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CROSS COUNTRY LINKAGES AS DETERMINANTS OF PROCYCLICALITY OF LOAN LOSS PROVISIONS – EMPIRICAL IMPORTANCE OF SURE SPECIFICATION

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Cross country linkages as determinants of procyclicality of loan loss provisions – empirical importance of sure specification

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ABSTRACT

Procyclicality in banking may result in financial instability and therefore be destructive to economic growth. The sensitivity of different banking balance sheet and income statement variables to the business cycle is diversified and may be prone to increasing integration of financial markets. In this paper we address the problem of the influence of financial integration on the transmission of economic shocks from one country to another and consequently on the sensitivity of loan loss provisions to the business cycle. We also aim to find out whether earnings management hypotheses are supported throughout the whole business cycle. Application of the SURE approach to 13 OECD countries in 1995-2009 shows that the procyclicality of LLP is statistically significant almost in thewhole sample of countries. Independent of the econometric specification, the earnings management hypotheses are hardly supported.

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Contents

1. INTRODUCTION

A common explanation for the procyclicality of the financial system in general, and the banking sector in particular, has its roots in information asymmetries between lenders and borrowers. Some authors argue that the misperceptions of risk and inappropriate responses to changes in risk over time constitute additional material source of financial procyclicality (Borio et al., 2001). Procyclicality of financial variables is one of two potential sources of systemic risk (Borio, 2009:33; BOE, 2009:17). Excessive procyclicality may lead to excessively high systemic risk, and as experience of the last crisis suggests, to boom-bust cycles in the macro-economy (Borio and Zhu, 2012:246).

Loan loss provisions normalized by average total assets or loans are usually applied in financial research to measure the level of credit risk (see e.g. Borio at al., 2001; Chen, 2007; Albertazzi and Gambacorta, 2009; Athanasoglou et al., 2009; Foos et al., 2010; Dietrich and Wanzenried, 2011; Fiordelisi et al., 2011; Haq and Heaney, 2012). If we consider this ratio in aggregated form, we obtain a tool which is usually applied in systemic risk analysis (e.g. by central banks) and cited in the early warnings indicators as well as macroprudential policy tools literature (see e.g. BOE, 2009; IMF, 2011; CFGS, 2010; BIS, FSB and IMF, 2011; Borio and Drehman, 2009, p. 18; Gerdesmeier et a; 2009; Alessi and Detken, 2009; Espinoza et al., 2009; Galati and Moesner, 2010). This risk measure is documented to be procyclical, as it increases when economy is in downswings and decreases during economic upswings. Laeven and Majnoni (2003), Bikker and Metzemakers (2005), Bouvatier and Lepetit (2007) and Albertazzi and Gambacorta (2009) have analyzed in an international sample of banks the relation between LLP and GDP growth and other variables. This research supports the procyclical behavior of LLP, as LLP are negatively related to GDP growth. The analysis of regressions run in those papers leads to the observation that LLP's sensitivity to the economic cycle differs from regression to regression as well as from one set of countries to another.

LLP may be utilized by banks for management objectives. At least three such objectives have been distinguished in the literature (Beaver and Engel, 1996; Ahmed et al., 1999), i.e. income smoothing, capital management and risk management (Fonseca and González, 2008). Previous studies tested those hypotheses (with ambiguous results) using individual banks' data spanning short horizons, which did not cover the whole business cycle. Consequently, it is not obvious if earnings management is a short or long-term phenomenon and whether it is likely to be detected with the application of national banking sectors data (as in Albertazzi and Gambacorta, 2009). Therefore we ask whether determinants related to the respective hypotheses affect LLP formation in the anticipated way throughout a whole business cycle?

Financial, and consequently economic, integration has increased dramatically over the past two decades. Increasing interconnectedness of financial institutions and markets, and more highly correlated financial risks intensified cross-border spillovers through many channels (see Claessens et al., 2010). Any shock to one of the integrated national markets, especially the U.S., is bound to have effects on other countries. But do shocks in any country analyzed in this paper influence the relation between LLP and its determinants in other countries? Previous research did not investigate this problem. We conduct our analysis with the aim of finding out whether linkages between countries affect the sensitivity of LLP to the business cycle and to other determinants of this risk measure.

This paper studies the link between bank loan loss provisions and their determinants using balanced panel dataset for 13 OECD countries (Belgium, Canada, Denmark, France, Germany, Italy, Netherlands, Norway, Poland, Spain, Sweden, Switzerland and United States) over the period of 1995-2009. We test the heterogeneity in the strength of the relationship between the real GDP changes to LLP across countries. Initially we apply country regression approach, commonly used in the literature. In this approach error terms are independent across countries, which makes the system of equation simple. In the next step we consider the SURE (Seemingly Unrelated Regression Equations) approach, to test the impact of economic linkages between countries on the tested relationship. In the SURE model error terms specific to a particular country may be dependent on error terms involved in regression equations related to other countries.

The main novelty of this paper lies in the analysis whether the economic and financial integration between countries affects the sensitivity of LLP to banking sector specific determinants as well as to the business cycle. By looking at how sensitivity of LLP to the business cycle (and its statistical significance) in one country changes in response to shocks in other countries we shed light on the problem of systemic risk spillovers. To the best of our knowledge we are the first to investigate this problem.

We find that LLP are procyclical in most countries considered in our analysis. In contrast to independent regression OLS analysis, the application of the SURE approach shows that the procyclicality of LLP is statistically significant almost in the whole sample of countries. We find support for income smoothing hypothesis only in Spain, where dynamic provisioning regulations are in force. Generally, we infer that regardless of the econometric specification, the earnings management hypotheses are hardly supported, even when the method of specification is accounted for.

The rest of the paper is organized as follows. Section 2 discusses the hypotheses regarding determinants of loan loss provisions with particular focus on the increasing financial integration and its influence on the sensitivity of LLP to the business cycle. Section 3 describes the dataset and empirical methodology. Section 4 reports empirical results. Finally, Section 5 presents conclusions and implications for further research.

2. DETERMINANTS OF LOAN LOSS PROVISIONS AND HYPOTHESES

In the literature, loan loss provisions as a tool of earnings management, are usually expressed as a function of bank specific (internal), macroeconomic and country specific (external) determinants. In our study the variables chosen as possibly explanatory of LLP are those traditionally applied for the income smoothing hypothesis (see Greenawalt and Sinkey, 1988; Beatty et al., 2002; Liu and Ryan, 2006) modified by the inclusion of business cycle measures (as in Laeven and Majnoni, 2003; Bikker and Metzemakers, 2005) (see Table 1).

2.1. Bank determinants

As banking sector specific determinants of loan loss provisions (i.e. net provisions normalized by average total assets) we use three variables representing three hypotheses applied in earnings management literature: profit, loans growth and capital.

PROFIT is operating profit before provisions and taxes divided by total average assets (PROFIT/TA). The relation between this variable and LLP is applied to verify income smoothing hypothesis by banks. If banks use LLP to smooth earnings, then we would expect a positive relationship between PROFIT and LLP. Empirical research on individual banks, both single and cross-country confirms that this variable and LLP are positively related (Greenawalt and Sinkey, 1988; Laeven and Majnoni, 2003; Bikker and Metzemakers, 2005; Liu and Ryan, 2006; Fonseca and González, 2008; and Bouvatier and Lepetit, 2008). The higher the positive coefficient on PROFIT the more income smoothing there is. A negative impact of PROFIT on LLP suggests that banks do not apply LLP to smooth their earnings.

Loans growth is real growth of loans (ΔLoans). Changes in total loans outstanding are related to changes in default risk (and also credit risk). If banks use LLP (i.e. their portion set aside to cover expected losses) to manage credit risk, then the relationship between LLP and ΔLoans is positive. Otherwise, i.e. when banks show imprudent loan loss provisioning behavior, LOANSGROWTH exerts a negative impact on LLP. Empirical results on this relationship do vary. Some papers find positive influence of real loan growth on LLP (Bikker and Metzemakers, 2005; Fonseca and González, 2008) implying that banks set aside provisions to cover risks which have built up during economic booms. Other studies document a negative coefficient on ΔLoans (Laeven and Majnoni, 2003) which implies the rejection of the hypothesis of prudent loan loss provisioning behavior.

Table 1. Definitions of variables.

Variable	Measure	Notation	Expected effect on LLP
Dependent variable:			
Aggregated credit risk	Net loan loss provisions divided by average total assets	LLP	
Determinants:			
Banking sector specific:			
Income smoothing measure	Profit before taxes and provisions to average total assets	$PROFIT/TA$	+
Risk management measure	Real growth of loans to non-financial customers	$\Delta LOANS$	+
Capital management measure	Capital to assets ratio.	CAP/TA	-/+
Macreconomic:			
Business cycle measure (real)	Real GDP growth	$GDPG$	-
Business cycle measure (prices)	Inflation (Consumer Prices Index)	INF	+/-

Capital normalized by total assets (CAP/TA) is introduced to test the capital management hypothesis. The capital management hypothesis emphasizes the role of loan loss provisions in capital ratio variation. The relationship between CAP and LPP may be both negative and positive. If capital variation is more related to retained earnings than to loan loss reserves, as stipulated in many accounting standards, the CAP may exert a negative effect on LPP. Such negative coefficient on CAP is found by Ahmed et al. (1999) and Bikker and

Metzemakers (2005). On the other hand, if the capital level is more affected by the loan loss allowances set aside by banks, then the influence of CAP on LLP is positive. Indeed, Liu and Ryan (2006) find a significantly positive coefficient on CAP, implying that better capitalized banks recorded charge-offs more quickly than poorly capitalized banks did. Shrieves and Dahl (2002) and Bouvatier and Lepetit (2008) find a positive coefficient on CAP and suggest that this observation is in line with capital management hypothesis, as poorly capitalized banks increase their LLP to increase their capital base.

2.2. Macroeconomic determinants

We focus on two macroeconomic determinants of LLP: the GDPG and the INF. The GDPG is real GDP growth. *GDPG* as a control variable is included to control for the documented procyclical effect of provisioning. The ratio of relationship between LLP and GDPG is the most interesting variable in our study, as its sensitivity to the business cycle measures the procyclicality of LLP. Empirical research shows that GDPG is negatively related to LLP (Laeven and Majnoni, 2003; Bikker and Metzemakers, 2005; Bouvatier and Lepetit, 2008; Fonseca and González, 2008). The stronger the negative coefficient of GDPG, the more procyclicality there is. A positive association between LLP and GDP would suggest countercyclical provisions and therefore support the hypothesis of prudent loan loss provisioning behaviour of banks emphasized by Laeven and Majnoni (2003).

INF is the inflation rate. We employ INF as an exogenous control variable. Inflation has been used as a determinant of LLP by Albertazzi and Gambacorta (2009). Their study finds that the coefficient on the INF is positive, suggesting that LLP increase as consumer prices get higher. However, if the INF is considered as economic cycle variable, increasing in economic booms and decreasing during economic busts we might expect that this variable is negatively related to LLP, which would be consistent with the procyclicality hypothesis emphasizing that loan loss provisions decrease in economic upswings and increase in economic downswings.

2.3. High integration of the financial system and its impact on systemic risk

Financial and consequently economic integration has increased dramatically over the past two decades. This phenomenon results in capital account openness and financial market reforms and is present especially among OECD countries. In those countries it manifests itself in cross-border gross positions (Kool, 2010). A number of resent papers show that financial integration may bring about indirect and catalytic growth (Kose et al., 2009). However, the last financial crisis reminds us of the risks of financial integration for both emerging and advanced economies (Obstfeld, 2009).

Increasing interconnectedness of financial institutions and markets, and more highly correlated financial risks intensified cross-border spillovers through many channels (see Claessens et al., 2010). Any shock to one of the integrated national markets, especially the U.S. is bound to have effects on other countries. Using VAR models Helbing et al. (2011) find that credit shocks originating in the United States have a significant impact on the evolution of world growth during global recessions. Credit (and sometimes other) shocks are events characteristic of unstable financial systems (Borio and Drehmann, 2009). This instability of financial system leads to excessive levels of systemic risk.

Excessive levels of systemic risk, exemplified by past and recent crises, reveal a range of distortions which might result in risk across the financial system rising above its socially optimal levels. Those distortions stem from market failures (BOE, 2009) as well as wrong responses by market participants to risks across time (Borio et al., 2001). These distortions propagate within the financial system and on to the real economy through two channels: leverage and maturity mismatch, both of which are features of banking activity. As is pointed out in the literature, in dealing with systemic risk, besides the leverage and maturity mismatch dimensions (BOE, 2009), two additional dimensions need to be considered: the cross-sectional dimension (also called network risk) and the time series dimension (Borio, 2009). Whereas in the cross – section dimension the key issue is how risk is distributed across individual institutions at a given point in time, in the time dimension the most important issue is how systemic risk can be amplified by interactions within the financial system as well as between the financial system and the real economy (for more see Borio, 2009). Procyclicality of financial variables, and in effect banking sector variables, is an example of the time dimension of systemic risk.

Previous studies suggest that business and financial cycles do interact (Claessens et a., 2012). These interactions are more prominent between credit and house price cycles (again implying a procyclicality of the financial system). Claessens et al. (2012) suggest that the empirical literature about important roles played by countries' institutional structures and regulatory frameworks in shaping the interactions between business and financial cycles is still limited. Given the importance of these interactions, we conduct our analysis with the SURE estimation to find out whether linkages between individual countries do contribute to the procyclicality of credit risk.

3. DATA AND RESEARCH METHODOLOGY

We use the aggregated yearly bank balance sheet and income statement data over the period of 1995-2009. This dataset is collected by OECD in a harmonized way which eliminates the effects of differences in statistical definitions and accounting and therefore allows meaningful comparisons across countries. We use information for national banking sectors in 13 countries. The basic model reads as:

$$\frac{LLP_{j,t}}{TA_{j,t}} = \alpha_{j,0} + \alpha_{j,1}\frac{LLP_{j,t-1}}{TA_{j,t}-1} + \alpha_{j,2}\Delta GDPG_{j,t} + \alpha_{j,3}INF_{j,t} + \alpha_{j,4}\frac{PROFIT_{j,t}}{TA_{j,t}} + \alpha_{j,5}\Delta Loans_{j,t} + \alpha_{j,6}\frac{CAP_{j,t}}{TA_{j,t}} + \varepsilon_{j,t}, \quad \text{(I)}$$

where all variables are observed for *j*-th country (*j*=1,…,*n*) at year *t*=1,…,T. The dependent variable is the loan loss provision (LLP) of bank divided by this bank's total assets (TA). The independent variables can be subdivided into two groups. In the first group we collect the macroeconomic variables, like annual growth of the real Gross Domestic Product ($\Delta GDPG_{j,t}$) and the inflation rate ($INF_{j,t}$). The second group of variables consist of various bank specific variables, like earnings before imposing LLP and taxes ($\frac{PROFIT_{j,t}}{TA_{j,t}}$), loans growth ($\Delta Loans_{j,t}$), and capital ratio measured as share of capital in total assets ($\frac{CAP_{j,t}}{TA_{j,t}}$). The model also includes the first lag of the dependent variable to capture adjustment costs that constrain the complete adjustment of LLP to an equilibrium level (see Laeven and Majnoni, 2003; Bikker and Metzemakers, 2005 and Fonseca and González, 2008). All banking sector specific variables are normalized by the bank total average assets (TA) to mitigate potential estimation problems with heteroscedasticity.

Standard assumption that, for each t, Gaussian error terms $\varepsilon_{j,t}$ and $\varepsilon_{i,t}$ in (I) are uncorrelated if $i \neq j$, makes the system of equations (I) independent. We denote this case by M_0.

However, in general, error terms $\varepsilon_{j,t}$ and $\varepsilon_{i,t}$ can be correlated and the system (I) can be treated as falling under the Seemingly Unrelated Regression Equations (SURE) model. We define this case as M_1, while $\varepsilon_t = (\varepsilon_{1,t}, \ldots, \varepsilon_{n,t})$ stands for the vector of error terms at time t with the covariance matrix Σ. In the case of model M_1 the matrix Σ is symmetric and positive definite with $n(n+1)/2$ free elements (σ_{ij}^2), i=1,…,n and j=1,…,n, such that $\sigma_{ij}^2 = \sigma_{ji}^2$. In the standard notation the variance of the error terms in the i-th country is denoted by σ_{ii}^2 and the covariance between error terms in j-th and i-*th* country is denoted by σ_{ij}^2. We apply the following notation to the dependent variable and the vector of explanatory variables:

$$y_{j,t} = \frac{LLP_{j,t}}{TA_{j,t}},\ x_{j,t} = \left(1, \frac{\mathrm{LLP}_{j,t-1}}{\mathrm{TA}_{j,t}-1}, \Delta\mathrm{GDPG}_{j,t}, \mathrm{INF}_{j,t}, \frac{\mathrm{PROFIT}_{j,t}}{\mathrm{TA}_{j,t}}, \Delta\mathrm{Loans}_{j,t}, \frac{\mathrm{CAP}_{j,t}}{\mathrm{TA}_{j,t}}\right).$$

The system of equations (I) can be formulated in the following closed form:

$$y^{(j)} = x^{(j)}\alpha^{(j)} + \varepsilon^{(j)},\ j=1,\ldots,n,$$

where $y^{(j)} = (y_{j,1}, \ldots, y_{j,T})'$, $x^{(j)} = \left(x'_{j,1}, \ldots, x'_{j,T}\right)'$, $\varepsilon^{(j)} = \left(\varepsilon_{j,1}, \ldots, \varepsilon_{j,T}\right)'$ and $\alpha^{(j)} = (\alpha_{j,0}, \alpha_{j,1}, \ldots, \alpha_{j,6})'$. In the next step we stack the observations presenting the system of equations as a regression of the following form:

$$\mathrm{Y} = \mathrm{X}\alpha + \varepsilon, \qquad \text{(II)}$$

where $Y_{[nTx1]} = (y^{(1)'}, \ldots, y^{(n)'})'$, $\varepsilon_{[nTx1]} = (\varepsilon^{(1)'}, \ldots, \varepsilon^{(n)'})'$, $\alpha_{[n7x1]} = (\alpha^{(1)'}, \ldots, \alpha^{(n)'})'$ and:

$$X_{[nTxn7]} = \begin{pmatrix} x^{(1)} & 0_{[Tx7]} & \cdots & 0_{[Tx7]} \\ 0_{[Tx7]} & x^{(2)} & \cdots & \vdots \\ \vdots & \ddots & \ddots & 0_{[Tx7]} \\ 0_{[Tx7]} & \cdots & 0_{[Tx7]} & x^{(n)} \end{pmatrix}.$$

Simple calculations yield the following form of the covariance matrix for the error term ε in (II):

$$\mathrm{V}(\varepsilon) = \Sigma \otimes I_n,$$

where $\otimes$ denotes the Kronecker product. The form of the covariance matrix of ε makes the system (II) a generalised linear regression. Given Σ, the Aitken Generalised Least Squares estimator of all parameters in the system can be expressed in the following form:

$$\hat{\alpha} = (X'(\Sigma \otimes I_n)^{-1}X)^{-1}X'(\Sigma \otimes I_n)^{-1}y.$$

In the M_0case, where $\Sigma = \mathrm{diag}(\sigma_{11}^2, \ldots, \sigma_{nn}^2)$ we have:

$$\hat{\alpha} = \hat{\alpha}_{OLS} = (X'X)^{-1}X'y,$$

which is equivalent to the application of the OLS estimator to each equation separately. In the general case, M_1, we have to estimate the covariance matrix Σ. In the empirical part of the paper we apply the Zellner (1962) method, and estimate elements of matrix Σ on the basis of OLS residuals, denoted by $\hat{\varepsilon}_{[nTx1]} = (\hat{\varepsilon}^{(1)'}, \ldots, \hat{\varepsilon}^{(n)'})$. The Estimated GLS, proposed by Zellner (1962) takes the following form:

$$\hat{\alpha}_{EGLS} = (X'(\mathrm{S} \otimes I_n)^{-1}X)^{-1}X'(\mathrm{S} \otimes I_n)^{-1}y,$$

where:

$$S = \frac{1}{T}(\hat{\varepsilon}^{(1)}, \dots, \hat{\varepsilon}^{(n)})'(\hat{\varepsilon}^{(1)}, \dots, \hat{\varepsilon}^{(n)}).$$

4. RESULTS AND DISCUSSION

Table 2 reports descriptive statistics for the variables applied in our study. Let us briefly highlight a few facts. On average, banking sectors in our sample have LLP of 0.327% over the entire period of 1995-2009. Of our two macroeconomic determinants, both show comparable mean levels, of over 2%. However, the INF is far more diversified across countries, with minimum and maximum values of -0.49% and 28.07%, respectively. With regard to profit before taxes and provisions, the mean value is around 1.19%.The minimum and maximum values range between -0.77% and 3.98%. The mean loans growth is about 6.23%, with a minimum value of -15.73% and maximum value of 44.9%. Finally, the mean value of capital ratio is 5.99%. The minimum and maximum values range between 2.52% and 11.05%.

Table 2. Descriptive statistics of data

	$\frac{LLP_{j,t}}{TA_{j,t}}$	$\Delta GDPG_{j,t}$	$INF_{j,t}$	$\frac{PROFIT_{j,t}}{TA_{j,t}}$	$\Delta Loans_{j,t}$	$\frac{CAP_{j,t}}{TA_{j,t}}$
Mean	0.00327	2.2149	2.3974	0.011850	0.062273	0.059899
Median	0.00278	2.4452	2.01667	0.011362	0.052095	0.056950
Maximum	0.01792	7.0863	28.072	0.039758	0.44851	0.110483
Minimum	-0.00734	-5.6667	-0.49446	-0.007736	-0.15738	0.025217
Std. Dev.	0.003193	2.1752	2.8142	0.006351	0.08620	0.01907
Skewness	1.3	-1.1	5.9	1.2	0.8	0.5
Kurtosis	6.79	5.35	46.67	6.19	5.27	2.52
Jarque-Bera	171.90	83.26	16626.61	128.64	63.83	9.83
Probability	0	0	0	0	1.38e-14	0.0073
Sum	0.63697	431.91	467.49	2.3107	12.143	11.680
Sum Sq. Dev.	0.001978	917.95	1536.4	0.007824	1.4415	0.07058
Observations	195	195	195	195	195	195

Table 3. Correlation matrix for variables

	$\frac{LLP_{j,t}}{TA_{j,t}}$	$\Delta GDPG_{j,t}$	$INF_{j,t}$	$\frac{PROFIT_{j,t}}{TA_{j,t}}$	$\Delta Loans_{j,t}$	$\frac{CAP_{j,t}}{TA_{j,t}}$
$\frac{LLP_{j,t}}{TA_{j,t}}$	1					
$\Delta GDPG_{j,t}$	**-0.32*** **	1				
$INF_{j,t}$	**0.14** **	0.34***	1			
$\frac{PROFIT_{j,t}}{TA_{j,t}}$	**0.29** **	0.41***	0.60***	1		
$\Delta Loans_{j,t}$	**-0.37*** **	0.59***	0.23***	0.29***	1	
$\frac{CAP_{j,t}}{TA_{j,t}}$	**0.44*** **	0.15**	0.28***	0.77***	0.09	1

** denotes significance at 5% level; *** denotes significance at 1% level

Table 3 presents the correlation matrix of the regression variables. The correlations indicate a statistically significant correlation between LLP and each of the explanatory variables. The correlation between LLP and real GDP growth is around 0.32 and is negative, suggesting procyclical behavior of banks' loan loss provisioning. The correlation between LLP and inflation rate is positive and around 0.14, indicating procyclical behavior of banking sectors, as LLP increases with increasing inflation (and possibly with increasing nominal interest rates, which might make financing conditions of borrowers more costly, and therefore result in higher default risk (see e.g. Borio and Zhu, 2012)). Correlation between LLP and profit before taxes and provisions is around 0.29, implying that banks do exercise income smoothing. The correlation between LLP and real loan growth is negative and quite strong (i.e. -0.37), suggesting imprudent risk management behavior. Finally, the correlation between our dependent variable and banking sector capital ratio is positive and stands around 0.44. Such correlation might support the capital management hypothesis.

4.1. Results of net provisions sensitivity to determinants – independent regressions

Table 4 presents the OLS estimation of the loan loss provisioning model (M_0), denoted by equation (I). The OLS regressions are run separately for each country in the sample with the assumption that the error term in equation (I) in any particular country is not correlated with error terms in the other countries. Such estimation treats the regression for each country separately, and ignores interactions among the equations, at the same time implying that there are no linkages between countries.

Both macroeconomic determinants suggest procyclicality of LLP. In 10 countries the GDP growth coefficient is negative, with 5 countries exhibiting statistical significance of this coefficient. In 3 countries this coefficient is positive, but statistically insignificant. In line with expectations, the INF coefficient is almost always positive (i.e. in 12 out of 13 countries). However, it turns out to be statistically significant only in 2 countries.

Concerning the banking sector specific determinants applied to test the three earnings management hypotheses, our results show that income smoothing hypothesis is rejected in 11 countries, where the relationship between LLP and profit before taxes and provisions is negative. However, this relationship is statistically significant only in 5 countries. The income smoothing hypothesis is supported only in 2 countries, of which in one (i.e. Spain) the positive coefficient is statistically significant. Our result is to some degree consistent with estimations obtained by Fonseca and González (2008, p. 224), who showed that income smoothing is a diversified phenomenon, and not in all countries it can be borne out.

Loans growth as a proxy for risk management appears to be a positive determinant of LLP in 7 countries. Although the coefficient between LLP and loans growth is positive, this observation does not imply that banks practice prudent risk management, due to the fact that the coefficient on loans growth in each of those 7 countries is statistically insignificant. We do not find support for imprudent risk management practices either, since the negative impact of loans growth in 6 countries is statistically insignificant as well.

Finally, the capital to assets ratio is negatively related to LLP in 6 countries, with 2 countries exhibiting a statistically significant relationship, and supports the capital management hypothesis predicting higher provisioning when the capital ratio is relatively low. In contrast, in 7 countries this relationship is positive, but only in 2 countries the coefficient on capital ratio is statistically significant. In general, our results suggest that with independent OLS regression analysis capital management hypothesis is hardly supported.

Table 4. Determinants of loan loss provisions in individual countries – the model M0 (independent regressions)

		$\frac{LLP_{j,t-1}}{TA_{j,t-1}}$	$\Delta GDPG_{j,t}$	$INF_{j,t}$	$\frac{PROFIT_{j,t}}{TA_{j,t}}$	$\Delta Loans_{j,t}$	$\frac{CAP_{j,t}}{TA_{j,t}}$	Intercept
Belgium	estimates	0.5575	0.0003	0.0003	-0.2230	-0.0067	0.0206	0.0004
	std. error	0.3137	0.0002	0.0005	0.1185	0.0061	0.0519	0.0030
	t-stat	1.7770	1.1929	0.6585	1.8815	1.0940	0.3976	0.1458
	prob	0.1188	0.2718	0.5313	0.1019	0.3101	0.7028	0.8882
Canada	estimates	-0.2254	-0.0006	0.0008	-0.0631	-0.0275	-0.2684	0.0195
	std. error	0.5338	0.0004	0.0008	0.2861	0.0153	0.2277	0.0134
	t-stat	0.4224	1.4296	0.9695	0.2206	1.7983	1.1790	1.4570
	prob	0.6854	0.1959	0.3646	0.8317	0.1152	0.2769	0.1885
Denmark	estimates	0.8630	-0.0012	0.0010	-0.5926	0.0066	0.1784	-0.0034
	std. error	0.2936	0.0003	0.0007	0.3015	0.0067	0.1513	0.0071
	t-stat	2.9399	3.6218	1.3576	1.9653	0.9767	1.1786	0.4876
	prob	0.0217	0.0085	0.2167	0.0901	0.3613	0.2771	0.6407
France	estimates	0.5719	-0.001	0.00005	-0.0109	0.0007	0.0106	0.0003
	std. error	0.1671	0.0001	0.0003	0.1403	0.0046	0.0794	0.0032
	t-stat	3.4232	0.9784	0.1775	0.0778	0.1473	0.1340	0.0996
	prob	0.0111	0.3604	0.8641	0.9402	0.8870	0.8971	0.9235
Germany	estimates	-0.1308	-0.0002	0.0007	-0.0643	-0.0041	0.2037	-0.0058
	std. error	0.3730	0.0004	0.0006	0.2662	0.0116	0.2214	0.0103
	t-stat	0.3507	0.6133	1.1465	0.2414	0.3507	0.9201	0.5635
	prob	0.7361	0.5590	0.2893	0.8161	0.7361	0.3881	0.5907
Italy	estimates	0.3236	-0.0007	0.0011	0.1518	0.0045	-0.1248	0.0077
	std. error	0.4246	0.0005	0.0007	0.2561	0.0225	0.1624	0.0143
	t-stat	0.7621	1.4906	1.4911	0.5928	0.2007	0.7686	0.5421
	prob	0.4709	0.1797	0.1796	0.5720	0.8467	0.4673	0.6046
Netherlands	estimates	0.5643	0.00002	0.0004	-0.4828	0.0014	0.0964	0.00002
	std. error	0.2615	0.0001	0.0002	0.0644	0.0017	0.0391	0.0010
	t-stat	2.1579	-0.1300	2.7229	7.5000	0.7817	2.4690	0.0197
	prob	0.0678	0.9002	0.0296	0.0001	0.4600	0.0429	0.9848
Norway	estimates	0.4162	-0.0011	0.0001	-0.9292	0.0070	0.2106	-0.0002
	std. error	0.2303	0.0005	0.0005	0.4297	0.0094	0.0970	0.0037
	t-stat	1.8072	2.1060	0.2309	2.1623	0.7443	2.1720	0.0468
	prob	0.1137	0.0732	0.8240	0.0674	0.4809	0.0664	0.9640
Poland	estimates	0.2218	-0.0017	0.0004	-0.4833	0.0023	-0.0587	0.0276
	std. error	0.2691	0.0007	0.0003	0.4043	0.0082	0.1692	0.0231
	t-stat	0.8242	2.5636	1.3388	1.1954	0.2773	0.3469	1.1947
	prob	0.4370	0.0374	0.2225	0.2708	0.7896	0.7388	0.2711
Spain	estimates	-0.1237	-0.0006	0.0001	0.6212	-0.0034	0.0980	-0.0089
	std. error	0.1735	0.0001	0.0002	0.1486	0.0032	0.0352	0.0039
	t-stat	0.7132	5.7244	0.7960	4.1790	1.0660	2.7890	2.3109
	prob	0.4988	0.0007	0.4522	0.0411	0.3218	0.0270	0.0541
Sweden	estimates	0.2550	-0.0004	-0.0004	-0.0178	0.0018	-0.4159	0.0247
	std. error	0.2200	0.0002	0.0005	0.1852	0.0051	0.1125	0.0066
	t-stat	1.1588	2.3241	0.7887	0.0959	0.3598	3.6961	3.7214
	prob	0.2845	0.0531	0.4562	0.9263	0.7296	0.0077	0.0074
Switzerland	estimates	0.8840	0.0001	0.0041	-0.0871	-0.0025	-0.0929	0.0027
	std. error	0.3774	0.0009	0.0020	0.2756	0.0191	0.1727	0.0101
	t-stat	2.3420	0.1082	2.0089	0.3160	0.1305	0.5381	0.2627
	prob	0.0517	0.9169	0.0845	0.7612	0.8999	0.6072	0.8004
US	estimates	0.9235	-0.0006	0.0002	-0.5665	-0.0130	-0.0809	0.0221
	std. error	0.2217	0.0004	0.0004	0.0904	0.0111	0.0439	0.0061
	t-stat	4.1645	1.7023	0.4691	6.2671	1.1699	1.8409	3.6067
	prob	0.0042	0.1325	0.6533	0.0004	0.2803	0.1082	0.0087

Source: Author's calculations. Note: we present the results of OLS estimation of independent regressions of Eq. (I) of loan loss provisions and its determinants. Standard specification tests have also been conducted; R-squared (Adjusted R-squared, respectively) ranges from 0.566 (0.194) for Canada to 0.989 (0.979) for the US; Probability values for F-statistics (testing the hypothesis of statistical significance of the coefficients) range from 0.297 (for Canada) to 0.000 (for the US).

4.2. Economic and financial relations as the driving forces of LLP sensitivity to banking sector specific determinants and business cycle determinants – results from the SURE model

In addition to the ordinary least squares (OLS) just described, we have also conducted seemingly unrelated regression estimates (SURE) of equation (I) for each country. Table 5 reports the SURE estimation of the loan loss provisioning model (M_1). As has been mentioned in the methodology section, the OLS treats the regression for each country separately and ignores interactions among the equations. The residuals (error terms) across countries are expected to be correlated, however, because countries' systemic risks (exemplified in its default risk dimension by the level of LLP) are driven by many of the same macro-financial conditions highlighted in section 2 of this paper. SURE uses this information to estimate the system of equations more efficiently (Zellner, 1962). Although SURE requires an estimation of the covariance matrix of disturbances, the efficiency gain is likely to be large for at least two reasons cited in the literature (Greene, 2012, pp. 292-299). First, the error terms are likely to be highly correlated across countries, due to the interconnectedness of economic and financial systems. Second, the dimension of the covariance matrix (in our case 13×13) is smaller than the length of the time series (15 years). Indeed, Table 5 shows that the SURE estimation has improved the statistical significance of all coefficients.

The GDP growth coefficients range from -0.0014 for Poland to 0.0004 for Switzerland, and 11 out of the 13 estimates are negative, with 9 countries exhibiting statistical significance of the negative coefficients. In 2 countries this coefficient is positive, but only in one country (Belgium) statistically significant. In line with expectations, the INF coefficients are almost always positive. These coefficients range from -0.0002 for Sweden to 0.0037 for Switzerland, and 12 out of 13 estimates are positive. In 10 countries this determinant of LLP is statistically significant. The results therefore indicate that aggregated credit risk proxied by LLP is procyclical, and this feature of LLP is predominant if we account for cross country linkages estimated with the SURE method. Our result is consistent with estimations of Albertazzi and Gambacorta (2009) who, in an unbalanced panel of countries, found a negative relationship between LLP and real GDP growth and a positive association between LLP and inflation.

The coefficients on profit before taxes and provisions range from -0.899 for Norway to 0.574 for Spain, with only 4 out of 13 estimates positive (and 1 estimation statistically significant, notably in the case of Spain where dynamic provisioning is implemented). In 6 out of 9 countries with negative coefficients this estimation is statistically significant. This result, with the exception of Spain, suggests a rejection of income smoothing hypothesis in our sample of countries. Our estimations are to a certain extent consistent with the results obtained by Fonseca and González (2008, pp. 224) who showed that income smoothing is a diversified phenomenon. In their analysis the coefficients on profits before taxes and provisions range from -0.6804 for Colombia to 0.63 for Peru, with 12 out of 18 statistically significant estimates positive. They also found that there is no statistically significant LLP – PROFIT relation in 21 other countries which were present in their research sample.

Loans growth as a proxy for risk management appears to be a positive determinant of LLP in 6 countries, with only two coefficient statistically significant (for Denmark and Netherlands). This implies that SURE estimation increased the number of countries in which banks practice prudent risk management (from 0 in OLS independent regressions estimation to 2). Having said that we must admit that our estimation suggests rejection of prudent risk management in 2 countries, in which the coefficient is negative and statistically significant.

Table 5. Determinants of loan loss provisions in individual countries – the model M_1 (SURE specification)

		$\frac{LLP_{j,t-1}}{TA_{j,t-1}}$	$\Delta GDPG_{j,t}$	$INF_{j,t}$	$\frac{PROFIT_{j,t}}{TA_{j,t}}$	$\Delta Loans_{j,t}$	$\frac{CAP_{j,t}}{TA_{j,t}}$	Intercept
Belgium	estimates	0.6217	0.0002	0.0004	-0.2241	-0.0042	0.0303	-0.0003
	std. error	0.1458	0.0001	0.0002	0.0584	0.0024	0.0231	0.0014
	t-stat	4.2657	2.2524	2.0136	3.8393	1.7641	1.3117	0.2001
	prob	0.0037	0.0590	0.0839	0.0064	0.1211	0.2310	0.8471
Canada	estimates	-0.0052	-0.0004	0.0003	0.01573	-0.0165	-0.0978	0.0088
	std. error	0.2356	0.0002	0.0004	0.1201	0.0065	0.1058	0.0063
	t-stat	0.0222	2.2663	0.8033	0.1310	2.5549	0.9239	1.4049
	prob	0.9830	0.0578	0.4482	0.8995	0.0378	0.3563	0.2028
Denmark	estimates	0.8685	-0.0012	0.0011	-0.5308	0.0073	0.1667	-0.0038
	std. error	0.1144	0.0002	0.0004	0.1437	0.0031	0.0612	0.0028
	t-stat	7.5896	7.8207	2.8546	3.6942	2.3685	2.7237	1.3707
	prob	0.0001	0.0001	0.0245	0.0077	0.0497	0.0296	0.2128
France	estimates	0.5232	-0.0001	0.0001	0.0128	0.0006	0.0020	0.0005
	std. error	0.0762	0.00007	0.0001	0.0629	0.0015	0.0341	0.0014
	t-stat	6.8652	1.9547	1.0314	0.2042	0.3710	0.0582	0.3840
	prob	0.0002	0.0915	0.3367	0.8440	0.7216	0.9552	0.7124
Germany	estimates	-0.1962	-0.0002	0.0008	0.1154	-0.0063	0.2850	-0.0103
	std. error	0.2039	0.0002	0.0003	0.1464	0.0062	0.1173	0.0055
	t-stat	0.9622	0.8986	2.4787	0.7883	1.0212	2.4287	1.8822
	prob	0.3680	0.3987	0.0423	0.4564	0.3411	0.0455	0.1018
Italy	estimates	0.2514	-0.0006	0.0007	-0.0497	0.0003	-0.1666	0.0144
	std. error	0.2269	0.0003	0.0004	0.1422	0.0120	0.0821	0.0073
	t-stat	1.1078	2.0901	1.8345	0.3494	0.0218	2.0300	1.9832
	prob	0.3046	0.0750	0.1092	0.7370	0.9832	0.0819	0.0878
Netherlands	estimates	0.4780	-0.00008	0.0004	-0.4488	0.0017	0.1027	-0.0001
	std. error	0.1365	0.00006	0.00007	0.0372	0.0007	0.0191	0.00005
	t-stat	3.5020	1.2329	4.916	12.0563	2.3762	5.3656	0.2216
	prob	0.0100	0.2574	0.0017	0.000006	0.0492	0.0001	0.8310
Norway	estimates	0.4362	-0.0007	0.0004	-0.8991	0.0006	0.1350	0.0034
	std. error	0.1025	0.0002	0.0002	0.1743	0.0041	0.0490	0.0020
	t-stat	4.2552	3.4095	1.6490	5.1579	0.1492	2.7568	1.7029
	prob	0.0038	0.0113	0.1432	0.0013	0.8856	0.0282	0.1324
Poland	estimates	0.1806	-0.0014	0.0003	-0.4853	-0.0001	-0.0413	0.0259
	std. error	0.1295	0.0003	0.0001	0.1542	0.0040	0.0796	0.0096
	t-stat	0.1394	5.4068	2.2046	3.1469	0.0315	0.5184	2.6916
	prob	0.2058	0.0010	0.0633	0.0162	0.9757	0.6201	0.0310
Spain	estimates	-0.0595	-0.0006	0.0002	0.5741	-0.0034	0.0794	-0.0074
	std. error	0.0907	0.00007	0.000097	0.0792	0.0020	0.0191	0.0022
	t-stat	0.6553	9.0745	2.3153	7.2491	1.7362	4.1556	3.4066
	prob	0.5332	0.00004	0.0538	0.0002	0.1261	0.0043	0.0113
Sweden	estimates	0.1658	-0.0005	-0.0002	-0.0295	0.0014	-0.3835	0.0228
	std. error	0.1134	0.0001	0.0003	0.0726	0.0026	0.0411	0.0027
	t-stat	1.4622	3.9732	0.9704	0.4065	0.5136	9.3228	8.3262
	prob	0.1871	0.0054	0.3642	0.6965	0.6233	0.00003	0.00007
Switzerland	estimates	0.9130	0.0004	0.0037	-0.2243	-0.0051	0.0491	0.0014
	std. error	0.1759	0.0003	0.0009	0.1566	0.0080	0.0656	0.0038
	t-stat	5.1900	1.3186	4.1233	1.4326	0.6394	0.7485	0.3766
	prob	0.0013	0.2288	0.0044	0.1951	0.5429	0.4785	0.7176
US	estimates	1.0025	-0.0005	0.0003	-0.5858	-0.0121	-0.0594	0.0195
	std. error	0.0853	0.0001	0.0001	0.0368	0.0036	0.0187	0.0021
	t-stat	11.7595	3.5701	1.9814	15.9021	3.3575	3.1830	9.4470
	prob	0.000007	0.0091	0.0880	0.00000009	0.0121	0.0154	0.00003

Source: Author's calculations.

The above result is consistent with findings of Laeven and Majnoni (2003), who found negative statistically significant results in most countries included in their research sample. Interestingly, the two countries in our sample in which banking sectors exhibit imprudent risk management practices include Canada and the US. In the light of the last financial crisis especially the US case is of huge interest and we are of the opinion that it is worth reflecting on in slightly more detail. Considering this imprudent risk management in the US combined with the fact that the US financial assets represent around 31 percent of global financial assets as well as the U.S. dollar share in reserve currency assets of central banks around the world is 62 percent, it shouldn't be surprising that US banking sector is prone to credit risk shocks which spread across the borders through the interconnected financial sector.

Finally, the capital to assets ratio coefficients range from -0.38355 for Sweden to 0.28495 for Germany, and 8 out of the 13 estimates are positive, with coefficients exhibiting statistical significance in 4 countries. In 5 countries this coefficient is negative, but only in 3 countries (Italy, Sweden and the US) it is statistically significant. Our SURE estimation has increased the number of countries in which the capital management hypothesis is supported. Notwithstanding this inference, it is worth noting that the sample of countries in which the capital management hypothesis is rejected is larger as well after application of the SURE method. No capital management is found in Germany, Norway, Netherlands, Spain and Sweden. Nevertheless, we think that this conclusion should not be drawn without a certain reserve. Specifically, loan loss provisioning practices are far from universal, as there is no uniformity among countries in setting the standards for classifying loans and provisioning (see Barth et al., 2006, pp.130-131). This lack of uniformity also relates to the rules of inclusion of provisions in the capital base. For example, in Spain banks are obliged to include the statistical provision in the capital base, consequently the relationship between provisions and capital is positive. Such a relationship in this case might as well be interpreted as evidence for prudent capital management behavior.

5. CONCLUSIONS AND IMPLICATIONS

This paper uses a balanced panel database of aggregated banking sector financial statements information in 13 countries to analyze determinants of credit risk in years 1995-2009. We proxy aggregated credit risk by loan loss provisions ratio and consider as explanatory variables determinants traditionally applied to test earnings management in firms. We conduct our analysis with two objectives in mind. First, we aim to find out whether variables which usually affect loan loss provisions in individual banks are important determinants of national banking sectors LLP for extended time period covering 15 years. Second, we would like to check whether increasing interconnectedness of financial markets and real economies among countries makes both the procyclicality of LLP and earnings management more predominant. To answer those two questions we apply independent OLS regression estimates and SURE estimation.

Generally, we infer that regardless of the econometric specification, the earnings management hypotheses are hardly supported. This conclusion notwithstanding, we must admit that we find support for income smoothing hypothesis in Spain, where dynamic provisioning regulations are in force. In only 2 countries out of 13 we find support for prudent risk management. SURE estimation has increased the number of countries in which the capital management hypothesis is supported.

Our results indicate that aggregated credit risk proxied by LLP is procyclical, and this feature of LLP is predominant if we account for cross country linkages estimated with the SURE method. We proxy the cross country linkages by correlations between error terms of independent OLS regressions conducted separately for each country in the sample. The error terms include information which is not accounted for by explanatory variables included in our econometric model, e.g. information on interconnectedness of financial markets and real markets.

Our research contributes to the ongoing debate on measures of systemic risk in its time series dimension. By looking at how relationship (and its statistical significance) of LLP to the business cycle in one country changes in response to shocks other countries we shed a light on the problem of systemic risk spillovers. To the best of our knowledge we are the first to investigate this problem.

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