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RESEARCH ARTICLE

The intertwining of credit and banking fragility

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Abstract

Although the literature has provided evidence of the predictive power of credit for financial and banking crises, this article aims to investigate the grounds of this link by assessing the interrelationships between credit and banking fragility. The main identification assumption represents credit and banking fragility as a system of simultaneous joint data generating processes whose error terms are correlated. We test the null hypotheses that credit positively affects banking fragility—a vulnerability effect—and that banking fragility has a negative effect on credit—a trauma effect. We use seemingly unrelated regressions and 3SLS on a panel of European Union (EU) countries from 1998 to 2012 and control for the financial and macroeconomic environment. We find a positive effect of credit on banking fragility in the EU as a whole, in the Eurozone, in the core of the EU but not at its periphery, and a negative effect of banking fragility on credit in all samples.

KEYWORDS

banking fragility, credit growth, nonperforming loans, SUR model

JEL CLASSIFICATION

E44; G20

1 | INTRODUCTION

The objective of this article is to link two strands of the literature. The first literature examines the nature of financial and banking crises and their determining factors (e.g., Allen & Gale, 2009, Barro, 2009, or Almunia, Bénétrix, Eichengreen, O'Rourke, & Rua, 2010). In this vein, Schularick and Taylor (2012) and Aikman, Haldane, and Nelson (2015) provide evidence, over a long era and for a large sample of countries, of the predictive power of credit for financial crises. The second one investigates the consequences of financial and banking crises on the subsequent recovery. Some papers (e.g., Brunnermeier & Pedersen, 2009; Geanakoplos, 2010; Shleifer & Vishny, 2011) focus on the behavior of the banking sector in the aftermath of such crises. In this article, we explore the interrelationships of credit and banking fragility in the European Union (EU). Three reasons motivate this study. First, the global financial crisis has shed light on the intertwining between the growth of the banking and financial sectors, financial deregulation, and banking fragility (e.g., Gorton & Metrick, 2012). Second, the EU has adopted a banking union, which gives the European Central Bank (ECB) a role of prudential supervisor for most banks in the EU. The ECB is *de facto* in charge of monitoring credit and bank stability. Third, although the determinants of credit, measured as the ratio of domestic credit to the private sector to GDP, and the determinants of banking fragility, such as nonperforming loans (NPLs), have been investigated separately in the empirical literature,[1] their cross-relationships have not been yet to our knowledge.

The use of the share of NPL to gross loans as a proxy for banking fragility is motivated by the outcomes of

Cihak and Schaeck (2010).[2] They find that the contemporaneous ratio of NPL to total loans provides relevant warning signals for systemic banking crisis. High levels of NPL constrain bank capital that could otherwise be used to increase lending. Aoki and Nikolov (2015) also show that the real effects of bubbles crucially depend on the identity of the bubble holder. Bubbles held by banks lead to a larger boom–bust cycle in credit and output compared with bubbles held by ordinary savers. High levels of NPL not only raise financing costs for small and medium enterprises but also trigger financial crisis and have devastating real effects.

We limit our investigation to the period 1998–2012 for which banking, macroeconomic, and market data are available for most of the EU countries. Figure 1 shows a scatter plot of NPL to total gross loans and credit to GDP. The relationship is unclear and the unconditional correlation is −0.23. In contrast, the contribution of this article is to assess the conditional correlation between credit and banking fragility and to single out the effect of each of these two variables on the other. We impose a panel structure on data and control for time and country-fixed effects, as well as financial and macroeconomic environment. The latter encompasses potential determinants of bank credit, as shown in the literature: GDP growth, inflation, and trade openness; and potential determinants of banking fragility: long-term real interest rates, taxes on business, a financial regulation index and market capitalization.

We test the following two null hypotheses: (a) there is a positive effect of credit on banking fragility labeled a "vulnerability effect", and (b) there is a negative effect of banking fragility on credit that we label a "trauma effect". The first hypothesis stems from the increasing fragility and risks of marginal loans, whereas the second results from the potential deleveraging and reduced risk-taking of banks following a period of banking fragility.

While estimating the link between credit and banking fragility, we are confronted to two types of endogenous processes. The first is related to the joint determination of the two left-hand-side variables. Like price and quantity on a given market, credit and banking fragility can be considered as the opposite sides of the same coin. To correct for their simultaneity, we represent credit and banking fragility as a system of simultaneous joint data generating processes estimated with seemingly unrelated regressions (SURs), which takes into account that contemporaneous error terms are correlated and provide more efficient estimates than ordinary least squares (OLS). The second type of endogeneity relates to the right-hand-side variables and to the estimation of their causal effect. A potential omitted variable bias or reverse causality would make these variables and the error term

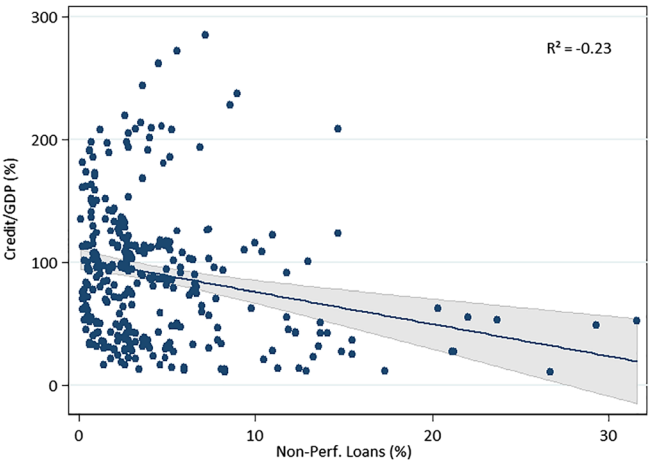

FIGURE 1 Credit and banking fragility (source: GFDD)

correlated. This second type of endogeneity is handled with instrumental variables. We perform a three-stage least squares (3SLS) estimation, which enables to combine the system estimation of SUR with the instrumental-variable method of two-stage least squares (2SLS).

Despite the negative correlation between credit and banking fragility, presented in Figure 1, we find a positive causal effect of the level of credit to GDP on the share of NPL and a negative causal effect of NPL on credit. These results are robust to using the growth rate of credit, alternative banking fragility variables, the introduction of government debt, to most EU subsamples, to non-linear specifications, and to a 3-equation SUR model in which long-term interest rates are also considered endogenous. More precisely, we find the existence of a vulnerability effect in the EU as a whole, in the Eurozone, in the core of the EU but not at its periphery. We attribute the difference between the core and the periphery to their different stages of financial development. We also find evidence of non-linearities between the two main variables. NPL have a non-linear effect on credit to GDP depending on the level of credit to GDP, whereas the effect of credit to GDP on NPL—the vulnerability effect—depends on the level of credit to GDP and is time contingent: this effect kicks-in during crisis times.

The rest of this article is organized as follows: Section 2 describes the model, the empirical strategy, and the hypotheses; Section 3 presents the data; Section 4 discusses the results; and Section 5 concludes.

2 | THE EMPIRICAL STRATEGY AND NULL HYPOTHESES

While assessing the link between credit and banking fragility, we face the issue of their potential endogeneity.

One solution, and this is the main identification assumption of this article, consists in thinking the problem not in a single-equation space, but as a system of simultaneous equations that jointly determine both dependent variables. The two equations are therefore mechanically related as the contemporaneous errors associated with each dependent variable are correlated, which seems a reasonable assumption for these two data processes. The most basic form of joint-system estimation is SUR, also called as Zellner (1962)—efficient regressions, using feasible generalized least squares (FGLS). When the two equations do not have the same set of explanatory variables and are not nested, it leads to more efficient estimates than estimating each individual equation separately with OLS because it takes into account the correlation between the error terms and therefore adds information on the error structure. Generally, the coefficients are only slightly different, but the *SE*s are uniformly larger.

We estimate simultaneously the cross effects of credit and banking fragility using the following model, in which we assess the contribution of our variables of interest above and beyond contemporaneous financial and macrocontrols and past information captured by the lagged value of the dependent variables:

$$\begin{cases} F_{i,t} = \alpha_F + \beta_F F_{i,t-1} + \beta_{FC} C_{i,t} + \beta_{FC'} C_{i,t-1} + \beta_{FX} X_{i,t} + \beta_{FZ} Z_{i,t} + \varepsilon_{F,t} \\ C_{i,t} = \alpha_C + \beta_C C_{i,t-1} + \beta_{CF} F_{i,t} + \beta_{CF'} F_{i,t-1} + \beta_{CX} X_{i,t} + \beta_{CZ} Z_{i,t} + \varepsilon_{C,t} \end{cases} \quad (1)$$

where $F_{i,t}$ is the banking fragility variable for country i, $C_{i,t}$ is the credit variable, $X_{i,t}$ is a vector of financial controls, namely long-term real interest rates, stock market capitalization, taxes, and a financial regulation variable, and $Z_{i,t}$ includes country and time-fixed effects and the macroeconomic environment, namely real GDP, inflation, and trade openness. Given the annual frequency of the data and the fact that the length between a loan disbursement and its possible classification as NPL is at least 90 days, the emission of a credit line and its reclassification as a NPL may happen during the same year, so we include a potential contemporaneous relationship between credit and banking fragility. Using this model, we test two hypotheses:

> **Hypothesis 1:** There is a positive effect of credit on banking fragility labeled a "vulnerability effect".

This vulnerability effect stems from the increasing fragility and risks of marginal loans. This effect also arises from the dependence of loan-loss provisioning on the evolution of bank lending. Pool, de Haan, and Jacobs (2015) show that banks reduce their loan-loss provisioning as a percentage of their total assets when bank lending increases, and therefore take on more risks. Gourinchas and Obstfeld (2012), Schularick and Taylor (2012), and Aikman et al. (2015) show that rapid domestic credit expansion is a robust indicator of financial crises. One could expect a U-shaped relationship between credit and NPL. Until a threshold, credit will help to develop an efficient market for loans, while the marginal utility of bank loans will be positive. However, once a threshold is reached, the risk of marginal loans increases. One could also expect the occurrence of a relationship that takes a convex form between credit and NPL: the risk of marginal loans increases disproportionately with the supply of loans. We therefore test for possible nonlinearities of this relationship.

> **Hypothesis 2:** There is a negative effect of banking fragility on credit that we label a "trauma effect".

This effect results from the potential deleveraging and reduced risk-taking of banks following a period of banking fragility. This is suggested by Adrian and Shin (2010, 2014) who theoretically document the procyclicality of the leverage of financial intermediaries. They show that financial intermediaries maintain a constant probability of default to shifts in the outcome distribution so it implies substantial deleveraging during downturns. This procyclicality may have been reinforced by regulatory measures. This hypothesis also relies on theoretical mechanisms that have been put forward by Brunnermeier and Pedersen (2009), Geanakoplos (2010), and Shleifer and Vishny (2011). Brei and Gambacorta (2016) show that the risk-weighted regulatory capital ratio of Basel III is less procyclical than the previous liquidity ratio, that was mandatory during our period of analysis. Similarly to the first hypothesis, one can expect nonlinearities in the effect of banking fragility on credit: the deeper the crisis, the stronger the deleveraging and the negative effect on credit supply.

We include financial variables in the regression that could impinge on the relationships between credit and banking fragility.[3] We expect a negative effect of long-term real interest rates (measuring financing costs) on credit. We assume that credit demand decreases and credit supply increases with interest rates. Fase (1995) reports results on credit for the Netherlands using nominal long-term interest rates. Alternatively, we focus on real long-term interest rates. We expect a positive correlation between the long-term real interest rate and banking fragility: the latter materializes after real interest rates go up, hence weakening debtors' positions. We expect a positive link between taxes and credit and between taxes and banking fragility. Following Keen and De Mooj (2016) and De Mooj, Keen, and Orihara (2013), the corporate tax would violate the Modigliani–Miller theorem in the case of banking institutions: the high corporate tax

induces recourse to borrowing (debt) to grasp the full benefit of interest payments' deduction at the expense of equity. We expect a negative link between stock market capitalization and credit, which may capture a substitution effect between direct finance and bank intermediation. This may in turn induce a negative correlation between stock market capitalization and banking fragility. Finally, we control for the existence of a positive link between financial deregulation and credit and a positive link between financial deregulation and banking fragility as deregulation may increase risk-taking. Chinn and Ito (2006) report a positive relationship between financial openness and financial development; whereas, Tressel and Detragiache (2008) show that financial liberalization has a limited impact on financial development. Kaminsky and Schmukler (2008) show that financial liberalization generates the banking fragility in the short run.

In addition, we control for the effect of macroeconomic variables like the GDP growth rate, the inflation rate, and the trade openness on credit and financial stability. Hofmann (2004) shows that a shock to real GDP can increase credit, for example, in Germany, Ireland, or Finland; or it can have no effect, for example, in United States, United Kingdom, and Japan. Louzis et al. (2012) report a negative impact of GDP growth on NPL. Finally, Gozgor (2014) provides evidence of a positive link between trade openness and credit.

Two other issues, related to the onset of the global financial crisis and its European sequel, the sovereign-debt crisis, require some attention. First, the crisis has revealed the divergence between the EZ and the late newcomers in the EU, where the former have benefited from financial deepening for decades; whereas, the latter are in a process of financial development. The crisis has also revealed the gap between a core of EU countries and the periphery. These regional features may impinge on the relationship between credit and banking fragility and require a specific investigation. Second, growing public debts may affect credit demand and crowd out some investments as well as it may deteriorate the balance sheets of banks and thus modify credit supply and increase risks in the banking and financial system. Therefore, we test the potential effects coming from fiscal variables by introducing government debt.

3 | DATA

3.1 | Dependent variables

We measure the credit with the level or alternatively the growth rate of the ratio of domestic credit to the private sector by deposit money banks and other financial institutions to GDP (in percentage) computed from the World Bank Global Financial Development Database (GFDD). We also use the deposit money banks' assets to GDP (%) as another measure of bank deepening. For the stock market view, we substitute credit to GDP by the turnover ratio (see Beck & Levine, 2004). Banking fragility is captured with an aggregate prudential ratio: the ratio of NPL to gross loans.[4] For the stock market view, we use a stock price volatility variable.

3.2 | Explanatory variables

GDP growth, the inflation rate, and the trade openness are included to control for the macroeconomic environment. We also include financial variables to control for factors that could affect the two variables of interest. Credit costs are captured by long-term real interest rates. The substitution effect between the direct and indirect finance is tested with the stock market capitalization or with the stock market turnover ratio. We assess the link between credit, banking fragility, and taxes by using different measures of tax policies. Our benchmark measure is cyclically adjusted-direct taxes on business. We also examine alternatively the ratio of total direct taxes to GDP, the ratio of capital taxes to GDP, and the ratio of cyclically adjusted taxes on production and imports to GDP. On the fiscal side, we consider the ratio of gross public debt to GDP. Finally, to isolate the effect of deregulation, we include an index of financial reform or alternatively the level of bank regulatory capital to risk-weighted assets. All variables are described in Table A1 in the Appendix, and the descriptive statistics are presented in Table A2.

4 | RESULTS

4.1 | Baseline

Starting with our first hypothesis of a vulnerability effect, Table 1 shows that credit is a positive and significant determinant of banking fragility. This is true with or without the controls, but their inclusion reduces the magnitude of the effects (parameter estimates of controls are shown in Table A5 in the Appendix). Following Schularick and Taylor (2012) and for the sake of clarity, we report the sum of the credit to GDP coefficients and its corresponding *SE*.[5] When including controls (Column 2), the coefficient is equal to 0.22 and is significant at the 1% level. According to our second hypothesis of a trauma effect, Table 1 shows that banking fragility (measured by NPL) has a negative effect on credit to GDP.[6] This is true with or without the financial and macrocontrols and the coefficient is equal to −0.15 and is significant at the 1%

TABLE 1 Benchmark

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Redux	**Benchmark**	**Square**	**Interaction**	**Crisis**	**3-var**	**Credit growth**
Variable	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**
Lag Dep. Var.	0.75***	0.70***	0.60***	0.70***	0.61***	0.65***	0.79***
	[0.05]	[0.05]	[0.05]	[0.05]	[0.05]	[0.05]	[0.05]
Credit/GDP	0.38***	−0.02	−0.07	0.00	−0.06	0.05	−0.05
	[0.10]	[0.11]	[0.10]	[0.11]	[0.10]	[0.11]	[0.05]
$Credit/GDP_{t-1}$	−0.03	0.24**	0.34***	0.22*	0.12	0.15	0.20***
	[0.11]	[0.11]	[0.11]	[0.11]	[0.11]	[0.11]	[0.05]
$(Credit/GDP_{t-1})^2$			0.22***				
			[0.05]				
Interaction				0.03			
				[0.04]			
$Credit/GDP_{t-1}$ * crisis					0.52***		
					[0.11]		
Crisis					−0.01		
					[0.13]		
$\Sigma Credit/GDP_{(t + t-1)}$	0.35***	0.22***	0.27***	0.22***	0.06	0.20***	0.15***
	[0.06]	[0.07]	[0.06]	[0.07]	[0.07]	[0.07]	[0.05]
	Credit/GDP	**Credit/GDP**	**Credit/GDP**	**Credit/GDP**	**Credit/GDP**	**Credit/GDP**	**Credit/GDP**
Lag Dep. Var.	0.86***	0.86***	0.86***	0.86***	0.85***	0.86***	0.37***
	[0.03]	[0.05]	[0.05]	[0.05]	[0.05]	[0.05]	[0.06]
Non-Perf L.	0.12***	−0.01	0.00	0.00	0.00	0.02	−0.10
	[0.03]	[0.05]	[0.05]	[0.05]	[0.05]	[0.05]	[0.09]
Non-Perf $L._{t-1}$	−0.25***	−0.14***	−0.16***	−0.14***	−0.11**	−0.13***	−0.44***
	[0.03]	[0.05]	[0.05]	[0.05]	[0.05]	[0.05]	[0.09]
(Non-Perf $L._{t-1})^2$			0.03				
			[0.03]				
Interaction				−0.07**			
				[0.03]			
Non-Perf $L._{t-1}$ * crisis					−0.06		
					[0.07]		
Crisis					0.11		
					[0.11]		
ΣNon-Perf $L._{(t+t-1)}$	−0.12***	−0.15***	−0.16***	−0.14***	−0.12**	−0.11***	−0.54***
	[0.03]	[0.03]	[0.04]	[0.03]	[0.05]	[0.04]	[0.06]
Controls $X_{i,t}$	No	Yes	Yes	Yes	Yes	Yes	No
Controls $Z_{i,t}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3-equation model	No	No	No	No	No	Yes	No
N	275	182	182	182	182	179	253
R^2_1	0.61	0.75	0.78	0.75	0.78	0.74	0.60
R^2_2	0.89	0.89	0.89	0.89	0.89	0.89	0.39

Note: *SE*s are in brackets, estimated from Equation (1). All variables are standardized to a normal distribution by country. The interaction term is between the lag of the dependent variable and credit/GDP in the upper panel and nonperforming loans in the lower panel. In Column 6, the seemingly unrelated regression

(SUR) model is estimated with three dependent variables: nonperforming loans; credit/GDP; and long-term interest rates, and the overall model is augmented with short-term interest rates. For the sake of simplicity, the third equation for long-term interest rates and the parameters for short-term interest rate are not shown here. They are available from the authors upon request. In Column 7, the credit variable, in level, is replaced by the credit growth.
*$p < .1$.
**$p < .05$.
***$p < .01$.

level. Since all variables have been standardized to a normal distribution, this means that a 1-*SD* increase in NPL (namely, an increase of five percentage points of the share of NPL) reduces credit to GDP by eight percentage points (the equivalent of 0.15 *SD* of the series of credit to GDP).[7] In both cases, the contemporaneous value of credit to GDP or NPL is not significant and suggests the existence of a dynamic process in the build-up of vulnerability and trauma effects. The last column of Table 1 shows the estimates of Equation (1) when the level of credit to GDP is replaced by the growth rate of credit to GDP. The positive effect of credit on banking fragility (the vulnerability effect) and the negative effect of NPL on credit (the trauma effect) are both confirmed. This suggests that this is not only the level of credit that matters but also the rhythm at which credit expands. Comparably, banking fragility has a negative influence on both the level and growth rate of credit.

We also assess in Table 1 the potential nonlinear relations between the credit and banking fragility. We first introduce squared values of each variable of interest as an explanatory variable of the other (column 3). We find that NPLs have the same linear effect on credit to GDP whatever the NPL level, whereas the effect of credit to GDP on NPL—the vulnerability effect—is larger for high values of the credit to GDP ratio. More precisely, the effect of credit to GDP is small (0.34 − 0.22, so 0.12) and nonsignificant at one *SD* below the mean (93% − 57% = 36%) of the credit to GDP distribution whereas the effect is 0.56 (0.34 + 0.22) and significant at the 1% level at one *SD* above the mean (93% + 57% = 150%) of its distribution. Second, we look at the cross-effects of each variable on the other by introducing an interaction term of the lagged dependent variable with the variable of interest (Column 4). The effect of NPL on credit to GDP depends on the level of credit to GDP, whereas the effect of credit to GDP on NPL does not depend on the level of the share of NPL. For low values of credit to GDP (around 36%), the effect of NPL on credit to GDP is −0.07 but nonsignificant, whereas for high values of credit to GDP (around 151%), the effect of NPL on credit to GDP is negative (−0.21) and significant at the 1% level. It suggests that credit generates additional vulnerabilities. Finally, we consider the time contingency of the effect and we interact the variable of interest with a dummy for the crisis taking the value 0 before 2007 and 1 from 2007 (Column 5). NPL increase from 4.5% before 2007 to 5.2% after (with the *SD* decreasing from 5.3 to 4.4%), while credit increases from 78% before 2007 to 126% after (with the *SD* increasing from 48 to 62%). The effect of NPL on credit to GDP has not been altered during the financial crisis (the marginal effect is not significant, and the overall effect after 2007 is −0.18 and significant at the 5% level), whereas the vulnerability effect appears to kick in during crisis times rather than during good times (the marginal effect is 0.52 and the overall effect after 2007 is 0.64 and significant at the 1% level). Interestingly, the crisis does not have an impact by itself. High levels of credit to GDP together with the occurrence of the crisis fuel banking fragility.

Finally, we estimate a 3-equation SUR model, which includes long-term interest rates as a third simultaneous variable. Although we have been interested so far in the relationship between credit and banking fragility with long-term interest rates included in the set of explanatory variables, one can view long-term interest rates as another variable whose determination is simultaneous to credit and banking fragility. Credit demand depends directly on interest rates and the evolution of interest rates can trigger loan defaults as the subprime crisis showed. Column 6 in Table 1 provides estimates of the equation for the two main variables of interest and shows that they are not modified by this assumption. For the sake of parsimony, we pursue the rest of the analysis with a 2-equation SUR model.[8]

4.2 | Estimating causal effects

So far, we have jointly estimated a set of equations assuming that they have no endogenous regressors. However, it is likely that the different variables on the right-hand-side of equations are endogenous. Using 3SLS (SUR-IV) enables to combine the system estimation of SUR with the instrumental variable method of 2SLS so as to get a consistent estimator of equations with endogenous regressors. The 3SLS estimator works in three steps: first, we calculate fitted values of the endogenous variables based on the reduced-form regressions on the exogenous variables as in 2SLS; second we estimate the individual equations by 2SLS, using their fitted values in place of the endogenous regressors; and third, we estimate the system of equations jointly by generalized least squares.

NPL are influenced by macroeconomic and bank-specific factors like the 'too-big-to-fail' presumption (Louzis et al., 2012). A model of NPL determination would then include an index of systemic risk, a volatility index or an index of financial stress. Therefore, we instrument NPL by the composite indicator of systemic stress (CISS), stock market volatility or the Saint Louis Fed Financial Stress Index (STLFSI) (upper panel of Table 2).[9] Because the CISS and the STLFSI include interest rate spreads to measure financial stress, we believe that they may be a good predictor of NPL. In the meantime, they could also influence banks' credit supply. To attenuate this issue, we use our instrument with a lag compared with our endogenous regressor, which itself explains our dependent variable with a lag. This means that we believe that the CISS and STLFSI in *t*-2 may have large effect on NPL in *t*-1 and low effects on credit in *t*, especially because these indicators of financial stress are not that much autocorrelated at the annual frequency. In addition, this timing structure enables to overcome the fact that interest rate spreads may partly depend contemporaneously on the level of NPL. Considering the CISS and STLFSI with a lag compared with NPLs enables to rule out this link. Similarly, a theoretical model of credit dynamics would nest the demand side of the credit market and also draw on the supply side, hence on the liquidity and depth of the financial system. Hence, we instrument credit to GDP by assets to GDP, turnover ratio, or market capitalization (lower panel of Table 2). For similar reasons than those described for NPL, we consider these variables in *t*-2 so that they would have a stronger effect on credit in *t*-1 than on NPL in *t*.

The identification depends on two main assumptions: the instrument does not itself appear in the equation, and the instrument does appear in another equation that influences the endogenous regressor. This means that there needs to be one omitted exogenous variable for each included endogenous variable. There are two ways to assess the relevance of our instrumental variables. They should explain a significant share of the variation in the endogenous regressor, and they should be exogenous to the dependent variables, or in other words, they should not be correlated with the dependent variables except through their effects on the endogenous regressors. To check for the validity of the instrumental variables, we provide the *F*-stat of the first-stage regression (testing that instrumental variables are good predictors of the endogenous regressors) and the R^2 of the regression of the 3SLS residuals on the instruments (the Sargan test equivalent).[10] It is noteworthy that both tests confirm the validity of the six instruments described previously.

We instrument each of our two endogenous regressors separately. For parsimony, we remove the contemporaneous terms of each endogenous variable that are not significant (see previous subsection). In the first set of instruments (i.e., for NPL), the correlation between the CISS and STLFSI is 0.71, but the one between CISS (resp. the STLFSI) and stock market volatility is only 0.38 (resp. 0.46). In the second set of instruments (i.e., for credit to GDP), the correlation of assets with the turnover ratio (resp. market capitalization) is 0.29 (resp. 0.33), whereas the correlation between the turnover ratio and market capitalization is 0.32. Each of these instruments has limitations in their relationship to the instrumented variable and in their relationship to the dependent variable. However, they all satisfy the relevance criterion of the first stage regression and the exclusion criterion of the Sargan test. Overall, while these instruments are not strongly correlated, the consistency of the estimated results for both instrumented variables supports the validity of the instrumental variable approach to estimate causal effects of credit or NPL one on the other.

Results of estimations with SUR-IV are reported in Table 2. They point to robust interrelationships between credit and banking fragility. More precisely, they show a negative causal impact of NPL on credit to GDP and a positive causal impact of credit to GDP on NPL, suggesting that the trauma and vulnerability effects put forward in the previous section are actually at work. While confirming the previous estimates, both effects are of higher magnitude with 3SLS than with a SUR model only. Since our baseline results are robust to IV estimation, the subsequent analysis is performed with the SUR model so as to provide conservative results, that is, with lower bound estimates rather than upper-bound ones.

4.3 | Discussion on subsamples and different controls

There have been important evolutions in financial institutions due to liberalization, innovation, and globalization, which have made differences between financial systems central to their analysis (Djankov, Glaeser, La Porta, Lopez-de-Silanes, & Shleifer, 2003). One important contribution in that respect is Bruno, De Bonis, and Silvestrini (2012), who analyse the heterogeneity of financial systems through the lens of asset allocation among OECD countries. To shed light on the heterogeneity of the relationship between financial stability and credit into the EU, we decompose the sample into several subsamples (EZ, core, core 2, newcomers, and periphery). The composition of these subsamples is discussed in Section A in the Appendix. Table A3 in the appendix shows the list of countries in each subsample, whereas Table A4 shows a comparison of the mean and *SD* of the main variables for all subsamples.

TABLE 2 Seemingly unrelated regression-instrumental variables (SUR-IV) three-stage least squares (3SLS) estimation

	(1)	(2)	(3)
Instrumented	**Non-Perf L_{t-1}**	**Non-Perf L_{t-1}**	**Non-Perf L_{t-1}**
Instrument	**CISS$_{t-2}$**	**Volat$_{t-2}$**	**STLFSI$_{t-2}$**
	First stage regression		
F-stat	89.5	45.3	60.6
	Credit/GDP	Credit/GDP	Credit/GDP
Lag Dep. Var.	0.84***	0.84***	0.84***
	[0.05]	[0.05]	[0.05]
Non-Perf L_{t-1}	−0.17***	−0.16***	−0.16***
	[0.03]	[0.03]	[0.03]
Controls $X_{i,t}$	Yes	Yes	Yes
Controls $Z_{i,t}$	Yes	Yes	Yes
N	167	170	170
	Regression of 3SLS residuals on instruments		
R^2	0.06	0.01	0.05
Instrumented	**Credit/GDP$_{t-1}$**	**Credit/GDP$_{t-1}$**	**Credit/GDP$_{t-1}$**
Instrument	**Asset/GDP$_{t-2}$**	**Turnover$_{t-2}$**	**Market Cap$_{t-2}$**
	First stage regression		
F-stat	4012.4	33.2	58.5
	Non-Perf L.	Non-Perf L.	Non-Perf L.
Lag Dep. Var.	0.69***	0.69***	0.69***
	[0.05]	[0.05]	[0.05]
Credit/GDP$_{t-1}$	0.18**	0.24***	0.24***
	[0.07]	[0.07]	[0.07]
Controls $X_{i,t}$	Yes	Yes	Yes
Controls $Z_{i,t}$	Yes	Yes	Yes
N	158	170	170
	Regression of 3SLS residuals on instruments		
R^2	0.05	0.01	0.04

Note: *SE*s are in brackets, estimated from Equation (1). All variables are standardized to a normal distribution by country.

*$p < .1$.

**$p < .05$.

***$p < .01$.

SUR estimates for subgroups of countries (Table 3) confirm the trauma effect for the EZ, and EU core, and periphery countries; the effect is more than four times higher in core than in periphery countries. Interestingly, there is a divergence for the vulnerability effect between the EZ and core countries on one side and periphery countries and newcomers on the other side: credit has no incidence on banking fragility in the latter. This may proceed from different stages of credit development between the core and the periphery of the EU and shed light on the threshold impact of credit to GDP ratios on banking fragility discussed in Section 4.1.

The coefficients associated to the lagged values of the dependent variables are in all cases very significant and account for the persistence of these processes. We also show in Table A5 in the Appendix that long-term real interest rates have no impact on credit to GDP and a positive impact on NPL. One possible interpretation of the coefficient associated to long-term real interest rates may be that long-term real interest rates have positive effects on the supply side of credits that offset their negative effects on the demand side. This would explain the absence of an impact on the credit to GDP ratio. High interest rates would reveal the fragility of the weakest debtors, increase the share of NPL, and trigger banking fragility. The substitution effect between bank intermediation and financial markets does not appear in the data: stock market capitalization has no significant impact on credit. In addition, stock market capitalization has no effect on NPL. It appears that direct taxes on business are negatively correlated to banking fragility. Finally, the index of financial reform is neither correlated with credit nor with banking fragility. This is consistent with Tressel and Detragiache (2008). We find evidence that the GDP growth rate is negatively correlated to the credit to GDP ratio and to NPL. The former result may be related to different degrees of credit development in the EU and may therefore be related to the convergence effect: most developed economies in the EU share the most developed banking and financial systems; hence, these developed countries with relatively low GDP growth rates would show a more dynamic credit, whereas least developed ones would have a less dynamic one. The negative impact of the growth rate on NPL would also match the argument of the convergence effect: the pace of growth in the least-developed-least financialized countries would not produce the same increase in risk-taking by banks and on financial markets as in the most-developed-most-financialized economies. When credit rises, the smaller economic growth rate would be synonymous of more risks, generating a rise in NPL. Evidence on the positive impact of inflation on banking fragility is strong. Finally, trade openness is not correlated to credit to GDP or banking fragility.[11]

4.4 | Introducing government debt

We enlarge, in Table 4, the scope of common determinants of credit and banking fragility to government debt following Cooper and Nikolov (2018). First, our previous results about the vulnerability effect still hold.

TABLE 3 Geographical zones

	(1)	(2)	(3)	(4)	(5)	(6)
	All	**EZ**	**Core**	**Core 2**	**Periphery**	**Newcomers**
Variable	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**
Lag Dep. Var.	0.70***	0.69***	0.58***	0.66***	0.75***	0.50***
	[0.05]	[0.06]	[0.07]	[0.05]	[0.07]	[0.15]
Credit/GDP	−0.02	−0.10	−0.44***	−0.24**	0.43**	1.03***
	[0.11]	[0.15]	[0.13]	[0.12]	[0.20]	[0.40]
$Credit/GDP_{t-1}$	0.24**	0.40**	0.66***	0.48***	−0.31	−0.97**
	[0.11]	[0.16]	[0.13]	[0.12]	[0.22]	[0.41]
$\Sigma Credit/GDP_{(t+t-1)}$	0.22***	0.30***	0.22***	0.24***	0.13	0.07
	[0.07]	[0.08]	[0.08]	[0.07]	[0.12]	[0.11]
	Credit/GDP	**Credit/GDP**	**Credit/GDP**	**Credit/GDP**	**Credit/GDP**	**Credit/GDP**
Lag Dep. Var.	0.86***	0.94***	0.94***	0.88***	0.89***	0.98***
	[0.05]	[0.05]	[0.06]	[0.06]	[0.06]	[0.05]
Non-Perf L.	−0.01	−0.03	−0.28***	−0.14**	0.11**	0.21***
	[0.05]	[0.05]	[0.08]	[0.07]	[0.05]	[0.08]
Non-Perf $L._{t-1}$	−0.14***	−0.10**	0.02	−0.03	−0.18***	−0.32***
	[0.05]	[0.05]	[0.07]	[0.06]	[0.05]	[0.05]
ΣNon-Perf $L._{(t+t-1)}$	−0.15***	−0.13***	−0.26***	−0.17***	−0.06*	−0.11
	[0.03]	[0.03]	[0.06]	[0.04]	[0.04]	[0.08]
Controls $X_{i,t}$	Yes	Yes	Yes	Yes	Yes	Yes
Controls $Z_{i,t}$	Yes	Yes	Yes	Yes	Yes	Yes
N	182	126	92	118	90	27
R^2_1	0.75	0.78	0.74	0.76	0.82	0.90
R^2_2	0.89	0.92	0.86	0.88	0.95	0.98

Note: *SE*s are in brackets, estimated from Equation (1). All variables are standardized to a normal distribution by country. The composition of country groups is presented in Table A3 in the Appendix.

*$p < .1$.

**$p < .05$.

***$p < .01$.

Second, it appears that public debt to GDP ratios have a positive effect on banking fragility in the EZ and core EU countries.[12] However, if we decompose this effect into normal times and crisis times, it seems that government debt impinges on banking fragility during crisis whereas the effect is null (EZ and core EU countries) or even negative (all countries or periphery EU countries) in normal times. This is consistent with the analysis of Caruana and Avdjiev (2012) and with the home bias in periphery countries that Acharya and Steffen (2015) reveal. A growing debt sustained by a home bias may reduce international financial contagion risks. Meanwhile, the trauma effect is no longer statistically significant in the EZ and EU core countries, and public debt to GDP ratios are negatively correlated to credit except in periphery EU countries. This supports the argument of a possible direct crowding-out effect in the core or of an indirect one in the periphery through the positive effect of higher public debt on banking fragility, which may push banks to reduce their supply of credits and to deleverage.

4.5 | The stock market view of financialization

So far, we have focused on intermediated finance through credit. We complement the analysis by looking at the direct finance through stock markets. In the EU, the two types of funding are not substitutes. Because of a selection bias, households and small and mid-sized corporations do not have the same access to financial markets as the large corporations. Consistent with Beck and Levine (2004), we measure financial deepening by the turnover ratio, which proxies the depth and liquidity of stock

TABLE 4 Introducing government debt

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	**EZ**	**Core**	**Periphery**	**All**	**EZ**	**Core**	**Periphery**
Variable	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**
Lag Dep. Var.	0.03	0.03	−0.34**	0.46**	−0.02	−0.09	−0.33***	0.14
	[0.11]	[0.15]	[0.13]	[0.20]	[0.10]	[0.15]	[0.12]	[0.21]
Credit/GDP	0.20*	0.30*	0.57***	−0.37	0.21**	0.37**	0.54***	−0.17
	[0.11]	[0.16]	[0.14]	[0.23]	[0.10]	[0.16]	[0.13]	[0.21]
Credit/GDP$_{t-1}$	0.68***	0.66***	0.57***	0.77***	0.65***	0.67***	0.55***	0.71***
	[0.05]	[0.06]	[0.07]	[0.07]	[0.05]	[0.06]	[0.07]	[0.07]
Gov. Debt	0.08	0.13*	0.07	−0.09	−0.22***	−0.17	−0.20*	−0.48***
	[0.06]	[0.07]	[0.07]	[0.10]	[0.08]	[0.14]	[0.10]	[0.13]
Gov. Debt * crisis					0.47***	0.38**	0.44***	0.63***
					[0.10]	[0.15]	[0.13]	[0.15]
Crisis					0.36***	0.33	0.37*	0.43**
					[0.14]	[0.20]	[0.21]	[0.19]
ΣCredit/GDP$_{(t\ +\ t-1)}$	0.24***	0.33***	0.23***	0.09	0.19***	0.28***	0.21***	−0.03
	[0.07]	[0.08]	[0.08]	[0.13]	[0.06]	[0.08]	[0.07]	[0.12]
	Credit/GDP	**Credit/GDP**	**Credit/GDP**	**Credit/GDP**	**Credit/GDP**	**Credit/GDP**	**Credit/GDP**	**Credit/GDP**
Lag Dep. Var.	0.84***	0.91***	0.92***	0.92***	0.83***	0.90***	0.92***	0.87***
	[0.05]	[0.05]	[0.06]	[0.06]	[0.05]	[0.05]	[0.06]	[0.06]
Non-Perf L.	0.02	0.01	−0.20**	0.12**	−0.01	−0.03	−0.23***	0.04
	[0.05]	[0.05]	[0.08]	[0.05]	[0.05]	[0.05]	[0.08]	[0.05]
Non-Perf L.$_{t-1}$	−0.13***	−0.09**	0.02	−0.19***	−0.10**	−0.06	0.03	−0.12**
	[0.05]	[0.05]	[0.07]	[0.05]	[0.05]	[0.05]	[0.07]	[0.05]
Gov. Debt	−0.09**	−0.10**	−0.13**	0.06	−0.12**	−0.22***	−0.19**	0
	[0.04]	[0.04]	[0.05]	[0.05]	[0.06]	[0.08]	[0.08]	[0.07]
Gov. Debt * crisis					0.03	0.15*	0.08	0.06
					[0.07]	[0.09]	[0.11]	[0.08]
Crisis					0.19*	0.22*	0.18	0.36***
					[0.10]	[0.12]	[0.18]	[0.09]
ΣNon-Perf L.$_{(t+t-1)}$	−0.11***	−0.09**	−0.19***	−0.07*	−0.11***	−0.09**	−0.19***	−0.09**
	[0.04]	[0.04]	[0.06]	[0.04]	[0.04]	[0.04]	[0.06]	[0.04]
Controls $X_{i,t}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls $Z_{i,t}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	182	126	92	90	182	126	92	90
R^2_1	0.75	0.78	0.75	0.82	0.78	0.79	0.78	0.85
R^2_2	0.89	0.93	0.87	0.95	0.89	0.93	0.87	0.96

Note: *SE*s are in brackets, estimated from Equation (1). All variables are standardized to a normal distribution by country.

*$p < .1$.

**$p < .05$.

***$p < .01$.

markets. In parallel, financial instability is captured by stock market volatility.

Table 5 reports the estimates with this new set of variables. The opposite effects between banking fragility (now financial instability) and credit (now turnover ratio) are still captured with some subsample limitations though. On the one hand, the turnover ratio positively affects stock market volatility, except in core EU

TABLE 5 Stock market view of financialization

	(1)	(2)	(3)	(4)
	All	**EZ**	**Core**	**Periphery**
Variable	**Volat**	**Volat**	**Volat**	**Volat**
Lag Dep. Var.	0.53***	0.55***	0.50***	0.51***
	[0.04]	[0.05]	[0.07]	[0.06]
Turnover	0.05	0.07	−0.12	0.16***
	[0.05]	[0.06]	[0.09]	[0.06]
Turnover_{t-1}	0.23***	0.21***	0.15	0.32***
	[0.05]	[0.06]	[0.10]	[0.06]
$\Sigma\text{Turnover}_{(t+t-1)}$	0.28***	0.27***	0.03	0.48***
	[0.05]	[0.06]	[0.10]	[0.07]
	Turnover	**Turnover**	**Turnover**	**Turnover**
Lag Dep. Var.	0.48***	0.45***	0.47***	0.22*
	[0.07]	[0.08]	[0.10]	[0.12]
Volat	0.08	0.12	−0.15	0.44***
	[0.09]	[0.12]	[0.11]	[0.17]
Volat_{t-1}	−0.17**	−0.21**	−0.1	−0.24*
	[0.08]	[0.09]	[0.09]	[0.13]
$\Sigma\text{Volat}_{(t+t-1)}$	−0.08	−0.09	−0.25***	0.20
	[0.07]	[0.09]	[0.09]	[0.13]
Controls $X_{i,t}$	Yes	Yes	Yes	Yes
Controls $Z_{i,t}$	Yes	Yes	Yes	Yes
N	200	138	107	93
R^2_1	0.67	0.71	0.68	0.75
R^2_2	0.42	0.39	0.58	0.34

Note: *SE*s are in brackets, estimated from Equation (1). All variables are standardized to a normal distribution by country.

*$p < .1$.

**$p < .05$.

***$p < .01$.

countries. This suggests that, except for the EU core, the vulnerability effect is not contingent on the definition of financialization, whether it depends on banks or on financial markets. On the other hand, stock market volatility has a negative effect on the depth and liquidity of financial markets (the turnover ratio) in the EU core only, confirming there a trauma effect. The specificity of the EU core results may stem from its high level of financial development.

5 | CONCLUSIONS

We represent credit and banking fragility as a system of simultaneous joint data generating processes (estimated with SUR) whose error terms are correlated and find that credit positively affects the banking fragility—the vulnerability effect—and banking fragility negatively affects the credit—the trauma effect. We find evidence of some nonlinearities between the two variables. NPL have a nonlinear effect on credit to GDP depending on the level of credit to GDP, whereas the effect of credit to GDP on NPL—the vulnerability effect—depends on the level of credit to GDP and is time contingent: this effect kicks in during crisis times. In addition, we show that the existence of vulnerability and trauma effects are not exclusively related to a credit view of financialization. Endorsing a market view of financialization gives similar outcomes, except for the EU core: a positive effect of financial deepening—measured by the turnover ratio—on financial instability—measured by stock market volatility—and a negative effect of stock market volatility on the turnover ratio.

The existence of a vulnerability effect in the EU as a whole, in the EZ, in the core of the EU but not at its

periphery, and of a trauma effect in all samples raises some policy recommendations. First, the existence of both effects confirms the requirement to control and supervise credit supply in the EZ and core countries of the EU. According to our results, monitoring credit, via policies, which remain to be discussed—for example, a change in capital adequacy ratios—would alleviate the risks of banking fragility. Second, in the EU periphery countries, the variations in long-term interest rates and inflation play a strong role in the rise of banking fragility: hence, supervising credit dynamics in the periphery, within the Banking union, should be complemented with macroeconomic policies aimed at achieving low and stable inflation and long-term interest rates.

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ENDNOTES

[1] Aisen and Franken (2010), Aiyar, Calomiris, and Wiedalek (2014), Altunbas, Gambacorta, and Marques-Ibanez (2009), Ashcraft (2006), Chinn and Ito (2006), Dell'Ariccia, Igan, Laeven, and Tong (2016), Cottarelli, Dell'Ariccia, and Vladkova-Hollar (2005), Goodhart (1995), Hofmann (2004), and Kashyap and Stein (1995) among others have contributed to the empirical literature on the determinants of bank credit. The literature on banking fragility and its determinants has developed along two different lines of reasoning. The first one assumes that capitalism is intrinsically unstable (Minsky, 1995) and leads to leverage and credit booms and busts. The second one sticks to a general equilibrium approach and assumes that banking fragility is caused by financial frictions (due to asymmetric information), hence by financial shocks and their propagation to the rest of the economy (Calomiris, 1995; Mishkin, 1999). The share of NPL in bank balance sheets has been shown to trigger the onset of a banking crisis (Reinhart & Rogoff, 2011). Empirical contributions on the determinants of banking fragility include Louzis, Vouldis, and Metaxas (2012), Gropp, Vesala, and Vulpes (2006), and Ruiz-Porras (2009).

[2] Other measures of banking fragility other than NPL have been proposed. Loayza and Ranciere (2006) measure it as the *SD* of the growth rate of the private credit to GDP ratio over non-overlapping 5-year averages. The ECB has developed a Composite Indicator of Systemic Stress (CISS) for the euro area. The International Monetary Fund (IMF) developed financial soundness indicators. At the micro level, several authors capture financial stability in the banking sector through the Z-score (Fink, Haiss, & Vuksic, 2009; Uhde & Heimeshoff, 2009), which measures the probability of default for a bank or a banking system.

[3] Another potentially interesting variable would have been the degree of securitization, enabling to have credit to GDP and NPL corrected for securitization, so capturing all loans issued and not only those still on banks' balance sheet. Unfortunately, to our knowledge, data are not available for our sample.

[4] A loan is classified as a NPL when the payments of the interest and principal are past due by 90 days or more.

[5] We also report the sum of the NPL coefficients for the second equation of the system.

[6] As a robustness test, we also introduced the deposit banks assets as a measure of bank deepening and the size of bank's balance sheet. Results hold and are available from the authors upon request.

[7] Figure 1 suggests some potential outliers for NPL. For robustness purposes, we removed data points above 20%. The raw correlation is −0.18 in that case. Column 2 of Table 1 has been reestimated using that sample. Coefficients and *t*-stats are similar. These estimates are available from the authors upon request.

[8] Relaxing our main identification assumption and performing individual panel estimations (pooled OLS, fixed- and random-effects) rather than joint ones over the entire sample of countries does not alter our main conclusion: both vulnerability and trauma effects hold. These estimates are available from the authors upon request.

[9] The CISS includes 15 raw measures, mainly of market-based financial stress, which are split equally into five categories, namely the financial intermediaries sector, money markets, equity markets, bond markets, and foreign exchange markets. The CISS places relatively more weight on situations in which stress prevails simultaneously in several market segments. It is unit free and constrained to lie within the unit interval (see Hollo, Kremer, & Lo Duca, 2012). The STLFSI is constructed on U.S. data, but because financial markets are much integrated, at least much more than labor, goods, or credit markets, we assume that this index could act as another relevant proxy for instability on financial markets in Europe.

[10] Staiger and Stock (1997) suggest that the *F*-stat of the first-stage regression should be above 10.

[11] This result is confirmed when replacing trade openness by an index measuring countries' degree of capital account openness, defined by Chinn and Ito (2006).

[12] For simplicity, we only present results for all countries, EZ, core, and periphery countries. Results for Core 2 and newcomers are

available upon request. Subsample choices do not affect our main results

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APPENDIX A.1.

SUBSAMPLES COMPOSITION

The Eurozone (EZ) is composed of the 12 first-member states of the euro area, leaving aside Luxembourg where banking deepening is so strong as to make this small

TABLE A1 Data description and sources

Abbreviation	Description	Source	Frequency
Credit/GDP	Private credit by deposit money banks and other financial institutions to GDP (%)	GFDD	Annual
Non-Perf L.	Bank nonperforming loans to gross loans (%)	GFDD	Annual
Asset/GDP	Deposit money banks' assets to GDP (%)	GFDD	Annual
Turnover	Stock market turnover ratio (%)	GFDD	Annual
CISS	Index comprising the five most important segments of a financial system: bank and non-bank financial intermediaries sector, money markets, securities markets and foreign exchange markets.	ECB	Weekly aggregated to annual
STLFSI	St. Louis Fed Financial Stress Index	FRED	Annual
Volat	Stock price volatility (%)	GFDD	Annual
LT Real IR	Real long-term interest rates (difference between long term interest rates and inflation)	Authors calculation using OECD & WDI	Annual
Market Cap.	Market capitalization of listed companies (% of GDP)	WDI	Annual
Tax. Business	Cyclically adjusted direct taxes on business (% of GDP)	OECD	Annual
Gov. Debt	Gross public debt, Maastricht criterion, as % of GDP	OECD	Annual
Fin. Reform	Index of financial reform	IMF	Annual
Inflation	Inflation, consumer prices (annual %)	WDI	Annual
GDP growth	GDP growth (annual %)	WDI	Annual
Trade open.	Trade (% of GDP)	WDI	Annual

Abbreviations: CISS, composite indicator of systemic stress; ECB, European central bank; FRED, federal reserve economic data; GFDD, global financial development database; WDI, World development indicators.

TABLE A2 Descriptive statistics

Variable	Obs	Mean	*SD*	Minimum	Maximum
Main variables					
Credit/GDP	344	93.12	57.61	6.38	284.62
Non-Perf L.	343	4.75	5.01	0.10	31.60
Financial controls					
LT Real IR	277	2.30	2.03	−1.72	21.00
Market Cap.	405	53.80	47.05	2.41	323.66
Tax. Business	278	0.21	0.55	0.01	3.44
Fin. Reform	330	0.92	0.08	0.49	1.00
Macro controls					
Inflation	405	3.68	5.16	−4.48	59.10
GDP growth	405	2.55	3.68	−17.95	12.23
Trade Open.	397	110.09	52.52	46.64	333.53

TABLE A3 Groups of countries

Eurozone (EZ)	Core	Core 2	Newcomers	Periphery
Austria	Austria	Austria	Bulgaria	Bulgaria
Belgium	Belgium	Belgium	Cyprus	Cyprus
Germany	Germany	Germany	Czech Republic	Czech Republic
Spain	Denmark	Denmark	Estonia	Estonia
Finland	Finland	Finland	Hungary	Spain
France	France	France	Lithuania	Greece
Greece	Luxembourg	Luxembourg	Latvia	Hungary
Ireland	Netherlands	Netherlands	Malta	Ireland
Italy	Sweden	Sweden	Poland	Italy
Netherlands	United Kingdom	United Kingdom	Romania	Lithuania
Portugal		Italy	Slovenia	Latvia
		Spain	Slovakia	Malta
				Poland
				Portugal
				Romania
				Slovenia
				Slovakia

TABLE A4 Mean of the main variables for the different subsamples

	All		Core		Core 2		Periphery		Newcomers	
Variable	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
Non-Perf L. (%)	4.78	3.01	2.19	1.22	2.68	2.22	6.30	2.69	6.95	6.32
Credit/GDP (% of GDP)	91.35	50.87	116.01	30.12	115.34	41.34	76.85	54.90	62.93	59.06
LT Real IR	2.28	0.58	2.16	0.30	2.15	1.31	2.42	0.76	2.09	1.67
Market Cap. (% of GDP)	53.80	40.65	91.05	39.90	86.05	49.74	31.89	19.83	22.32	17.91
Tax. Business (% of GDP)	0.20	0.53	0.08	0.11	0.07	0.10	0.31	0.70	0.65	0.98

(Continues)

TABLE A4 (Continued)

	All		Core		Core 2		Periphery		Newcomers	
Variable	**Mean**	***SD***	**Mean**	***SD***	**Mean**	***SD***	**Mean**	***SD***	**Mean**	***SD***
Fin. Reform (index)	0.92	0.07	0.95	0.06	0.95	0.06	0.90	0.08	0.89	0.10
Inflation (annual %)	3.68	3.32	1.90	0.30	1.86	2.54	4.72	3.81	3.37	4.33
GDP growth (annual %)	2.55	1.13	1.96	0.65	2.00	0.96	2.91	1.20	5.57	7.21
Trade Open. (% of GDP)	110.40	50.76	112.37	66.18	102.85	65.17	109.24	39.03	120.98	32.78

TABLE A5 Coefficients for controls in Table 1

	(2)	(3)	(4)	(5)	(6)
	All	**All**	**All**	**All**	**All**
Variable	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**
LT Real IR	0.19***	0.16***	0.18***	0.21***	0.41***
	[0.06]	[0.06]	[0.07]	[0.06]	[0.07]
Market Cap.	0.03	0.03	0.03	0.04	0.05
	[0.05]	[0.04]	[0.05]	[0.04]	[0.05]
Tax. Business	−0.10**	−0.05	−0.09**	−0.08**	−0.09**
	[0.04]	[0.04]	[0.04]	[0.04]	[0.04]
Fin. Reform	−0.09	−0.21	−0.12	−0.38	0.05
	[0.50]	[0.48]	[0.50]	[0.48]	[0.50]
GDP growth	−0.29***	−0.28***	−0.30***	−0.28***	−0.26***
	[0.05]	[0.05]	[0.06]	[0.05]	[0.06]
Inflation	0.15**	0.10*	0.14**	0.14***	0.32***
	[0.06]	[0.06]	[0.06]	[0.06]	[0.07]
Trade Open.	−0.04	−0.06	−0.03	−0.04	0.00
	[0.05]	[0.05]	[0.05]	[0.05]	[0.06]
	Credit/GDP	**Credit/GDP**	**Credit/GDP**	**Credit/GDP**	**Credit/GDP**
LT Real IR	0.01	0.01	0.02	0.00	−0.06
	[0.05]	[0.05]	[0.05]	[0.05]	[0.05]
Market Cap.	0.03	0.03	0.03	0.03	0.03
	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]
Tax. Business	0.02	0.01	0.01	0.01	0.01
	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]
Fin. Reform	−0.46	−0.43	−0.36	−0.37	−0.41
	[0.35]	[0.35]	[0.35]	[0.35]	[0.35]
GDP growth	−0.14***	−0.13***	−0.12***	−0.12***	−0.12***
	[0.04]	[0.04]	[0.04]	[0.04]	[0.04]
Inflation	0.00	−0.01	0.01	−0.01	−0.08*
	[0.04]	[0.04]	[0.04]	[0.04]	[0.05]
Trade Open.	0.03	0.02	0.02	0.01	0
	[0.04]	[0.04]	[0.04]	[0.04]	[0.04]
Controls $X_{i,t}$	Yes	Yes	Yes	Yes	Yes
Controls $Z_{i,t}$	Yes	Yes	Yes	Yes	Yes
3-equation model	No	No	No	No	Yes

(Continues)

TABLE A5 (Continued)

	(2)	(3)	(4)	(5)	(6)
	All	All	All	All	All
Variable	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**	**Non-Perf L.**
N	182	182	182	182	179
R^2_1	0.75	0.78	0.75	0.78	0.74
R^2_2	0.89	0.89	0.89	0.89	0.89

Note: *SE*s are in brackets, estimated from Equation (1). All variables are standardized to a normal distribution by country. For sake of simplicity, the third equation for long-term interest rates and the parameters for short-term interest rate are not shown here. They are available from the authors upon request.
*$p < .1$.
**$p < .05$.
***$p < .01$.

country an outlier. The sovereign debt crisis highlighted the fragmentation in the EU. We then disentangle member states that belong to the core of the EU and member states that are more at the periphery. This separation is based on the spread between the domestic long-term sovereign interest rates and the German long-term sovereign interest rate post-2007. We choose the value of 0.80% as a cut-off criterion. Consequently, Spain and Italy are included in the periphery of the EU, whereas the United Kingdom is part of the core. The differences in the variables of the core EU and the EU periphery (in Table A4 below) suggest that our grouping is reasonable. On the one hand, NPL, taxes on business, inflation, and growth are on average higher in the periphery than in the core. On the other hand, credits to GDP and market capitalization are on average higher in the core than in the periphery. For robustness purposes, we propose another sample (core 2) to test whether the inclusion of countries in the core (such as Spain or Italy) would change the results. We analyse another subsample (Newcomers) based on the recent waves of European enlargement.