 and are very similar for five-year bonds.

Next, we examine whether the government bond effects carry over to the pricing of sovereign risk more generally. Specifically, we obtain five-year CDS spreads for the largest four euro area countries (Germany, France, Italy, and Spain), which represent the most commonly traded CDS tenor. Figure 10 shows the results. Again, we observe a significantly negative effect of expansionary collateral policy, which is more pronounced for riskier borrowers: while German and French CDS spreads decline by about 2bps, Italian and Spanish CDS spreads peak at around -8bps, which is remarkably similar to the effects on government bond spreads.

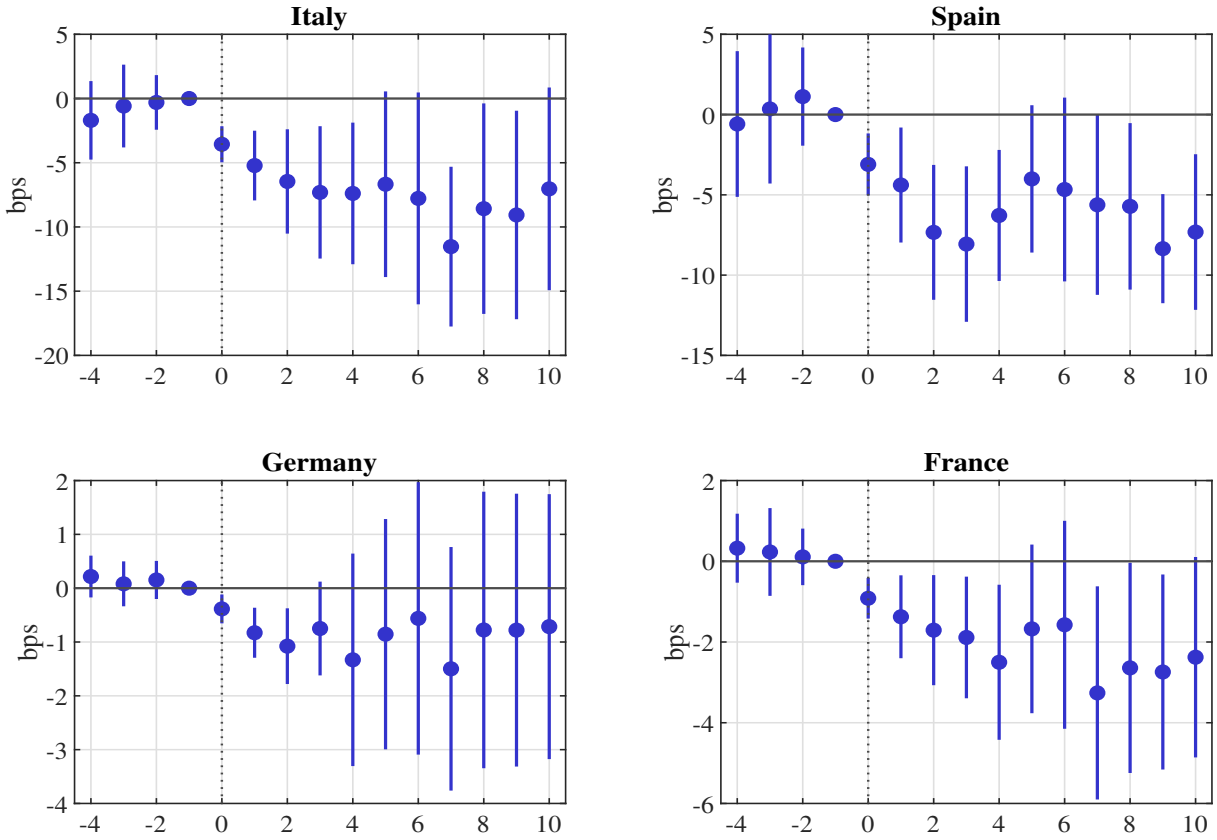


**Figure 10: Collateral Policy Surprises and Sovereign CDS**: Results from estimating (12) for 5-year Sovereign Credit Default Swap Spreads. Dots represent estimated coefficients and vertical lines denote 90% confidence intervals based on heteroskedasticity- and autocorrelation-consistent (Newey-West) standard errors. The horizontal axis reports event time in days relative to the policy announcements, with $t = 0$ marking the announcement dates.

Taken together with the positive effects of expansionary collateral policy on aggregate uncertainty and bank default risk, these results suggest that expansionary collateral policy surprises act as a positive "bank risk shock". In an intermediary asset pricing framework, banks' default risk is a crucial driver of asset prices. A decline in bank default risk raises banks' willingness to pay for a broad range of assets — including sovereign bonds and CDS — which drives bond and CDS spreads down. Consistent with this interpretation, we show in Appendix B that the CDS-bond basis does not respond significantly to collateral policy, pointing towards a transmis-

sion mechanism that operates through bank risk rather than through the convenience yield of government bonds.

**Bank Heterogeneity in the Euro Area** To further corroborate this interpretation, we revisit the bank-specific CDS responses in Figure 7. Periphery banks react considerably more strongly, and these banks were also holding more periphery sovereign bonds during our sample period. An intermediary asset pricing framework, that also accounts for this home bias predicts an uneven transmission of a symmetric collateral policy surprise to the government bond market. Our analysis suggests that the source of the uneven transmission of collateral policy lies in bank heterogeneity rather than in heterogeneity in fiscal fundamentals.

### 5.3 Sample Splits

To deepen our understanding of the transmission of collateral policy to financial markets, we analyze how its effects differ across specific sub-samples.

**Non-Sovereign vs Sovereign Events** Collateral policy changes often refer to government bonds, which play a central role in banks' collateral management due to their extraordinary safety and liquidity. However, the broad scope of the Eurosystem collateral framework means that events also affect other assets, such as asset-backed securities (see also our classification into sovereign and non-sovereign events in Appendix A.1). To investigate whether the transmission differs across these two groups, Column (1) in Table 3 focuses on events that only affect private sector assets, leaving the collateral treatment of government bonds unaffected. Column (2), by contrast, considers events that also or exclusively affect government bonds.

We find that equity market responses are generally similar across sub-samples. Similarly, the volatility measures and bank CDS spreads decline for both types of events. This finding further supports our identification strategy based on bank stock returns: the effects of collateral policy are not confined to events directly targeting sovereign bonds. Indeed, the periphery-core spread narrows significantly for events unrelated to sovereign bonds, irrespective of bond maturity and estimation horizon.

**Targeted Events** The heterogeneous transmission of collateral policy to the government bond market is particularly pronounced for events directly related to the collateral treatment of government bonds. Of the 20 events affecting government bonds, we identify 13 that directly targeted sovereign borrowers most affected by the euro area sovereign debt crisis. These events are marked with an asterisk Table A.1. Figure 12 demonstrates that periphery spreads decline by almost 25 basis points, compared to around 12bps for the more general sub-sample. It is worth noting that the reaction of core government bond spreads is also considerably stronger at -5bps, compared to -3bps for all events affecting government bonds.

In particular, we consider three individual events that triggered large movements in bank stocks, exceeding one percent over the 45-minute event window. On 31 March 2011, the ECB

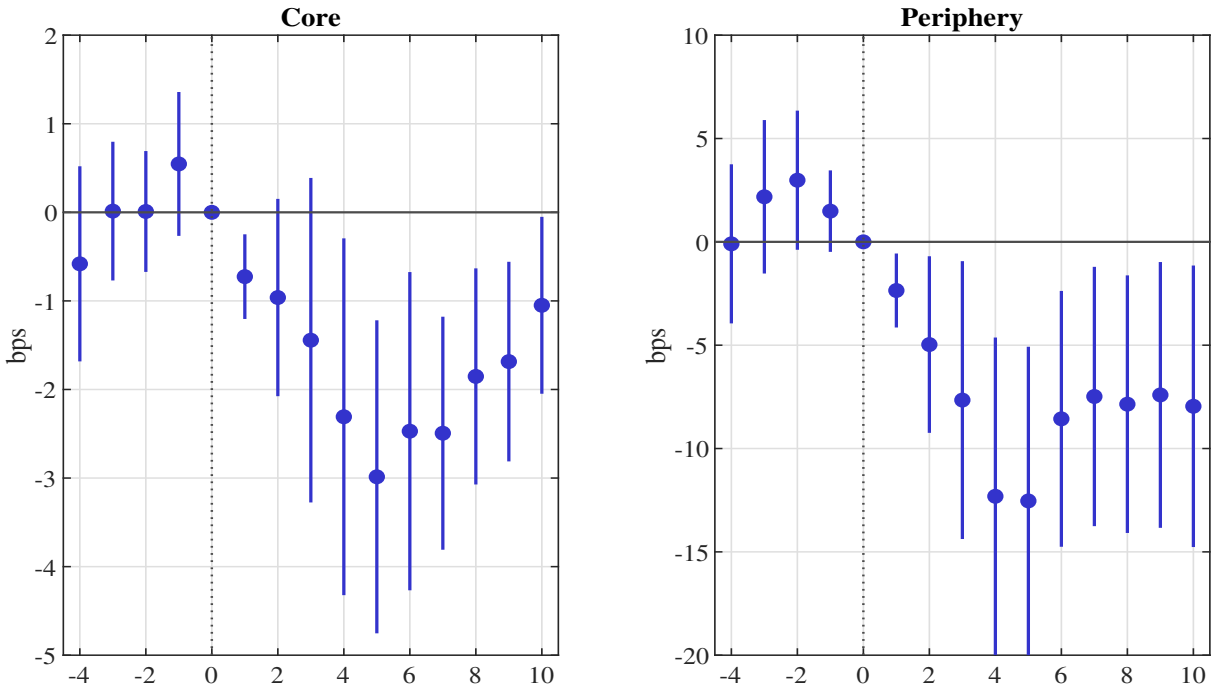


**Figure 11: Collateral Policy Surprises and Bond Spreads for All Sovereign Events**: Results from estimating (12) for 5-year government bond yield spreads relative to OIS for core versus periphery euro area countries on the sub-sample of events that affect the collateral treatment of government bonds. Core countries are Germany, Belgium, France and the Netherlands. Periphery countries are Italy, Spain, Ireland and Portugal. Dots represent estimated coefficients and vertical lines denote 90% confidence intervals based on heteroskedasticity- and autocorrelation-consistent (Newey-West) standard errors. The horizontal axis reports event time in days relative to the policy announcements, with $t = 0$ marking the announcement dates.

suspended the minimum rating requirement on Irish government bonds, making them eligible as collateral. This announcement was associated with an increase in aggregate bank stock prices and a narrowing of the 5-year Italian–German government bond spread by 4.2 basis points within one trading day. By contrast, on 20 July 2012, the ECB excluded Greek government bonds from the list of eligible collateral, inducing a decline in bank stocks and a widening of the Italian–German spread by 37.5 basis points within a single day. This contractionary collateral policy change occurred during a period when periphery bond spreads exceeded 500 basis points. Finally, on 20 February 2015, the ECB reinstated Greek government bonds as collateral, which was associated with positive bank stock returns and a reduction of the Italian–German spread by 6.4 basis points.

These events are noteworthy because they affect only the collateral treatment of risky sovereign debt while leaving haircuts on safe bonds, such as the German bund, unchanged. As a result, the collateral value of periphery government bonds changes, which in turn transmits heterogeneously to government bond prices. To the extent that long-term government bond yields influence the interest rates at which firms across different jurisdictions borrow from banks, collateral policy surprises may also transmit heterogeneously to the real economy. Conversely, broadening the collateral framework could be justified by concerns about monetary policy transmission to the real economy, particularly if some banks rely heavily on periphery sovereign bonds

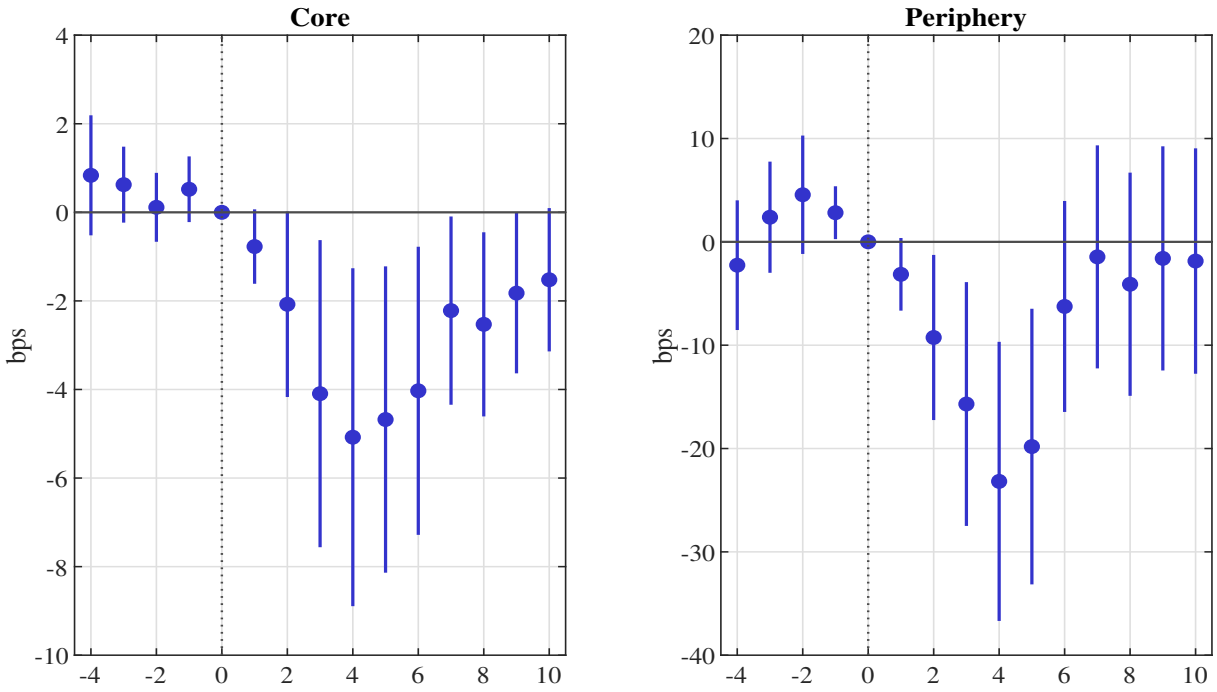


**Figure 12: Collateral Policy Surprises and Bond Spreads for Targeted Sovereign Events**: Results from estimating (12) for 5-year government bond yield spreads relative to OIS for core versus periphery euro area countries on the sub-sample of events that affect the collateral treatment of *specific* government bonds. Core countries are Germany, Belgium, France and the Netherlands. Periphery countries are Italy, Spain, Ireland and Portugal. Dots represent estimated coefficients and vertical lines denote 90% confidence intervals based on heteroskedasticity- and autocorrelation-consistent (Newey-West) standard errors. The horizontal axis reports event time in days relative to the policy announcements, with $t = 0$ marking the announcement dates.

to collateralize their central bank borrowing.

| Variable | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Non-Sov. | Sovereign | Expansion | Recession | Pre APP | Post APP |
| STOXX Banks-50 | 1.1*** | 0.8*** | 0.3*** | 1.5*** | 1.0*** | 0.7*** |
| V2X | -3.7** | -4.5*** | -2.6 | -4.7** | -4.3*** | -3.6 |
| EURUSDVol | -2.0*** | -1.2 | -1.6*** | -1.4 | -2.5*** | -0.5 |
| Bank CDS | -3.6*** | -3.2** | -1.2 | -4.6*** | -4.3*** | -0.9 |
| Periphery-Core, 5Y | -3.3* | -1.6 | -0.9 | -3.5* | -2.9* | -1.0*** |
| Core Yield, 5Y | 2.2** | -0.2 | 1.1** | 0.6 | 0.7 | 0.9 |
| Periphery Yield, 5Y | -1.1 | -1.7 | 0.3 | -2.9* | -2.3** | -0.2 |
| Germany CDS, 5Y | -0.3* | -0.5* | -0.1 | -0.6* | -0.5** | -0.1 |
| France CDS, 5Y | -0.3 | -1.6*** | -0.6* | -1.5** | -1.1** | -0.7 |
| Italy CDS, 5Y | -2.2* | -5.6*** | -1.9*** | -5.0*** | -4.1*** | -2.2** |
| Spain CDS, 5Y | -2.1 | -4.5** | -1.6** | -3.7* | -4.3*** | -0.4 |

**Table 3: Sub-Samples.** The table reports the contemporaneous response to a one standard deviation expansionary CPS for different sample splits. Columns (1) and (2) report the results for events affecting government bonds and other assets. Columns (3) and (4) report results for expansions and recessions. Columns (5) and (6) report the results for Pre- and Post-APP events. All yields and spreads are expressed in basis points. ***, **, * indicate significance at the 1, 5, and 10% level.

**Business Cycle** Next, we investigate the role of the macroeconomic environment for the transmission of collateral policy. If adverse economic conditions are associated with elevated stress in the banking system, an expansionary CPS might have more pronounced effects on banks and the government bond market. For example, Brunetti et al. (2011) study the effects of central bank policy interventions on interbank market stress and find different effects in crisis and normal times. Hence, we separately estimate our baseline specification during periods classified as expansions and recessions by the CEPR.[5] In this context, it is important to recall that collateral policy typically accommodates the temporarily high demand for central bank funding during crisis times, which otherwise might be constrained by the limited availability of eligible collateral. However, our CPS isolates the unexpected change in collateral policy, so our results do not reflect the systematic responses of collateral policy to the macro-financial environment.

In Table 3, we summarize the contemporaneous effects of a collateral policy surprise. Consistent with a temporarily high liquidity demand during downturns, we observe that bank stocks react more strongly during recessions (Column 4). Consequently, the banks excess return is larger at 1.5 percent, while it is only 0.3 percent during expansions. At the same time, collateral policy induces roughly double the decline in the V2X during recessions, while bank CDS spreads decline by almost 5 basis points compared to merely one basis point during expansions. In line with the larger financial market effects, the periphery-core spread is also compressed much more during recessions (around 3 basis points) than in expansions (around one basis point). Again, these responses are primarily driven by periphery yields. Similarly, periphery CDS spreads decline much more during recessions. Taken together, this suggests that the macroeconomic environment plays an important role in the transmission of collateral policy.

**Asset Purchases and Excess Liquidity** In addition to the macroeconomic environment and hence liquidity demand, it is also natural to examine the role of liquidity supply for the transmission of collateral policy. The overall amount of central bank liquidity in the form of excess reserves may soften the effects of collateral policy by reducing banks' reliance on central bank facilities. Large-scale asset purchases by the Eurosystem expand central bank reserves and reduce the demand for collateral. Consistent with this, we find stronger and highly significant effects for most variables in the period preceding these purchases (Column 5). Nevertheless, we still observe significant effects in the Post-APP sub-sample (Column 6), especially when it comes to government bond yields and CDS spreads. This observation suggests that some banks continue to benefit from access to central bank facilities even in periods of elevated aggregate liquidity.

[5]The CEPR recession indicator can be found under this link.

### 5.4 Comparison to Monetary Policy Surprises

To benchmark the effects of our newly identified collateral policy surprises against conventional monetary policy surprises, we estimate equation (12), using the monetary policy surprise series from Jarociński and Karadi (2020). An expansionary one standard deviation monetary policy surprise raises the STOXX 50 index by 0.4 percent and lowers nominal bond yields by around 2 basis points. We normalize the MPS to match the same STOXX 50 response as an expansionary one standard deviation CPS. Table 4 presents the results for CPS in Column (1) and MPS in Column (2), focusing on the contemporaneous response ($\beta_0$). The results are robust across different estimation horizons.

| Variable | CPS (1) | MPS (2) |
|---|---|---|
| *Panel A: Financial Markets* | | |
| STOXX 50 | 0.9*** | 0.9** |
| STOXX Banks | 1.8*** | 0.9* |
| V2X | -3.8*** | -2.7** |
| EURUSDVOL | -1.5** | 0.2 |
| Bank CDS Spread | -3.2*** | -0.5 |
| *Panel B: Government Bond Market* | | |
| Core Yield, 10Y | 0.7** | -4.7*** |
| Periphery Yield, 10Y | -1.6** | -3.8*** |
| Periphery-Core Spread, 10Y | -2.3** | 0.9*** |
| Germany CDS, 5Y | -0.4** | 0.9 |
| France CDS, 5Y | -0.9*** | -0.7 |
| Italy CDS, 5Y | -3.6*** | 1.1 |
| Spain CDS, 5Y | -3.1*** | 3.4 |
| *Panel C: International Transmission* | | |
| EURUSD | 0.2 | -0.2** |

**Table 4: Collateral and Monetary Policy Surprises.** The table reports the contemporaneous response ($\beta_0$) to a one standard deviation expansionary collateral policy surprise (CPS) and an expansionary monetary policy surprise (MPS, Jarociński and Karadi, 2020) normalized to the same STOXX 50 reaction. *Panel A* shows results for financial markets; *Panel B* for the government bond market. STOXX 50 is an overall euro area stock market index; STOXX Banks is the banking sector index; STOXX (exc. Financials) excludes financial firms; V2X: option-implied Euro STOXX 50 volatility; EURUSDVOL: 1-month implied volatility on EUR/USD options; Bank CDS: average 5y CDS spread of euro area banks; EURUSD: Euro to US Dollar exchange rate; Core/Periphery Yields: 5- and 10-year sovereign yields; CDS: 5-year sovereign credit default swap spreads. ***, **, * indicate significance at the 1, 5, and 10% levels.

Panel A of Table 4 reports financial market effects. Monetary policy surprises have little effect on equity markets. The responses of the EUROSTOXX 50 and the EURO STOXX bank index are smaller in magnitude and less statistically significant. Importantly, there is no visible excess return by the bank index in comparison to the wider stock market. While the effects of monetary policy surprises on the V2X are also negative, they are only a third of the

magnitude compared to CPS effects. Furthermore, there appears to be no effect on FX-option-implied volatility and bank CDS spreads. However, we observe the well-documented impact on the exchange rate, which is absent for the collateral policy surprise. In Appendix B.2, we demonstrate that collateral policy surprises also do not materially affect CIP deviations and cross-border funding conditions more generally.

Turning to the effects on the government bond market in Panel B of Table 4, we document that an expansionary MPS lowers government bond yields. Importantly, the magnitudes are almost the same between core and periphery countries, i.e., the spread between core and periphery bonds is essentially constant (Column 2). This is in sharp contrast to the heterogeneous effects of expansionary CPS (Column 1). Consistent with this observation, we do not find any effect on sovereign CDS. Taken together, these results highlight that collateral policy operates through very different transmission channels compared to monetary policy, both across financial and government bond markets.

# 6 Conclusion

In this paper, we develop a high-frequency approach to identify the effects of central bank collateral policy on banks, general financial markets, and sovereign bonds. We identify collateral policy surprises using bank stock price changes over short time windows around Eurosystem collateral announcements. By broadening access to central bank funding, expansionary collateral policies increase bank stock excess returns, reduce financial uncertainty indicators and bank CDS spreads, in particular for banks located in the periphery. These effects are more pronounced during times of economic stress and in the pre-APP period, when liquidity was less abundant and central bank borrowing played a greater role. We then show that expansionary collateral policy reduces government bond yields, in particular for the euro area periphery. A similarly uneven decline is observed for sovereign CDS spreads, in line with intermediary asset pricing theory. Our results suggest that the transmission of collateral policy differs across countries, and that this variation seems to be closely linked to fragmentation in the banking sector. This has broader implications for the design of monetary policy in a currency union. To the extent that home bias and bank heterogeneity drive the differential transmission of collateral policy across countries, progress towards a banking union and capital markets union could be key to ensuring a more uniform transmission of monetary policy across the euro area.

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# A Appendix: Measurement of Collateral Policy Surprises

This section provides detailed information on the collateral policy events that received media coverage and are potential candidates to be included in our collateral policy surprise series. For each event, we know the exact time stamp of the ECB's policy announcement. We summarize briefly the main content of each announcement and report relevant market commentary and additionally relevant background information in the third column of Table A.1.

## A.1 List of Collateral Policy Announcements

**Table A.1:** The table lists the *Date* and *Title* of ECB press releases concerning collateral policy announcements, together with corresponding market commentary. *Stock* reports the sign of the average intraday stock price change. *Sovereign* indicates whether the announcement is related to sovereign bonds. An asterisk (*) denotes events that affect the collateral treatment of an individual sovereign issuer, or the closely related treatment of bank debt that receives government guarantees. *Source:* LSEG Refinitiv and ECB website.

| Date | Title | Market Commentary/Background Info | Stock | Sovereign |
|---|---|---|---|---|
| 15 Oct 2008 (1) | ECB says list of assets to eligible as colleral in Eurosystem credit operations will be expanded until the end of 2008 | In its latest bid to tame the financial market crisis, the ECB lowered its threshold for accepting assets to BBB- from A- and said it would accept assets denominated in foreign currencies and debt instruments issued by credit institutions, among other changes. The dollar and euro both pared losses against the yen on Wednesday after the European Central Bank said it would extend a series of efforts to boost liquidity until the end of 2009. The moves, which include a plan to offer U.S. dollar liquidity through foreign currency swaps, eased risk aversion. Money market interest rates have eased this week as banks now have fewer concerns about access to liquidity and analysts said the changes should help to bring wholesale rates down further. | (-) | 1 |
| 26 Nov 2008 (2) | ECB says to no longer accept syndicated loans as collateral | No relevant market commentary. | (+) | 0 |

| Date | Title | Market Commentary/Background Info | Stock | Sovereign |
|---|---|---|---|---|
| 20 Jan 2009 (3) | ECB says to require a rating of AAA/Aaa for ABS as collateral issued as of March 1 | Analysts were mixed in their reaction to the move, the third substantive change to the ECB's collateral framework since last September, as the financial crisis has intensified. "From the banks' perspective, it's more restrictive, but it's not so drastic that it will shrink the mortgage market," said an analyst specialising in structured credit at a German bank. RBS economist Silvio Peruzzo said the announcement was minor compared to other changes announced to the ECB's collateral rules. "It provides an additional control on the quality of assets," he said. But Tullett Prebon economist Lena Komileva said the move sent the wrong signal at a time when the Bank of England and the U.S. Federal Reserve were stepping in to support illiquid markets. "Rather than responding to an underlying improvement in market liquidity conditions, the ECB's collateral tightening reflects quite the opposite – poor asset quality and insufficient market transparency – resulting in greater financial stresses," she said. | (-) | 0 |
| 03 May 2010 (4) | ECB suspends limits on Greek debt | Move avoids Greek debt falling off collateral list * Removes role of rating agencies in Greek crisis * They want to make sure that the question of Greek banks having access to liquidity will not be an issue in this crisis. It's one less thing to worry about." "We always thought the ECB would be quite flexible and pragmatic. | (-) | 1* |
| 28 Jul 2010 (5) | ECB lays out new sliding-scale of collateral haircuts | ECB tightens rules on weaker-rated collateral. The changes are slightly more aggressive than expected, but overall they should not impact banks financing too significantly, said Credit Agricole economist Frederik Ducrozet. "The biggest changes are on lower-rated assets and they are the type of assets that are not used to such a large degree." | (-) | 1 |

| Date | Title | Market Commentary/Background Info | Stock | Sovereign |
|---|---|---|---|---|
| 09 Oct 2010 (6) | ECB underscores power to limit banks' borrowing | The changes, published on Saturday, clarify the ECB's ability to bar or restrict banks from borrowing from the ECB and impose ad-hoc limits on what assets can be swapped for loans. "On the grounds of prudence, the Eurosystem may also reject assets, limit the use of assets or apply supplementary haircuts to assets submitted as collateral in Eurosystem credit operations by specific counterparties." | (+) | 0 |
| 16 Dec 2010 (7) | ECB says it plans to introduce loan-by-loan information requirements for ABS in collateral framework within 18 months | News mainly about capital increase ECB. "We infer from this that the ECB ... is seeking a greater cushion in order to offset potential losses, given that its portfolio of securities holdings has risen substantially, as well as to protect itself from potential collateral losses," Barclays Capital economists said in a research note. | (-) | 0 |
| 31 Mar 2011 (8) | ECB has decided to suspend the application of minimum credit rating threshold in collateral eligibility requirements for Ireland government bonds until further notice | * ECB helps Irish banks by loosening lending requirements * Commits to continue providing funds * But appears to shelve plan for new liquidity facility * Disagreements over plan within Governing Council. | (+) | 1* |
| 29 Apr 2011 (9) | ECB to require loan-by-loan data for commercial MBSs | No relevant market commentary. | (-) | 0 |

| Date | Title | Market Commentary/Background Info | Stock | Sovereign |
|---|---|---|---|---|
| 21 Sep 2011 (10) | ECB says Eurosystem has reduced limit for use of unsecured debt instrument issued by banks, such assets may be used as ECB collateral with value not to exceed 5 pct vs 10 pct earlier | ECB abolishes eligibility rules for some bank-issued debt * Reduces limit on bank-issued unsecured debt to 5 pct * Analysts see net loosening effect. The move comes amid growing fears of a renewed credit crunch as the euro zone sovereign debt crisis is shaking confidence in the region's banks. "They are really trying to make it easier for banks to access liquidity, widening the pool of assets they can use," Marie Diron, an economist at Oxford Economics, said. "They are trying to avoid problems in the sector which would then spill over to the economy." The 17-country bloc's central bank also said it had limited the use of bank-issued unsecured debt instruments. "Such assets may only be used as collateral to the extent that the value assigned does not exceed 5 percent of the total value of collateral submitted," the ECB said. The limit was previously 10 percent. "I'm not sure that's too much of a constraint, as big banks have not been able to issue many of these bonds lately, so it was not their main source of collateral," Diron said. | (+) | 0* |
| 28 Feb 2012 (11) | ECB has decided to temporarily suspend eligibility of Greek bonds used as collateral | A senior Greek banker said the only access for banks during this period will be the Bank of Greece, which will expand the ELA facility to accommodate liquidity needs until the European Financial Stability Facility money is available. That the euro zone's deal makers and the ECB did not foresee the potential risk of the EFSF support scheme not being activated in time is likely to leave some with red faces. The issue is vital because Greek banks would almost certainly go bust if their central bank funding was withdrawn. Other banks in countries like France also own large chunks of Greek debt, though they have other assets to use as collateral. " The decision of the ECB to suspend temporarily Greek bonds as collateral has no impact on French banks, " a Bank of France spokeswoman said. | (+) | 1* |

| Date | Title | Market Commentary/Background Info | Stock | Sovereign |
|---|---|---|---|---|
| 22 Jun 2012 (12) | ECB reduces rating threshold for ABS | German debt extended falls and stocks trimmed losses on Friday after the European Central Bank announced it would accept a wider range of assets as collateral, including those of a lower quality, in move designed to ease pressure on Spain. [ID:nF9E8F402O] "It just means that they are willing to take as collateral lower-quality credit, which is probably why the periphery is getting a bit of a bid against Germany," a trader said. | (+) | 0* |
| 03 Jul 2012 (13) | ECB says banks may not submit government guaranteed bank bonds as collateral above nominal value without ECB Pre-approval | No relevant market commentary. Background info: banks in troubled euro zone countries such as Greece have been increasingly borrowing ultra-cheap funds from the ECB using self-issued bonds which are then given a state guarantee by the government which make them eligible at the ECB. The amounts involved could be over 100 billion euros. Central bank policymakers have become increasingly disgruntled by the practice in recent months, worried it could leave the ECB facing enormous losses if Greece or others doing the same left the euro. | (+) | 0* |
| 06 Jul 2012 (14) | ECB to require more data on ABS starting this year | No relevant market commentary. | (-) | 0 |

| Date | Title | Market Commentary/Background Info | Stock | Sovereign |
|---|---|---|---|---|
| 20 Jul 2012 (15) | ECB says Greek government bonds to be ineligible as collateral from July 25 | Greek banks would almost certainly go bust if their central bank funding was withdrawn. Banks in other euro zone countries also own large chunks of Greek debt, though they are more likely have other assets to use as collateral and are thus not hit as hard. "In this way the ECB could be putting pressure (on the Greek government) to bring about a positive review by the troika," Alpha Finance bank analyst Nikos Lianeris said. "If there is a positive review by the troika then the Greek banks will regain direct access to ECB funding." Greek bankers took the decision in their stride. "It's something we were expecting," one banker speaking on the condition of anonymity said. "The only difference is the borrowing cost for the banks." In a separate statement, the ECB said it would start accepting some Greek credit claims as collateral, but this move is unlikely to make up for much of the exclusion of the country's sovereign bonds. The ECB also said it had agreed to extend the collateral use of credit claims by banks in struggling euro zone members Cyprus, Portugal and Italy. The ECB could not provide immediate estimates of how much extra collateral the changes would provide for banks. It also could not say why Spain, whose ailing banks will receive a bailout, w as not included in the expansion. | (-) | 1* |
| 27 Nov 2012 (16) | ECB delays implementation of ABS loan data reporting | No relevant market commentary. | (-) | 0 |

| Date | Title | Market Commentary/Background Info | Stock | Sovereign |
|---|---|---|---|---|
| 19 Dec 2012 (17) | ECB - Greek sovereign debt shall again constitute eligible collateral for ECB credit operations, subject to haircuts | Lifting a ban in place since July, the ECB said it was making Greek debt eligible again in light of the country's progress with reform measures, budget cutting and privatisations. Greek bank shares extended gains on the news, some trading up more than 10 percent on the day. Greek bonds rallied sharply in response to the change, which makes the debt more attractive for domestic banks, with 10-year sovereign yields falling by almost 1.5 percentage points to 11.42 percent. | (+) | 1* |
| 22 Mar 2013 (18) | ECB says it will stop collateral use of uncovered government-guaranteed bank bonds that have been issued by bank itself, or entity closely linked to it, from March 1, 2015 | No relevant market commentary. | (-) | 0* |
| 28 Jun 2013 (19) | ECB says it has decided to temporarily suspend eligibility of Cyprus debt for use as collateral at its monetary policy operations | Background: In response to Cyprus's announcement on the debt exchange, Standard & Poor's downgraded the sovereign foreign currency credit rating on Cyprus to SD (selective default) from CCC. S&P said that after the exchange, which is expected to occur on July 1, the liquidity strains on the government should be alleviated. After the exchange, the rating is expected to rise to CCC-plus. The ECB move is likely to be temporary. | (+) | 1* |
| 05 Jul 2013 (20) | ECB lifts suspension on Cyprus debt eligibility | No relevant market commentary. Background info: The European Central Bank said on Friday it was lifting a suspension on the eligibility of Cyprus's debt for use in its refinancing operations after Standard & Poor's upgraded the island state's credit rating." | (+) | 1* |

| Date | Title | Market Commentary/Background Info | Stock | Sovereign |
|---|---|---|---|---|
| 18 Jul 2013 (21) | ECB says to expand list of collateral it accepts at liquidity operations | *Banks rally as ECB expands collateral rules* French, Italian and Spanish banks extend gains, with sentiment on the sector bolstered after the European Central Bank expands the list of eligible collateral to include more asset-backed securities (ABS). Among the top risers are Popolare Milano (PMII.MI) and Bankinter (BKT.MC), which add 8.5 percent each. "Shares in Italian banks are boosted by the ECB move because they could be among the main beneficiaries of these new rules as they have high exposure" to loans for SMEs, says a trader in Milan. | (+) | 0* |
| 09 Sep 2013 (22) | ECB says it could offer leniency in ABS loan reporting | Background info: this move offers some exceptions to the ECB's loan-level reporting requirements, which was designed to increase transparency for the hard-to-value assets. | (+) | 0 |
| 19 Sep 2013 (23) | ECB asks for data on ABS backed by credit card debt | No relevant market commentary. | (-) | 0 |
| 27 Sep 2013 (24) | ECB collateral rules to increase ABS eligibility apply from Oct | Background info: The European Central Bank's new collateral rules that let banks use more of the assets once blamed for triggering the financial crisis in the central bank's refinancing operations will come into force in October, the ECB said on Friday. | (+) | 0 |
| 24 Jan 2014 (25) | ECB postpones minimum threshold for credit claims | No relevant market commentary. | (-) | 0 |
| 12 Mar 2014 (26) | ECB's Coeure - Development of ABS market is probably beyond remit of monetary policy, European Commission should lead it | No relevant market commentary. | (-) | 0 |

| Date | Title | Market Commentary/Background Info | Stock | Sovereign |
|---|---|---|---|---|
| 19 Sep 2014 (27) | ECB's Praet urges governments to rethink support for ABS | The ECB will detail its plans at its October policy meeting. Some analysts have criticised the plan, saying it would fail to free capital on banks' balance sheets if the ECB sticks to only buying the senior and most secure ABS tranches, leaving the riskier parts with the bank. | (-) | 0 |
| 04 Feb 2015 (28) | ECB lifts waiver on credit rating requirements for Greek bonds | U.S. Treasuries prices turned positive in late trading on Thursday, erasing earlier losses after the European Central Bank would not accept Greek government bonds as collateral for loans to banks. The ECB move rekindled safe-haven demand for low-risk U.S. and German government debt as it stoked worries about runs at Greek banks and concerns the new Greek government would have trouble renegotiating debt terms with its euro zone partners, analysts said. | (-) | 1* |
| 20 Feb 2015 (29) | ECB ready to reintroduce waiver for Greek collateral once it assesses that program likely to be concluded - ECB sources | No relevant market commentary. | (+) | 1* |
| 31 Aug 2015 (30) | ECB to accept loan bundles as collateral | The decision is aimed at expanding the pool of collateral available to euro zone banks and stimulating lending, which has been slow as the economy struggles. | (+) | 0 |
| 22 Jun 2016 (31) | ECB set to reinstate Greek banks' access to cheap funding | The reinstatement of the waiver for Greek assets by the ECB could benefit Greek core banks' net interest income by as much as around 80 million euros – after tax at around 60 million euros – depending on the eligibility of the Greek assets and the level of haircut imposed, Greek brokerage Euroxx said. "This, in our view, will be essential for the reduction of Greek banks funding costs, which along with the gradual easing of capital controls should also help the all-important return of deposits into the system," it said. | (+) | 1* |

| Date | Title | Market Commentary/Background Info | Stock | Sovereign |
|---|---|---|---|---|
| 05 Oct 2016 (32) | ECB says it has decided to reduce, as of 1 Jan 2017, the usage limit for uncovered bank bonds from 5% to 2.5% for collateral eligibility | Background info: The European Central Bank will continue to accept unsecured bank bonds as collateral for lending, including some that may be written down if a bank fails, but it is restricting their use and increasing checks, it said on Wednesday. The move comes in response to new European rules stating that investors in a bank, including holders of bonds that are not backed by collateral, must suffer losses in case of default before public money can be used. | (+) | 0* |
| 03 Nov 2016 (33) | ECB to tighten collateral rules | No relevant market commentary. | (+) | 0 |
| 14 Dec 2017 (34) | ECB says UBSS that are subject to statutory, contractual or structural subordination (e.g., UBSS issued by bankholding companies) will become ineligible as collateral | No relevant market commentary. | (-) | 0 |
| 08 Feb 2018 (35) | ECB says it amends criteria on interest payment structures for eligible credit claims and other technical changes related to collateral framework | No relevant market commentary. Background info: The European Central Bank is tightening regulations to prevent banks from pledging some riskier forms of collateral when they borrow from euro zone central bank. | (-) | 0 |

| Date | Title | Market Commentary/Background Info | Stock | Sovereign |
|---|---|---|---|---|
| 22 Mar 2019 (36) | ECB says eligibility requirements for loan-level data reporting in collateral framework to be adjusted to reflect EU securisation regulations and disclosure requirements | No relevant market commentary. | (-) | 0 |
| 07 Apr 2020 (37) | ECB announces package of temporary collateral easing measures | No relevant market commentary. Background info: In a series of measures unveiled after an unscheduled Governing Council meeting, the ECB said it would ease collateral requirements, making it easier for banks to use its funding operations, which banks tapped for hundreds of billions of euros. | (-) | 1 |
| 22 Apr 2020 (38) | ECB says it takes steps to mitigate impact of possible rating downgrades on collateral availability | Background info: Limited reaction to ECB, market focused on EU conference. | (+) | 1 |
| 22 Sep 2020 (39) | ECB says to accept sustainability-linked bonds as collateral | Nevertheless, analysts expect that ECB announcement to trigger an issuance boom. | (+) | 0 |

| Date | Title | Market Commentary/Background Info | Stock | Sovereign |
|---|---|---|---|---|
| 08 Jul 2021 (40) | ECB says it will introduce disclosure requirements for private sector assets as a new eligibility criterion or as a basis for a differentiated treatment for collateral and asset purchases | "Other central banks are going to be reading this and thinking hard about how they can show a similar commitment to greening monetary policy," said Paul Diggle, deputy chief economist of Aberdeen Standard Investments. | (+) | 0 |
| 24 Mar 2022 (41) | ECB to gradually phase out collateral-easing measures between Jul 2022 and Mar 2024 | No relevant market commentary. Background info: "The ECB also reaffirmed a waiver on Greek government bonds for as long as it keeps investing the proceeds from its Pandemic Emergency Purchase Program (PEPP). In a hopeful sign for other countries with lower credit ratings, such as Cyprus, Portugal or Italy, the ECB added that it may disregard agencies' ratings again in the future." "The ECB's Governing Council reserves the right to deviate also in the future from credit rating agencies' ratings if warranted," the ECB said. | (-) | 1 |
| 04 Jul 2022 (42) | ECB says it will limit the share of assets issued by high polluters that can be pledged as collateral when borrowing from the ECB | No relevant market commentary. | (+) | 0 |
| 02 Dec 2022 (43) | ECB says Eurosystem reschedules launch of new collateral management system | No relevant market commentary. | (+) | 0 |

| Date | Title | Market Commentary/Background Info | Stock | Sovereign |
|---|---|---|---|---|
| 20 Dec 2022 (44) | ECB tightens collateral rules. Bonds issued by the European Commission receive an haircut category upgrade | No relevant market commentary. | (+) | 1 |

## A.2 Bank Selection and Bank Heterogeneity

Table A.2 demonstrates that removing one bank at a time does not affect the construction of the collateral policy surprise series. Specifically, the first column demonstrates that the correlation is at least 99.5%. The second column shows how the average stock price reaction changes when individual institutions are left out. A positive $\Delta$ mean reaction implies that the omitted bank profits relatively less from a collateral policy expansion. As the last column shows, the exact bank selection is also less relevant when it comes to classifying individual events into contractionary or expansionary. In Figure A.1, we compare how individual banks respond to each announcement, relative to the mean stock price reaction.

| **Bank** | **Correlation** | **$\Delta$ Mean Reaction** | **# Sign Flips** |
|---|---|---|---|
| BBVA | 0.998 | 0.020 | 1 |
| BC Portugues | 0.997 | -0.013 | 4 |
| BNP Paribas | 0.997 | 0.003 | 1 |
| Deutsche Bank | 0.995 | 0.022 | 0 |
| Intesa Sanpaolo | 0.998 | 0.008 | 2 |
| Santander | 0.996 | 0.018 | 0 |
| Societe Generale | 0.996 | 0.005 | 1 |
| UniCredit | 0.997 | 0.011 | 1 |

**Table A.2:** "Leave-One-Out" Surprise Series

In Figure A.2, we demonstrate that the distinction between banks located in euro area core and periphery countries does not affect the *measurement* of collateral policy surprises over a short time window. We show that the first principal component in either sub-sample is very highly correlated with the first principal component in the full sample of banks.

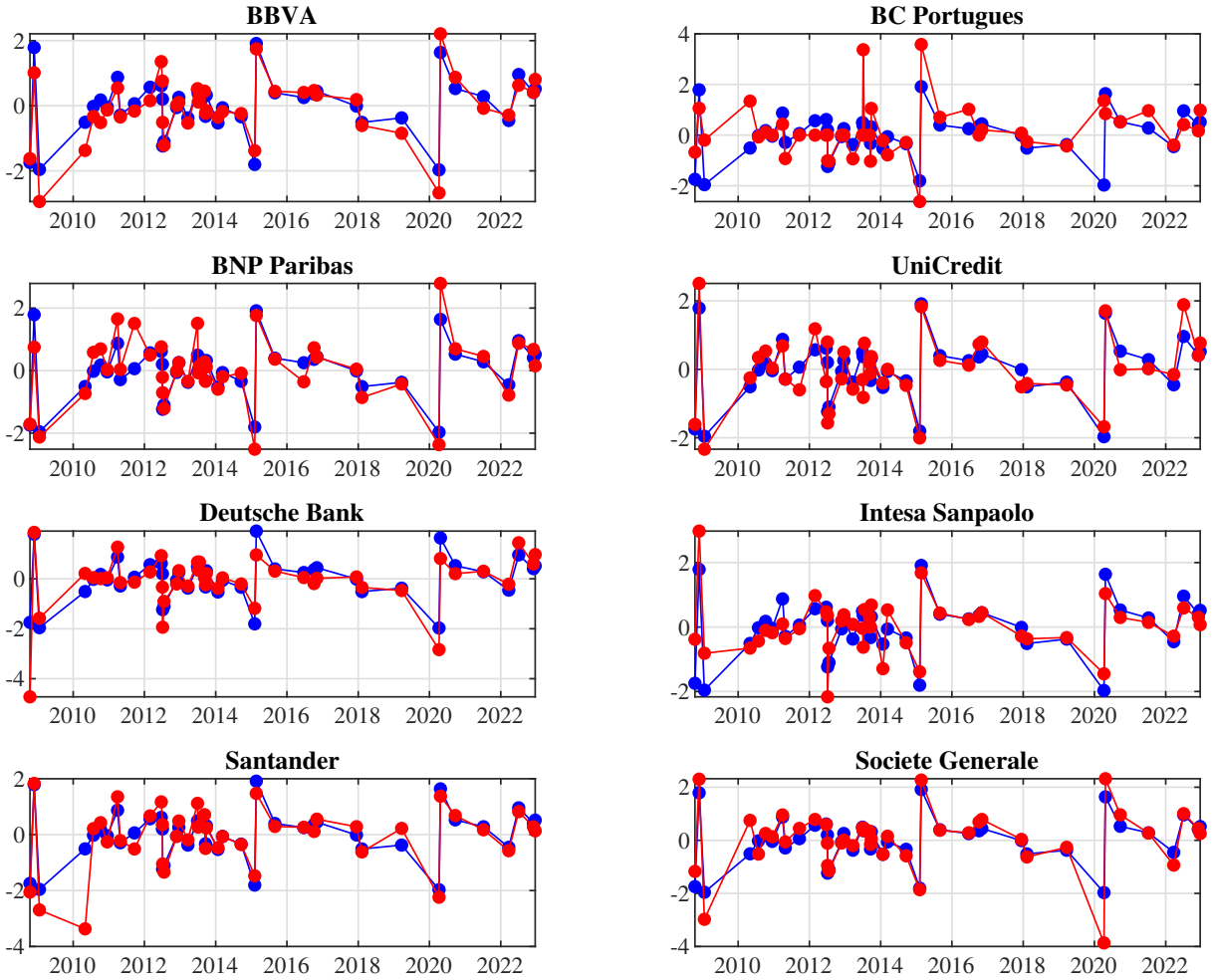


**Figure A.1: Collateral Policy Surprises: Individual Stock Price Reactions**. This figure plots the stock price response by each individual bank against the average stock price reaction. Note that average is different from, but highly correlated with the first principal component that we use as collateral policy surprise.

| Variable | Mean | SD | Min | Max | N |
|---|---|---|---|---|---|
| Δ Stockreturn | 0.29 | 1.42 | -2.94 | 8.10 | 235 |
| ln(Assets) | 13.49 | 0.94 | 11.18 | 14.92 | 235 |
| Loans Ratio | 51.18 | 15.22 | 12.74 | 80.49 | 235 |
| ROE | 6.05 | 4.22 | 0.00 | 15.62 | 235 |
| Debt Ratio | 25.94 | 12.05 | 2.29 | 56.22 | 235 |
| Deposits Ratio | 52.58 | 15.73 | 19.87 | 81.88 | 235 |
| Leverage Ratio | 25.94 | 12.05 | 2.29 | 56.22 | 235 |
| Sec over Assets | 33.54 | 12.99 | 10.44 | 75.63 | 235 |
| Tier1Ratio | 13.19 | 2.62 | 7.10 | 19.10 | 216 |

**Table A.3: Cross Section of Banks**. This table presents summary statistics for the banks in the sample to estimate equation (11).

Table A.4 compares core and periphery banks along key characteristics, which we also use as explanatory variables in panel local projections.

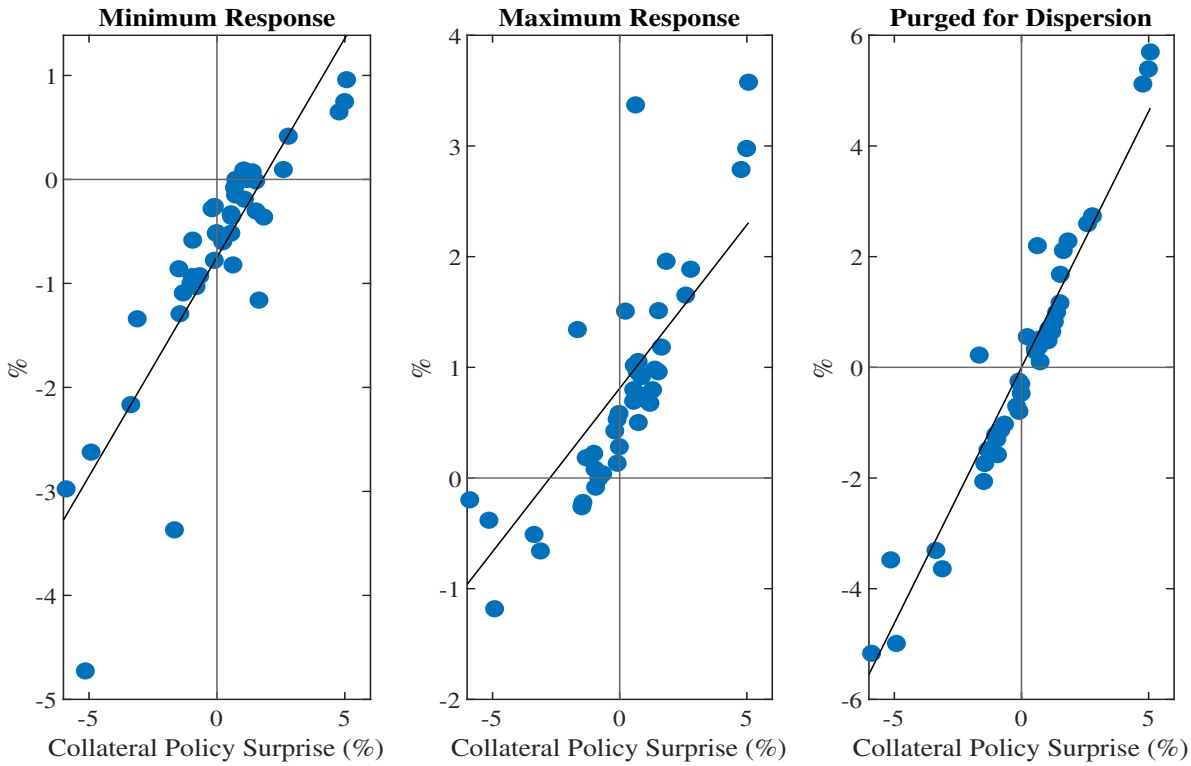


**Figure A.2: Collateral Policy Surprises and the Role of Bank Selection**. The top row compares our baseline collateral policy surprise to the surprises estimated on the subsample of core and periphery banks, respectively. The bottom row compares our baseline collateral policy surprise to the maximum and minimum stock price reaction at each event. The solid line represents a simple linear fit.

| Variable | Full Sample | Core | Periphery |
|---|---|---|---|
| CDS Spread (bps) | 177.11 | 136.00 | 228.49 |
| Securities Ratio (%) | 41.76 | 53.18 | 27.49 |
| Tier-1 Ratio (%) | 9.30 | 9.73 | 8.75 |
| Home Bias | 63 | 51 | 78 |

**Table A.4: Euro Area Bank Heterogeneity**. This table presents summary statistics for core and periphery banks. The CDS-spread refers to the full-sample average from 2008-2022. Home bias in sovereign bond holdings is obtained from the 2013 EBA stress test. The securities and tier-1 capital ratios are computed with respect to total assets, also computed in 2013.

**Bank CDS** In Figure A.3, we complement our results from the main text (Figure 7) by plotting the response of individual bank CDS spreads. It is worth noting that the response is persistently negative for each individual bank and economically meaningful. Negative estimation horizons permit an assessment of pre-announcement trends, which turn out to be generally small and insignificant for all banks. The absence of pre-announcement effects further corroborates the validity of our identification strategy of the unexpected component of collateral policy announcements.

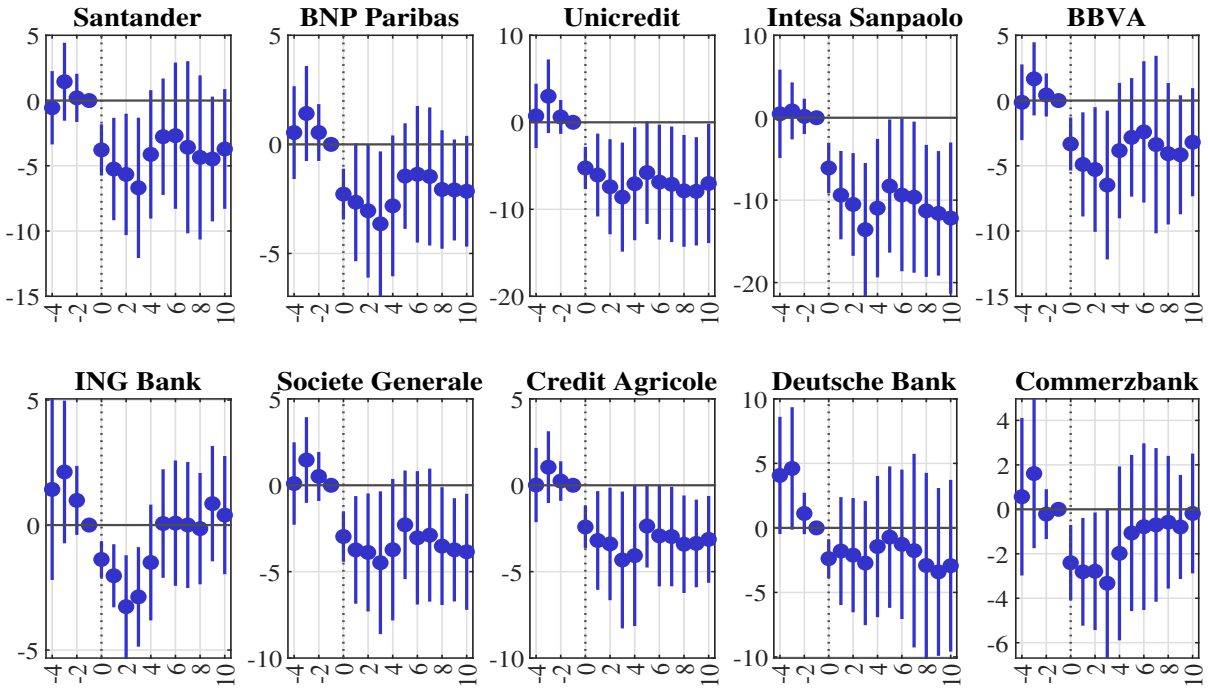


**Figure A.3: Bank CDS**: Results from estimating (12) using all collateral policy surprises. The dependent variables are 5 Year senior CDS written on single-name banks, expressed in basis points. Dots represent estimated coefficients, and vertical lines denote 90% confidence intervals based on heteroskedasticity- and autocorrelation-consistent (Newey-West) standard errors. The horizontal axis reports event time in days relative to the policy announcements, with $t = 0$ marking the announcement dates.

# B Additional Results: Financial and Sovereign Bond Markets

## B.1 Government Bond Market

**10 Year Government Bond Spreads** Figure B.1 complements the main results for 5-year government bonds with 10-year bonds. Similar to the findings in the main text (Figure 9), we observe a significant effect after three trading days for core countries, which is, however, quite small at slightly less than -2 basis points and becomes insignificant after five trading days. By contrast, the periphery government bond spreads decline significantly already after one day, and the effect remains significantly negative for ten trading days. The effect peaks after four days at around -8 basis points.

**Individual Government Bond Spreads** In Figure B.2, we display the response of individual countries to an expansionary CPS. Consistent with the panel local projections presented in the main text, we find little or no effect on core countries, while all periphery spreads decline by 5 to 10 basis points within two days after the event.

**CDS-Bond Basis** In Figure B.3, we show that the CDS-bond basis of country $i$, which we define as $basis_{i,t} \equiv ois_t - cds_{i,t} - yield_{i,t}$ does not respond to a collateral policy surprise. The basis is positive for all core countries and for periphery countries outside of the euro area debt crisis, indicating that governments could issue debt at comparatively low yields. While collateral

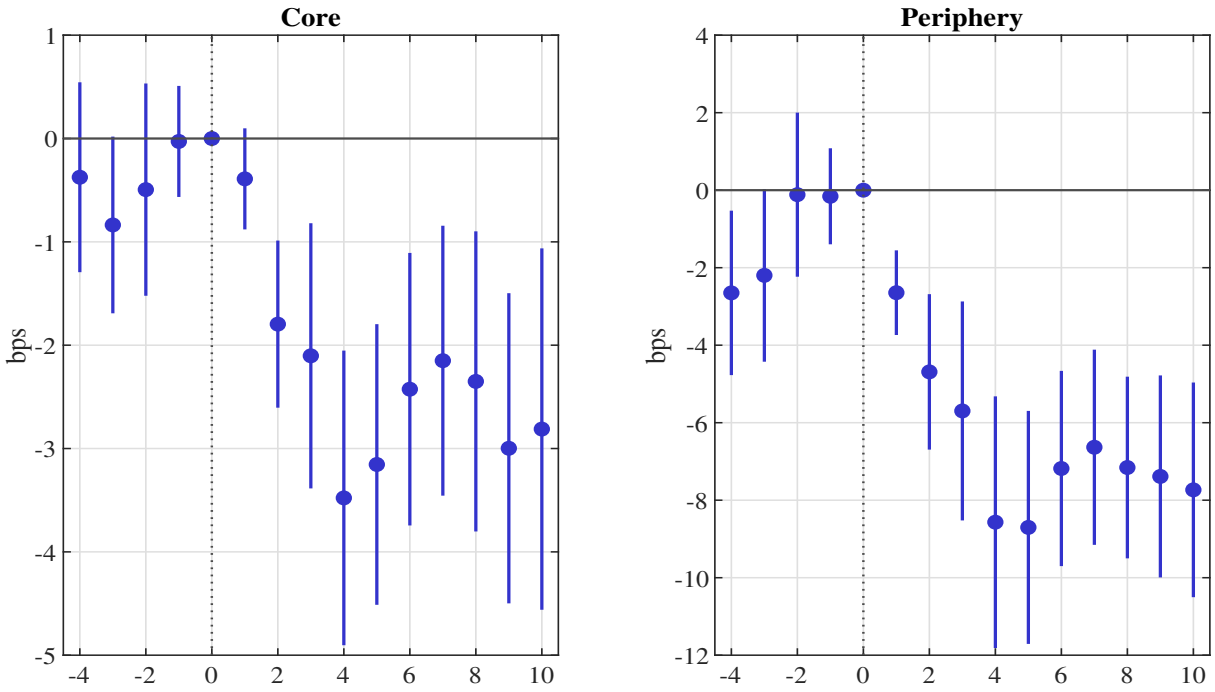


**Figure B.1: Collateral Policy Surprises and 10Y Bond Spreads over OIS**: Results from estimating (12) for 5-year government bond yield spreads relative to OIS for core versus periphery euro area countries. Core countries are Germany, Belgium, France and the Netherlands. Periphery countries are Italy, Spain, Ireland and Portugal. Dots represent estimated coefficients, and vertical lines denote 90% confidence intervals based on heteroskedasticity- and autocorrelation-consistent (Newey-West) standard errors. The horizontal axis reports event time in days relative to the policy announcements, with $t = 0$ marking the announcement dates.

eligibility is one common microfoundation for the persistent discrepancy between government bond yields and the combination of risk-free rate and CDS-spread, our findings indicate that collateral policy has little impact on the CDS-bond basis.

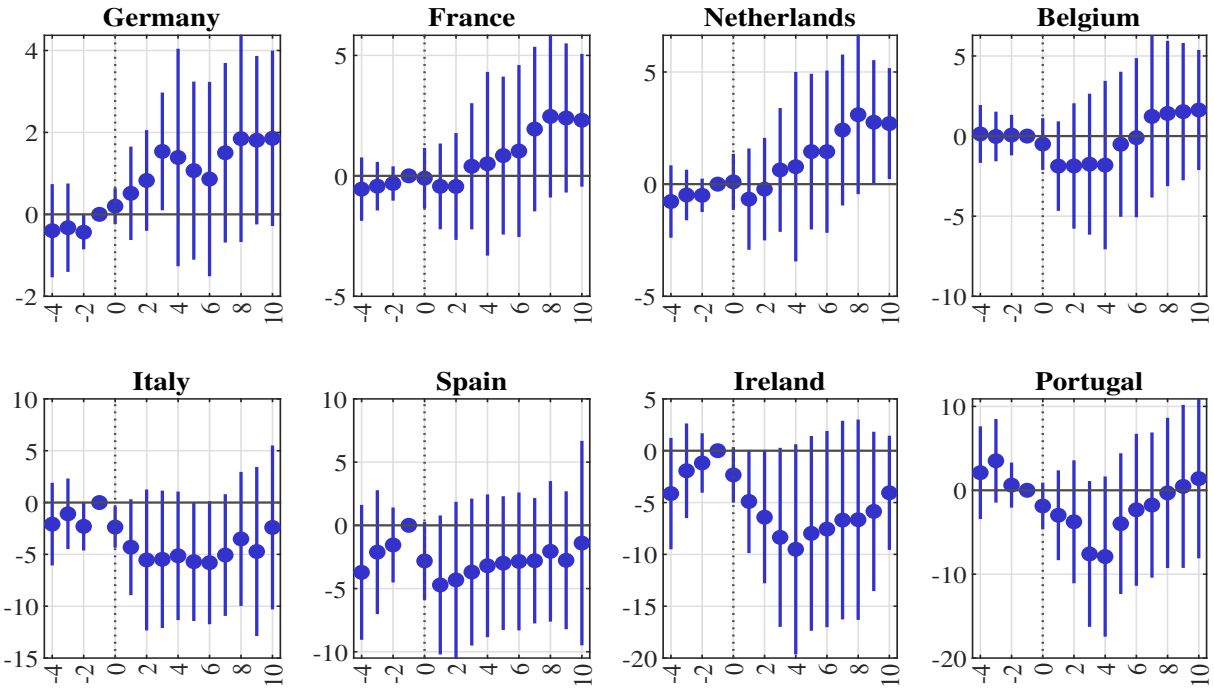


**Figure B.2: Collateral Policy Surprises and 5Y Bond Spreads over OIS**: Results from estimating (12) for 5-year government bond yield spreads relative to OIS for all countries. Dots represent estimated coefficients, and vertical lines denote 90% confidence intervals based on heteroskedasticity- and autocorrelation-consistent (Newey-West) standard errors. The horizontal axis reports event time in days relative to the policy announcements, with $t = 0$ marking the announcement dates.

## B.2 Exchange Rate and CIP

In the main text, we demonstrate that collateral policy does not affect the EUR/USD spot exchange rate. However, this does not imply that cross-border funding conditions remain unaffected. Recent work emphasizes the global risk-taking channel and the role of the U.S. dollar in shaping international financial conditions (Bruno and Shin, 2015; Rey, 2015; Miranda-Agrippino and Ricco, 2021). In this framework, monetary policy affects global financial conditions by altering leverage, risk-taking, and cross-border funding structures rather than solely through the traditional trade or exchange rate channel. While much of this literature focuses on U.S. monetary policy, recent evidence suggests that ECB policy shocks can also generate meaningful international financial spillovers, albeit smaller in magnitude (Miranda-Agrippino and Nenova, 2022; Corsetti et al., 2024).

Against this background, collateral policy surprises may also operate through a funding channel. By relaxing euro funding constraints for banks active in international markets, collateral policy reduces the relative cost of EUR funding. If EUR funding becomes cheaper relative to USD funding, banks may increasingly borrow in EUR and obtain USD via FX swaps rather than borrowing USD directly. This shift in funding structure increases pressure in FX swap markets and can generate deviations from covered interest parity (CIP), reflected in a more negative EUR/USD basis, even in the absence of spot exchange rate movements. To shed light on this

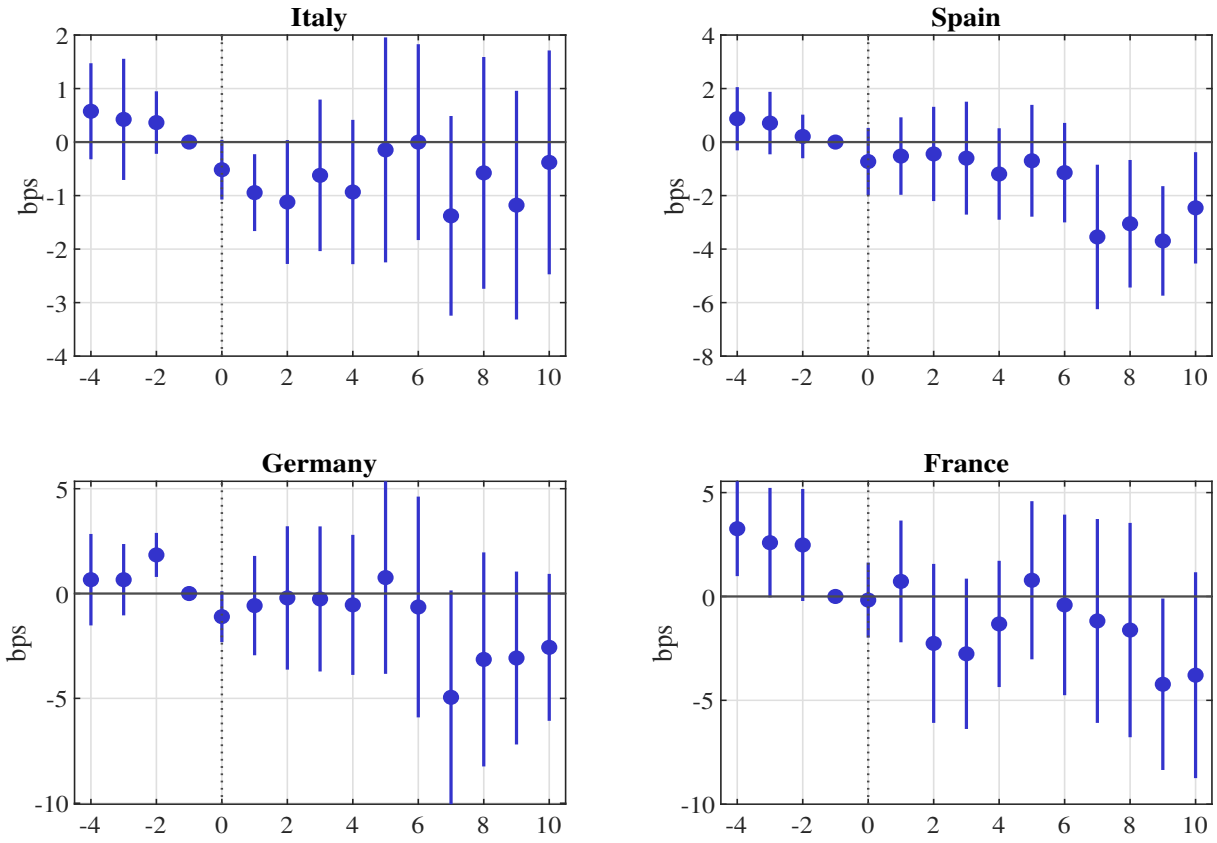


**Figure B.3: CDS-Bond Basis**: Results from estimating (12) for the 5-year CDS-Bond Basis. Dots represent estimated coefficients, and vertical lines denote 90% confidence intervals based on heteroskedasticity- and autocorrelation-consistent (Newey-West) standard errors. The horizontal axis reports event time in days relative to the policy announcements, with $t = 0$ marking the announcement dates.

mechanism, we compute the CIP-implied forward exchange rate

$$F_{t,T}^{CIP} = S_t \times \frac{1 + r_{t,T}^{USD}}{1 + r_{t,T}^{EUR}}, \tag{B.1}$$

where $S_t$ denotes the spot USD/EUR exchange rate, $r_{t,T}^{USD}$ the USD money market rate, and $r_{t,T}^{EUR}$ the euro-area money market rate for maturity $T$. The CIP is defined as the deviation between the observed forward rate and the CIP-implied forward rate,

$$\text{CIP}_{t,T} = F_{t,T}^{obs} - F_{t,T}^{CIP}. \tag{B.2}$$

We then estimate (12) for the spot rate, the 1-year forward rate, and the 1-year CIP; results are shown in Figure B.4. Collateral policy shocks do not significantly affect the EUR/USD spot or forward rate. In contrast, we observe a sizeable and persistent decline in the 1-year CIP. This indicates that collateral policy primarily operates through international funding markets rather than through exchange rate adjustment.

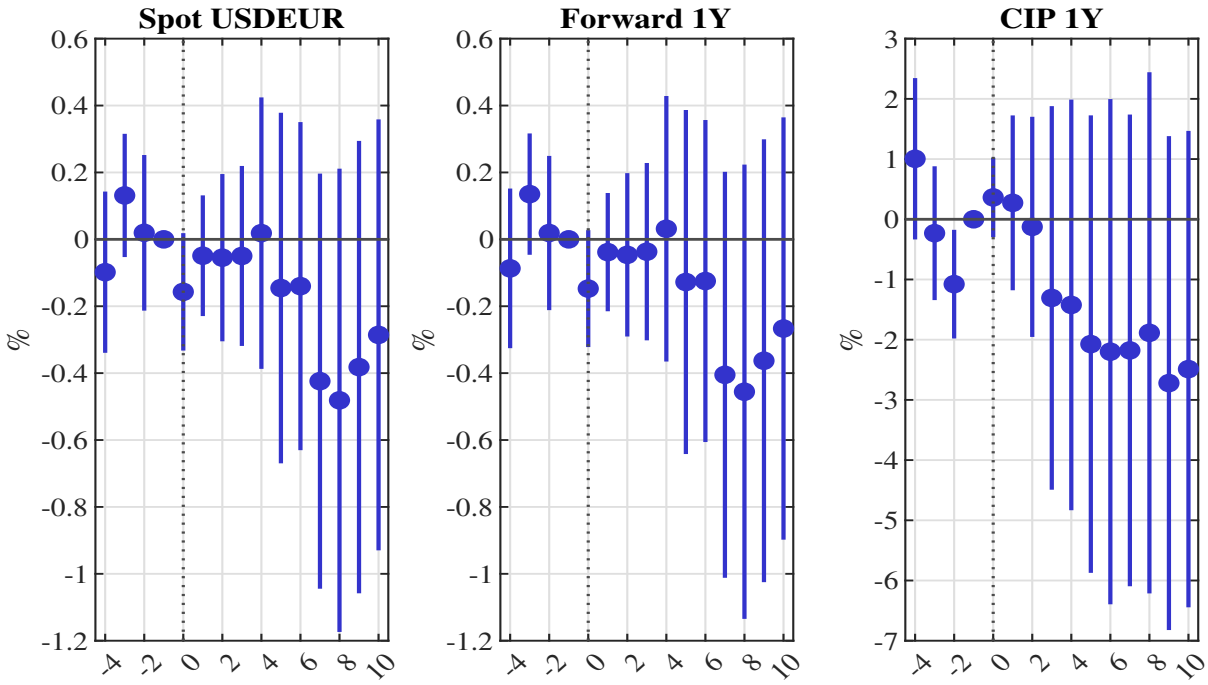


**Figure B.4: Collateral Policy Surprises; Spot, Forward Rate and Covered Interest Rate Parity**: Results from estimating (12) for deviations from covered interest rate parity (CIP) at the 1-year maturity. The CIP-implied forward exchange rate is computed as

$$F_{t,T}^{CIP} = S_t \times \frac{1 + r_{t,T}^{USD}}{1 + r_{t,T}^{EUR}},$$

where $S_t$ denotes the spot USD/EUR exchange rate, $r_{t,T}^{USD}$ the USD money market rate, and $r_{t,T}^{EUR}$ the euro-area money market rate for maturity $T$. The CIP is defined as the deviation between the observed forward rate and the CIP-implied forward rate,

$$\text{CIP}_{t,T} = F_{t,T}^{obs} - F_{t,T}^{CIP}.$$

Blue shaded areas denote 68% and 90% confidence intervals computed from heteroskedasticity-consistent (White) standard errors. Horizon in days.