The impact of (un)conventional monetary policy on the sovereign-bank nexus in the euro area

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Abstract

Sovereign debt holdings by banks and large-scale asset purchase programmes influence the transmission of risk between the banking sector and the government. This study examines their impact in the euro area from February 2005 to December 2023. We begin by quantifying the dynamic net directional connectedness between sovereign and bank risk using the Diebold-Yilmaz connectedness framework. We then assess how sovereign debt holdings, both by banks and the European Central Bank (ECB), affect the transmission of risk between the two sectors while controlling for the conventional monetary policy stance and other standard macro-financial variables. Our results show that risk transmission varies over time but generally flows from banks to sovereigns, except during periods of economic distress, most notably during the European Sovereign Debt Crisis. Bank holdings of sovereign debt emerge as the primary channel for transmitting risk to the sovereign sector, with conventional monetary policy also playing a significant role in this process. By contrast, large-scale asset purchase programmes by the ECB have had a neutral effect on this transmission.

Keywords: Bank risk, Sovereign risk, Sovereign-bank nexus, Euro area.

JEL codes: G01, G15, G21, H63.

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1. Introduction

Concerns about fiscal sustainability and the deteriorating financial health of major banks fuelled a self-reinforcing negative feedback loop between sovereigns and banks during the European Sovereign Debt Crisis (2010–2013). Government interventions aimed at stabilising the financial system resulted in substantial fiscal costs, triggering sharp increases in public debt. At the same time, banks' large exposures to domestic sovereign bonds heightened their vulnerability to sovereign risk, thereby undermining financial stability through increased collateral risk, valuation losses, and elevated counterparty risk. The resulting weaknesses in bank balance sheets posed systemic threats to the banking sector as a whole (Broner *et al*., 2014; Brunnermeier *et al*., 2016; Altavilla *et al*., 2017).

The holdings of national sovereign debt by domestic banks, which had increased during the European Sovereign Debt Crisis, have gradually declined, albeit at a slow pace (Becker and Ivashina, 2018), and remain substantial. As Figure 1 shows, during the period 2004- 2023, nearly 60 per cent of all sovereign loans and securities in the euro area were still held domestically.

[Insert Figure 1 here]

This persistent "home bias" in sovereign bond portfolios may stem from several factors. One explanation is moral suasion, whereby governments encourage banks to purchase domestic bonds (Becker and Ivashina, 2018; Ongena *et al*., 2019), sometimes reinforced by regulatory and fiscal incentives (Hryckiewicz *et al*., 2022). Additionally, banks have sought to expand their sovereign bond holdings as part of carry-trade strategies (Altavilla *et al*, 2017; Carpinelli and Crosignani, 2021), and possibly collateral-trade strategies (Crosignani *et al*, 2020; Janbaz *et al.,* 2024), using government bonds as collateral in refinancing operations, particularly when alternative investment opportunities are limited (Molyneux *et al*., 2021). A growing body of empirical literature documents the

transmission of risk between sovereigns and banks. Most evidence suggests a bidirectional relationship (Fratzscher and Rieth, 2019; Gómez-Puig *et al.*, 2019); however, extensive holdings of public debt have been identified as a key channel for heightened risk transmission from banks to sovereigns (Erce, 2020; Crosignani, 2021).

As the Global Financial Crisis unfolded, a gradual shift in sovereign debt holdings occurred in parallel with the European Central Bank's (ECB) expansion of its large-scale asset purchase programmes under its broader Quantitative Easing (QE) strategy. In May 2010, the ECB initiated one of its first unconventional monetary policy tools—the Securities Markets Programme (SMP)—which was later replaced in September 2012 by the Outright Monetary Transactions (OMT) framework. Earlier, in July 2009, the ECB launched its first Covered Bond Purchase Programme (CBPP-1), which lasted one year. This was followed by CBPP-2 in November 2011, which remained active until October 2012. While these initial interventions were relatively limited in scale, a significant expansion began in mid-2014. The ECB launched its third Covered Bond Purchase Programme (CBPP-3) and, in March 2015, introduced the Public Sector Purchase Programme (PSPP)—the largest of the four asset purchase programmes. The PSPP notably increased the size of the ECB's balance sheet until December 2018 and was reactivated during the early stages of the COVID-19 pandemic (see Figure 2), eventually reaching a peak of €2.744 trillion in June 2022, equivalent to approximately 17% of euro area GDP.[1] The PSPP has far exceeded the scale of earlier programmes. However, as of July 2023, the ECB has started to unwind its holdings. This gradual exit from QE, combined with a rapid increase in interest rates and a significant rise in public debt in the

[1] The purchases under the PSPP included central or regional (and local) government bonds or bonds issued by recognised agencies, international organisations and multilateral development banks located in the euro area. The purchase of bonds is conditional on compliance with fiscal and economic criteria. The share of bonds by country is in line with ECB's capital key contributions, subject to eligibility.

aftermath of the pandemic, has reignited concerns about the interconnections between sovereigns and the banking sector (Corsetti *et al*., 2023).

[Insert Figure 2 here]

In contrast to conventional monetary policy, which is not expected to affect risk pass-through,[2] unconventional monetary policy influences risk transmission between banks and sovereigns through several distinct channels. First, the signalling channel central bank announcements influences bond prices by shaping market expectations (D'Amico and Seida, 2024). Second, the duration extraction channel operates by flattening the yield curve as the term premium declines (Krishnamurthy, 2022). Third, the backstop channel implies that sovereign bonds are perceived as low-risk assets, either because the central bank explicitly aims to stabilise bond markets or because it implicitly supports sovereign borrowing by easing monetary transmission and enabling governments to issue debt at more favourable rates (Broeders *et al.,* 2023). Fourth, the portfolio rebalancing channel directly affects banks by removing risky sovereign bonds from their balance sheets, thereby increasing the value of the remaining bonds and expanding banks' holdings of risk-free central bank reserves. If, in addition, Quantitative Easing stimulates overall economic activity (Rostagno *et al.,* 2021; Boehl *et al.,* 2024), the resulting improvement in the banking sector's equity position may further enhance lending and risk-taking capacity. Jointly, these four channels are expected to dampen the transmission of risk from banks to sovereigns by redistributing or absorbing risk. However, a fifth channel— collateral trading— may have the opposite effect. Large-scale asset purchases by the central bank may incentivise banks to use their reserves to purchase government bonds

[2] Conventional monetary policy has an impact on bank risk: an accommodative monetary stance is usually beneficial for bank profitability as economic activity picks up and banks are stimulated to shift to finance riskier activities in search of yield (Soenen and Vander Vennet, 2022a). Under 'normal' circumstances, sovereign risk should not be affected by these shifts in the transmission of monetary policy.

for use as collateral in refinancing operations. This behaviour increases banks' exposure to sovereign debt, potentially heightening systemic risk (Janbaz *et al*., 2024).

Empirical evidence on the impact of unconventional monetary policy on risk transmission remains limited and inconclusive, with existing research addressing only a subset of the potential channels for risk transmission. Studies focusing on the banking sector suggest that unconventional measures may create perverse incentives: instead of recapitalising, banks may engage in a search for yield, altering their risk profiles and accumulating cash reserves (Christensen and Krogstrup, 2019; Acharya *et al*., 2022). These reserves are often used to pursue carry-trade (Crosignani *et al.,* 2020) or collateral-trade strategies (Janbaz *et al.,* 2024), which can affect risk pass-through in divergent ways.[3]

At the macroeconomic level, most studies have examined the aggregate effects of unconventional policies through their stimulus to private investment (Kandrac and Schlusche, 2021), sometimes even with excessive risk-taking (Acharya *et al*., 2025) but have not focused on risk pass-through. In fact, only a few studies explicitly address this issue. Bechtel *et al.* (2021), for example, analyse the impact of the Public Sector Purchase Programme (PSPP) on the spillover of risk from banks to sovereigns. However, their analysis is restricted to the early phase following the programme's launch. Similarly, studies by Erce (2020) and Bochmann *et al.* (2024) investigate the determinants of bank–sovereign risk pass-through but do not explicitly consider the role of monetary policy. Furthermore, research on large-scale asset purchase programmes tends to examine individual interventions in isolation or focus on specific episodes of market turbulence, thereby limiting the comparability of unconventional monetary policy effects across different contexts and over time. The impact of large-scale asset purchase programmes

[3] All of these studies use bank-specific measures of risk that do not capture aggregate market dynamics.

on risk transmission is not a priori clear. Not all transmission channels may be effective, and some may even produce opposing effects (Benigno *et al*., 2023). Moreover, a range of conditioning economic factors must be considered.

This paper offers three main contributions to the existing literature. First, we examine how shifts in unconventional monetary policy—specifically through large-scale asset purchase programmes—have influenced the transmission of risk from banks to sovereigns. In doing so, we control for conventional monetary policy, banks' sovereign bond holdings, and a range of relevant macroeconomic variables. Second, we extend the analysis over a longer time horizon, covering the period from February 2005 to December 2023. This allows us to capture dynamics both before and after major crises, as well as during the implementation and withdrawal of various forms of unconventional monetary policy. Finally, we construct aggregate indices of bank risk, following the methodology proposed by Molyneux *et al.* (2021), to assess risk pass-through both from and to the banking sector as a whole.

We measure the net connectedness between sovereign and banking sector risk across ten euro area countries using the Global Vector Autoregressive (GVAR) framework developed by Diebold and Yilmaz (2014). This metric is directly comparable to other empirical measures of risk pass-through. To assess the impact of unconventional monetary policy on this measure, we employ dynamic Augmented Mean Group (AMG) panel models.[4] The AMG approach accounts for the heterogeneous effects of both conventional and unconventional monetary policies across countries, as well as for cross-

[4] The approach employed by Erce (2020), and Bechtel *et al*. (2021) consists of regressing one aggregate risk measure on another, while controlling for additional explanatory variables. In contrast, our two-step approach allows these variables to condition the transmission mechanism itself, rather than treating them as mere controls.

sectional dependencies arising from market spillovers. Both features cause cross-country spillover and have been recognised as significant drivers of risk transmission.[5]

We find that banks have been net transmitters of risk during periods of economic turmoil, as seen in the Global Financial Crisis or the Pandemic, but transmission from sovereigns to banks has been limited, mostly to the European Sovereign Debt crisis (2009-2013). The primary driver of the dynamics within the sovereign–bank nexus is the level of domestic bank holdings of government debt: higher sovereign exposure significantly increases net risk propagation from banks to sovereigns. Restrictive conventional monetary policy has a similar impact; however, large-scale asset purchases by the ECB of sovereign debt have been neutral for transmission.

The remainder of the paper is structured as follows: Section 2 outlines the data and methodology; Section 3 presents the empirical results; and Section 4 concludes.

2. Data and methodology

2.1 Measuring sovereign and banking risk

Although Credit Default Swaps (CDS) are commonly used as indicators of sovereign and banking sector risk, the CDS market only gained significant depth following the Global Financial Crisis. As a result, many previous studies suffer from limited bank coverage (Erce, 2020; Lamers *et al*., 2024) or are confined to specific crisis periods (Fratzscher and Rieth, 2019). To address these limitations, we follow the approach of Holló *et al.* (2012) and Molyneux *et al.* (2021), relying on measures of aggregate default risk in the banking sector to facilitate analysis over a longer time horizon. Compared to individual bank CDS

[5] See Crosignani *et al*. (2020) for the heterogeneous impact of LTRO across the euro area, and Breckenfelder and Schwaab (2018) for the spillover across different markets.

spreads, the use of an aggregate measure reduces the influence of idiosyncratic market dynamics across institutions or countries and better captures systemic risk in the banking sector, including that originating from smaller banks.[6]

Financial Stress Indices are essential tools for capturing real-time levels of financial stress by consolidating diverse signals of market information. They serve as *ex-post* indicators of systemic risk and, as such, can be viewed as a coincident indicator of financial stability, offering a single summary statistic that provides a continuous measure of the intensity of financial stress. The ECB has developed aggregate proxies for systemic stress: the Sovereign Composite Indicator of Systemic Stress (SovCISS), which measures stress in sovereign debt markets, and the Banking Composite Indicator of Systemic Stress (BanCISS), which gauges stress among financial intermediaries. The BanCISS is computed daily by aggregating each country's Composite Indicator of Systemic Stress (CISS), assuming the contribution from the financial intermediaries' subindex is consistent with that of the euro area as a whole (Holló *et al*., 2012). The BanCISS correlates highly with alternative measures based on CDS. Using an asset-weighted average of CDS spreads for major domestic banks across all EU countries from July 2019 to November 2023—the period for which CDS data are available for all major euro area banks—we observe a strong correlation between the ECB's BanCISS indicator and a country's BanCISS, ranging from 0.72 for Ireland to 0.82 for Germany. Additionally, for Spain, the BanCISS exhibits a high correlation (0.81) and cointegration over the period from September 2000 to November 2023 with the financial intermediaries' stress indicator developed by the Spanish National Securities Market Commission. This

[6] Molyneux *et al.* (2021) compute the weighted country-by-country sovereign bond exposures of a sample of 51 European banks and link these to the specific risk profile of each country.

evidence supports the validity of the ECB's BanCISS as a reliable proxy for aggregate bank risk and as a suitable alternative when traded CDS data are unavailable.[7]

In our empirical analysis, we use the monthly SovCISS and BanCISS indices from the ECB database for ten euro-area countries, encompassing both core countries (Austria, Belgium, Finland, France, Germany, and the Netherlands) and peripheral countries (Ireland, Italy, Portugal, and Spain), covering the period from February 2005 to November 2023.

2.2. Quantifying directional intensity of transmission between sovereign and bank risk

The Diebold and Yilmaz (2014) GVAR method infers connectedness by decomposing forecast error variances, which correspond to the edge weights in a network, and captures the bilateral spillovers among the *n* markets included in the model (Andrada-Félix *et al*., 2020). This methodology has been widely applied in studies of the sovereign-bank nexus to quantify the directional influence of sovereign and banking sector risks (Alter and Beyer, 2014; Dungey *et al*., 2019; Bales, 2022; Bochmann *et al*., 2024).

Specifically, we include the sovereign *s* and bank *b* risk indicator in a VAR for each country and measure their net pairwise directional connectedness, denoted as $C_{sb,t}$. This dynamic measure of risk pass-through captures the direction and strength of linkages over time. If $C_{sb,t} > 0$, then bank risk transmits to sovereign risk, indicating that bank risk has a stronger influence on sovereign risk than the reverse.

[7] Additional results from the correlation and cointegration analyses, not shown here to save space, are available from the authors upon request.

2.3. Determinants of net directional connectedness.

We then analyse the dynamics of this risk transmission measure for monetary policy.[8] On the one hand, to assess the impact of conventional monetary policy, we include the ECB shadow rate as a proxy for the stance of conventional policy (Wu and Xia, 2016). On the other hand, to capture the role of unconventional monetary policy, we use the (log real) euro value of central bank holdings of government debt, as reported in the updated Sovereign Debt Investor database by Arslanalp and Tsuda (2014). We hypothesise that a more accommodative conventional monetary policy reduces the transmission of risk from banks (Soenen and Vander Vennet, 2022b). In contrast, large-scale asset purchase programmes mitigate risk transmission through the portfolio rebalancing channel.

As ECB purchases represent only a portion of sovereign debt holdings (see Figure 1), we must also control for domestic and foreign bank holdings. Increased bond holdings by domestic banks raise their overall risk profile and are therefore expected to amplify the transmission of risk. By contrast, holdings by foreign banks are likely to have a limited impact, as the associated risk is transferred abroad. Both series are sourced from the Sovereign Debt Investor database by Arslanalp and Tsuda (2014).

Typically, risk transmission has been analysed by including variables that gauge uncertainty (Singh *et al.*, 2020). Specifically, a measure of expected future volatility in stock markets, such as the VSTOXX index, is likely to amplify the transmission of risk. An indicator of bond market volatility, such as the Merrill Lynch Option Volatility Estimate Index on US Treasuries (MOVE), indicates turbulence in bond markets, while the five-year cross-currency basis swap spread (CCBSS5y) serves as a proxy for funding

[8] Our two-step approach is very similar to Bechtel *et al*. (2021). However, on their sample of 26 euro area banks and 15 sovereigns, they examine as drivers of transmission only the characteristics of both banks and sovereigns, without looking into monetary policy.

liquidity stress. Both forms of stress tend to be associated with greater risk transmission from sovereigns to banks.

The European Sovereign Debt crisis has stimulated research on policy uncertainty. Consequently, we include the Economic Policy Uncertainty (EPU) index developed by Baker *et al*. (2016) as a proxy for uncertainty related to economic policies and financial decision-making. Increased policy uncertainty has been found to be associated with heightened risk transmission, often intensifying risk pass-through from banks to sovereigns (Bales, 2022). More recently, some studies have incorporated measures of geopolitical risk to capture adverse geopolitical events and their associated risks; accordingly, we employ the Geopolitical Risk (GPR) index developed by Caldara and Iacoviello (2022).[9]

Model (1) summarises the impact of sovereign debt holdings *B* by domestic or foreign banks or the central bank, *X* represents a set of domestic control variables, and *Z* denotes a set of common (euro area) control variables on the transmission of risk from bank to sovereign in country *i* in period *t*, represented by $C_{sb,i,t}$:

$$C_{sb,i,t} = \mu_i + \lambda B_{i,t} + \theta X_{i,t} + \phi Z_t + \varepsilon_{i,t}. \quad (1)$$

Estimators in equation (1) must account for the fact that common factors drive risk transmission between banks and sovereigns in the euro area, and that policies have had heterogeneous impacts across member countries. The Augmented Mean Group (AMG) – in contrast to a classical panel fixed effects model – allows for heterogeneous slopes

[9] Bank holding data are linearly interpolated from quarterly to monthly frequency. For the VSTOXX, MOVE, and CCBSS5y indices, daily data are aggregated to a monthly frequency by selecting the end-of-period value.

across panel units, as well as cross-sectional dependence. The AMG estimator operates in two steps. First, it runs a pooled regression on first differences, including time dummies, to filter out the common dynamic process. This process, in our context, captures the overall exposure to a common risk factor shared by banks and sovereigns in the euro area. Second, the panel model corrects the regressor estimates by incorporating this common process, and the group-specific model parameters are averaged across the panel. In addition to the panel-level estimates, country-specific parameters are also obtained. A country-specific linear trend is included in the model. To validate the relevance of risk transmission across euro area markets, we initially perform several tests for cross-sectional independence on a fixed effects panel of equation (1). Both the Friedman and Pesaran tests decisively reject the null hypothesis of independence.[10] These results justify the use of the AMG estimator, yet we conduct various robustness checks to make our findings robust.

3. Empirical results

We first present the measure of risk pass through, followed by the panel results and several robustness checks.

3.1. Dynamic net pairwise directional connectedness

The Diebold-Yilmaz approach provides an accurate indicator of risk propagation by identifying distinct episodes within the sovereign-bank nexus. Figure 3 displays the net pairwise directional connectedness indicator $C_{sb,t}$ for each country. Several patterns

[10] The Friedman test yields a test statistic of 400,51 (p-value=0.00), and the Pesaran test produces a test statistic of 7.97 (p-value=0.00). Additionally, a modified Wald test for groupwise heteroscedasticity indicates that variance is not constant across countries, with a χ^2 test statistic of 126.40 (p-value=0.00).

emerge regarding the pass-through of bank-sovereign risk. First, since $C_{sb,t}$ is predominantly positive, bank risk has driven sovereign risk in all ten countries throughout most of the sample period. Using alternative methodologies over a similarly extended sample, Bales (2022) also finds that bank risk transmits to sovereign risk in the medium term.[11] However, the net connectedness varies significantly over time and across countries. Until the onset of the Global Financial Crisis, bank risk dominated in all countries, with its impact rising substantially in Ireland, Italy, and Portugal until the European Council's decision to establish the European Stability Mechanism (ESM) in 2012,[12] when the direction of the impact reversed. Only in Belgium and Spain did bank risk continue to dominate sovereign risk. After 2014, risk spillovers from banks to sovereigns increased again, particularly in most core EMU countries, but gradually diminished over time until the onset of the pandemic, when the net spillover from bank risk transmission surged dramatically.[13] Our finding that risk transmission primarily flows from banks to sovereigns—interrupted by reversals during times of economic distress—is supported by other studies covering more extended periods (Fratzscher and Rieth, 2019; Cifarelli and Paladino, 2020; Bochmann *et al.,* 2024).

[Insert Figure 3 here]

Second, periods when sovereigns act as the primary transmitters of risk are limited to specific episodes of crisis. It is unsurprising to observe this shift in pass-through during the early phases of the Global Financial Crisis and the European Sovereign Debt crisis

[11] Bales (2022) employs wavelet analysis, and his findings for the medium term correspond to the monthly frequency of our dataset.

[12] The ESM is a permanent crisis management facility for euro-area countries that provides financial support to Member States experiencing or at risk of severe funding difficulties, aiming to maintain the stability of the euro area. It raises funds by issuing debt instruments to finance loans and other types of assistance for euro area countries facing financial challenges.

[13] See Covi and Eydam (2020) for a similar result.

from April 2010 to October 2012. From May 2018 until the onset of the Pandemic, sovereign risk again dominated, likely related to the tapering of ECB asset purchases (see Hofmann *et al.,* 2020). However, the resumption of purchases under the Pandemic Emergency Purchase Programme (PEPP) helped reduce sovereign risk transmission (Bales, 2022; Blotevogel *et al*., 2024). This shift persisted until the ECB reversed its asset purchase programs again in July 2022, with no reinvestment of redemptions as of July 2023 (ECB, 2024).

3.2. Determinants of net directional connectedness

Several factors influence the pass-through of risk from banks to sovereigns. The first main insight of Table 1 (column a) is that domestic banks' holdings of government debt significantly increase the net risk pass-through from banks to sovereigns. This effect is driven by a strong home bias since only domestic banks' purchases have a meaningful impact. In contrast, foreign banks' holdings do not significantly affect risk transmission.[14] European banks tend to be closely connected to their own country's sovereign debt, with comparatively less exposure to the sovereign debt of other EU countries (Fang *et al.,* 2022). These findings align with much of the existing research on the "doom loop," which suggests that higher exposure of banks to public debt increases overall risk (De Bruyckere *et al*., 2013).[15]

[Insert Table 1 here]

[14] The positive sign nevertheless indicates that holdings by foreign banks also contribute to transmission. This is likely unsurprising, given that most of these foreign banks are based in the euro area, leading to cross-border spillovers within the euro area, as demonstrated by Breckenfelder and Schwaab (2018).

[15] Numerous studies have examined the impact of various ECB programmes, consistently finding significant effects of both announcements and implementation on bond yields and risk premia. Blotevogel *et al.* (2024) offer a comprehensive overview of this literature.

The results also imply that banks might strategically hold domestic sovereign debt to increase their chances of receiving government bailouts, reflecting a "too interconnected to fail" dynamic (Capponi *et al*., 2022). This means the more a bank is exposed to its domestic sovereign debt, the greater the risk transferred from banks to sovereigns. Furthermore, as noted by Hryckiewicz *et al.* (2022), large investments in government securities may signal significant risk for the banking sector, which could be intensified under stricter regulations, exposing banks to greater market risk in the event of shocks to the yield curve.

A second main result is the neutral impact of unconventional monetary policy. Although concerns have been raised about the effects of the ECB's large-scale asset purchase programs, particularly the PSPP, and the perverse incentives they may create for sovereigns and banks (Benigno *et al*., 2023), our findings indicate that these purchases have not influenced risk transmission in either direction, remaining neutral overall. Some other studies have found that central bank purchases of government debt reduce risk transmission, but their evidence often focuses on individual programs studied in isolation.

By contrast, conventional monetary policy does affect the transmission of risk. More restrictive policies increase the flow of risk from banks to sovereigns, consistent with Soenen and Vander Vennet (2022b), who find that restrictive ECB policies raise bank default risk both directly and indirectly through sovereign risk. These effects persist even when unconventional tools, such as asset purchase programs, are in place.

The control variables display signs that align with the predictions. Not surprisingly, higher stock market volatility is associated with increased transmission from banks to sovereigns. Conversely, higher bond market volatility and funding liquidity stress reduce transmission. Janbaz *et al.* (2024) have a similar result and explain that banks under liquidity pressure tend to buy more sovereign bonds for liquidity management, resulting

in a 'flight to liquidity' that lowers sovereign risk and transmission. The same reasoning applies to bond market volatility: sovereign bonds are seen as safer, and bank purchases of domestic sovereign bonds reduce sovereign risk.

Bales (2022) suggests that policy uncertainty drives sovereign-bank interdependence; however, we do not find significant evidence to support this. Controlling for both conventional and unconventional monetary policies seems sufficient to explain risk pass-through. In fact, an alternative specification in which we drop economic policy uncertainty from the model does not affect the main results (Table 1, column c). However, when considering geopolitical risks, increased tensions reduce transmission, possibly due to a 'flight to safety' toward domestic sovereign bonds by major European banks.

A concern with the results in column a is that both foreign banks' and the ECB's holdings of sovereign debt might be correlated with movements in the domestic holdings. When dropping both from (1), the AMG-estimates for domestic bank holdings are similar, but the ECB shadow rate loses significance (Table 1, column b). This result suggests an interaction between conventional and unconventional monetary policy, with large-scale asset purchases being essential for the effectiveness of conventional policy. Market volatility also loses significance as a driver of transmission, indicating that unconventional monetary policy has helped reduce bond market risk.

Finally, the aggregate linear trend is not statistically significant; however, at the country level, nine out of ten countries exhibit significant group-specific trends.

3.3. Transmission across the euro area and policy changes

The evidence so far indicates that large-scale asset purchases in the euro area have had a limited overall impact. Some studies suggest that while ECB policies were neutral on average, their effects varied across banks and countries, especially between core and

peripheral nations (Crosignani *et al.,* 2020; Soenen and Vander Vennet, 2022b). Since the AMG estimator provides a weighted average of country-specific estimates, corrected for cross-country correlation and common factors, we can examine how each variable influences risk transmission in individual countries. Figure 4 presents a box plot of the coefficients, illustrating the variation in the effects of sovereign debt holdings and conventional monetary policy across countries, with statistical significance denoted by an asterisk next to the country name.

[Insert Figure 4 here]

A striking finding is that the effect of domestic bank holdings on risk transmission is measured with high precision. For most euro area countries, a stronger home bias has increased the risk spillover to the sovereign, and the magnitude of this impact is relatively consistent across nations. This suggests that no particular euro area banking system was substantially more vulnerable than others due to sovereign exposure. The only exception is Italy, and holdings by Italian banks have reduced the impact on the sovereign. Véron (2017) attributes this to the large share of Italian bonds held domestically and two bailouts since 2016 that spread the impact across the euro area rather than concentrating it on the Italian sovereign (Capasso *et al*., 2023).

By contrast, the effect of ECB holdings is more mixed across the euro area. While we find that ECB purchases are, on average, neutral, they have heightened risk transmission in most countries, but reduced it in Austria, Belgium, and France (though only France shows statistically significant results at the 5% level). There is no correlation between the cumulative net purchases under the PSPP and the size of the effect (as the correlation is actually slightly negative at -0.19). There is also no clear core-periphery divide, as Austria, Belgium, and France are considered to be core EMU countries in most studies. Our result could be related to the size of French banks (five of the ten largest euro area

banks are French) and the important role Belgian banks play in transmitting sovereign risk between Southern and Northern Europe. In contrast, Austrian banks do so for Central and Eastern Europe (Claeys and Vasicek, 2014). This diverse impact of large-scale asset purchases sharply contrasts with the relatively uniform positive effect of conventional ECB policy on risk transmission.[16]

A box plot provides valuable insights but does not constitute definitive proof; we therefore formally test for heterogeneity across the panel of 10 EU countries. We start by testing for slope homogeneity using the delta test developed by Pesaran and Yamagata (2008). We apply both the HAC-consistent version and a variant that adjusts for cross-sectional correlation in the panel, as proposed by Blomquist and Westerlund (2013). Table 2 shows that the null hypothesis of homogeneous slope coefficients is rejected across all model specifications (columns a-c). Next, we investigate whether the source of heterogeneity stems from monetary policy or sovereign debt purchases by separately controlling for the shadow rate (column d) and the sovereign holdings of (central) banks (column e). While homogeneity is rejected in both cases, the rejection is stronger when sovereign holdings are held constant. In line with the country-specific estimates, this result suggests that monetary policy effects are relatively uniform across countries, whereas sovereign holdings contribute more to cross-country differences.

[Insert Table 2 here]

Besides differences across countries, time variation over the sample period might explain some of the results. Although we account for shifts to unconventional monetary policy by considering the ECB's aggregate sovereign debt purchases, there could be breaks due to other policy changes or underlying economic turmoil in the sample. We therefore run

[16] Only in Ireland, Italy, and Portugal does a higher ECB shadow rate appear to dampen risk transmission, although this effect is not statistically significant.

a sequential test for multiple unknown breakpoints developed by Ditzen *et al*. (2024). This test evaluates three hypotheses: (a) no breaks versus s breaks, (b) no breaks versus a range between a lower and upper limit of breaks, and (c) *s* breaks versus *s+1* breaks. The test results, along with critical values, are reported in Table 3. The evidence clearly supports the presence of at least four breaks, and possibly five, at the 10% significance level.

[Insert Table 3 here]

We then identify the timing of these five breakpoints using a sequential method, adapted by Karavias *et al.* (2023) and Ditzen *et al.* (2024), and include confidence intervals for each break. These breaks mark significant shifts in risk transmission between banks and sovereigns.

[Insert Table 4 here]

Specifically, Table 4 indicates they occurred at:

- The onset of the Global Financial Crisis occurred shortly before the collapse of Lehman Brothers.
- The discussion around creating the ESM in February 2011 following the Greek and Irish bailouts in late 2010.
- The beginning of the euro area's recovery in the second quarter of 2013;[17]
- The start of the ECB's PSPP asset purchases.
- The onset of the COVID-19 Pandemic.

Given the long sample period we use, these turning points in transmission do not come as a surprise and confirm many of the previous findings in the field. However, in contrast

[17] Similar evidence is given by Cifarelli and Paladino (2020).

to the results in Covi and Eydam (2020) or Lamers *et al*. (2024) –which are based on shorter samples than ours–we do not find evidence that the implementation of the Bank Recovery and Resolution Directive in 2016 is causing a significant change in the direction of risk transmission. At the very least, our results suggest that many other factors play a role in the transmission simultaneously.

We re-estimate panel model (1) including time dummies for the five breakpoints. Table 1 (column d) shows that the results remain essentially unchanged. The breaks themselves significantly shift the response. It amplifies the transmission of risk from banks to sovereigns, reinforcing our initial finding that economic turmoil alters the transmission dynamics.

3.4. Robustness checks

We further look into alternative estimators for model (1). Table 1 (column e) presents results using Pesaran's (2006) Common Correlated Effects Mean Group (CCEMG) estimator, which accounts for cross-sectional dependence and includes time-varying unobservables with heterogeneous effects across panel members. Its limitation is that the CCEMG cannot analyse the impact of common variables on dynamics, so the ECB shadow rate is excluded. Excluding conventional monetary policy notably distorts the results, as none of the included variables is significant for risk transmission.

A simpler alternative is the Pesaran and Smith (1995) Mean Group (MG) estimator, which ignores cross-sectional dependence. It calculates coefficient averages as unweighted means, which are robust to outliers. We find that in this case, only monetary policy (*and liquidity stress*) has a positive (*and negative*) effect on transmission from banks to sovereigns. However, the impact of both is mitigated because of the bias in the estimates.

The most basic approach, often used in applied research, is to run a panel fixed effects model with time dummies to control for common shocks. As can be seen from Table 1 (column f), only bank holdings remain significant, while none of the control variables are. This panel estimator overlooks cross-sectional dependence, which we confirmed as problematic, as both the Friedman and Pesaran tests for cross-sectional independence reject the null.

4. Conclusion

Despite the EU's institutional and regulatory reforms, such as the establishment of the Banking Union, the harmful feedback loop between sovereign and banking debt still persists and remains a major structural risk to the euro area's financial and economic stability.

This paper employs a two-step approach to examine how bank holdings of government debt influence the risk pass-through between the banking and sovereign sectors in the euro area. We first estimate the time-varying transmission from domestic bank risk to sovereign risk, and then analyse the impact of large-scale asset purchases as well as bank holdings of government debt, on the previous estimate of the sovereign-bank nexus, also controlling for the stance of conventional monetary policy and other uncertainty indicators.

The main findings of our research indicate that risk transmission dynamics evolve over time, with risk typically flowing from banks to sovereigns. However, this direction reverses during episodes of economic distress, most notably throughout the European Sovereign Debt Crisis (2009–2013). The primary factor driving the dynamics of the sovereign-bank nexus is domestic bank holdings of government debt, which increase sovereign risk exposure. Restrictive conventional monetary policy has a comparable

effect, whereas ECB large-scale asset purchases have not significantly influenced risk transmission.

Several policy recommendations follow from our results. The pronounced home bias leaves domestic banks heavily exposed to their own government debt. To reduce systemic vulnerabilities, policymakers should limit banks' exposure to domestic sovereign bonds through prudential regulation and promote diversification, potentially through instruments like European Safe Bonds (Brunnermeier *et al*, 2016). Reducing home bias and risk fragmentation requires accelerating euro area financial integration, completing the Banking Union, and strengthening cross-border supervisory cooperation. As conventional monetary policy modifies risk spillovers from banks to sovereigns, interest rate decisions should be accompanied by coordinated macroprudential policies to cushion its effects. Unconventional monetary policy, while neutral on average for risk transmission, has divergent effects across countries. Although ending QE will not necessarily trigger the doom loop again, and the use of unconventional policies has facilitated the transmission of ECB policies, future programmes should include clear exit strategies and guardrails to prevent excessive risk-taking, particularly through collateral or carry trades.

Disclosure of interest

The authors have no declaration of interest to make.

Funding

This research was funded by the Spanish Ministry of Science and Innovation [grants PID2019-105986GB-C21 and TED2021-129891B-I00] and the Spanish State Investigation Agency [grant AEI/10.13039/501100011033].

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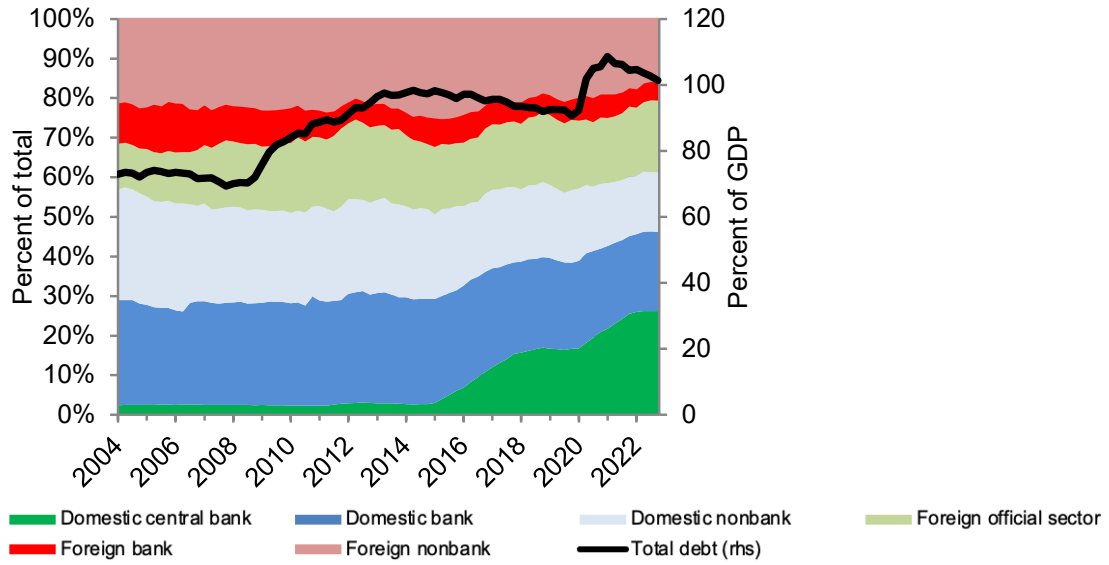
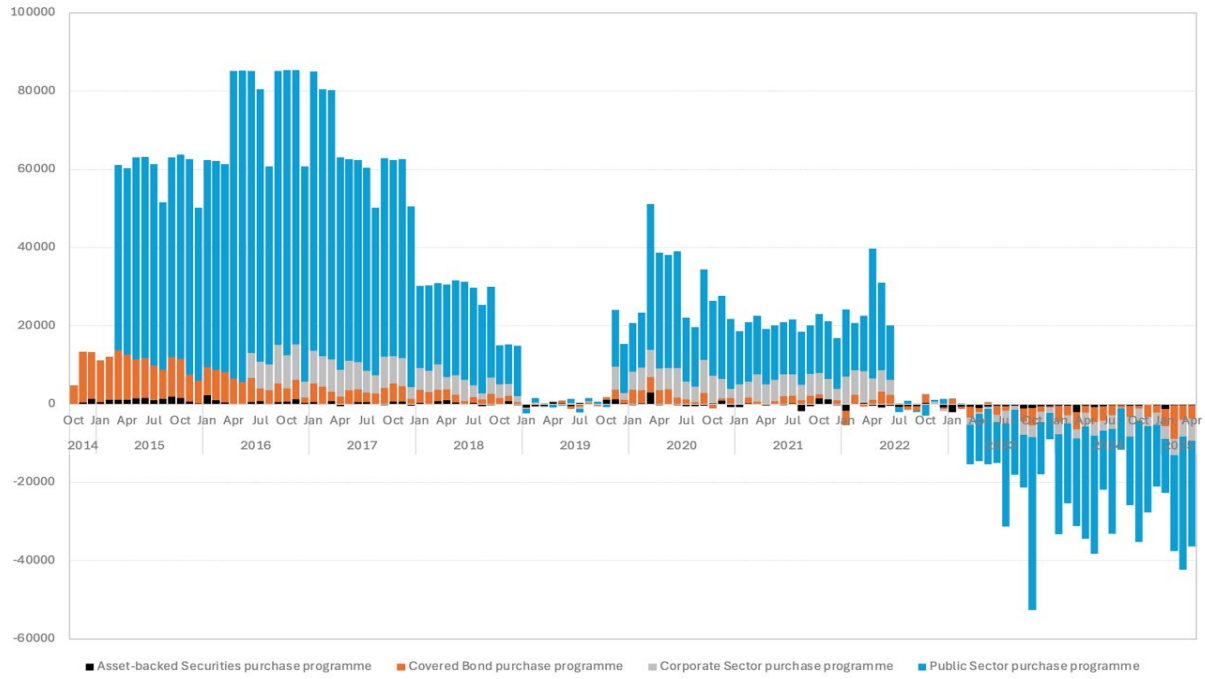
Figure 1. Sovereign debt holdings by origin in four largest EU countries by GDP, 2004-2023.



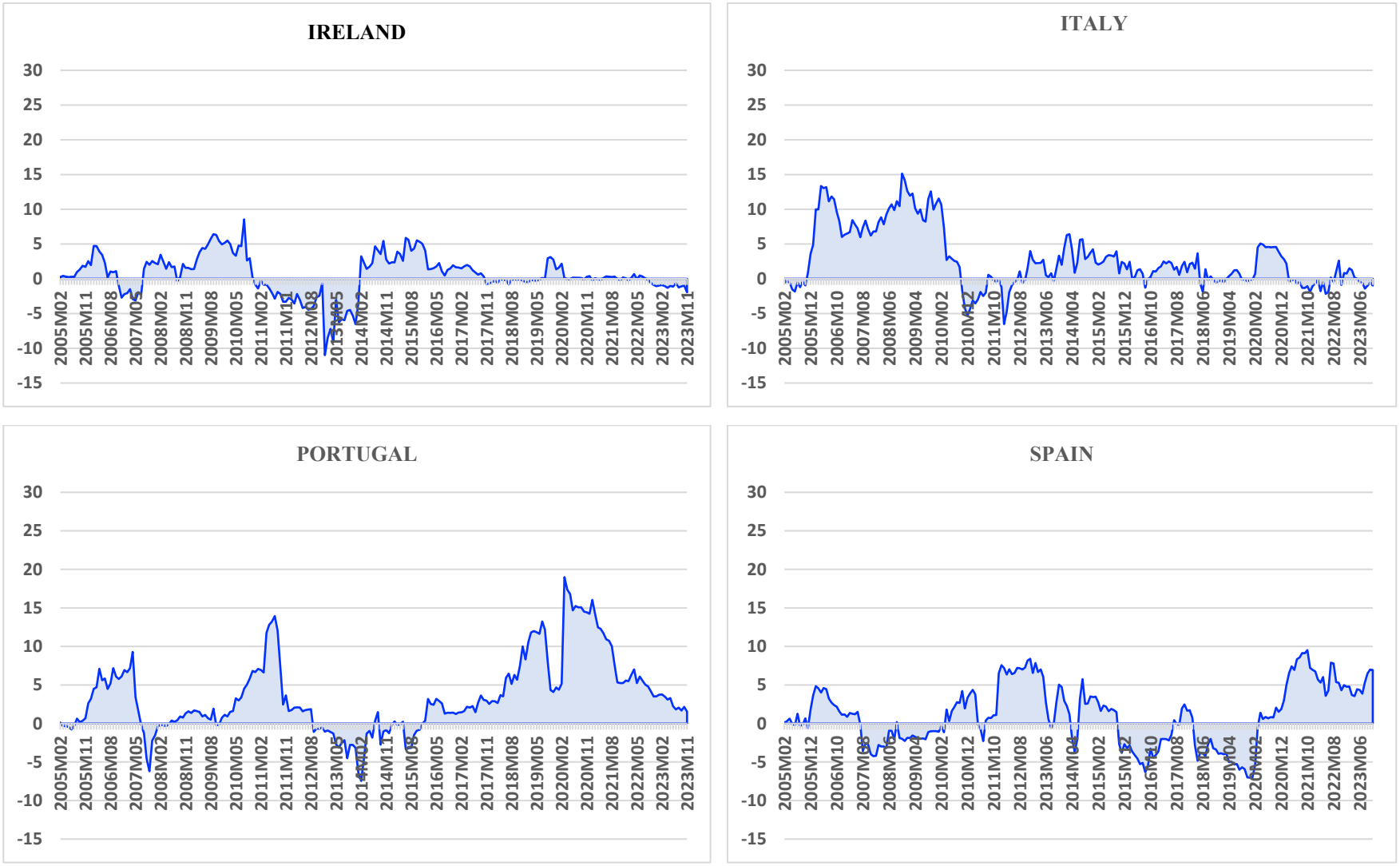
Notes: Data from the updated version of Arslanalp and Tsuda (2014). Holdings in the largest four EU countries by GDP (Spain, France, Germany, Italy).

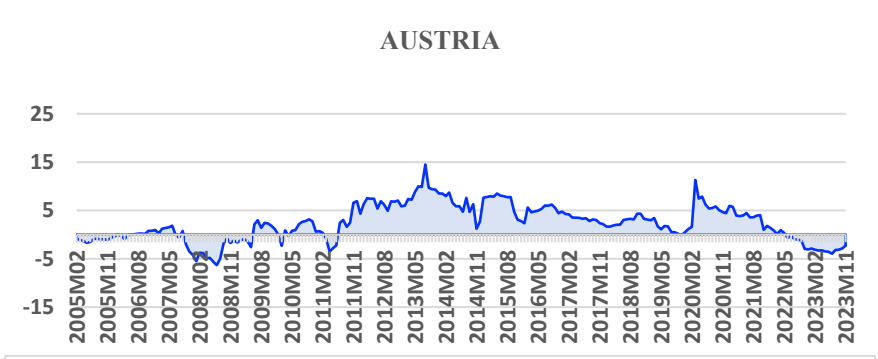
Figure 2. Net cumulative purchases under ECB Purchase Programmes (end of month, in millions of euros).



Notes: ECB (2024).

Figure 3. Dynamic net pairwise directional connectedness from domestic banks to sovereign risks (2005-2023)

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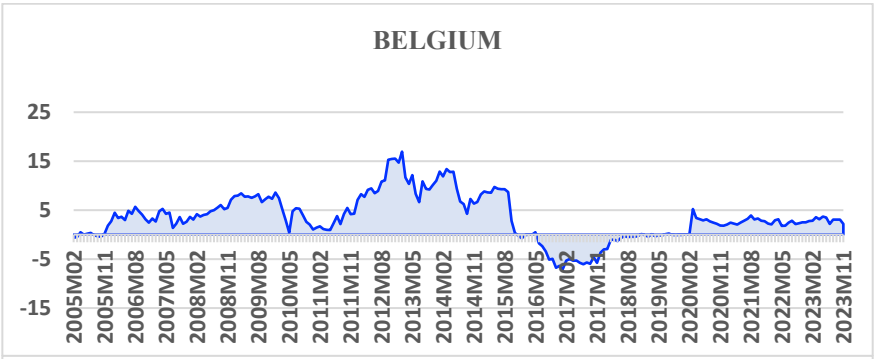
2023M11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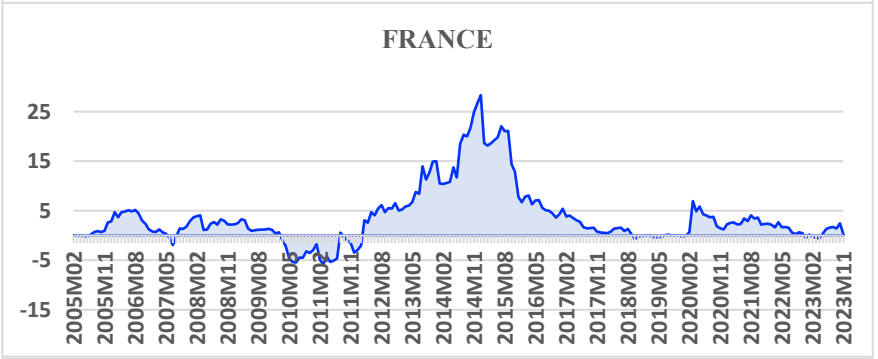
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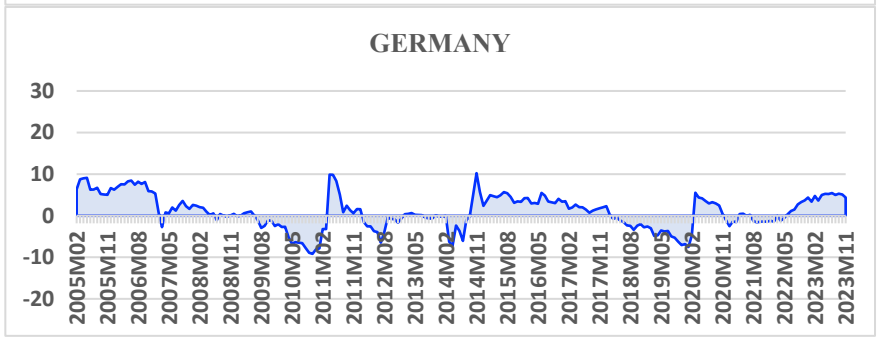
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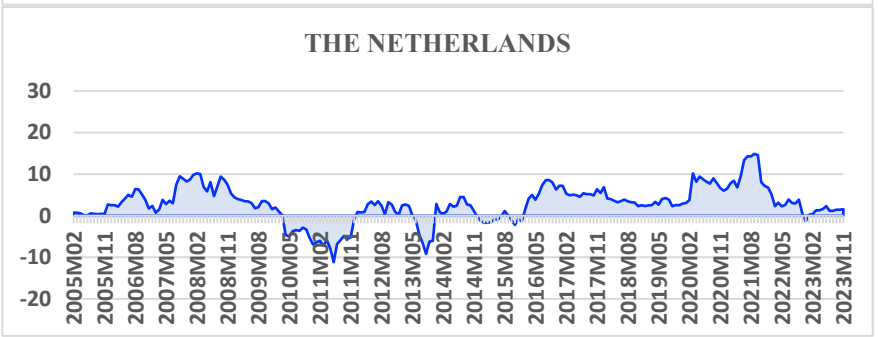
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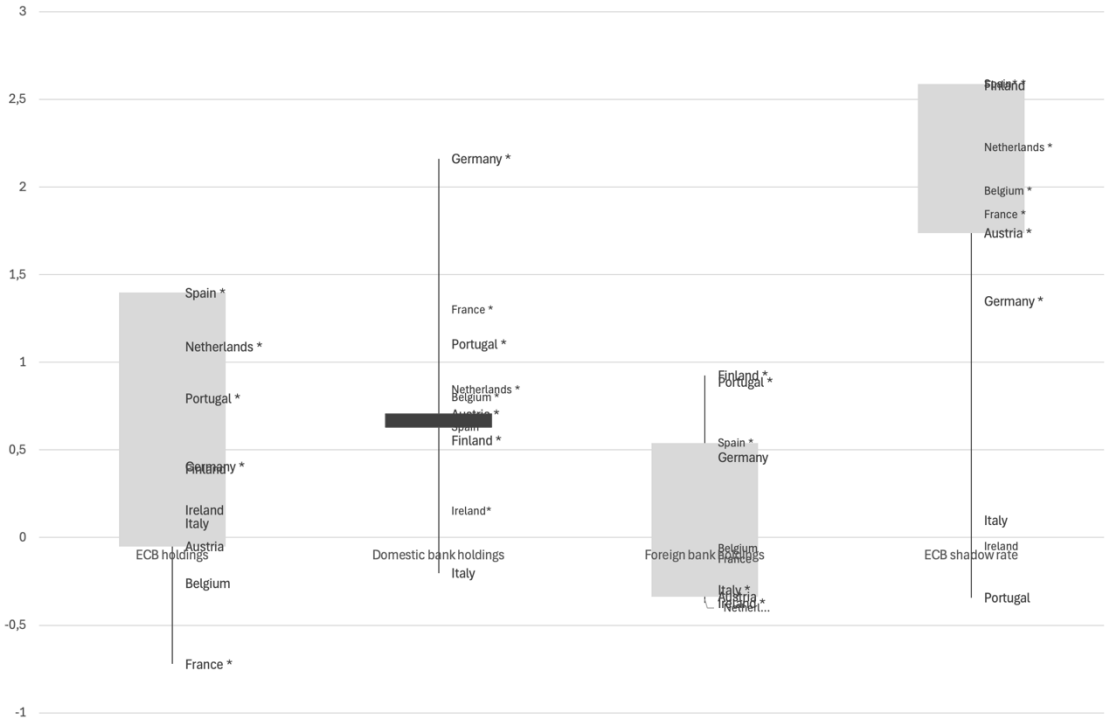
Figure 4. Box plot of country-specific response under the AMG estimate of (1).



Source: Authors' calculations.

Notes: * indicates significance of country-specific effect at 5 per cent.

Table 1. Panel model (1) for testing drivers of net risk transmission.

	(a)	(b)	(c)	(d)	(e)	(f)	(g)
estimator	**AMG**	**AMG**	**AMG**	**AMG with time dummies**	**CCEMG**	**MG**	**Panel FE with month dummies**
ECB holdings	0.324		0.318	0.323	0.917	0.255	0.171
	(0.202)		(0.199)	(0.202)	(0.837)	(0.213)	(0.045)
Domestic bank holdings	0.805***	0.792***	0.853***	0.823***	0.335	0.461	0.179***
	(0.203)	(0.218)	(0.216)	(0.211)	(0.274)	(0.312)	(0.031)
Foreign bank holdings	0.126		0.132	0.131	0.107	-0.096	0.153***
	(0.166)		(0.165)	(0.167)	(0.204)	(0.163)	(0.025)
Shadow rate ECB	1.401***	0.271	1.586***	1.365***		0.682**	-35.605
	(0.349)	(0.491)	(0.337)	(0.350)		(0.352)	(25.368)
Economic Policy Uncertainty	0.001	0.001		0.001	-0.001	0.001	0.008***
	(0.002)	(0.003)		(0.002)	(0.005)	(0.004)	(0.002)
MOVE	-0.063***	0.010	-0.080***	0.001	0.009	-0.006	1.682
	(0.010)	(0.016)	(0.010)	(0.010)	(0.010))	(0.012)	(1.230)
Vstoxx	0.127***	-0.023	0.153***	0.062**	-0.022	0.023	-11.107
	(0.025)	(0.029)	(0.028)	(0.025)	(0.022)	(0.026)	(7.916)
CCBSS5y	-2.322***	-0.201	-2.374***	-2.156**	-0.609	-1.855**	82.926
	(0.732)	(1.105)	(0.721)	(0.734)	(0.699)	(0.850)	(57.699)
GPR	-0.016***	0.012***	-0.011***	0.038***	0.001	-0.003	0.275
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.195)
Group-specific linear trend	0.016	0.035*	0.017	0.018		-0.035	
	(0.030)	(0.019)	(0.032)	(0.031)		(0.021)	
Break dummy				3.411			
				(0.331)***			
Constant	-11.557	-20.859***	-12.154	-25.469**	7.409	-5.361	
	(9.372)	(6.990)	(10.114)	(9.783)	(12.209)	(8.751)	
Number of observations	1980	1980	2000	1980	1980	1980	1980
Number of countries	10	10	10	10	10	10	10
Dummies				Breaks from table 4			Not reported

Notes: *, **, and *** denote significance at the 10, 5, and 1 per cent level respectively; break dummies are from a Ditzen *et al*. (2024) sequential break test; CCEMG is the Pesaran (2006) Common Correlated Effects Mean Group estimator; MG is the Pesaran and Smith (1995) Mean Group HAC robust estimator.

Table 2. Test for homogeneity of slope coefficients.

	(a)	(b)	(c)	(d)	(e)
	Delta test	HAC robust	Cross-sectional correction	Cross-sectional correction	Cross-sectional correction
Test statistic	65,87	49,39	25,14	52,27	31,06
p-value	(0,00)	(0,00)	(0,00)	(0,00)	(0,00)

Notes: Delta test by Pesaran and Yamagata (2008) and Blomquist and Westerlund (2013). The chosen window is 4 months long.

Table 3. Results from sequential breakpoint test.

	Test statistic	Critical value 1%	Critical value 5%	Critical value 10%
F(1|0)	33.74	3.40	2.85	2.56
F(2|1)	10.44	3.59	3.07	2.84
F(3|2)	18.29	3.72	3.21	2.96
F(4|3)	3.85	3.81	3.30	3.07
F(5|4)	3.57	3.88	3.39	3.14
Detected number of breaks		4	5	5

Notes: critical values from Ditzen *et al*. (2024). The detected number of breaks indicates the highest number of breaks for which the null is rejected.

Table 4. Results from sequential estimation.

Break no.	Break	95% Conf. Interval	
1	June 2008	May 2008	July 2008
2	December 2010	November 2010	January 2011
3	June 2013	May 2013	July 2013
4	December 2015	November 2015	January 2016
5	February 2020	January 2020	March 2020

Notes: critical values are indicated by dates.