Do CDS maturities matter in the evaluation of the information content of regulatory banking stress tests? Evidence from European and US stress tests.

Amavi AGBODJI*, Emmanuelle NYS*, Alain SAUVIAT*

*Université de Limoges, LAPE, 5 rue Félix Eboué, 87031 Limoges Cedex 1, France

This Version: March 04, 2019

Very very Preliminary draft. Not edited.

Please do not circulate

Abstract

This paper questions the appropriateness of using only the 5-year maturity CDS spreads to examine the CDS market response to a regulatory stress test. Since the stress testing exercises are performed on short-term forward-looking scenarios (1 to 3 years), we assume that short-term maturities of CDS spreads should be more relevant to assess the CDS market response. Based on ten regulatory stress tests conducted in Europe and in the US in the time period from 2009 to 2017, we analyze the market response by investigating its reaction through all the different CDS maturities. Our results show that whatever the maturities, the nature of the market response (to correct either the under or over evaluation of default risk) is the same. However, the extent of the response differs between short term maturities (from 6-month to 3-year) and the 5-year maturity. We often find that the lower the maturity of the CDS, the stronger the market reaction. Our result also show that the information content of the different stress tests is more diverse than what is highlighted in the existing literature.

Keywords: Regulatory Stress Test, CDS maturity, Market reaction, Event Study, Disclosure

JEL Classification Numbers: G00, G14, G21, G28

1. Introduction

A regulatory stress testing exercise is an important banking supervision tool whose main objective is to assess and analyze the resilience of participating banks to hypothetical extreme but plausible stressed scenarios. These latter simulate crisis situations (with different levels of severity) characterized by a recession at the national and global levels, a very high unemployment etc. At the end of the test, and for each of the scenarios, hundreds of data that reflect the financial health of each participating bank throughout these crisis situations (including data on capitalization, solvency, and data on market, credit and liquidity risks) are disclosed in a very detailed way, thus giving reliable information on the bank's situation (strength, resilience, risks…). However, CDS spreads precisely reflecting the market perception of the bank's situation, stress test results' disclosure may be more informative for credit default swap. Most of empirical papers that study stress test impacts on CDS performance show that new and relevant information was revealed by highlighting significant reactions from the CDS market around the stress tests' key event dates (especially the results' disclosure date).

This paper questions the appropriateness of the 5-year maturity CDS spreads to examine the CDS market response to the disclosure of a regulatory stress test results. Based on a sample of banks that participated in at least one of the ten regulatory banking stress tests performed in Europe and in the US, in the time period from 2009 to 2017, we therefore investigate whether the CDS market response to the disclosure of a stress test results is the same from one maturity to another. In other words, is the market reaction the same depending on whether one considers the short-term maturities of CDS spreads (6 months, 1, 2 and 3 years) or the long-term maturities (4, 5, 7 and 10 years)?

Our research is motivated by the following. To measure (with CDS spreads) the impact and the informative value of a regulatory stress testing exercise, the literature almost systematically uses the 5-year maturity CDS spreads (among others, Morgan et al., 2014; Neretina et al., 2014; Flannery et al., 2017; Georgescu et al., 2017 and Ahnert et al., 2018). However, is the maturity of five-year the one that best reflects the response of the market? Since the hypothetical forward-looking scenarios of a stress testing exercise have a time horizon of 3 years, and since the disclosed results (on participating banks' financial health and solvency under these "dark" scenarios) only cover these 3 years, we assume that short-term maturities of CDS spreads should be more relevant to assess the market response rather than the 5-year maturity CDS spreads. In other words, the short-term maturities of CDS spreads (6 months, 1, 2 and 3 years) should be more relevant because the stress testing exercises are performed on short-term forward-looking scenarios (1, 2 and 3 years). Hence, we assume that the market should react more strongly on short-term maturities of CDS spreads than on 5-year maturity or more.

To our best knowledge, no paper has in the past investigated this issue. Our study is therefore important since it will examine whether the CDS market response is the same from one maturity to another. Consequently, it will examine whether the systematic choice of the 5Y maturity CDS spreads by the literature (in the CDS market reaction analysis) is appropriate or not.

Applying an event study methodology on tested banks' CDS spread returns, we estimate the CDS market response to the disclosure of the results of ten European and US regulatory stress tests, in the time period from 2009 to 2017. We perform these estimates using daily data on senior CDS spreads and considering each of the eight maturities (6 months, 1Y, 2Y, 3Y, 4Y, 5Y, 7Y and 10Y maturity) in order to examine whether the CDS market response is the same from one maturity to another.

On the one hand, our empirical results show that following the release of the results of a given stress test, the nature of the CDS market reaction is the same whatever the maturity considered since the different CAARs estimated using the different CDS maturities have the same sign. In other words, for a given stress test, the CDS market will not react positively on one maturity (significant negative CAARs) and negatively on another one (significant positive CAARs) after the disclosure; whatever the maturity considered, the nature of the reaction (positive or negative) is the same. However, if the nature of the CDS market reaction is the same for all maturities, its importance differs from one maturity to another. Indeed, we evidence that for a given stress test, the CDS market may react highly on one maturity (very high CAARs in absolute value) and weakly on another one (very low CAARs in absolute value) after the disclosure. More precisely, we show that the CDS market reacts more strongly on short-term maturities of CDS spreads comparing to long-term maturities. And interestingly, we find that the lower the maturity of the CDS, the stronger the market reaction i.e. the higher the CAARs in absolute value. Hence, we argue that the maturity of 5-year may not be the "appropriate" or the "suitable" maturity to measure the impact and the informative content of a regulatory banking stress test. On the other hand, this CDS market's behavior highlights the fact that the difference between several stress tests in term of market response is not the same from one maturity to another. We find that this difference is higher on short term maturities comparing to long term maturities and generally, the lower the maturity of the CDS, the higher the difference. We therefore argue that short term CDS maturities allow to better discriminate stress tests according to their revealed information's relevance, comparing to 5Y maturities or more.

Being the first to perform such empirical investigations, our paper attempts to contribute to the existing literature on regulatory banking stress tests, more precisely the literature on the impact, the information content and the effectiveness of stress tests (Petrella and Resti, 2013; Morgan et al., 2014; Neretina et al., 2014; Flannery et al., 2017; Georgescu et al., 2017 and Ahnert et al., 2018). Secondly, our paper also contributes to the strand of the literature on banking opacity (among others, Flannery and Houston, 1999; Jordan et al., 2000; Morgan, 2002; Flannery et al., 2010) since we evidence that following the disclosure of stress test results, the CDS market considering the new information revealed corrects the CDS spreads of participating banks. This correction from the market highlights the existence of a banking opacity, i.e. the impossibility for market participants to have access to reliable financial data on banks. Our paper finally contributes to the debate on transparency in banking supervision (Jordan, 2000; Dudley, 2009; GAO, 2010; Goldstein and Sapra, 2011) since our results show that more disclosure about banks' situation and financial health can help market participants to better assess the risks of banks and thus, to better discriminate them.

The remainder of our paper is organized as follows: in Section 2, we provide an overview of the existing literature on the CDS market reaction around stress tests' key event dates. In Section 3, we first present a brief description of the regulatory stress tests that we consider. We then describe the sample, the data and the empirical methodology employed to perform our investigations. The presentation of the results follows in Section 4 while Section 5 concludes.

2. Related literature and research question

Banks are intrinsically opaque because of their intermediation function. Investors and savers place their money in banks which are supposed to lend to borrowers after a rigorous screening, and with an intensive monitoring (Diamond, 1983). But the risks taken by banks in this intermediation process are hard to observe for investors and savers. Indeed, if banks were completely transparent, there should be no market reaction to the release of supervisory information; but it is not the case since the release of such information induce substantial and significant movements in stock prices (Berger and Davies, 1998; Flannery and Houston, 1999; Jordan, 2000). Therefore, several empirical papers have been interested in the impact and the informative value of regulatory banking stress tests. Almost all of them examines at least the stock market reaction around these stress tests' key event dates but there is an emerging literature on the effects of regulatory stress tests on CDS performance.

Morgan et al. (2014) for example were interested in the 2009 US SCAP effects. Using a standard event study methodology, they investigate whether this latter produced useful and valuable information for the market by considering two groups of banks: the GAP banks and the NO GAP banks[1]. In summary, they show that the test provided useful information to the market. More precisely, they evidence that prior to the test, financial markets were largely able to identify the banks without capital gaps and those which are under-capitalized; what they didn't know was the exact amount of capital required for under-capitalized banks. Therefore, at the results' disclosure, the market was surprised and reacted significantly by correcting banks' stock prices (which increased) and spreads of CDS. These latter decline, particularly for undercapitalized banks whose spreads fell by 59 basis points relative to spreads for NO GAP banks. Based on the US banking stress tests from 2009 to 2015 (SCAP, CCAR

[1] The GAP banks are those with capital gaps while the NO GAP banks are those without capital gaps.

and DFAST), Neretina et al. (2015) complement the work of Morgan et al. (2014) by reassessing their findings and investigating whether their conclusions are also valid for other stress tests. In contrast with Morgan et al. (2014) findings, they show that the disclosure of the 2009 US SCAP results had no effect on equity returns. But they evidence on the other hand a decline in CDS spreads, especially for NO GAP banks (with an average CAR of -55,43 basis points). For the stress tests conducted after the SCAP, they find evidence that CDS spreads declined in response to the publication of stress test results only in 2012 and 2013.

Then, Flannery et al. (2015) examine changes in banks' stock prices, trading volumes and CDS spreads around several disclosure dates of regulatory stress test results in the US, in the time period from 2009 to 2015. Unlike previous studies, they don't use a standard event study methodology since they argue that this latter is not suitable for measuring the true informative value of a stress testing exercise because of inappropriate assumptions embedded in it. Using their "customized" event study methodology, they show that the nine tests produce new and valuable information not only about stress-tested banks' situation, but also about non-stress-tested banking companies; the tested sample's reaction almost always exceeding the one of the non-stress-tested sample. More precisely, using an absolute cumulative abnormal CDS Spread (|CACDS|), they evidence that the CDS spreads of stress tested banks change abnormally and significantly around all the stress test disclosure dates considered (especially around the 2009 SCAP disclosure date). Then considering respectively the tested and the non-tested banks' group average |CACDS|, they highlight significant differences between them thus confirming the fact that the response of the tested sample almost always exceeds the one of the non-stress-tested sample.

Like in the US, European banking authorities have also performed several regulatory stress testing exercises since 2009 and many empirical papers have been interested in the effects of their results' disclosure on CDS markets.

Georgescu et al. (2017) try to determine empirically if European regulatory stress tests are really useful (if they provide new and valuable information to the market), basing on the 2014 and 2016 EBA-ECB stress tests. They therefore assess the reaction of market participants by estimating the cumulative abnormal returns (CAR) using tested banks'

CDS spreads and stock prices, and sovereign CDS spreads. For these estimates, they employ an event study methodology, around several event dates (e.g. announcement dates, disclosure dates etc...). With somewhat mixed results, they argue that stress tests provide new information to the market. More precisely, they find that new and useful information was revealed to the CDS market participants around the announcement of the test (only in 2014), the announcement of the key features (in 2014 and 2016) and following the results' disclosure (only in 2016); new information that was immediately integrated in tested banks' CDS spreads as reflected in statistically significant abnormal CDS returns. Authors also find that the publication of stress test results allows markets to better discriminate between "good" (strong) banks and "bad" (weak) banks. Indeed, authors show that under the adverse scenario, banks that lost a large part of their Common Equity Tier 1 ratio (what prove their weakness) were been punished by the market; following the results' disclosure, these latter reported significantly higher positive abnormal CDS returns compared to better performing banks. Similarly, analyzing the impact of stress testing results' publication on bank's equity and CDS performance, Ahnert et al. (2018) also come to the same conclusion. Indeed, performing their empirical investigations on a larger number of regulatory stress tests (ten tests including six US CCAR and four EBA/ECB stress tests in the time period between 2010 and 2017), authors show that the results' disclosure provide new information to market participants and reduce bank opacity by improving the quality and the quantity of information available on tested banks' situation. Hence, it allows markets to better discriminate between strong banks (which were rewarded) and weak banks (which were sanctioned). Indeed, they highlight that following the results' release, strong banks have better funding costs and higher stock prices unlike weak ones. More precisely, they show that banks that passed the test show significant and positive abnormal stock returns and smaller CDS spreads (with an abnormal CDS returns of -83 basis points). In contrast, those that failed experience significant and negative abnormal stock returns and higher CDS spread (172 basis points). Concerning the announcement date, they find that banks that are announced to be stress tested surprisingly experience on average wider CDS spreads (78 basis points of abnormal CDS returns). Performing finally a multivariate regression analysis, they evidence that bank's asset quality and return on equity are significant predictors of the pass/fail outcome of a bank during a stress test.

To examine the CDS market response to regulatory stress tests, all the above papers used the 5-year maturity contract as it is generally considered to be the most liquid segment of the market (Annaert et al., 2013; Völz & Wedow, 2011). The prior empirical literature on regulatory stress tests effects has highlighted a reaction of the CDS market following the disclosure, based on 5-year maturity CDS spreads. However, we question the appropriateness of this 5-year maturity CDS spreads in the examination of the CDS market response. Indeed, we assume that the disclosure of stress test results should be more relevant (should more impact) for spreads of CDS whose maturities are less than or equal to 3 years. Since stress testing exercises are performed on 3-year forward-looking scenarios, these short-term maturities of CDS spreads should be more relevant to assess the market response rather than the 5-year maturity CDS spreads. Therefore, by considering several maturities' CDS spreads, our goal is to investigate whether the CDS market reaction is the same from one maturity to another after the disclosure. In other words, is the market reaction the same depending on the maturity considered? The aim is to better assess the market evaluation of a bank default risk: does the 5-year maturity correctly reflect the market response? Does a shorter maturity give a better information?

Based on ten US and European regulatory stress tests, we will therefore investigate the CDS market reaction considering all the different maturities; the aim is to determine first whether the nature of the CDS market response to regulatory stress tests is the same from one maturity to another. Second, we will investigate whether the importance of this response is also the same from one maturity to another.

3. Sample, Data and Methodology

In this section, we first present a brief overview of the US and European regulatory stress tests that we consider for our investigations. Then, we describe respectively the sample on which this study is based, the data used to perform our investigations and the methodology employed to estimate the market reaction.

3.1. Regulatory stress testing exercises in Europe and in the US

To perform our empirical investigations on the CDS market response to stress test results' disclosure, we consider all relevant regulatory stress tests conducted in Europe and in the US, in the time period from 2009 to 2017.

In Europe, five stress testing exercises were carried out during this period. The first and the second ones that took place respectively in 2009 and 2010 was conducted by the Committee of European Banking Supervisors (CEBS) [2]. The next one was conducted in 2011 by the European Banking Authority (EBA), on the same sample of banks as the 2010 test. The remaining tests were also performed by the EBA, respectively in 2014 and 2016[3] in close cooperation with the European Central Bank (ECB) within the Single Supervisory Mechanism (SSM). Among these five tests, we will not consider the 2009 one in our study since its aim was not to assess banks individually, but to evaluate the resilience of the European banking industry in aggregate, without publication of the participating banks' names.

In the US, the first regulatory stress test was the 2009 Supervisory Capital Assessment Program (SCAP). Nineteen US bank holding companies (representing two-thirds of the US banking system's assets) participated in this test which was unprecedent in terms of supervisory information disclosure. Since then, the Federal Reserve (FED) formally introduced a regulatory framework to annually assess, regulate, and supervise US BHCs. This supervisory assessment consists of two related programs: The Comprehensive Capital Analysis and Review (CCAR) and the Dodd-Frank Act stress tests (DFAST). The first program involves both a qualitative and a quantitative evaluation. More precisely, the FED performs for each participating BHC a qualitative analysis of its internal capital planning processes and governance, and a quantitative assessment of its capital positions (capital adequacy). In the other side, like the SCAP,

---

[2] The 2009 CEBS stress test was conducted on a sample of 22 major European cross-border institutions representing on a consolidated basis, 60% of the total assets of the EU banking sector. At the end of the test, supervisors did not disclose the names of the 22 participating banks, nor the detailed results of the test. The 2010 and 2011 exercises were conducted on a sample of 91 European banks representing together 65% of the total assets of the EU banking sector. Unlike the 2009 test, details data on each tested bank were disclosed at the end of the test.

[3] The 2014 stress test includes 123 European banking groups (representing more than 70% of the EU banking industry assets) while the 2016 exercise was carried out on a sample of 51 banking groups. The results of these two tests were also disclosed in a very detail way.

the DFAST program examines how banks' capital levels would evolve under severely adverse economic conditions (stressed period) in order to assess their ability to absorb possible future shocks. The first CCAR took place in 2011 while the first DFAST took place in 2013[4].

For the US, this study focuses on the DFAST program as it is the one that assesses banks' financial health under hypothetical forward-looking "dark" scenarios (like the SCAP and all European tests), unlike the CCAR program. In addition, the results of the DFAST stress tests are disclosed approximately a week before the corresponding CCAR results.

3.2. Sample, Data and Methodology

3.2.1. Sample and Data

The number of stress tested banks varies from one test to another, in Europe as in the US. Consequently, our overall initial sample includes all the banks that have been tested in at least one of our considered stress tests. Then, to perform our investigations, we collect daily data on senior CDS spread from Bloomberg™, for each of the participating banking institutions in our initial sample and for all maturities. We get these data exclusively from the CMA New York source, which provides closing bid and ask CDS quotes. However, CDS spreads data are not available for all of them; for some banks, tradable CDS doesn't exist while it exists for others but with no available data. At the end, in our US final sample, the number of tested banks with available information on tradable credit default swap range from 9 to 12 per stress test (considering all maturities). In Europe, this number varies from 33 to 50 per stress test. Appendix A.1 provides an overview of the banks included in our final sample, test by test in the US (Panel A) and in Europe (Panel B).

As Indices for bank CDS, following Norden and Weber (2004), Morgan et al. (2014), Neretina et al. (2014), Flannery et al. (2017) and Ahnert et al. (2018), we employ the

[4] The 2013, 2014 and 2015 DFAST was performed respectively on 18, 30 and 31 bank holding companies (BHCs). In 2016, 33 BHCs participated in the DFAST while they were 34 for the 2017 exercise.

Markit CDX North America Investment Grade Index for the US. For Europe, we use the *Markit iTraxx Europe Investment Grade index*. Both are composed of 125 equally weighted credit default swaps on US (European) investment grade entities, distributed among several sub-indices (Financials, Non-Financials and High Volatility). We then collect daily data from Bloomberg™ for each of these two indexes, but not for all maturities. Indeed, only four maturities are available (3, 5, 7 and 10 years). Therefore, we compute the 4Y daily CDX spreads for each index by taking the average between the 3Y and the 5Y CDX spreads, at the level of each date. For the remaining unavailable maturities (6M, 1 and 2 year), we assigned them the spreads of the nearest available maturity to perform our investigations (so the spreads of the 3Y maturity).

3.2.2. Methodology

In order to investigate whether the market reaction is the same depending on whether one considers the short-term or the long-term CDS maturities, we employ an event study methodology (described in Campbell, Lo, and MacKinlay (1997) among others) that has been extensively used in the regulatory stress test literature.

3.2.2.1. Research Design

In our study, to capture the CDS market reaction to the publication of a given stress test results, we compute the Cumulative Average Abnormal (CDS) Returns CAARs of the group of participating banks following the disclosure date; the CAARs being an estimation of the impact of the stress test outcomes' publication on the group of participating banks' spreads.

Hence, in the US as in Europe, to check whether the market reaction is the same from one maturity to another, we estimate for each stress test eight different CAARs considering each of the eight CDS maturities. In other words, we apprehend the response of the market using not only the 5Y maturity data (as previous papers), but also all the remaining maturities data in order to highlight possible differences in reactions depending on the maturity considered.

3.2.2.2. Events and Event dates

In our study, for a given stress test, we consider as "event" the disclosure of its results. Following Flannery et al. (2017) and Ahnert et al. (2018) among others, we will not consider as "event date" the stress test results' publication date but rather the next trading day. Indeed, the results are published either on a trading day but after market closing (in the US as in Europe), or during a non-trading day (as it was the case for the 2014 ECB-EBA stress test results' disclosure). Table 1 reports, for each stress testing exercise, the results' disclosure date and the corresponding event date in the US (Panel A) and in Europe (Panel B).

3.2.2.3. Event study methodology description

To obtain the CAARs of a group of banks, we measure first of all the abnormal return ARi,t of each bank i in this group, at time t. It is the difference between the observed (actual) CDS return Rit and an expected (normal) return R̂it. This latter is the return that would be expected if the event did not take place. To estimate it, following Campbell et al. (2010), Morgan et al. (2014), Neretina et al. (2014) and Ahnert et al. (2018), we use a one-factor market model (equation 1) over an 84 trading days window (consistent with Weston et al. (2004) suggestion and previous research).

$$R_{i,t} = \alpha_i + \beta_i.R_{m(i),t} + \varepsilon_{i,t} \quad (1)$$

Therefore, the abnormal return or residuals $AR_{i,t}$ of a bank i, at time t is given by:

$$AR_{i,t} = R_{i,t} - [\ \hat{\alpha}_i + \hat{\beta}_i(R_{m(i),t})\ ] \quad (2)$$

With:

$$R_{i,t} = log(\frac{S_{i,t}}{S_{i,t-1}}) \quad \text{and} \quad R_{m(i),t} = log(\frac{S_{m(i),t}}{S_{m(i),t-1}}) \quad (3)$$

Where:

$R_{i,t}$ is the daily CDS spread return of bank i, on day t and $R_{m(i),t}$ the daily CDX spread return of bank i's index, on day t. $S_{i,t}$ is the daily CDS spread of bank i, on day t when $S_{m(i),t}$ is the daily CDX spread of bank i's index, on day t. $\hat{\alpha}_i$ and $\hat{\beta}_i$ are respectively the estimators of α_i and β_i. As we can see, α and β are estimated separately for each bank i.

Then, since we are working on a pool of banks, we compute in a second time the Average Abnormal Returns (AAR_t) which is the average of participating banks' abnormal returns at time t.

$$AAR_t = \frac{\sum_{i=1}^{N} AR_{i,t}}{N} \quad (4)$$

Where N is the number of stress tested banks. We perform this computation for each date of the event window (which is a relevant window around the event date). We focus on a three-day event window including the event date and the two following days (t, t+1, t+2).

Finally, we calculate the Cumulative Average Abnormal (CDS) Returns CAARs by summing the Average Abnormal Returns AAR_t over our event window.

$$\text{CAAR}\ (t_0, t_1, t_2) = \sum_{t=t_0}^{t_2} \text{AAR}_t \quad (5)$$

Statistical significance of CAARs

After estimating a CAARs, we perform several significance tests in order to establish its statistical validity. In other words, we compute and analyze several statistics in order to "attest" whether the Cumulative Average Abnormal Returns that we estimated are significantly different from zero (and thus not the result of pure chance) or not.

A vast literature exists on significance tests in event study methodology. These latter can be categorized into two groups: parametric and non-parametric tests.

Parametric tests are based on the traditional t-test and rely on specific assumptions about the population parameters (normal distribution of CDS spreads in our case). To establish the statistical significance of our computed CAARs, we use three of them which we think, are the most relevant for our study.

The first one is the standardized abnormal return test developed by **Patell** (1976) who tried to adjust the classic t-test by standardizing the event window's ARs. But Brown and Warner (1980, 1985) among others show later that a variance (volatility) increase on the event date can seriously bias the Patell test. Therefore, Boehmer, Musumeci and Poulsen (1991) improve this latter by developing the standardized cross-sectional test (**BMP test**) which is robust to possible event-induced volatility and thereby outperforms the Patell test (Higgins and Peterson, 1998; Graham, Pirie and Powell, 1996; Harrington and Shrider, 2007; Campbell, Cowan and Salotti, 2010; Marks and Musumeci, 2017). It is widely considered as the default and the "best" parametric test (Marks and Musumeci, 2017; Cowan, 2017). Nonetheless, it does not account for possible cross-sectional correlation of abnormal returns which can arise when all banks experience the event on the same date. To overcome this problem, Kolari and Pynnonen (2010) propose an adjustment of the BMP test that will account for cross-sectional correlation. It is the **Kolari test** (or the adjusted standardized cross-sectional test).

However, since these three parametric tests assume that CDS spreads returns are normally distributed, they may underperform if this assumption is no longer respected. Hence, to avoid this situation, we compute in addition two non-parametric tests that are not relied on any underlying assumptions. These latter are particularly important in our study since CDS spreads are not normally distributed.

Investigating the accuracy and power of statistical tests applied to one-factor market model abnormal returns (with a single-market sample), Campbell, Cowan and Salotti (2010) find that the Cowan (1992) **Generalized Sign test** and the Corrado (1989) rank test are more powerful than two commonly used parametric tests, the BMP test and the Crude Dependence Adjustment CDA test (Brown and Warner; 1980, 1985). We therefore use as non-parametric tests, the Cowan (1992) Generalized Sign test following Harvey et al. (2004), among others.

Based on the rank testing approach of Corrado (1989) and Corrado and Zivney (1992), Kolari and Pynnonen (2011) developed the "so-called" generalized rank (GRANK) non-parametric test which is, to our best knowledge, the most reliable and powerful test available. It dominates all parametric tests as well as the Corrado (1989) and the Corrado and Zivney (1992) rank tests (Kolari and Pynnonen, 2011). Consequently, it will be our second non-parametric tests.

4. Empirical Results

In this paper, using several maturities' CDS spreads, we examine the CDS market reaction to the disclosure of regulatory stress test results. More precisely, we examine the market response by taking into account all the different CDS maturities.

4.1. Is the market response the same for all maturities?

Table 2 presents the estimates of the CDS market response to the disclosure of EU-wide stress test results, at the level of all maturities. Panel A, B, C and D apply respectively to the 2010 CEBS stress test and to the 2011, 2014 and 2016 EBA stress tests. Figure 1 then presents graphically these different estimates, test by test and for all maturities.

Table 3 provides the estimates of the CDS market response to the disclosure of US stress test results, for all CDS maturities[5]. Panel A, B, C and D apply respectively to the 2009 Supervisory Capital Assessment Program (SCAP) and to the 2013, 2014, 2015, 2016 and 2017 Dodd-Frank Act stress tests (DFAST). All the estimates in this table are presented graphically in Figure 2.

For each panel (of tables 2 and 3), we have eight different rows corresponding to the eight different estimates (according to the eight different CDS maturities) of the CDS market response to the disclosure of the corresponding stress test results. To establish the statistical validity of our estimated CAARs, we use three parametric tests and two non-parametric tests. Columns (1), (2) and (3) report the results of the parametric tests (respectively the *Patell* test, the *BMP* test and the *Kolari* test) while the columns (4) and (5) provide the results of the non-parametric tests (respectively the *GenSign* test and the *GRANK* test).

We observe that, for each panel of Table 2, all CAARs (whatever the different CDS maturities) have the same sign: they are either negative and significant (tests of 2010,

[5] For the 2009 SCAP (Panel A), we could not estimate the market response using the 6-month and the 7-year maturities because of missing data.

2014 and 2016) or positive and significant (test of 2011). The strength of the significance of panel A (2010 CEBS test) is particularly strong.

While considering US SCAP and DFA stress tests (Table 3), we also observe the same conclusions: the eight CAARs estimated for panels A, C, E and F have the same sign. They are either negative and significant (Panels A, C and F) or positive and significant (Panel E) whatever the maturity considered. Panel A (2009 SCAP) and panel D (2016 DFAST) show a strong statistical significance.

In view of the foregoing, we argue that the nature of the CDS market response to the release of a regulatory stress test results is the same from one maturity to another. Following the disclosure of the results, the CDS market reacts in the same way, whatever the maturity considered: the nature of the reaction is the same, either a positive reaction or a negative reaction. We therefore argue that following the disclosure, with the new relevant information available to them, the CDS market (among others) reassesses the default risk of participating banks and adjusts accordingly their corresponding spreads of CDS, for each maturity. This adjustment can be an *upward correction* (significant positive CAARs), that is an increase in the CDS spread required, in case of bad news on banks' real situation, or a *downward correction* (significant negative CAARs), that is a decrease in the CDS spread required, in case of good news.

If the nature of the CDS market reaction (to the disclosure of a given stress test results) is the same for the different maturities, is the extent of the reaction the same from one maturity to another?

4.2. Is the market response different depending on the maturities?

Our empirical investigations clearly show that this is not the case. For a given stress test, even if the nature of the correction following the results' disclosure is the same from one maturity to another, the size of the reaction mostly differs in most cases.

For each panel presented Table 2 (the different European stress tests), we observe that the different CAARs value differ substantially from one maturity to another. Likewise when we consider the different US stress tests (Panels A, C, E and F of Table 3), our results show that, at the exception of 2009, the CAARs vary substantially from one maturity to another.

In summary, our results present evidence that the impact of the disclosure of a stress test results on tested banks' CDS spreads vary significantly from one maturity to another since the Cumulative Average Abnormal (CDS) Returns estimated using different maturities differ. In other words, for a given stress test, the CDS market adjusts differently the spread depending on the maturity considered.

A deeper analysis shows that the CDS market seems to react more strongly on short term maturities (from 6M to 3Y) than on 5Y maturity or more, whatever the nature of the correction. Indeed, for a given stress test, the CAARs (in absolute value) is often higher on short term maturities than on 5Y maturity or more. It is the case following the 2010 and 2016 stress testing exercises in Europe, and the 2014 and 2016 US DFA stress tests. For the remaining tests (the 2011 and 2014 EU-wide stress tests in Europe and the 2017 US DFA stress test), the CDS market also reacts differently depending on the maturity considered since the CAARs differ from one maturity to another. But in that case, the correction is less severe on short term maturities compared to the 5-year maturity.

Our results show that information contents provided by the disclosure of the stress test results is not the same time trough time. Since the hypothetical forward-looking scenarios of a stress testing exercise have a time horizon of 3 years, and since the disclosed results cover only these 3 years, we might argue that analyzing the market response using shorter maturities than 5 year will better reflect the assessment of participating banks' financial health and solvency made by the market.

4.3. Difference between several stress tests in term of the relevance of the information revealed.

Our results also show that using shorter maturities enables to better evaluate whether stress tests brings new information to the market. Indeed, we observe that the absolute value of CAARs varies more, from one stress test to another, for short maturities compared to the 5-year maturity. To measure the impact and informative value of a banking stress test using the spreads of CDS, the literature almost systematically uses the maturity of 5-year. But in view of our findings (supported by empirical evidence), we argue that it may not be the most suitable maturity to perform this measure. We suggest that short-term maturities of CDS spreads (6 months, 1 year, 2 years and 3 years) should be more appropriate to assess the market response rather than the 5-year maturity CDS spreads.

The most striking example concerns the 2014 and 2017 US stress tests. By analyzing these latter basing only on the 5Y maturity, one would conclude that there is almost no difference between them. In other words, the market response to both tests is almost the same. But, looking at the shorter maturities (6M, 1Y, 2Y, 3Y and 4Y), we can see that this is no longer the case. While the difference between the two tests' CAARs is 0,3% with the 5Y maturity, we find a difference of 10,41% with the 6M maturity. And considering the other maturities (1Y, 2Y, 3Y, 4Y), we observe that the lower the maturity of the CDS, the higher the difference. What leads us to argue that short term CDS maturities allow to better discriminate stress tests according to their revealed information's relevance, comparing to 5Y maturities or more and the lower the maturity, the better the discrimination is.

Consequently, we recommend to use short-term maturity CDS spread to measure the impact and the informative value of a stress test.

5. Conclusion

In this paper, we were interested to know if the use of the 5-year maturity CDS spreads in the examination of the CDS market response to regulatory stress tests was appropriate. To conduct our investigations and find an answer to this question, we consider the ten regulatory banking stress tests performed in Europe and in the US, in the time period from 2009 to 2017.

Assuming that the disclosure of stress test results should be more relevant (should more impact) for the short-term maturities' CDS spreads (6 months, 1 year, 2 years and 3 years CDS spreads), since the stress testing exercises are performed on short-term scenarios (1, 2 and 3 years), we examine whether the CDS market reaction is the same from one maturity to another. We therefore apply, for each stress test, an event study methodology on tested banks' CDS spread returns considering each of the eight maturities (6 months, 1Y, 2Y, 3Y, 4Y, 5Y, 7Y and 10Y maturity).

We evidence that for a given stress test, the nature of the CDS market response following the disclosure of stress test results is the same whatever the maturity considered since the different CAARs that we estimate using the different CDS maturities have the same sign. However, the value of these CAARs (in absolute value) are not the same; what lead us to argue that even if the nature of the CDS market response is the same, its importance differs considerably from one maturity to another. More accurately, we evidence that the lower the maturity of the CDS, the stronger the market reaction i.e. the higher the CAARs in absolute value. Consequently, we firstly argue that the 5-year maturity may not be the suitable maturity to examine and analyse the effects of a regulatory banking stress test on CDS market. Secondly, we argue that short term CDS maturities allow to better discriminate stress tests according to their revealed information's relevance and the lower the maturity, the better the discrimination is.

References

Annaert, J. M., De Ceuster, M., Van Roy, P., & Vespro, C. (2013). What determines Euro area bank CDS spreads. Journal of International Money and Finance, 32, 444–461.

Barrucci, E., Baviera, R., Milani, C.(2014), "Is the comprehensive assessment really comprehensive?", SSRN Working Paper.

Berger, Allen, Sally Davies, and Mark Flannery. (2000) “Comparing Market and Supervisory Assessments of Bank Performance: Who Knows What When?” Journal of Money, Credit and Banking, 32, 641-67.

Candelon B. and Sy A. N., 2015, “How did Markets React to Stress Tests?” IMF Working Paper WP/15/75, April 2015.

Ellahie A., "Capital Market Consequences of EU Bank Stress Tests", 2013, Available at SSRN: http://ssrn.com/abstract=2157715 or http://dx.doi.org/10.2139/ssrn.2157715

Flannery M., Hirtle B. and Kovner A., 2015, “Evaluating the Information in the Federal Reserve Stress Tests”, Federal Reserve Bank of New York Staff Reports, No. 744, October 2015.

Flannery, Mark J., Kwan, Simon H., Nimalendran, M., 2010. The 2007–09 Financial Crisis and Bank Opaqueness. Working Paper Series, Federal Reserve Bank of San Francisco.

Johannes Breckenfelder and Bernd Schwaab, 2015, “Bank to sovereign risk spillovers across borders: Evidence from the ECB’s comprehensive assessment”, Journal of Empirical Finance, August 2018, https://doi.org/10.1016/j.jempfin.2018.08.001

Lukas Ahnert, Pascal Vogt, Volker Vonhoff and Florian Weigert, 2018, "The Impact of Regulatory Stress Testing on Bank's Equity and CDS Performance", University of St.Gallen - School of Finance Research Paper No. 2018/15, May 2018.

Morgan D. P., Peristiani S. and Savino V., 2014, “The Information Value of the Stress Test”. Journal of Money, Credit and Banking, Volume 46, Issue 7, October 2014, pages 1479–1500.

Morgan, D.P., 2002. Rating banks: risk and uncertainty in an opaque industry. American Economic Review, 874–888.

Neretina, E., Sahin, C., and De Haan, J. (2014). Bank stress test effects on returns and risks. Working Paper, De Nederlandsche Bank.

Oana-Maria Georgescu, Marco Gross, Daniel Kapp and Christoffer Kok, 2017, "Do stress tests matter? Evidence from the 2014 and 2016 stress tests", ECB Working Paper N° 2054, May 2017.

Petrella G. and Resti A., 2013, "Supervisors as information producers: Do stress tests reduce bank opaqueness?" Journal of Banking & Finance, Volume 37, Issue 12, December 2013, Pages 5406–5420.

Völz, M., & Wedow, M. (2011). Market discipline and too-big-to fail in the CDS market: Does banks' size reduce market discipline? Journal of Empirical Finance, 18, 195–210

Tables

<u>Table 1</u>: The results' disclosure date and the corresponding event date in the US and in Europe.

Panel A: Timeline of regulatory stress test disclosures in the US (2009–2017)

Stress Test	**Release Date**	**Event Date**
2009 SCAP	Thursday May 7, 2009	Friday May 8, 2009
2013 DFA Stress Test	Thursday March 7, 2013	Friday March 8, 2013
2014 DFA Stress Test	Thursday March 20, 2014	Friday March 21, 2014
2015 DFA Stress Test	Thursday March 5, 2015	Friday March 6, 2015
2016 DFA Stress Test	Thursday June 23, 2016	Friday June 24, 2016
2017 DFA Stress Test	Thursday June 22, 2017	Friday June 23, 2017

Panel B: Timeline of regulatory stress test disclosures in Europe (2009–2017)

Stress Test	**Release Date**	**Event Date**
2010 EU-wide Stress Test	Friday, 23 July 2010	Monday, 26 July 2010
2011 EU-wide Stress Test	Friday, 15th July 2011	Monday, 18 July 2011
2014 EU-wide Stress Test	Sunday, 26 October 2014	Monday, 27 October 2014
2016 EU-wide Stress Test	Friday, 29 July 2016	Monday, 01 August 2016

Table 2: The impact on CDS market of the disclosure of European stress tests' results.

Maturity	Number of banks	CAARs	Patell p-value (1)	BMP p-value (2)	KP p-value (3)	GenSign p-value (4)	GRANK p-value (5)
Panel A: The 2010 CEBS Stress test							
0,5	41	-10,26%	***	***	***	***	**
1	40	-10,36%	***	***	***	***	**
2	39	-9,06%	***	***	**	***	**
3	41	-7,71%	***	***	**	***	**
4	38	-6,87%	***	***	*	***	**
5	41	-7,00%	***	***		***	**
7	39	-7,60%	***	***	**	***	**
10	41	-7,68%	***	***	*	***	**
Panel B: The 2011 EBA Stress test							
0,5	39	1,83%	***	***		**	
1	38	1,93%	***	***		**	
2	37	1,77%	***	***		*	
3	39	1,53%	***	***		*	
4	36	2,03%	***	***		**	
5	39	1,70%	***	***		***	
7	37	1,52%	***	***		*	
10	39	1,15%	***	**			
Panel C: The 2014 EBA-ECB Stress test							
0,5	50	-0,57%	**	*		*	
1	48	-0,94%	**	*		*	
2	48	-1,76%	***	**			
3	50	-2,48%	***	***			
4	48	-3,15%	***	***		*	
5	50	-3,80%	***	***		**	
7	48	-1,60%	***	***		*	
10	50	-3,46%	***	***	*	***	
Panel D: The 2016 EBA-ECB Stress test							
0,5	33	-3,36%	***	***		***	
1	33	-3,31%	***	***		***	
2	33	-2,66%	***	***		***	
3	33	-2,64%	***	***		***	
4	33	-2,10%	***	***		***	
5	33	-2,22%	***	***	*	***	
7	33	-1,79%	***	***		***	
10	33	-2,10%	***	***	*	***	

Source: Authors' calculation.

Notes: This Table presents the estimates of the CDS market response to the disclosure of EU-wide stress test results, in the time period from 2009 to 2017 and at the level of all maturities. Panel A applies to the 2010 CEBS stress test while Panel B, C and D apply respectively to the 2011, 2014 and 2016 EBA stress tests. Each Panel presents eight different columns. The column (1) corresponds to the CDS *Maturity* used to estimate the market response while the column (2) reports the *Number of banks* in the sample used to estimate the market response. This latter (*CAARs*) is reported in column (3). *CAARs* indeed refers to the Cumulative Average Abnormal (CDS) Returns computed on a three-day event window including the event date and the two following days (t, t+1, t+2). To establish its statistical validity, we use three parametric tests and two non-parametric tests. The columns (4), (5) and (6) report the results of the parametric tests (respectively the *Patell* test, the *Boehmer-Musumeci-Poulsen* test and the *Kolari-Pynnonen* test) while the columns (7) and (8) provide the results of the non-parametric tests (respectively the *Generalized Sign* test and the *Generalized Rank* test). *, **, *** indicate statistical significance respectively at 10%, 5% and 1% levels.

Table 3: The impact on CDS market of the disclosure of US stress tests' results.

Maturity	Number of banks	CAARs	Patell p-value (1)	BMP p-value (2)	KP p-value (3)	GenSign p-value (4)	GRANK p-value (5)
Panel A: The 2009 SCAP							
1	9	-14,21%	***	***	*	**	*
2	9	-14,46%	***	***	**	***	**
3	9	-14,29%	***	***	**	***	**
4	9	-14,39%	***	***	***	***	**
5	9	-14,34%	***	***	**	***	**
10	9	-16,95%	***	***	***	***	**
Panel B: The 2013 DFA Stress test							
0,5	11	-3,24%					
1	11	-0,97%					
2	11	-0,65%					
3	11	-0,53%					
4	11	-1,11%		**		*	
5	11	0,19%					
7	11	-0,18%					
10	11	-0,03%					
Panel C: The 2014 DFA Stress test							
0,5	11	-12,50%	**	***		***	*
1	11	-10,39%	***	***			
2	11	-6,55%	***	***			*
3	11	-5,12%	***	***	**	***	**
4	11	-3,37%	**	***		***	*
5	11	-3,11%	***	***		***	
7	11	-1,49%					
10	11	-1,52%				**	*
Panel D: The 2015 DFA Stress test							
0,5	11	4,27%				*	
1	11	-0,93%					
2	11	1,99%					
3	11	0,08%					
4	11	0,97%					
5	11	0,36%					
7	11	2,12%		**			
10	11	1,84%		**		**	
Panel E: The 2016 DFA Stress test							
0,5	11	22,42%	***	***	***	***	**
1	11	0,1741	***	***	***	**	**
2	11	0,1655	***	***	***	***	***
3	11	0,1631	***	***	***	***	***
4	11	0,1468	***	***	***	***	***
5	11	0,1232	***	***	***	***	***
7	11	0,1066	***	***	***	***	***

10	11	0,106	***	***	***	***	***
Panel F: The 2017 DFA Stress test							
0,5	12	-0,0208	**				
1	12	-0,0288	***				
2	12	-0,0339	***	*		*	
3	12	-0,0343	***	*		**	
4	12	-0,0397	***	***		***	**
5	12	-0,028	***	**		***	
7	12	-0,0391	***	***		***	
10	12	-0,0416	***	***		**	

Source: Authors' calculation.

Notes: This Table presents the estimates of the CDS market response to the disclosure of US stress test results, in the time period from 2009 to 2017 and at the level of all maturities. Panel A applies to the 2009 Supervisory Capital Assessment Program (SCAP) while Panel B, C, D, E and F apply respectively to the 2013, 2014, 2015, 2016 and 2017 Dodd-Frank Act stress tests (DFAST). Each Panel presents eight different columns. The column (1) corresponds to the CDS Maturity used to estimate the market response while the column (2) reports the Number of banks in the sample used to estimate the market response. This latter (CAARs) is reported in column (3). CAARs indeed refers to the Cumulative Average Abnormal (CDS) Returns computed on a three-day event window including the event date and the two following days (t, t+1, t+2). To establish its statistical validity, we use three parametric tests and two non-parametric tests. The columns (4), (5) and (6) report the results of the parametric tests (respectively the Patell test, the Boehmer-Musumeci-Poulsen test and the Kolari-Pynnonen test) while the columns (7) and (8) provide the results of the non-parametric tests (respectively the Generalized Sign test and the Generalized Rank test). *, **, *** indicate statistical significance respectively at 10%, 5% and 1% levels.

Figures

Figure 1: The impact of the disclosure of European stress tests' results

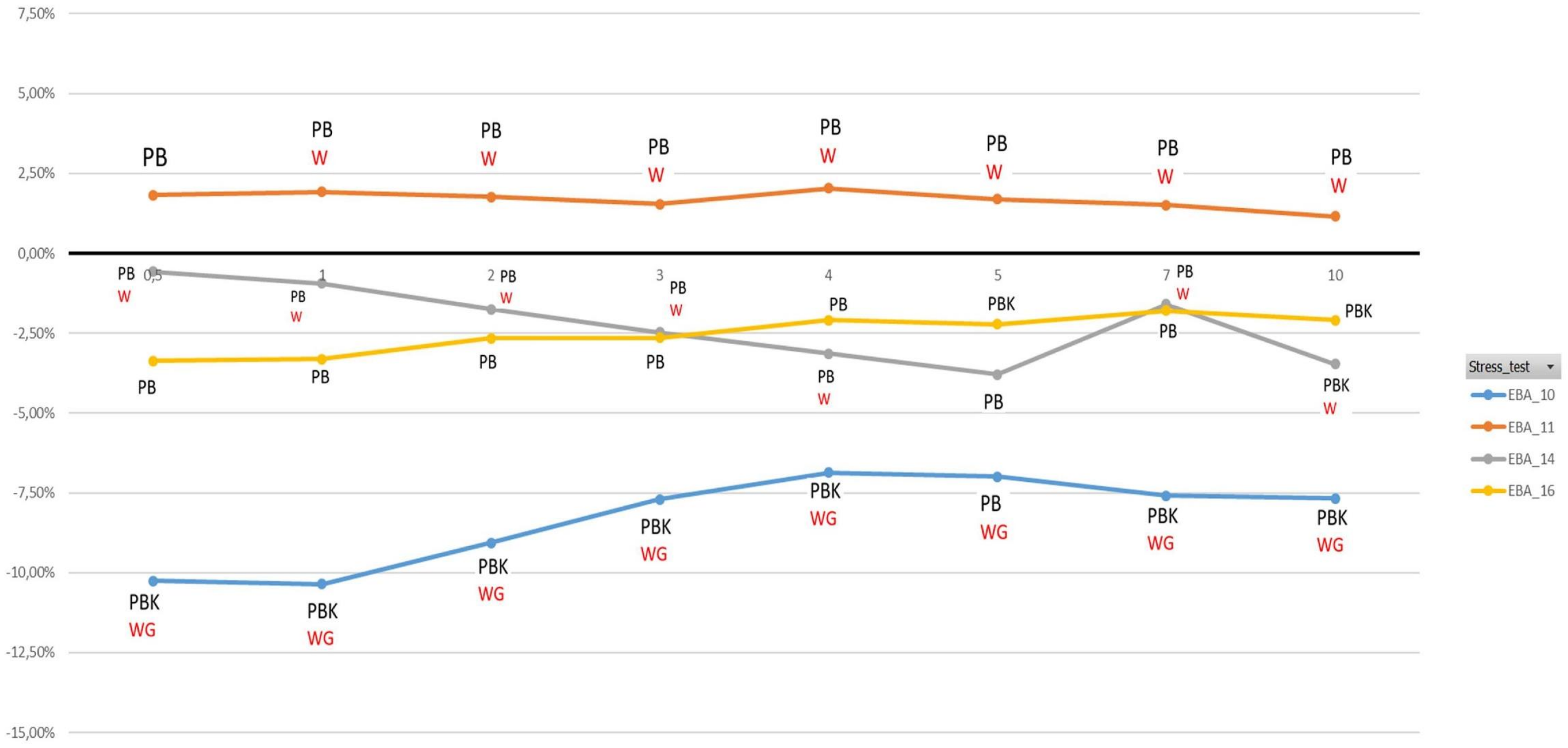
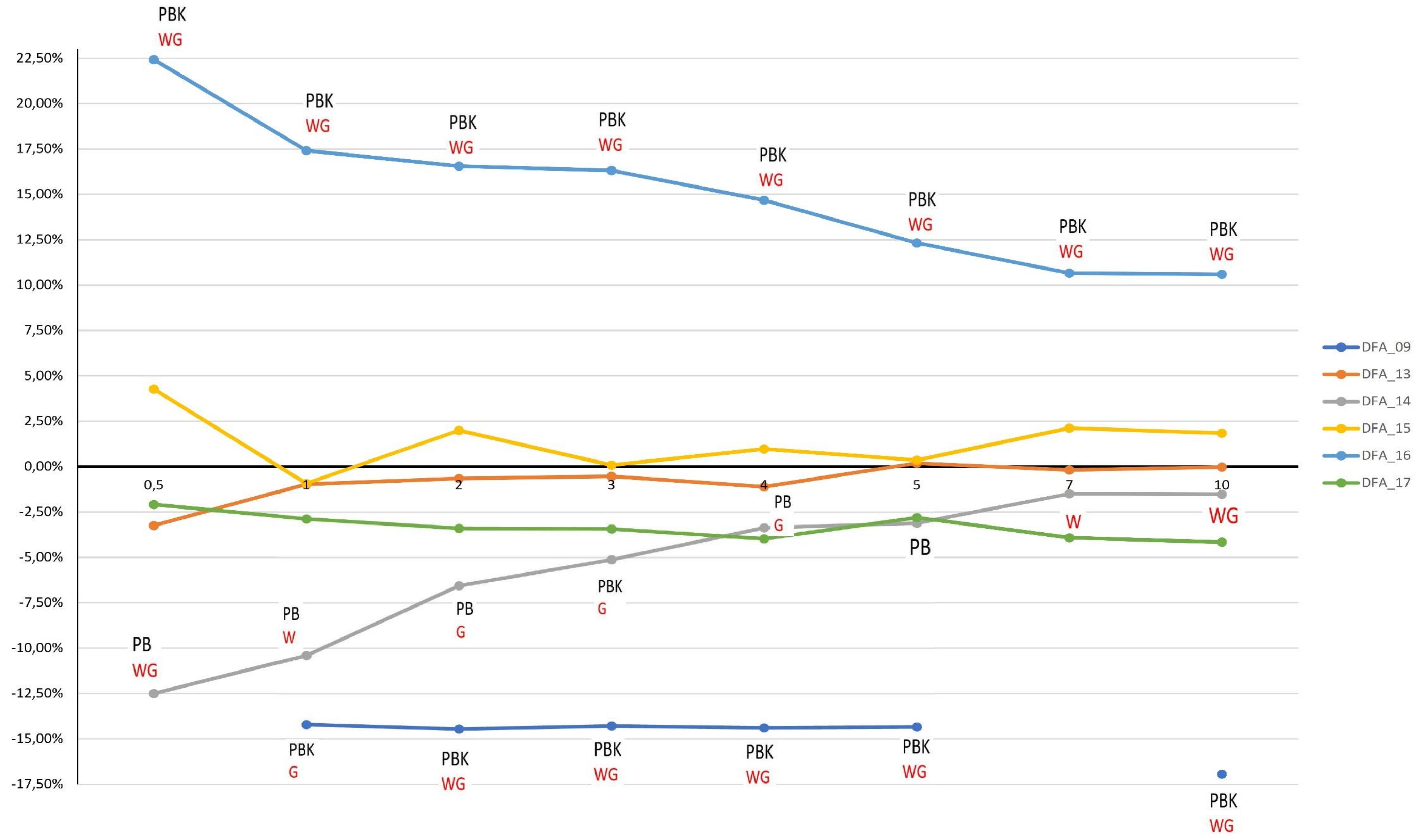


Figure 2: The impact of the disclosure of US stress tests' results.



Appendix

Appendix A.1: List of the banks included in our final sample, test by test.

Considering a given stress test column, × indicates banks with available data on tradable credit default swap (so banks with CDS spread returns). Hence, it indicates banks that we consider to examine the impacts of the test.

Panel A: List of banks included in our final US sample

Bank Name	Bank Country	2009 SCAP	2013 DFA test	2014 DFA test	2015 DFA test	2016 DFA test	2017 DFA test
Ally Financial Inc	U.S.	×	×	×	×	×	×
American Express Co	U.S.	×	×	×	×	×	×
Bank of America Corp	U.S.	×	×	×	×	×	×
Capital One Financial Corp	U.S.	×	×	×	×	×	×
CIT Group Inc	U.S.						×
Citigroup Inc	U.S.	×	×	×	×	×	×
JPMorgan Chase & Co	U.S.	×	×	×	×	×	×
Morgan Stanley	U.S.	×	×	×	×	×	×
The Goldman Sachs Group Inc	U.S.	×	×	×	×	×	×
The PNC Financial Services Group Inc	U.S.		×	×	×	×	×
US Bancorp	U.S.		×	×	×	×	×
Wells Fargo & Co	U.S.	×	×	×	×	×	×
Total Number of participating banks		**9**	**11**	**11**	**11**	**11**	**12**

Sources: U.S. Federal Reserve (FED) and Authors' calculation.

Panel B: List of banks included in our final European sample

Bank_Name	Bank Country	2010 CEBS test	2011 EBA test	2014 EBA test	2016 EBA test
ABN AMRO Bank NV	NETHERLANDS			×	
Allied Irish Banks PLC	IRELAND	×		×	×
Alpha Bank AE	GREECE	×	×	×	
Banca Monte dei Paschi di Siena SpA	ITALY	×	×	×	×
Banca Popolare di Milano Scarl	ITALY			×	
Banco Bilbao Vizcaya Argentaria SA	SPAIN	×	×	×	×
Banco BPI SA	PORTUGAL	×	×	×	
Banco Comercial Portugues SA	PORTUGAL	×	×	×	
Banco de Sabadell SA	SPAIN	×	×	×	×
Banco Popolare SC	ITALY	×	×	×	×
Banco Popular Espanol SA	SPAIN	×	×	×	×
Banco Santander SA	SPAIN	×	×	×	×
Bank of Ireland	IRELAND	×	×	×	×
Bankinter SA	SPAIN	×	×	×	

Barclays Bank PLC	BRITAIN	×	×	×	×
BAWAG PSK Bank fuer Arbeit und Wirtschaft und OP AG	AUSTRIA			×	
Bayerische Landesbank	GERMANY	×	×	×	×
BNP Paribas SA	FRANCE	×	×	×	×
Caixa Geral de Depositos SA	PORTUGAL	×	×	×	
Caja de Ahorros del Mediterraneo	SPAIN	×	×		
Commerzbank AG	GERMANY	×	×	×	×
Cooperatieve Rabobank UA	NETHERLANDS	×	×		
Credit Agricole SA	FRANCE	×	×	×	×
Danske Bank A/S	DENMARK	×	×	×	×
Deutsche Bank AG	GERMANY	×	×	×	×
DNB Bank ASA	NORWAY	×	×	×	×
DZ Bank AG Deutsche Zentral-Genossenschaftsbank	GERMANY	×	×	×	
Erste Group Bank AG	AUSTRIA	×	×	×	×
Eurobank Ergasias SA	GREECE			×	
HSBC Bank PLC	BRITAIN	×	×	×	×
HSH Nordbank AG	GERMANY	×	×	×	
IKB Deutsche Industriebank AG	GERMANY			×	
ING Bank NV	NETHERLANDS	×	×	×	×
Intesa Sanpaolo SpA	ITALY	×	×	×	×
KBC Group NV	BELGIUM	×	×	×	×
Landesbank Baden-Wuerttemberg	GERMANY	×	×	×	×
Landesbank Hessen-Thueringen Girozentrale	GERMANY			×	×
Lloyds Bank PLC	BRITAIN	×	×	×	×
Mediobanca Banca di Credito Finanziario SpA	ITALY			×	
National Bank of Greece SA	GREECE			×	
Norddeutsche Landesbank Girozentrale	GERMANY			×	×
Nordea Bank AB	SWEDEN	×	×	×	×
Permanent TSB Group Holdings PLC	IRELAND			×	
Piraeus Bank SA	GREECE			×	
Raiffeisen Zentralbank Oesterreich AG	AUSTRIA	×	×	×	
Royal Bank of Scotland PLC/The	BRITAIN	×	×	×	×
Skandinaviska Enskilda Banken AB	SWEDEN	×	×	×	×
Societe Generale SA	FRANCE	×	×	×	×
Svenska Handelsbanken AB	SWEDEN	×	×	×	×
Swedbank AB	SWEDEN	×	×	×	×
UniCredit SpA	ITALY	×	×	×	×
Unione di Banche Italiane SpA	ITALY	×	×	×	×
Total Number of participating banks		**41**	**40**	**50**	**33**

Sources: European Banking Authority (EBA) and Authors' calculation.