MASTER THESIS

MSC ACCOUNTING, STRATEGY AND CONTROL

# EVENT STUDY OF THE EFFECTS OF THE 2011 EBA EU-WIDE STRESS TEST ON THE MARKET VALUATION OF BANKS

by

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**Abstract**

The thesis analyzes whether the EU-wide stress test 2011 conducted by the European Banking Authority (EBAST2011) revealed any new information to investors about assets (in particular stocks and CDS premiae) of banks' tested.

For the measurement of the effects of EBAST2011 on stocks and CDS premiae the event study approach is applied, using standard econometric tools. An estimation window (3 August 2010 to 16 June 2011) and and seven event window (20 June to 16 August 2011) were defined. In the estimation window, market models for stock returns resp. CDS premium returns are estimated using domestic market indices resp. the i.TRAXX index as independent variables. Coefficients of determination are mostly between the 0.40 – 0.70.

Normal returns are predicted for event windows and abnormal returns calculated for all banks. Significance tests are carried out for banks individually, using cumulative abnormal returns (CAR), and for groups of banks, using average cumulative abnormal returns. The time series analysis is supplemented by a cross sectional analysis. An analysis of variance analyzes the volatility of market before and after the publication of the EBAST2011 results.

The results of the analysis points to few, if any, significant effects of the EBAST2011 on stock and CDS returns. Changes in Core Tier 1 ratios of banks as a result of the EBAST2011 show some predictive power for stock and CDS returns.

The hypothesis, that the EBAST2011 results increased the volatility of stock returns cannot be rejected on the 0.05 probability level.

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## Abbreviations

| | |
|---|---|
| A | Appendix |
| AR | Abnormal return |
| CAR | Cumulative abnormal return |
| CAAR | Cumulative average abnormal return |
| CEBS | Committee of European Banking Supervisors |
| CDS | Credit Default Swap |
| Core Tier 1 ratio | Benchmark for passing the EBA stress test |
| Cv | Critical Value |
| df | Degrees of freedom |
| EBA | European Banking Authority |
| EBAST2011 | 2011 EU-wide stress test conducted by the EBA |
| FSAPs | Financial Stability Assessment Programs |
| IMF | International Monetary Fund |
| ITRAXX | Group of international credit derivative indexes |
| PIIGS | Portugal, Italy, Ireland, Greece and Spain |
| S&P Europe 350 | Equity index drawn from 17 major European markets |
| Stoxx50 | Europe's leading Blue-chip index |
| SCAP | Supervisory Capital Assessment Program |

# 1 Introduction

## 1.1 Problem Identification

On 13 January 2011 the European Banking Authority (EBA) announced a stress test to assess the resilience of the European banking system. The EBA stress test of 2011 (EBAST2011) aimed to test the resilience of a large sample of European banks against an “adverse” scenario. The EBAST2011 was a consequence of the European financial crisis of 2010 and 2011. Long-term interest rates of European countries’ sovereign bonds (called “sovereigns” in this thesis) in 2010-mid2011 reached difficult to sustain levels in particular in the so-called PIIGS countries (Portugal, Italy, Ireland, Greece, Spain). European sovereigns – and, consequently, banks’ finances – were under pressure, and the need for information about the extent of systemic risk became apparent.

The adverse scenario of the EBAST2011 included – inter alia – a major deterioration of economic conditions in the EU, a sovereign stress, with haircuts applied to sovereign and bank exposures, changes of interest rates and sovereign spreads. The EBAST2011 runs from 2010 to 2012, with end of 2010 capital positions of banks as starting point (however, the EBA allowed specific capital actions until end of April 2011 to be considered).

When the EBAST2011 results were published on 18 July 2011, the EBA claimed “an unprecedented level of transparency and disclosure to the market to make its own judgement” (www.eba.europe.eu 6, p. 1). The “unprecedented transparency” of the results was confirmed and its public disclosure lamented by banks resp. their associations (for instance from the Association of German Banks, www.germanbanks.org). Critics of the EBAST2011 design alternatively mentioned the mildness (German Council of Economic Expers, 2011/12, p. 131) or the harshness (ECB president Mario Draghi, www.ft.com) of the test scenarios.

To sum up, the stated goal of the EBAST2011 – to provide a transparent and realistic view of the risk level of European Banks – was openly contested.

## 1.2 Research Questions

The main goal of the thesis is to analyze whether the EBAST2011 revealed any new information to investors about assets (in particular stocks and CDS premiae) of banks’ tested.

Market valuations of banks are tested on the significant occurrence of effects of the publication of the EBAST2011 results. Did the EBAST2011 produce abnormal (i.e. event-induced) returns for the stocks/CDS premiae of the banks tested? Did market participants anticipate the results of the EBAST2011?

The thesis uses an event study approach with standard econometric tools to assess the market reactions to EBAST2011 results.

### 1.3 Structure of the Thesis

Chapter 2 describes the financial crisis of 2010-2011 as the background for the EBAST2011.

Chapter 3 presents general aspects of bank stress tests as well as elements of the EBAST2011. Results of the test and the information value of the EBAST2011, as judged by the EBA and by market participants, are summarized.

Chapter 4 dicusses characteristics of the event study approach and in particular the definition of normal and abnormal returns.

Chapter 5 presents the design of the empirical analysis of the thesis and a statement of the hypotheses.

Chapter 6 lists the results of the empirical analysis of the thesis for the estimation and the event windows.

Chapter 7 summarizes the empirical results and provides a critical assessment of the results.

Empirical results are presented in detail in tables in the appendix of the thesis.

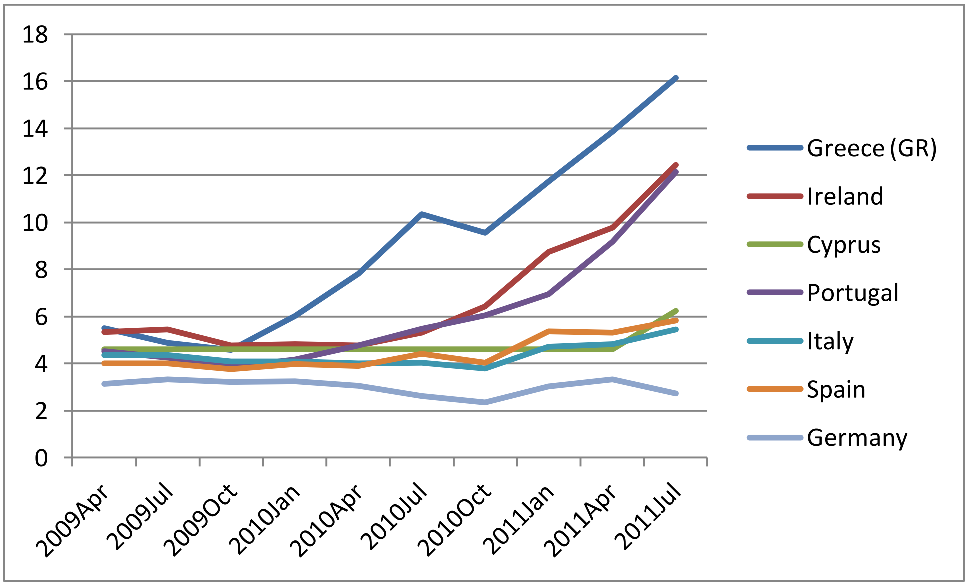
## 2 The Financial Crisis of 2010-2011 as Cause for the EBAST2011

### 2.1 Background and extent of the financial crisis of 2010-2011

The 2010-2011 financial crisis is a liaison of a banking and a sovereign debt crisis. European banks' assets had suffered from the 2007-2008 subprime crisis, the Lehman Brothers bankruptcy and the bust of real estate booms, particularly in Spain, Ireland and Portugal. The European sovereign debt crisis was "exacerbated by recession, transfers to help banks, and in some cases very poor fiscal management over a number of years that was inconsistent with the principles laid down in the Stability and Growth Pact and the Maastricht Treaty" (Blundell-Wignall and Slovik , 2010, p.2). As a result, credit ratings of sovereigns were lowered and debt spreads increased.

The development of the long-term interest rates of European countries' sovereign bonds in 2010-mid2011 reached difficult to sustain levels in particular in the so-called PIIGS countries (Portugal, Italy, Ireland, Greece, Spain) (Fig. 2.1). The above average interest rates of the PIIGS countries resulted from their fiscal problems: "Governments which already had significant fiscal imbalances ahead of the crisis exited from the recession with the highest deficit and debt-to-GDP ratios recorded in times of peace" (www.ecb.int).

FIGURE 2.1 SECONDARY MARKET YIELDS OF GOVERNMENT BONDS WITH A REMAINING MATURITY CLOSE TO TEN YEARS




SOURCE: WWW.ECB.INT/STATS

The reputation of sovereign bonds – and in particular those of PIIGS countries – was also negatively affected by a decision of the European Council in December 2010 for all new Euro area government bonds starting in June 2013 allowing a legally binding change to the terms of payment (standstill, extension of the maturity, interest-rate cut and/or haircut) in the event that the debtor is unable to pay (European Council). Investors reacted with a loss of confidence in European sovereigns.

The impact of increasing sovereign risks on European banks' funding conditions in the financial crisis of 2010-2011 was severe. According to a report by a Study Group established by the Committee on the Global Financial System of the BIS in July 2011, "higher sovereign risk since late 2009 has pushed up the cost and adversely affected the composition of some Euro area banks' funding, with the extent of the impact broadly in line with the deterioration in the creditworthiness of the home sovereign. (...) The increase in the cost of wholesale funding has spilled over to banks located in other European countries, although to a much lesser extent" (BIS 1, p.7). This is in agreement with a more general analysis of Elton et al. (2001), identifying country-specific rating factors as an important influence for the amount of spread reduction (or increase) of a hypothetical bank bond.

The link between the holdings of sovereigns and the cost of funding for banks is particularly strong in cases where European banks "have sizeable exposures to the home sovereign, and generally have a strong home bias in their sovereign portfolios. … Holdings of domestic government bonds as a percentage of bank capital tend to be larger in countries with high public debt" (BIS 1, p. 20).

Also, ratings of banks often take a beating when sovereigns are downgraded. "In particular, sovereign ratings generally represent a ceiling for the ratings of domestic banks. (…) Rating downgrades generally cause banks to pay higher spreads on their bond funding, and may reduce market access" (BIS 1, p.26).

As a result, even banks themselves became reluctant to lend to each other, which was signaled by a rise of Libor EUR Overnight rate (see figure A1).

## 2.2 The need for an EU-wide banking stress test

Thus, with European sovereigns – and, consequently, banks' finances – under pressure, the need for information about the extent of system risk affiliated with the financial crisis of

2010-2011 became apparent. However, banks were not required to publish in detail their exposure to peripheral debt. Thus, investors were left insecure how to judge the banks' value and their solvency. That was true for individual banks as well as for the banking system as a whole. Jürgen Stark, former ECB chief economist, in retrospect identified the need for an EU-wide stress testing exercise: "Eventually, when the global financial system was thrown into crisis, many policy-makers were shocked to discover that they did not have the macro-prudential tools to deal with part of the financial system spiralling out of control" (www.ecb.int).

January 13th 2011, EBA announced a new round of stress tests: "The EBA Board of Supervisors agreed yesterday on a strategic work plan for an EU-wide stress test to take place in the first half of 2011 and to publish results in mid-2011. The objective of the stress test is to assess the resilience of the EU banking system to hypothetical stress events under certain restrictive conditions. The stress test is one of a range of supervisory tools for assessing the strength of individual institutions as well as the overall resilience of the system" (www.eba.europa.eu 1).

# 3. Stress Testing the Banking Sector

## 3.1 General aspects of Banking Stress Tests

### 3.1.1 System-wide stress testing of banks: Goals and boundaries

The basic principle of bank stress tests is to test bank portfolios against an unlikely yet plausible adverse scenario (Čihák, 2004, p.4). Originally, stress tests were developed for firm-wide risk assessment. Most banks use stress testing as part of their internal risk management, inter alia because regular stress testing is required by the Basel II accords of the Basel Committee on Banking Supervision (Drehmann, 2008, p. 60).

Increasingly, whole financial systems are tested with aggregated system-wide stress tests. This is partly due to the launch of the Financial Sector Assessment Programs (FSAPs) in 1999 by the IMF and the World Bank which encouraged authorities to "monitor financial system soundness" of countries (FSA, p.1). "Stress tests have become an integral tool for banks' risk management practices as well as for financial stability assessments by central banks" (Drehmann, 2008, p.60).

Table 3.1: Comparison of system-wide vs. bank-wide stress tests

| | **System-wide stress tests** | **Bank-wide stress tests** |
|---|---|---|
| Objective | Assessment of system-wide vulnerabilities | Identification of vulnerabilities on a bank's portfolio |
| Users | National or supervisory authorities | Individual bank |
| Scenario selection | By national or supervisory authority | By individual bank |

System-wide stress tests differ in their objectives and implementation from bank-wide stress tests. The aim of bank-wide tests is to identify weak spots in the portfolio and help in decision making on management level (Drehman, 2008, p.61). Though the results are reviewed afterwards by supervisory institutions, the banks have some influence over the severity of the stress test as the enforcement and scenario definition is done by the firm itself.

The goal of system-wide stress tests is to reveal system wide vulnerabilities[1]. Methodological issues are defined by the supervising authority. The users of system-wide stress tests are supervisory institutions and authorities. Examples of system-wide financial risk assessments are the EU-wide stress test conducted by the Committee of European Banking Supervisors (CEBS) resp. the European Banking Authority (EBA) from 2009-2011 and the Supervisory Capital Assessment Program (SCAP) by the Federal Reserve in 2009. The SCAP assessed the 19 largest US bank holding companies on their Tier 1 common capital development under a baseline and an adverse scenario.

### 3.1.2 The process of system-wide stress testing

System-wide stress tests usually start with the selection of participating banks and the identification of vulnerabilities that might threaten the financial system. The group of banks selected should be representative for the system. Availability of appropriate data is an important prerequisite to build a realistic stress testing model (Čihák, 2004, p. 8).

Stress tests can be conducted through sensitivity analysis or scenario analysis[2]. Sensitivity analysis tests how a change of a single risk factor such as the interest rate affects the value of

[1] The description of system-wide stress testing mainly follows Čihák (2004), p. 4

[2] For a discussion of benefits and shortcomings of sensitivity analysis and scenario analysis see: Principles for sound stress testing practices and supervision, BIS, 2009, p. 3

a portfolio, assuming all other variables to remain constant. A scenario analysis tests the impact of a simultaneous change of a group of risk factors on the value of a portfolio.

Choosing a relevant scenario is crucial for the information value of the test. One way to construct a scenario is to rebuild historical extreme events such as the 2000 dot.com bubble or the “Black Monday” of 1987. The banks’ portfolios performance will be evaluated assuming a reoccurrence of the historic shock. The advantage of this approach is that the variable changes and their interdependencies are known and are easier to interpret than hypothetically constructed scenarios. However, using historical scenarios for forward looking risk-assessment has shortcomings: identified vulnerabilities might not be relevant as it is very unlikely that a historic scenario will reoccur in identical fashion. According to an analysis by the BIS, historical scenarios tend to underestimate the risk level and the duration of the shock (BIS 2, p.5).

An alternative is to construct hypothetical scenarios that are unlikely yet plausible. Hypothetical scenarios can directly be tailored to current threats. Further choices have to be made concerning which risk type to include, over which horizon the stress scenario should be run and to what degree which kind of parameters are to be shocked (BIS 3, p.4). In contrast to historic scenarios hypothetical scenarios are limited to the risk perception of the creator. There is no guarantee that the “right” and relevant scenario is chosen.

The effects of the shocks have to be measured for outcome variables such as profit and losses. This can be done either with a bottom-up or a top-down approach. The two approaches differ in the level of aggregation of profit or losses of the participating firms. In the bottom-up approach each bank has to calculate the impacts of the scenarios on their own on request of a supervisory authority. Afterwards data are collected, summarized and interpreted by the supervisory authority.

In the top-down approach the supervisory authorities themselves collect the data of the stress test. This minimizes the possible influence of participating banks on the test results since a coherent methodology is used to provide for better comparability across banks. Central banks usually prefer top-down approaches as they are primarily interested in the risk of a financial system as a whole (Melecky and Podpiera, 2010, p.4). Finally, the results have to be summarized and interpreted. Further, the decision has to be made whether testing methodologies and results shall be published.

As stress test results depend on the scenario chosen, they do not capture all possible risk outcomes. Hilberts and Jones (2004) advise to use for interpretation additional information such as financial soundness indicators (FSI) which were developed by the International Monetary Fund.

3.1.3 History of system-wide stress testing

Historically, the main stress testing approaches were the Supervisory Capital Assessment Program (SCAP) in the U.S., the Financial Stability Assessment Programs (FSAPs) by the International Monetary Fund (IMF) and the World Bank as well as EU-wide stress tests by the Committee of European Banking Supervisors (CEBS*)* resp. the EBA. (SCAP is commonly referred to as a stress test, though the name does not reveal this.)

EU-wide stress testing is conducted on an annual basis since 2009, the first two times by the CEBS, since 2011 by the subsequent organization EBA.

## 3.2 The EBA 2011 Banking Stress Test (EBAST2011)

3.2.1 Elements of the EBAST2011

The EBAST2011's goal was twofold: to assess the "prudential soundness" of a large sample of European banks as well as to provide information about "the overall resilience of the EU banking system" (www.eba.europa.eu 2, p.1). The eventual target variable of the test – on the level of individual banks as well as on the system level – was the capital position of the banks.

A comparison of the SCAP in 2009 with the EU wide stress tests of 2010 and 2011 reveals some of the unique properties of the EBAST2011.

TABLE 3.2: COMPARISON OF EBAST2011 WITH TWO STRESS TESTING EXERCISES

| | **SCAP 2009** | **EU-wide 2010** | **EU-wide 2011** |
|---|---|---|---|

| Conducted by | Federal Government | CEBS | EBA |
|---|---|---|---|
| Goal | "to conduct a comprehensive and consistent assessment simultaneously across the 19 largest BHC" (SCAP, 2009, p.2). | "to provide policy information for assessing the resilience of the EU banking system to possible adverse economic developments and to assess the ability of banks in the exercise to absorb possible shocks on credit and market risks, including sovereign risks" (www.eba.europa.eu 2). | "assessing the resilience of a large sample of banks in the EU1 against an adverse but plausible scenario" (www.eba.europa.eu 3). |
| Type of analysis | Scenario analysis | Scenario analysis | Scenario analysis |
| Type of scenario | Hypothetical | Hypothetical | Hypothetical |
| Nbr. of banks | 19 | 91 | 90 resp. 91 |
| Coverage | 2/3 of total assets; and >50% of total US loans | 65% of total assets of European banks | 65% of total assets of European banks |
| Approach | Bottom-up and Top-down | Mostly Bottom-up | Bottom-up / Top-down in peer review |
| Criteria to pass | Capital ratios above pre-defined threshold | Threshold value for a CT1 ratio of 6% | Threshold value for a CT1 ratio of 5% |
| Quality assurance | Federal Reserve | Peer review | Peer review |
| Consequences | Recapitalization; banks need to design an action plan | Banks might be asked to design an action plan | Recapitalization |
| Transparancy Methodology | Moderate | Moderate | Full disclosure a priori |

**SOURCE: SCHWAIGER (2001, P. 6), WITH OWN AMENDMENTS**

In total 91[3] banks were subject to the EBAST2011, which represented approximately 65% of total assets of the European banking sector (www.eba.europa.eu 3). The stress test consisted of two scenarios:

[3] The German Helaba decided to pull out from the test reducing the actual number to 90 banks.

- A baseline scenario, which moderately stressed the banks portfolios. The scenario is derived from the autumn 2010 European Commission forecast, which implied a continuing of recovery of the EU economy.
- An adverse scenario, which can be seen as a deviation from the baseline scenario. It consists of three shock areas: - "a set of EU shocks – mostly tied to the persistence of the ongoing sovereign debt crisis; a global negative demand shock originating in the US; and a USD depreciation vis-à-vis all currencies" (www.eba.europa.eu 4).

In addition, the adverse scenario included a sovereign stress, "with haircuts applied to sovereign and bank exposures in the trading book and increased provisions for these exposures in the banking book" (www.eba.europa.eu 5, p.2).

> The scenarios were constructed over a two-year horizon starting in 2011 using consolidated 2010 year-end figures. The benchmark for passing the test under the adverse scenario was a CT1 ratio of at least 5% of risk weighted assets (RWA). Though there were no legal consequences missing the benchmark, banks were expected to "promptly" disclose remedial actions, on request by national supervisory authorities: "In particular, national supervisors should ensure that these banks are requested to present within three months (by 15 October 2011) to their competent authorities a plan to restore the capital position to a level at least equal to the 5% benchmark based on this analysis" (www.eba.europa.eu 5, p.4).

The test was done as a bottom-up, microprudential approach. After in-house calculations by the banks, results were submitted to the resp. national supervisory authority for review and then passed to the EBA for an "appropriate peer review" (www.eba.europa.eu 3). As a "lesson-learnt" from the previous exercise in 2010 the peer review was conducted in a very detailed way to ensure a consistent methodology among participating banks.

While the design of EBAST2011 – with the collection of detailed bank-wise information and the thorough review process – assured high quality and comparability of results, typical problems of banking stress tests based on hypothetical scenarios persisted. Though the EBA during the stress testing procedure decided to aggravate the sovereign haircuts, taking into account the worsening of the sovereign crisis, critics still assailed the lack of realistic stress conditions: the adverse scenario was considered to be too mild, being overtaken by reality already during the test period:

- "All in all, market players felt the stress tests were far too mild. The EBA thus failed to reduce nerves in the market" (German Council of Economic Experts, 2011/12, p.131)

- "The haircut composition is also interesting in that under the EBA's parameters, of the 3 per cent total haircut on Italian two-year bonds, only about 2.1 per cent is related to credit risk. Interesting because we sense that the 3 per cent market haircut on the 2013 bond this week was most likely entirely credit-related…" (http://ftalphaville.ft.com).

On the other hand, some critics argued the adverse scenario of EBAST2011 did not take into account measures that would have produced a more optimistic picture of banks' capital position:

- *Mario Draghi* : "Last week, we had the results of the European Banking Authority (EBA) "stress tests" exercise. But ideally, the sequence ought to have been different: We should have had the EFSF in place first. This would have had certainly a positive impact on sovereign bonds, and therefore a positive impact on the capital positions of the banks with sovereign bonds in their balance sheet. So the ideal sequencing would have been to have the recapitalisation of the banks after EFSF had been in place and had been tested" (www.ft.com).

- "The four savings banks and one traditional commercial bank that did not make the cut failed because the European Banking Authority applied a one-size-fits-all criterion that ignores certain Spanish capital buffers" (www.forbes.com).

### 3.2.2 Results of the EBAST2011

The majority of banks doing poorly under the adverse scenario were from Spain or Greece. Eight of the 90 banks flunk the stress test[4]. Five of these eight banks were from Spain: Catalunya Caixa, Pastor, Unnim, Caja3 and CAM did not pass the required 5% CT1 ratio hurdle. In Austria, the Oestereichische Volksbank AG failed the test. Further, the Greek banks ATEbank and EFG Eurobank did not pass. The German Helaba decided before the

[4] Results of the stress test recognizing capital issuances and mandatory restructuring plans publicly announced and fully committed before 30 April 2011.

publishing of the results to “pull out of the stress test” (www.helaba.de). Including Helaba, nine banks failed the stress tests benchmark. 16 banks were close to failing, with CT1 ratios between 5% and 6%.

The CT1 was calibrated and published for each bank both under the baseline and the adverse scenario. The banks with the highest drop in CT1 under the adverse scenario were the Greek TT Hellenic Postbank (drop of 13%) and National Bank of Greece (-4%), the Spanish Banco Pastor (-4%) and the German Commerzbank (-4%). On average the banks denoted a drop of CT1 of 1% under the adverse scenario compared to the end of 2010 figures.

Details about the stress test results can be found in table A3 in the appendix.

### 3.2.3 Information value of the EBAST2011

While the expressed intention of the EBAST2011 was to quantify the capital positions of major European banks under stress conditions - in particular the changes in CT1 ratios – the EBA claimed that as an additional benefit of the testing exercise opacity in the European banking sector was reduced:

> “The 2011 EU wide stress test contains an unprecedented level of transparency on banks’ exposures and capital composition to allow investors, analysts and other market participants to develop an informed view on the resilience of the EU banking sector” (www.eba.europe.eu 5, p.3). (…) Today’s publication provides unprecedented transparency and disclosure for the market to make its own judgement. It gives access to the data they need to make informed decisions about the exposure to the risk of 90 EU banks” (www.eba.europe.eu 6, p.1).

As an additional feature of the EBAST2011 results not yet available before to market participants, individual banks’ sovereign holdings in the banking and the trading book were disclosed.

The information value of the EBAST2011 – according to the EBA – went beyond the 2010 stress test exercise: “There are some 3,200 data points in today’s results compared to just 149 in last year’s CEBS run test” (www.eba.europe.eu 6, p.2).

The “unprecedented transparency” of the EBAST2011 results was indirectly confirmed (and its public disclosure lamented) by the Association of German Banks:

> "…it is highly regrettable that the EBA has not taken up our criticism of the present form of publication of the stress test results and unfortunately discloses wide-ranging details of individual banks' business strategy. In the current uneasy situation on the financial markets, it cannot be ruled out that this detailed information may seriously exacerbate market volatility or could even be used for speculation against some banks" (www.germanbanks.org).

It is of vital importance for the design of an event study of the EBAST2011, in particular for the event windows to be chosen, to determine when test results became available for the interested public. The very logistic of the EBAST2011 practically assured pre-publication spreading of results. Of course, the banks included in the test knew about their own results (because they produced them in-house) and the national supervisory authorities had knowledge about all domestic banks' results, because they had to review them before transmission to the EBA. Therefore, market participants were in a situation to make at least educated guesses before publication day.

Also, some news organizations published results of the EBAST2011 before July 15. Already June, 28th 2011 the news agency Reuters published a statement predicting a regional concentration of failing banks:

> "Euro zone sources said the European Banking Authority was set to announce within weeks that 10-15 of 91 banks being scrutinized had failed, with casualties expected in Germany, Greece, Portugal and Spain" (www.reuters.com).

On 15 July 2011, two hours before the official EBA presentation, the British news organization Sky News revealed results of the stress test separately for Barclays, HSBC, Lloyds Banking Group and Royal Bank of Scotland (CT1 ratios for the adverse scenario) (www.news.sky.com).

# 4. Event Study Evaluation

## 4.1. Event Studies as a scientific approach

Event studies typically analyze the effects of events such as stock split announcements, mergers, earning announcements etc., on the value of a firm. Researching banks' balance sheets are of limited usefulness for this purpose, though. Firstly, financial statements usually are only published annually or semi-annually – a link to a specific event is thus ambiguous (MacKinlay, 1997, p. 13). Ball and Brown (1986) found that most of the information content of annual statements was already captured by more timely media. Also, balance sheet figures can be influenced by many factors such as accounting choices or creative accounting.

Mitchell and Netter (1994) define event studies as follows:

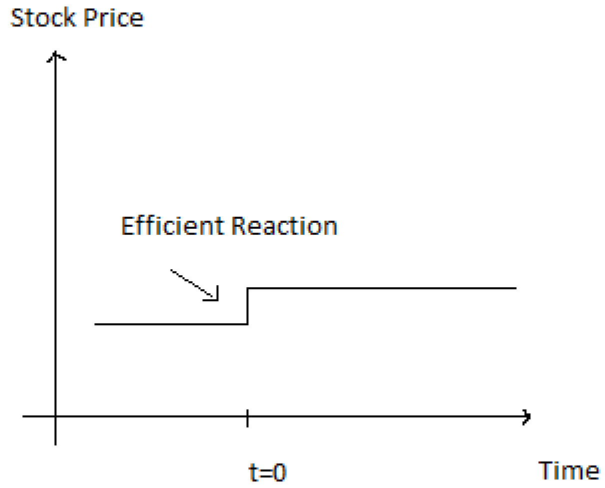
> "An event study is a statistical technique that estimates the stock price impact of occurrences such as mergers, earnings announcements, and so forth. The basic notion is to disentangle the effects of two types of information on stock prices – information that is specific to the firm under question (e.g., dividend announcement) and information that is likely to affect stock prices marketwide (e.g., change in interest rates)."

## 4.2 History and Background of Event Studies

Khotari and Warner (2005, p.5) refer to over 500 conducted event studies in literature. The pioneers in this field were Ball and Brown (1968) and Fama (1969). Ball and Brown's study linked the announcement of income numbers with the movement of the security of the firm around the time of the announcement. Fama et al. studied the market reaction to stock split announcements. Analyzing stocks market behavior 60 month surrounding a stock split they concluded that markets are "efficient". Malkiel (1991) defines an efficient market as follows: "I take the market efficiency hypothesis to be the simple statement that security prices fully reflect all available information" (Fama, 1991, p. 1575).

Graphically, an efficient reaction to an unexpected event at time t = 0 can be illustrated as follows:

FIGURE 4.1: EFFICIENT MARKET REACTION




Given an efficient market, the information content of an event can be detected by a change in the market price. Vice versa, if a market does not react to unexpected and relevant information, the EMH does not hold. The jump in the stock price at event time t = 0 can be described as "abnormal return", whereas the continuation of the stock price curve under the assumption of no event is called "normal return". (For formal definitions of "abnormal returns" and "normal returns" see below).

Roberts (1967) distinguished three specifications of market efficiency: weak, semi-strong and strong - depending on how far markets are assumed to reflect information. The event study approach is based on the concept of semi-strong markets that only adjust to publicly available new information.  Fama (1991, p.1577): "Instead of semi-strong-form tests of the adjustment of prices to public announcements, I use the now common title, event studies".

### 4.3 Framework of event studies

MacKinlay's (1997, p.14) and Campbell et al. (1997, p.151) devised recommendations for the structure of event studies regarding the definition of an event and the event windows, the inclusion of firms in the study sample, the definition of an estimation window for the parameters of a prediction model, the calculation of normal and abnormal returns and the testing of abnormal returns.

### 4.3.1 Defining an event and the event window

An event of interest has to be chosen. MacKinlay (1997) chose as an event the announcement of quarterly earnings, while Blacconiere and Northcutt (1997) assess in their study the market reaction to US. firm's annual toxic chemical releases.

In traditional event studies, the sampling interval of historic data can vary from daily to monthly data (MacKinlay, 1997). Morse (1984, p.619) surveys the impact of the sample interval on the power of the statistical test. He advises to only prefer monthly data if the exact event day is not definable, otherwise the use of daily returns is advised as it allows for more accurate determination of abnormal returns.

For the analytical part of an event study it is common practice to partition the timeline of interest into two segments: an estimation window and an event window. The event window consists at least of the day of the event; usually it additionally comprises several days around the event day to account for lag and lead effects. Lead effects in periods predating the event show up when markets anticipate – on the basis of assumptions or of leaked information – the event resp. the event's result. Lag effects occur when the reaction of the market with regard to a stock's return is distributed over several time periods following the event. Siegel and McWilliams (1997) summarized common event study approaches and found that most researches used multiple event windows without justifying it. Including pre-event days in the event window is directly comprehensible. The concept to test for lag effects after the event seems however not to conform with the efficient market hypothesis. De Bondth and Thaler (1985) however found that most investors tend to "overreact" to unexpected events, thereby producing event induced effects even in lengthier post-event windows.

### 4.3.2 Identifying criteria to select firms in the study sample

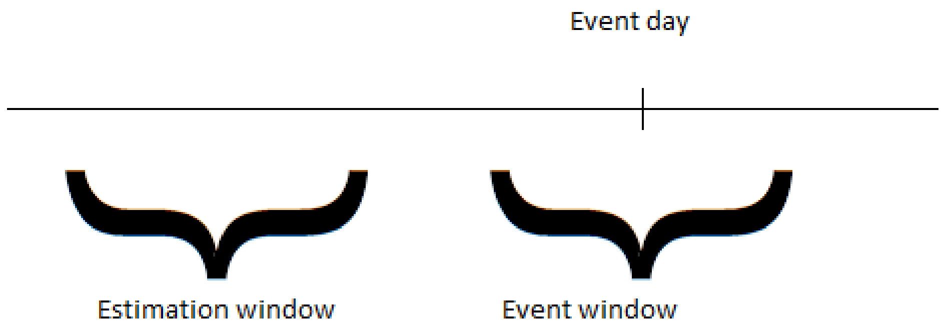
Selection criteria have to be defined about which firm to include in the study. MacKinlay (1997) for instance only included in his event study example companies that were listed on the Dow Jones Industrial Index. Restrictions might be imposed by lack of data availability – not all companies are listed on stock exchanges. In order to imply normal distribution the sample size should be sufficient large. Campbell et al. (1997) suggest classifying the data at this point regarding characteristics such as industry affiliation or market capitalization.

### 4.3.3 Defining an estimation window

The estimation window consists of historic data previous to the event day and is used to build a model for the prediction of normal returns for the event window. It should not overlap with the event window to make sure that no event related abnormal returns are included in the estimation process for the parameters of the model.

The following graphic depicts the relationship between the two windows:

FIGURE 4.2: ESTIMATION WINDOW AND EVENT WINDOW




The length of the estimation window can vary. Kothari and Warner (1997) define multi-year estimation windows as long-horizon tests, event studies with shorter estimation window as short-horizon tests. They discuss problems imposed through long-horizon tests and conclude that many aspects still remain, such as problems with increasing variance during event window. In contrast to that they are confident concerning the reliability of short-horizon tests (p.9).

### 4.3.4 Calculating normal and abnormal returns

Asset returns are defined as:

$$R_t = \frac{SP_t - SP_{t-1}}{SP_{t-1}} \qquad (1)$$

where $SP_t$ is the asset price at time t and $SP_{t-1}$ the asset price at time t-1. Asset return $R_t$ then is the relative change of the asset price SP from (t-1) to t.

The basic concept of event studies is to identify abnormal returns caused by an event. Abnormal returns (AR) are defined as the difference of the actual return minus the expected return in absence of the event under consideration, defined as “normal return” (NR).

For each firm i on event day t the abnormal return is defined as (Campbell et al., p. 151, but with different notation):

$$AR_{it} = R_{it} - E(R_t/X_t) \qquad (2)$$

where $AR_{it}$ is the abnormal return of stock i on day t, $R_{it}$ is the actual return of stock i on day t, and $E(R_{it}/X_t)$ is the expected return (the normal return) of stock i on day t. $X_t$ is the conditioning information for the normal performance model. (Campbell et al., 1997, p. 151).

It is usually assumed that asset returns are normal and independently and identically distributed through time (Campbell et al., 1997, p. 154). To forecast normal returns during the event window, estimation window return data are used to build a forecasting model. Most common forecasting models are the constant mean model and the market model. Both are statistical approaches, i.e. stochastic assumptions are made regarding the behavior of returns, but they “do not depend on economic arguments” (Campbell et al., 1997, p. 153f).

In the constant mean model, normal returns are constant for all event window t. In the market-model approach, the normal returns are dependent on a market portfolio. As an a priori hypothesis, the market model is supposed to be an improvement compared to the constant mean model. After all, the movement of stock prices is related to exogenous information (a market index), while the constant mean model simply assumes the continuation into the event window of purely stochastic fluctuations around a mean return that was calculated for the estimation window. The market model will lead to a reduction in the abnormal return variance (Campbell et al., 1997, p. 163).

Compared to economic models, which use economic theory to define causal relations between the models’ variables (in addition to statistical concepts), the advantages of a market model rest on its simplicity, whereas economic models tend to increase complexity without improving the predictive power. “There seems to be no good reason to use an economic model rather than a statistical model in an event study” (Campbell et al., 1997, p. 157).

4.3.5 Calculating cumulative abnormal returns (CAR)

A common analytical approach is to test securities' abnormal returns in groups in order to detect statistical similarities between group members. It is hereby assumed that the abnormal returns across securities are not correlated and that they are distributed identically and independently.

As a first step, event window abnormal returns for each bank are aggregated over time. Given an event window consisting of $t_2 - t_1$ days, CAR is defined as (MacKinlay, 1997, p.21):

$$CAR_i(t_1, t_2) = \sum_{t_1 = t_1}^{t_2} AR_{it} \qquad (3)$$

where $CAR_i(t_1, t_2)$ is the cumulative abnormal return for security i from $t_1$ to $t_2$.

Under the null-hypothesis of no abnormal returns CAR is expected to be normally distributed with mean zero and a conditional variance:

$$CAR_i(t_1, t_2) \sim N[0, \sigma_i^2\ (t_1, t_2)] \qquad (4)$$

For groups of securities, the cumulative average abnormal return (CAAR) is defined as:

$$CAAR = \frac{I}{n} \sum_{i=1}^{n} CAR_i \qquad (5)$$

$$CAAR(t_1, t_2) \sim N[0, \bar{\sigma}^2\ (t_1, t_2)] \qquad (6)$$

where n is the number of securities, $\sigma_i^2$ is the variance of abnormal returns of bank i between from $t_1$ to $t_2$ and $\bar{\sigma}^2$ is the variance of average abnormal returns across banks from $t_1$ to $t_2$. N denotes the normal distribution.

The definition of groups for the analysis of the CAAR depends on the type of returns to be tested. MacKinlay (1997, p.25) grouped sample firms into three categories: firms with positive earnings announcements, firms with negative earnings announcements and firms that did not provide any news.

4.3.6 Significance testing of abnormal returns

The purpose of testing of abnormal returns in the event window is the detection of significant event related effects: "The event date abnormal return (…) is then assessed for statistical significance relative to the distribution of abnormal returns … in the control window" (Corrado, 2011, p. 210)[5]. This basic concept holds whether the event window consists of just one day or several days and whether returns of a single company are assessed or of a group of companies.

Depending on the structure of the underlying data both parametric and non-parametric tests can be used. Commonly used parametric tests are approaches by Patell (1976) and Boehmer et al. (1991). Assumptions for the use of parametric tests are normal distribution of the sample data, no autocorrelation and homogenous variances in estimation and event window.

Following Khotari and Warner (2005, p. 13), for the test of cumulative abnormal returns (CAR) of an individual bank i the test statistic

$$\theta = \frac{CAR}{\sqrt{(t_2 - t_1)} \times \sqrt{\sigma^2}} \qquad (7)$$

where $\sigma_i^2$ is the variance of abnormal returns of bank i

is used. For the test of significance of the CAAR values across a group of banks, the test statistic

$$\theta = \frac{CAAR}{\sqrt{(t_2 - t_1)} \times \sqrt{\bar{\sigma}^2}} \qquad (8)$$

where $\bar{\sigma}^2$ is the variance of the average of abnormal returns across banks

is computed. $\theta$ follows Student's t-distribution with n-1 degrees of freedom. The t-test distribution approaches the normal distribution; for sample sizes greater than 30 the two distributions are very similar. In practice, the variance of the residuals resp. of the average residuals in the estimation window is used as a substitute for the unknown variance in the denominator in (7) resp. (8). For sufficiently long estimation windows the substitution will provide satisfactory, while not exact results (Campbell et al.,1997, p. 160).

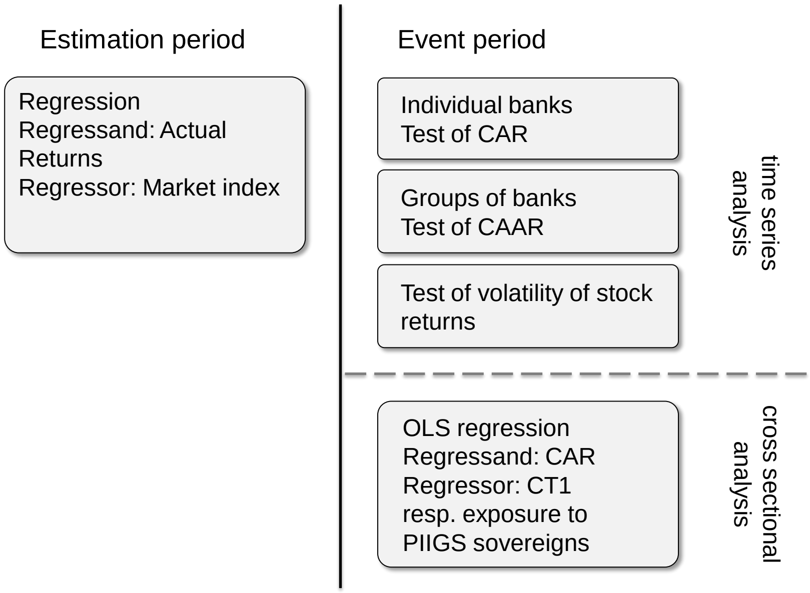
If the t-statistic $\theta$ exceeds a critical value C – as provided in tables by standard econometric publications (Brooks, C., 2011, p. 617) –, abnormal returns are significant on the predetermined probability level.

[5]control period = estimation window

# 5. Event study: Design of Empirical Analysis

Figure 5.1 provides an overview of the elements of the empirical analysis carried out.

FIGURE 5.1: DESIGN OF EMPIRICAL ANALYSIS




In the estimation window, market model parameters for each bank's returns are estimated using OLS regression. Based on these models, event window forecasts of normal returns are generated. Significance testing of abnormal returns in the event windows is done for individual banks (CAR) and for groups of banks (CAAR) to identify event related effects. A test of the volatility of stock returns within event windows analyzes the event's effect on stock return volatility. A cross sectional analysis, based on OLS regressions, estimates the relevance of CT1 changes resp. the PIIGS sovereign's exposure for abnormal returns of the banks tested.

## 5.1 Statement of hypotheses

The very purpose of the EBAST2011 was to determine the effects of an adverse scenario on CT1 ratios of major European banks in order "to allow investors, analysts and other market participants to develop an informed view on the resilience of the EU banking sector" (www.eba.europa.eu 5, p.3). Also, EBA's claim of "unprecedented transparency and disclosure" of EBAST2011 – in particular: holdings of sovereign bonds – could, according to the German Association of Banks, influence market conditions and stock market returns of individual banks (www.germanbanks.org). If these claims of the EBA and the German Association of Banks have merit, European banks' exchange traded asset returns should have reacted to the publication of the EBAST2011 results.

Based on these considerations, the following null hypotheses are tested:

> Hypothesis A: The EBAST2011 results did not change stock market abnormal returns resp. CDS abnormal returns of individual banks.
> Hypothesis B: The EBAST2011 results did not change stock market abnormal returns of groups of banks with similar characteristics.
> Hypothesis C: The EBAST2011 results did not increase stock market volatility.

For hypotheses A and B a two-tailed significance test must be used, since deviations of abnormal returns in both directions are tested. For hypothesis C a one-sided test is appropriate, since only the increase of volatilities is tested.

Supplementing the testing of these hypotheses, an explanatory analysis discusses when – if at all – stock market returns resp. CDS premium returns reacted to the EBAST2011 results.

### 5.2 Data Selection

Not every bank included in the EBAST 2011 is suited for consideration within the framework of this event study design. There are two criteria that both were necessary conditions for inclusion:

- a bank's shares have to be tracked on at least one stock exchange;
- the bank shares' trading volume has to be significantly large enough to apply standard hypotheses testing procedures about the dependency of share prices on exogenous factors, such as events or indices.

90[6] European banks participated in the EBAST2011. Only approx. half of them are publicly traded. In the case of Spain, most of the banks are too small to be listed and therefore did not qualify for this analysis. The German Banking system is dominated by public sector and cooperative banks (“Landesbanken”, “Sparkassen”, and “Volksbanken”) which – with one exception – are not listed on the country’s stock exchanges. Thus, only for three of the 12 German banks in the EBAST2011 historic stock market data are available. For some banks in the EBAST2011, shares actually are traded on a domestic bourse, but the trading volume is too low to warrant inclusion in the analysis[7]. The final sample, therefore, comprises of only 44 banks of the EBAST2011’s 90 banks (see appendix for details).

Stock and index data are extracted from the web site of yahoo.finance.com. If a bank is listed on different stock exchanges the one with the highest average trading volume is selected. Usually this is the domestic stock exchange, in case of Hungarian OTP bank Frankfurt serves as exchange place. For all banks, adjusted closing stock prices are used to calculate returns.

To broaden the scope of the analysis, Credit Default Swap (CDS) premium returns are included besides stock market returns. A Credit Default Swap (CDS) is “a derivative that prices insurance against the default of its underlying bond” (Gottschalka and Walkerb, 2008, p.1). Assessing the reaction of the CDS premium market will give an insight of the investor`s risk assessment of the firm’s bonds. Stock market returns are expected to reflect the market’s judgement about the financial status and prospects of a company. CDS premium returns may provide additional insight into the risk profile of a company. CDS data are taken over the alternative – bond prices – as they “respond more quickly to changes in credit conditions” (BIS 4, p.2).

The CDS data are from Thompson Reuters Datastream. Datastream provides CDS quotes with different documentary clauses and maturities. CDS quotes with a CR (Complete Restructuring) clause are chosen as they are the most common in the sample of EBAST2011 banks. 5-year CDS quotes are used for the analysis since they are supposed to be the most liquid tenor (www.markit.com). CDS market data could be obtained for 11 banks.

[6] Original sample was 91

[7] It was decided to include one German bank with small trading volume into the analysis in order to have a broader representation of the German banking sector in the sample.

As the exact event day (publication of EBAST2011 results) is known, daily data can be used for the analysis. Also, daily data appear much better suited for the diagnosis of event related effects if the reaction can be assumed – as is typical for the behavior of stock resp. CDS prices – to be immediate.

### 5.3 Estimation window and event windows

Following standard event study rules outlined in chapter 4.3, an estimation window was defined for the purpose of calculating estimates of model parameters for the prediction of event windows abnormal returns. The estimation window in this study is limited to the trading days during the 02 August 2010 to 22 June 2011. The trading days during this time-span differ slightly among countries, ranging from 215 (U.K.) to 222 (Portugal, Italy, Netherlands).

In line with the definition presented in 4.3, the release of the EBAST2011 results has been chosen as the event. The announcement was made on 15 July 2011, after closure of the markets in Europe. 18 July 2011, therefore, was the first trading day European markets could react to the event. Consequently, for the purpose of this analysis, 18 July 2011 is the designated event day ("day 0" in the following analysis).

As has been discussed in chapter 3.2.3, EBAST2011 results were known to banks, to supervising institutions and news organizations ahead of 18 July 2011, the official day of publication of results. To allow for information spills ahead of day 0 and delayed reactions after day 0, the occurrence of abnormal returns therefore is analyzed for seven event windows. The shortest event window includes one day prior and one day after the event. The other event windows cover different time spans before and after the event day.[8] Given the extent of information sharing of EBAST2011 results among banks and news organizations prior to the publication date 18 July 2011, it seems plausible to assume that abnormal returns showed up several weeks ahead of event day. As the earliest possible date for the occurrence of abnormal returns 20 June 2011 has been chosen, i.e. 20 trading days ahead of the event day. For reasons of symmetry to the pre-event day window, the event window's end date has been set at 20 days after event day.

[8] The event window starting 20 days prior to the event might be influenced by the release of the results of the stress test by the European Insurance and Occupational Pension Authority.

TABLE 5.1: EVENT WINDOWS

| **Number of event window** | **Length of event window (from day … to day …)** | **Reason for selection** |
|---|---|---|
| (1) | (-1 to 1) | Measuring the direct impact of the event |
| (2) | (-5 to 1) | Allowing for information leakage during the week ahead of the event |
| (3) | (-10 to 1) | Allowing for information leakage during 10 days ahead of the event |
| (4) | (-20 to 1) | Allowing for information leakage during 20 days ahead of the event |
| (5) | (-1 to 5) | Allowing for 1 week delayed reaction after the event |
| (6) | (-1 to 10) | Allowing for 10 days delayed reaction after the event |
| (7) | (-1 to 20) | Allowing for 20 days delayed reaction after the event |

## 5.4 Model specification

### 5.4.1 Definition of the prediction model in the estimation window

The market model, as described in chapter 4.3.4, appears to be the appropriate approach for the prediction of event window abnormal returns. Using a market index as predictor of normal returns generates forecasts which are in line with the general market movement; differences between actual returns of an asset and predicted normal returns are valid estimates of abnormal returns of the asset in the event window. As to the choice of market index for the regression in the estimation window, there is no need to select the same index for each bank in the sample and for both types of securities (stocks and CDS). The superordinate goal is to produce for each bank the best possible event window forecasts of normal returns, based on the highest $R^2$ in the estimation window.

Two market index alternatives were pre-tested for the selection of the optimal prediction model: the Stoxx50 index of the 50 largest stock market traded European companies and the domestic stock market indices of the countries included in the test. Regressing the stock market returns of all banks in the sample on the Stoxx50 index yields an average of 0,26, while the average $R^2$ for a regression of market returns on the respective domestic market index is 0,44[9]. Since the domestic market indices exert superior explanatory power compared to the Stoxx50, the former are chosen as respective predictor variable for the market models for all banks. Of course, regressing returns of a specific stock on an index that contains the stock's returns – as is the case for all domestic indices – will lead to an upward biased coefficient of determination. Also, the abnormal returns in the event window may be smaller, if a bank's returns are part of the model forecasting these returns. However, the effects in the estimation as well as the event window seem negligible, since the contribution of individual banks is limited for all domestic market indices.

As a market index for the group of CDS spreads, the ITRAXX Europe has been chosen.

### 5.4.2 Analysis of abnormal returns in subgroups

The analysis of event related abnormal returns can be refined by grouping bank data into subgroups. Event related effects may show up more clearly when banks with similar characteristics are grouped together; while stochastic disturbances could easily mask the occurrence of abnormal returns of an individual bank, aggregating results across banks within a group should cancel out such effects.

#### 5.4.2.1 Country subgroups

Analyzing abnormal returns of banks grouped by country seems logical, since banks' typically hold domestic sovereigns rather than sovereigns from other countries (Blundell-Wignall, A. and Slovik, P., 2011, p.8). As a consequence, abnormal returns of banks should be correlated within country subgroups. Using a minimum number of two banks per country, the following country groups can be defined: Austria, Belgium, Denmark, France, Germany, Greece/Cyprus, Ireland, Italy, Portugal, Spain, Sweden, U.K. (Countries that participated in the test but do not have a banking stock traded at an exchange: Finland, Luxembourg, Malta, Norway, Slovenia).

[9] See tables A6 and A7 in the appendix, which present individual $R^2$ values of all banks for the regression on Stoxx50 resp. the domestic indices, in addition to the parameter estimates.

5.4.2.2 PIIGS vs. Non-PIIGS subgroups

Distinguishing abnormal returns of sovereigns of PIIGS countries (Portugal, Ireland, Italy, Greece and Spain) vs. Non-PIIGS countries promises additional insight into the extent of the event's influence. As an effect of the EBAST2011 results, market evaluation of PIIGS banks' EBAST2011 results should be different from evaluation of results for Non-PIIGS banks, as the former are supposed to hold an overproportionate share of sovereigns with looming large haircuts.

5.4.2.3 Positive vs. negative CT1 change in adverse scenario

The difference between CT1 ratios at the end of 2010 vs. CT1 ratios in the adverse scenario of EBAST2011 is an indicator of a bank's resilience to stress conditions. Therefore, if the EBAST2011 "publication (of EBAST2011) provides unprecedented transparency and disclosure for the market to make its own judgement" (www.eba.europe.eu 6), differences in CT1 changes across banks should show up in differences in abnormal returns. Asset returns of banks with a relatively large deterioration of CT1 in the EBAST2011 results should experience worse stock resp. CDS market reactions than banks with better CT1 results.

Relative change in the CT1 ratio for each bank is calculated using the formula

$$\Delta CT1 = \frac{CT1_{after} - CT1_{before}}{CT1_{before}} \quad (9)$$

where

$CT1_{before}$ = CT1 at the end of 2010

$CT1_{after}$ = CT1 end of 2012 under the adverse scenario (but including capital injections between end of 2010 until end of April 2011to strengthen the banks' capital position)

Based on equation 9 two groups are defined:

"CT1 positive": banks which increase or hold stable their CT1 ratio under the adverse scenario ($\Delta CT1 \geq 0$) / 14 banks

"CT1 negative": banks whose CT1 ratio decreased under the adverse scenario ($\Delta CT1 < 0$) / 30 banks

Data of CT1 before and after the adverse scenario are to be found in the EBA disclosures of the EBA stress test results (www.eba.europa.eu 7).

For CDS premiums, data are only grouped into PIIGS states/Non-PIIGS states and by relative change of the CT1 ratio. Country related grouping for CDS premiums was not reasonable given the small sample size of only 11 banks with CDS data.

5.4.2.4 Test of volatility of stock returns

As has been quoted in chapter 3.2.3, the Association of German banks feared that the "detailed information" in the EBAST2011 "may seriously exacerbate market volatility". A significance test of the difference between the variances of the average abnormal returns of all banks for the windows -20 to -1 vs. 0 to 20 should give indications as to the correctness of the German Banks Association's claim.

$$H_o: \sigma_1^2 = \sigma_2^2$$

$$H_1: \sigma_1^2 > \sigma_2^2$$

where

$\sigma_1^2$= variance of average abnormal returns from day 0 to 20

$\sigma_2^2$ = variance of average abnormal returns from day -20 to -1

5.4.2.5 Cross sectional analysis

Relating abnormal returns of banks to CT1 ratios to PIIGS holdings sheds light on event induced effects. "Theoretical models often suggest that there should be an association between the magnitude of abnormal returns and characteristics specific to the event observation." (Campbell et al, 1997, p. 173).

CT1 ratios are a logical choice as regressor variable for a cross sectional regression model of abnormal returns. Therefore, cumulative abnormal returns for each event window were regressed on CT1 returns, using OLS estimates. If at all, CT1 returns are clearly the cause and not the effect of abnormal returns – a selection bias appears out of question (Campbell et al., 1997, p. 175).

The regression model used:

$$(CAR_{t1}^{t2})_i = \alpha + \beta * (\Delta CT1)_i + \varepsilon_i \qquad (10)$$

where

$(CAR_{t1}^{t2})_i$ = CAR from $t_1$ to $t_2$ for bank i
$(\Delta CT1)_i$ as in equation (9)

Holdings of PIIGS sovereigns per bank, expressed as ratio to Core Tier 1 capital end of 2010, could be another important factor for the understanding of event induced effects. A high ratio (= a bank's holdings of PIIGS sovereigns is large relative to Core Tier 1 capital) could lead to negative abnormal returns in event windows. Banks with high relative ratios could be seen as prime candidates for stress induced losses.

The regression model used:

$$(CAR_{t1}^{t2})_i = \alpha + \beta * \left(\frac{P.h.}{Cor1_{before}}\right)_i + \varepsilon_i \qquad (11)$$

where

$(CAR_{t1}^{t2})_i$ as in equation (10)
$\left(\frac{P.h.}{Cor1_{before}}\right)_i$ = Holdings of PIIGS sovereigns of bank i in relation to Core Tier 1 capital (absolute sum) end of 2010.

Results of cross sectional regressions are presented just for stock returns - with only 11 banks, the sample basis for CDS is too small to warrant useful interpretation.

# 6. Event study: Results of Empirical Analysis

## 6.1 Individual Banks

### 6.1.1 Estimation window

#### 6.1.1.1 Market model regression for individual banks / stock market

For each bank, stock returns in the estimation window were OLS regressed on the index returns, which – with few exceptions[10] – was the relevant domestic stock price index.

$$Y_{it} = \alpha_i + \beta_i X_{mt} + \varepsilon_{it} \qquad (12)$$

$$E(\varepsilon_{it} = 0) \qquad (13)$$

$$var(\varepsilon_{it}) = \sigma^2_{\varepsilon i} \qquad (14)$$

where $Y_{it}$ and $X_{mt}$ are returns on bank i and the domestic market index m, both in day t, $\varepsilon_{it}$ is the zero mean disturbance term for bank i in t, and the regression coefficients $\alpha_i$, $\beta_i$ and the variance $\sigma^2_{\varepsilon i}$ are the parameters of the market model for bank i.

Results of all regressions are shown in the table A6. Given sample sizes of 200 and more for the individual banks' times series, the critical value of the t-distribution for probability level 0.05 (resp. 0.01) is 1.96 (resp. 2.56). Therefore, values greater than 1.96 (resp. 2.56) in t-test columns (for the regression coefficients) allow rejection of the null hypothesis for the coefficients on probability level 0.05 (resp. 0.01). For the same sample size, the critical value of the F-distribution for probability level 0.05 (resp. 0.01) is 3.84 (resp. 6.63). Values greater than 3.84 (resp. 6.63) allow the rejection of the null hypothesis for $R^2$ on probability level 0.05 (resp. 0.01).

Of particular importance for the interpretation of the regression results is the t-statistic for $\beta$ and the F-statistic for $R^2$. The regressor coefficient $\beta$ is expected to be positive, thus – if significant – indicating a parallel movement of a bank's stock return with the domestic index return. A negative value of $\beta$ appears unlikely – it seems unusual for bank stock returns to be negatively correlated with the domestic market index' returns.

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[10] The Hungarian OTP bank was regressed against the German index DAX and the Cyprian Marfin Popular Bank against the Athen Index Compos, since for these two bank yahoo.finance.com only provided return data for German exchanges (OTP) resp. the Athen's exchange (Marfin).

As expected, for most banks the estimate of the $\beta$ coefficient is positive and significant, mostly even on the 0.01 probability level. $R^2$ – again, for most banks – indicates a significant positive co-movement of the individual stock returns with the relevant domestic index returns (significance level in most cases 0.01). Variances of banks' stock returns are explained by the variance of the relevant index' returns by up to 73 per cent, with the bulk of the banks' explained variances ranging from 40 per cent to 70 per cent. Bank-specific factors therefore account mostly for 30 per cent to 60 per cent of a bank's stock return variance.

Stock returns of only a few banks show very little correlation with the relevant index. These banks are mostly located in one of the PIIGS countries (but the results of these banks are not typical for other banks in their domestic country). In some cases (notably the Spanish bank Caja de Ahorros del Mediterraneo (CAM.MC), the Irish Life & Permanent (ILO.IR) and the German bank Landesbank Berlin (BEB2.F)), the main reason for the not existing correlation of the stock return with the domestic index appears to be the below average trading volume (table A5).

For the analysis of time series variables it is useful to consider the effects of autocorrelation. Regressions with autocorrelated dependent and independent variables are frequently biased in favor of detecting causal or correlative relations where actually no relationship exists. It should be noted that regressor and regressand in all equations were expressed as relative changes, thereby reducing the impact of autocorrelation on the parameters of the regression. In fact, first order autocorrelations coefficients of regression residuals (i.e. abnormal returns in the estimation window) are all practically of insignificant size, as table A4 in the appendix shows. The average first order autocorrelation coefficient is -0.007 and the standard deviation of the autocorrelation coefficients across banks is 0.117. On the 0.05 probability level, the 2-sigma interval is +/-0.234. The autocorrelation coefficients of just two banks are slightly outside this intervall. The null hypothesis of no autocorrelation of residuals in the estimation window market models therefore cannot be rejected.

Since the relevant – mostly domestic – indices appear to be good predictor variables for the banks' stock returns the estimated alpha and beta coefficients of table A6 are used to generate normal returns in the event window(s). To apply a common standard for all banks, even for the 3 banks (TT.AT, BEB2.F and BKT.MC) where the coefficients of determination were not significant different from zero, the relevant index was used for the calculation of event window normal returns.

6.1.1.2. Market model regression for individual banks / CDS market

For each bank, CDS premium returns in the estimation window were regressed on the ITRAXX index returns. In line with the regression conducted in 6.1.1.1 the market model

$$Y_{it} = \alpha_i + \beta_i X_{mt} + \varepsilon_{it} \qquad (15)$$

was used, where $Y_{it}$ is the return the CDS premium of bank i on day t and $X_{mt}$ is the return of the ITRAXX index on day t. The other terms are defined analogous to equation (12).

None of the $R^2$ values in table A8 exceed 0.42: obviously the pan-European ITRAXX index explains only a limited share of the variances of the individual banks' CDS premium returns during the estimation window. In contrast, $R^2$ values of the market models for stock prices (table A7), based on domestic indices, reached levels of up to 0.75. Apparently country-specific factors to a substantial amount contribute to the variance of bank stock returns. The lack of country-specific information in the CDS models diminishes their predictive abilities. But even with most $R^2$ values in the 0.20 – 0.35 area, predictions for normal returns of CDS premiums in the event window can be generated, since the test statistics in table A8 show significance of $\beta$ and $R^2$ values on the 0.01 probability level.

6.1.2 Event window

Abnormal returns – for stocks as well as CDS premiums – in the event window are calculated by subtracting normal returns – generated through market models, whose parameters are estimated in the estimation window – from actual returns:

$$AR_{it} = R_{it} - \hat{R}_{it} \qquad (16)$$

where $AR_{it}$ is the abnormal return of bank i on day t, $R_{it}$ is the actual return of bank i in t and $\hat{R}_{it}$ is the predicted normal return of bank i on day t.

For significance testing, the cumulative abnormal return (CAR) for stock and CDS premium returns as defined in equation (3) was calculated for each bank. T-tests based on equation (7) were carried out for all banks. For testing of significance of the CAR the degrees of freedom (df) for the seven event windows are presented in table 6.1. Tables A9 (stock returns) and

A11 (CDS premium returns) in the appendix presents the detailed results of the t-tests of the CARs of all banks for the seven event windows.

TABLE 6.1: TEST STATISTICS FOR EVENT WINDOWS (1) TO (7)

| **Number of event window** | **Length of event window (from day … to day …)** | **Degrees of freedom (n – 1)** (n = number of days per window) | **Critical value (cv) of Student's t for 0.05 probability level** |
|---|---|---|---|
| (1) | (-1 to 1) | 2 | 4.30 |
| (2) | (-5 to 1) | 6 | 2.45 |
| (3) | (-10 to 1) | 11 | 2.20 |
| (4) | (-20 to 1) | 21 | 2.08 |
| (5) | (-1 to 5) | 6 | 2.45 |
| (6) | (-1 to 10) | 11 | 2.20 |
| (7) | (-1 to 20) | 21 | 2.08 |

Source: Student's t-values taken from Brooks, C., (2011, p. 617).

6.1.2.1 Interpretation of t-tests on cumulative abnormal returns in event window / stock market

A summary of the results is shown below in tables 6.2 and 6.3.

TABLE 6.2: NUMBER OF BANKS WITH SIGNIFICANT CUMULATIVE ABNORMAL RETURNS / STOCK MARKET / 0.05 PROBABILITY LEVEL

| | **(a)** **Number of banks with /t/ > cv** | **(b)** **Number of banks with t > + cv** | **(c)** **Number of banks with t < - cv** |
|---|---|---|---|
| Day -1 to 1 | 0 | 0 | 0 |
| Day -5 to 1 | 2 | 1 | 1 |
| Day -10 to 1 | 7 | 4 | 3 |
| Day -20 to 1 | 2 | 1 | 1 |
| Day -1 to 5 | 3 | 3 | 0 |
| Day -1 to 10 | 3 | 3 | 0 |
| Day -1 to 20 | 6 | 6 | 0 |

(cv = critical value of Student's t on the 0.05 probability level)

TABLE 6.3: BANKS WITH SIGNIFICANT CUMULATIVE ABNORMAL RETURNS / STOCK MARKET / 0.05 PROBABILITY LEVEL

| **Bank** | **Country** | **Event windows with significant positive CAR*** | **Event windows with significant negative CAR*** |
|---|---|---|---|
| RBI.VI | Austria | -5 to 1<br>-10 to 1 | |
| DEXB.BR | Belgium | -1 to 20 | |
| KBC.BR | Belgium | | -5 to 1<br>-10 to 1 |
| SYDB.CO | Denmark | -1 to 10<br>-1 to 20 | |
| BNP.PA | France | -20 to 1 | |
| ALPHA.AT | Greece | -10 to 1 | |
| ETE.AT | Greece | | -10 to 1<br>-1 to 20 |
| MARFB.AT | Greece | -1 to 5 | -10 to 1 |
| BMPS.MI | Italy | -20 to 1<br>-1 to 20 | |
| UCG.MI | Italy | -1 to 20 | |
| BKT.MC | Spain | -10 to 1 | |
| POP.MC | Spain | -1 to 20 | |
| SAB.MC | Spain | -1 to 20 | |
| SAN.MC | Spain | -10 to 1 | |
| SHB-A.ST | Sweden | -1 to 10 | |
| SWED-A.ST | Sweden | -1 to 5 | |
| BARC.L | U.K | -1 to 10<br>-20 to 1 | |

* significant on the 0.05 probability level

As a broad generalization, there appears to be only limited market relevant information in the EBAST2011 results that influenced stock returns of the banks included in the test. There is significant event induced influence on cumulative abnormal returns of just 17 banks. Returns of 27 banks did not at all (in none of the seven event windows) react significantly to the EBAST2011 results.

The foremost conclusion must be that in event windows 1, the three days around 18 July 2011 (the day European exchanges could react to the publication of the EBAST2011 results), no significant reaction of banks' stock market returns can be detected. There is a spike in the frequency distribution of significant abnormal returns in the event windows 3 (day -10 to 1) and 7 (day -1 to 20), but these could possibly be interpreted as random occurrences, given the small sample size of just 17 banks with significant cumulative abnormal returns in at least one event window.

A splitting of the results for the 17 banks by positive resp. negative t-statistics suggests:

- banks' significant *negative* cumulative abnormal returns concentrate in the *pre-event* windows, presumably because pessimistic expectations regarding the results of the EBAST2011 had a correspondingly negative influence on the returns of these banks;

- banks' significant *positive* cumulative abnormal returns tend to concentrate in the *post-event* windows, presumably because the upward revision of pessimistic expectations (results of EBAST2011 were not as bad as expected) or – in some cases – outright positive results of EBAST2011 had a correspondingly positive influence on bank stock prices.

Just three banks accounted for all significant negative cumulative abnormal returns: one from Belgium (KBC.BR) and two from Greece (ETE.AT and MARFB.AT).

6.1.2.2 Interpretation of t-tests on cumulative abnormal returns in event window / CDS market

TABLE 6.4: NUMBER OF BANKS WITH SIGNIFICANT CUMULATIVE ABNORMAL RETURNS / CDS PREMIUMS / 0.05 PROBABILITY LEVEL

| | **(a) Number of banks with /t/ > cv** | **(b) Number of banks with t > + cv** | **(c) Number of banks with t < - cv** |
|---|---|---|---|
| Day -1 to 1 | 0 | 0 | 0 |
| Day -5 to 1 | 0 | 0 | 0 |
| Day -10 to 1 | 3 | 3 | 0 |
| Day -20 to 1 | 3 | 3 | 0 |
| Day -1 to 5 | 0 | 0 | 0 |

| | | | |
|---|---|---|---|
| Day -1 to 10 | 3 | 3 | 0 |
| Day -1 to 20 | 0 | 0 | 0 |

(cv = critical value of Student's t on the 0.05 probability level)

TABLE 6.5: BANKS WITH SIGNIFICANT CUMULATIVE ABNORMAL RETURNS / CDS PREMIUMS / 0.05 PROBABILITY LEVEL

| Bank | Country | Event windows with significant positive CAR* | Event windows with significant negative CAR* |
|---|---|---|---|
| BNP5EAC | France | - 10 to 1<br>-1 to 10 | |
| POP5EAC | Italy | -20 to 1 | |
| BCI5EAC | Italy | -10 to 1<br>-20 to 1<br>-1 to 10 | |
| UCB5EAC | Italy | -5 to 1<br>-10 to 1<br>-20 to 1<br>-1 to 10 | |

* significant on the 0.05 probability level

The limited number of banks (11) for which times series data of CDS returns are available does not lend itself to an elaborated analysis of the event window cumulative abnormal returns of CDS premiums. For CDS premiums of four banks significant positive cumulative abnormal returns can be detected, with no significant negative CAR. Since positive CAR values of CDS premium returns signal a worsening of the market position of a bank (because higher premiums have to be paid for the bank's bonds), for the four banks affected negative evaluations ahead of publication of EBAST2011 results can be diagnosed. This parallels results for the analysis of stock market returns.

Same as for the stock returns, no widespread significant event induced effects on CDS premium CAR can be detected. Information on the EBAST2011 results was apparently fully or almost fully available for market participants and already taken into account before 18 July 2011.

### 6.1.3 Summary of analysis of individual banks

Estimation window OLS regressions of banks' stock returns on domestic index returns provided high $R^2$ values for most banks. $R^2$ values for regressions of CDS premium returns on returns of the iTRAXX are lower than those for the stock return regressions, but still of significant size. Residual autocorrelation effects are negligible for both stock and CDS premium regressions. Forecasts of event window normal returns of stock returns resp. CDS premium returns are therefore based on models with good predictive power.

For individual banks, the publication of the EBAST2011 results had only limited effects on stock returns resp. CDS premium returns. In particular, in the immediate days around publication day no significant reaction of banks' stocks returns can be detected.
With a caveat for the rather small number of banks affected one can conclude that – if at all – pessimistic expectations for some banks caused negative stock returns ahead of the publication of EBAST2011 results while after the publication for other banks more positive reactions materialized. For the CDS premium returns – albeit based on a very small number of banks – a negative development ahead of the publication of EBAST2011 results can be diagnosed.

## 6.2 Groups of banks

As explained in 5.4.2, grouping of banks into categories can help to identify event related effects that are typical for banks of a mutual affiliation. Differences between groups of banks with regard to abnormal returns may highlight the importance of specific group characteristics. The groups chosen for further analysis are (see 5.4.2 for details):

- Country groups
- PIIGS vs. Non-PIIGS groups
- "Positive CT1" vs. "Negative CT1" groups

These are the grouping categories used for the analysis of stock returns; for the analysis of the CDS premium returns the country affiliation was dropped because of the small sample of banks for which CDS premium data were available.
For all groups of banks, average cumulative abnormal returns (CAAR) were calculated, based on equations in chapter 4.3.5 (equation (6)).

### 6.2.1 Country groups

For results of banks' CAAR grouped by country see table A10 in the appendix. Tables 6.6 and 6.7 show details of banks with significant results (0.05 significance level).

Banks in France, Germany and in the UK experienced negative average cumulative abnormal stock returns in event windows before 18 July 2011: day -5 to 1/Germany, day -10 to 1/France, Germany and UK and day -20 to 1/UK. Denmark, Greece, Italy and Sweden all had positive average cumulative abnormal stock returns in event windows starting ahead of 18 January 2011. The analysis points out that there were some country-related abnormal return effects of the EBAST2011 results.

TABLE 6.6: NUMBER OF COUNTRIES WITH SIGNIFICANT AVERAGE CUMULATIVE ABNORMAL RETURNS / STOCK MARKET / 0.05 PROBABILITY LEVEL

| | **(a) Number of countries with /t/ > cv** | **(b) Number of countries with t > + cv** | **(c) Number of countries with t < - cv** |
|---|---|---|---|
| Day -1 to 1 | 0 | 0 | 0 |
| Day -5 to 1 | 1 | 0 | 1 |
| Day -10 to 1 | 3 | 0 | 3 |
| Day -20 to 1 | 1 | 0 | 1 |
| Day -1 to 5 | 3 | 3 | 0 |
| Day -1 to 10 | 1 | 1 | 0 |
| Day -1 to 20 | 1 | 1 | 0 |

(cv = critical value of Student's t on the 0.05 probability level)

TABLE 6.7: COUNTRIES WITH SIGNIFICANT AVERAGE CUMULATIVE ABNORMAL RETURNS / STOCK MARKET / 0.05 PROBABILITY LEVEL

| **Country** | **Event windows with significant positive CAAR*** | **Event windows with significant negative CAAR*** |
|---|---|---|
| Denmark | day -1 to 5 | |
| France | | day -10 to 1 |
| Germany | | day-5 to 1<br>day-10 to 1 |
| Greece | day -1 to 5 | |
| Italy | day -1 to 20 | |
| Sweden | day -1 to 5<br>day -1 to 10 | |
| UK | | day -10 to 1<br>-day 20 to 1 |

* significant on the 0.05 probability level

6.2.2 PIIGS vs. Non-PIIGS countries

CAAR stock market results for PIIGS countries are significant (0.05 probability level) in the three event windows, starting at day -1 until days 5/10/20. No significant results can be detected for Non-PIIGS countries in any of the seven event windows. (Table A17 in the appendix)

The results for the PIIGS countries lend credibility to the assumption that the EBAST2011 results turned out better than expected and let to a post-event day surge of bank stock returns in PIIGS countries. For Non-PIIGS countries, no significant event induced effect can be found – neither before nor after event day.

For CAAR results and test statistics for the CDS premium market in the seven event windows see table A12 in the appendix.

Significant results of the PIIGS group for the CDS premium market can be found in event windows (day -5 to 1), (day -10 to 1) and (day -20 to 1). The CAAR values in these event periods are positive, which – by definition of CDS premium returns – indicates a deterioration of the market position for bonds of PIIGS countries in the weeks before 18 July 2011. Interpreted in connection with the CAAR results for the stock market, this suggests negative expectations for PIIGS countries' banks on CDS premium markets ahead of 18 July 2011, and positive assessments of the PIIGS countries stocks after 18 July 2011. The EBAST2011 results for the PIIGS countries' banks were feared to be more disastrous than they actually turned out.

### 6.2.3 "CT1 positive" vs. "CT1 negative"

Following the subgroup definition in chapter 5.4.2.3, stock market and CDS premium market CAAR for groups "CT1 positive" and "CT1 negative" were calculated and tested for significance (0.05 significance level). Results are presented in tables A18 (stock market) and A13 (CDS market) in the appendix.

Significant stock market results (0.05 probability level) can be found for the group of 14 banks with positive or no change of CT1 ("CT1 positive") in event window 3 (day -10 to 1). The CAAR value for event window 3 is negative, suggesting a stock return decrease for banks with improving CT1 position. Possibly market expectations were even more optimistic regarding the outcome of the test for this group; when expectations failed to materialize – as an effect of information leaks in the days before 18 July 2011 – stock returns of banks in the "CT1 positive" group suffered.

For the group of 30 banks with negative changes of CT1 ("CT1 negative"), significant results can be found in three event windows: (day -1 to 5), (day -1 to 10) and (day -1 to 20). For these three windows the CAAR values are positive, suggesting – on average across the banks in this group – an improvement in abnormal returns in the days after the publication of the results (18 July 2011). It can be assumed that the test results were not as bad as expected by investors, who may have foreseen even graver deteriorations in the CT1 positions.

As a caveat, it should be mentioned that of the 11 banks with CDS premium returns in the analysis, just 5 fell in the "CT1 positive" group and 6 in the "CT1 negative" group. Therefore, cell frequencies are rather small and results should been seen as indicative.

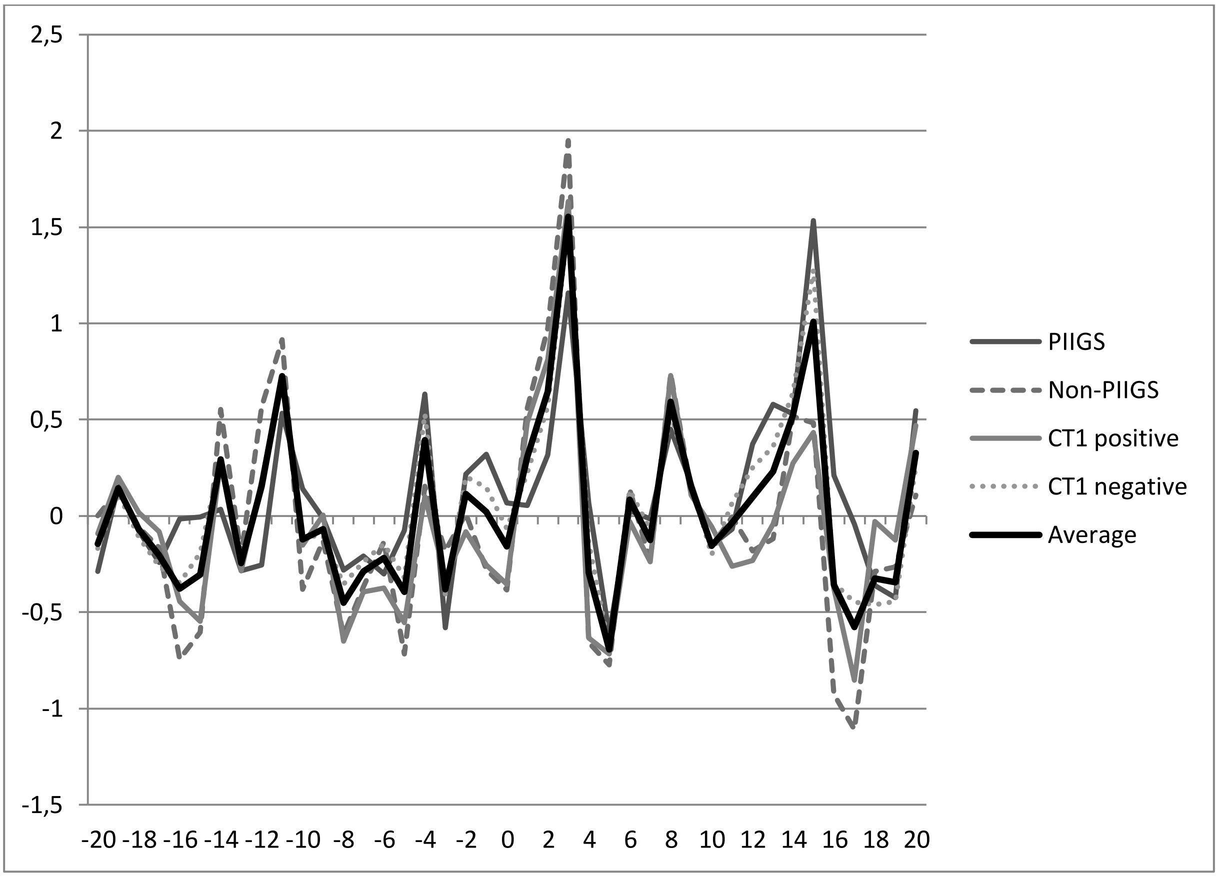
Significant CDS premium market results (0.05 probability level) can be found for the group of banks with positive or no change of CT1 ("CT1 positive") in event windows (day -5 to 1), (day -10 to 1) and (day -20 to 1). In all event windows, CAAR values are positive, which – by definition of the CDS premiums – represent a deteriorating market position for bonds of countries in the "CT1 positive" group. This is consistent with the result above for the stock market: the group of banks with positive changes of the CT1 position (as a result of the test) experience negative stock returns and negative CDS premium returns ahead of 18 July 2011.

### 6.2.4 Average abnormal returns: Analysis of variance

For the test of the variances $\sigma_1^2$ and $\sigma_2^2$, as described in 5.4.2.4, the standardized average abnormal returns across all 44 banks for the 41 data points in the event window from day -20 to day 20 were calculated (table A16 in the appendix). An F-test of the relation of both variances yielded a value of 3.1. Therefore, the null hypothesis of no difference between $\sigma_1^2$ and $\sigma_2^2$ has to be rejected, since the F-statistic calculated is larger than the critical value of the F distribution of 2.16 (20 df for numerator, 19 df for denominator) on the 0.05 probability level. The variance of the average abnormal returns from 18 July to day 20 is significantly larger than the variance of the average abnormal returns from day -20 to 15 July 2011 (day -1). The claim of the Association of the German banks that the detailed publication of the EBAST2011 results "may seriously exacerbate market volatility" has merit.

The different variances for the windows -20 to 1 and 0 to 20 show up even on visual inspection (figure 6.1).

**FIGURE 6.1: AVERAGE ABNORMAL RETURNS FOR ALL BANKS AND FOR GROUPS OF BANKS FROM WINDOWS -20 TO 20**




6.2.5 Summary of analysis of groups of banks

There are a few country-related abnormal return effects of the EBAST2011 results, but no clear patterns exist as to the countries affected resp. the timing of the effects.
PIIGS countries banks' returns for both stocks and CDS premiae suggest negative expectations of the market ahead of the publication of results and positive assessments thereafter.

Changes in the CT1 ratio as a result of the EBAST2011 seem to have had similar consequences for both stock and CDS premium results: the group of banks with positive CT1 ratio changes experience negative returns ahead of 18 July 2011, while banks with negative CT1 ratio changes experience positive returns after 18 July 2011. Markets punished banks because EBAST2011 results were not as good as expected and rewarded banks, whose results were not as bad as feared.

The analysis of stock market return variances before and after the publication of EBAST2011 results suggests that the claim of the Association of the German banks, the detailed publication of the EBAST2011 results “may seriously exacerbate market volatility”, has merit: market volatility increased after the publication of EBAST2011 results.

### 6.3 Cross sectional analysis

The results in the chapter relate to the definitions in chapter 5.4.3.
For significance testing, Student’s t-test and the F-test are used. The critical value of Student’s t is 2.02 (0.05 probability level; n = 44; 43 df). The critical value for the F-Test of $R^2$ is 4.08 (0.05 probability level). (Brooks, C. (2011), p. 617-618)

6.3.1 Regression of CAR on CT1 change

Table A14 presents the results of OLS regressions for the model presented in equation 10.

Significant relations exist for event windows (-10 to 1), (-5 to 1), (-1 to 1), (-1 to 5) and (-1 to 10). All significant $\beta$ values are positive: the larger the positive (the smaller the negative) CT1 return, the higher the cumulative abnormal return and vice versa. Banks with improving CT1 ratios experience positive event induced stock returns, while banks with decreasing CT1 ratios experience negative event induced stock returns. Of course, this is an interpretation based on cross sectional data. The analysis of times series data for the relation between cumulative abnormal returns

6.3.2 Regression of CAR on holdings of PIIGS sovereigns relative to Core Tier 1 ratio

Table A15 presents the results of OLS regressions for the model presented in equation 11.

It should be noted that the change in CT1 is a direct consequence of the EBAST2011adverse scenario stress exerted on the banks balance sheets. The change in CT1 is a test result. On contrast, the regressor variable here – PIIGS sovereign holdings relative to Core Tier 1 capital end of 2010 – is not a stress test result, but a pre-test statistic describing the capital position of each of the banks in the sample. Though banks were reluctant to publish their holdings of PIIGS sovereigns ahead of the test, the capital position of each bank vis-à-vis PIIGS sovereigns was probably known by informed investors even before the start of EBAST2011 and certainly before 18 July 2011, the day of publication of the results.

As a consequence, no significant (linear) relation (0.05 probability level) seems to exist between the cumulative abnormal returns and the holdings of PIIGS sovereigns, expressed as ratio to Core Tier 1 capital (table A19 in the appendix).

6.3.3 Summary of cross sectional analysis

Cumulative abnormal returns across banks show significant positive correlation with changes in the CT1 position of banks (resulting from the stress exerted in EBAST2011), but seem to be uncorrelated with the holdings of PIIGS sovereigns as a ratio to Core Tier 1 capital.

# 7. Conclusions

## 7.1 Summary of results

The results of the estimation of market models for the 44 banks showed a significant positive correlation between stock market returns and the domestic market indices. Estimation window OLS regressions of banks' stock returns on domestic index returns provided high $R^2$ values for most banks. Residual autocorrelation effects are negligible for both stock and CDS premium regressions. Forecasts of event window normal returns of stock returns resp. CDS premium returns are therefore based on models with good predictive power.

For individual banks, the publication of the EBAST2011 results had only limited effects on stock returns resp. CDS premium returns. In particular, in the immediate days around publication day no significant reaction of banks' stocks returns can be detected.

With a caveat for the rather small number of banks affected one can conclude that – if at all – pessimistic expectations for some banks caused negative stock as well as CDS premium returns ahead of the publication of EBAST2011 results while after the publication for other banks more positive reactions materialized.

As to the group-wise analysis, banks from PIIGS countries as a group experienced to some extent negative market evaluations ahead of the publication of EBAST2011 results and positive assessments thereafter.

Changes in the CT1 ratio as a result of the EBAST2011 seem to have had similar consequences for both stock and CDS premium results: the group of banks with positive CT1 ratio changes experience negative returns ahead of 18 July 2011, while banks with negative CT1 ratio changes experience positive returns after 18 July 2011.

Cumulative abnormal returns across banks show significant positive correlation with changes in the CT1 position of banks (resulting from the stress exerted in EBAST2011), but seem to be uncorrelated with the holdings of PIIGS sovereigns as a ratio to Core Tier 1 capital.

As a general find across groups and banks it can be stated, that there are indications based on the empirical analysis that markets punished banks because their EBAST2011 results were not as good as expected and rewarded banks, whose results were not as bad as feared.

The analysis of stock market return variances before and after the publication of EBAST2011 results suggests that the claim of the Association of the German Banks, the detailed publication of the EBAST2011 results "may seriously exacerbate market volatility", has merit: market volatility increased significantly after the publication of EBAST2011 results.

## 7.2 Critical Assessment of Results

The results summarized in 7.1 can be critically challenged in a number of ways:

- While daily stock/CDS market data allow for a more detailed analysis of abnormal returns than monthly data, the use of even more calibrated time series data (as, for instance, returns per hour) could provide deeper insights into the relation between event and event-induced effects for individual banks. This is particularly true for returns on 15 July 2011, when information providers published EBAST2011 results during exchanges' opening hours, ahead of the official early-evening publication.

Using hourly data for at least some event window days could be a topic for further research of the EBAST2011 effects.

- The estimation window regression estimates of market model parameters have not been corrected for heteroscedasticity (Brooks, C., 2011, p. 132). Brown, Harlow and Tinic (1993) describe the case of an increased variance due to a temporary increased systemic risk of a firm. However, events that just relate to one bank and have no relevance for all banks in the sample, need not to be considered. On the other hand, there was no major event during the estimation period that could have changed residual variances across banks. Also, it can assumed that because the use of returns, i.e. relative changes, residual variances of bank returns do not or do not much vary over the estimation window, so heteroscedasticity should not be a major concern. In any case, the choice where to split the estimation window for a test of heteroscedasticity would be arbitrary. Even under the presence of heteroscedasticity OLS estimators will still give unbiased coefficient estimates (even though they no longer have minimum variance among the class of unbiased estimators) (Brooks, C., 2011, p. 135).

- The use of domestic market indices for the regression models in the estimation window might be challenged because these market indices are still to general. More bank-specific domestic indices could provide even better forecasts of normal returns in the event window. However, using bank-specific domestic indices would in all European countries be composed mostly of the banks for which normal return forecasts were to be generated. High correlation between individual banks' asset returns and the bank indices would be guaranteed because the dependent variable would represent a major part of the independent variable. Forecasts of normal returns of a stock would mostly be a replicate of the actual returns of the same stock.

- Event-induced effects could already have shown up during the estimation window (2 August 2010 to 22 June 2011) because of leakage of EBAST2011 results. This would produce downward biased abnormal returns in the event window, leading to the conclusion that no significant event-induced effects exist. However, because of the length of the estimation window (at least 200 days for each bank) it can be assumed that parameter estimates of market model regressions in the estimation period are still predominantly not event-induced.

- Treating PIIGS countries sovereigns as one entity might cloud event window effects. Distinguishing between individual PIIGS countries could reveal a more differentiated picture of the consequences of EBAST2011. Analyzing banks' individual PIIGS countries holdings, however, goes beyond the scope of the analysis at hand.

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# Appendix:

Table A1: Abbreviation of bank names/ stock market

| Bank | Country | Abbr. |
|---|---|---|
| Erste bank group | Austria | EBS.VI |
| Raiffeisen bank international | Austria | RBI.VI |
| Dexia | Belgium | DEXB.BR |
| Kbc bank | Belgium | KBC.BR |
| Marfin popular bank public co | Cyprus | MARFB.AT |
| National bank of greece | Greece | ETE.AT |
| Alpha bank | Greece | ALPHA.AT |
| Piraeus bank group | Greece | TPEIR.AT |
| Tt hellenic postbank s.a. | Greece | TT.AT |
| Jyske bank | Denmark | JYSK.CO |
| Sydbank | Denmark | SYDB.CO |
| Bnp paribas | France | BNP.PA |
| Credit agricole | France | ACA.PA |
| Societe generale | France | GLE.PA |
| Deutsche bank ag | Germany | DBK.DE |
| Commerzbank ag | Germany | CBK.DE |
| Landesbank berlin ag | Germany | BEB2.F |
| Otp bank nyrt. | Hungary | OTP.F |
| Allied irish banks plc | Ireland | AIB.IR |
| Bank of ireland | Ireland | BIR.IR |
| Irish life and permanent | Ireland | IL0.IR |
| Intesa sanpaolo s.p.a | Italy | ISP.MI |
| Unicredit s.p.a | Italy | UCG.MI |
| Banca monte dei paschi di siena | Italy | BMPS.MI |
| Banco popolare - s.c. | Italy | BP.MI |
| Unione di banche italiane scpa | Italy | UBI.MI |
| Ing bank nv | Netherlands | INGA.AS |
| Espírito santo financial group, | Portugal | BES.LS |
| Banco bpi, sa | Portugal | BPI.LS |
| Banco santander s.a. | Spain | SAN.MC |
| Banco bilbao vizcaya argentaria | Spain | BBVA.MC |
| Caja de ahorros del mediterrane | Spain | CAM.MC |
| Banco popular espanol | Spain | POP.MC |
| Banco de sabadell sa | Spain | SAB.MC |
| Bankinter sa. | Spain | BKT.MC |
| Banco pastor, s.a. | Spain | PAS.MC |
| Nordea bank ab (publ) | Sweden | NDA-SEK.ST |
| Skandinaviska enskilda banken ab (publ) | Sweden | SEB-A.ST |

| | | |
|---|---|---|
| Svenska handelsbanken ab (publ) | Sweden | SHB-A.ST |
| Swedbank ab (publ) | Sweden | SWED-A.ST |
| Royal bank of scotland group pl | U.K. | RBS.L |
| Hsbc holdings plc | U.K. | HSBA.L |
| Barclays plc | U.K. | BARC.L |
| Lloyds banking group plc | U.K. | LLOY.L |

Table A2: Abbreviation of bank names/ CDS premium market

| **Banks** | **Country** | **Abbr.** |
|---|---|---|
| Bnp paribas | France | BNP5EAC |
| Credit agricole sa | France | CRI5EAC |
| Societe Generale | France | SG.5EAC |
| Commerzbank aktiengesellschaft | Germany | CBG5EAM |
| Deutsche bank aktiengesellschaft | Germany | DB.5EAC |
| Banca Monte die Pascha die siena s.p.a. | Italy | BMP5EAM |
| Banco popolare societa cooperativa | Italy | POP5EAC |
| Intesa sanpaolo spa | Italy | BCI5EAC |
| Unicredit, Societa per azioni | Italy | UCB5EAC |
| Banco santander, s.a. | Spain | SAN5EAC |
| Barclays banks plc | U.K. | BCS5ESC |

Table A3: Stress test result: CT1 ratio

| | **CT1 ratio Dec. 2010** | **CT1 ratio Dec. 2012 adverse scenario** | **ΔCT1** |
|---|---|---|---|
| EBS.VI | 0,087 | 0,081 | -0,06896552 |
| RBI.VI | 0,081 | 0,078 | -0,03703704 |
| DEXB.BR | 0,121 | 0,104 | -0,14049587 |
| KBC.BR | 0,105 | 0,1 | -0,04761905 |
| MARFB.AT | 0,073 | 0,053 | -0,2739726 |
| ETE.AT | 0,119 | 0,077 | -0,35294118 |
| ALPHA.AT | 0,108 | 0,074 | -0,31481481 |
| TPEIR.AT | 0,08 | 0,053 | -0,3375 |
| TT.AT | 0,185 | 0,055 | -0,7027027 |
| JYSK.CO | 0,121 | 0,128 | 0,05785124 |
| SYDB.CO | 0,124 | 0,136 | 0,09677419 |
| BNP.PA | 0,092 | 0,079 | -0,14130435 |
| ACA.PA | 0,082 | 0,085 | 0,03658537 |
| GLE.PA | 0,081 | 0,066 | -0,18518519 |
| DBK.DE | 0,088 | 0,065 | -0,26136364 |

| | | | |
|---|---|---|---|
| CBK.DE | 0,1 | 0,064 | -0,36 |
| BEB2.F | 0,146 | 0,104 | -0,28767123 |
| OTP.F | 0,123 | 0,136 | 0,10569106 |
| AIB.IR | 0,037 | 0,1 | 1,7027027 |
| BIR.IR | 0,084 | 0,071 | -0,1547619 |
| ILO.IR | 0,106 | 0,204 | 0,9245283 |
| ISP.MI | 0,079 | 0,089 | 0,12658228 |
| UCG.MI | 0,078 | 0,067 | -0,14102564 |
| BMPS.MI | 0,058 | 0,063 | 0,0862069 |
| BP.MI | 0,058 | 0,057 | -0,01724138 |
| UBI.MI | 0,07 | 0,074 | 0,05714286 |
| INGA.AS | 0,096 | 0,087 | -0,09375 |
| BES.LS | 0,064 | 0,051 | -0,203125 |
| BPI.LS | 0,082 | 0,067 | -0,18292683 |
| SAN.MC | 0,071 | 0,084 | 0,18309859 |
| BBVA.MC | 0,08 | 0,092 | 0,15 |
| CAM.MC | 0,068 | 0,064 | -0,05882353 |
| POP.MC | 0,064 | 0,053 | -0,171875 |
| SAB.MC | 0,062 | 0,057 | -0,08064516 |
| BKT.MC | 0,062 | 0,053 | -0,14516129 |
| PAS.MC | 0,076 | 0,033 | -0,56578947 |
| NDA-SEK.ST | 0,089 | 0,095 | 0,06741573 |
| SEB-A.ST | 0,111 | 0,105 | -0,05405405 |
| SHB-A.ST | 0,077 | 0,086 | 0,11688312 |
| SWED-A.ST | 0,087 | 0,094 | 0,08045977 |
| RBS.L | 0,097 | 0,063 | -0,35051546 |
| HSBA.L | 0,105 | 0,085 | -0,19047619 |
| BARC.L | 0,1 | 0,073 | -0,27 |
| LLOY.L | 0,102 | 0,077 | -0,24509804 |

Table A4: Autocorrelation of bank’s stocks

| **Autocorrelation** | |
|---|---|
| EBS.VI | -0,11697316 |
| RBI.VI | -0,09549676 |
| DEXB.BR | 0,00655474 |
| KBC.BR | 0,08833845 |
| MARFB.AT | -0,08706555 |
| ETE.AT | 0,022633 |
| ALPHA.AT | -0,02902852 |
| TPEIR.AT | -0,00733311 |
| TT.AT | -0,24645365 |
| JYSK.CO | -0,06101571 |

| | |
|---|---|
| SYDB.CO | 0,05000427 |
| BNP.PA | 0,1083366 |
| ACA.PA | 0,06513196 |
| GLE.PA | 0,15140337 |
| DBK.DE | 0,1131331 |
| CBK.DE | -0,00577818 |
| BEB2.F | -0,30482348 |
| OTP.F | -0,00326597 |
| AIB.IR | -0,00649144 |
| BIR.IR | 0,06568076 |
| IL0.IR | 0,00323199 |
| ISP.MI | -0,0018946 |
| UCG.MI | 0,02770021 |
| BMPS.MI | 0,00595704 |
| BP.MI | 0,0419359 |
| UBI.MI | -0,000826 |
| INGA.AS | 0,10260065 |
| BES.LS | 0,0021226 |
| BPI.LS | 0,03238775 |
| SAN.MC | 0,20426648 |
| BBVA.MC | -0,04277357 |
| CAM.MC | -0,05779069 |
| POP.MC | 0,22979082 |
| SAB.MC | 0,14129653 |
| BKT.MC | 0,19772917 |
| PAS.MC | -0,02929468 |
| NDA-SEK.ST | -0,1744574 |
| SEB-A.ST | -0,10819668 |
| SHB-A.ST | -0,0377217 |
| SWED-A.ST | -0,06594566 |
| RBS.L | -0,00839511 |
| HSBA.L | -0,12097027 |
| BARC.L | -0,06212337 |
| LLOY.L | -0,31186593 |

Table A5: Average Trading Volume

(obtained through www.yahoo.finance.com)

| **Bank** | **Ø daily trading Volumen (3 m)** |
|---|---|
| EBS.VI | 1078570 |
| RBI.VI | 338874 |

| | |
|---|---|
| DEXB.BR | 6703140 |
| KBC.BR | 1093890 |
| MARFB.AT | 3410640 |
| ETE.AT | 5875200 |
| ALPHA.AT | 3193030 |
| TPEIR.AT | 3264490 |
| TT.AT | 945020 |
| JYSK.CO | 74873 |
| SYDB.CO | 133042 |
| BNP.PA | 8457260 |
| ACA.PA | 13277200 |
| GLE.PA | 8398300 |
| DBK.DE | 12043700 |
| CBK.DE | 66678700 |
| BEB2.F | 6674 |
| OTP.F | 954 |
| AIB.IR | 1833890 |
| BIR.IR | 47291800 |
| IL0.IR | 436512 |
| ISP.MI | 209048000 |
| UCG.MI | 334313000 |
| BMPS.MI | 47147100 |
| BP.MI | 11502000 |
| UBI.MI | 5055100 |
| INGA.AS | 37913500 |
| BES.LS | 2701060 |
| BPI.LS | 1281430 |
| SAN.MC | 1281430 |
| BBVA.MC | 36480800 |
| CAM.MC | 210881 |
| POP.MC | 4455980 |
| SAB.MC | 2892450 |
| BKT.MC | 955773 |
| PAS.MC | 122512 |
| NDA-SEK.ST | 11523000 |
| SEB-A.ST | 10317300 |
| SHB-A.ST | 2319960 |
| SWED-A.ST | 6335920 |
| RBS.L | 106681000 |
| HSBA.L | 26486400 |
| BARC.L | 63397300 |
| LLOY.L | 67218384 |

Table A6: Regression results for parameter estimates/ estimation window /stock market

| Country | Bank | Estimate of $\alpha$ | Estimate of $\beta$ | t-test $\alpha$ | t-test $\beta$ | $R^2$ | F-test R2 | Index used as regressor |
|---|---|---|---|---|---|---|---|---|
| Austria | EBS.VI | 0 | 1,205 | 0,41 | 17,265 | 0,576 | 298,064 | ATX |
| | RBI.VI | -0,001 | 1,447 | -0,737 | 18,345 | 0,606 | 336,541 | ATX |
| Belgium | DEXB.BR | -0,002 | 1,373 | -2,050 | 10,732 | 0,34 | 115,184 | BFX |
| | KBC.BR | -0,001 | 1,825 | -0,779 | 15,045 | 0,502 | 226,369 | BFX |
| Greece/ | MARFB.AT | -0,003 | 1,007 | 24,407 | 13,008 | 0,433 | 169,217 | GD.AT |
| Cyprus | ETE.AT | -0,001 | 1,586 | -1,344 | 25,509 | 0,746 | 650,747 | GD.AT |
| | ALPHA.AT | 0 | 1,764 | 0,0683 | 21,621 | 0,678 | 467,494 | GD.AT |
| | TPEIR.AT | -0,004 | 1,577 | -1,525 | 11,140 | 0,359 | 124,111 | GD.AT |
| | TT.AT | -0,002 | 1,119 | -0,554 | -0,221 | 0,298 | 0,049 | GD.AT |
| Denmark | JYSK.CO | 0 | 0,586 | 0,244 | 5,345 | 0,114 | 28,574 | OMXC20.CO |
| | SYDB.CO | -0,001 | 0,728 | 0,107 | 1,89 | 0,246 | 3,578 | OMXC20.CO |
| France | BNP.PA | 0 | 1,32 | -0,560 | 22,370 | 0,689 | 500,441 | CAC 40 |
| | ACA.PA | 0 | 1,395 | -0,414 | 15,255 | 0,507 | 232,720 | CAC 40 |
| | GLE.PA | -0,001 | 1,44 | -0,743 | 16,564 | 0,544 | 274,370 | CAC 40 |
| Germany | DBK.DE | -0,002 | 1,073 | -2,200 | 12,535 | 0,412 | 157,131 | GDAXI |
| | CBK.DE | -0,004 | 0,868 | -2,930 | 6,291 | 0,149 | 39,577 | GDAXI |
| | BEB2.F | 0 | 0,126 | 0,126 | 0,704 | 0,012 | 0,495 | GDAXI |
| Hungary | OTP.F | 0 | 1,065 | 0,0327 | 6,715 | 0,167 | 45,093 | GDAXI |
| Ireland | AIB.IR | -0,006 | 2,152 | -1,379 | 6,044 | 0,141 | 36,532 | ISEQ |
| | BIR.IR | -0,006 | 2,715 | -1,501 | 7,680 | 0,21 | 58,992 | ISEQ |
| | IL0.IR | -0,009 | 1,178 | -1,501 | 2,177 | 0,021 | 4,741 | ISEQ |
| Italy | ISP.MI | -0,001 | 1,76 | -0,923 | 24,864 | 0,733 | 618,256 | FTSEMIB.MI |
| | UCG.MI | -0,001 | 1,577 | -1,141 | 24,536 | 0,725 | 602,041 | FTSEMIB.MI |
| | BMPS.MI | -0,002 | 1,331 | -1,589 | 13,146 | 0,436 | 172,842 | FTSEMIB.MI |
| | BP.MI | -0,004 | 1,28 | -2,449 | 8,843 | 0,259 | 78,207 | FTSEMIB.MI |
| | UBI.MI | -0,001 | 1,577 | -2,676 | 16,247 | 0,725 | 263,983 | FTSEMIB.MI |
| Netherlands | INGA.AS | 0 | 1,774 | 0,637 | 21,536 | 0,676 | 463,835 | AEX |
| Portugal | BES.LS | -0,001 | 1,47 | -1,537 | 17,121 | 0,57 | 293,129 | PSI 20 |
| | BPI.LS | -0,002 | 1,319 | -2,469 | 14,531 | 0,488 | 211,157 | PSI 20 |
| Spain | SAN.MC | -0,001 | 1,5 | -1,309 | 44,247 | 0,879 | 1957,851 | IBEX 35 |
| | BBCA.MC | -0,001 | 1,518 | -1,559 | 37,649 | 0,846 | 1417,506 | IBEX 35 |
| | CAM.MC | -0,001 | 0,155 | -0,915 | 1,613 | 0,011 | 2,603 | IBEX 35 |
| | POP.MC | -0,001 | 1,124 | -1,052 | 20,629 | 0,655 | 425,572 | IBEX 35 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | SAB.MC | -0,001 | 1,032 | -2,168 | 19,150 | 0,621 | 366,725 | IBEX 35 |
| | BKT.MC | 0,00077 | -3,3 | -0,105 | -0,296 | 0,42 | 0,087 | IBEX 35 |
| | PAS.MC | -0,001 | 0,601 | -1,206 | 8,470 | 0,243 | 71,751 | IBEX 35 |
| Sweden | NDA-SEK.ST | 0,001 | 1,109 | -0,865 | 16,029 | 0,536 | 256,929 | OMXSPI |
| | SEB-A.ST | 0 | 1,189 | 0,174 | 17,797 | 0,588 | 316,733 | OMXSPI |
| | SHB-A.ST | -0,001 | 0,837 | -0,920 | 13,161 | 0,438 | 173,227 | OMXSPI |
| | SWED-A.ST | 0,001 | 1,143 | 1,151 | 14,744 | 0,495 | 217,410 | OMXSPI |
| UK | RBS.L | -0,002 | 1,259 | -1,355 | 9,844 | 0,305 | 96,919 | FTSE |
| | HSBA.L | 0 | 0,888 | -0,837 | 13,451 | 0,45 | 180,943 | FTSE |
| | BARC.L | -0,002 | 1,043 | -1,352 | 8.157 | 0,231 | 66,545 | FTSE |
| | LLOY.L | -0,002 | 1,199 | -1,931 | 9.677 | 0,298 | 93,644 | FTSE |

Table A7: Coefficient of Determination: Stoxx50 used as regressor

| **Bank** | **$R^2$ Stoxx50** |
|---|---|
| EBS.VI | 0,44974489 |
| RAW.DE | 0,27474183 |
| DEXB.BR | 0,31465746 |
| JXG.F | 0,00127151 |
| DANSKE.F | 0,00206856 |
| JYSK.CO | 0,19356172 |
| SYDB.CO | 0,00336084 |
| BNP.PA | 0,66026895 |
| ACA.PA | 0,50659039 |
| GLE.PA | 0,55563495 |
| DBK.DE | 0,4958627 |
| CBK.DE | 0,05874664 |
| ETE.AT | 0,12000938 |
| ACB.F | 0,04161019 |
| TPEIR.AT | 0,09888965 |
| TT.AT | 0,08367803 |
| AIB.IR | 0,01453248 |
| BIR.IR | 0,04054636 |
| ISP.MI | 0,10208247 |
| UCG.MI | 0,11100959 |
| BMPS.MI | 0,27443645 |
| BP.MI | 0,19201368 |
| UBI.MI | 0,3210693 |
| INGA.AS | 0,64284456 |
| MBC.LS | 0,15591062 |

| | |
|---|---|
| BES.LS | 0,24113616 |
| BPI.LS | 0,22115627 |
| SAN.MC | 0,65344334 |
| BBCA.MC | 0,58744818 |
| CAM.MC | 0,00353944 |
| POP.MC | 0,39894959 |
| SAB.MC | 0,32746261 |
| BKT.MC | 0,41471783 |
| PAS.MC | 0,14964717 |
| NDA-SEK.ST | 0,3895899 |
| SEB-A.ST | 0,01478787 |
| SHB-A.ST | 0,26231762 |
| SWED-A.ST | 0,36615951 |
| RBS.L | 0,36541695 |
| HSBA.L | 0,3172265 |
| BARC.L | 0,33549721 |
| LLOY.L | 0,32776281 |
| Average | 0,264081 |

Table A8: Regression results for parameter estimates/ estimation window /CDS premium market

| **Country** | **Bank** | **alpha** | **beta** | **t-test alpha** | **t-test beta** | **$R^2$** | **F-test $R^2$** | **Index** |
|---|---|---|---|---|---|---|---|---|
| France | BNP5EAC | 0,001 | 0,973 | 0,725126 | 10,70888 | 0,341 | 114,6801 | ITRAXX |
| France | CRI5EAC | 0,001 | 1,046 | 0,528599 | 10,86707 | 0,349 | 118,0933 | ITRAXX |
| France | SG.5EAC | 0,002 | 1,032 | 0,958099 | 12,4234 | 0,411 | 154,3408 | ITRAXX |
| Germany | CBG5EAM | 0,003 | 1,22 | 0,989113 | 8,216414 | 0,23 | 67,50946 | ITRAXX |
| Germany | DB.5EAC | 0 | 1,011 | 0,055556 | 11,12714 | 0,35 | 123,8132 | ITRAXX |
| Italy | BMP5EAM | 0,002 | 0,915 | 0,986963 | 10,04351 | 0,312 | 100,8721 | ITRAXX |
| Italy | POP5EAC | 0,002 | 0,477 | 1,36304 | 6,270734 | 0,149 | 39,3221 | ITRAXX |
| Italy | BCI5EAC | 0,002 | 1,045 | 1,098038 | 10,56386 | 0,331 | 111,5952 | ITRAXX |
| Italy | UCB5EAC | 0,001 | 0,573 | 0,345885 | 8,048335 | 0,219 | 64,77569 | ITRAXX |
| Spain | SAN5EAC | 0,003 | 1,061 | 1,093113 | 9,27903 | 0,279 | 86,10039 | ITRAXX |
| U.K. | BCS5ESC | 0,02 | 0,904 | 0,897691 | 9,11241 | 0,272 | 83,03602 | ITRAXX |

**Table A9: T-test results for CAR stock market single banks**

(The test statistic has been presented in chapter 4.3.5):

| | BNP5EAC | CRI5EAC | SG.5EAC | CBG5EAM | DB.5EAC | BMP5EAM |
|---|---|---|---|---|---|---|
| Day -1 to 1 | 2,331683 | 2,604492 | 2,097940 | 0,595729 | 2,670481 | 0,936390 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Day -5 to 1 | 2,082240 | 1,882354 | 2,327783 | 0,359954 | 1,092029 | 1,484797 |
| Day -10 to 1 | 2,240339 | 1,879508 | 1,897063 | 0,127397 | 1,064088 | 2,026226 |
| Day -20 to 1 | 1,458689 | 0,722678 | 0,647933 | 0,097777 | 0,933285 | 1,873427 |
| Day -1 to 5 | 0,498760 | 0,859841 | 0,927406 | 0,029119 | 1,292189 | -0,803518 |
| Day -1 to 10 | 2,240339 | 1,879508 | 1,897063 | 0,127397 | 1,064088 | 2,026226 |
| Day -1 to 20 | 1,606004 | 1,280797 | 3,235127 | -0,164266 | 1,481922 | -0,195830 |

| | POP5EAC | BCI5EAC | UCB5EAC | SAN5EAC | BCS5ESC |
|---|---|---|---|---|---|
| Day -1 to 1 | 0,546162 | 1,955243 | 2,616390 | 0,6847801 | -0,522779 |
| Day -5 to 1 | 1,084779 | 2,154806 | 8,81892 | -0,088211 | -1,513849 |
| Day -10 to 1 | 0,997275 | 2,671832 | 6,696664 | 0,229914 | -1,682134 |
| Day -20 to 1 | 2,440503 | 2,435657 | 4,697767 | 0,033410 | -2,675346 |
| Day -1 to 5 | 0,075426 | 0,131616 | 0,429222 | -0,409950 | -1,673335 |
| Day -1 to 10 | 0,997275 | 2,671832 | 6,696664 | 0,229914 | -1,682134 |
| Day -1 to 20 | 1,917678 | 0,075985 | 1,508963 | -0,642590 | -2,301564 |

| | Number of banks with /t/ > 1.96 | Number of banks with t > 1.96 | Number of banks with t < 1.96 |
|---|---|---|---|
| Day -1 to 1 | 5 | 5 | 0 |
| Day -5 to 1 | 4 | 4 | 0 |
| Day -10 to 1 | 4 | 4 | 0 |
| Day -20 to 1 | 4 | 3 | 1 |
| Day -1 to 5 | 0 | 0 | 0 |
| Day -1 to 10 | 4 | 4 | 0 |
| Day -1 to 20 | 2 | 1 | 1 |

Table A10: Country results of average cumulative abnormal returns (CAAR) / stock market

| | day - 1 to 1 | | day -5 to 1 | | day -10 to 1 | | day -20 to 1 | |
|---|---|---|---|---|---|---|---|---|
| | CAAR | t | CAAR | t | CAAR | t | CAAR | t |
| Austria | 0,0197 | 1,278 | 0,021 | 0,9035 | 0,0006 | 0,0196 | 0,0498 | 1,19 |
| Belgium | -0,004 | -0,152 | -0,002 | -0,052 | -0,0575 | -1,164 | -0,057 | -0,85 |
| Greece / Cyprus | 0,0111 | 0,4293 | -0,036 | -0,917 | -0,0643 | -1,249 | -0,046 | -0,66 |
| Denmark | -0,002 | -0,103 | -0,027 | -0,894 | -0,0470 | -1,184 | -0,056 | -1,05 |
| France | -0,009 | -0,501 | -0,027 | -0,937 | -0,0978 | -2,548 | -0,093 | -1,79 |
| Germany | -0,043 | -2,372 | -0,082 | -2,939 | -0,1101 | -3,013 | -0,094 | -1,91 |
| Ireland | 0,1392 | 1,7231 | 0,12 | 0,9746 | 0,25344 | 1,569 | 0,0288 | 0,132 |
| Italy | -0,001 | -0,049 | 0,028 | 1,0335 | 0,01874 | 0,5296 | -0,027 | -0,58 |
| Portugal | 0,0069 | 0,2419 | 0,058 | 1,3198 | 0,01924 | 0,3369 | 0,0338 | 0,437 |
| Spain | -0,005 | -0,273 | -0,024 | -0,86 | -0,0700 | -1,91 | -0,054 | -1,10 |
| Sweden | 0,0197 | 1,6207 | 8E-04 | 0,0443 | -0,0202 | -0,831 | -0,025 | -0,76 |
| UK | -0,036 | -1,977 | -0,052 | -1,852 | 0,09947 | -2,681 | -0,107 | -2,13 |
| Critical value of Student’s t for 0.05 probability level | 4.30 | | 2.45 | | 2.20 | | 2.08 | |
| Average | 0,003 | -0,147 | -0,009 | -0,451 | -0,0308 | -1,066 | -0,042 | -0,78 |

| | day -1 to 5 | | day -1 to 10 | | day -1 to 20 | |
|---|---|---|---|---|---|---|
| | CAAR | t | CAAR | t | CAAR | t |
| Austria | 0,0258 | 1,0953 | 0,0378 | 1,223 | 0,051 | 1,2149 |
| Belgium | 0,0273 | 0,7234 | 0,0471 | 0,955 | 0,112 | 1,6807 |
| Greece / Cyprus | 0,0984 | 2,5029 | 0,0781 | 1,516 | 0,091 | 1,3019 |
| Denmark | 0,0843 | 2,7796 | 0,0731 | 1,84 | 0,011 | 0,1984 |
| France | 0,0023 | 0,0781 | 0,0138 | 0,359 | -0,038 | -0,733 |
| Germany | 0,0246 | 0,8832 | 0,0269 | 0,736 | 0,015 | 0,2979 |
| Ireland | 0,2171 | 1,76 | 0,3147 | 1,948 | 0,401 | 1,8317 |
| Italy | -0,01 | -0,358 | 0,0236 | 0,668 | 0,134 | 2,7894 |
| Portugal | 0,0566 | 1,2981 | 0,0664 | 1,163 | 0,08 | 1,0323 |
| Spain | 0,0225 | 0,8033 | -0,002 | -0,05 | 0,02 | 0,3969 |
| Sweden | 0,0535 | 2,8778 | 0,0709 | 2,913 | 0,041 | 1,2303 |
| UK | 0,0149 | 0,5242 | -0,007 | -0,19 | -0,094 | -1,873 |
| Critical value of Student’s t for 0.05 probability level | 2.45 | | 2.20 | | 2.08 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Average | 0,0422 | 1,0117 | 0,0522 | 0,912 | 0,055 | 0,6406 |

Table A11: results of the t-tests for cumulative abnormal returns of CDS prices of 11 banks for seven event periods

The test statistic used has been presented in chapter 4.3.5.

| | BNP5EAC | CRI5EAC | SG.5EAC | CBG5EAM | DB.5EAC | BMP5EAM |
|---|---|---|---|---|---|---|
| Day -1 to 1 | 2,331683 | 2,604492 | 2,097940 | 0,595729 | 2,670481 | 0,936390 |
| Day -5 to 1 | 2,082240 | 1,882354 | 2,327783 | 0,359954 | 1,092029 | 1,484797 |
| Day -10 to 1 | 2,240339 | 1,879508 | 1,897063 | 0,127397 | 1,064088 | 2,026226 |
| Day -20 to 1 | 1,458689 | 0,722678 | 0,647933 | 0,097777 | 0,933285 | 1,873427 |
| Day -1 to 5 | 0,498760 | 0,859841 | 0,927406 | 0,029119 | 1,292189 | -0,803518 |
| Day -1 to 10 | 2,240339 | 1,879508 | 1,897063 | 0,127397 | 1,064088 | 2,026226 |
| Day -1 to 20 | 1,606004 | 1,280797 | 3,235127 | -0,164266 | 1,481922 | -0,195830 |

| | POP5EAC | BCI5EAC | UCB5EAC | SAN5EAC | BCS5ESC |
|---|---|---|---|---|---|
| Day -1 to 1 | 0,546162 | 1,955243 | 2,616390 | 0,6847801 | -0,522779 |
| Day -5 to 1 | 1,084779 | 2,154806 | 8,81892 | -0,088211 | -1,513849 |
| Day -10 to 1 | 0,997275 | 2,671832 | 6,696664 | 0,229914 | -1,682134 |
| Day -20 to 1 | 2,440503 | 2,435657 | 4,697767 | 0,033410 | -2,675346 |
| Day -1 to 5 | 0,075426 | 0,131616 | 0,429222 | -0,409950 | -1,673335 |
| Day -1 to 10 | 0,997275 | 2,671832 | 6,696664 | 0,229914 | -1,682134 |
| Day -1 to 20 | 1,917678 | 0,075985 | 1,508963 | -0,642590 | -2,301564 |

| | Number of banks with /t/ > 1.96 | Number of banks with t > 1.96 | Number of banks with t < 1.96 |
|---|---|---|---|
| Day -1 to 1 | 5 | 5 | 0 |
| Day -5 to 1 | 4 | 4 | 0 |
| Day -10 to 1 | 4 | 4 | 0 |

| | | | |
|---|---|---|---|
| Day -20 to 1 | 4 | 3 | 1 |
| Day -1 to 5 | 0 | 0 | 0 |
| Day -1 to 10 | 4 | 4 | 0 |
| Day -1 to 20 | 2 | 1 | 1 |

Table A12: Significance test results for the average cumulative abnormal returns (CAAR) / CDS premium market

Grouping: PIIGS vs. Non-PIIGS CDS premium market

| | **day - 1 to 1** | | **day -5 to 1** | | **day -10 to 1** | | **day -20 to 1** | |
|---|---|---|---|---|---|---|---|---|
| | CAAR | t | CAAR | t | CAAR | t | CAAR | t |
| PIIGS | 0,06 | 1,81 | 0,18 | 3,25 | 0,23 | 3,18 | 0,28 | 2,89 |
| Non-PIIGS | 0,01 | 0,32 | -0,02 | -0,26 | -0,08 | -0,89 | -0,04 | -0,36 |
| Critical value of Student's t for 0.05 probability level | 4.30 | | 2.45 | | 2.20 | | 2.08 | |

| | **day -1 to 5** | | **day -1 to 10** | | **day -1 to 20** | |
|---|---|---|---|---|---|---|
| | CAAR | t | CAAR | t | CAAR | t |
| PIIGS | -0,01 | -0,21 | 0,09 | 1,28 | 0,05 | 0,52 |
| Non-PIIGS | -0,03 | -0,44 | 0,06 | 0,69 | -0,17 | -1,74 |
| Critical value of Student's t for 0.05 probability level | 2.45 | | 2.20 | | 2.08 | |

Table A13: "CT1 positive" vs. "CT1 negative" (as defined in chapter 4.5.2.3) CDS premium market

| | **day - 1 to 1** | | **day -5 to 1** | | **day -10 to 1** | | **day -20 to 1** | |
|---|---|---|---|---|---|---|---|---|
| | CAAR | t | CAAR | t | CAAR | t | CAAR | t |
| CT1 positive | 0,09 | 2,25 | 0,192 | 3,2719 | 0,248 | 3,223 | 0,24 | 2,3313 |
| CT1 negative | 0,06 | 0,32 | 0,065 | 1,0929 | 0,07 | 0,9011 | 0,05 | 0,4816 |
| Critical value of Student's t for 0.05 | 4.30 | | 2.45 | | 2.20 | | 2.08 | |

| probability level | | | | |
|---|---|---|---|---|

| | day -1 to 5 | | day -1 to 10 | | day -1 to 20 | |
|---|---|---|---|---|---|---|
| | CAAR | t | CAAR | t | CAAR | t |
| CT1 positive | 0,0011 | 0,0189 | 0,1074 | 1,395 | 0,044 | 0,4189 |
| CT1 negative | 0,0117 | 0,1981 | 0,0468 | 0,603 | 0,109 | 1,0329 |
| Critical value of Student's t for 0.05 probability level | 2.45 | | 2.20 | | 2.08 | |

Table A14: Regression of cumulative average abnormal returns (CAAR) on CT1 returns

| | Day -1 to 1 | Day -5 to 1 | Day -10 to 1 | Day -20 to 1 |
|---|---|---|---|---|
| $R^2$ | 0,2427525 | 0,19857993 | 0,14897087 | 0,02690385 |
| F | 13,4640327 | 10,4069732 | 7,35201211 | 1,16120249 |
| | | | | |
| $\alpha$ | 0,01013299 | -5,5284E-1 | -0,0164208 | -0,0355321 |
| $\beta$ | 0,07456057 | 0,1021482 | 0,16554777 | 0,04792379 |
| t-test $\alpha$ | 1,35499748 | -0,0004744 | -0,7307969 | -2,1709261 |
| t-test $\beta$ | 3,66933681 | 3,22598407 | 2,71145941 | 1,07759106 |

| | Day -1 to 5 | Day -1 to 10 | Day -1 to 20 |
|---|---|---|---|
| $R^2$ | 0,25923463 | 0,26831979 | 0,06708137 |
| F | 14,6981146 | 15,4021265 | 3,02000364 |
| $\alpha$ | 0,04995277 | 0,0586125 | 0,0630181 |
| $\beta$ | 0,10941558 | 0,12915548 | 0,11349508 |
| t-test $\alpha$ | 4,7559111 | 4,83938651 | 2,62189043 |
| t-test $\beta$ | 3,83381203 | 3,9245543 | 1,73781577 |

A15: Regression of cumulative average abnormal returns (CAAR) on rel. PIIGS exposure

| | Day -1 to 1 | Day -5 to 1 | Day -10 to 1 | Day -20 to 1 |
|---|---|---|---|---|
| $R^2$ | 0,00028271 | 0,00123247 | 0,00330269 | 0,0046167 |
| F | 0,01187729 | 0,05182755 | 0,13917267 | 0,19480055 |
| | | | | |
| $\alpha$ | 0,00514065 | -0,0077599 | -0,0313163 | -0,0423947 |
| $\beta$ | 0,00032317 | 0,00102208 | 0,0031307 | 0,00252142 |

| | | | | |
|---|---|---|---|---|
| t-test $\alpha$ | 0,53080654 | -0,5292343 | -1,1426159 | -2,2722525 |
| t-test $\beta$ | 0,10898297 | 0,22765666 | 0,37305854 | 0,44136215 |

| | Day -1 to 5 | Day -1 to 10 | Day -1 to 20 |
|---|---|---|---|
| $R^2$ | 0,0141075 | 0,01494685 | 0,00286863 |
| F | 0,60099359 | 0,63729307 | 0,12082887 |
| | | | |
| $\alpha$ | 0,04849525 | 0,05696299 | 0,06090327 |
| $\beta$ | -0,0032418 | -0,0038716 | -0,0029809 |
| t-test $\alpha$ | 3,55087869 | 3,59633858 | 2,17456498 |
| t-test $\beta$ | -0,7752377 | -0,7983063 | -0,3476044 |

Table A16: Variance for average standardized abnormal returns in event period

| **Day** | **Average standardized abnormal returns** | **Day** | **Average standardized abnormal returns** |
|---|---|---|---|
| 20 | 0,32809105 | -1 | 0,01995544 |
| 19 | -0,34318515 | -2 | 0,11447718 |
| 18 | -0,32413743 | -3 | -0,38029546 |
| 17 | -0,575436 | -4 | 0,39325286 |
| 16 | -0,35748934 | -5 | -0,39472286 |
| 15 | 1,00897087 | -6 | -0,21878804 |
| 14 | 0,52399811 | -7 | -0,28859678 |
| 13 | 0,23087509 | -8 | -0,44919247 |
| 12 | 0,09708751 | -9 | -0,06988316 |
| 11 | -0,03564816 | -10 | -0,1204389 |
| 10 | -0,15410755 | -11 | 0,72527367 |
| 9 | 0,15105644 | -12 | 0,15595708 |
| 8 | 0,59426788 | -13 | -0,24316459 |
| 7 | -0,12523978 | -14 | 0,29534381 |
| 6 | 0,08318803 | -15 | -0,30508947 |
| 5 | -0,69249525 | -16 | -0,37909854 |
| 4 | -0,29493637 | -17 | -0,2031017 |
| 3 | 1,55272935 | -18 | -0,06795655 |
| 2 | 0,64632818 | -19 | 0,14415746 |
| 1 | 0,30668329 | -20 | -0,14356904 |
| 0 | -0,15731031 | | |
| | | | |
| Variance | 0,28967186 | Variance | 0,09165687 |

Table A17: Stock Market PIIGS vs. Non PIIGS

| | day - 1 to 1 | | day -5 to 1 | | day -10 to 1 | | day -20 to 1 | |
|---|---|---|---|---|---|---|---|---|
| | CAAR | t | CAAR | t | CAAR | t | CAAR | t |
| PIIGS | 0,03025 | 1,72148 | 0,02911 | 1,08464 | 0,03141 | 0,89387 | -0,0131 | -0,2765 |
| Non-PIIGS | -0,0122 | -1,0682 | -0,0298 | -1,7072 | -0,0654 | -2,8626 | -0,0525 | -1,6978 |
| Critical value of Student's t for 0.05 probability level | 4.30 | | 2.45 | | 2.20 | | 2.08 | |

| | day -1 to 5 | | day -1 to 10 | | day -1 to 20 | |
|---|---|---|---|---|---|---|
| | CAAR | t | CAAR | t | CAAR | t |
| PIIGS | 0,07700 | 2,86857 | 0,09619 | 2,73682 | 0,14490 | 3,0450 |
| Non-PIIGS | 0,02372 | 1,35871 | 0,02775 | 1,21432 | 0,00570 | 0,18449 |
| Critical value of Student's t for 0.05 probability level | 2.45 | | 2.20 | | 2.08 | |

**Table A18: Stock Market Core 1 increase vs. Core 1 decrease**

| | day - 1 to 1 | | day -5 to 1 | | day -10 to 1 | | day -20 to 1 | |
|---|---|---|---|---|---|---|---|---|
| | CAAR | t | CAAR | t | CAAR | t | CAAR | t |
| CT1 positive | -0,0107 | -0,7246 | -0,0337 | -1,4864 | -0,0777 | -2,6162 | -0,0680 | -1,6902 |
| CT1 negative | 0,01151 | 0,84159 | 0,0142 | 0,68384 | -0,0099 | -0,3632 | -0,0335 | -0,9048 |
| Critical value of Student's t for 0.05 probability level | 4.30 | | 2.45 | | 2.20 | | 2.08 | |

| | day -1 to 5 | | day -1 to 10 | | day -1 to 20 | |
|---|---|---|---|---|---|---|
| | CAAR | t | CAAR | t | CAAR | t |
| CT1 positive | 0,02281 | 1,00475 | 0,01782 | 0,59952 | -0,0144 | -1,6837 |
| CT1 negative | 0,05495 | 2,63036 | 0,06679 | 2,44183 | 0,09471 | 2,55702 |

| | | | |
|---|---|---|---|
| Critical value of Student's t for 0.05 probability level | 2.45 | 2.20 | 2.08 |

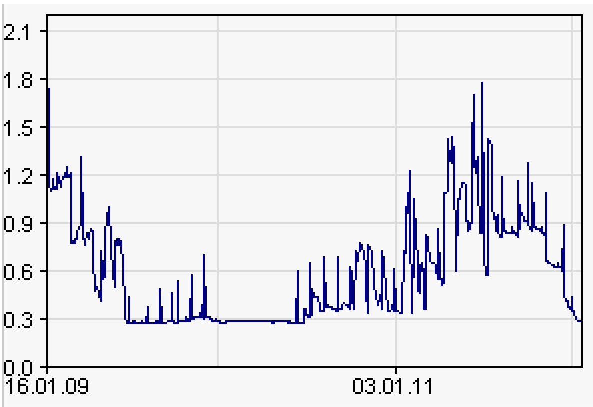
Table A19: relative PIIGS holding

| Bank | Exposure to PIIGS bn | Core 1 bn | Rel. exposure |
|---|---|---|---|
| EBS.VI | 1,196 | 11 | 0,108727273 |
| RBI.VI | 0,456 | 8 | 0,057 |
| DEXB.BR | 22,675 | 17 | 1,333823529 |
| KBC.BR | 7,86 | 12 | 0,655 |
| MARFB.AT | 3,446 | 2 | 1,723 |
| ETE.AT | 18,814 | 8 | 2,35175 |
| ALPHA.AT | 5,475 | 5 | 1,095 |
| TPEIR.AT | 8,221 | 3 | 2,740333333 |
| TT.AT | 5,313 | 1 | 5,313 |
| JYSK.CO | 0,12 | 2 | 0,06 |
| SYDB.CO | 0 | 1 | 0 |
| BNP.PA | 41,138 | 55 | 0,747963636 |
| ACA.PA | 16,651 | 46 | 0,361978261 |
| GLE.PA | 18,289 | 28 | 0,653178571 |
| DBK.DE | 12,811 | 30 | 0,427033333 |
| CBK.DE | 19,82 | 27 | 0,734074074 |
| BEB2.F | 1,146 | 5 | 0,2292 |
| OTP.F | 0 | 3 | 0 |
| AIB.IR | 6,479 | 4 | 1,61975 |
| BIR.IR | 5,6 | 7 | 0,8 |
| ILO.IR | 1,852 | 2 | 0,926 |
| ISP.MI | 61,769 | 26 | 2,375730769 |
| UCG.MI | 51,836 | 36 | 1,439888889 |
| BMPS.MI | 32,967 | 6 | 5,4945 |
| BP.MI | 12,055 | 5 | 2,411 |
| UBI.MI | 10,569 | 7 | 1,509857143 |
| INGA.AS | 11,205 | 31 | 0,361451613 |
| BES.LS | 3,05 | 4 | 0,7625 |
| BPI.LS | 5,476 | 2 | 2,738 |
| SAN.MC | 50,594 | 42 | 1,204619048 |
| BBVA.MC | 60,68 | 25 | 2,4272 |
| CAM.MC | 36,811 | 2 | 18,4055 |

| | | | |
|---|---|---|---|
| POP.MC | 9,727 | 7 | 1,389571429 |
| SAB.MC | 7,425 | 4 | 1,85625 |
| BKT.MC | 3,595 | 2 | 1,7975 |
| PAS.MC | 2,554 | 1 | 2,554 |
| NDA-SEK.ST | 0,162 | 19 | 0,008526316 |
| SEB-A.ST | 0,632 | 10 | 0,0632 |
| SHB-A.ST | 0 | 8 | 0 |
| SWED-A.ST | 0 | 7 | 0 |
| RBS.L | 10,429 | 59 | 0,176762712 |
| HSBA.L | 14,571 | 87 | 0,167482759 |
| BARC.L | 20,259 | 46 | 0,440413043 |
| LLOY.L | 0,094 | 48 | 0,001958333 |

Source: http://economicsintelligence.com

**Figure A1: Libor Overnight Funds**




Source: http://www.finanzen.net/zinsen/libor/Libor-EUR-Overnight