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Government failures and non-performing loans in European countries: a spatial approach

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Abstract

Purpose – The purpose is to analyze the spatially varying impacts of corruption and public debt as % of GDP (proxies of government failures) on non-performing loans (NPLs) in European countries; comparing two periods: one prior to the crisis of 2007 and another one after that. The authors first modeled the NPLs with an ordinary lest square (OLS) regression and found clear evidence of spatial instability in the distribution of the residuals. As a second step, the authors utilized the geographically weighted regression (GWR) to explore regional variations in the relationship between NPLs and the proxies of "Government failures".

Design/methodology/approach – The authors first modeled the NPL with an OLS regression and found clear evidence of spatial instability in the distribution of the residuals. As a second step, the author utilized the Geographically Weighted Regression (GWR) (Fotheringham *et al.*, 2002) to explore regional variations in the relationship between NPLs and proxies of "Government failures" (corruption and public debt as % of GDP).

Findings – The results confirm that corruption and public debt as % of GDP, after the crisis of 2007, have affected significantly on NPLs of the EU countries and the following countries neighboring the EU: Switzerland, Iceland, Norway, Montenegro, and Turkey.

Originality/value – In a spatial prospective, unprecedented in the literature, this research focused on the impact of corruption and public debt as % of GDP on NPLs in European countries. The positive correlation, as expected, between public debt and NPLs highlights that fiscal problems in Eurozone countries have led to an important rise of problem loans. The impact of institutional corruption on NPLs reports that the higher the corruption, the higher is the level of NPLs.

Keywords Non-performing loans (NPLs), GWR model, Bank credit risk, Corruption, Public debt, European Union countries, European crisis, Financial crisis

Paper type Research paper

1. Introduction

The global financial crisis of 2007–2009 was marked by a surge in non-performing loans (NPLs) in the countries of the European Union (EU). According to The World Bank (2020), we recall that the ratio of bank NPLs to total gross loans is the value of NPLs (gross value of the loan as recorded on the balance sheet) divided by the total value of the loan portfolio (including NPLs before the deduction of loan loss provisions). This measures bank health and efficiency by identifying problems with asset quality in the loan portfolio. International guidelines recommend that a loan is considered to be non-performing when payments of principal and interest are 90 days or more overdue or when future payments are not expected to be received in full.

JEL Classification — C21, D73, E32, G21, H63

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NPLs are important because they reflect the credit quality of banks' loan portfolio, and in aggregate terms, reflect the credit quality of the loan portfolio of a country's banking sector (Ozili, 2019). A high rate of NPLs may also lead to expectations that the stability of the banking system will deteriorate, creating systemic risk that may in turn lead to a run on deposits, significantly reducing the intermediation power of banks (Anastasiou *et al.*, 2019a). Therefore, uncovering the determinants of NPLs is of great interest to banks, governments and banking supervisors in order to enable them take appropriate preventive measures.

Several studies have attempted to estimate macroeconomic determinants of NPLs for a variety of countries for the years following the financial crisis of 2007 (Škarica, 2014; Beck *et al.*, 2015; Ghosh, 2015; Tanaskovic and Jandric, 2015), Anastasiou *et al.* (2016, 2019a, b). The main macroeconomic variables that these studies consider to be determinant on NPLs are: GDP, unemployment and inflation rate. For the EU countries, after the crisis in 2007, no study considered as statistically significant the impact on NPLs of corruption and public debt as % of GDP, which are proxies of "Government failures" (Kearl, 1983; Orbach, 2013; Keech and Munger, 2015; Gozgor, 2018). This is very different from the US, where Public debt as % of GDP has a significant effect on NPLs (Ghosh, 2015). For the period prior to the crisis in 2007, the significance of this variable on NPLs for the Eurozone countries was measured by Louzis *et al.* (2012) and by Makri *et al.* (2014). A rise in public debt may lead to fiscal measures, especially cuts in social expenditure and the wage component of government consumption (Perotti, 1996). This may render a number of outstanding loans unserviceable, as household incomes will experience a negative shock, while second-order effects on corporate loans may occur due to decreasing demand (Louizis *et al.*, 2012, p. 1015) in countries of the EU.

Goel and Hasan (2011) and Park (2012) investigated the association between economic corruption and NPLs, for a period prior to 2007. The former showed that more corrupt countries have higher levels of NPLs, while Park (2012) suggests that corruption degrades: (a) the quality of private investment by distorting the banks' intermediation of loanable funds; (b) the quality of public investment. The default rates are at a lower level in economies with high growth rates, high lending rates and which are in the Eurozone. From a statistical point of view, in regional science the use of linear regression as an analytical technique has been widely employed. This method presupposes that the phenomenon being studied is spatially independent of the regions and does not therefore take into consideration local spatial information. There has recently been a surge in econometric work focusing on the inclusion of spatial effects in econometric models. One line of research has developed various approaches aimed at incorporating spatial instability. We should stress that the assumption of spatial stability has been recognized as highly unrealistic, and it has been accepted that parameters may vary over the study area. Indeed, in European Countries, NPLs show fragmentation between core and peripheral banking markets (see Figure 1). The present study thus shows the utility of geographically weighted regression (GWR) for exploring by-country variation in NPLs.

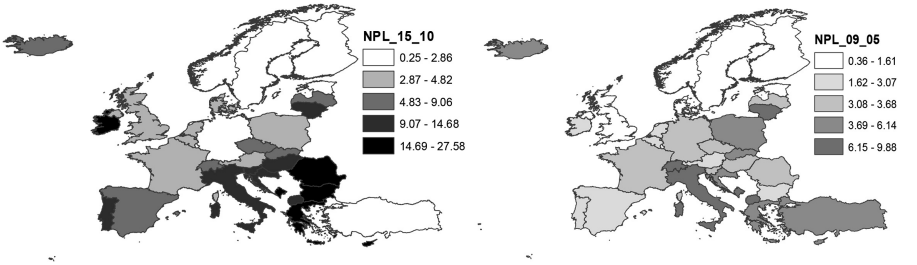

Figure 1.
Spatial distribution (in quantile) of NPLs 2015–2010 (left) and NPLs 2009–2005 (right)

In the light of the above, the objective of this paper, unprecedented in the literature, is to analyze the spatially varying impacts of some typical regressors on NPLs in EU countries. We first modeled NPLs using an ordinary lest square (OLS) regression and found clear evidence of spatial instability in the distribution of the residuals. As a second step, we utilized the GWR (Fotheringham *et al.*, 2002) to explore regional variations in the relationship between NPLs and proxies of "Government failures" (corruption and public debt as % of GDP). Our results confirm that proxies of "Government failures" adversely affected NPLs after the financial crisis of 2007. Corruption may hinder the efficient intermediation of capital, forcing some borrowers without bank connections to reject sound financial projects, which may reduce their growth (Beck *et al.*, 2015), while borrowers with such ties may have easier access to funding (Laeven, 2001; Charumilind *et al.*, 2006). Borrowers who have good connections in the banking system may have a higher default rate and therefore a lower average recovery rate than those lacing such connections. The stability of the banking system is a pre-condition for economic stability and a basis for sustained growth (Ali *et al.*, 2020). In reference to Public debt as % of GDP, the deterioration of public finances places a "ceiling" on the market evaluation of credibility for the national banks and consequently banks become hard-pressed for liquidity (Reinhart and Rogoff, 2010). In this context, banks have to cut lending and thus debtors cannot refinance their debts (Ghosh, 2015).

The present work is structured as follows. The next section illustrates a few important studies that have focused on this topic, on the basis of empirical data, particularly for European countries after the 2007 crisis. The third section discusses the statistical model employed and the empirical results achieved. The fourth section draws the main conclusions.

2. A short review of the empirical studies on NPLs in European countries

In this section, we present the results of major empirical studies that have considered the effects of some macroeconomic variables on the NPLs of EU countries after the 2007 financial crisis. For a review of the topic on the years before the 2007 crisis, see Beck *et al.* (2015), Ghosh (2015), Ozili (2015) and Tanasković and Jandrić (2015). Studies that have considered the causes of rising NPLs after the 2007 financial crisis for (all or some) EU countries include: Škarica (2014), Beck *et al.* (2015), Barra *et al.* (2016), Tanasković and Jandrić (2015) and Anastasiou *et al.* (2016, 2019a, b) [1].

Škarica (2014) is the first empirical study on the countries of the CEE region using aggregate, country-level data on problem loans. In particular, the data set contains quarterly observations for seven countries in the Central and Eastern Europe (CEE) region, from the third quarter of 2007 to the third quarter of 2012. The countries included in the sample are: Bulgaria, Croatia, the Czech Republic, Hungary, Latvia, Romania and Slovakia. The independent variables include real GDP growth, unemployment rate, nominal effective exchange rate (NEER), harmonized index of consumer prices (HICP), share price index and the 3-month money market interest rate. The data on real GDP growth, unemployment rates, HICP, 3-month money market interest rates and the share price indices were obtained from Eurostat. Nominal effective exchange rates were calculated as geometric weighted averages of bilateral exchange rates, with 61 economies included in the sample and were taken from the Bank for International Settlements database. The data on total loans refer to outstanding amounts of domestic loans in all currencies (originally in millions of Euro) at the end of each period (quarter) and were retrieved from the European Central Bank statistics. The estimation technique used was a fixed effects model (p. 49). The results show that the primary cause of high levels of NPLs is the economic slowdown, which is evident from statistically significant and economically large coefficients on GDP, unemployment and the inflation rate.

Also Tanasković and Jandrić (2015) consider some countries in Central, Eastern and South-Eastern Europe for a similar period (2006–2013) to that examined by Škarica (2014).

In particular, the countries included in the sample were: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Hungary, Lithuania, Montenegro, FYR Macedonia, Romania, Serbia and Slovenia. Tanaskovic and Jandric implement fixed effects estimation in order to account for the time-constant unobserved heterogeneity between countries. The independent variables are: (1) *macroeconomic indicators* (*FX_cred*, is the local currency value of FX denominated debt and its servicing cost; *ex_rate* is the change in the nominal US dollar exchange rate for each country; *intr_r* is Increases in lending rates; *infl* is inflation); (2) *institutional indicators* (*fin_mark* is financial market developments; *sound_b* is soundness of the banking system). Tanaskovic and Jandric use three models (p. 58). The first model presents only the effects of macroeconomic indicators on the level of NPLs. The second presents the combined effects of macroeconomic and institutional indicators on NPLs. The third model shows only explanatory variables that are statistically significant (p. 58). The authors' results (pp. 59–60) show a "negative relationship between increases in GDP and a rise in the NPL ratio. The foreign currency loans ratio and the level of exchange rate are positively related with the increase of NPL ratio and they are statistically significant in all models. This confirms the expectation that countries with a high level of euroization will have more problems with the level of NPLs, which is even more pronounced in periods of domestic currency depreciation. In the presented models, the inflation rate is reported as statistically insignificant for sample countries, which is not surprising given that theoretical impact of inflation is ambiguous. In the group of institutional variables, only the financial market level of development is reported as statistically significant, which means that with a more developed financial market the level of NPLs should be lower".

Beck *et al.* (2015) examine the macroeconomic determinants of NPLs across 75 countries, including 26 of the 28 EU countries (excluding, Cyprus and Malta), for the years 2000–2010. The independent variables are: real gross domestic product (*RGDP*); nominal effective exchange rate (*NEER*); lending interest rate (Lending IR); share prices; international claims (ICL). From a methodology point of view, they use two econometric methods: fixed effects (as in previous studies outlined above) and the Arellano-Bond estimation, which inserts nplgr-1 equations. For Beck *et al.* (2015, pp. 540–542), the most significant factors affecting NPLs are: GDP growth (major driver during the last decade), share prices, interest rates and the exchange rate. In the case of share prices, the impact is found to be larger in countries which have a large stock market relative to GDP.

Anastasiou *et al.* (2016, 2019a) use GMM estimations and VAR to identify the main determinants of NPLs in the Euro-area banking system for the period 1990Q1-2015Q2 and for the period 2003–2016. The independent variables are: (1) *ROA* and *ROE*, which reveal the managerial efficiency of a bank to convert its assets and equity into returns (profits). Good management should lead to lower *NPLs*; (2) *LTD*, which is an increasing loans to deposits ratio, reveals a risk preference and is expected to lead to higher NPLs; (3) *UNEMP*, which is increasing unemployment and makes more borrowers unable to meet their debt obligations; (4) *TAXINC* is expressed as % of GDP. As taxed (personal) income increases, disposable income and capacity to pay loans back are reduced; (5) *fiscal* stands for the government budget balance as % of GDP which (together with DEBT may affect NPLs in an ambiguous way, e.g. when an expansionary fiscal policy alleviates/worsens the NPL problem; (6) *DEBT* is the general gross government debt as % of GDP; (7) *growth* is the percentage growth rate of real GDP and is anticipated to have a negative effect on NPLs; (8) *infl* is the inflation rate, which is proxied by the percentage change of the "consumer price index" (CPI) and is thought to improve loan repayment since it makes it cheaper. Most of the estimated coefficients have ± signs compatible with the theoretical arguments in the literature (pp. 3–4). Starting with the bank-specific variables *ltd* and *ltd* −1, which reflect the risk attitude of banks, they are both significant. The banks' performance indicators, *roa* and *roe*, were found to be negatively related to *npls* in most

models. However, only *roe* and *roe-1* were found to be significant in all models. A bank that is characterized by strong profitability is less likely to participate in unsafe activities, such as granting risky loans. The variables *output_gap* and *taxinc* significantly affect the quality of the loan portfolio. *Taxinc* was estimated to exert a strong positive influence. Furthermore, *Fiscal* and *debt* have negative but not significant coefficients as do *growth* and *inflra*. The unemployment rate was found to have a strong positive relationship with NPLs.

Anastasiou *et al.* (2019b) use a sample of yearly observations from 1996 to 2016 (covering both the pre- and post- crisis period). The variables used include the six Worldwide Governance Indicators (hereafter WGI), aggregate NPLs plus additional control variables for Greece. The main innovation of this study is that it includes a new variable (GOVERNANCE index), created by obtaining the first component of a principal component analysis that we performed for the six WGI (voice and accountability, political stability, government effectiveness, regulatory quality, rule of law and control of corruption). This paper, using OLS with robust standard errors, produces three main findings: (1) GOVERNANCE is statistically significant and showed the expected negative value, implying that higher levels of these governance indicators signify a relatively stronger and more stable banking system and hence lower levels of NPLs; (2) the additional control variable employed, namely "systemic liquidity risk", is statistically significant and exerts a positive impact on NPLs; (3) CRISIS_DUMMY is the variable with the greatest magnitude and thus the one with the highest impact on Greek NPLs. "Hence, the recent financial crisis led to increased NPLs in Greece probably due to the fact that after its outburst, higher unemployment rate occurred and thus more people were unable to meet their debt obligations" (p. 12).

In other studies (Louizies *et al.*, 2012; Makri *et al.*, 2014; Ghosh, 2015), *debt* (debt as a percent of GDP) was found to have a strong positive relationship with NPLs.

Louzis *et al.* (2012) and Makri *et al.* (2014) consider the Eurozone countries for a period prior to the 2007 economic crisis. Meanwhile, Ghosh (2015) highlights the significant effect of debt on NPLs also for the years subsequent to 2007 (2007–2013) in US States and the District of Columbia. Only Goel and Hasan (2011) investigate the association between economy corruption and NPLs, for a period prior to 2007. They used a large sample of over 100 countries (including the Eurozone countries) with annual data of all the variables. They used 7 parameters to investigate the impact of institutional corruption on NPLs and employed the ordinary least square technique for the analysis. The results showed that more corrupt countries have higher NPL levels. The default rates are at lower levels in economies with high growth rates, high lending rates and which are in the Eurozone. Furthermore, institutional factors such as financial underdevelopment, central bank autonomy, transition economies and bank based economies have no significant influence on the NPLs.

Table 1 shows a synoptic framework of the main empirical studies that have considered the effects of some macroeconomic variables on the NPLs of EU countries after the 2007 financial crisis. In the next section we will analyze the techniques used and the main results achieved.

3. Estimation methodology, results and discussion

As mentioned above, the objective of this paper is to analyze the spatially varying impacts of "Government failures" (corruption and public debt as % of GDP) on NPLs in European countries. The analysis compares the 2005–2009 and the 2010–2015 periods (after the 2007 crisis), for the 28 EU and the following countries neighboring the EU: Switzerland, Iceland, Norway, Montenegro, and Turkey.

Author	Independent variables	Countries	Years	Econometric method
Škarica (2014)	*GDP, unemployment, inflation rate*	*Bulgaria, Croatia, Czech Republic, Hungary, Latvia, Romania and Slovakia*	2007–2012	Fixed effects
Tanasković and Jandrić (2015)	(*FX_cred*; *ex_rate*; *intr_r*; *infl*; *fin_mark*; *sound_b*)[1]	Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Hungary, Lithuania, Montenegro, FYR Macedonia, Romania, Serbia and Slovenia	2006 to 2013 period	Fixed effects
Beck *et al.* (2015)	*RGDP*; *NEER*; *Lending IR*; *ICL*[2]	75 Western countries, including 26 of the 28 EU countries (countries not considered: Cyprus and Malta	2000–2010	(1) Fixed effects (2) Arellano-Bond estimation
Anastasiou *et al.* (2016)	*ROA, ROE, LTD, UNEMP, TAXINC, FISCAL, DEBT, GROWTH, infl*[3]	Euro-area	1990–2015	GMM estimations
Anastasiou *et al.* (2019a)	*ROA, ROE, LTD, UNEMP, TAXINC, FISCAL, DEBT, GROWTH, infl*	Euro-area	2003–2016	VAR
Anastasiou *et al.* (2019b)	*GOVERNANCE index (PCA for all the Worldwide Governance Indicators, WGI)*	Greece	1996–2016	OLS

Note(s): [1]*FX_cred*, is the local currency value of FX denominated debt and its servicing cost; *ex_rate* is the change in the nominal US dollar exchange rate for each country; *intr_r* is Increases in lending rates; *infl* is inflation rate; *fin_mark* is financial market developments; *sound_b* is soundness of the banking system; [2]*RGDP* (Real Gross domestic Product); *NEER* (Nominal Effective Exchange Rate); *LendingIR* (Lending Interest Rate); *ICL* (International Claims); [3]*ROA* (return on assets); *ROE* (return on equity); *LTD* (increasing loans to deposits ratio); *UNEMP* (increasing unemployment). *TAXINC* (income tax as % of GDP); *FISCAL* (government budget balance as % of GDP). *DEBT* (the general gross government debt as % of GDP); *GROWTH* (the percentage growth rate of real GDP); Infl (inflation rate)

Table 1. Empirical studies that have considered the effects of some macroeconomic variables on the NPLs of EU countries after the 2007 financial crisis

First of all, we show the spatial distribution of NPLs for European countries in the periods 2015–2010 and 2009–2005 (Figure 1). The NPLs vary from 0.25 to more than 27% in the 2015–2010 period and from 0.36 to 9.88% in the 2006–2005 period. Looking at the min-max values we see a fair amount of spatial variation. The highest values are clustered in southern Europe, in particular in the 2015–2010 period, compared to northern Europe (see Table 2).

Indicator	Indicator name	Source	Expected sign
NPLs	Bank non-performing loans to total gross loans (%)	International monetary fund, global financial stability report	*
CP	Corruption Perceptions Index	Transparency international	−
DP	Public debt as % of GDP (General government gross debt % of GDP and million EUR)	EUROSTAT	+

Table 2. Macroeconomic variables in the EU countries considering in this study

The sources of the estimate variables and expected sign (+/−) are shown in Table 2 [2]. In particular:

(1) Bank non-performing loans to total gross loans (%) (*NPLs*) is the dependent variable;

(2) Corruption Perceptions Index (*CP*) [3]; note that *CP* scores range from 0 to 100 and a higher score represents a lower level of corruption. Hence, the expected sign (+/−) of the estimates is negative.

(3) Public debt as % of GDP (*DP*), for which the expected sign (+/−) of the estimates is positive.

Corruption and the Public debt as % of GDP are commonly considered as proxies of "Government failures". As is known in the literature, "Government failures" (Coase, 1964; McKean, 1965), according to the School of Public Choice, represent the inefficiencies and iniquities that may be associated with public action (Wolf, 1979, 1988) [4].

First we specify a basic global model, for the two periods considered, which is estimated by OLS regression, verifying the absence of collinearity in the regressors through the Variance Inflation Factor (VIF) [5] (see Tables 3 and 4). We note that standard OLS regression cannot detect non-stationarity and thus its use may obscure regional variation in the relationships between predictors and the outcome variable. We thus tested the OLS model for spatial autocorrelation and found clear evidence of spatial instability in the distribution of the residuals of the OLS regression (see Moran Test in Tables 3 and 4). We thus utilized the GWR model to explore regional variations in the relationship between NPLs with CP and DP as predictors (Tables 5 and 6). We briefly mention that the GWR model is a spatial statistical method for modeling spatially heterogeneous processes that allows the relationships between a dependent variable and a set of covariates to vary across geographic space. A central

Table 3. Global model (OLS) – period 2015–2010 [8]

Variable	Estimate	S.E.	*t*(Est/S.E.)	*p*-value	VIF
Intercept	18.170	4.021	4.519	$p < 0.01$	–
CP_15_10	−0.220	0.053	−4.146	$p < 0.01$	1.01
DP_15_10	0.069	0.026	2.611	$p < 0.05$	1.01

Note(s): $R^2_{OLS} = 0.45$; Moran test on OLS residues $p < 0.05$

Table 4. Global model (OLS) – period 2009–2005

Variable	Estimate	S.E.	t(Est/S.E.)	*p*-value	VIF
Intercept	7.279	1.219	5.972	$p < 0.01$	–
CP_09_05	−0.068	0.017	−4.149	$p < 0.01$	1.00
DP_09_05	0.016	0.013	1.243	N.S.	1.00

Note(s): $R^2_{OLS} = 0.32$; Moran test on OLS residues $p < 0.05$

Table 5. Local model (GWR) – period 2015–2010

Variable	Min	Lwr quartile	Median	Upr quartile	Max
Intercept*	−0.403	18.077	19.651	20.139	33.705
CP_15_10*	−0.488	−0.243	−0.233	−0.197	0.148
DP_15_10	0.029	0.037	0.056	0.069	0.140

Note(s): $R^2_{GWR} = 0.68$; *F test for spatial variability $p < 0.05$

component of GWR is the spatial weight matrix by which the local spatial relationships are constructed. Usually, spatial weights are defined by spatial kernel functions such as Gaussian or bi-square functions (see for more details Fotheringham *et al.*, 1997, 2002) in which larger weights are assigned to closer observations according to distance decay function.

The estimates, which compare the 2005–2009 and the 2010–2015 period, show [6]:

(1) With regard to the corruption perceptions index (CP), it is statistically significant, at a global level, for the two periods considered: the incidence is clearly stronger in the period 2015–2010 (see the OLS estimates in Tables 3 and 4), that is the period after the crisis. Moreover, spatial analysis reveals that this incidence varies between countries: in particular in the period 2015–2010 in Iceland, Montenegro, Malta, Romania, Macedonia, Hungary, Slovak Republic, Croatia, Lithuania, Latvia and Estonia the coefficient GWR regressor (Table 5) is more negative (compare Figures 2a and 2b). Similarly to what is argued by Park (2012, p. 909), these results provide a possible explanation of why corruption is so frequently cited as one of the main forces causing a financial crisis: "Corruption degrades bank soundness, which leads to a weak banking system, and hence makes a country more vulnerable to a financial crisis".

(2) With reference to public debt as % of GDP (*DP*), it is shown that for the period 2015–2010, it was significant for the following countries: Bulgaria, Cyprus, Greece, Hungary, Ireland, Montenegro, Macedonia, Romania, Turkey and the Slovak Republic (see the darkest countries in Figure 2c). By contrast, during the period

Variable	Min	Lwr quartile	Median	Upr quartile	Max
Intercept	6.834	7.451	7.527	7.552	7.591
CP_09_05*	−0.075	−0.073	−0.072	−0.070	−0.060
DP_09_05	0.013	0.015	0.015	0.016	0.017

Note(s): $R^2_{GWR} = 0.38$; *F test for spatial variability $p < 0.05$

Table 6.
Local model (GWR) – period 2009–2005

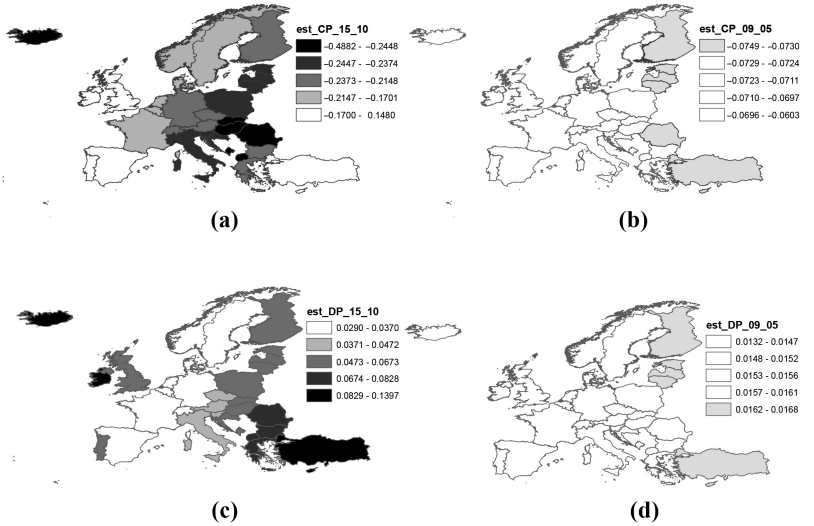

Figure 2.
Mapping (in quantiles) of the estimations of the local coefficients CP and DP

2009–2005, this variable was not significant [7] in any country taken into account for the period prior to the crisis (similarly to the results by Anastasiou *et al.*, 2016, 2019a). In fact, the range of the GWR coefficient value ranges from 0.0013 to −0.0016 and there are no significant spatial differences (see Figure 2d).

4. Concluding remarks

After the financial crisis of 2007, as has been shown in Figure 1, the values of NPLs worsened for the countries of the EU. A rising share of NPLs in the loan portfolio of banks signifies greater risks affecting both the liquidity and profitability of banks (Ghosh, 2015). Since the financial crisis, NPLs have especially been in the spotlight for both regulators and banks, as they have been linked to bank failures and are often a harbinger of banking crises (Bijsterbosch and Falagiarda, 2015). Many recent studies have focused on the estimation of macroeconomic determinants of NPLs for various countries for the years following the financial crisis of 2007.

In a spatial prospective, unprecedented in the literature, this research confirms that the variables of "Government failures" (corruption and public debt as % of GDP), following the crisis of 2007, significantly affected the NPLs of EU countries and the following countries neighboring the EU: Switzerland, Iceland, Norway, Montenegro and Turkey.

The positive correlation, as expected, between public debt and NPLs highlights that fiscal problems in Eurozone countries have led to a significant rise in problem loans. On this point, in terms of policy, compliance with the rules of the "stability and growth pact" by EU countries is important.

The results obtained also show that countries with bad governance might have a weaker banking system due to corruption. According to Park (2012, p. 908), corruption was one of the factors that contributed to the 2008 worldwide financial crisis through its adverse effect on banks' balance sheets. On this point, it is essential that individual EU countries respect "The Criminal Law Convention on Corruption" of the Council of Europe (adopted 27 January 1999 and ratified by almost all EU countries).

In light of the above, our results could be of interest to policy makers and regulators as a macro prudential policy tool; since the fight against corruption and the pursuit of virtuous tax policies are a priority for States with high levels of NPLs.

Notes

1. Barra *et al.* (2016) however quote some works, such as Destefanis (2001), according to which NPLs may have been a longstanding issue, at least in certain socioeconomic contexts.
2. All calculations are carried out using jointly STATA 13.0, GWR 4.0 and QGIS.
3. This index is used by Pagano (2008), Goel and Hasan (2011), Park (2012), Huang (2016) and Gomes *et al.* (2018). Similar estimates are obtained when we use other corruption indices: (1) "Control of corruption captures perceptions of the extent to which public power is exercised for private gain" of Word Bank (used by Ozili, 2018); (2) International Country Risk Guide corruption index (used by Chen *et al.*, 2016, 2018); (3) World Business Environment Survey (used by Akins *et al.*, 2017).
4. Keech and Munger (2015, p. 1) define government failure as follows: "We organize government failure into two types: substantive and procedural. Substantive failures include the inability or unwillingness to maintain order, to maintain sound fiscal and monetary policies, and to reduce risks of transaction costs, which we classify as corruption, agency and rent-seeking. Procedural failures are inadequacies of available social choice mechanisms, causing collective decisions to be arbitrary, capricious, or manipulated".
5. The standard rule of thumb for evaluating VIF is: (1) a VIF greater than 4 indicates concerning levels of collinearity; (2) a VIF greater than 10 indicates problematic levels of collinearity (Chatterjee and Price, 1991).

6. In order to have a wide perspective, in accordance with the current literature (see, par. 2), we have considered the following macroeconomic variables too: GDP per capita (source, World Bank), unemployment (source, International Labor Organization), inflation (source, World Bank national accounts data and OECD National Accounts data files). But, after careful statistical analysis, we decide to focus only on these variables: Corruption Perceptions Index (CP) and General government gross debt % of Gross Domestic Product (DP) which are commonly considered as proxies of "Government failure". In addition, for a robustness check, we used two distinct procedures. First we utilized the work of Anastasiou *et al.* (2019b) by using this new alternative proxy capturing "Government failure". Then we re-estimated the GWR model using this new alternative proxy that captures government failures. Second, restructuring the data according to a panel structure, we verified the estimates obtained by using the first difference GMM model. In both procedures we obtained similar results. Results are available on request.
7. For the significance of the European countries, we consider the *t*-test values of the coefficients of the GWR model (see Fotheringham *et al.*, 1997, 2002 for more information).
8. Both OLS and GWR estimations are conducted using STATA software.

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