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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.

JEL classification: F30; F36; F45; G11; G15

Keywords: Private bank deposits, macro/fiscal risk, euro area, TVP panel

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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 1990s 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% to 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 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 Figure 1 and Section 2 below).

[1] The proportion of bank deposits in household savings takes even larger values in periphery countries (Valiante 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).

In this paper we analyse the link between private bank deposits, relative to Germany, and macro/fiscal risk in the EMU. As we explain in Section 2 below, the ratio of deposits between an EMU member state and Germany conveys important information regarding the probability of wealth losses across the eurozone's national banking systems. 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 global financial and European debt crises 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 and 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. In the case of the euro area, both effects have been observed in recent years.[2] Our paper contributes to this strand of the literature by providing evidence corroborating the hypothesis stated above: We find that national fiscal/macro risk is indeed an important determinant of

[2] In addition to the cross-border deposits substitution found 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.

relative bank deposits in the euro area, with the link between relative deposits and macro/fiscal risks becoming stronger as macro/fiscal risks increase in size.

This finding 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] 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). The majority of 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. Specifically, our study provides evidence that the stabilisation effect 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.

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

[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 Mayordromo et al. (2015); for corporate bond markets, see Zaghini (2016, 2017) and De Santis (2018); for equity markets, see Bley (2009); and for retail banking borrowing and lending rates, see Arnold and Ewjik (2014) and Rughoo and Sarantis (2014).

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 member state's (MS) 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.

Figure 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 section 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 section (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.

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 $i = 1 \ldots N$ and $t = 1 \ldots T$.

$$y_{it} = x'_{it-1}\beta_t + \alpha_\iota + f_t + v_{it} \quad (1)$$

We define y_{it} to be the log-index of private deposits of country i relative to Germany. $x_{it} = [x_{it,1}, \ldots, x_{it,k}]'$ is a vector of k regressors and $\beta_t = [\beta_{t,1}, \ldots, \beta_{t,k}]'$ 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 $\widehat{\beta_t}$. 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 on this trade-off, they propose a data-driven, cross-validation selection method selecting h* by minimizing the mean squared error of the resulting estimates.[7] For our benchmark specification this selection method yields h* = 0.15. Furthermore, following Dai and Sperlich (2010), we apply a bandwidth correction procedure reducing the "boundary effect" bias observed at the

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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 (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.

[7] 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.

beginning and end of the sample. We set the value of the bandwidth correction parameter value $\varepsilon = 0.08$, 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 by1000 replications, estimated using the same $h^* = 0.15$ and $\varepsilon = 0.08$ values as in the source regression.

Compared to the TVP model given by equation (1), 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: 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).[8]

Second, non-linear panel models, such as the panel smooth regression transition (PSRT) model by González et al. (2017). Despite its advantages over other non-linear approaches, such as Hansen (1999), the PSRT model has its own drawbacks.[9] The TVP model by Li et al. (2011) addresses these drawbacks. First, it allows the identification of multiple regimes. Second, it accounts for gradual transition among the regimes, allowing the different regimes to be non-recurrent. Third, 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

[8] Baltagi et al. (2016) develop a panel estimation model accounting for multiple structural breaks and cross-sectional dependence. This model, however, captures regime changes that are more likely to occur over a longer time span. This assumption is not applicable in capturing regime shifts taking place in quick succession within a relatively short period of time characterized by high data volatility. As such, they are not well suited for capturing regime shifts occurring in European financial markets occurring during the period of the GFC and the ESDC, as documented by Delatte et al. (2017), among others, for the euro area sovereign bond markets.

[9] For a comparison of the threshold panel model by Hansen (1999) with the PSRT model, see footnote 9 in Afonso et al. (2018).

between regimes. Fourth, it accounts 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".

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:

$$\widehat{\beta_t^j} = \gamma + z'_{t-1}\delta \ + u_t \qquad (2)$$

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 $j = (1\ldots k)$, 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.

4. Data

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. 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. To measure fiscal risk, we use the 10-year government bond yield spread (*spread*) against the German bund, calculated using data from the ECB. 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, 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; 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.

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). Distinguishing these two groups is common in the literature (see, among others, Afonso et al., 2014 and Paniagua et al.,2016). 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 ($\Delta shmp$), 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).

[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.

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 LTRO dataset[11] to measure the total amount of LTROs and further transform the variable into growth rate using log-difference ($\Delta ltro$).

5. Empirical findings

5.1 TVP panel estimates of the determinants of euro area relative bank deposits

Figure 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 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 (Figure 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).

[11] Available at: https://www.bruegel.org/publications/datasets/eurosystem-liquidity/

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 2013-15, 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 2004-2007 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.[12, 13]

Figure 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 2000s. 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,

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[12] 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.

[13] 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).

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 Figure 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 2000s 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 2011-2015.

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 bank deposits.

5.2 Robustness checks and additional findings

We test the robustness of the empirical findings reported in section 5.1 in numerous ways. 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. 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. Finally, we estimate the model using relative households' and non-financial corporations (NFCs) deposits, respectively, as the dependent variable. The results from this analysis are presented and discussed in the following section.

5.2.1. 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 Figures 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 A12, A13 and A14) 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 2013-2015. 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]

5.3 Modelling the TVP coefficients

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 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

[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. We would like to thank two anonymous Referees for pointing this issue.

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%. 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 (euro area wide) 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 during the crisis: to increase deposits, in line with precautionary saving; and to decrease deposits, in response to higher default risk.[15] The final outcome on deposits is likely to be determined by the interaction of these forces.

[15] 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).

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 Figures 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 http://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.[16]

6. 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 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

[16] We thank an anonymous Referee for raising this point.

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.

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 third pillar of the EBU (European Commission, 2015b,c). 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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APPENDIX

Appendix A: Data, additional results and robustness checks

A1. Changing panel's composition

We change the composition of the panel in two ways: first, by excluding Greece from the analysis, since it presents unique characteristics relative to the rest of the sample countries; and second by moving Italy from the periphery to the core panel. Unlike all other sample countries, which joined the euro in 1999, Greece accessed the EMU in 2001. Also, Greece is the only country where capital controls have been in place since July 2015 and up to the end of our sample. Finally, Greece is the country that has been mostly hit by the crisis in all respects (size of deposits' reduction, spread increases and output reduction), a factor rendering it a likely outlier among the rest of the sample countries. Regarding Italy, a visual inspection of Figure 1, as well as Figure A1 in Appendix A, suggests that the movements of Italian bank deposits are closer to those of core countries.

Figure A6 in Appendix A reports the results for the full panel excluding Greece, while Figure A7 in Appendix A shows the results for the periphery panel minus Greece. The results of the estimations referring to the revised core and periphery groups for the case of Italy are reported in Figures A8 and A9, respectively, in Appendix A. To facilitate comparison, we only report the TVP coefficients of the models with the revised panel specification against those of the benchmark model. The full set of results, including the estimated confidence intervals, is available upon request. Overall, the main empirical findings are robust to the two checks regarding the panel's specification.

A2. Changing model's estimation parameters

We estimate equation (1) using alternative bandwidth estimation parameter values. Specifically, we set h = 0.10, 0.20 to examine the robustness of our findings relative to the benchmark value of 0.15. By construction, lower (higher) bandwidth parameter values involve higher (lower) TVP variability, which explains occasional deviations regarding the coefficients' size and turning points obtained using alternative h values. Also, we estimate equation (1) using alternative bandwidth correction parameter values, keeping the optimal bandwidth parameter ($h^* = 0.15$) constant. We consider $\varepsilon = 0.05, 0.10$ against the benchmark value of $\varepsilon = 0.08$. In all cases, the results (available upon request) are very close to those obtained by the benchmark model, indicating the baseline findings are robust to the specification of the model's estimation parameters.

A3. Alternative measure of fiscal risk

We replace the spread with a measure of fiscal risk derived from the countries' fiscal accounts, that is, the expected debt differential against Germany. We use the one-year ahead expected general government gross debt-to-GDP ratio relative to Germany (*ed*), provided by the European Commission's Economic Forecasts. The use of expected, as opposed to historical fiscal data, is in line with previous studies of the ESDC (Arghyrou and Kontonikas, 2012; Afonso et al., 2018).[1] Theoretically, fiscal conditions are related to credit quality, with fiscal deterioration (increased values for *ed*) resulting in higher spread levels. The results in Figure A10 in Appendix A show that the TVP coefficient of the alternative measure of fiscal risk displays broadly similar behaviour with that of the benchmark full panel model. The findings for the other variables also remain consistent with the baseline estimates. The estimated confidence intervals are shown in Figure A11 in Appendix A.

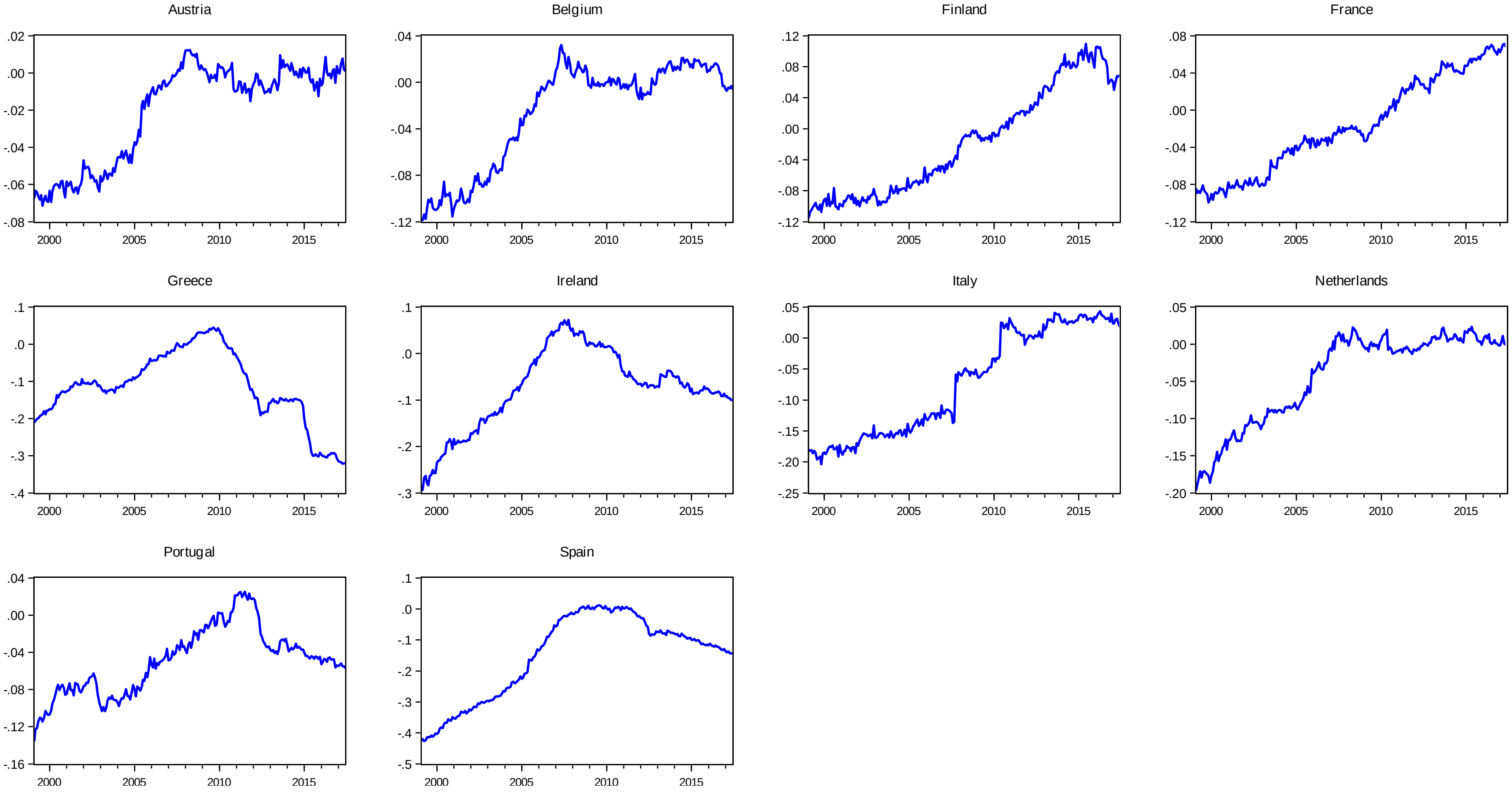
[1] As Arghyrou and Kontonikas (2012) point out, given the prominent role of the European Commission's forecasts, investors use them as a source of information to form their expectations. These forecasts used to be released at a bi-annual basis (spring and autumn); later, a third release (winter) was added. To transform this dataset into monthly frequency, we keep the expected debt-to-GDP observations constant (equal to the last forecast) for the months between a projection announcement and its subsequent revisions, when new information becomes available. This is consistent with the idea that before a new projection arrives, investors can only use the latest available projection.

Table A1: Break dates from Bai and Perron structural break test – Full panel

β_t^{esi}	β_t^{spr}	β_t^{inf}	β_t^{hp}
2013M12	2010M08	2009M02	2012M11
2007M11	2007M06	2006M02	2007M10
2004M08	2004M09		

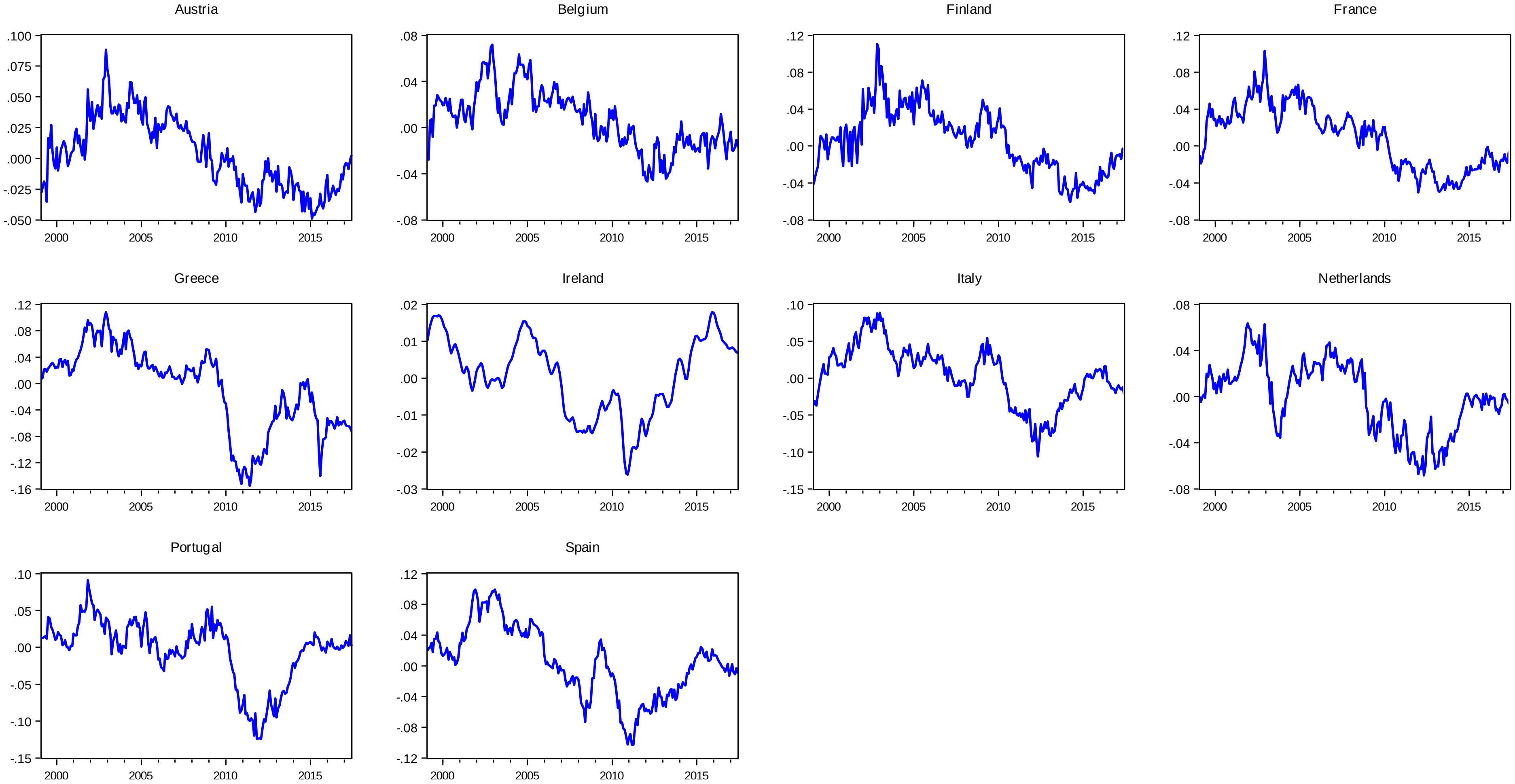
Note: This table presents the break dates from the Bai and Perron (BP) test applied to equation (2) over the period February 1999 – June 2017. The model tested for breaks includes as dependent variable, respectively, the time-varying panel coefficient (β_t) of equation (1) associated with the log-index 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* ($PCspread_{t-1}$); the orthogonalized first principal component of *esi* ($PCesi_{t-1}$); the orthogonalized first principal component of *inf* ($PCinf_{t-1}$); and the orthogonalized first principal component of *hp* ($PChp_{t-1}$); 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 ($\Delta ltro_{t-1}$). The full panel includes Austria, Belgium, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal and Spain. Up to five structural breaks are allowed in the intercept, using the BP sequential method (*l* vs. *l*+1) of break detection, a 15% trimming parameter, and the 5% level of significance.

Figure A1: Private bank deposits relative to Germany in euro area countries



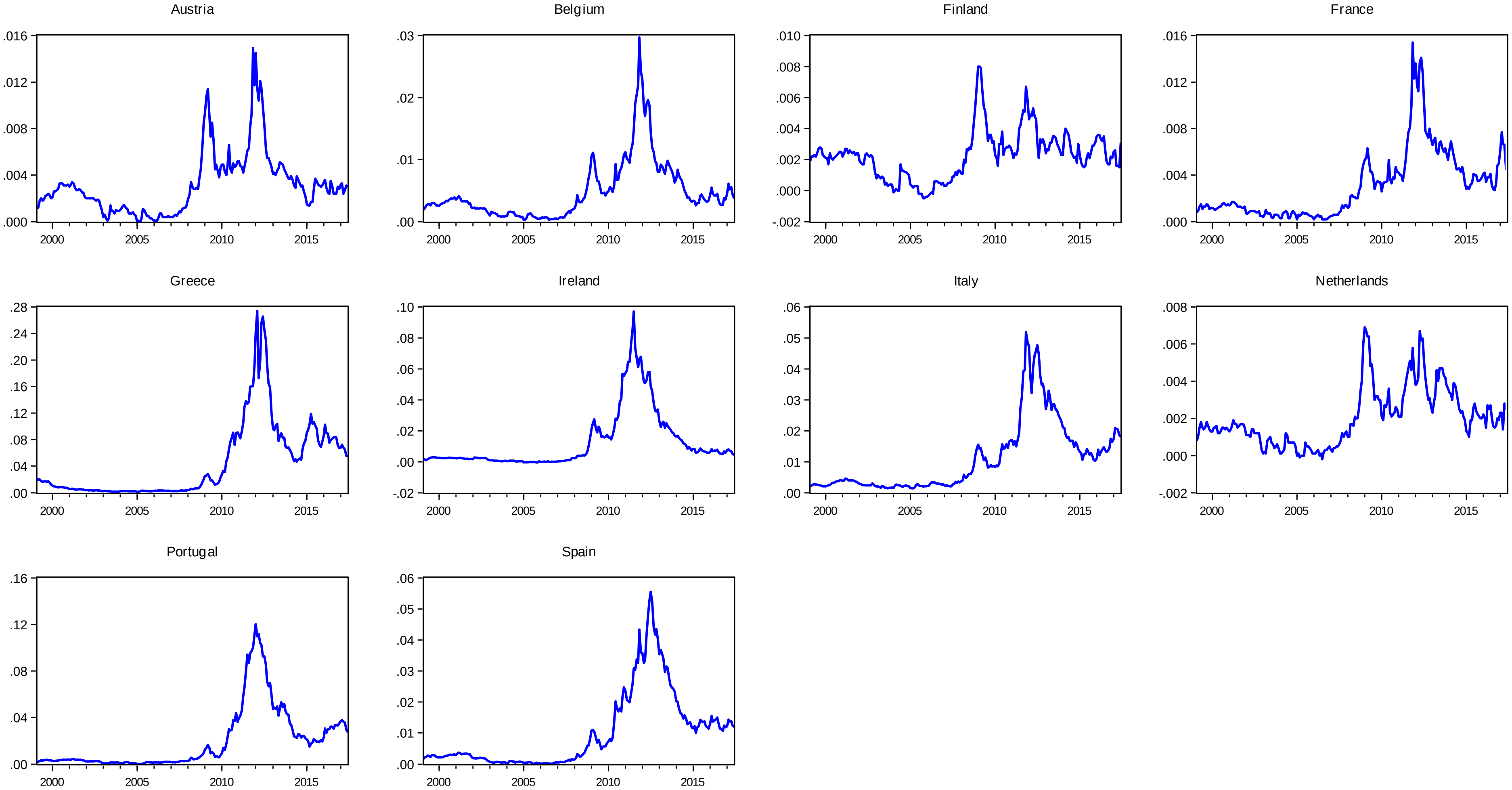
Note: The figure presents the log-index of private bank deposits relative to Germany. The sample period is January 1999 – June 2017, and the data source is the European Central Bank

Figure A2: Economic Sentiment Indicator relative to Germany in euro area countries



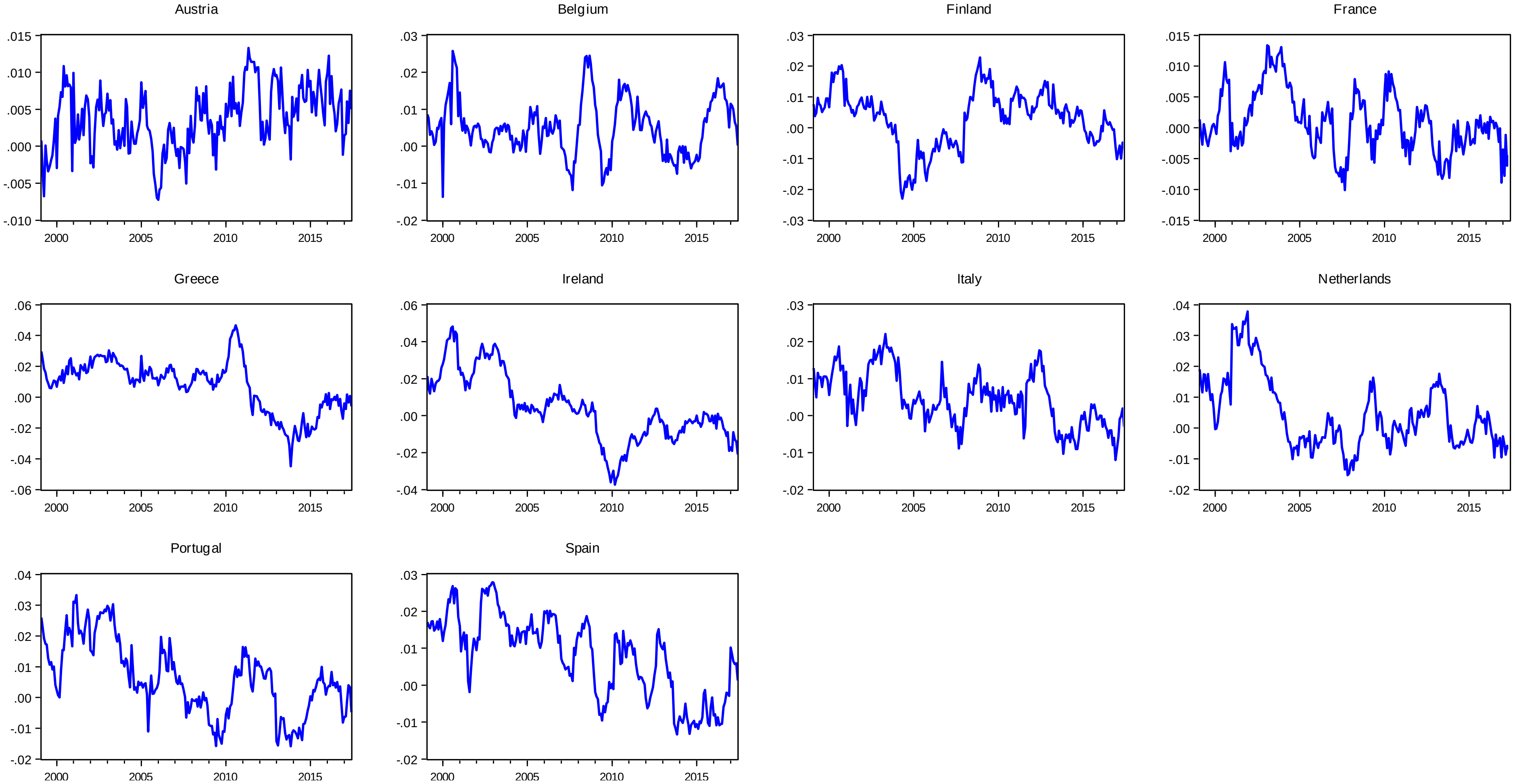
Note: The figure presents the log-index of the Economic Sentiment Indicator series relative to Germany. The sample period is January 1999 – June 2017, and the data source is the European Commission.

Figure A3: Bond yield spread against Germany in euro area countries



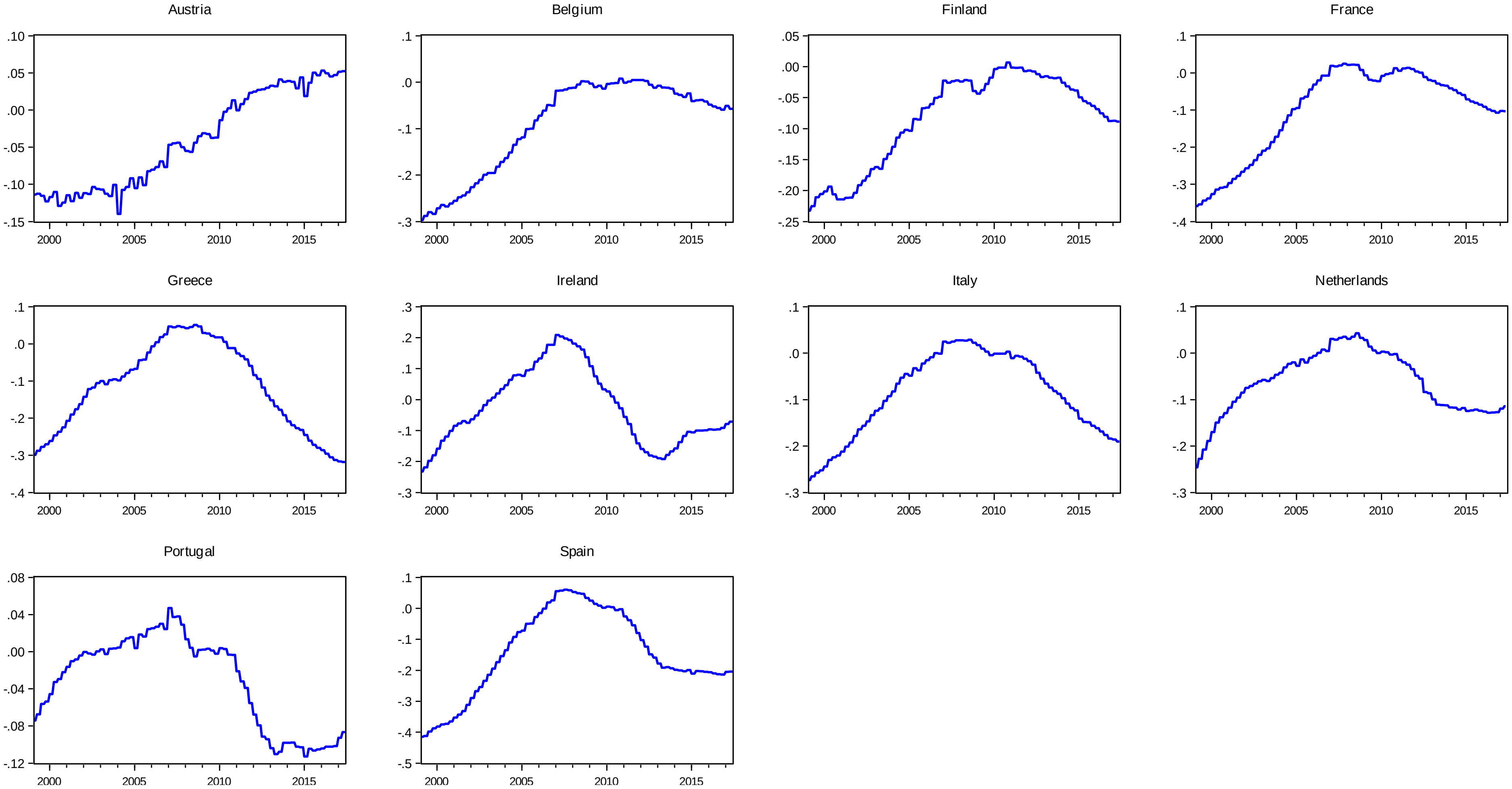
Note: The figure presents the 10-year government bond yield spread against Germany. The sample period is January 1999 – June 2017, and the data source is the European Central Bank.

Figure A4: Inflation differential against Germany in euro area countries



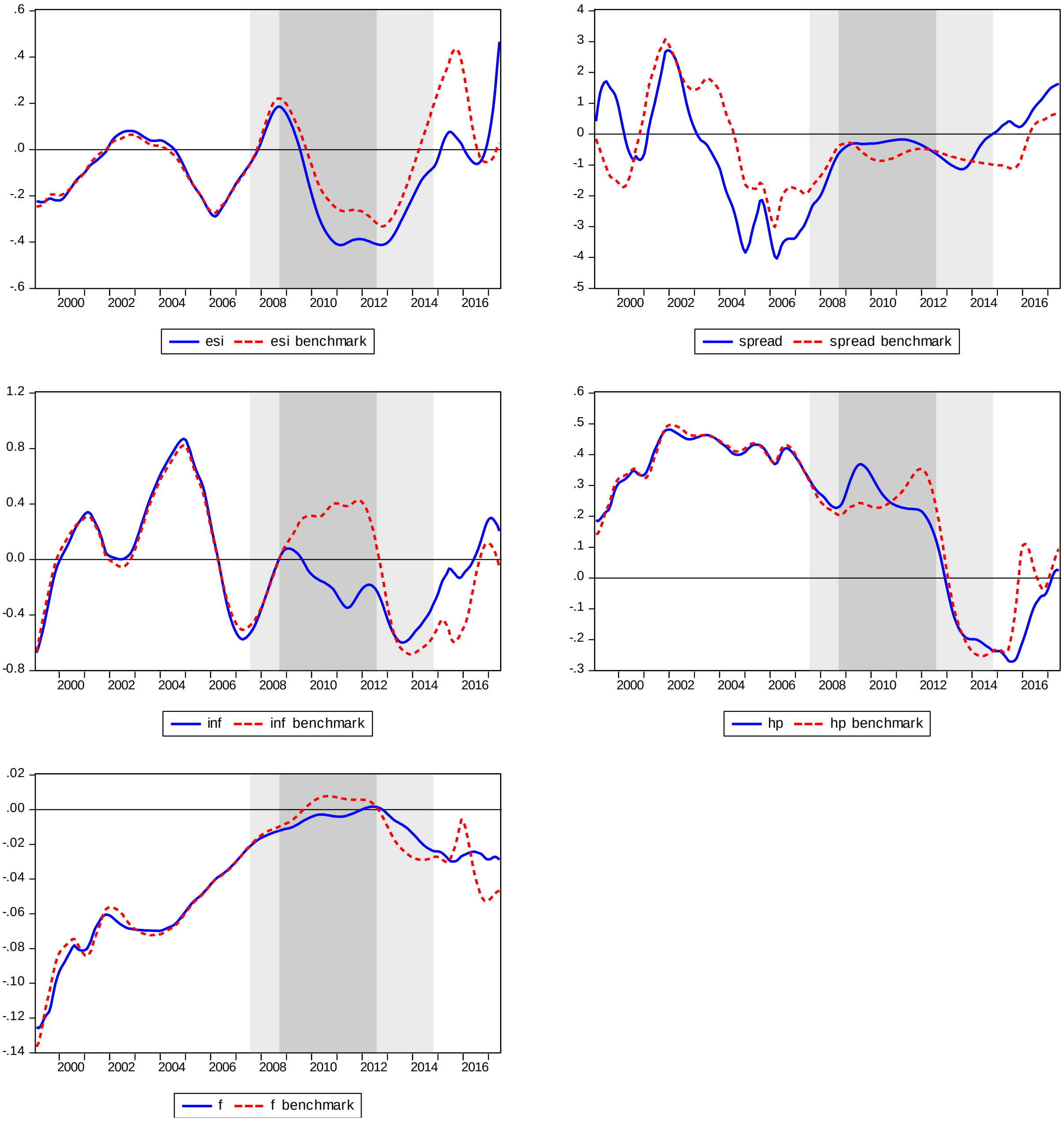
Note: The figure presents the year-to-year inflation rate, calculated using the Harmonised Index of Consumer Prices, relative to Germany. The sample period is January 1999 – June 2017, and the data source is the European Central Bank.

Figure A5: House price differential against Germany in euro area countries



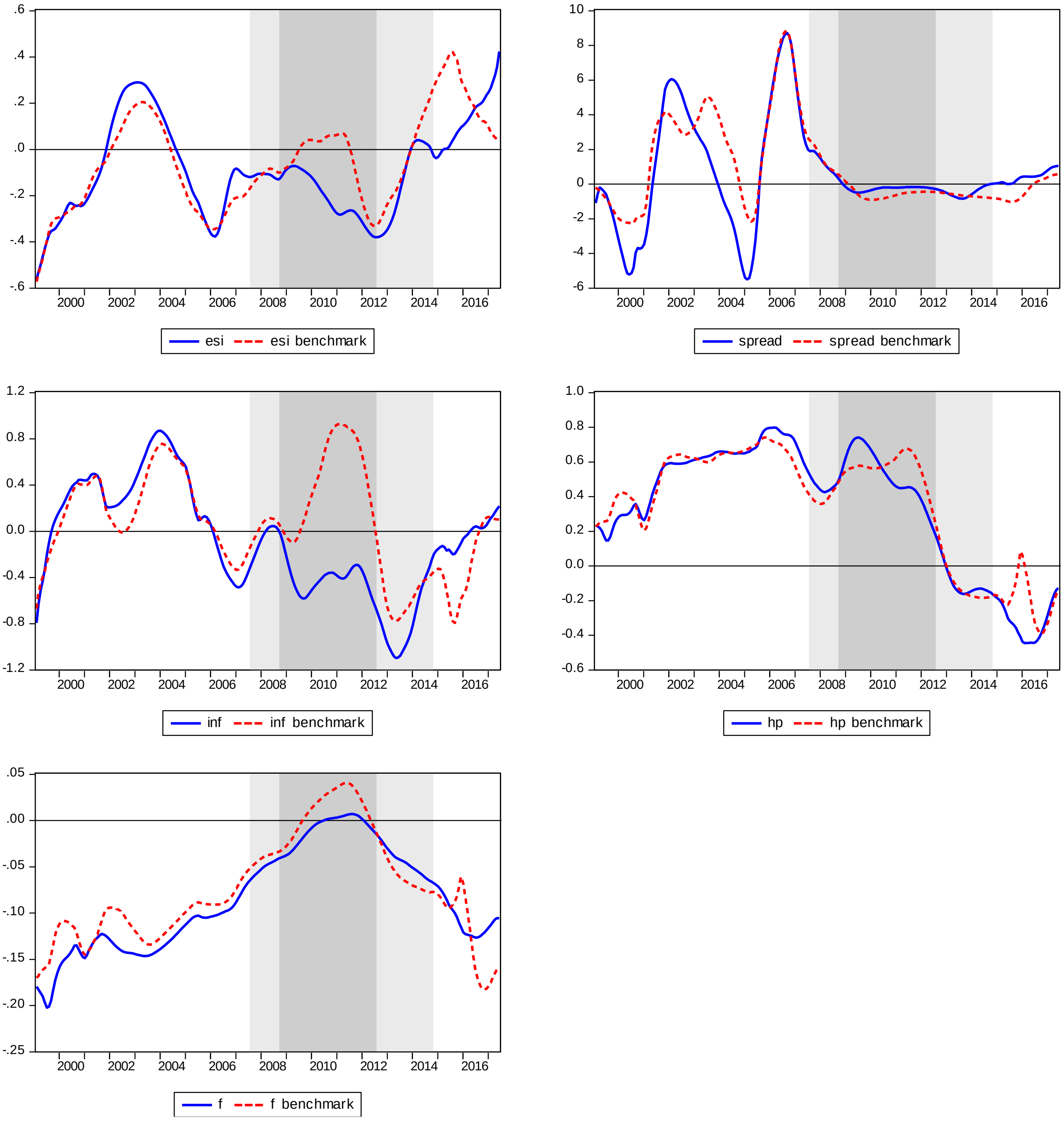
Note: The figure presents the log-index of house prices relative to Germany. The sample period is January 1999 – June 2017, and the data source is the European Central Bank.

Figure A6: Excluding Greece versus benchmark model – Full panel



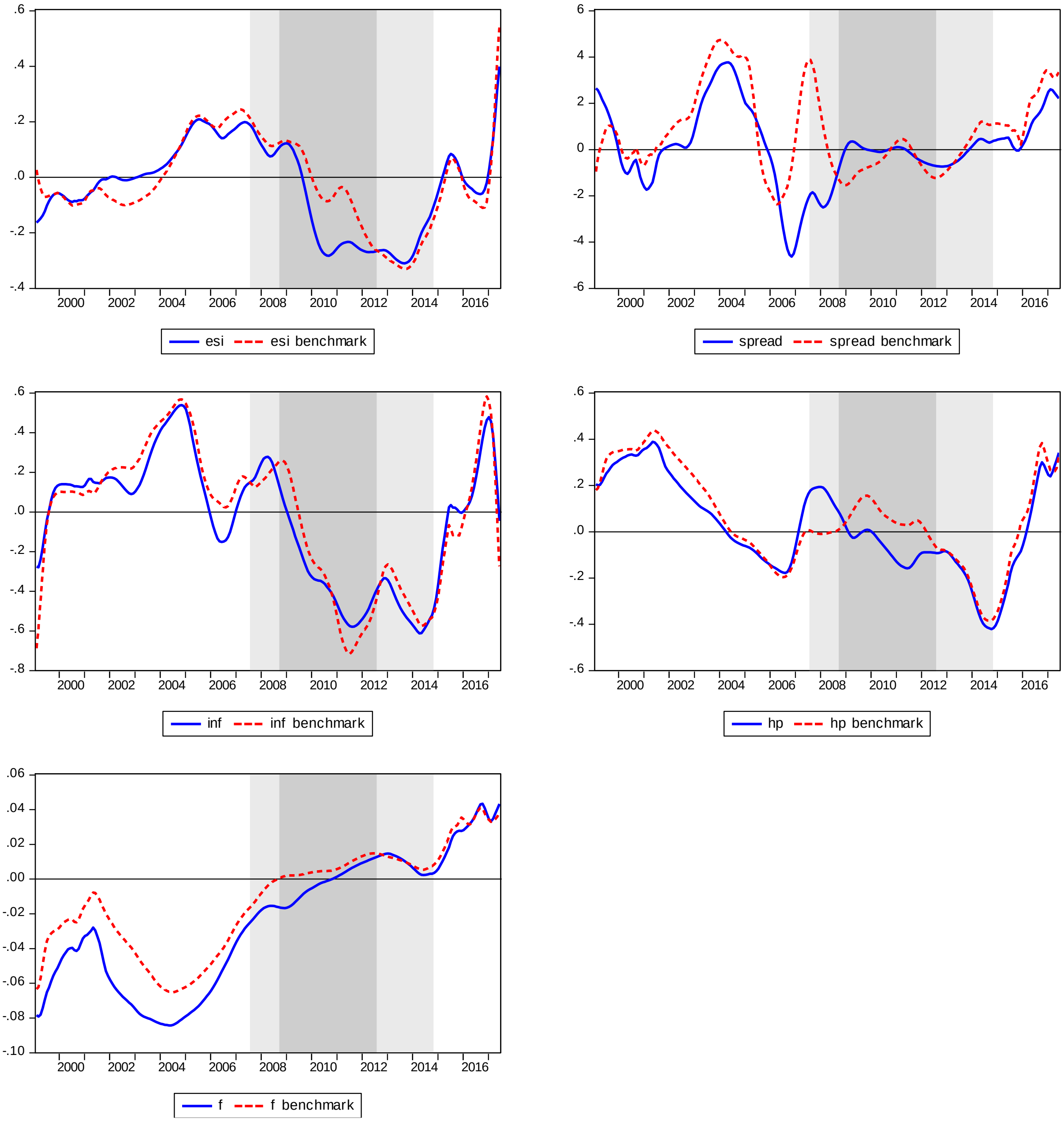
Note: The figure presents the coefficients obtained from the estimation of the time varying parameters (TVP) model given by equation (1) for the full panel excluding Greece over the period January 1999 - June 2017 (solid lines) against the TVP coefficients obtained from the benchmark model presented in Figure 2 (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, 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.

Figure A7: Excluding Greece from periphery versus benchmark periphery panel model



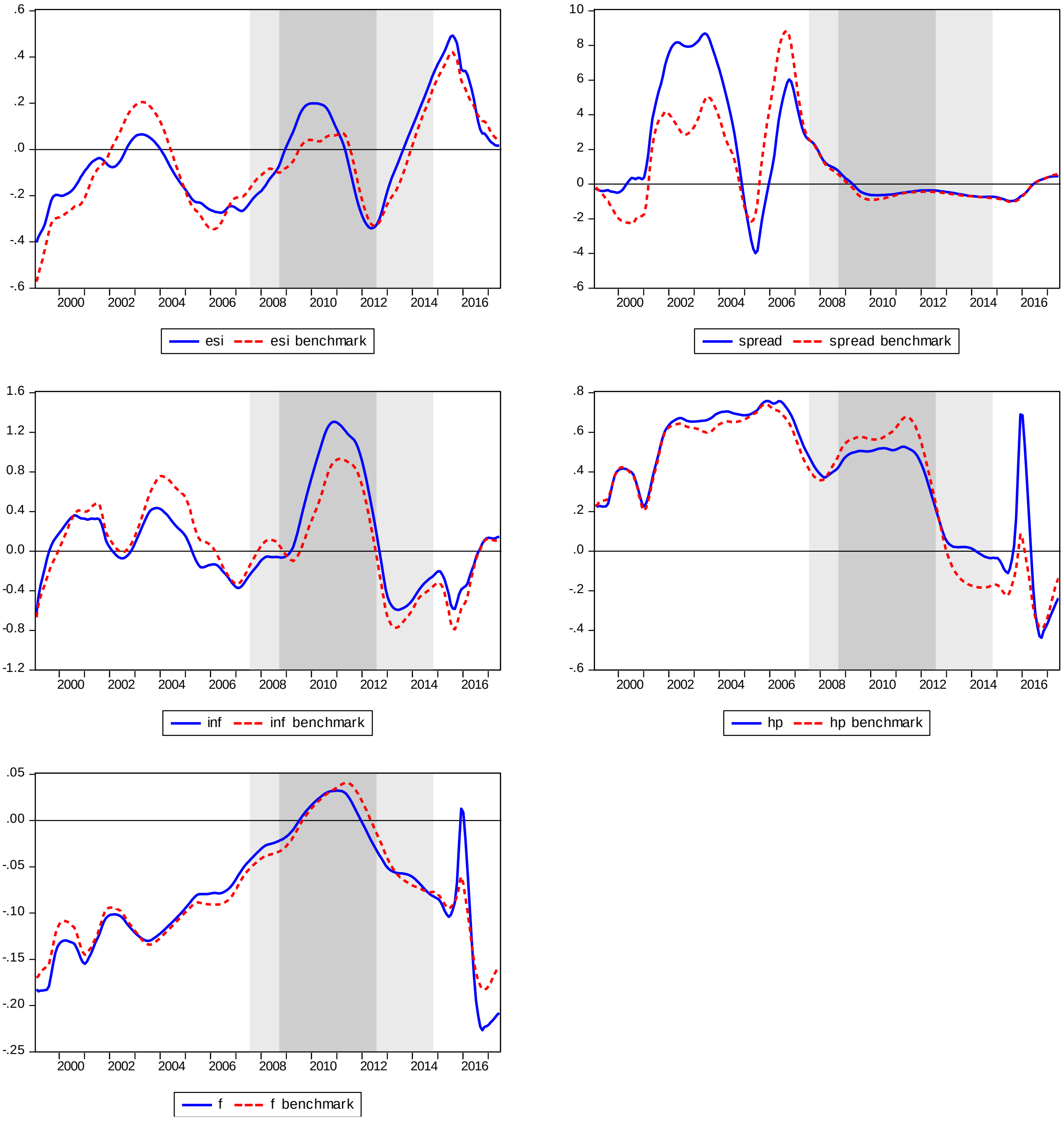
Note: The figure presents the coefficients obtained from the estimation of the time varying parameters (TVP) model given by equation (1) for the panel of periphery countries excluding Greece over the period January 1999 - June 2017 (solid lines) against the TVP coefficients obtained from the benchmark model presented in Figure 4 of main text (dotted lines). The estimation bandwidth parameter (*h*) is set to 0.15 and the bandwidth correction parameter (ε) to 0.08. The panel includes 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.

Figure A8: Including Italy in core versus benchmark core panel model



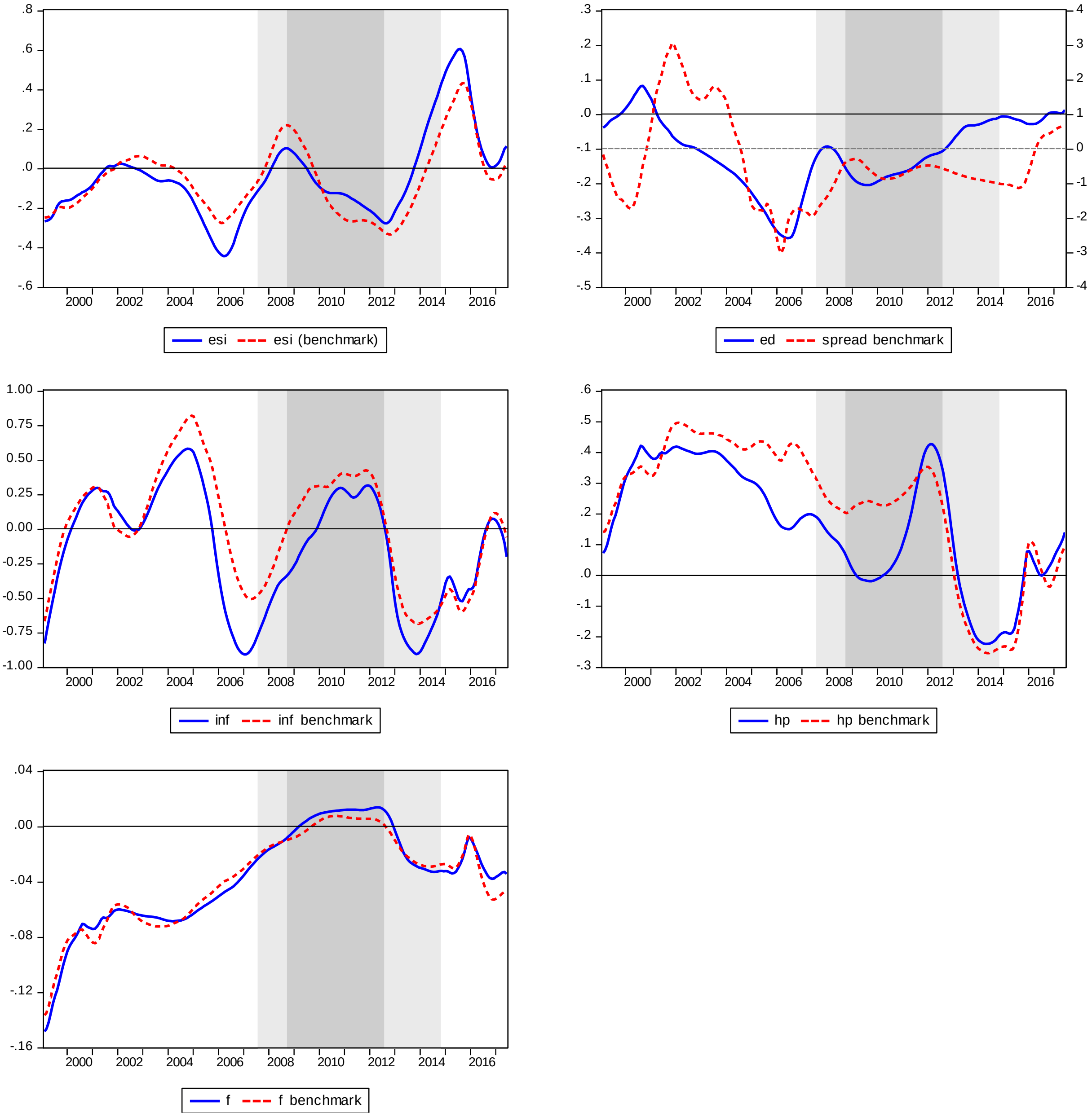
Note: The figure presents the coefficients obtained from the estimation of the time varying parameters (TVP) model given by equation (1) for the panel of core countries including Italy over the period January 1999 - June 2017 (solid lines) against the TVP coefficients obtained from the benchmark model estimated for core countries, presented in Figure 3 of main text (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, Italy 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.

Figure A9: Excluding Italy from periphery versus benchmark periphery panel model



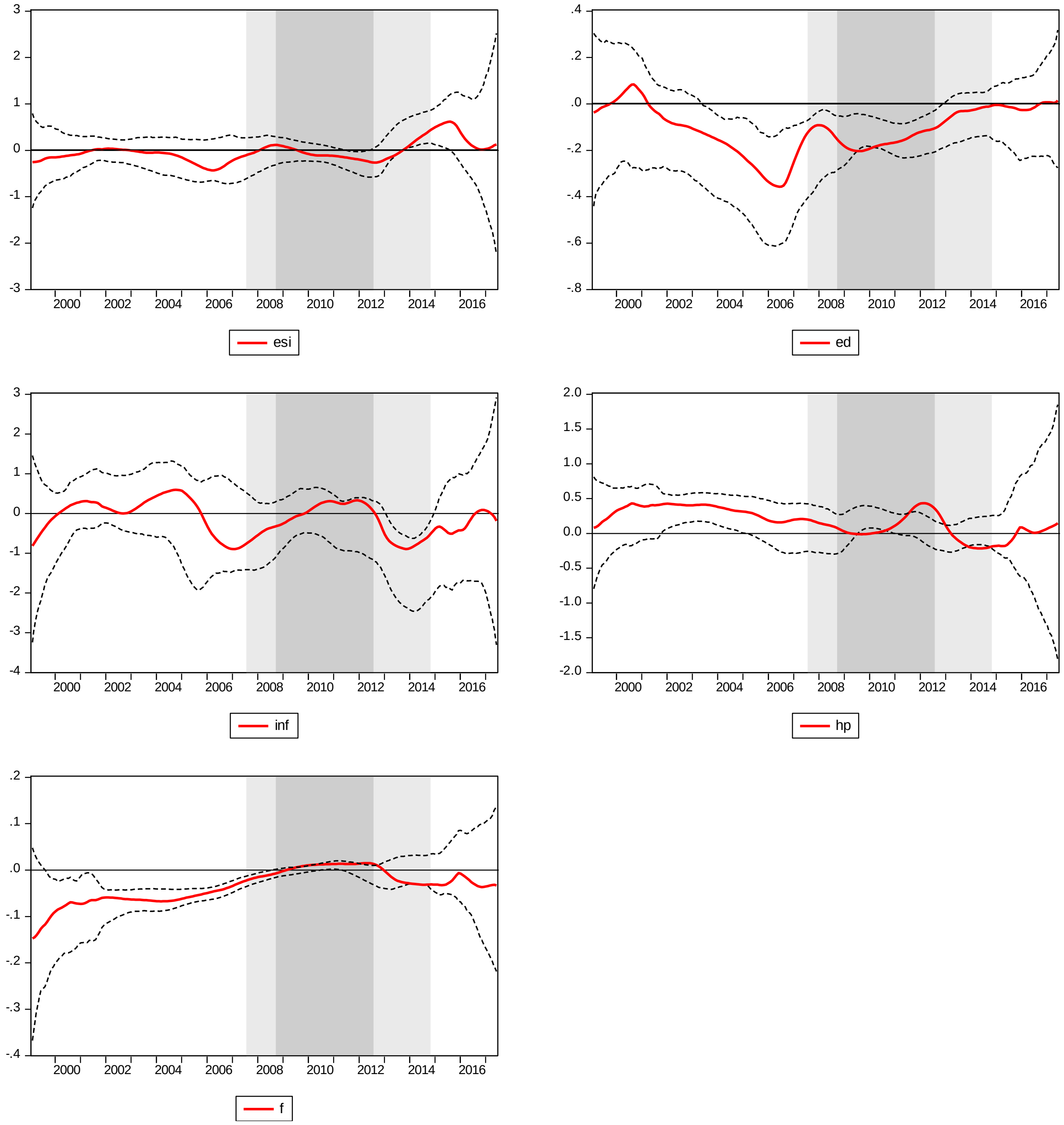
Note: The figure presents the coefficients obtained from the estimation of the time varying parameters (TVP) model given by equation (1) for the panel of periphery countries excluding Italy over the period January 1999 - June 2017 (solid lines) against the TVP coefficients obtained from the benchmark model estimated for periphery countries presented in Figure 4 of main text (dotted lines). The estimation bandwidth parameter (*h*) is set to 0.15 and the bandwidth correction parameter (ε) to 0.08. The panel includes Greece, Ireland, 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.

Figure A10: Alternative measure of fiscal risk versus benchmark model – Full panel



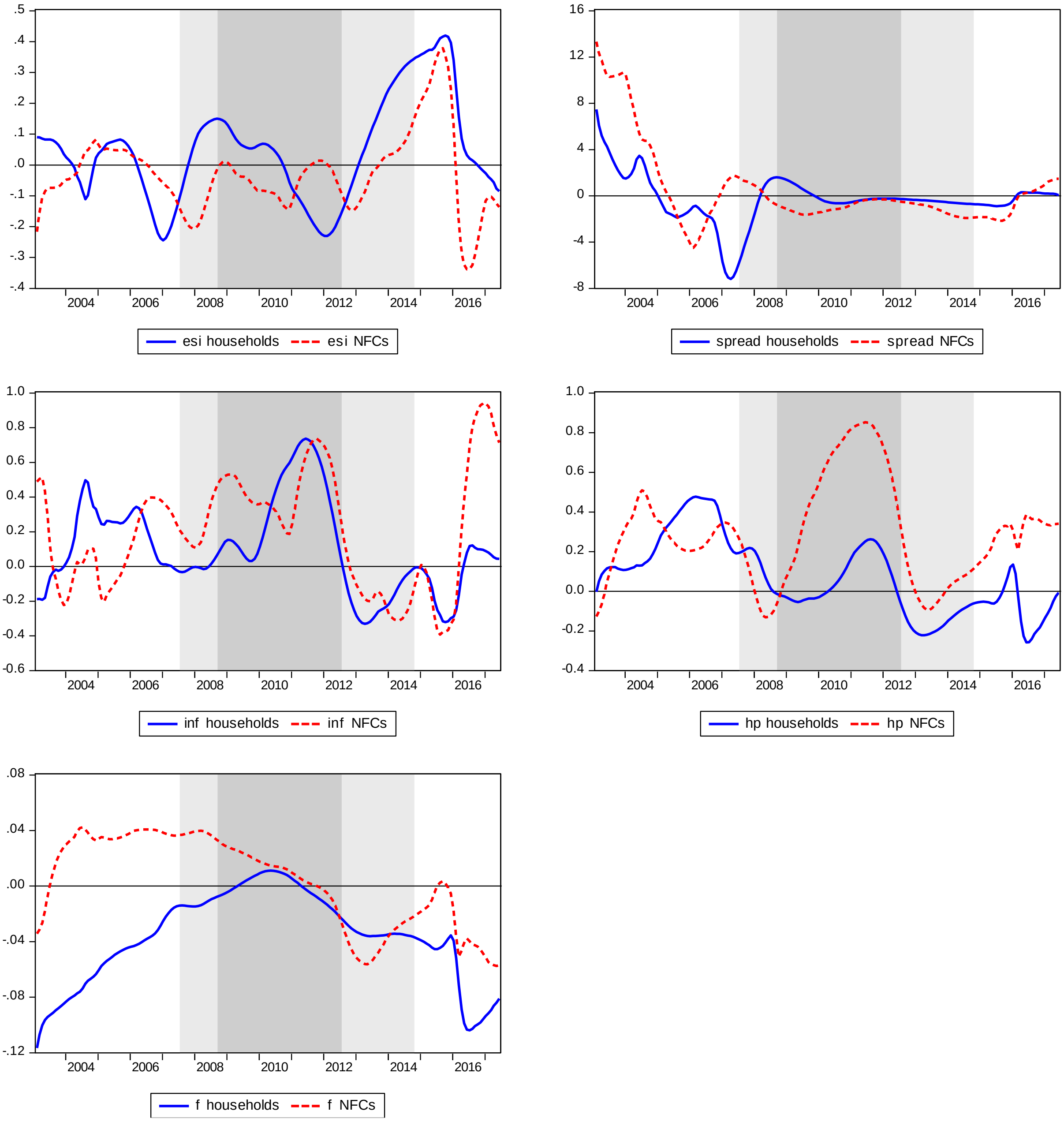
Note: The figure presents the coefficients obtained from the estimation of the time varying parameters (TVP) model given by equation (1) replacing spread with expected debt for the full panel over the period January 1999 - June 2017 (solid lines) against the TVP coefficients obtained from the benchmark model presented in Figure 2 (dotted lines). In the upper-right graph, the solid (dotted) line's axis is on the left- (right) hand side. 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, 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 1-year ahead expected debt-to-GDP ratio (*ed*) relative to 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.

Figure A11: Alternative measure of fiscal risk – Full panel



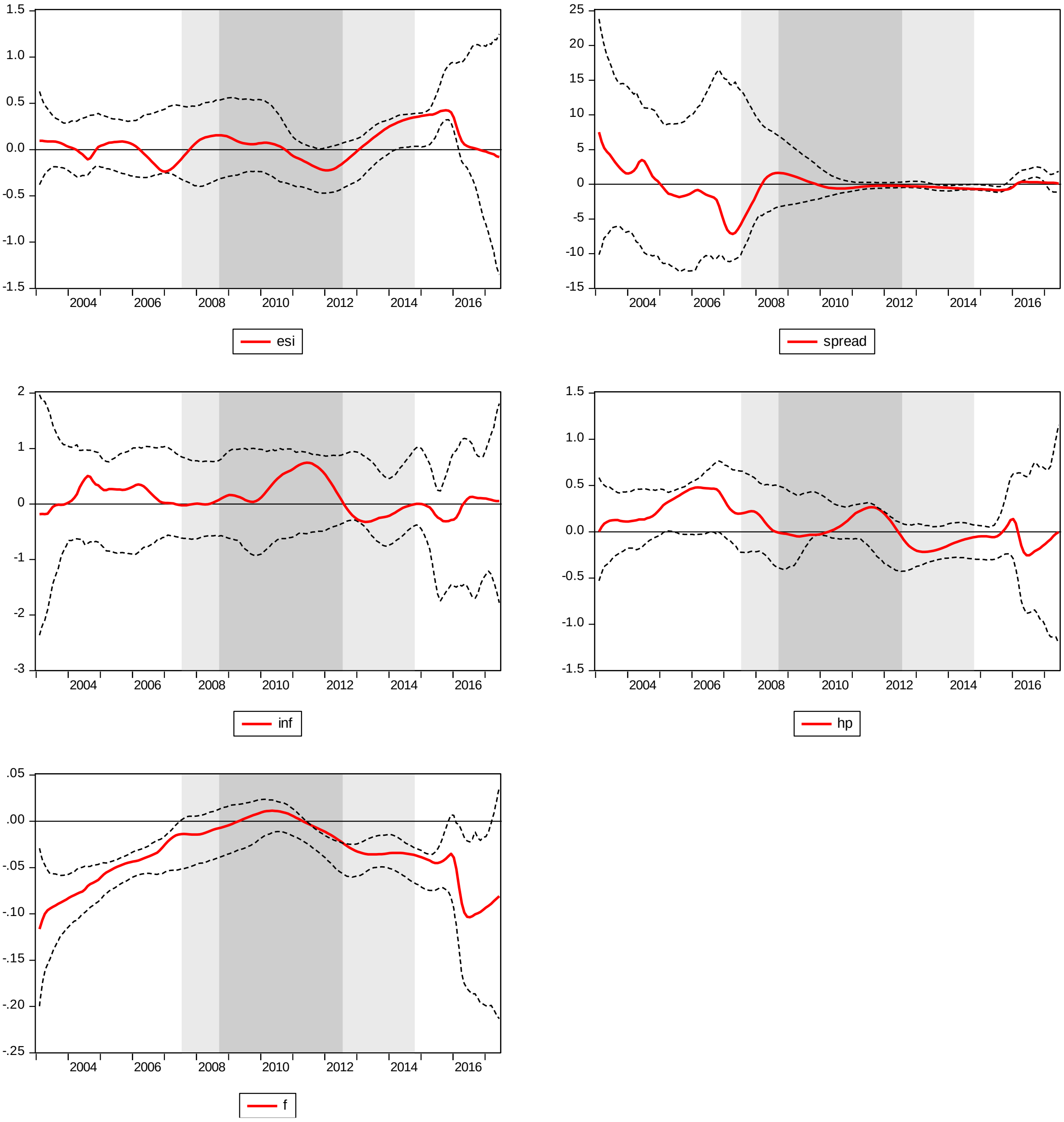
Note: The figure presents the coefficients obtained from the estimation of the time varying parameters (TVP) model given by equation (1) replacing spread with expected debt for the full panel over the period January 1999 – June 2017; and the corresponding 90% confidence intervals (dotted lines) calculated 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 1-year ahead expected debt-to-GDP ratio (*ed*) relative to 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.

Figure A12: Households versus non-financial corporations – Full panel



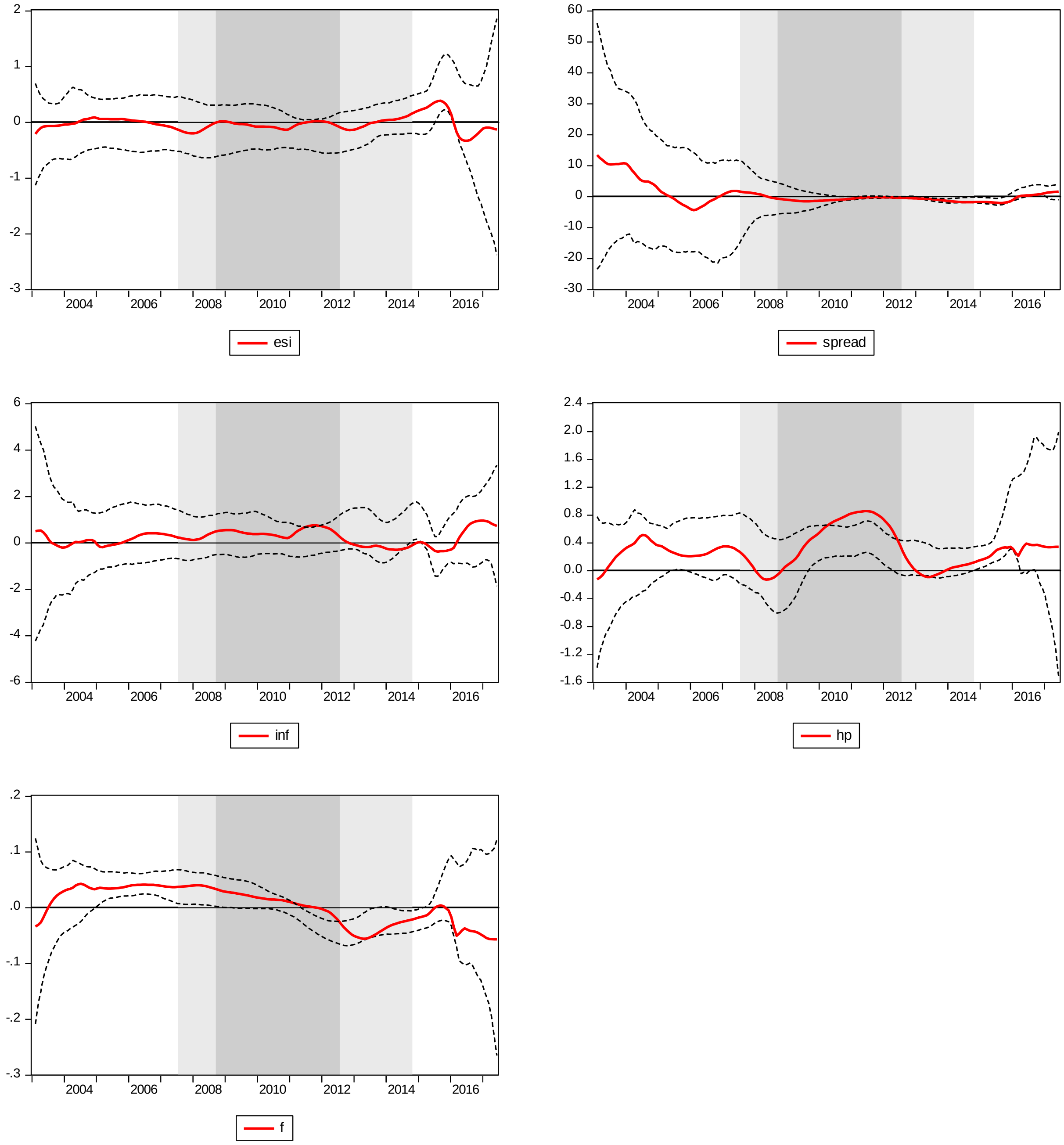
Note: The figure presents the coefficients obtained from the estimation of the time varying parameters (TVP) model given by equation (1) for the full panel with the dependent variable being the log-index of households private deposits relative to Germany over the period January 2003 – June 2017 (solid lines) against the TVP coefficients for the case of non-financial corporations (NFCs) deposits (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.

Figure A13: Households – 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 2003 – 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 households 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.

Figure A14: Non-financial corporations – 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 2003 – 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 non-financial corporations 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.

Appendix B: A simple model for relative deposits

We present a simple partial equilibrium model determining relative aggregate deposits. The model's set-up is similar to the baseline version of the flexible price monetary model of exchange rate determination assuming rational expectations, risk neutrality and full capital mobility (Taylor, 1995). We assume that demand for aggregate real domestic deposits is a positive function of domestic output and the rate of return paid on money (Bomberger, 1993), captured by the domestic nominal interest rate. Specifically, we use the bond yield to proxy the latter, in line with Balfoussia et al. (2019) in whose model banking risk is fully determined by fiscal risk. We assume that the set of saving instruments includes domestic bank deposits, foreign bank deposits and cash holdings. To account for international deposits' substitution, we allow foreign (domestic) savers to save in domestic (foreign) banks. As a result, demand for domestic deposits is a function of two scale variables, namely domestic and foreign output levels:

$$d_t - p_t = \alpha_1 y_t + \alpha_2 i_t + \beta_1 y_t^* \quad \text{(B1)}$$

where $\alpha_1, \alpha_2,\ \beta_1 > 0,$ In a similar fashion, aggregate foreign bank deposits are a function of domestic and foreign output, and the foreign nominal interest rate. For simplicity, we assume identical across countries income elasticities and interest rate semi-elasticities, so that:

$$d_t^* - p_t^* = \alpha_1 y_t^* + a_2 i_t^* + \beta_1 y_t \quad \text{(B2)}$$

We assume that purchasing power parity (PPP) holds:

$$s_t = p_t - p_t^* \quad \text{(B3)}$$

implying that expected exchange rate changes equal expected inflation differentials:

$$\Delta s_t^e = \pi_t^e - \pi_t^{e*} \quad \text{(B4)}$$

We assume that Uncovered Interest Parity (UIP) holds, adjusted for the aggregate fiscal risk differential (ρ_t), as is given by:

$$i_t = i_t^* + \Delta s_t^e + \rho_t \quad \text{(B5)}$$

Solving equations (B4) and (B5) with respect to Δs_t^e, we obtain:

$$i_t - i_t^* = (\pi_t^e - \pi_t^{e*}) + \rho_t \quad \text{(B6)}$$

Assume that the two countries form a monetary union, in which case the exchange rate s_t is a constant, normalised for simplicity to zero. In that case, PPP in equation (B3) becomes:

$$p_t = p_t^* \quad \text{(B7)}$$

Solving equations (B1) and (B2) with respect to p_t and p_t^* respectively, replacing in equation (B7) and re-arranging we obtain:

$$d_t - d_t^* = (\alpha_1 - \beta_1)(y_t - y_t^*) + \alpha_2 (i_t - i_t^*) \qquad \text{(B8)}$$

Using equation (B6) to replace for $(i_t - i_t^*)$, we obtain:

$$d_t - d_t^* = (\alpha_1 - \beta_1)(y_t - y_t^*) + \alpha_2(\pi_t^e - \pi_t^{e*}) + \alpha_2\rho_t \quad \text{(B9)}$$

Provided that the elasticity of domestic deposits to domestic income is higher than the elasticity of foreign deposits to domestic income ($\alpha_1 > \beta_1$), equation (B9) predicts a positive link between relative deposits and relative output, inflation and fiscal risk. Note that a fully credible monetary union implies $\Delta s_t^e = \pi_t^e - \pi_t^{e*} = 0$, in which case relative deposits are given by:

$$d_t - d_t^* = (\alpha_1 - \beta_1)(y_t - y_t^*) + \alpha_2\rho_t \quad \text{(B10)}$$

Assume now that the foreign country is a safe-haven for investors, i.e. it is perceived by investors (domestic and foreign) to have zero fiscal default and, by extension, zero bank default risk. On the other hand, domestic bank deposits are subject to non-zero, and nondiversifiable within the domestic banking system bank default risk, driven by non-zero fiscal risk (Clerc et al., 2015; Balfoussia et al., 2019). Assume also that the behaviour of foreign investors is not subject to any changes, i.e. the elasticity and semi-elasticity of domestic and foreign deposits to changes in foreign output levels and foreign interest rates is constant.[2] Finally, assume that the elasticity of demand for domestic and foreign deposits to changes in domestic output, as well as the semi-elasticity of domestic deposits to changes in domestic interest rates is a function of the level of relative macro/fiscal risk, denoted by ζ_t.

Specifically, the elasticity of domestic deposits to changes in relative output and the semi-elasticity of domestic deposits to changes in the interest rate differential are both a positive function of relative output and a negative function of relative expected inflation and relative fiscal risk. On the other hand, the elasticity of foreign deposits to changes in relative output is a negative function of relative output and a positive function of relative expected inflation and relative fiscal risk.

The key intuition is that as the domestic country experiences economic downturns (captured by a fall in relative output), and/or increased fiscal default risk (captured by a higher cost of public borrowing), and/or a higher probability of exiting the monetary union (captured by real appreciation driven by a higher relative inflation differential), domestic savers, fearing wealth losses due to fiscal/banking default and/or deposits' redenomination into a new, devalued national currency, substitute domestic deposits bank with foreign bank deposits and/or cash, resulting into lower relative deposits.[3] This capital-flight effect is captured by

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[2] Existing empirical evidence (Deutsche Bundesbank, 2016) suggests that for Germany, the country used as benchmark for our analysis, this hypothesis is valid.

[3] For empirical evidence supporting this hypothesis, see Levy-Yeyati et al (2010), Kleimeier et al (2013) and Cubilas et al. (2012, 2017). For a theoretical model predicting capital flight driven by fiscal and redenomination (euro exit) risk in the context of a monetary union (applied to sovereign bond markets) see Arghyrou and Tsoukalas (2011).

changes in the elasticities and semi-elasticities entering equation (B9), as described by equation (B11) below:

$$d_t - d_t^* = [(\alpha_1(\zeta_t) - \beta_1(\zeta_t))(y_t - y_t^*) + \alpha_2(\zeta_t)(\pi_t^e - \pi_t^{e*}) + \alpha_2(\zeta_t)\rho_t \quad \text{(B11)}$$

$$(\zeta_t)' = [(y_t - y_t^*), (\pi_t^e - \pi_t^{e*}), \rho_t]'$$

$$\partial\alpha_1\,(t)/\partial(y - y^*)_t > 0,\ \partial\alpha_1(t)/\partial(\pi_t^e - \pi_t^{e*})_t < 0,\ \partial\alpha_1(t\,)/\vartheta(\rho_t) < 0$$

$$\partial\beta_1(t\,)/\partial(y - y^*)_t < 0,\ \partial\beta_1(t\,)/\partial(\pi_t^e - \pi_t^{e*})_t > 0,\ \partial\beta_1(t\,)/\vartheta(\rho_t) > 0$$

$$\partial\alpha_2(t\,)/\partial(y - y^*)_t > 0,\ \partial\alpha_2\,(t\,)/\partial(\pi_t^e - \pi_t^{e*})_t < 0,\ \partial\alpha_2(t\,)/\vartheta(\rho_t) < 0$$

Our empirical framework aims to test the implications of the simple theoretical framework, and related literature, that we present in this section. Most importantly, we are interested in the notion of changes in the link between relative deposits and their fundamental determinants during periods of elevated macro/fiscal risk. In our estimations, relative house prices are included in the list of potential determinants of relative deposits. House prices serve as a proxy for wealth (Campbell and Cocco, 2007). In addition to income, wealth is a measure of the scale of operations in the economy (Bomberger, 1993). Hence, we expect similar patterns to materialise in the link between relative house prices and relative deposits, as those described above pertaining to the relationship between relative output and relative deposits.