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What is the information value of bank's stress tests? An investigation using banks' bond split ratings

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Abstract: We study the informative value of stress tests by investigating the impact of the disclosure of their results on banks' bonds split ratings taken as a measure of bank opacity. We consider bonds jointly rated by Moody's and Standard & Poor's and issued by banks that participated to the European and US banks' stress tests. Our results suggest that the disclosure of stress results has mixed effect on split ratings. Our findings also suggest a frequent divergence of interpretation of the stress test results between the two rating agencies meaning that information would not be as relevant as hoped by regulators. Market players certainly could not extract an unambiguous signal from all the results disclosed by the stress tests.

JEL Classification: G01, G02, G14, G21,

Keywords: stress tests, credit rating, split rating, banks' opacity.

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1. Introduction

Banking sector is one of the most regulated sectors in the economy in order to protect debt holders, especially depositors, and to prevent systemic risk. Arguments supporting the regulation of banks generally stem from asymmetric information that characterizes banks' activities (Santos, 2001). Because of bank opacity, it may be difficult for market's participants to correctly anticipate the performance and evaluate the riskiness of banks. Even if prudential regulation tends to favor market discipline, the opaqueness of banks remains a concern for the regulatory authorities.

Since the end of the 2008 financial crisis, European and American regulators, among others, have conducted different stress tests exercises in order to provide reliable information about banks and restore investors' confidence. In this paper, we aim to appreciate the informative value of stress tests by investigating the impact of the disclosure of the stress tests results on banks' bonds split ratings. Several papers have investigated the efficiency of stress tests to reduce bank opacity. Petrella and Resti (2013), Morgan et al. (2014), Flannery et al. (2015) give some evidence that investors react to the information disclosed by the stress tests. Bank opacity decreases due to the transparency brought by the stress tests results. On the other hand, Sahin and Haan (2016) and Lazzari et al. (2017) find that the stress tests do not bring valuable information to the financial market. All these papers use an event study methodology to estimate the stock or CDS market prices' reactions after the disclosure of the stress tests results. However, market players have different positions (buyer or seller) and different stakes that may bring different perceptions and interpretations of the revealed information. Analyzing a global market reaction may hide disparate and even opposite reactions to the disclosure of the information that is not necessarily a synonym of transparency and could also create negative externalities. The release of information might not be beneficial for the market particularly if the information could give rise to a subjective interpretation by the financial market's participants (Banerjee and Maier, 2016, Chen et al., 2010, Gaballo, 2016, Goldstein and Sapra, 2014). If stress tests are not properly designed, the disclosure may create more panic in the financial market and thereby lower the confidence in the banking sector. Because banks operate in a *second-best* environment with market and informational frictions, the conventional wisdom that more disclosure leads to better market discipline of banks due to an increase in transparency does not hold unconditionally.

Our paper is the first one to use bond split ratings as a measure of the effectiveness of bank stress tests assuming that a growing convergence of views on banks credit risk between rating agencies implies a decrease in opacity and thus an improvement of market discipline. We consider all the stress tests conducted in Europe (3) and in the United-States (6) between 2009 and 2015 as they cover, especially in Europe, a large sample of individual banks and we consider bonds jointly rated by Moody's and Standard & Poor's issued by banks participating to the European or US banks stress tests. First, we statistically analyze bonds' ratings before and after each stress test to establish if the disclosure of the results leads to a reduction of split ratings, what would be logical from the typical expected effect of a greater and shared information, or if it leads to an increase in split ratings, what would on the opposite give weight to counterintuitive interpretations. Second, we estimate an econometrical model to analyze if the stress variables explain the changes in rating disagreements after the disclosure of the stress test results. We select the more representative variables indicating the expected strengths or weaknesses of a bank (credit exposure, capital, profitability…).

Our results suggest that stress tests have mixed effect on split ratings. We can clearly identify the first European (2010) and two first American (2009, 2011) tests, those following the global financial crisis, and the 2014 tests both in EU and the US, as those that best correspond to a counterintuitive and maybe counterproductive impact of information

disclosure since they reveal a higher divergence between the two rating agencies in the post stress test periods. This mixed effect of stress tests is confirmed by the regressions relating the changes in split ratings to data from the stress tests results disclosure. The stressed risk, capital and profitability variables affect significantly or not, sometimes in opposite ways, the change in average absolute rating gap around each stress test. The credibility of the stress tests, the period of disclosure (crisis or non-crisis period), the backstops measures proposed by the regulators, the individual stress test analysis of each agents and other externalities could lead to different perceptions of stress test and could contribute to explain this mixed effect of disclosure. Our finding suggests a frequent divergence of interpretation of the stress test results between the two rating agencies meaning that information would not be as relevant as hoped by regulators, market players certainly could not extract an unambiguous signal from all the results disclosed by the stress tests.

The rest of the paper is organized as follows: section 2 presents the sample and the methodology of our empirical analysis, section 3 the results and section 4 concludes.

2. Sample & Methodology

2.1. Sample and key features of the stress tests

Since the end of the 2008 financial crisis, both European and US regulators have evaluated the ability of the different banks to maintain post-stress test capital ratios above the minimum required. The first stress test or SCAP (Supervisory Capital Assessment Program) was conducted in the US in 2009 in order to respond to the concerns of market participants about US banks financial health at the end of the 2008 financial crisis. This first US stress test required the 19 largest US Banks Holding Companies (BHCs) to simultaneously undergo a forward-looking exam in order to determine if they have enough capital to support lending in the event of an unexpected severe recession. This stress test was performed by banks with more than $10 billion in assets. Since 2011, the Comprehensive Capital Analysis and Review (CCAR) is the regulatory framework of the Federal Reserve and since 2013, the Dodd-Frank Act has required the Federal Reserve to conduct every year a stress test in addition to the CCAR. In Europe, the European Banking Authority (EBA) conducted a stress test in 2010 based on 91 banks and another one in 2011 based on 90 banks to reassure financial markets on the banks' resilience to the sovereign debt crisis but also to bring more transparency about banks' statements. In each country, the sample of tested banks has been built to cover at least 50% of the national banking sector, as expressed in terms of total assets. In 2014 and in order to prepare the Single Supervisory Mechanism (SSM), the European Central Bank in close cooperation with the EBA conducted another stress test based on 130 banks, which was more global and included asset quality review (AQR). The AQR is an assessment of the accuracy of the carrying value of banks' assets at December 31, 2013, which is the starting point of the stress test. In Table 1, we present the disclosure dates of the different stress tests conducted in Europe and in the United-States[2].

For each stress test, we analyze the period of 127 days (six months) before and 127 days after the results disclosure. So, we extract from Bloomberg data on bonds jointly rated by Moody's and Standard & Poor's issued in the period between six months before and six months after each stress test. We collect the initial ratings[3] of bonds issued by European banks on the period between February 2010 and April 2015 and for US banks on the period between

[2] Note that for the United-States, starting in 2013, the Federal Reserve conducts at the same time both the Dodd-Frank act stress test (DFAST) and the Comprehensive Capital Analysis and review (CCAR) and discloses first the DFAST's results, one week before the CCAR's results. In our study, we consider the disclosure date and the results of the first chronological event, which is DFAST.

[3] The letter ratings of the two agencies are mapped to a common numerical scale, with better letter ratings corresponding to lower numbers: Aaa = AAA = 1, Aa1 = AA+ = 2 … Caa3 = CCC- = 19.

November 2008 and September 2015. We also collect the maturity and the amount issued for each issue. For each stress test, we keep only the bonds issued by banks participating to the stress exercise. Our sample includes 960 bonds issued by 38 European tested banks and 1,932 bonds issued by 16 US tested banks.

Table 1: Results announcement dates for stress tests conducted in Europe and in the United-States

Dates of stress tests results disclosure	
Europe	United-States
	May 07, 2009
July 23, 2010	
	March 18, 2011
July 15, 2011	
	March 13, 2012
	March 07, 2013
	March 20, 2014
October 26, 2014	
	March 05, 2015

2.2. Methodology

2.2.1. Statistical measures of rating disagreement

With the ratings collected, we build different statistical measures of disagreement between rating agencies as the correlation between the ratings, the percentage of disagreements, the mean average absolute gap (defined as the mean of the absolute values of the rating differences between the two agencies) based on notch or category rating split[4]. We compute these measures both before and after the disclosure of each stress test results.

2.2.2. Determinants of split ratings changes

To determine how data disclosed in each stress test influence banks' bonds split ratings, we run a linear model relating the change in the rating absolute gap to key data disclosed in the stress test results. The change in the rating absolute gap corresponds to the difference between the rating absolute gap of a bond issued by a bank on the 127-day period after the disclosure of the stress test results and the mean of the rating absolute gaps of all bonds issued by this bank on the 127-day period before the disclosure of the results. Stress test results[5] provide information about banks' credit exposure, capital and revenue on the financial market. In the case of Europe, the key variables we considered are the sovereign debt exposure[6], the risk weighted assets, the capital ratio and the net income resulting from the

[4] Notch ratings are given plus and minus symbols by Standard & Poor's, and numerical 1, 2, and 3 in the case of Moody's. Hence, for example using Standard & Poor's notation, a category level split differentiates AA from A but not AA+ from AA and a notch level split differentiates, for example, A from AA but also AA+ from AA. The different ratings classes for Moody's and Standard & Poor's were mapped into numerical values following the common numerical scale generally used in the literature (see Morgan (2002) for example).

[5] For European banks, we get the stress tests results from the website of European Bank Authority while for US banks, the stress tests results are collected from the website of the Federal Reserve.

[6] Because PIIGS (Portugal, Ireland, Italy, Greece and Spain) are the countries the most affected by the sovereign debt crisis, we consider in all stress tests only the banks' exposure to PIIGS countries which corresponds to the riskier sovereign debt.

adverse scenario[7]. We choose to build the explanatory variables as the differences between the one period adverse scenario value (as it is the only value available for the three stress tests[8]) and the current value published in the stress tests results. In the US case, the key variables we consider are the capital gap from SCAP, the total loan losses, the tier 1 capital, the leverage ratio and the net income. The US stress test adverse scenarios have generally a time horizon of nine quarters, but data are only available for the last period of the adverse scenarios. We then calculate the differences using the values on this last period of the adverse scenario (if available) and the current values published in the stress test results[9]. 7 banks of our sample failed the first US stress test. To control for this, we introduce a dummy variable *Failed_dummy* indicating if a bank failed or not the stress test. As in Morgan (2002), the regression controls also for the issue characteristics. The estimated model is the following:

$$\Delta Gapk_{i,j} = \alpha + \beta' Bank_j + \gamma' Controls_i + \varepsilon_{i,j} \quad (1)$$

where $\Delta Gapk_{i,j}$ is the difference between the rating absolute gap of the bond i issued by the bank j on the 127-day period after a stress test results disclosure and the mean of the rating absolute gaps of all bonds issued by the bank j on the 127_day period before this stress test results disclosure, the gap being measured at the notch level for k=1 and at the category level for k=2. $Bank_j$ is a vector of variables built from the stress tests results disclosed for the bank j, $Controls_i$ is a vector of characteristics related to the bond issuance i, $\varepsilon_{k,i,j}$ is the error term. The definitions of variables are presented in Table 2. Table 3 (Europe) and Table 4 (US) present statistics of independent and explanatory variables of the model.

Table 2: Explanatory variable definitions

PIIGS exposure	PIIGS[10] countries sovereign debt exposure from the EBA stress test results disclosure for a specific bank divided by the Tier 1 capital for the 2010 stress test and divided by Core tier 1 capital for the 2011 and 2014 stress test.
ΔRWA	Difference between the risk weighted assets from adverse scenario of the EBA stress test and the actual risk weighted assets divided by total assets.
Δ(C)Tier1	Difference between the tier 1 ratio in the case of the 2010 stress test and Core tier 1 ratio for the 2010 and 2011 stress test from adverse scenario of the EBA stress test and the actual tier 1 (Core tier 1) capital ratio.
ΔNet Income	Difference between the net income from adverse scenario of the EBA stress test results disclosure and the actual net income divided by total assets.
Gap_to_Asset	Capital GAP from 2009 US stress test results disclosure on 07/05/2009 for a specific bank divided by the total assets.
ΔTier1	Difference between the tier 1 capital ratio from the adverse scenario of the US stress test and the actual tier 1 capital ratio.
ΔLeverage	Difference between the leverage ratio from the adverse scenario of the US stress test and the actual leverage ratio.
ΔNet_income	Difference between net income over the period of the stress test adverse scenario of the US stress test and the actual net income divided by total assets
Δloss_loan	Difference between loan losses over the periods of the adverse scenario of the US stress test and the actual loan losses divided by total loans.
Failed_dummy	Dummy variable equal to 1 when the bank failed to the stress test and equal to 0 otherwise.
Average_rating	Average notch rating of the Moody's and S&P bonds issue rating
Ln_amount_issued	Logarithm of bond issuance amount
Maturity	Bond maturity in years

[7] Given the strong correlation between the capitalization variables and the risk weighted assets variable, we do not include them simultaneously in our regressions.

[8] The adverse scenario of the first stress test covers only one period (1 year), the second two periods (2 years) and the third three periods (3 years)

[9] The detailed results of the second US stress tests conducted in 2011 were not released by Federal Reserve. Thus, in the regression we do not consider the 2011 stress test.

[10] PIIGS is an acronym used to refer to the five countries: Portugal, Ireland, Italy, Greece and Spain

Table 3: Statistics of dependent and explanatory variables on the 127-day period after each stress test results disclosure, European banks.

For each bond issued on the 127-day period after the stress test disclosure, ΔGap1 is the difference between its notch rating absolute gap and the mean notch rating absolute gap computed for all bonds of the same issuing bank issued on the 127 day-period before the stress test disclosure date. ΔGap2 is the same indicator built for category rating. The rating absolute gap is the absolute difference between Moody's and Standard & Poor's bonds' ratings. PIIGS exposure is the PIIGS countries sovereign debt exposure of a bank (disclosed in the EBA stress test results), divided by its Tier 1 capital for the 2010 stress test and Core Tier 1 capital for the 2011 and 2014 stress tests. Δ(C)Tier1 is the difference between the stressed value of the Tier 1 ratio in the case of the 2010 stress test or the Core Tier 1 ratio for the 2011 and 2014 stress tests and the current Tier 1 (Core tier 1) capital ratio. ΔRWA is the difference between the stressed risk weighted assets and the current risk weighted assets divided by total assets. ΔNet Income is the difference between the stressed net income and the current net income divided by total assets. Average_rating is the average notch rating of the Moody's and S&P bonds issue rating, Ln_amount_issued is the logarithm of bond issuance amount and Maturity is bond maturity in years.

		ΔGap1	ΔGap2	PIIGS exposure	Δ(C)Tier1(%)		ΔRWA(%)		ΔNet Income(%)		Average_rating	Ln_amount_issued	Maturity
EU 2010	Obs.	71	71	71	71		71				71	71	71
Stress test	Mean	0.218	0.090	0.636	-0.461		2.655				3.965	19.628	5.540
	Median	0.000	0.000	0.321	-0.500		3.099				4.000	20.314	4.999
	Maximum	6.000	2.000	2.833	1.800		6.296				10.000	21.701	14.995
	Minimum	-5.000	-1.000	0.000	-1.600		-0.866				1.000	15.425	1.251
	Std. Dev.	1.732	0.639	0.780	0.659		1.321				1.527	1.454	2.935
					First period	*Last period*	*First period*	*Last period*	*First period*	*Last period*			
EU 2011	Obs.	36	36	36	36	36	36	36	36	36	36	36	36
Stress test	Mean	-0.357	-0.147	1.013	-0.858	-1.089	3.855	5.593	-0.394	-0.367	5.306	18.296	5.932
	Median	-0.286	-0.095	0.741	-0.453	-0.921	3.628	4.676	-0.394	-0.318	6.000	17.956	4.463
	Maximum	4.000	2.000	2.567	0.700	1.228	9.908	12.977	-0.083	-0.153	10.000	21.416	30.160
	Minimum	-6.000	-2.000	0.000	-2.163	-2.549	-0.337	-0.781	-0.631	-0.849	1.000	14.914	1.500
	Std. Dev.	1.521	0.591	0.876	1.018	1.252	3.037	4.465	0.198	0.155	1.614	1.855	5.570
EU 2014	Obs.	44	44	44	44	44	44	44	44	44	44	44	44
Stress test	Mean	0.341	0.091	11.910	-1.248	-2.469	2.455	3.411	-0.148	-0.080	6.750	19.565	5.657
	Median	0.000	0.000	0.298	-1.121	-2.458	1.844	2.882	-0.291	-0.185	6.250	19.811	4.999
	Maximum	2.000	1.000	54.537	-0.351	-0.676	4.806	7.314	1.356	1.559	10.500	21.416	12.006
	Minimum	-2.000	-1.000	0.000	-2.384	-4.528	0.442	0.705	-0.689	-0.475	4.000	17.034	1.213
	Std. Dev.	0.676	0.461	18.622	0.546	0.894	1.345	1.776	0.406	0.462	2.059	1.476	3.046

Table 4: Statistics of dependent and explanatory variables on the 127-days period after each stress test results disclosure, U.S. banks.

For each bond issued on the 127-day period after the stress test disclosure, ΔGap1 is the difference between its notch rating absolute gap and the mean notch rating absolute gap computed for all bonds of the same issuing bank issued on the 127 day-period before the stress test disclosure date. ΔGap2 is the same indicator built for category rating. The rating absolute gap is the absolute difference between Moody's and Standard & Poor's bonds' ratings. GAP_to_Assets is capital GAP from 2009 US stress test results for a specific bank divided by its total assets. ΔTier1 is the difference between the Tier 1 capital ratio from the adverse scenario of the US stress test and the current tier 1 capital ratio. Net income is the net income rate over the period of the stress test adverse scenario of the US stress test. Total_loss_loan is the losses on total loans over the periods of the adverse scenario of US stress test divided by total loans. ΔLeverage is the difference between the leverage ratio from the adverse scenario of the US stress test and the current leverage ratio. Failed_dummy is a dummy variable equal to 1 when the bank failed the stress test and equal to 0 otherwise. Average_rating is the average notch rating of the Moody's and S&P bonds issue rating, Ln_amount_issued is the logarithm of bond issuance amount and Maturity is bond maturity in years.

		ΔGap1	ΔGap2	Gap_to_Asset	ΔTier1 (%)	Δleverage (%)	Δloss_loan (%)	ΔNet_income (%)	Average_rating	Ln_amount_issued	Maturity
2009 US Stress test	Obs.	55	55	55			55		55	55	55
	Mean	0.409	0.068	0.458			4.152		5.591	18.327	6.550
	Median	0.545	0.000	0.000			0.900		5.500	17.439	6.031
	Maximum	1.000	1.000	1.460			8.783		6.500	21.956	10.010
	Minimum	0.000	0.000	0.000			0.400		4.500	13.816	1.999
	Std. Dev.	0.344	0.246	0.653			3.718		0.420	2.133	2.015
2012 US Stress test	Obs.	105	105		105		105	105	105	105	105
	Mean	-0.101	-0.024		-4.247		3.118	-5.306	6.471	17.099	8.422
	Median	0.280	0.000		-4.400		1.600	-2.722	6.000	16.530	6.015
	Maximum	0.429	0.960		-2.500		8.107	-2.596	14.000	21.640	29.999
	Minimum	-1.786	-1.000		-4.900		0.900	-15.325	5.000	14.771	1.999
	Std. Dev.	0.708	0.352		0.825		3.110	4.746	1.286	1.895	6.546
2013 US Stress test	Obs.	150	150		150	150	150	150	150	150	150
	Mean	0.020	0.012		-5.384	-1.999	5.095	-2.631	7.173	16.423	9.920
	Median	0.000	0.000		-4.900	-2.100	5.200	-2.621	7.000	15.734	9.473
	Maximum	1.000	1.000		-1.400	-1.200	10.432	-0.186	14.000	21.640	29.985
	Minimum	0.000	-0.984		-7.500	-2.400	3.100	-6.355	5.500	12.780	1.500
	Std. Dev.	0.140	0.141		1.764	0.325	1.792	0.756	1.204	2.468	6.377
2014 US Stress test	Obs.	101	101		101	101	101	101	101	101	101
	Mean	0.129	0.068		-4.451	-2.811	5.526	-2.345	7.411	17.420	11.068
	Median	0.111	0.000		-5.000	-2.700	5.691	-2.394	7.500	16.338	10.001
	Maximum	0.227	1.000		-0.900	-1.700	10.777	-0.920	9.000	21.822	30.001
	Minimum	0.000	-1.000		-5.100	-3.400	3.000	-3.446	5.500	13.891	2.998
	Std. Dev.	0.092	0.217		1.086	0.392	2.344	0.491	0.898	2.577	6.850
2015 US Stress test	Obs.	72	72		72	72	72	72	72	72	72
	Mean	-0.444	-0.241		-4.690	-3.279	5.242	-2.399	7.076	19.459	9.034
	Median	0.000	0.000		-5.200	-3.200	4.818	-2.510	7.500	20.419	5.002
	Maximum	1.000	0.833		0.400	-1.000	8.607	1.066	9.000	21.976	30.010
	Minimum	-2.000	-1.000		-6.200	-4.300	3.200	-3.137	5.500	13.629	1.996
	Std. Dev.	0.748	0.461		1.428	0.667	1.797	0.845	1.057	2.303	7.690

3. Results

We first identify how the disagreements between rating agencies evolve before and after the stress test results. We then investigate how these evolutions are linked to the nature of the information disclosed about key variables of stressed bank performance and risk.

3.1. Highlighting the impact of stress tests on split ratings

Table 5 presents various measures of disagreements as the average rating by rating agency, the correlation between the two ratings, the percentage of disagreement and the average absolute gap between the ratings of Moody's and Standard & Poor's for each period of 127 days before and after each EU and US banks stress test. Furthermore, we break down the percentage of disagreements according to the extent of the split rating, difference of 1 degree (GAP=1), 2 degrees (GAP=2), 3 degrees or more (GAP=3+), for both notch and category ratings[11]. Higher correlation between the ratings of the two agencies may indicate convergence of their appraisal (usually but not necessarily less split rating). The correlation, either notch or category rating, is always weaker after the stress test disclosure for European bonds but this finding only applies to half of the US tests. The percentage of disagreement is high both for European and US banks. This measure shows a higher disagreement after the stress tests in one out of three tests (notch) or two out of three tests (category) for European bonds and a perfectly balanced outcome for US bonds. It is worth noting that the average absolute gap gives quite the same insights for both European and US cases. Examining the rating gap distribution, the proportion of the largest gaps (3 + for notch rating or 2 for category rating), is consistently higher after the European stress tests than before. However, in the US case, this increased disagreement is observed only for the largest notch gaps (2 notches differentials) and only in half of the tests.

Looking at the successive tests, we can clearly identify the first European (2010) and two first American (2009, 2011) tests, those following the global financial crisis, and the 2014 tests both in EU and the US, as those that best correspond to a counterintuitive and maybe counterproductive impact of information disclosure since they reveal a higher divergence of the two rating agencies in the post stress test periods. However, these short-term impacts should not hide the fact that on the whole period of European stress tests, there is a convergence trend in the opinions of rating agencies, whatever the measures selected. Even if it does not necessarily mean a favorable long-term impact of repeated stress tests insofar as many other parameters can explain a decrease of the European banking sector uncertainty in a less troubled period after the Global Financial Crisis and the Debt Crisis, we cannot dismiss this possibility. Nonetheless, this is not a trend observed over the period of the six US stress tests.[12]

[11] These gaps are built in absolute values. For a given difference of ratings (numerical values) a gap is the same regardless of the agency that gave the highest rating.

[12] The overall mean average absolute gap is quite the same for UE and US bank bonds (around 0.9 for the notch rating, 0.3 for the category rating) but the time profile is very different, a downward trend in Europe, a high volatility in the US. Furthermore, in the US case, there is virtually no Gap 3+ for notch rating and only GAP 1 for category rating.

Table 5: Measures of disagreement between Moody's and S&P for European and U.S. banks' bonds ratings.

This table reports different bonds disagreement measures between Moody's and Standard & Poor's. Correlation is the correlation index between their ratings. Moody's <> S&P indicates the percentage of their disagreements. The absolute gap is the absolute difference between Moody's and Standard & Poor's ratings. Rating gap distribution represents the percentage of Gap= 1, Gap= 2 or Gap = 3 and more in the total number of disagreements.

Issue period	Average ratings Moody's / S&P	Correlation between ratings	Moody's <> S&P (%)	Average absolute gap	Rating gap distribution (%) Gap=1	Gap= 2	Gap=3+
Europe							
			Notch rating				
Tested Banks	**5.69 / 5.92**	**0.85**	**57.8**	**0.89**	**66.3**	**23.2**	**10.5**
2010 stress test 127 days before	3.59 / 4.76	0.69	79.7	1.42	49.2	39.7	11.1
127 days after	3.53 / 4.91	0.63	77.3	1.60	35.3	47.1	17.6
2011 stress test 127 days before	4.16 / 4.98	0.73	58.3	1.09	48.6	31.4	20.0
127 days after	5.20 / 5.80	0.61	45.0	1.05	61.1	0.0	38.9
2014 stress test 127 days before	7.13 / 6.77	0.97	34.4	0.45	68.2	31.8	0.0
127 days after	7.53 / 7.45	0.91	56.7	0.75	79.4	11.8	8.8
			Category rating				
Tested Banks	**2.87 / 2.96**	**0.79**	**27.1**	**0.30**	**90.4**	**9.6**	**0.0**
2010 stress test 127 days before	2.11 / 2.52	0.60	43.0	0.48	88.2	11.8	0.0
127 days after	2.14 / 2.60	0.55	50.0	0.58	84.1	15.9	0.0
2011 stress test 127 days before	2.36 / 2.61	0.64	31.7	0.37	84.2	15.8	0.0
127 days after	2.67 / 2.90	0.59	22.5	0.32	55.6	44.4	0.0
2014 stress test 127 days before	3.34 / 3.19	0.89	18.8	0.19	100.0	0.0	0.0
127 days after	3.53 / 3.53	0.80	26.7	0.27	100.0	0.0	0.0
United-States							
			Notch rating				
Tested Banks	**6.29 / 6.28**	**0.79**	**69.7**	**0.88**	**73.6**	**26.0**	**0.4**
2009 stress test 127 days before	1.79 / 1.95	0.99	15.4	0.15	100.0	0.0	0.0
127 days after	5.21 / 5.79	0.86	64.5	0.65	100.0	0.0	0.0
2011 stress test 127 days before	5.42 / 6.08	0.73	65.8	0.77	82.2	17.8	0.0
127 days after	5.53 / 6.02	0.74	79.5	0.98	77.4	22.6	0.0
2012 stress test 127 days before	5.68 / 6.31	0.35	93.4	1.42	47.8	52.2	0.0
127 days after	6.19 / 6.75	0.57	83.8	1.29	46.6	53.4	0.0
2013 stress test 127 days before	7.50 / 6.98	0.86	57.6	0.64	89.8	10.2	0.0
127 days after	7.36 / 6.90	0.88	51.3	0.55	93.7	6.3	0.0
2014 stress test 127 days before	7.86 / 6.76	0.90	87.5	1.12	72.4	27.6	0.0
127 days after	8.13 / 6.69	0.86	98.4	1.47	50.4	49.6	0.0
2015 stress test 127 days before	8.37 / 6.88	0.96	98.9	1.48	50.0	50.0	0.0
127 days after	7.56 /6.60	0.85	72.2	0.96	67.3	32.7	0.0
			Category rating				
Tested Banks	**3.16 / 2.99**	**0.63**	**31.6**	**0.32**	**100.0**	**0.0**	**0.0**
2009 stress test 127 days before	1.38 / 1.41	0.98	2.6	0.03	100.0	0.0	0.0
127 days after	2.87 /2.95	0.64	14.5	0.15	100.0	0.0	0.0
2011 stress test 127 days before	2.89 / 3.01	0.47	18.3	0.18	100.0	0.0	0.0
127 days after	2.96 / 2.95	0.58	26.0	0.26	100.0	0.0	0.0
2012 stress test 127 days before	3.03 / 2.97	0.37	29.8	0.30	100.0	0.0	0.0
127 days after	3.17 / 3.06	0.70	17.1	0.17	100.0	0.0	0.0
2013 stress test 127 days before	3.52 / 3.14	0.50	47.6	0.48	100.0	0.0	0.0
127 days after	3.48 / 3.10	0.57	40.3	0.40	100.0	0.0	0.0
2014 stress test 127 days before	3.63 / 3.08	0.61	55.4	0.55	100.0	0.0	0.0
127 days after	3.76 / 3.08	0.16	68.5	0.69	100.0	0.0	0.0
2015 stress test 127 days before	3.87 / 3.11	0.71	76.8	0.77	100.0	0.0	0.0
127 days after	3.51 / 3.10	0.32	41.7	0.42	100.0	0.0	0.0

We also provide mean difference tests (table 6). Differences appear globally not significant for European bonds except for a positive and significant (5% level) difference for the 2014 test (notch gap). For US bonds, differences are positive and significant for the 2009, 2011 and 2014 tests (with a higher significance for notch gaps (1% level) than category gaps (5% level)). There is only one result showing the generally expected favorable effect of stress test disclosure as we find a negative and significant (1% level) decrease of disagreement between Moody's and S&P ratings for the 2015 US test.

Table 6: Mean difference tests for rating absolute gap at bond level on the periods before and after stress test for European and U.S. banks' bonds.

	Mean difference test: 127 days after - 127 days before		Mean difference test: 127 days after - 127 days before	
	Bond notch rating absolute gap	P-value	Bond category rating absolute gap	P-value
EUROPE				
2010 stress test	0.19	0.38	0.1	0.31
2011 stress test	-0.042	0.87	-0.04	0.7
2014 stress test	0.3**	0.04	0.08	0.3
UNITED-STATES				
2009 stress test	0.49***	0.00	0.12**	0.05
2011 stress test	0.2***	0.00	0.08**	0.05
2012 stress test	-0.14	0.13	-0.13**	0.03
2013 stress test	-0.09	0.16	-0.07	0.91
2014 stress test	0.36***	0.00	0.13**	0.02
2015 stress test	-0.53***	0.00	-0.35***	0.00

Overall, our findings suggest that the impact of stress test results disclosure is mixed both for US and European banks bond split ratings but underline many episodes where information disclosure increases the immediate disagreement between rating agencies[13]. To go further in the analysis, we then try to identify which results disclosed after each stress test are more likely to explain the evolution of split ratings in order to understand which information could reduce bank opacity.

3.2. Identifying relevant stress test variables in the explanation of split rating changes

We select the rating absolute gap change (ΔGap) as a specific and tractable measure of disagreements evolution between rating agencies. We then regress this measure over some specific variables extracted from the disclosed results of each stress test in order to determine which information might explain the observed changes in split ratings in pre/post disclosure periods.

The results for the European tests are shown in Table 7. Given the context that prevailed during the first implementation of the European stress tests, we, first of all, focus on exposures to PIIGS. Banks' sovereign exposure were not reported in detailed in the banks' balance sheet, then market's participants could not get a clear vision about these exposures before they were disclosed by EBA tests. We find that a higher banks' PIIGS debt exposure leads to an increase in the rating disagreements for the first stress test conducted in 2010, with the highest significance of all our explanatory variables. While sovereign debts were previously considered quite completely safe, the question of sovereign credit risk arose in financial markets with the outbreak of the debt crisis and gave rise to multiple views and prospects on the future of PIIGS solvability. In this regard, uncertainty about PIIGS sovereign debts and the difficulty to evaluate their actual risk may explain that a higher global exposure to PIIGS causes an increased divergence between rating agencies. On the contrary, we find

[13] As a robustness check, we also built split rating measures on a restricted sample where we retain for each test only banks having issues both on the periods of 127 days before and 127 days after the results disclosure in order to avoid a possible selection bias related to the fact that some banks should decide to issue bonds either before or after the stress test results according to their expectations of their own results. We draw conclusions very similar to those obtained in the overall sample as most measures give the same indications. Considering measures of split rating disagreements between Moody's and Fitch or between Fitch and Standard & Poor's or changing the window to 100 days before and 100 days after the results disclosure leads also to quite similar findings.

that a higher PIIGS debt exposure reduces the split ratings on the 2011 and 2014 tests but only for category gap and with a weaker effect on the 2014 test[14]. These two tests provided more detailed information on bank's resilience, their methodology was sharpened and their scenarios more severe in order to increase their credibility. These improvements, the enhanced transparency about gradually reduced sovereign exposure for many banks and more consensual mid-term views could explain this higher convergence of appraisal for those banks that remain with PIIGS exposure after the 2011 stress test, and to a lesser extent, after the 2014 stress test. Indeed, the European sovereign crisis reached its peak and the financial market its highest uncertainty at the time of the 2011 test. This situation created high need of information and transparency about banks' financial health that the 2011 test partly addressed while bringing relevant information and reducing banks opacity (Petrella and Resti (2013), Schuermann (2014), Goldstein and Sapra (2014)).

Risk weighted assets (RWA) are a wider indicator of bank credit risk. We use the difference between the adverse scenario risk weighted assets divided by total assets and the current value as an inverse indicator of the expected strength of the bank in the adverse scenario. Higher RWA has an impact on the change in split rating only after the disclosure of the 2010 results and leads to the same result as PIIGS exposure. Greater expected risks increase uncertainty and differences of opinion. One year later, in 2011, in a period of higher volatility, even if information on the bank difficulties that may occur on a one-year horizon should be more credible given the improvement of the test exercise and thus allowing agencies to converge towards common views, RWA variable shows no effect at all. In fact, the 2011 stress test brings more detailed information about banks' sovereign exposure. This has certainly been the focal point and explains the non-significance of a broader measure of weighted risks.

Considering the capital ratio variable, which is of course a major signal to analyze the resistance of banks to extreme events, the difference between the stressed Tier 1 and the current one should indicate the resilience of the bank and we could expect that a higher resilience would lead to a convergence about bank solvability. However, we find no significant impact of this variable except for the 2014 stress test (notch gaps) with a result opposite to the one supposed. An explanation may be found in a greater divergence of analysis between agencies in the quieter period following the Debt Crisis, when the future of the least resilient banks in the adverse scenario may give rise to more diverse interpretations than in the height of the Debt Crisis when the opinions narrowed on pessimistic perspectives, whatever the stressed Tier 1 disclosed by the EBA.

Finally, our last variable, the stressed net income minus the current one has no impact on split ratings changes whatever the stress test.

[14] The novelty of the 2014 stress test is the fact that before the stress test realization, the ECB conducted an assets quality review in the context of the implementation of the single supervisory mechanism. Ong and Pazarbasioglu (2014) argue that additional steps such as asset quality review comprising audits and expert valuations of banks portfolios are crucial for an effective and credible stress test

Table 7: Regression results for the Europe

For each bond issued on the 127-day period after the stress test disclosure, ΔGap1 is the difference between rating absolute gap of each bond issued on the period 127 days after the stress test disclosure and the mean of the rating absolute gap of all bonds of corresponding issuer issued on the period 127 days before the stress test disclosure date. ΔGap2 is the difference between the category rating absolute gap of each bond issued on the period 127 days after the stress test disclosure and the mean of the category rating absolute gap of all bonds of corresponding issuer issued on the period 127 days before the stress test disclosure date. The rating absolute gap is the difference between Moody's and Standard & Poor's bonds' ratings. PIIGS exposure is PIIGS countries sovereign debt exposure from the EBA stress test results disclosure for a specific bank divided by the Tier 1 capital for the 2010 stress test and divided by Core tier 1 capital for the 2011 and 2014 stress test. Δ(C)Tier1 is the difference between the stressed value of the Tier 1 ratio in the case of the 2010 stress test or the Core Tier 1 ratio for the 2011 and 2014 stress tests t and the current Tier 1 (Core tier 1) capital ratio. ΔNet Income is the difference between the stressed net income and the current net income divided by total assets. ΔRWA is the difference between the risk weighted assets from adverse scenario of the EBA stress test divided and the actual risk weighted assets divided by total assets. Controls stands for the following variables: Average_rating, Ln_amount_issued (EUR), Maturity (see table 2).

	EU 2010				EU 2011				EU 2014			
VARIABLES	ΔGap1	ΔGap2	ΔGap1	ΔGap2	ΔGap1	ΔGap2	ΔGap1	ΔGap2	ΔGap1	ΔGap2	ΔGap1	ΔGap2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
PIIGS exposure	1.271***	0.523***	1.062***	0.435***	-0.900***	-0.371***	-0.772**	-0.351***	-0.00418	-0.00836***	0.00359	-0.00680*
	(0.437)	(0.127)	(0.400)	(0.123)	(0.273)	(0.0876)	(0.292)	(0.0922)	(0.00534)	(0.00300)	(0.00555)	(0.00369)
ΔRWA	54.94**	16.30**			-10.28	-6.538			-1.039	2.146		
	(21.65)	(7.579)			(12.48)	(4.596)			(13.67)	(7.104)		
Δ(C)Tier1			-31.89	-7.499			-26.79	1.895			80.75**	11.54
			(47.29)	(17.00)			(53.17)	(17.84)			(35.20)	(22.92)
ΔNet Income					-65.19	-74.56	147.3	-16.93	-11.20	-23.27	-11.40	-22.76
					(138.9)	(47.31)	(232.2)	(75.42)	(40.13)	(19.55)	(32.42)	(18.65)
Constant	-0.877	-0.868	-4.522	-2.245*	1.764	1.120	1.785	1.057	-1.203	-0.384	-0.849	-0.290
	(2.683)	(1.164)	(2.727)	(1.159)	(4.578)	(1.504)	(4.687)	(1.586)	(1.583)	(0.947)	(1.209)	(0.841)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	71	71	71	71	36	36	36	36	44	44	44	44
R-squared	0.360	0.413	0.232	0.304	0.339	0.482	0.328	0.425	0.063	0.137	0.256	0.143

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results for the US tests are shown in Table 8. A higher capital shortfall (*Gap_to_Asset*) from SCAP conducted in 2009 has a negative impact on the changes in rating disagreements. This impact and its significance are higher for notch gaps than for category gaps, the failed dummy becoming in this case the most powerful indicator of an improved agreement between agencies. On the other US stress tests, as the capital shortfall is not disclosed, we consider the difference between the capital ratio (Tier 1) from the adverse scenario and the current one. For the 2012 and 2015 US stress tests, the results are in the same vein as for the 2009 stress test: there is a statistical decrease in rating disagreements for the less resilient banks while during the 2014 stress test, the split ratings increase for these banks (only for notch gaps). Morgan et al. (2014) argue that before the disclosure of the 2009 stress test, financial market's participants were able to make difference between good and bad banks but ignored the extent of their possible capital shortfall. Therefore, the disclosure of stress test results brought information, which allowed the rating agencies to have fewer disagreements about banks' ratings. Unlike other tests that indicate that worse news about the capital coverage tend to align the views of agencies, the 2014 US test shows a decrease in the notch split rating for the post-stress best capitalized banks. Nevertheless, the simple leverage ratio (calculated as the capital divided by total assets) has in this same test (and only for this one) an opposite effect and, as the other indicators in the other tests, increases disagreements in case of better news. Net Income and Total loan losses ratios (differences between stressed and current values of these variables) provide quite different results depending on the test we are looking at.

We find that agencies agree more in their interpretations of comparatively bad results (disagree more for comparatively good results) in 2012 for both variables. However, these stressed values have no impact at all in 2013 and the two variables provide puzzling findings in 2014 and 2015 as we obtain exactly separate and opposite effects on these two dates. Agencies views converge in 2014 (diverge in 2015) with either a higher value of income variation, meaning a higher stress resistance of the bank, or either a higher value of loans losses variation, meaning a lower stress resistance of the same bank.

Our global findings show the diversity of determinants of split rating changes both in the case of European and US stress tests, without providing a clear vision of what could explain, in reference to our first statistical analysis, why certain tests lead to a convergence of agencies opinions and others not. The mixed findings drawn over the different stress tests underline that several other factors could influence split ratings, i.e. the design and the credibility of the stress test, the backstops measures, the economic climate (in several cases, the intensity of the crisis), etc... Because of the large panel of data disclosed by the stress test results and due to the diversity of the context of the disclosure, the information provided give rise to many subjective perceptions, even when considering the reaction of experts such as rating agencies.

Table 8: Regression results for the US

For each bond issued on the 127-day period after the stress test disclosure, ΔGap1 is the difference between rating absolute gap of each bond issued on the period 127 days after the stress test disclosure and the mean of the rating absolute gap of all bonds of corresponding issuer issued on the period 127 days before the stress test disclosure date. ΔGap2 is the difference between the category rating absolute gap of each bond issued on the period 127 days after the stress test disclosure and the mean of the category rating absolute gap of all bonds of corresponding issuer issued on the period 127 days before the stress test disclosure date. The rating absolute gap is the difference between Moody's and Standard & Poor's bonds' ratings. GAP_to_Assets is capital GAP from 2009 US stress test results disclosure on 07/05/2009 for a specific bank divided by the total assets. ΔTier1 is the difference between the tier 1 capital ratio from the adverse scenario of the US stress test and the actual tier 1 capital ratio. ΔNet_income is the difference between net income over the period of the stress test adverse scenario of the US stress test and the actual net income divided by total assets. ΔLeverage is the difference between the leverage ratio from the adverse scenario of the US stress test and the actual leverage ratio. Δloss_loan is difference between loss loan over the periods of the adverse scenario of US stress test and the actual loss loan divided by total loans. Failed_dummy is a dummy variable equal to 1 when the bank failed to the stress test and equal to 0 otherwise. Controls stands for the following variables: Average_rating, Ln_amount_issued (EUR), Maturity (see table 2).

	US 2009		US 2012				US 2013				US 2014				US 2015			
VARIABLES	ΔGap1	ΔGap2	ΔGap1	ΔGap2	ΔGap1	ΔGap2	ΔGap1	ΔGap2	ΔGap1	ΔGap2	ΔGap1	ΔGap2	ΔGap1	ΔGap2	ΔGap1	ΔGap2	ΔGap1	ΔGap2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Gap_to_Asset	-0.687***	-0.198**																
	(0.242)	(0.0959)																
Failed_dummy	-0.368	-0.508***																
	(0.315)	(0.0963)																
ΔTier1			1.240***	0.336**			-0.00397	0.00479			-0.0391***	-0.103**			0.514***	0.115**		
			(0.334)	(0.166)			(0.0136)	(0.00923)			(0.00804)	(0.0436)			(0.0658)	(0.0551)		
ΔLeverage							0.0399	0.0587	0.0310	0.0663	0.110***	0.286*	0.0737***	0.315**	-0.140	0.0521	0.315	0.227
							(0.0440)	(0.0417)	(0.0495)	(0.0452)	(0.00832)	(0.156)	(0.0200)	(0.147)	(0.178)	(0.149)	(0.224)	(0.150)
Δloss_loan	0.0398**	0.0153	-0.361***	-0.137***	0.0274	-0.0316**	0.00915	0.00646	-0.000224	0.0148	-0.0415***	0.0224	-0.0488***	0.0507	0.00335	0.107**	0.142**	0.142***
	(0.0166)	(0.00921)	(0.0875)	(0.0469)	(0.0353)	(0.0137)	(0.0140)	(0.0115)	(0.00402)	(0.0161)	(0.00228)	(0.0412)	(0.00505)	(0.0482)	(0.0548)	(0.0459)	(0.0661)	(0.0441)
ΔNet_income					0.0663***	0.0180**			0.0335	-0.0225			-0.0167	-0.289***			0.433***	0.0253
					(0.0182)	(0.00756)			(0.0339)	(0.0398)			(0.0293)	(0.102)			(0.136)	(0.0910)
Constant	2.761**	4.021***	6.901***	1.712*	0.742	0.0457	0.0128	0.347	0.0435	0.310*	0.825***	0.908*	0.789***	0.186	0.460	0.753	0.902	0.799
	(1.214)	(0.158)	(1.803)	(0.966)	(0.687)	(0.429)	(0.267)	(0.219)	(0.175)	(0.176)	(0.0383)	(0.529)	(0.0730)	(0.756)	(0.641)	(0.537)	(0.837)	(0.558)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	55	55	105	105	105	105	150	150	150	150	101	101	101	101	72	72	72	72
R-squared	0.633	0.891	0.227	0.400	0.095	0.361	0.013	0.056	0.018	0.058	0.928	0.225	0.874	0.254	0.606	0.273	0.339	0.225

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4. Conclusion

In this paper, we study the information value of banks' stress tests using banks' bond split ratings as an indicator of the efficiency of the disclosure of the stress test results. We consider ratings at issuance of bonds jointly rated by Moody's and Standard & Poor's and issued by banks participating to the European and US banks' stress tests conducted between 2009 and 2015. Overall, our findings suggest that the impact of the stress test results disclosure is mixed both on the US and European banks' bond split ratings. Indeed, we underline many episodes where information disclosure increases the disagreements between rating agencies. Market participants could parse differently the detailed data disclosed by the stress tests and these differing interpretations may create more disagreements among different agents and, in our case, between rating agencies. However, in a period of turmoil as the European sovereign Debt Crisis, when the market faces a lot of fear and uncertainty and when information is highly needed, the disclosure of the stress tests results leads to a greater convergence of views of rating agencies. We then focus on crucial disclosed information regarding to risk, capital and profitability of tested banks and find no clear-cut results that would allow us to clearly identify the causal factors of the change in absolute rating gaps around each stress test. The credibility of the testing procedure, the severity of the scenarios, crisis or non-crisis time, the regulatory backstops measures and the externalities related to disclosure could affect the perceptions of the stress tests and explain the mixed effects of disclosure.

This notwithstanding, supervisors may implement methods which may combine quantitative and qualitative assessments in order to provide unambiguous signals to the market and increase the efficiency of the stress tests by a higher reliability in the results disclosed. An effective stress test may reach its objective of transparency by decreasing each bank's opacity but also by diminishing global sector uncertainty. This may be a big challenge to the extent that the tests are based on extreme events scenarios that are obviously not the most probable cases. Market players interpret not only the thoroughness of the disclosed information but also the relevance of the assumptions made by supervisors, with possible own subjective and divergent interpretations but also high incentives to act in the same direction in distress periods.

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