Private bank deposits and macro/fiscal risk in the euro-area

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ABSTRACT

We use a panel of ten euro area member states to examine the link between macro/fiscal risk and private bank deposits relative to Germany. Our main findings are summarised as follows: First, the relationship between relative deposits and macro/fiscal risk factors is not stable over time. Second, the significant time variation characterizing this relationship is driven by aggregate EMU-wide macro/fiscal risk conditions. Third, relative deposits in periphery EMU countries are generally more responsive to macro/fiscal risk. Fourth, the ECB's unconventional monetary policy moderated the effect of the global financial and European debt crises on the relationship between relative deposits and macro/fiscal risk. Our empirical findings can inform the ongoing policy debate regarding the completion of the European Banking Union.

1. Introduction

A large literature has documented that the global financial crisis (GFC) of 2007–2009 and the ensuing European sovereign debt crisis (ESDC) largely reversed the process of financial integration observed across the European Economic and Monetary Union (EMU) in the 1990 s and the early years of the euro. Despite its extensive coverage, however, this literature has overlooked a significant aspect of the European financial system, namely private bank deposits and their link to macro/fiscal risk. This is an important gap, especially given the following considerations:

First, deposits are a key building block of financial intermediation in the euro area where investors (especially households), show a strong bias towards bank deposits relative to other forms of financial investment.[1] According to the European Central Bank (2016), deposits are held by 97% of European households and possess the largest proportion in households' portfolio of financial assets, with an average share between 30% and 40%. This renders deposits a very significant factor determining output developments, both in the short-run through credit provision, as well as in the long run through enhancement of the allocation of economic resources (Ramirez, 2009). Second, the safety of deposits is a major priority for policy makers, as evidenced by the increased provision of deposits insurance in the wake of the global financial crisis (Engineer et al., 2013; Wruuck, 2014; Demirgüç-Kunt et al, 2015) and plans to introduce a European Deposit Insurance Scheme (EDIS), endorsed by the Five Presidents Report on Completing Europe's Economic and Monetary

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[1] The proportion of bank deposits in household savings takes even larger values in periphery countries (Valiante et al., 2016, p. 91). European non-financial corporations also hold a significant share of their total financial assets in bank deposits (European Commission, 2015a). Finally, the share of deposits as a source of funding of European banks increased substantially during the crisis years (European Commission, 2015b).

Union (European Commission, 2015b,c). Third, prima-facie evidence suggests that deposits are no exception to the fragmentation dynamics observed in other areas of the euro financial system (see Fig. 1 and Section 2 below).

In this paper we analyse the link between private bank deposits, relative to Germany, and macro/fiscal risk in the EMU. We focus on the ratio of a euro area member state's (MS) bank deposits to German deposits since, as we argue in Section 2, this ratio conveys important information for the state of the MS's national banking system as a safe-investment destination. Essentially, changes in relative deposits reflect the probability of wealth losses across the eurozone's national banking systems. We develop a theoretical model (presented in Appendix B), to support this argument. In the model, the set of saving instruments includes domestic bank deposits, foreign bank deposits and cash holdings.

The key theoretical insight is that in the presence of heightened macro/fiscal risk, investors move deposits from the MS to the safe haven's banking system and/or increase their holdings of cash. In the case of the euro area, both effects have been observed during the ESDC. Several academic studies and other reports offer support for this stylised fact. For instance, Kleimeier et al. (2013) argue that crises can drive customers living in affected countries to search for safe havens abroad. Cheung et al. (2020) show that during the ESDC capital flight towards Germany has been considerable and largely driven by crisis-related factors. Steiner et al. (2019) and Merler and Pisani-Ferry (2012), among others, highlight that the periphery of the euro area was strongly affected by these capital-flow reversals. In addition to the cross-border deposits substitution identified by Kleimeier et al. (2013), the studies by Mai (2016) and Gros (2017) document a substantial increase in the use of cash in the euro area during the crisis years.[2]

Using a panel of ten euro area countries, we examine the macro/fiscal determinants of relative banking deposits; whether the link between relative deposits and macro/fiscal risk is stable over time; and the potential drivers of the time-variation characterizing the link between relative deposits and macro/fiscal risk. To do so, we adopt a two-stage empirical strategy similar to Manasse and Zavalloni (2013) and Afonso et al. (2018). In the first stage, we use a time- varying parameter (TVP) panel specification to estimate the sensitivity of euro area deposits, relative to Germany, to a set of country-specific explanatory macro/fiscal variables. This TVP specification allows us to capture time variation in the relationship between relative deposits and their macro/fiscal determinants for the euro area panel as a whole. The second stage investigates whether the time-varying sensitivity of deposits to macro/fiscal risk for the panel as a whole is related to the aggregate (euro area wide) level of the macro/fiscal risk factors as well as measures of the ECB's unconventional monetary policy, while controlling for the effect of structural breaks.

Our main findings can be summarised as follows: First, the relationship between relative deposits and macro/fiscal risk factors is not stable over time. Second, the significant time variation characterizing this relationship is driven by aggregate EMU-wide macro/fiscal risk conditions. Third, relative deposits in periphery EMU countries are generally more responsive to macro/fiscal risk. Fourth, the ECB's unconventional monetary policy moderated the effect of the GFC and the ESDC on the relationship between relative deposits and macro/fiscal risk.

Our work is related to, and provides a bridge between, two important strands of the financial literature, namely depositors' behaviour in the presence of banking risk and European financial integration. As far as the former is concerned, the literature linking savers' behaviour with banking risk has largely been shaped by two highly influential models. The first is the market discipline model by Berger (1991) according to which savers demand higher interest rates (price discipline mechanism) from or/and reduce the volume of their deposits with banks (quantity discipline mechanism) following excessively risky business models (see, among others, Flannery, 1998, and Bennett et al., 2015). The second is the Diamond and Dybvig (1983) model, predicting self-fulfilling banking crises, not explained (at least fully) by idiosyncratic banking fundamentals. The high macro/welfare costs of banking failures justify deposit insurance schemes at the national level. These, however, may cause moral hazard in banking behaviour, as extensively documented by previous studies (see, for example, Demirgüç-Kunt and Huizinga, 2004; Karas et al., 2013).

In recent years, and especially since the onset of the GFC, numerous studies have offered new insights on the relationship between bank deposits and banking risk. A key feature of these studies is that as domestic macro/fiscal risk increases, domestic savers increasingly move away from the classic market discipline savings paradigm discussed above. Instead, they move towards a model where they determine deposits for the domestic banking system as a whole on the basis of national macro/fiscal risk (Levy-Yeyati et al., 2010; Cubillas et al. 2012, 2017). This feature, incorporated in the DSGE macro models of Clerc et al. (2015) and Balfoussia et al. (2019), results into a mutation of market discipline from deposits' reallocation within national banking systems to international deposits substitution and/or increasing holdings of cash. Our paper contributes to this strand of the literature by providing evidence supporting a significant link between national fiscal/macro risk and relative bank deposits in the euro area. Moreover, the link becomes stronger as macro/fiscal risks increase in size.

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[2] Apart from academic studies, there are several reports in the financial press supporting the argument about deposit flight and high cash holdings during the ESDC. For example, Bloomberg (2012) argues that "An accelerating flight of deposits…is undermining a main tenet of the common currency: an integrated financial system. A total of €326 billion was pulled from banks in Spain, Portugal, Ireland and Greece in the 12 months ended July 31, according to data compiled by Bloomberg. The flight of deposits from the four countries coincides with an increase of about €300 billion at lenders in seven nations considered the core of the euro zone…, almost matching the outflow." Kathimerini (2014) analyses Greek deposits over the ESDC and concludes that flight to safe havens (including Germany) and higher cash holdings can explain the decline in Greek bank deposits. The prominent role of Germany as a safe haven destination in the context of this intra-EMU capital reallocation has been extensively documented (see e.g. Cheung et al., 2020).
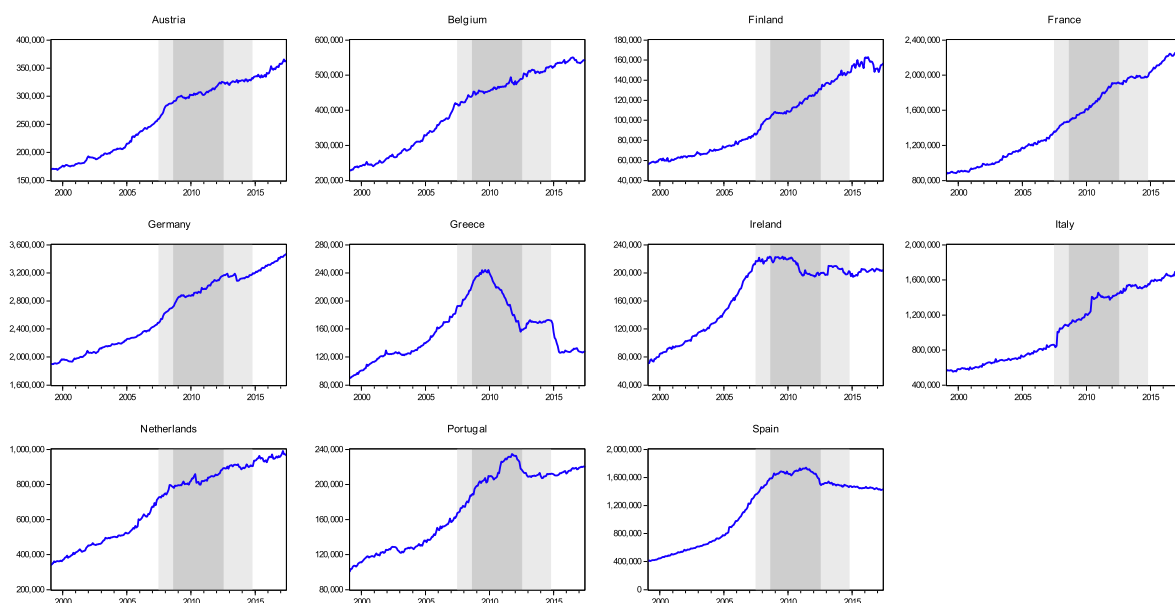
Fig. 1. Private bank deposits in euro area countries. Note: The figure presents private bank deposits. These are defined as outstanding amounts (in euro millions) at the end of each month covering maturities of all types and all currency denominations, for deposits of households, non-financial corporations and other entities excluding central government and Monetary and Financial Institutions. The sample period is January 1999 – June 2017, and the data source is the European Central Bank. The light-shaded area covers the period July 2007 – October 2014; the dark-shaded area covers the period September 2008 – July 2012.

These findings provides the bridge to an extensive literature on financial fragmentation in the EMU during the GFC and the ESDC documented in the markets of numerous assets.[3] The study of McLemore et al. (2022) analyses changes in global banking over the last decades. They use a dataset compiled by the Bank of International Settlements dataset that indicates a deceleration in financial integration since the onset of the GFC. McCauley et al. (2019) show that the decline in global cross-border banking since 2007 is driven by European banks. Financial fragmentation has disrupted the transmission of the single monetary policy (Durré et al., 2014) causing economic costs (Hristov et al., 2012; Bijsterbosch and Falagiarda, 2015) consistent with the predictions of macroeconomic models incorporating financial frictions (Gerali et al., 2010; Bocola, 2016). Most existing studies find a partial reversal of fragmentation following the announcement of the Outright Transactions Programme (OMT) in July 2012, also documented by the European Central Bank (2015).

The literature has also established a strong feedback loop between fiscal and banking risk, particularly strong among euro area countries during the ESDC (Alter and Schüler; 2012); Acharya et al., 2014; Fahri and Tirole, 2018) and has highlighted the important role of the ECB's unconventional monetary policy for reversing the dynamics of crisis (Delatte et al., 2017; Afonso et al., 2018). Our paper contributes to this strand of the literature by providing evidence that private bank deposits also display the fragmentation dynamics present in other areas of the euro financial system; and that the ECB's unconventional monetary policy has moderated these fragmentation dynamics. We show that the stabilisation effect that unconventional monetary policy has had on the link between euro area sovereign bond spreads and their macro/fiscal determinants is also present in the link between relative deposits and macro/fiscal risk.

Our findings concerning the importance of macro/fiscal risk for the determination of bank deposits can inform the discussion on EDIS, which is endorsed by European authorities as the European Banking Union's (EBU) third pillar (European Commission, 2015b,c). Building upon the system of national deposit guarantee schemes (DGS), in November 2015 the European Commission proposed to create EDIS as a part of a series of measures that aim to deepen the EMU and complete the EBU. According to the proposal, this would reduce the vulnerability of national DGS to large local shocks, thereby supporting depositors' confidence. EDIS remains a controversial topic, with arguments both against as well as in favour of its introduction, and various proposals concerning its design (Bénassy-Quéré et al., 2018; Carmassi et al., 2020; Dombret and Kenadjian, 2020). Among other potential advantages, it has been argued that, by weakening the "doom loop" between banks and their home sovereign, EDIS will help to reassure depositors, increase the resilience of national banking systems against future crises, and reduce banking fragmentation in the euro area (European Commission, 2015b,c). On the other hand, the moral hazard that common funds could create, is often raised as a potential disadvantage (Schuknecht, 2016; Howath and Quaglia, 2016). Our analysis provides empirical findings relevant to this ongoing policy debate.

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[3] For evidence of sovereign bond markets' fragmentation, see Delatte et al., (2017) and Afonso et al. (2018), among others; for interbank money markets, see Mayordomo et al. (2015); for corporate bond markets, see Zaghini (2017) and De Santis (2018); for equity markets, see Bley (2009); and for retail banking borrowing and lending rates, see Arnold and van Ewijk (2014) and Rughoo and Sarantis (2014).

The remainder of the paper is structured as follows: Section 2 presents an overview of the information content of relative deposits and the related theoretical background. Section 3 and 4 respectively present our empirical methodology and data. Section 5 presents and discusses the empirical findings. Section 6 concludes.

2. Modelling relative deposits: Overview and stylised facts

It is important to explain why we analyse euro area countries private bank deposits relative to Germany. First, and in relation to the choice of Germany as the reference country of our analysis, this is in line with a vast literature that highlights Germany's central role in the euro area and its consequent perception as safe haven for investors. For example, the studies on the ESDC commonly employ the spread of the national bond yield vis-à-vis the German bund as a measure of market pressure and crisis intensity (see, among others, De Grauwe and Ji, 2013; Delatte et al., 2017; Afonso et al., 2018).

Second, and regarding the focus on relative deposits, the ratio of a euro area MS's bank deposits to German deposits conveys important information for the state of the MS's national banking system as a safe-investment destination. Specifically, the ratio reflects the perceived probability of bank default in the MS relative to Germany. To obtain this insight, assume a demand for assets approach (a bare-bone version of the simple theoretical model presented in Appendix B), where an MS-resident investor has two saving options. The first is a domestic bank account while the second is a German bank account. Crucially, both accounts are denominated in the same currency, the euro. Assume a frictionless (perfect capital mobility) investment environment, identical investors, and otherwise identical economies. All else being equal, if both banking systems are perceived as being equally safe, i.e., if both systems involve the same probability of wealth loss for the investor, one euro in a MS bank account would be equally valuable with one euro in a German bank account, irrespective of the investor's place of residence within the euro-area. In that case, investors would have no incentive to relocate deposits across the two banking systems.

Starting from this steady-state, assume now that investors perceive the MS banking system to be subject to a significant probability of banking failure causing wealth losses, whereas the German banking system is not subject to such risk. In that case, to protect their savings, depositors will withdraw deposits from the MS banking system. In a frictionless world, they will deposit their savings into the German banking system, leading to a decline in relative deposits. This is driven by a decline in the numerator (MS deposits) and an equal increase in the denominator (German deposits). In the presence of frictions restricting capital mobility, investors might instead hold cash too. In this case as well, the ratio of deposits will fall, albeit at a slower pace compared to the previous case, since the increase in the denominator will be smaller. Therefore, in this example the movements in the ratio of deposits can be interpreted as capturing the size of the perceived probability of wealth losses in the MS domestic banking system.

Let us now introduce a non-zero wealth loss probability for the German banking system as well. If the only savings instruments available to investors are the MS and German bank accounts, the movement in the ratio will depend on the relative size of perceived banking default risk. If the MS banking system is perceived to be riskier, investors will relocate deposits from the MS to Germany to minimise the risk to which they are exposed. In that case, the ratio will fall (driven by a decline in numerator and an equal increase in the denominator). If we consider the option of holding cash, investors in both MS and German bank accounts may also withdraw deposits to hold cash. But again, given the higher perceived default risk in the MS, the total capital flight from the MS banking sector (given by the sum of deposit relocation to Germany and increased cash holdings) will be higher than the substitution between German deposits and cash (recalling that we have assumed otherwise identical economies). Therefore, in this case too, the ratio of deposits will decline since the fall in the numerator will be more pronounced than the fall in the denominator. From the discussion above, it follows as all EMU banking accounts are denominated in euros, shifts in the ratio of the MS to German deposits capture divergences in the two banking systems' perceived safety. From that point of view the ratio can be interpreted as a proxy for the two banking systems' divergence/fragmentation, defined as differential probabilities of wealth losses.

Fig. 1 plots the index of private bank deposits across the sample euro area countries including Germany, while deposits relative to Germany are shown in Figure A1 in Appendix A. Two key stylized facts emerge. First, both in absolute and relative terms, the series display a general upward trend prior to the GFC. Second, during the crisis period in absolute terms the trend discontinues, or even reverses, in most periphery countries (Greece, Ireland, Portugal and Spain). For these countries we also observe a decline in relative deposits, which is strongly driven by the deposit outflows they experienced. Importantly, by the end of our sample period deposits in periphery countries, both in absolute and relative terms, remain lower than their pre-crisis peak. By contrast, in the remaining sample countries the pre-crisis increasing trend for absolute deposits is maintained after the crisis' onset, albeit in most cases at a slower pace. Relative deposits outside the periphery did not fall during the crisis, though in most cases they present a deceleration path. Overall, the prima facie evidence suggests that bank deposits relative to Germany are not exempt from the fragmentation dynamics observed in other parts of the euro area financial system; and although periphery countries have been affected most by the crisis, the latter has affected relative private bank deposits across the whole of the euro area.

The central question investigated by our paper is whether shifts in deposits relative to Germany are driven by macro/fiscal risk, as suggested by the literature reviewed in the introduction and in the simple theoretical model presented in Appendix B. According to this literature, during macro/fiscal crises depositors discipline the domestic banking market as a whole by withdrawing deposits and transferring them to safer banks abroad, or by keeping cash. From the point of view of financial stability, and to the extent the final outcome is capital flight from the domestic banking system, both kinds of withdrawals (increased cash holdings or flight to Germany) exert this kind of system-wide market discipline.

3. Econometric methodology

Our empirical analysis follows a two-stage modelling approach in line with Manasse and Zavalloni (2013) and Afonso et al. (2018). In the first stage we use a TVP panel specification to estimate the time-varying sensitivity (for the panel as a whole) of euro area deposits, relative to Germany, using a set of country-specific explanatory macro/fiscal explanatory variables. The explanatory variables for the first stage panel regressions are selected based on existing literature on the link between deposits and macro/fiscal risk, reviewed in the introduction (see Levy-Yeyati et al., 2010; Cubillas et al. 2012, 2017). These insights are captured by a simple theoretical model for the determination of relative deposits presented in Appendix B. In the second stage, the time-varying coefficients identified in the first step, representing the sensitivity of the relative deposits for the panel as a whole, are regressed on a set of variables that capture aggregate (euro area wide) macro/fiscal risk factors, as well as measures of the ECB's unconventional monetary policy. Our time-series analysis in the second stage also accounts for structural breaks.

3.1. First stage model

The first stage of our econometric analysis employs the TVP panel estimation approach of Li et al. (2011). In equation (1), y_{it} denotes the model's dependent variable, with $i = 1...N$ and $t = 1...T$.

$$y_{it} = x'_{it-1}\beta_t + \alpha_i + f_t + v_{it} \tag{1}$$

We define y_{it} to be the log-index of private deposits of country i relative to Germany. $x_{it} = [x_{it,1}, \cdots, x_{it,k}]'$ is a vector of k regressors and $\beta_t = [\beta_{t,1}, \cdots, \beta_{t,k}]'$ is a vector of k time-varying coefficients. Vector x_{it} includes country-specific fiscal and macro risk measures relative to Germany, as well as a proxy for relative wealth.[4] The use of lagged, as opposed to contemporaneous, values for the explanatory variables is motivated by the need to minimise endogeneity concerns. α_i captures time-invariant country fixed effects.[5] The trend function f_t captures time-specific effects that account for omitted variables having a common impact over time across the panel's cross-sections, with v_{it} being a random error term.[6]

The model of Li et al. (2011) involves the choice of an estimation method and two modelling parameters. As far as the former is concerned, they favor the local linear dummy variable method (LLDV) which, they show, outperforms the alternative averaged local linear method (ALLM). Specifically, compared to the ALLM which eliminates the fixed effects by taking cross-section averages, the LLDV removes the fixed effects through a smoothed version of cross-time average from each individual cross-section, improving the rate of convergence of $\hat{\beta}_t$. The LLDV involves the use of bandwidth parameter, h^*, to whose value the estimation results are typically sensitive: A higher (lower) bandwidth value reduces (increases) biases in the estimated TVP coefficients but increases (reduces) their variance. To optimize this trade-off, they propose a data-driven, cross-validation selection method selecting h^* by minimizing the mean squared error of the resulting estimates. For our benchmark specification this selection method yields $h^* = 0.15$ (see also Sun et al., 2009). An alternative method for choosing the value of h^* is a "rule-of-thumb" approach, which is computationally appealing but can lead to non-robust results in empirical applications, especially when the data present high volatility, as it the case with the time-series used in our analysis.

Furthermore, following Dai and Sperlich (2010), we apply a bandwidth correction procedure reducing the "boundary effect" bias observed at the beginning and end of the sample. We set the value of the bandwidth correction parameter value ε equal to 0.08, which satisfies the restriction $0 < \varepsilon < h^*$. Finally, for each estimated TVP coefficient we calculate a 90% confidence interval by applying the wild bootstrap method using the approach of McMurry and Politis (2008). This is based on the estimated residuals of the non-parametric estimated regression obtained by 1000 replications, estimated using the same $h^* = 0.15$ and $\varepsilon = 0.08$ values as in the source regression.

In sum, the modelling approach that we follow has two potential drawbacks: the trade-off between estimation bias in the TVP coefficients and their variance, related to the choice of the bandwidth parameter; and the "boundary effect" according to which the estimated coefficients are biased at the beginning and end of the estimation sample. As explained above, both issues are addressed in a manner consistent with the previous literature. Moreover, as we point out in the robustness checks (see Appendix A2), the TVP results are robust to the use of alternative values for the bandwidth and the bandwidth correction parameters. Beyond the potential drawbacks of the TVP panel model there are two alternative approaches for capturing changes in the sign and strength of the relationship between relative bank deposits and their macro/fiscal determinants.

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[4] The vector of regressors in equation (1) does not include aggregate euro area variables. Whether it is possible for aggregate risks to directly affect deposits in certain countries, is an interesting question. This can motivate further theoretical and empirical work on deposits' behaviour in a monetary union since the related literature on the link between macro/fiscal risks and deposits does not clearly suggest any potential channel through which such an effect may arise. We thank the Editor for raising our attention to this issue.

[5] The model allows the fixed effect terms α_i to be correlated with X_{it} and, for the purpose of identification, assumes that $\sum_{i=1}^{N} \alpha_j = 0$ (Su and Ullah, 2006).

[6] We analysed the stationarity of the data panel for each variable entering equation (1) described below using the methodology proposed by Bai and Carrion-i-Silvestre (2009). In all cases, the presence of a unit root can be rejected, although the inclusion of structural changes is necessary in several cases. The break points are mostly related to the start of the Great Recession and the end of the most intense phase of the European sovereign debt crisis. These results are not included to preserve space but are available upon request.

The alternatives include, first, panel data models accounting for structural breaks in their coefficients. The majority of such models, however, assume the absence of cross-sectional dependence (Boldea et al., 2016), an assumption that is not suitable to EMU financial markets, where unobservable common factors and/or spatial spillover effects are pervasive (see Arghyrou and Kontonikas, 2012; De Grauwe and Yi, 2013; Afonso et al., 2018).[7] Second, non-linear panel models, such as the panel smooth regression transition (PSRT) model by Gonzalez et al. (2017). Despite its advantages over other non-linear approaches, such as Hansen (1999), the PSRT model has its own drawbacks.[8]

The TVP model by Li et al. (2011) has several advantages over the alternative approaches. First, it allows the identification of multiple regimes. Second, it accounts for gradual transition among the regimes. Third, it allows the different regimes to be non-recurrent. Fourth, by not imposing any single transition variable it lets the data to determine freely (through observed changes in individual TVP coefficients) the driver(s) of transition between regimes. Fifth, additivity of the individual predicting variables is the only assumption regarding the functional form of the model. Sixth, the Li et al. (2011) TVP approach allows for cross-sectional dependence. Finally, it should be highlighted that the notions of non-linear threshold effects and TVP behavior are related. As Granger (2008, p.1) points out, "any non-linear model can be approximated by a time-varying parameter linear model".

3.2. Second stage model

In the second stage of our analysis we model each TVP coefficient obtained in the first stage on a vector of explanatory variables z_t as per equation (2) below:

$$\widehat{\beta}_t^j = \gamma + z'_{t-1}\delta + u_t \tag{2}$$

In equation (2), the dependent variable $\widehat{\beta}_t^j$ is the time-series estimated for the TVP coefficient of each of the spreads' determinants, with $j = (1...k)$, and u_t is a random error term. We estimate equation (2) using Ordinary Least Squares (OLS) and two definitions of z_t. The first case includes proxies for aggregate fiscal and macro risk. The second case adds measures of the ECB's unconventional monetary policy. We further add intercept dummies identified using the methodology developed by Bai and Perron (1998, 2003) to test for endogenous multiple structural breaks. More specifically, we allow up to five structural breaks in the intercept of equation (2), using Bai and Perron's sequential method (l vs. $l + 1$) of break detection, a standard 15% trimming parameter, and the 5% level of significance.

Essentially, the second stage of our modelling examines whether the sensitivity of relative deposits to each of the country-specific macro/fiscal risk factors, measured by the relevant estimated TVP coefficients, is related to euro area wide risk proxies and the ECB's stance. This analysis will uncover the potential drivers of shifts in the link between relative deposits and national macro/fiscal risk, stemming from developments at the aggregate (eurozone) level. For example, it can offer insights on what happens to the relationship between relative deposits and *national* macro/fiscal risk when we enter the crisis regime, which is characterized by high *aggregate* macro/fiscal risk. Moreover, it allows us to assess the impact of the ECB's unconventional policy interventions.

4. Data

4.1. First stage variables

Our monthly dataset covers eleven euro area countries (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal and Spain) over the period January 1999 – June 2017.[9] Private bank deposits, sourced from the ECB, are defined as outstanding amounts at the end of each month, expressed in millions of euros, covering maturities of all types and all currency denominations. They include deposits of euro area households, non-financial corporations and other entities, and exclude deposits of the central government and Monetary and Financial Institutions. To obtain the dependent variable for the first stage estimations, private deposits of euro area countries are transformed into a log-index relative to Germany (*dep*). The set of explanatory variables includes proxies for fiscal and macro risk, as well as wealth, relative to Germany.

Given the lack of monthly data for real GDP, we approximate economic conditions relative to Germany using the log-index of the Economic Sentiment Indicator (*esi*), available from the European Commission. The ESI is a weighted average of five sectoral indexes,

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whose scores are gathered from surveys stating agents' assessment of the current economic situation and their expectations about future developments. This survey-based index is the European Commission's flagship economic sentiment indicator. As such, it is closely monitored by economists and policymakers and provides a timely indicator of developments in the real economy (Dewachter et al., 2015; de Bondt and Forsells, 2017). The European Commission's survey results are released monthly (from the third week of the reference month), while the preliminary flash GDP estimate is released only 30 days after the end of the reference quarter. The use of ESI as a proxy for economic conditions is consistent with a growing body of literature which shows that expectations constitute a key driver of business cycles; see Beaudry and Portier (2014) for a review. At the same time, though, it should be acknowledged that survey-based economic sentiment may not always perfectly align with actual economic performance.

To measure fiscal risk, we use the 10-year government bond yield spread (*spread*) against the German bund, calculated using data from the ECB. We also use the year-to-year inflation rate relative to Germany (*inf*), calculated from the monthly Harmonised Index of Consumer Prices, available from the ECB. Finally, the log-index of house prices relative to Germany (*hp*), available from the OECD, is employed as a measure of relative wealth (Campbell and Cocco, 2007). The dependent and explanatory variables are plotted in Figures A1-A5 of Appendix A.

Following the variables' transformation to relative terms, the TVP panel model for relative deposits is estimated using ten euro area countries, i.e. the initial eleven minus Germany. To get some insight on the potential implications of heterogeneity within the euro area for our analysis, we also estimate the TVP model across two sub-panels of core (Austria, Belgium, Finland, France and the Netherlands) and periphery countries (Greece, Ireland, Italy, Portugal and Spain). The distinction of the countries across core and periphery is in line with a long and well-established literature in European economics. These studies include, for example, Arghyrou and Kontonikas (2012), Afonso et al. (2014, 2018), Paniagua et al. (2017). Delatte et al. (2017), among others, highlight the fact that the periphery countries have faced the most financial stress during the European crisis, including significant capital flight (Merler and Pisani-Ferry, 2012; Steiner et al., 2019; Cheung et al., 2020).

4.2. Second stage variables

For the second stage modelling of the estimated TVP coefficients, we employ proxies for aggregate (euro area wide) fiscal and macro risk as explanatory variables. These include the first principal component (*PC*1) of the spread, as well the first principal components of the economic sentiment index, inflation and house prices relative to Germany, respectively. The principal components are estimated using the full set of sample countries. Moreover, in line with Bekaert et al. (2009), they are orthogonalized in order to account for the non-trivial correlations observed among them.[10]

Measures of the ECB's unconventional monetary policy are also used in the second stage analysis. The first measure is the growth (logarithmic difference) in the euro value of securities held by the ECB for monetary policy purposes (Δ*shmp*), as reported in the ECB's weekly financial statements (Delatte et al., 2017; Afonso et al., 2018). To construct a monthly series for securities holdings, we use the relevant figure quoted in each month's last weekly consolidated financial statement of the Eurosystem, published by the ECB (assets side, item 7.1). The ECB's balance sheet expanded over time, reflecting the Securities Markets Programme (SMP) of 2010–11, in the context of which the ECB purchased sovereign bonds of euro area periphery countries, and more importantly the ECB's Quantitative Easing (QE) programme. The latter commenced in late 2014 and expanded significantly since the announcement of the Public Sector Purchase Programme (PSPP) in January 2015 (effective since March 2015).

The second measure of non-standard ECB policy involves the liquidity provided to cover the funding needs of the banking sector through Long Term Refinancing Operations (LTROs). The horizon of LTROs progressively increased since the GFC, initially to six months (first time in April 2008) and later to one and three years, involving operations of substantial size. As Nyborg (2017, p. 43) points out, "the impact was massive…Two three-year LTROs were held, one in December 2011 and one in February 2012, through which the ECB lent more than 1 trillion euros in aggregate to banks. This is almost as much as the consolidated Eurosystem balance sheet in 2006, the last full pre-crisis year". Given the full allotment policy (since October 2008), this implied that banks could receive virtually unlimited long-term funding from the ECB, subject to having sufficient collateral (Nyborg, 2017). We use the Bruegel dataset (https://www.bruegel.org/publications/datasets/eurosystem-liquidity/) to measure the total amount of LTROs. We further transform the LTRO variable into growth rate using log-difference (Δ*ltro*).

5. Empirical findings

5.1. First stage results

Fig. 2 presents estimates of the benchmark model given by equation (1) for the full panel of euro area countries over the sample period January 1999 – June 2017. The estimated TVP coefficients provide evidence of substantial time variation in the relationship between bank deposits relative to Germany and macro/fiscal risk factors. As a general feature, we observe an upward movement for all

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[10] For example, the correlation coefficient of the relative log-ESI's *PC*1 with that of the spread (relative inflation) is −0.81 (0.53). To obtain the orthogonalized version of the former, we regress it on the spread's *PC*1 and collect the residuals. We then calculate the orthogonalized version of the *PC*1 of relative inflation as the residuals of the equation that regresses this variable on the spread's *PC*1 and the orthogonalized *PC*1 of relative log-ESI. Finally, the regression used to extract the orthogonalized version of relative log-house prices' *PC*1 includes as explanatory variables the *PC*1 of the spread and the orthogonalized *PC*1s of relative log-ESI and inflation.
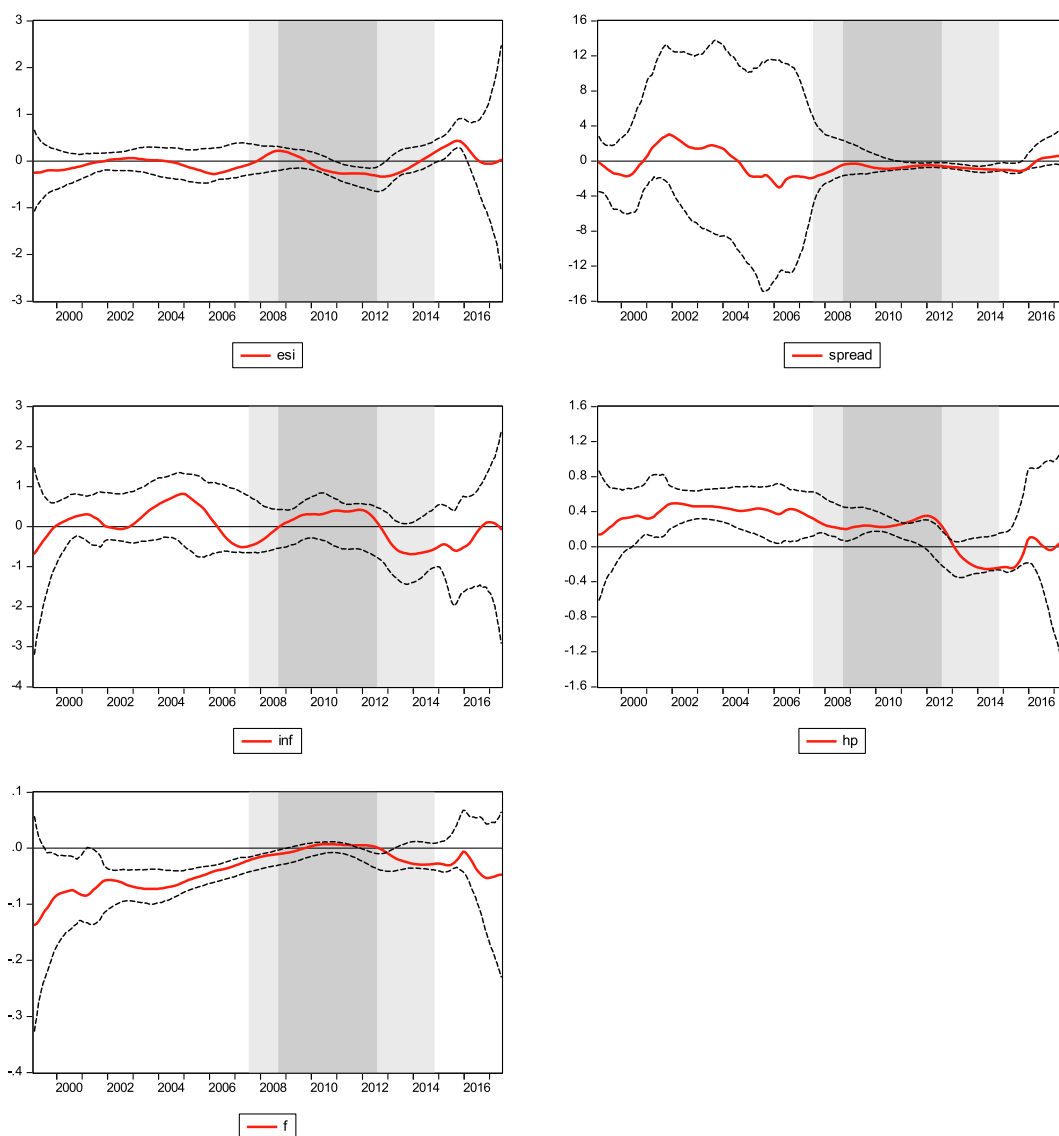
Fig. 2. Benchmark model – Full panel. Note: The figure presents the coefficients obtained from the estimation of the time varying parameters (TVP) model given by equation (1) for the full panel over the period January 1999 – June 2017; and the corresponding 90% confidence intervals (dotted lines) calculated using the wild bootstrap method (1000 iterations). The estimation bandwidth parameter (h) is set to 0.15 and the bandwidth correction parameter (ε) to 0.08. The panel includes Austria, Belgium, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal and Spain. The dependent variable is the log-index of private deposits relative to Germany. The set of explanatory variables includes the first lag of: the log-index of the Economic Sentiment Indicator (esi) series relative to Germany; the 10-year government bond yield spread (spread) against Germany; the year-to-year inflation rate, calculated using the Harmonised Index of Consumer Prices, relative to Germany (inf); and the log-index of house prices relative to Germany (hp). The model also includes a trend function (f) capturing time-specific effects accounting for omitted variables having a common, over time, impact across the panel's cross sections. The light-shaded area covers the period July 2007 – October 2014; the dark-shaded area covers the period September 2008 – July 2012.

coefficients at the start of the sample period, which however reverses after a few years. These reversals occur close to a sharp decline in relative economic sentiment in most euro area countries around 2002 (Figures A2 in Appendix A). Typically, before the onset of the GFC, the estimated confidence intervals include zero. This mirrors the findings of the vast empirical literature on EMU sovereign bond markets according to which before the GFC investors did not price macro/fiscal risk to a significant degree (Arghyrou and Kontonikas, 2012; Delatte et al., 2017; Afonso et al., 2018).

Only relative house prices are statistically significant prior to the GFC. Ceteris paribus, we expect a positive relationship between deposits and house prices. This reflects the idea that, in addition to income, bank deposits are a positive function of wealth (Bomberger, 1993), with house prices serving as proxy for wealth (Campbell and Cocco, 2007). Our pre-crisis evidence supports this conjecture. The average house price TVP coefficient during the pre-crisis period is around 0.4, implying that relative deposits increase by 0.4% in

response to a 1% rise in relative house prices. However, the link weakens significantly since 2007, the year that was marked by the onset of the GFC. The latter reached its climax in September 2008, when Lehman Brothers collapsed, and was followed by the European sovereign debt crisis that started in autumn 2009 in Greece. This was a period of heightened macro/fiscal risk, reflected in a marked fall in relative economic sentiment and a sharp rise in spreads (Figures A2 and A3 in Appendix A). The house price TVP coefficient records negative values between 2013 and 15, but it is statistically insignificant since 2011.

As far as the other explanatory variables are concerned, the TVP coefficient of economic sentiment declines substantially during the crisis. From a peak of 0.2 in summer 2008, which implies that a 1% increase in relative sentiment raises relative deposits by 0.2%, it drops to about −0.25 by summer 2011. The estimated confidence intervals show that the negative link between economic sentiment and deposits is statistically significant during 2011–2012. The same holds true for the effect of the spread, whose TVP coefficient becomes statistically significant with a negative sign in November 2010 and stays significant until September 2015. The TVP coefficient of inflation records two sharp declines, between 2004 and 2007 and 2011–2013, but remains statistically insignificant throughout the entire sample period.

The OMT announcement in late July 2012 is immediately followed by an increase in the TVP coefficient of relative economic sentiment. The effect of economic sentiment turns positive *and* significant in January 2015 (and for the remainder of that year). This reflects a positive relationship between deposits and agents' assessment of economic conditions outside crisis periods, in line with earlier models of the demand for deposits (Bomberger, 1993). The coefficients of the other explanatory variables record a partial recovery towards the end of the sample, a period of lower macro/fiscal risk relative to the crisis, but they are not statistically significant.

Overall, our findings support the view that the relationship between relative deposits and house prices, as well as economic sentiment and the spread, is not constant over time but may strengthen/weaken, or even switch sign. In agreement with the insights from the models of Clerc et al. (2015) and Balfoussia et al. (2019), and the simple theoretical model for relative deposits presented in Appendix B, the shift to a negative link tends to occur during periods of heightened macro/fiscal risk, as domestic savers substitute domestic bank deposits with foreign bank deposits ("flight to quality") and/or cash.,[11][12]

Fig. 3 presents the results from estimating the TVP model using the panel of core countries. We obtain evidence for positive and statistically significant house price TVP coefficient only in the early 2000 s. Prior to the crisis, the TVP coefficient of economic sentiment tends to rise and switches sign from significantly negative to positive, by early 2005. Around the start of the GFC, however, it starts to decline and becomes insignificant until the end of the sample. Unlike the full panel results, in the core countries there is evidence for a positive pre-crisis (2001–2005) relationship between relative deposits and relative inflation. The positive link can be rationalized considering arguments related to opportunity costs and real money balances. An increase in inflation raises the opportunity cost of holding cash, prompting savers to substitute cash holdings with bank deposits. At the same time, as inflation increases, deposits in nominal terms will increase to the extent that depositors want to hold a constant real amount in their bank accounts. Finally, contrary to the full panel findings, in the core countries there is no evidence for a statistically significant link between relative deposits and the spread.

Moving to the periphery panel results in Fig. 4, there is a significantly positive effect from relative house prices (since 2001) that persists for several years. Consistent with the full panel evidence, the house price TVP coefficient exhibits a major decline within 2011 and turns insignificant thereafter. Also, the effect of relative inflation is always insignificant. Moreover, the impact of relative economic sentiment is significantly positive only for a short period at the end of the sample. The TVP coefficient of the spread is insignificant prior to the GFC, except for a short period in the early 2000 s where it is significantly positive. A positive relationship between relative deposits and yield differentials in the absence of default risk is consistent with the theoretical framework outlined in Appendix B. During the GFC the spread's TVP coefficient declines, turning negative by 2009. In line with the full panel findings, there is statistically significant negative link between relative deposits and fiscal risk between 2011 and 2015.

All in all, it can be argued that the full panel evidence regarding time-variation in the link between relative deposits and their fundamental determinants mainly reflects the behavior exhibited by the periphery countries. Deposits in the latter group are generally more responsive to macro/fiscal risk factors, and their sensitivity displays significant shifts when such risks are elevated. The TVP coefficients in the core countries also tend to shift during turmoil periods but, overall, they exhibit considerably fewer instances of statistically significant responses. The prominence of periphery countries in affecting the results of the overall panel is particularly evident in the case the spread's TVP coefficient, which, unlike the core panel, turns significantly negative during the crisis. This evidence suggests that the coefficients' sign and size matter in economic terms as they support the view that during periods of heightened fiscal risk, captured by the significantly higher spread in periphery countries, depositors change their behavior penalizing fiscal risk more aggressively. Similar insights are obtained when comparing the TVP coefficient of relative house prices, which exhibits a stronger decline in periphery countries during the crisis. In addition, towards the end of the sample period, the time trend coefficients reveal distinctly different patterns across the core and periphery groups. All these differences support the notion of fragmentation in euro area

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[11] The theoretical model in Appendix B does not account for the role of house prices, as proxy for wealth. However, the same reasoning used to explain the crisis-related breakdown of the positive link between relative deposits and economic sentiment, can also be applied to the breakdown of the link with house prices.

[12] Evidence of deposits' "flight to quality" from distressed to non-distressed euro area countries during the ESDC is presented by the European Central Bank (2015, p. 33). The same ECB report also presents evidence according to which deposits in national EMU banking systems are overwhelmingly held by domestic depositors. Specifically, in January 2014, cross border EMU banking deposits accounted for only 3% of total non-MFI deposits in distressed countries and 7% in non-distressed countries (ECB 2015, p.33).
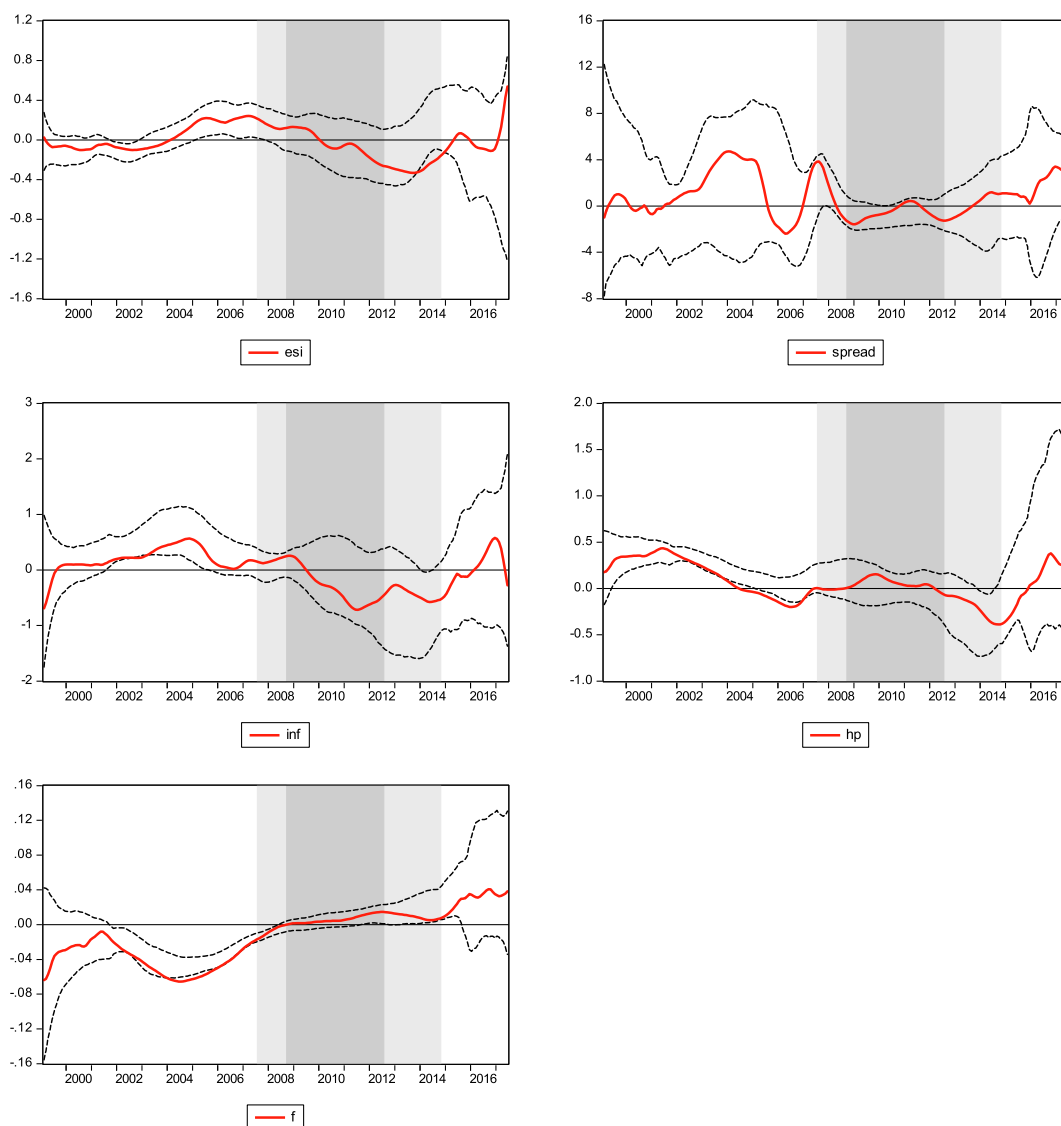
Fig. 3. Benchmark model – Core panel. Note: The figure presents the coefficients obtained from the estimation of the time varying parameters (TVP) model given by equation (1) for the panel of core countries over the period January 1999 - June 2017; and the corresponding 90% confidence intervals (dotted lines) calculated using the wild bootstrap method (1000 iterations). The estimation bandwidth parameter (h) is set to 0.15 and the bandwidth correction parameter (ε) to 0.08. The panel includes Austria, Belgium, Finland, France and the Netherlands Austria, Belgium, Finland, France and the Netherlands. The dependent variable is the log-index of private deposits relative to Germany. The set of explanatory variables includes the first lag of: the log-index of the Economic Sentiment Indicator (esi) series relative to Germany; the 10-year government bond yield spread (spread) against Germany; the year-to-year inflation rate, calculated using the Harmonised Index of Consumer Prices, relative to Germany (inf); and the log-index of house prices relative to Germany (hp). The model also includes a trend function (f) capturing time-specific effects accounting for omitted variables having a common, over time, impact across the panel's cross sections. The light-shaded area covers the period July 2007 – October 2014; the dark-shaded area covers the period September 2008 – July 2012.

bank deposits.

5.2. Second stage results

In this section we investigate whether time variation in the relationship between bank deposits and macro/fiscal risk is related to the aggregate (euro area wide) level of these risk factors, as well as the ECB's unconventional monetary policy. We also account for endogenously determined structural breaks. This analysis focuses on the case of the full panel that includes all sample countries, while results for the core and periphery groups are available upon request. We start by modelling the point estimates of the TVP coefficients obtained in the first stage panel analysis, capturing the sign and size of the response (for the panel as a whole) of relative deposits to
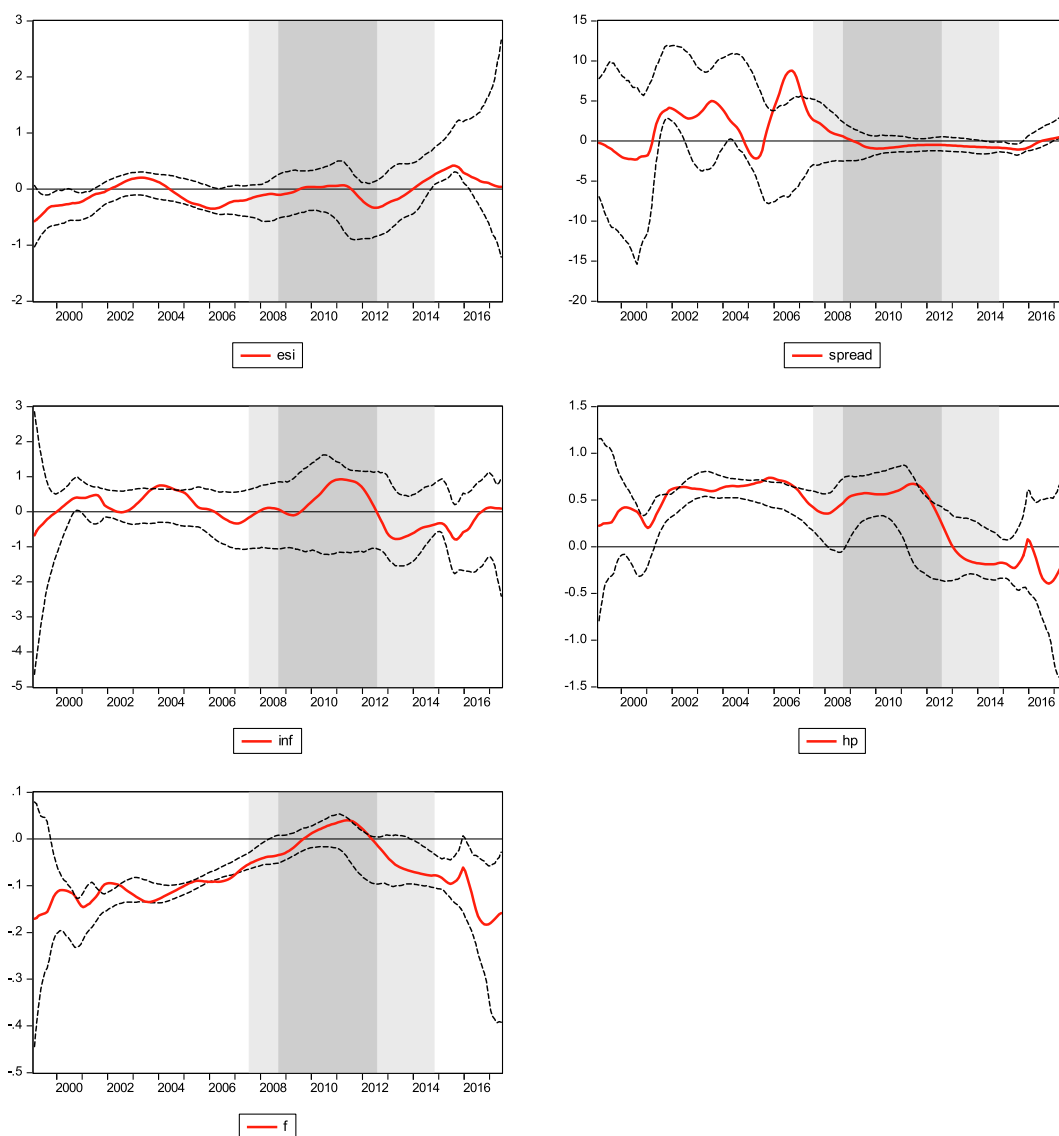
Fig. 4. Benchmark model – Periphery panel. Note: The figure presents the coefficients obtained from the estimation of the time varying parameters (TVP) model given by equation (1) for the panel of periphery countries over the period January 1999 - June 2017; and the corresponding 90% confidence intervals (dotted lines) calculated using the wild bootstrap method (1000 iterations). The estimation bandwidth parameter (h) is set to 0.15 and the bandwidth correction parameter (ε) to 0.08. The panel includes Greece, Ireland, Italy, Portugal and Spain. The dependent variable is the log-index of private deposits relative to Germany. The set of explanatory variables includes the first lag of: the log-index of the Economic Sentiment Indicator (esi) series relative to Germany; the 10-year government bond yield spread (spread) against Germany; the year-to-year inflation rate, calculated using the Harmonised Index of Consumer Prices, relative to Germany (inf); and the log-index of house prices relative to Germany (hp). The model also includes a trend function (f) capturing time-specific effects accounting for omitted variables having a common, over time, impact across the panel's cross sections. The light-shaded area covers the period July 2007 – October 2014; the dark-shaded area covers the period September 2008 – July 2012.

macro/fiscal variables, on the first lag of the orthogonalized first principal component ($PC1$) of the spread, economic sentiment, inflation and house prices relative to Germany.

OLS estimates of equation (2), with heteroskedasticity and autocorrelation consistent standard errors, corresponding to this parsimonious specification are shown in column 1 of Table 1. We then add the first lag of the growth in the securities held by the ECB for monetary policy purposes and the growth in LTROs (column 2 of Table 1). Finally, we add intercept dummies reflecting structural breaks that are identified by applying Bai and Perron's (1998, 2003) methodology on the model that includes the ECB variables (column 3 of Table 1). In all cases, moving to more extended specifications generate improvements in explanatory power, especially when the intercept dummies are added. For instance, the adjusted R^2 of the models for the TVP coefficient of economic sentiment (β_t^{esi}) rises from 11% in column 1 to 69% in column 3, while that of house prices (β_t^{hp}) increases from 71% to 89%.

Table 1

Modelling time-varying coefficients obtained from the benchmark model – Full panel.

	β_t^{esi}			β_t^{spread}			β_t^{inf}			β_t^{hp}		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Intercept	−0.057**	−0.065***	−0.112**	−0.412***	−0.429***	0.212	0.010	−0.014	0.480***	0.226***	0.221***	0.372***
	(0.025)	(0.024)	(0.054)	(0.146)	(0.148)	(0.511)	(0.050)	(0.052)	(0.099)	(0.016)	(0.016)	(0.017)
$PC1spread_{t-1}$	−0.016**	−0.017***	−0.041***	−0.019	−0.022	−0.182***	−0.008	−0.011	0.032	−0.028***	−0.029***	0.002
	(0.006)	(0.006)	(0.009)	(0.042)	(0.042)	(0.062)	(0.016)	(0.015)	(0.020)	(0.007)	(0.006)	(0.005)
$PC1^{orth}esi_{t-1}$	0.005	0.006	0.041***	0.373***	0.378***	0.431***	0.112***	0.113***	−0.006	0.079***	0.078***	0.033***
	(0.014)	(0.014)	(0.011)	(0.070)	(0.071)	(0.089)	(0.033)	(0.033)	(0.030)	(0.011)	(0.010)	(0.007)
$PC1^{orth}inf_{t-1}$	−0.025**	−0.023**	−0.006	0.231***	0.235***	0.029	0.056**	0.063**	−0.009	0.051***	0.053***	0.017***
	(0.010)	(0.010)	(0.012)	(0.073)	(0.074)	(0.095)	(0.026)	(0.026)	(0.024)	(0.008)	(0.007)	(0.005)
$PC1^{orth}hp_{t-1}$	−0.005	−0.007	0.030***	−0.157**	−0.159**	0.138	0.040**	0.036*	0.136***	0.031***	0.030***	0.019***
	(0.011)	(0.011)	(0.009)	(0.072)	(0.073)	(0.094)	(0.019)	(0.018)	(0.019)	(0.007)	(0.007)	(0.004)
$\Delta shmp_{t-1}$		0.252	0.014		0.713**	0.770**		0.622***	0.481***		0.043	0.113*
		(0.201)	(0.098)		(0.332)	(0.365)		(0.124)	(0.171)		(0.103)	(0.068)
$\Delta ltro_{t-1}$		0.054	0.143		−0.261	0.214		0.396	0.752***		0.249**	0.132**
		(0.139)	(0.089)		(0.779)	(0.562)		(0.276)	(0.205)		(0.107)	(0.062)
Intercept dummies			Yes			Yes			Yes			Yes
Adj.-R^2	0.11	0.12	0.69	0.38	0.39	0.64	0.28	0.31	0.67	0.71	0.72	0.89

Note: This table presents OLS estimates with heteroscedasticity and autocorrelation consistent standard errors (in parentheses) of equation (2) over the period February 1999 – June 2017. The dependent variable is, respectively, the time-varying panel coefficient (β_t) of equation (1) associated with the log-index of the Economic Sentiment Indicator (*esi*) series relative to Germany; the 10-year government bond yield spread (*spread*) against Germany; the year-to-year inflation rate, calculated using the Harmonised Index of Consumer Prices, relative to Germany (*inf*); and the log-index of house prices relative to Germany (*hp*). The set of explanatory variables includes the first lag of the: first principal component of *spread* ($PC1spread_{t-1}$); the orthogonalized first principal component of *esi* ($PC1^{orth}esi_{t-1}$); the orthogonalized first principal component of *inf* ($PC1^{orth}inf_{t-1}$); and the orthogonalized first principal component of *hp* ($PC1^{orth}hp_{t-1}$); the first difference of the logarithm of securities held for monetary policy purposes by the ECB ($\Delta shmp_{t-1}$); the first difference of the logarithm of long-term refinancing operations by the ECB ($\Delta ltro_{t-1}$); a set of intercept dummy variables reflecting break dates identified by the Bai and Perron (BP) test in the models of column (2). Up to five structural breaks are allowed in the intercept, using the BP sequential method (*l* vs. *l* + 1) of break detection and a 15% trimming parameter. The full panel includes Austria, Belgium, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal and Spain. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

The break dates from Bai and Perron's test, shown in Table A1 in Appendix A, range over time across the different cases. The earliest breaks occur in the second semester of 2004, well before the onset of the financial crisis, and are related to the TVP coefficients of economic sentiment and the spread (β_t^{spr}), respectively. All TVP coefficients, apart from that of inflation (β_t^{inf}), exhibit a break around the start of the financial crisis in 2007. The latest break, reflecting an upward shift in the coefficient of economic sentiment, occurs in late 2013. In general, the endogenously determined structural breaks do not overlap with the announcement of the OMT in summer 2012. Moreover, there are no breaks in 2014, the year when the first pillar of the EBU (Single Supervisory Mechanism; 4/11/2014) was introduced. These findings are robust to the use of an alternative trimming parameter (10%) for the Bai and Perron test.

Focusing on the most extended models in column 3 that display the highest adjusted R^2, the key findings can be summarised as follows: First, consistent with our expectations and the patterns identified in Section 5.1, an increase in aggregate fiscal risk (higher $PC1$ of spread) is associated with a fall in β_t^{esi}. This effect is statistically significant at the 1% level. Second, the impact of aggregate macroeconomic risk is also in line with theoretical arguments and our previous analysis. The positive sign of the economic sentiment's $PC1$ coefficient in the models for β_t^{spr} and β_t^{hp} (significant at the 1% level) implies that a decrease in the former variable, reflecting higher aggregate macro risk, is associated with lower β_t^{spr} and β_t^{hp}. In a similar fashion, a decline in the $PC1$ of house prices, as observed in the context of the crisis (see Figure A5 in Appendix A), is associated with lower β_t^{esi} and β_t^{inf}. In most cases, the $PC1$ of inflation has limited explanatory power, suggesting that developments in inflation do not play a significant role once structural breaks are considered. Third, moving away from the "cross-effects" (reaction of β_t^i to $PC1_{t-1}^j$) to the "own-effects" (reaction of β_t^i to $PC1_{t-1}^i$) the results imply that the link between relative deposits and fiscal (macro) risk also depends on the level of aggregate fiscal (macro) risk. Apart from the "own-effect" of inflation, which is statistically insignificant, in all other cases of column 3 these effects are significant at the 1% level.

Fourth, the evidence highlights the importance of unconventional monetary policy actions, since the growth of the ECB's security holdings and LTROs is statistically significant in many instances. The positive and significant effect of $\Delta shmp_{t-1}$ in the models for β_t^{spr}, β_t^{inf} and β_t^{hp} indicates that these TVP coefficients increase in response to expansionary unconventional monetary policy. The same holds true for the effect of $\Delta ltro_{t-1}$ in the models for β_t^{inf} and β_t^{hp}. These results suggest that the ECB's unconventional monetary policy moderated the effect of the crisis on the relationship between relative deposits and macro/fiscal risks. These findings are consistent with the previous studies on the ESDC which show that the ECB's interventions attenuated the "doom-loop" between banks and sovereigns and allowed the euro area to exit the crisis regime of high default risk (Delatte et al., 2017; Afonso et al., 2018; Acharya et al., 2019).

In sum, the TVP coefficients' modelling reveals that the relationship between deposits and macro/fiscal risk is affected by developments in aggregate macro/fiscal risk. As the latter increases, indicating higher default risk for banks and governments, the relationship enters the crisis regime. This regime is characterised by the negative elasticity of deposits to economic sentiment and the spread. Thus, falling economic sentiment and rising spreads generate two opposing tendencies on deposits during the crisis: to increase, in line with precautionary saving; and to decrease, in response to higher default risk.[13] The final outcome depends on the interaction of these forces.

Our findings imply that, with the likely exception of Italy, the default risk channel is more prevalent in the periphery group, since deposits decline during the crisis both in absolute and relative to Germany terms (see Figs. 1 and A1 in Appendix A). We should acknowledge that the aforementioned development may also reflect redenomination risk, which is highly correlated with default risk at the peak of the crisis. The theoretical and empirical work linking redenomination risk with euro area bond yield spreads has been extensively discussed in the literature, among others by Arghyrou and Tsoukalas (2011), Arghyrou and Kontonikas (2012), Krishnamurthy et al. (2018) and De Santis (2019). As Afonso et al. (2018) argue, concerns about a possible break-up of the euro area became widespread by late spring/early summer 2012. They use, among other analyses, the Sentix euro breakup index (proportion of investors predicting at least one country leaving the euro area within the next twelve months; available at https://www.sentix.de/) to demonstrate this point. Consistently with this view, ECB officials have publicly stated that one of the targets of the unconventional policy interventions was to reduce redenomination risk, a prime example being President Draghi's "whatever it takes to preserve the euro" speech on 26 July 2012.

We would also like to point out that another type of exchange risk that may be relevant for our analysis is related to the exchange rate between the euro and other currencies. This type of risk stems from the fact that euro-area residents may hold deposits in non-euro currencies. The ECB data used in our analysis includes deposits held by euro-area residents in all currencies and doesn't allow us to decompose them into those in euros and those in other currencies. Anecdotal evidence suggests that such "foreign currency" deposit accounts are not among the usual types of bank accounts held by euro area households and non-financial corporations. Given the likely dominance of euros within the deposit accounts of euro area residents, we think that the second type of exchange rate effects do not pose a significant challenge to our analysis. In relation to this, the role of exchange rate movements of the euro versus other international currencies is implicitly captured by the spread variable.

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[13] Under the precautionary saving theory, households and firms build up liquidity buffers to protect themselves against adverse shocks. It is well established that exposure to crises strengthens the motives for precautionary saving (Mody et al., 2012; Garcia-Appendini and Montoriol-Garriga, 2013; Malmendier and Shen, 2020).

6. Robustness checks and additional findings

This section presents results from several robustness checks regarding the empirical findings reported in Section 5.1. Moreover, we present additional findings from estimating the panel TVP model using relative households' and non-financial corporations (NFCs) deposits, respectively, as the dependent variable.

6.1. Robustness checks

The first group of robustness checks changes the panel's composition. More specifically, we exclude Greece from the analysis, on the grounds that it presents unique characteristics relative to the rest of the sample countries, and move Italy from the periphery to the core panel. We also remove one sample country at a time from the full panel and re-estimate the TVP model to assess the impact of individual countries on the results. The second group of tests considers the sensitivity of the baseline findings to the TVP panel estimation parameters. The third group of tests involves the use of an alternative measure of fiscal risk (expected debt differential against Germany). The results from these estimations are presented and discussed in Appendix A, their main feature being that they do not change materially the findings of the baseline models presented above.

6.2. Households and non-financial corporations' deposits

In this section we use in turn households and non-financial corporations' relative deposits as the dependent variable, while keeping the same set of explanatory variables. Data on these two types of deposits is available from the ECB since January 2003. Households' deposits are commonly the most significant component of total deposits. On average, their ratio is equal to 60% across the sample euro area countries, ranging from 44% in Ireland and the Netherlands to 80% in Greece. Deposits from non-financial corporations are also important, with an 18% average share in total deposits, ranging from 13% in Germany to 26% in the Netherlands. Households and non-financial corporations' deposits tend to comove over time, exhibiting an average correlation coefficient of 0.8 across the sample countries.

The TVP coefficients for the cases of households and non-financial corporations are shown in Figs. 5 and 6, respectively. In order to compare them with those from the benchmark model for total deposits, we re-estimate the latter over the period January 2003 – June 2017. Three main findings arise from this analysis. First, in line with the results for total deposits, there is significant time variation in the reaction of households and non-financial corporations' deposits to macro/fiscal risk factors. Second, patterns in the TVP coefficients of total deposits and their two key constituents broadly match, especially in the case of households. Having said that, despite these broad similarities, the results also highlight some important differences. In particular, the TVP coefficients of non-financial corporations are generally more volatile compared to households. The detailed results presented in the Appendix (Figures A13, A14 and A15) indicate an overall stronger sensitivity of non-financial corporations TVP coefficients to macro/fiscal risk, especially during the crisis period.

Specifically, the spread's TVP coefficient in the case of non-financial corporations turns significantly negative in 2010 and remains statistically significant for several years thereafter. In addition, it exhibits a larger magnitude relative to its households' counterpart; the latter being negative and significant only between 2013 and 2015. Along the same lines, the sensitivity of relative deposits to house prices during the crisis is significantly more pronounced for non-financial corporations. On the other hand, the response to relative inflation and economic sentiment does not significantly differ between the two groups. Thus, our results support the view that non-financial corporations, react more aggressively to shifts in macro/fiscal risk. This behaviour could reflect the smaller level of effective protection enjoyed by non-financial corporations in the context of deposit insurance.[14]

7. Conclusions

The aim of this paper is to shed more light on the link between deposits and macro/fiscal risk using data from ten euro area countries over the period January 1999 to June 2017. We examine whether this link is stable over time and also consider potential sources of time-variation. To do so, we adopt a two-stage empirical strategy. The first stage relies on a TVP panel methodology to estimate the sensitivity of deposits, relative to Germany, to a set of country-specific measures of relative macro/fiscal risk. The second stage uses time series analysis to investigate whether the time-varying sensitivity of deposits to euro area wide macro/fiscal risk is related to the aggregate level of these risk factors, as well as measures of the ECB's unconventional monetary policy, while controlling for the effect of structural breaks.

Our main findings can be summarised as follows. First, the relationship between euro area relative deposits and macro/fiscal risk factors is not stable over time. Second, the significant time variation that characterizes this relationship is linked to aggregate risk conditions. Major changes in the TVP coefficients typically occur during periods of heightened macro/fiscal risk, as domestic savers substitute domestic bank deposits with foreign bank deposits and/or cash. This evidence is consistent with the insights from theoretical models that highlight the "doom loop" between banks and sovereigns. Third, deposits in euro area periphery countries are generally more responsive to macro/fiscal risk. Fourth, our results suggest that the ECB's unconventional monetary policy moderated the effect

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[14] Households are typically protected to a much larger extent than firms, since deposit insurance is limited, and household deposits rarely exceed the limit while firm deposits largely do.
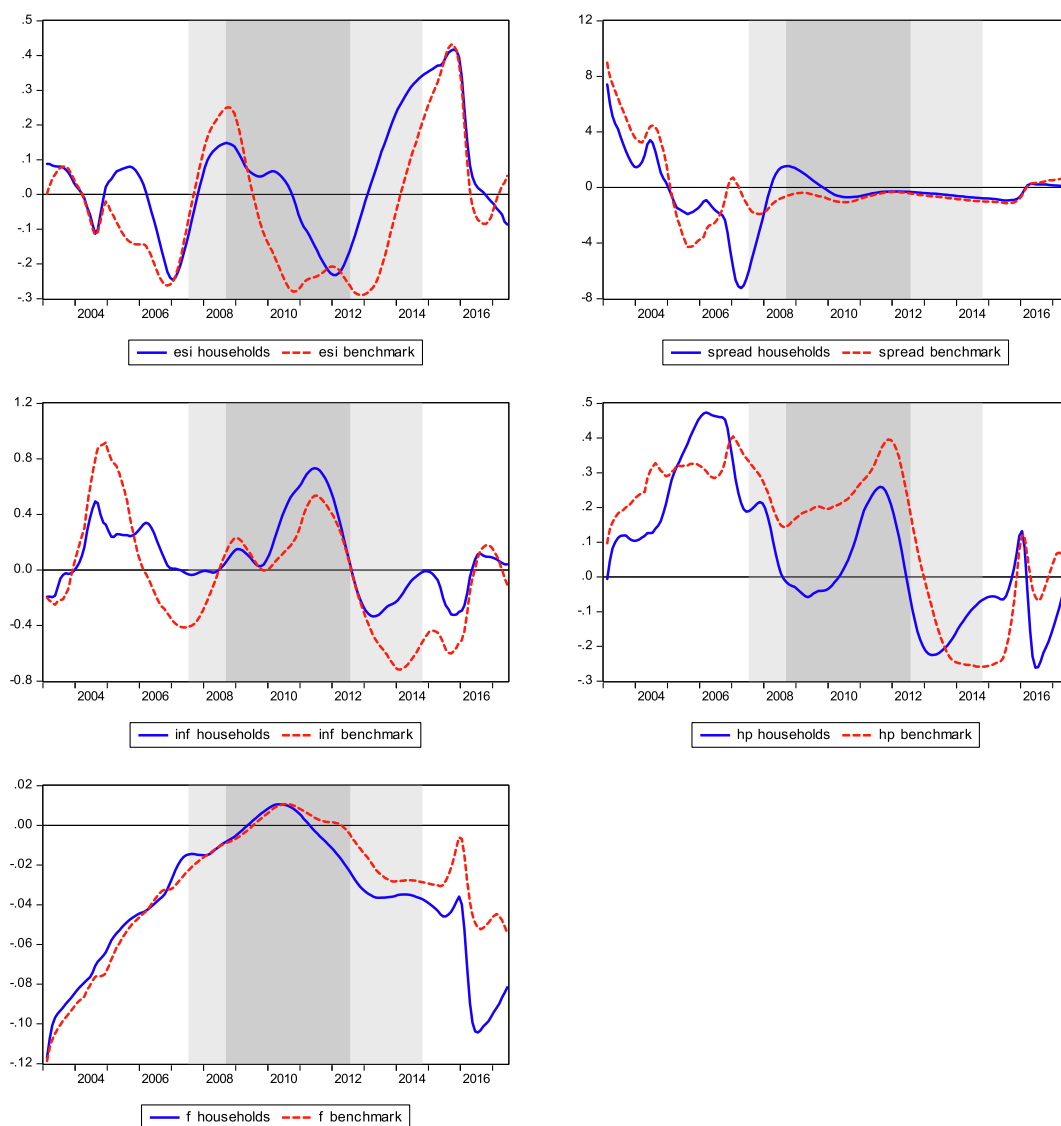
Fig. 5. Households versus benchmark model – Full panel. Note: The figure presents the coefficients obtained from the estimation of the time varying parameters (TVP) model given by equation (1) for the full panel with the dependent variable being the log-index of households' private deposits relative to Germany over the period January 2003 – June 2017 (solid lines) against the TVP coefficients obtained from the benchmark model for the log-index of private relative deposits estimated over the same period (dotted lines). The estimation bandwidth parameter (h) is set to 0.15 and the bandwidth correction parameter (ε) to 0.08. The panel includes Austria, Belgium, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal and Spain. The set of explanatory variables includes the first lag of: the log-index of the Economic Sentiment Indicator (esi) series relative to Germany; the 10-year government bond yield spread (spread) against Germany; the year-to-year inflation rate, calculated using the Harmonised Index of Consumer Prices, relative to Germany (inf); and the log-index of house prices relative to Germany (hp). The model also includes a trend function (f) capturing time-specific effects accounting for omitted variables having a common, over time, impact across the panel's cross sections. The light-shaded area covers the period July 2007 – October 2014; the dark-shaded area covers the period September 2008 – July 2012.

of the crisis on the relationship between relative deposits and macro/fiscal risks. Our findings imply that during crisis periods euro area national banking systems are potentially subject to stability risks, as per the classic Diamond and Dybvig (1983) model predicting self-fulfilling banking crises not justified (at least fully) by idiosyncratic bank fundamentals. These risks, our findings indicate, have been significantly moderated by the ECB monetary policy.
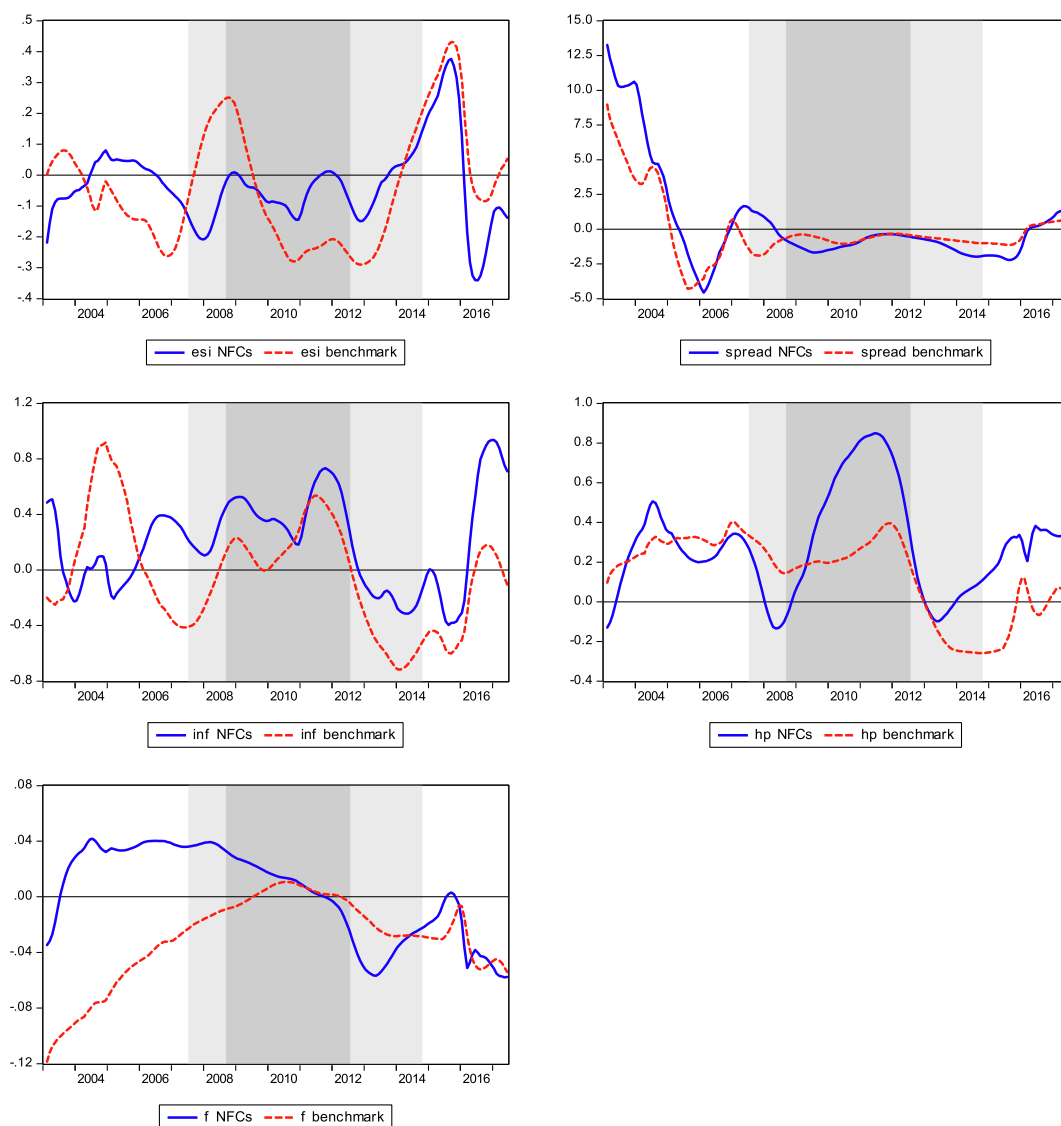
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Fig. 6. Non-financial corporations versus benchmark model – Full panel. Note: The figure presents the coefficients obtained from the estimation of the time varying parameters (TVP) model given by equation (1) for the full panel with the dependent variable being the log-index of non-financial corporations' private deposits relative to Germany over the period January 2003 – June 2017 (solid lines) against the TVP coefficients obtained from the benchmark model for the log-index of private relative deposits estimated over the same period (dotted lines). The estimation bandwidth parameter (h) is set to 0.15 and the bandwidth correction parameter (ε) to 0.08. The panel includes Austria, Belgium, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal and Spain. The set of explanatory variables includes the first lag of: the log-index of the Economic Sentiment Indicator (esi) series relative to Germany; the 10-year government bond yield spread (spread) against Germany; the year-to-year inflation rate, calculated using the Harmonised Index of Consumer Prices, relative to Germany (inf); and the log-index of house prices relative to Germany (hp). The model also includes a trend function (f) capturing time-specific effects accounting for omitted variables having a common, over time, impact across the panel's cross sections. The light-shaded area covers the period July 2007 – October 2014; the dark-shaded area covers the period September 2008 – July 2012.

Disclaimer.

The views expressed in this paper are those of the authors and do not necessarily reflect those of the Ministry of Finance of the Hellenic Republic.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jimonfin.2023.102992.

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