DE GRUYTER OPEN

DOI: 10.1515/ijme-2015-0027

International Journal of Management and Economics
No. 47, July–September 2015, pp. 36–55; http://www.sgh.waw.pl/ijme/

Katarzyna Sum[1]
Chair of International Finance
Warsaw School of Economics, Poland

Basic Indicators of Systemic Risk in the EU Banking Sector. Implications for Banking Regulation

Abstract

The issue of systemic risk regulation and management has gained substantial attention following the latest financial crisis. In the case of the EU it became crucial to deal with the systemic risk problem on a supranational level since the banking sectors of the member countries are highly integrated. While substantial measures have been undertaken to mitigate systemic risk in the EU, the discussion of further reforms continues. This study's goal is to assess basic indicators of systemic risk in the EU banking sector by using three complementary methods: a forward-looking stock market data analysis, an EU-stress test analysis for systemically important banks, and an empirical investigation of the relation between banking regulation and systemic risk as measured by bank balance sheet indicators. The results lead to a recommendation of further necessary regulatory reforms, which appear in the conclusion.

Keywords: systemic risk, stress test, banking regulation, EU banking
JEL: G21, G28, F36

Introduction

The issue of systemic risk regulation and management has gained substantial attention following the latest financial crisis. In the case of the EU it became crucial to deal with the systemic risk problem on a supranational level since the banking sectors of the member countries are highly integrated. Moreover, the use of the common currency contributed to financial contagion within the Euro banking sector. Additionally, the Eurozone debt crisis affected the risk exposure of banks, since sovereign bonds issued by distressed governments constituted substantial parts of bank portfolio. To cope with the problem of systemic risk on a supranational level new supervisory institutions and procedures were created. The European Systemic Risk Board [ESRB] was tasked with macro prudential supervision of the EU banking system, and the European Banking Authority [EBA] was established to supervise systemically important EU banks from a micro prudential point of view. A new feature added to the banking supervisory authorities was in that in the case of a detected potential bank failure, EU rules became superior to national rules.

The goal of this study is to assess the basic indicators of systemic risk in the EU-banking sector formulate conclusions for further necessary regulatory changes. The vast and growing literature on systemic risk measurement has been reviewed by the author in a separate study [Sum, 2014]. Notable contributions on this topic were made e.g. by Acharaya et al. [2010], Adrian and Brunnermeier [2011], Brownlees and Engle [2012], De Jonghe [2010], Drehmann and Tarashev [2013], Bartram et al. [2007], Huang et al. 2009. This literature suggests that to assess the level of systemic risk in the banking sector, measures of interconnectedness, e.g. the co-movements of stock market returns of banks, various bank risk measures, and bank balance sheet developments need to be considered. This study assesses the level of systemic risk in the EU- banking sector and formulates conclusions for banking regulations by using three complementary methods: a forward-looking stock market data analysis based on Saldias [2013]; an EU-stress test analysis for systemically important banks; and an empirical investigation of the relation between banking regulation and systemic risk, as measured by bank balance sheet indicators.

Stock Market Data Analysis

To assess the level of systemic risk in the banking sector interconnectedness measures based on high-frequency stock return and equity option price data are often used. Due to the unavailability of such data, this study relies on measures calculated by Saldias [2013] to assess the level of systemic risk in the EU-banking sector.

The measures calculated by Saldias [2013] are: the aggregated distance to default series computed on the base of balance sheets; equity option prices; and the STOXX Europe 600 Banks Index. The indexes are computed for a sample of 96 systemically important European banks[2]. The measures reflect the degree to which these banks are exposed to common shocks and are suitable as early warning indicators, based on the extraction of information from options prices implying forward looking properties. Due to the application of high frequency data for their calculation the measures react quickly to market distress. Also, the information extracted from equity option prices allows tail risk to be estimated more precisely.

Saldias [2013] computes two variations of aggregated distance of default measures: average distance to default indicators and portfolio distance to default indicators. The former is an average of bank level distance to default based on equity options and provides information about overall risk. The latter is based on bank balance sheet data, equity option prices and the STOXX Europe 600 Banks Index and informs about the exposure to common shocks of banks due to their asset correlation and bank index developments during tail risk events. Both series are computed on the basis of contingent claims analysis[3].

In addition, when assessing risk, the absolute levels of the distance to default series the difference between the average distance to default and the portfolio distance to default are relevant. The average distance to default assumes perfect assets correlation of banks and abstracts from bank heterogeneity, especially bank size, risk interdependences and system tail risk, particularly if tail risk events occur. The portfolio distance to default provides more relevant information and insights into the behavioural aspects of market developments. The gap between the two measures shows the default probability resulting from bank heterogeneity and portfolio interdependences. Particularly, it mirrors tail risk dependence and market reaction to public guarantees [Saldias, 2013].

The sample period is September 1, 2002 to July 1, 2013, which permits us to assess systemic risk during market distress and tranquil times. Since our focus is to provide recommendations for banking regulation counteracting systemic risk, we include the 2007–2008 liquidity crisis and the period of global contagion, followed by the sovereign debt crisis which emerged in 2010 [Drudi et al., 2012].

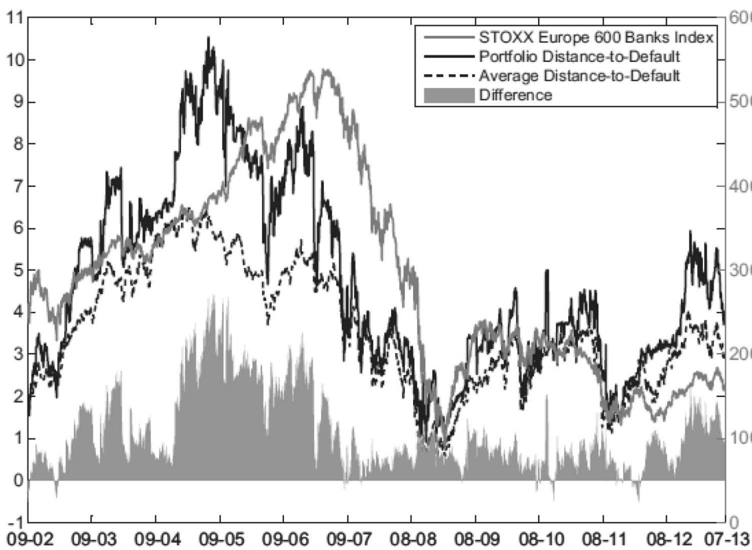
Figure 1 shows the changes in distance to default series and the STOXX Europe 600 during the period September, 2009 – July, 2013.

According to Figure 1, the portfolio distance to default exceeds the average distance to default during almost the entire period. This means that bank heterogeneity and the effect of public guarantees decreases the distance to default i.e. the level of systemic risk. Moreover, the gap also reflects the effect of bank stock returns co-movement on systemic risk. The portfolio distance to default shows more fluctuation than other measures indicating its quicker reaction to market events.

There is also a substantial synchronization in both series. The gap tends to be narrower when sudden market distress occurs e.g. in August 2008 after the Lehman Brothers failure and in August 2011 at the height of the sovereign debt crisis. Positive market events contribute to a widening of the gap, for example during the period 2005–2006 when the STOXX index increased substantially. High portfolio distance to default signalizes a decline of systemic risk during that time.

In terms of the respective phases of the financial crisis beginning in August 2007, risk measure volatility increased, and stock returns and high stock return co-movement of banks declined, as reflected in a narrowed gap between the distance to default measures. Despite the various rescue measures applied by the ECB [Cour and Winkler, 2013] no decrease in systemic risk is observed. Both distance to default measures, as well as the STOXX index reached their minima in August 2008, recovered slightly in 2009, and then dropped in 2010, following the onset of the sovereign debt crisis. During the second phase of the crisis the gap between risk measures was narrow and reflected high bank asset correlations. At the culmination of the third phase, during the sovereign debt crisis the STOXX index dropped again and the gap between risk measures narrowed, indicating intensified wide spread banking exposures to market declines related to the sovereign debt crisis. At the end of the last phase the gap widened again, which might be a result of the recapitalization of banks, ECB liquidity injections and decreasing bank stock co-movements due to intensified regional factors shaping respective bank performance.

FIGURE 1. Aggregate Distance-to-Default series based on STOXX Europe 600 during the period 01.09.2002–1.07.2013



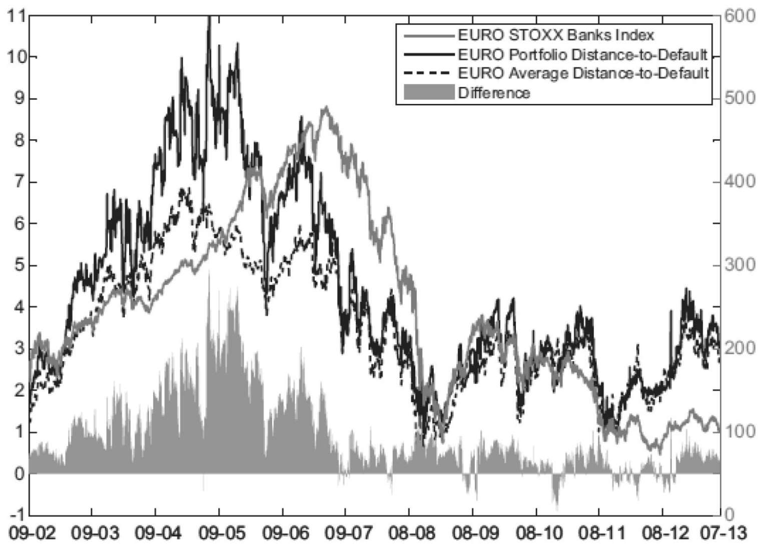
Source: Adapted from Saldias [2013].

To account for differences in regional factors shaping banks' distance to default developments in the Eurozone banks are considered separately in Figure 2, which depicts the portfolio distance to default and average distance to default calculations.

The graph shows that the distance to default measures for all euro area banks exhibit similar patterns until the outbreak of the liquidity crisis in August 2007. Afterwards the gap between the two risk measures narrowed substantially despite temporary EURO

STOXX index improvements. While some increase in the distance to default occurs, there is a high correlation of euro area bank exposures over the whole crisis period, which might have been caused by a high sovereign risk exposures of euro area banks. A comparison with Figure 1 indicates that this exposure, or its market perception, is much higher for Eurozone countries than for the rest of the EU.

FIGURE 2. **Aggregate Distance-to-Default series based on EURO STOXX during the period 01.09.2002–1.07.2013**



Source: adapted from Saldias [2013].

Consequently, the systemic risk in the EU is likely driven by common exposures to sovereign debt and behavioural factors, and., the correlation of systemically important banks' assets tends to be substantially higher during times of market stress. Mitigating factors of systemic risk are bank heterogeneity and public support programs. The first factor decreases the risk of common exposures, the second shapes market expectations and mitigates behavioural risk.

Stress Tests Analysis

To determine factors of systemic risk in the banking sector stress tests are often conducted for major banks. Stress tests on the individual level aim at determining the level of bank capitalization needed to withstand a financial crisis. Macro-stress tests help to identify capital requirements to maintain the stability of the entire banking system in the event of a crisis.

Macro stress test has a number of drawbacks [Borio et al., 2012]. Above all, they cannot be used as early warning indicators due to their inability to predict the dynamics of financial distress and feedback effects, as they focus only on extreme shocks to the system ignoring lesser ones. Moreover, the indicators drawn from the tests are procyclical and they do not account for risk builds up during economic booms. Consequently, the outcomes from such tests may make the system appear strongest when it is the most susceptible to crises [Borio et al., 2012]. Despite those weaknesses they are still viewed as an effective crisis management tool [Henry and Kok, 2013] for determining necessary capital buffers and to identify failing institutions. Given the shortcomings of stress test, regulators continuously adopt new methods to improve the process..

Since the establishment of the European ESRB and the three European Supervisory Authorities: the EBA, the European Insurance and Occupational Pensions Authority and the European Securities and Markets Authority in 2011 [Henry and Kok 2013], stress tests have been regularly carried out in the EU in 2010, 2011 and 2014. In 2011 and 2012 EBA conducted a stress test in response to the sovereign debts crisis. That stress test was aimed at restoring the necessary capital buffers and confidence in the EU-banking sector. Although the EBA stress tests are conducted from a micro-prudential perspective, their results are designed to test the banking system's soundness and systemic risk resistance. Despite problems embedded in stress tests, such as a failure to detect the interconnectedness of the institutions, they convey information about the financial condition of systemically important banks whose failure would pose a threat to the stability of the entire EU banking system. The issue of interconnectedness was addressed in section 1, hence the stress test results are used as a complementary method to assess systemic risk.

The stress tests are conducted for a sample of over 100 systemically important banks.[4] The sample includes the major EU cross-border banking groups and the biggest banks in the respective countries, with assets of at least 50 percent of the national banking sector [EBA 2011]. In order to pass the stress test those banks have to maintain a core tier 1 capital level at 5 percent of risk weighted assets. If the ratio is below this threshold the bank has to be recapitalized.[5]

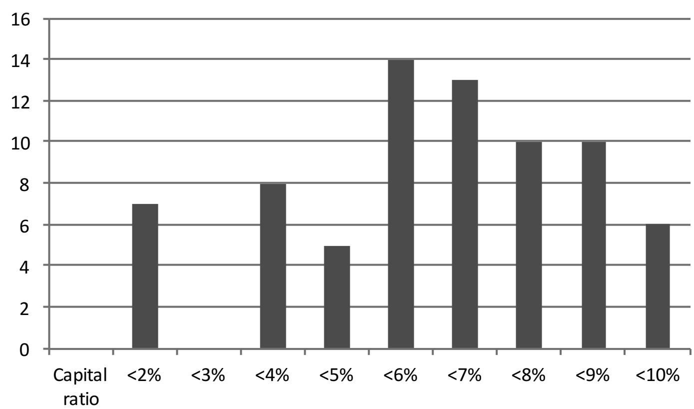
The banks are tested against adverse scenarios, i.e. the deterioration of the major macroeconomic variables GDP, unemployment and house prices and the results are compared to a baseline forecast. The test also takes into account sovereign stress for bank exposure in trading and bank books. Moreover, the banks are tested against interest rate changes, sovereign spread changes [EBA, 2011] and credit and market risk.

The 2011 test, which covered the 2010–2012 period led to 8 banks' failure.[6] Initially, banks held on average a 8.9 percent core tier 1 capital ratio, which was partially the result of government aid [EBA, 2011].[7] By the end of the stress test period that ratio had declined to 7.4 percent. The overall assessment over the two years reference period revealed a 2,5 billion EUR capital shortfall in the EU-banking system. However, the shortfall would have been much higher, amounting to 26,8 billion EUR with 20 banks failing the test, if the EBA had not permitted a strengthening of the banks' capital positions at the beginning of 2011. These results indicate a high level of systemic risk in the EU-banking sector in the years 2010/2011, although the tests were conducted as the sovereign debt crisis unfolded.

The tests revealed the amount of provisions needed to cover losses in the case of adverse scenarios, which was 200 billion EUR per year and meant an almost 100 percent increase compared to the baseline scenario. The banks had to specify the measures they would have to undertake to counteract the consequences of adverse scenarios. Such measures included countercyclical provisions, divestments, and capital raisings [EBA, 2011].

Figures 3 and 4 show the number of banks classified in the several groups of capital ratios in the scenario without and with increasing their capital. Figures 3 and 4 point to a large dispersion of tier 1 capital ratios among EU banks. Considering the scenario with no capitalization, 20 banks fell under the 5 percent threshold, 14 banks had capital ratios between 5 and 6 percent, and 22 banks achieved an over 9 percent capital ratio. In the second recapitalization scenario, 8 banks fell under the 5 percent ratio, 16 EU banks had core tier 1 capital ratios between 5 and 6 percent of RWA, and 25 banks achieved a capital ratio of over 9.

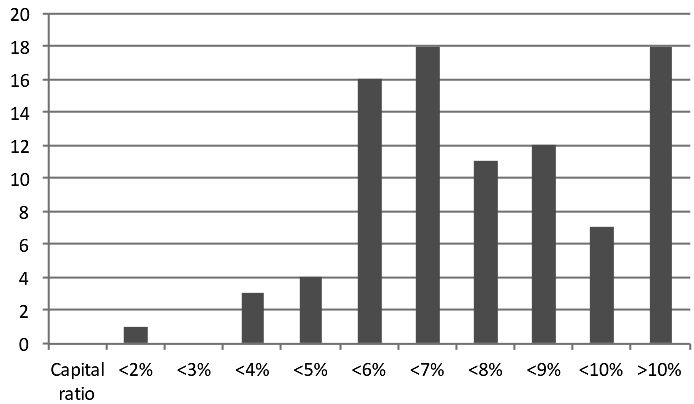
FIGURE 3. **Number of banks in each bucket of core tier 1 capital ratio without capital raising**



Source: own elaboration based on EBA [2011].

The EBA statistics show that the average change in the core tier 1 capital ratio under the adverse scenario is 1.2 percent points. For the respective banks the changes varied from 18 percent, up to 10 percent, which indicates a substantial diversity. Not all systemically important institutions managed to improve their capital ratios despite the opportunity given by EBA. For the majority of the banks the ratio deteriorated, but not by more than 5 percent points and only 3 percent of sampled banks managed to increase their capital levels.

FIGURE 4. Number of banks in each bucket of core tier 1 capital ratio with capital raising



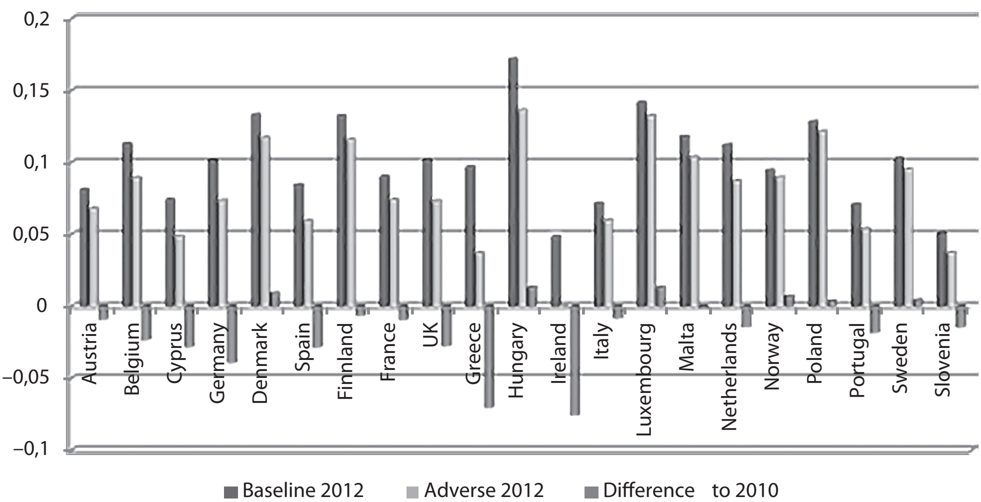
Source: own elaboration based on EBA [2011].

The decrease of core capital ratios in the adverse scenario was mainly due to impairment charges, particularly increased provisions against sovereign exposures. Less significant factors were the increase of risk weighted assets and trading losses. The level of impairment charges depended largely on the default and loss rates estimated by banks. According to the stress test data the default rates would increase from 1.9 percent in 2010 to 2.5 percent in 2012 under the adverse scenario. When considering the components of the core tier 1 capital ratio banks' equity issuance decreased in the adverse scenario by 14 percent over the examined period whereas the value of risk weighted assets increased by 14 percent [EBA, 2011]. The latter increase was mainly due to the changes of risk weights attributed to default assets and securitization exposures. The stress test focused also on the level of non-interest income, which declined from 360 billion EUR in 2010 to 325 billion EUR in 2012 under the adverse scenario.

One factor decreasing bank risk was the large share of deposit funding, which amounted to 54 percent. On the other hand 58 percent of wholesale or interbank funding was debt maturing in less than 2 years, which is a risky source of funding., The statistics indicate that the cost of funding increased in all groups of funding sources over the sample period.

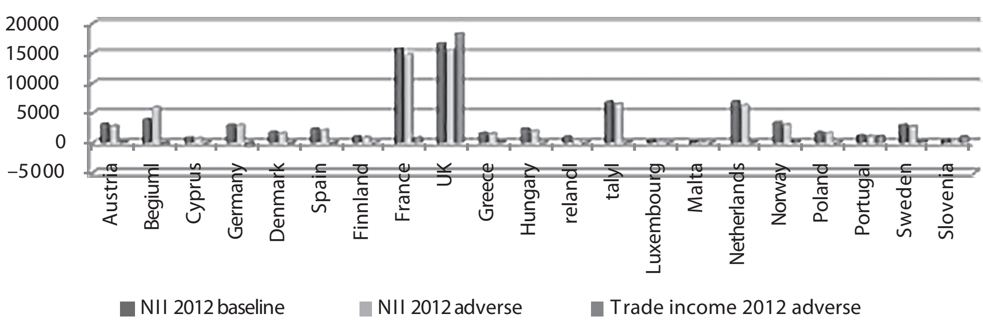
For the purpose of formulating banking regulatory recommendations aggregate data at the country level are required. Figures 5 to 10 depict, respectively: the average core tier 1 capital ratios per country, the average net interest income per country, the average ratio of net interest income to trading income per country, the average level of provisions per country as well as average loss rates in the corporate and retail sector per country. The averages are computed for the baseline and adverse scenarios in 2012 and compared to reference values from 2010 with the exception of the income ratio, for the purpose depicting systemic risk factors.[8]

FIGURE 5. Average capital ratios per country for the baseline and adverse scenario and the difference to the 2010 baseline



Source: author's computations based on stress test data.

FIGURE 6. Net interest income under the adverse scenario compared to the baseline and trade income million EUR

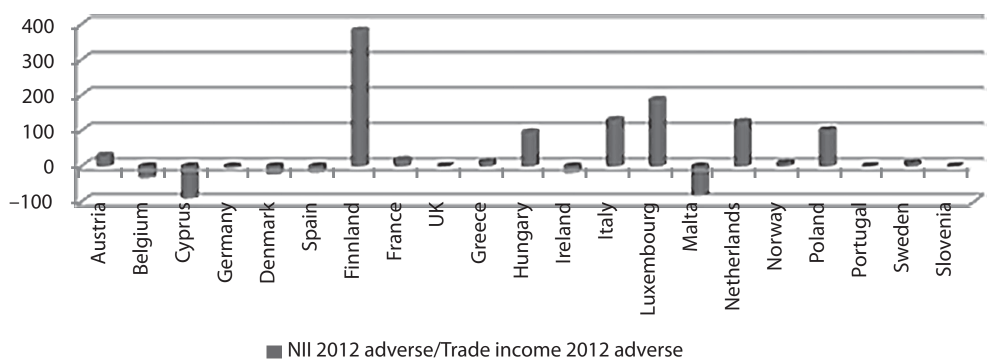


Source: author's computation based on the EU stress test.

The largest declines in core tier 1 capital ratios occurred in Ireland –0,08 percent points and Greece –0,07 percent points, which is likely caused by the severity of the banking and public finance crises in these countries. Substantial declines also occurred in Germany –0.04, Spain, UK and Cyprus –0,03. The majority of the EU-countries experienced only slight average decreases of capital ratios, and Hungary, Denmark, Sweden and Poland improved their average bank capitalization as compared to 2010, even under the adverse scenario. This latter observation might be due to the fact that these economies were relatively sheltered from the banking crisis.

The majority of the countries experienced a decline of net interest income in the adverse scenario as compared to the baseline scenario. While in most countries this number was between –3 percent and –8 percent, in Hungary the decline was –13 percent, and Belgium and Slovenia experienced an increase in net interest income under the adverse scenario. The trade income of EU-banks amounted to substantially lower levels than the interest income, with the exception of UK and Slovenia where the opposite was true. The ratio of net interest income to trade income under the adverse scenario Figure 7 is an important indicator of bank risk. The highest value of this ratio was achieved in Finland 370, and high ratios above 100 were demonstrated by Luxembourg, Italy and Netherlands. The remaining countries achieved on average levels lower than 30, while for 7 countries the ratio was negative due to losses in trading income.

FIGURE 7. **The ratio of net interest income to trade income under the adverse scenario**

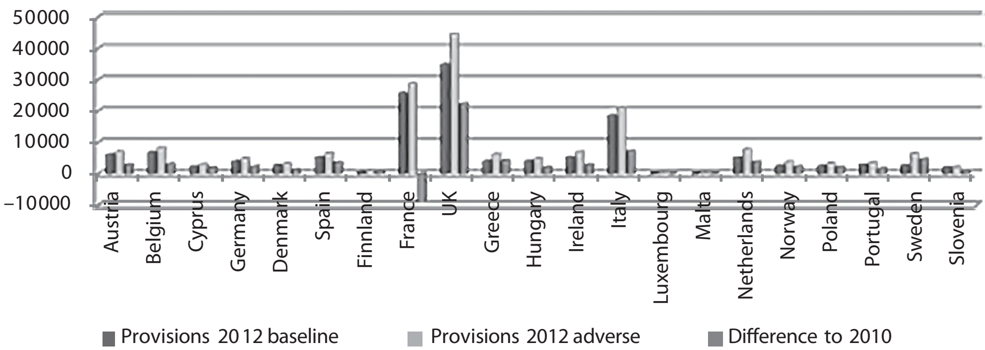


S o u r c e : author's computation based on the EU stress test.

These Figures also indicate the necessity of provision growth in the systemically important EU-banks. In absolute terms the highest provision increase was required in UK banks and the highest relative increase was needed in Finland and Greece, where the level of provisions increased twice under the adverse scenario.

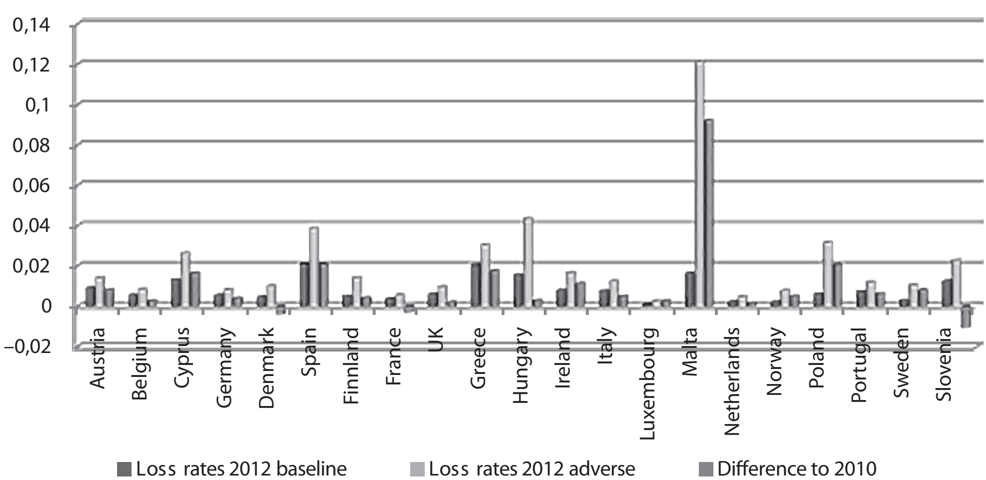
The majority of EU banking systems experienced an increase in loss lending rates to the corporate sector under the adverse scenario, except for Slovenia, Denmark and France where the loss rates decreased. A particularly strong increase could be observed in Malta where this number grew by 0.09. In the remaining countries the increase of loss rates did not exceed 0.02.

FIGURE 8. Provisions per country for the baseline and adverse scenario and the difference to the 2010 baseline (million EUR)



S o u r c e : author's computation based on the EU stress test.

FIGURE 9. Loss rates in the corporate sector per country for the baseline and adverse scenario and the difference to the 2010 baseline

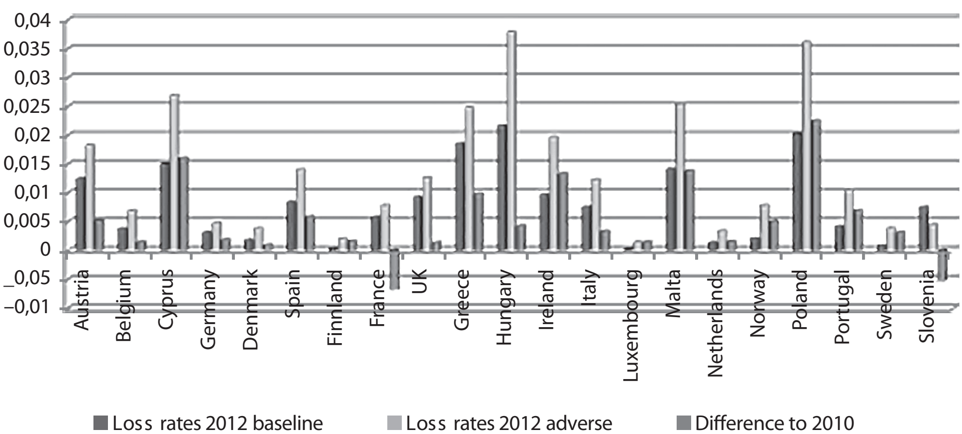


S o u r c e : author's computation based on the EU stress test.

As far as lending to the retail sector is concerned Figure 10, all countries with the exception of Slovenia and France incurred large loss rates under the adverse scenario. In the majority of the EU banking systems the average loss rates increase was below 0.02 with the exception of Poland where this value was slightly higher.

Based on the statistics presented in this section we can conclude that the EU-banking sector is prone to systemic risk. The 2011 stress test points to the vulnerability of systemically important banks to market distress. Without the recapitalization procedure, which took place in 2011, 20 such banks would have failed the test. While the strengthened capital positions of the banks were achieved partially with government aid, its repayment may exacerbate the banks' financial situations in the future. Another systemic risk factor is the involvement of systemically important banks in non-traditional bank activities, here the ratio of net interest income to trade income was at a low level in the majority of the EU banking systems. The literature on systemic risk points to the level of leverage and the maturity structure of the wholesale funding as an important source of banking sector instability while heavy reliance on deposits is considered a stabilizing factor. The EU banks carried out additional capitalization and hence were deleveraged.

FIGURE 10. Loss rates in the retail sector per country for the baseline and adverse scenario and the difference to the 2010 baseline



S o u r c e: author's computation based on the EU stress test.

Required increase in core tier 1 capital ratios and the EBA's introduction of the leverage ratio as a monitoring tool should contribute to further deleveraging of banks and is likely to be a factor counteracting systemic risk in the EU banking sector. Furthermore, specified mitigating measures available in the case of the adverse scenario occurrence should also diminish systemic risk.

Empirical Exercise – Banking Regulation and Systemic Risk in the EU

Current regulatory reforms focus on measuring and regulating systemic risk [Arnold et al., 2012]. The necessity of introducing such reforms has been especially apparent following the latest financial crisis. Current debate on the necessary banking regulation is intense. To determine the focus of these reforms it is essential to analyse which banking features and forms of regulations matter for bank performance on the systemic level. Hence, the objective of this exercise is to investigate banking regulation impact on systemic risk in the EU-banking sector.

As mentioned, the literature concerning the impact of bank features on systemic risk was reviewed by the author in a separate study. Papers which focus directly on the impact of regulations on systemic risk include for example de Jonghe [2010], Vallacas and Keasey [2012].

De Jonghe [2010] finds that one of the most substantial measures to reduce systemic risk is capital regulation, since high capital levels decrease the risk of default. If regulators want to formulate capital requirements on the systemic level they have to increase individual capital levels accounting for correlated asset risk weights. Another important regulatory aspect aimed at counteracting systemic risk is deposit insurance. This measure should help constrain the behavioural factors of systemic risk, i.e. bank runs [de Jonghe, 2010]. The latest financial crisis also showed that substantial systemic risks arise if banks are involved in various non-bank activities such as investment banking or insurance activities. According to de Jonghe [2010] the shift to non-traditional banking activities induced by deregulation may increase extreme bank risk and destabilize the banking system. Individual and systemic bank size, when unregulated, also impacts systemic soundness by substantially increasing tail risk [de Jonghe, 2010; Vallacas and Keasey, 2012].

Vallascas and Keasey [2012] investigated the propensity of EU-banks to systemic shocks depending on existing regulations and unregulated bank features. They found that important factors shaping bank resilience to crises were: restrictions on a bank's leverage ratio, liquidity requirements, asset growth, bank size and the share of non-interest income. Their results also suggested that bank size should be regulated from a systemic point of view, i.e. it should be adjusted to the size of the economy. The related papers also stress the importance of the supranational dimension of banking regulation and supervision since banks operate internationally.

This study attempts to quantify those regulatory factors and investigate their impact on systemic risk in the EU banking sector. The study relies on the measures on banking regulation obtained from the World Bank Survey [2012]. The regulations considered are: bank entry regulations, capital requirements, activity regulations, auditing standards, liquidity requirements, deposit insurance schemes, problematic institutions regulation and supervisory power. The estimates of bank regulatory indices based on these data allow us to measure regulatory features during the sample period (2005-2010) with close to 630 indicators, and aggregate them into broad regulatory groups by means of principal component analysis. To estimate bank regulatory measures, scores are assigned to each answer in the survey. The scoring follows the line of Barth et al. [2004], i.e. it assigns higher values to more stringent regulations. The final measures are calculated by means of principal component analysis. The summary statistics of the indicators are presented in Table 1. Based on Table 1, the respective banking regulatory measures differ largely within and between countries.

TABLE 1. Banking regulatory indexes in the EU countries

Variable	Observations	Mean	Std. Dev.	Min	Max
Entry regulation	397	–0.24	1.05	–2.90	0.53
Capital adequacy	397	–0.17	0.33	–0.42	2.49
Activity regulation	397	–0.31	0.94	–2.22	2.07
Auditing requirements	397	0.07	0.38	–0.94	0.69
Liquidity requirements	397	0.13	0.51	–2.29	0.90
Asset classification	291	0.08	0.33	–0.36	0.80
Deposit insurance	284	0.17	0.45	–0.54	0.77
Problematic institution regulation	397	–0.88	2.67	–7.02	0.79
Supervision	220	0.03	0.56	–1.23	0.86

Source: author's computations based on World Bank data.

The exercise covers 397 banks from 23 EU-countries. The Czech Republic, Luxembourg, Malta and Sweden are not included due to the unavailability of data on banking regulation or/and on bank characteristics. The data on individual bank characteristics are taken from Bankscope. Table 1 presents summary statistics, which point to a large variation of banking features and banking regulatory measures within the sample. The mean z-score takes the value of 27.62 which range from –0.73 to 681.11 respectively, pointing to a large variation of default risk resistance among banks in the EU-countries. The profitability measures range from –1.19 to 0.89 in the case of ROE's and from –0.06 to 0.13 in the case of ROA's. Bank liquidity also demonstrates large variability. Systemic bank size proxied by the total assets to GDP ranges from 0.01 to 2.92, with an average of 0.25.

TABLE 2. Summary statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
ROE	397	0.07	0.18	–1.19	0.89
ROA	397	0.01	0.01	–0.06	0.13
Liquid assets to total deposits and borrowing	395	26.16	20.87	0.04	128.98
z-score	397	27.62	47.72	–0.73	681.11
Total assets to GDP	397	0.25	0.42	0.01	2.92
Log of total assets [ts EUR]	390	7.62	0.79	4.99	9.26

Source: Bankscope.

As a measure of systemic risk aggregate z-scores are used, which indicate the amounts that the banking system's profits must fall to render it insolvent. A drawback of this measure is that it does not capture the interconnectedness of banks, nevertheless it allows to proxy the overall soundness of the banking system and hence can serve as a measure of propensity to systemic risk. Given that the interconnectedness of EU banks has been analyzed in section 1, the z-score can be viewed as a complementary indicator of systemic risk. This measure has also been used in related studies [e.g. Demirgüc-Kunt, Detragiache, 2011]. The aggregate z-score is obtained by adding the profits, assets and equities of banks in the respective countries. Then standard deviations of ROA's are estimated for each country over a 6 year period. The system wide z-score is calculated according to the formula:

$$Z_{jt} = ROA_{jt} + Equity_{jt}/Assets_{jt}/\text{std dev } ROA_{j}$$

where the j stands for the respective countries and t for the respective years. For the purpose of the cross-sectional model the six year averages of the z-score are used.

The systemic z-score is regressed on: aggregated systemic size of the banking sector; banking regulatory measures; and macroeconomic control variables. Due to the short time period the data, the time invariance of the banking regulatory measure and the resulting limitations to a panel approach the study uses a cross-sectional model. The model has the following form:

$$\ln 1 + Z^{agr}_{j} = BR_{j} + SYSSIZE^{agr}_{j} + MACRO_{j} + \eta_{j}$$

Z^{agr}_{j} stands for the aggregate z-score for country j, $SYSSIZE^{agr}_{j}$ is the banking sector systemic size measured by aggregating bank systemic size from the individual bank levels. MACRO stands for a set of control variables, η_{j} is the error term. In order to smooth out higher values of the Z-score and avoid zero values on the left side of the regression the transformation of the z-score to ln1 + Z-score is applied.

The results of the regressions are presented in Table 3.

TABLE 3. Results of the regressions

	Regression incl. entry regulation	Regression incl. capital adequacy	Regression incl. activity regulation	Regression incl. auditing standards	Regression incl. liquidity requirements	Regression incl. asset classification	Regression incl. depositor protection	Regression incl. problematic institutions' regulation	Regression incl. supervision
Aggregate bank systemic size	−1,9032	−1,8451	−2,1644*	−2,0981	−2,0271	−0,3967	−2,4167	−1,9090	−2,5466
Banking regulatory measure	−0,1083	−0,8179	0,6632*	0,7600	0,0544	0,5529	−1,0935	−0,1028	−0,2840
Exchange rate changes	10,7006	22,8856	2,3038	9,7431	11,5246	13,2442	10,1869	13,2421	14,0287
Real GDP growth	−0,0240	−0,1833	−0,1150	0,0473	−0,0275	−0,0052	−0,0354	−0,0400	−0,0283
Euro area member	1,6676**	1,3864**	1,7764***	1,4903**	1,6389**	2,4751**	1,9445**	1,7612**	1,7902*
Private credit	0,0147**	0,0141**	0,0169***	0,0168**	0,0154**	0,003	0,0150*	0,0138*	0,015
Inflation	0,5941***	0,8246***	0,6427***	0,5187***	0,5957***	0,5900**	0,5878***	0,6184***	0,6354**
R^2	0,9187	0,9261	0,9351	0,9242	0,9184	0,9252	0,9250	0,9196	0,9038
Prob>F	25,85***	28,63***	32,93***	27,85***	25,74***	19,45***	24,66***	26,15***	14,76***

*** significance at 0.01 level, ** significance at 0.05 level, * significance at 0.1 level

Source: author's computations.

Based on this exercise we find that the systemic size of the banking sector impacts banking system soundness negatively, although this effect is statistically significant only in one regression. As far as banking regulatory measures are concerned, banking activity regulation seems to matter for banking system soundness as the coefficient is positive, i.e. the more stringent the regulations the higher the z-scores.

Analysis of the Results – Implications for Banking Regulation

The results of the above analysis point to the necessity to regulate banks from both a systemic and individual point of view. Moreover, they imply the need to monitor risk during market stress separately, which outlines the importance of conducting stress tests for systemically important banks. Since stress tests for systemic banks capture the default risk resistance of important market players, rather than the interconnectedness of these institutions, the assessment of systemic risk should be complemented by interconnectedness measures such as stock market co-movement indicators or the probability of a simultaneous default. The application of the complementary measures would also help address the drawbacks of stress test, i.e. procyclicality.

Based on section 1 we conclude that systemic risk in the EU is driven largely by common exposures to sovereign debt and behavioral factors. The correlation of systemically important banks' assets tends to be substantially higher during times of market stress than otherwise. Mitigating factors of systemic risk are bank heterogeneity and public support programs. The former decreases the risk of common exposures; the latter shapes market expectations and mitigates behavioral risk. The implications for banking regulation are to increase bank heterogeneity. One possible measure is to impose asset concentration limits and exposures to counterparties. Such solution was proposed by the Basel III framework and was implemented into the EU-framework by the CRR and CRD IV Directives [ESRB, 2015; BCBS, 2014].

Given that systemic risk emerged as a result of sovereign debt exposures as shown earlier, regulators might consider the introduction of non-zero risk weights to sovereign exposures. Such an approach was also proposed already by Basel II. The framework did not assign automatically zero risk weights to sovereign bonds, allowing for a differentiation of respective sovereign exposures. Further changes, introduced by Basel 2.5 allow the assignment of non-zero risk weights to sovereign bonds capturing default risk in trading book. Though the Basel II rules have been implemented in the EU framework by CRR and CRD IV Directives, existing exemptions allow the assignment of zero risk weights to many sovereign exposures. Additionally, the EU framework grants much broader exemptions to the euro-denominated debt of EU sovereigns than the Basel Accord. Another controversial issue related to sovereign exposures regulation is the bulkiness of sovereign debt holding, which could be addressed by the above-mentioned regulatory concentration measures, though the current version of the Basel framework exempts sovereign exposures from the "large exposure treatment" [ESRB, 2015; BCBS, 2014].

Another factor which might complement the above-mentioned measures to counteract systemic risk is banking activity separation traditional and non-traditional banking. The statistics from the stress test, as well as the results of the econometric exercise, point to this necessity. The ring fencing of these activities is still being discussed. Moreover, the increased loss rates under the adverse scenarios point to the necessity of introducing measures limiting loan default. This could be achieved either by introducing loan concentration standards or strengthening supervision over systemically important banks in terms of asset loan classification. The latter solution should be preceded by asset quality review in order to assess the necessary improvements.

The stress test showed that under the adverse scenario provisions would substantially increase in value in the majority of the EU countries. This may be an argument for the introduction of dynamic provisioning, which could be cyclically adjusted. Dynamic provisioning would substantially help to mitigate the procyclicality of provisioning and hence limit bank default risk in extreme market conditions [de Lis and Herrero, 2009], although, as shown by the example of the Spanish regulatory framework, such a solution might not be sufficient to counteract the negative effects of market turmoil. Moreover, this technique might increase risk, as it can make banks appear sound when they are actually not until they deplete their excess reserves and become insolvent. Hence, dynamic provisioning should be accompanied also by other tools preventing unstable credit booms, e.g. countercyclical capital buffers and proper loan quality assessment, conducive to portfolio risk mitigation. Consequently, despite improved capital positions the need to enforce increased regulatory core tier 1 capital ratios is still apparent.

Conclusions

This study provides evidence supporting the need for enhanced regulations to counteract systemic risk in the EU. The empirical exercises imply the need to separately monitor risk during times of market stress and tranquillity since universal measures tend to be procyclical. The results also indicate a need to complement stress tests with interconnectedness measures.

In terms of risk factors, regulators should limit common exposures to respective asset groups and counterparties, which could be done, for example, by imposing concentration ratios. An important regulatory challenge remains when addressing sovereign exposures, which are actually excluded from the "large exposure" regulation.

The results of this study also indicate the need for stricter separation of traditional and non-traditional banking activities, introducing measures limiting loan default and techniques mitigating the procyclicality of provisioning. Despite improved capital positions the need to enforce the increased regulatory core tier 1 capital ratios remains.

Given the complexity of the planned banking union further research is needed to determine necessary reforms. Especially the interbank linkages and contagion possibilities should be further analyzed and better understood.

Notes

[1] Author's e-mail address: ksum@sgh.waw.pl
[2] The assessment of systemic importance is based on bank size, cross-jurisdictional activity, interconnectedness, and other criteria defined in April 2009 by the Financial Stability Board.
[3] Derived from the Merton model [1974].
[4] Until 2014 only 91 banks were analyzed.
[5] In 2010 it was a 6percent threshold of Tier 1 capital.
[6] The stress test data from 2014 was not available at the moment this analysis was conducted.
[7] 14 percent of core Tier 1 capital was accumulated due to government aid.
[8] As mentioned in many studies non-traditional banking activities increase systemic risk.

References

Acharya, V., Pedersen, L., Philippon, T., Richardson, M. (2010), Measuring Systemic Risk, *Working Paper*, No. 1002, Federal Reserve Bank of Cleveland.

Adrian, T., Brunnermeier, M. (2011), CoVaR, *Federal Reserve Bank of New York Staff Reports*, No. 348.

Arnold, B., Borio, C., Ellis, L., Moshirian, F. (2012), Systemic risk, macroprudential policy frameworks, monitoring financial systems and the evolution of capital adequacy, *Journal of Banking & Finance*, No. 36, pp. 3125–3132.

Bartram, S., Brown, G., Hund, J. (2007), Estimating systemic risk in the international financial system, *Journal of Financial Economics*, No. 86, pp. 835–869.

Basel Committee on Banking Supervision (BCBS) (2014), *Supervisory framework for measuring and controlling large exposures*, BIS.

Borio, C., Drehmann, M., Tsatsaronis, K. (2012), Stress testing macro stress testing: does it live up to expectations?, *BIS Working Paper*, No. 369.

Brownlees, C.T., Engle, R. (2012), *Volatility, correlation and tails for systemic risk measurement*, available at SSRN: http://ssrn.com/abstract=1611229

Cour-Thimann, P., Winkler, B. (2013), The ECB's non-standard policy measures. The role of institutional factors and financial structure, *ECB Working Paper*, No. 1528.

De Jonghe, O. (2010), Back to the basics in banking? A micro-analysis of banking system stability, *Journal of Financial Intermediation*, No. 19, pp. 387–417.

De Lis, S., García Herrero, A. (2009), The Spanish Approach: Dynamic Provisioning and other Tools, *BBVA Economic Research Department Working Paper*, No. 0903.

Demirgüc-Kunt, A., Detragiache, E. (2011), Basel Core Principles and bank soundness: Does compliance matter?, *Journal of Financial Stability*, No. 7, pp. 179–190.

Drehmann, M., Tarashev, N. (2013), Measuring the systemic importance of interconnected banks, *Journal of Financial Intermediation*, No. 22, pp. 586–607.

Drudi, F., Durre, A., Mongelli, F. (2012), The interplay of economic reforms and monetary policy. The case of the euro area., *ECB Working Paper*, No. 1467.

EBA (2011), EBA *2011 EU-wide stress test. Aggregate report.*

EBA (2012), *EBA Guidelines on Stressed Value At Risk* (Stressed VaR), EBA/GL/2012/2.

ESRB, (2015), *ESRB report on the regulatory treatment of sovereign exposures.*

Henry, J., Kok, C. (eds.) (2013), *A Macro Stress Testing Framework for Assessing Systemic Risks in the Banking Sector*, ECB Occasional Paper, No. 152.

Huang, X., Zhou, H., Zhu, H. (2010), Assessing the systemic risk of a heterogeneous portfolio of banks during the recent financial crisis, *BIS Woking Papers*, No. 296.

Merton, R. (1974), On the Pricing of Corporate Debt: The Risk Structure of Interest Rates, *Journal of Finance*, No. 29, pp. 449–70.

Saldias, M. (2013), Systemic risk analysis using forward-looking Distance-to-Default series, *Journal of Financial Stability*, No. 9, pp. 498–517.

Sum, K. (2014), Individual and systemic risk measures in banking- challenges of the financial crisis for banking regulations, *Working Paper* within a statutory grant for young researchers, Warsaw School of Economics.

Vallascas, F., Keasey, K. (2012), Bank resilience to systemic shocks and the stability of banking systems: Small is beautiful, *Journal of International Money and Finance*, Vol. 31, pp. 1745–1776.