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Stress testing programs and credit risk opacity of banks: USA vs Europe

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ABSTRACT

Regulators strengthened banking supervision in the aftermath of the Great Financial Crisis by stress testing banks intending to increase the amount of information available about the risks they face, improving their transparency and restoring market confidence. This study examines whether the results of stress tests conducted between 2009 and 2019 in the US and the EU have reduced the opacity of information about banks' credit risk. We study changes in banking sector opacity around the disclosure of stress test results in a panel data framework. We measure opacity by discrepancies in bank credit ratings issued by different agencies. The findings indicate a lower opacity level after disclosing the US test results. The most significant reduction occurs for systemic banks with higher leverage that fail the test. The European testing programme has specific disclosure features that could justify that the effect of disclosure of stress test results is more attenuated for EU banks. Some indirect evidence suggests that differences in stress test programmes and banking sector structure between the two regions may explain the result.

Even outside of a period of crisis, the disclosure of stress test results and assessments provides valuable information to market participants and the public, enhances transparency, and promotes market discipline.
Bernanke (2013)

1. Introduction

The lack of transparency in the information about banks' financial health was one of the main factors contributing to the deepening of the 2008 financial crisis (Flannery et al., 2013). Authors such as Zheng (2020) show how this information opacity fostered distrust between parties and worsened the lack of liquidity in the wholesale bank funding channel, seriously affecting the whole economy. Industry regulators saw the need to control the system's risks better and increase the information available to strengthen resilience and decrease banks' credit risk (Kok et al., 2023). The new regulation included stress testing programs to assess the strength and stability of the banking sector in the face of extreme economic downturns and increases in systemic risk. Stress tests (ST ahead) were also intended to improve the information transparency of the banking sector to boost investor confidence and facilitate proper risk assessment.

The United States (US) Federal Reserve established the Supervisory Capital Assessment Program in 2009 (SCAP09), which

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continued with the Comprehensive Capital Analysis and Review (CCAR). In the European Union (EU), the European Banking Authority (EBA) launched the EU-wide ST program in 2010. Despite common objectives, they differ in several ways, including the scope, which is more extensive in the US case; the methodology, a standardised approach in the US case while in EU banks can use their models and assumptions; the frequency, annual in US and biennial in EU; US discloses detailed results for individual banks while EU only disclose aggregate results; and focus: US has a greater focus on capital adequacy, while the European ST program includes a broader range of risk factors, such as liquidity and funding risk (Baudino et al., 2018; Ahnert et al., 2020).[1,2]

According to Goldstein and Sapra (2014), disclosing ST results could improve market discipline, increase confidence in the supervision process and improve price formation by providing valuable information to decision-makers. However, in situations where the ST programs are not well designed, or the information disclosed is not transparent enough, they may lead to subjective interpretations, increasing information asymmetry (Banerjee and Maier, 2016; Gaballo, 2016; Goldstein and Sapra, 2014). In addition, there can be an information crowding-out effect, whereby ST disclosures may crowd out other sources of private information like that generated by the tested banks, affecting the pricing process (Jayaraman and Wu, 2018; Goldstein and Leitner, 2022).

In this paper, we examine the informative role of the disclosure of the ST results by examining to what extent they help to mitigate the information opacity problem in the banking sector. We focus on how the disclosure of ST results affects direct measures of information opacity, offering a fresh perspective to complement existing literature in this area.

The research on the informative content of ST results has focused on indirect measures, particularly examining abnormal stock returns and CDS spreads in the period surrounding the disclosure date (e.g., Fernandes et al., 2020; Flannery et al., 2017; Morgan et al., 2014; Alves et al., 2015; Georgescu et al., 2017; Sahin et al. 2020; Lazzari et al., 2017). The perceptions of market participants with different positions and interests in the information provided by ST may differ. The analysis of the overall market reaction may mask disparate reactions and does not allow a precise determination of whether such disclosure generates greater transparency.

Our approach will enable us to identify better the impact of the publication of the ST results on information asymmetry, even if there is a crowding-out of information. Of all the matters where transparency is relevant, we are particularly interested in information about banks' credit risk. We follow the main literature (e.g., Morgan, 2002; Livingston and Zhou, 2010; Abad et al., 2020; Kladakis et al., 2020; Dala et al., 2020) in proxy the information opacity with the discrepancies among rating agencies in the credit rating they give to the same reference (an issue or the issuer itself). These discrepancies emerge when the agencies differ in their assessment of banks' credit risk, which reflects the information opacity inherent in the banking sector (Morgan, 2002).

Dala et al. (2020) explore the effects of the ST disclosure on Moody's and S&P discrepancy ratings in an analysis close to ours. Our setting differs in several respects. They analysed each ST from 2009 to 2015 at the bond level based on the initial bond ratings of bonds issued by tested banks during the 127 days after the publication of ST results. Our approach is more general in several respects. We consider issuer and bond ratings by all agencies that rate them (from 3 to 5 agencies) and compare with same rating in a prior time. We provide a richer view of opacity by considering the full rating distribution to compute four proxies that measure the distance between all ratings assigned and the distances to the best and to the worst rating, to capture asymmetries. As Dala et al. (2020), we analyse the US and EU ST separately to study to what extent the differences in the ST programs implemented in both regions are relevant to achieve a more transparent banking system. We cover the set of ST programmes from 2009 to 2019[3] that we analyse in a panel data framework that includes individual and time-fixed effects, and firm-observable prior test characteristics to control for their possible effect on the bank opacity level. We examine information opacity surrounding the disclosure of ST results of two groups of banks, stress-tested and non-stress-tested, to test for changes in information opacity of the former relative to the latter by considering whether the opacity response after the ST depends on the results obtained in the ST (i.e., to determine if there is a different opacity response for banks that pass it).

The analysis of a sample of 24 US banks (17 tested at least in one ST program and seven never tested) and 39 EU banks (24 evaluated in at least one ST program and 15 never tested) gives us interesting insights. Although the main results point out that the disclosure of ST results has informational value, affecting the opacity of the banking sector, the effect is mainly detected in the US case. This result gives a justification for the impact on the US stock market as presented in the literature (see Morgan et al., 2014; Flannery et al., 2017; Ahnert et al., 2020; Sahin et al., 2020). We find a reduction in information opacity following the publication of ST results; that is, ST programs have improved the transparency of the US banking system. While the banks that pass the test show slight changes in their opacity after disclosing ST results, the most significant opacity reduction occurs in those that do not pass the test.

This differs from the EU banking system findings, where the disclosures of ST results do not seem to mitigate the opacity of the banks assessed. This result aligns with Petrella and Resti (2013), who find little impact of EU ST in the stock market, and Candelon and

[1] SCAP09 assesses the capital and internal action plans of bank holdings companies with capitalisation greater than $50 trillion in three scenarios (standard, adverse, and severely negative). Since 2013, the CCAR and the Dodd-Frank Act Stress test (DFAST) have coexisted. The latter arose with enacting the Dodd-Frank Act and only assesses the bank holding companies' capital level with capitalisation between 10 and 50 billion dollars. Following the Dodd-Frank Act, the assessment of capital needs is determined by Federal Reserve models, which are published, as does the result of each stress-tested bank.

[2] The 2010, 2011, and 2014 EBA programs cover around 50% of total bank assets in each member state. Hence, they include significantly smaller banks than in the US case. In 2014, Asset Quality Reviews were introduced to add qualitative supervision as in the US programs. Since 2016, only banks with consolidated assets of more than 30 billion euros have been supervised, and the individual result is not published. The capital ratio and the quality of the bank's action plans are assessed in two scenarios (adverse and standard) two years ahead. Each bank builds and runs its risk models following the EBA guidelines, which publish the results obtained by tested banks aggregately.

[3] We excluded 2020 to prevent the effect of the Covid-19 pandemic from distorting the results.

Sy (2015), who also report differences in the effects of ST programs in EU and US banking sectors. The different implications of ST programs observed in the two regions connect to the critical differences in the regulatory framework, the ST programs' characteristics, the structural elements of the banking systems, and the objectives pursued by regulators. This finding aligns with work that has highlighted the differences between the EU and the US programmes and their implications for the effect of regulation (Niepmann and Stebunovs, 2018; Tsagkarakis et al., 2021).

The findings in this paper contribute to understanding the role of ST disclosures in enhancing banking transparency. We provide new evidence on the information content of ST programs by analysing their direct impact on banks' opacity, a topic that has not been previously addressed. We document how the disclosure of ST results affects different opacity measures that directly focus on banks' credit risk and, therefore, on the solvency of the banking sector. This analysis allows us to assess whether the supervisory policy meets its objective of acting on banks' private information. The comparison of the US and EU ST programmes with different designs and implementation of ST is handy to understand better the role of supervision in mitigating opacity in the banking sector. These results can help improve the supervisory policy to bring its outcomes closer to the desired goals. Our paper complements the literature focused on the effect of ST on bank risk-taking (e.g. Acharya et al., 2018; Kok et al., 2023) by giving evidence on the role of ST in aligning the assessment of bank creditworthiness by credit rating agencies. It also connects with the literature on the effect of information disclosures on rating disagreements (e.g., Kim and An, 2021) and the value of regulatory disclosure in markets (Leuz and Wysocki, 2016; Goldstein and Yang, 2017, 2019).

The rest of the paper is organised as follows. Section 2 reviews the literature on bank opacity and the impact of ST on information and develops the hypotheses. Section 3 describes the data and the different measures of opacity, while Section 4 presents the data. Section 5 presents the model and the main results for both regions, as well as a robustness checks and a discussion of the differences found. Section 6 concludes.

2. Hypothesis development

We are interested in assessing the role of the publication of ST results in reducing opacity in the banking sector. We examine the information opacity related to credit risk information relying on banks' credit ratings. Following the extant literature (Morgan, 2002; Livingston et al., 2007; Dala et al., 2020, among many others), we consider the information opacity behind the discrepancies in the credit risk assessment among multiple rating agencies, that is, in the credit rating they give to the same issue or issuer. Rating agencies are information intermediaries that use bank information to assign their ratings. Disagreements among them point to uncertainties in determining the creditworthiness of a bank that each agency may value differently. The disclosure of ST results could offer new insights into a bank's risk profile, aligning rating agencies' views and reducing disagreements due to increased information transparency.

According to Acharya and Ryan (2016) and Flannery et al. (2013), bank opacity can risk financial stability as it hinders understanding of banks' risk profile, financial health, and the potential for crisis contagion for investors, regulators, and other stakeholders. ST programs evaluate the banking sector's stability to foster investor confidence, enable effective risk assessment, and promote more information to enhance resilience and reduce credit risk (Kok et al., 2023). Goldstein and Sapra (2014) explore the benefits and drawbacks of ST disclosure and how it affects stress testing. Though ST can reveal important information that promotes transparency and accountability, market and operational frictions may lead to additional costs after the disclosure of ST results.

Since their implementation, there has been a clear interest in assessing the impact of ST programs on the tested banks, the banking system, and the financial markets (e.g., Acharya et al., 2018; Cortés et al., 2020; Gambetta et al., 2019). Empirical work on the information content of ST mainly focuses on the announcement of the ST programs and the publication of ST results by studying abnormal returns in the stock and CDS markets. Although the main findings suggest that STs have information content, they are inconclusive. Fernandes et al. (2020), Flannery et al. (2017) and Morgan et al. (2014) in the US, Alves et al. (2015), and Georgescu et al. (2017) in Europe find that ST results provide relevant information. However, Sahin et al. (2020) and Petrella and Resti (2013) find much more limited effects, while Sahin and Haan (2016) and Lazzari et al. (2017) find that ST results do not provide any novel information.

Morgan et al. (2014) show that the US 2009 tests provide important information, with banks with higher capital gaps showing a more significant returns decline. Fernandes et al. (2020) find positive returns in 2009 and negative returns between 2011 and 2013. Banks that pass the tests obtain abnormally positive returns, while those that fail get negatives. They find a significant increase in trading around the disclosure of ST results for the latter. Flannery et al. (2017) and Bird et al. (2020) also find a significant response in prices and volumes following ST disclosures. Flannery et al. (2017) analyse the variability of returns and find that ST results provide information that is also relevant for non-tested banks. Sahin et al. (2020) examine the systematic risk and returns in the stock and CDS markets in 2009–2015 and find abnormal behaviour only in the CDS market and decreased systematic risk in the years after ST. During periods of high uncertainty, the ST effect is more significant than in periods of macroeconomic stability.

For EU banks, Alves et al. (2015), Georgescu et al. (2017), and Laidroo (2022) find significant effects, while Petrella and Resti (2013) find little impact. Alves et al. (2015) study EBA-2010 and -2011 tests and find higher stock returns and lower CDS returns with a more substantial effect on riskier banks. Georgescu et al. (2017) show that only the 2014 and 2016 ST results provide new information, while Philippon et al. (2017) find the same in the 2011 and 2014 tests. Laidroo (2022) studies the response of the absolute value of bank returns to ST implemented in the EU between 2010 and 2018 and finds a positive reaction over time.

Candelon and Sy (2015), Ahnert et al. (2020), and Dala et al. (2020) are among the few papers that compare the market response to ST programs in the USA and the EU. The former study CCAR-2009 and EBA-2011 programs to find their impact differs in the two regions. Ahnert et al. (2020) analyse the STs conducted between 2012 and 2017 and find that both EU and US ST programs positively impact banks that pass the test, while banks that fail exhibit negative abnormal returns. Dala et al. (2020) find mixed effects on split

ratings for STs conducted between 2009 and 2015.

The research above mainly finds significant investor responses as measured by abnormal returns, pointing to an informative effect of ST result disclosures that would reduce bank opacity. This leads us to formulate our first hypothesis:

H1. The publication of ST results discloses relevant new information about the credit risk of banks that reduces their information opacity.

Although the publication of ST results seems to cause abnormal returns, the response detected is asymmetric depending on whether the tested bank passes or fails.[4] Under H1, the disclosed information would be relevant in both cases, so we expect a decrease in opacity irrespective of whether the bank passes or fails the test. However, banks with a strong position will probably disclose their low credit risk information before being assessed, making it available to the rating agencies and the market. Conversely, more vulnerable banks (with a higher probability of failing the ST) may prefer to keep this information private. They may be reluctant to provide adverse information to the agencies trying to get a better rating. Ponte Marques et al. (2022) find that ST results generated more valuable information for vulnerable banks leading to more sizeable returns responses. The model of Ding et al. (2022) shows that information production in the financial market is less effective for banks with a higher probability of failing the ST as traders cannot profit from acquiring information in case of fail the test. So, the ST disclosures are more informative for those banks. That is, obtaining a negative result may offer more novel information than passing the test, leading to a more significant decline in opacity in the former case. These results lead us to establish the second hypothesis:

H2. The ST result reduces bank opacity to a greater extent for banks that perform poorly in ST exercises than for those that perform well.

We also find theoretical models on regulatory disclosure that underscore situations in which the information revealed in the ST process might not improve the transparency of the tested bank and the banking sector (Goldstein and Sapra, 2014; Goldstein and Leitner, 2022; Banerjee and Maier, 2016; Chakravarty et al., 2021; Breuer et al., 2019). First, the regulatory disclosure could substitute information between sources. Jayaraman and Wu (2018) show that greater disclosure by the regulator may crowd out other private information sources in financial markets. Bond and Goldstein (2015) and Siemroth (2019) show that more public information may crowd out private information as it reduces the informational advantage of speculators. Breuer et al. (2019) find that mandatory disclosure of regulated firms can crowd out voluntary disclosure of unregulated firms. Heitz and Wheeler (2023) find that the ST disclosures decline analyst following and lead to less bank-specific information in stock prices, which suggests a crowding out of private information. Ding et al. (2022) state that the ST disclosures affect speculators' incentives to produce and trade on costly information. So, the substitution of private for regulatory information will affect the formation of asset prices, which may be less informative as investors' ability to make informed decisions is reduced. In this scenario, the information disclosed by the ST acts as a replacement for the data that the tested bank is no longer producing. When announced, ST results will generate a significant response in asset prices. However, this new information does not increase transparency nor reduce information asymmetry, as it replaces the information institutions have ceased to generate. Therefore, the analysis of returns' response to the announcement of ST results does not provide conclusive results on whether it helps to reduce banks' opacity.

Second, depending on the ST program design and whether the subsequent publication of the information generated is not transparent enough, the disclosure might not improve the transparency.[5] In these cases, the new information may lead to subjective interpretations by financial market participants (Banerjee and Maier, 2016; Gaballo, 2016; Goldstein and Sapra, 2014). Publishing ST results may generate more noise, increase information asymmetry, and decrease investor confidence. Ding et al. (2022) model how ST design will impact traders' information production, affecting the final effect on transparency. Chakravarty et al. (2021) estate that regulators may occasionally choose to withhold information about banks' health. It may be optimal to "keep secrets" or, in some circumstances, to be as ambiguous as possible. Due to market frictions, some degree of opacity could benefit the financial system, helping banks to provide liquidity more efficiently by avoiding market speculation or other adverse reactions that could undermine their stability and solvency (Dang et al., 2017). Opacity could enhance financial stability by reducing the risk of bank runs (Jungherr, 2018).

This research suggests that, although the ST may positively affect the control of banks' risk exposure by regulators, it may not increase the transparency of the assessed banks. On this basis, our third hypothesis is:

H3. The information generated by the ST does not increase the relevant information on the banks assessed and does not reduce their opacity.

3. Opacity measures

Jin and Myers (2006) define information opacity as a situation in which investors lack the necessary information to assess firms'

[4] The literature on the effects of rating announcements on financial markets shows an asymmetric effect: Downgrades induce negative abnormal returns, while upgrades cause much weaker effects indicating that these include less relevant information. See Hubler et al. (2019) for a recent survey.

[5] There are differences between the ST programmes implemented in different countries (Baudino et al., 2018) that are especially relevant between EU and US programs (Ahnert et al., 2020; Niepmann & Stebunovs, 2018; Tsagkarakis et al., 2021). For instance, Niepmann and Stebunovs (2018) estate that the bottom-up approach could underreport vulnerabilities and undermine the reliability of EU ST in assessing the risk profiles. The decision support system to assess bank vulnerabilities by Tsagkarakis et al. (2021) finds different criteria used by U.S. and EU regulators to decide which banks need more capital.

risks and properly determine their value.[6] We focus on information opacity concerning banks' credit risk, as controlling this risk is one of the regulators' main concerns. This is measured by the discrepancies in the credit rating given to the debt or the bank itself by different credit rating agencies. These agencies issue the ratings after assessing the bank's creditworthiness from public and private information. The literature (e.g., Morgan, 2002; Livingston et al., 2007) shows that the probability of finding divergences in the credit rating assigned by different agencies to the same issue (or issuer) is higher for more opaque institutions.[7] Therefore, we calculate four opacity measures based on the disagreement between the ratings assigned by various agencies to the same issues or issuers. The first is the Split rating, widely used in the literature, which is the difference between the best and the worst rating issued across the n rating agencies:

$$Split_{t,i} = BR_{t,i} - WR_{t,i} \tag{1}$$

where $BR_{t,i} = max\{CR_{j,t,i}\}_{j=1}^{n}$, $WR_{t,i} = min\{CR_{j,t,i}\}_{j=1}^{n}$, and $CR_{j,t,i}$ is the credit rating given by the agency j (j = 1,…,n) to the bank i on day t.

When the issue i is rated by only two agencies, the *Split* captures all the information about the inter-agency discrepancy. However, when the number of agencies exceeds 2, it ignores the distribution of intermediate ratings. Abad et al. (2020) propose two measures based on the distance between all the ratings given to the same issue/issuer that allow us to incorporate the information provided by the intermediate ratings. The first one approximates the opacity by the Euclidean distance ($ED_{i,t}$) between all the ratings of different agencies given to the same issue:

$$ED_{i,t} = \sqrt{\underbrace{\sum_{j=1}^{n}\sum_{m=1}^{n}}_{m\neq j}\left(CR_{j,t,i} - CR_{m,t,i}\right)^2} \tag{2}$$

where $CR_{j,t,i}$ and $CR_{m,t,i}$ are the ratings by agencies j and m on day t to the bank i.

The second is the Euclidean distance to the worst rating ($EDW_{i,t}$). This measure provides information about how far away the agencies' opinion is from the most severe one, which gives the worse rating, i.e., the most extreme rating in the left tail of the rating distribution. So, $EDW_{i,t}$ captures the negative asymmetry in the rating distribution.

$$EDW_{t,i} = \sqrt{\sum_{j=1}^{n}\left(CR_{j,t,i} - WR_{t,i}\right)^2} \tag{3}$$

This paper proposes a fourth measure based on the same idea, the Euclidean distance from the best rating ($EDB_{t,i}$). In this case, we quantify how far the agencies' opinions are from the most optimistic one, which considers the bank less risky. Thus, it captures information about the positive skewness of the rating distribution:

$$EDB_{t,i} = \sqrt{\sum_{j=1}^{n}\left(CR_{j,t,i} - BR_{t,i}\right)^2} \tag{4}$$

To study how opacity behaves after the publication of the ST results, we define the variable $\Delta Op_{\tau,i}$ as the difference in the value of opacity following the disclosure of the ST result from that before the ST:

$$\Delta Op_{\tau,i} = Op_{\tau_a,i} - Op_{\tau_b,i} \tag{5}$$

where $Op = \{Split, ED, EDW, EDB\}$ as appropriate, i is the bank, and τ is the date of publication of the ST results. Thus, $Op_{\tau_a,i}$ is the value of opacity after the first rating change in the window of six months following the publication of the test results, and $Op_{\tau_b,i}$ is the value of opacity on the day before the ST results were published.[8]

[6] Information opacity is not observable, which has led to proxies such as earnings management (e.g., Leuz et al., 2003), auditor quality (Fan & Wong, 2005) and the dispersion among analyst recommendations (Stenzel & Wagner, 2022).

[7] Morgan (2002) observes that the discrepancies between S&P and Moodys are related to the level of opacity of banks. Iannotta (2006) reaches similar conclusions in the European case. Livingston et al. (2007) and Kladakis et al. (2020) show that firms with more opaque assets are more likely to have disagreements. Flannery et al. (2013) show that bank opacity is higher in periods of crisis.

[8] We consider a six-month horizon for several reasons. First, the banks that fail the ST will have to raise new capital within six months and could issue new bonds in this period (see Schuermann, 2014). Second, Inghelbrecht and Vantieghem (2020) argue that the effect of the ST on the credit rating of tested banks starts to decrease six months after the ST disclosure. Finally, according to the rating stability hypothesis related to the through-the-cycle approach (Cantor, 2001; Altman & Rijken, 2006), as well as the policy of rating bounce avoidance (Cantor, 2001; Löffler, 2005), rating adjustments are generally seldom.

Table 1
Stress test programs and banks.

Panel A: USA					Panel B: European Union				
Test	Date	ST	C	Total	Test	Date	ST	C	Total
SCAP 2009	5/7/2009	12	8	20	EBA 2010	6/8/2010	22	7	29
CCAR 2012	3/13/2012	10	10	20	EBA 2011	7/15/2011	21	8	29
CCAR 2013	3/13/2013	10	10	20	EBA 2014	10/26/2014	28	5	33
CCAR 2014	3/26/2014	6	13	19	EBA 2016	7/29/2016	22	10	32
CCAR 2015	3/5/2015	7	12	19	EBA 2018	11/2/2018	22	7	29
CCAR 2016	6/29/2016	4	15	19					
CCAR 2017	6/28/2017	5	13	18					
CCAR 2018	6/30/2018	6	12	18					
CCAR 2019	6/30/2019	8	7	15					

Date is the day of the ST result disclosure. ST: Stress-tested banks; C: non-stress-tested banks (control group).

4. Data

We select rated banks subject to ST programs in the US and the EU between 2009 and 2019.[9] Stress-tested banks are selected according to their size and relevance to the banking system. To identify the effects better, we also select rated banks not subject to ST programs, which will serve as a control group.[10] To ensure that the banks included in the final sample (participating and non-participating banks) are as homogeneous as possible in terms of the information they disclose to the market, we select banks that are listed on the stock exchange since they must fulfil the obligation to publish relevant information openly and homogeneously to be listed. From the initial sample of 266 European and 540 American banks, we select those whose credit risk is rated by two or more rating agencies (long-term senior debt and issuer rating) in the sample period.

For each bank, we gather information on the initial rating and the successive changes (downgrades and upgrades) from the *Refinitiv EIKON* database. The set of agencies with ratings in the sample are *Standard & Poor's*, *Moody's, Fitch-Ratings*, *Rating and Investment Information* (*R&I*), and *Egan-Jones Rating*. The final sample contains 39 European banks (31 evaluated in at least one ST program and eight never stress-tested) and 24 US banks (17 tested at least in one ST program and seven never stress-tested). However, there is insufficient information to calculate opacity measures for some banks-ST programs, resulting in an unbalanced panel of 152 pairs of bank-ST programs for Europe and 168 for the US. The number of agencies that rate each bank in our sample ranks from 3 to 5. This number is growing throughout the period, being lower for earlier STs (from 2009 to 2015 in both regions) and 5 for the latter (from 2016 to 2019). The average number of agencies across banks is 2.9 for participating banks in both regions and 2.5 and 2.9 for participating banks in US and EU, respectively. Table 1 reports the final number of banks by region, ST program and group of banks.

Besides effective rating changes, we analyse the subsequent rating refinements (placing on the watchlist and removing from it, and changes in rating outlook). Agencies use them to provide updated bank creditworthiness information before changing the effective rating. So, they give relevant information to measuring opacity through inter-agency discrepancies in credit risk assessment. We convert the ratings to a broad numerical scale ranging from 1 to 58 (e.g., Abad et al., 2020). The scale incorporates the rating refinements so that an effective change in rating is a leap of $+/-3$ on the scale, placing on or removing to the watch list is a leap of $+/-2$, and a change in outlook implies a jump of $+/-1$.[11] Table 2 depicts the distribution of the opacity changes around the date of the ST result disclosure and the opacity level preannouncement, considering the entire sample and both bank groups (stress-tested and control banks). Expression (5) is used to calculate the change in opacity. Panels A and B contain the analysis for US and EU, respectively.

The pre-ST mean opacity level is higher in Europe than in the US, as is the standard deviation for all the analysed opacity measures. For instance, the mean *Split* is 5.88 for European and 4.76 for US banks. When comparing participating and control banks in each region, we find that the former generally present higher opacity levels except for the US EDB measure and the European EDW. We test whether there are differences in pre-ST opacity levels between the stress-tested banks and the control bank with a simple test of equality of means. The results show apparent differences in the case of the United States, while they are not in the case of Europe.

The change in opacity after the ST result disclosure in the US seems to depend on the measure we use. Split and EDW point to a reduction of opacity for both groups of banks. For instance, the mean change in the Split is -1.521 for stress-tested banks and -0.456 for control banks. However, the other two measures point to the opposite, with higher opacity bus larger for control banks (e.g., 0.57 versus 1.095). These results indicate a lower range in the ratings with a general movement to the worst rating, leading to a lower split and distance to the worse and a higher distance to the best. The high absolute values of means and standard deviations of EDW and EDB are remarkable in the case of the control banks group. In the case of Europe, all measures point to an increase in opacity after the release of ST results, generally higher for stress-tested banks. In this case, we also test whether there are differences in the mean opacity change between the stress-tested and control banks with a simple test of equality of means. The results show clear differences regards

[9] We discarded the US CCAR2011 because the US regulator did not disclose the ST results.

[10] We identify stress-tested banks at the ST programme level. This means that some banks are in the sample of control banks or the sample of stress-tested banks of a specific ST programme, depending on whether they participated. See Tables A.1 and A.2in the Appendix.

[11] The highest rating (e.g., AAA from S&P) takes a value of 58, while the lowest rating takes a value of 1. AA rating with a positive (negative) outlook has a value of $55 + 2(-2) = 57(53)$.

Table 2
Descriptives of preannouncement opacity distribution and changes in opacity around the ST result announcement.

	Preanouncement opacity		ΔOp around ST			
	Mean	*Std.*	*Mean*	*Max.*	*Min.*	*Std.*
Panel A: US (n = 168)						
Split	4.754	2.692	−1.196	9.000	−21.821	2.757
ED	6.076	3.841	0.730	12.728	−13.865	2.468
EDW	5.423	3.272	−1.327	9.000	−24.659	5.630
EDB	6.867	5.413	2.103	24.659	−6.000	5.201
Tested Banks (n = 117)						
Split	5,086***	2.793	−1.521	9.000	−21.821	2.921
ED	6,607***	4.021	0.570	9.000	−13.865	2.334
EDW	5,931***	3.424	−0,017***	9.000	−20.950	2.941
EDB	5,917***	3.690	0,788***	14.812	−6.000	2.389
Control Banks (n = 51)						
Split	4.000	2.298	−0.456	9.000	−4.348	2.194
ED	4.868	3.110	1.095	12.728	−3.708	2.740
EDW	4.268	2.573	−4.305	8.127	−24.659	8.504
EDB	9.027	7.687	5.094	24.659	−3.000	7.972
Panel B: EU (n = 152)						
Split	5.882	5.231	0.237	15.000	−12.000	2.816
ED	7.885	7.303	0.410	21.213	−16.971	3.768
EDW	6.784	6.163	0.259	15.000	−12.000	3.009
EDB	7.084	6.599	0.340	21.213	−16.971	3.682
Tested Banks (n = 115)						
Split	5.845	5.561	0.273	15.000	−12.000	3.214
ED	7.783	7.571	0.451	21.213	−16.971	4.288
EDW	6.646	6.372	0.229	15.000	−12.000	3.361
EDB	7.121	7.005	0.439	21.213	−16.971	4.235
Control Banks (n = 37)						
Split	5.976	4.308	0.143	3.000	−3.000	1.317
ED	8.153	6.628	0.304	4.833	−4.243	1.843
EDW	7.147	5.718	0.335	4.616	−4.757	1.821
EDB	6.988	5.470	0.080	3.708	−4.243	1.464

Descriptive statistics by opacity measure for the whole sample and stress-tested and control banks separately. Panel A contains the US banks, and Panel B the EU banks. Mean and Std. are the average and the standard deviation of the pre-announcement opacity level, respectively. *, ** and *** indicate the rejection of the null hypothesis of no difference between the mean of the corresponding opacity measure (change in opacity measure) of stress-tested and non-stress-tested banks.

to the case of the United States for EDW and EDB measures, while again, they are not in the case of Split and ED.

5. Model and results

We built a panel data model to study the determinants of the change in the opacity level following the disclosure of ST results:

$$\Delta Op_{\tau,i} = \beta_1 + \beta_2 \mathrm{ST}_{\tau,i} + \beta_3 \mathrm{Pass}_{\tau,i} + \beta_4 \mathrm{Rating}_{\tau-1,i} + C'\Gamma + \epsilon_{\tau,i} \quad (6)$$

where $\Delta Op_{\tau,i}$ is the change in the opacity of bank i after the publication of the ST result at date τ; $\mathrm{ST}_{\tau,i}$ is a dummy variable that takes the value 1 if bank i has been evaluated in the ST program at date τ and 0 otherwise; $\mathrm{Pass}_{\tau,i}$ takes a value of 1 if bank i has passed the test and 0 otherwise[12]; $\mathrm{Rating}_{\tau\text{-}1,I}$ is the rating level averaged across agencies before the ST result disclosure. Finally, **C** is a vector of control covariates.

We are interested in and β_3 to analyse the informative effect of ST result disclosure on opacity. The first parameter captures the difference in the opacity change after disclosing ST results between the participating banks and those in the control group. Suppose the publication of these ST results provides new relevant information that reduces the information asymmetry. In that case, the agencies will react by including it in their credit risk assessment and re-rate the issue/issuer accordingly. These new ratings should be more aligned across agencies, as they incorporate the same piece of novel information, leading to lowering the discrepancy measures, that is,

[12] European tests from 2016 onwards do not provide this information. In this case, we assume that the bank passes the ST if the CET1 capital level in the adverse scenario is above the regulatory CET1 capital level imposed by Basel III.

reflecting the lower opacity. In this case, we expect the sign of β_2 to be negative. If the information were already embedded in the rating the agencies gave, we would expect a non-significant coefficient. If the information on the banks evaluated is vague, ambiguous, and subject to different interpretations, the opacity will increase, and the coefficient β_2 could be positive. The coefficient β_3 accounts for the difference in the response of opacity between banks that pass the test and those that fail. A positive coefficient means a greater decrease in opacity for banks receiving a negative result.

The model (6) includes a set of covariates that could affect the change in opacity and whose omission could bias the estimation of the relevant parameters. We account for the prior rating, $\text{Rating}_{\tau\text{-}1,i}$, to control for the effect of rating level on disagreements found in the literature (e.g., Kladakis et al., 2020; Morgan, 2002). The vector **C** comprises two types of variables: a set of variables that characterise the discrepancy across agencies; and bank-specific attributes that describe the financial situation of banks in the period preceding the ST implementation. The first group includes characteristics of inter-agency disagreement. Differences in the roles and reputation of the rating agencies and herding behaviour would affect the discrepancy among agencies. Lugo et al. (2015) find that agencies with the strongest reputations are the most influential and less influenced by agency rivals. In this line, we consider that Moody's' position and reputation may affect the decision of other agencies, especially smaller ones, by including *Moody's*, which takes the value of 1 when Moody's gives the less severe rating and 0 otherwise[13]; we also consider differences in the time agencies last in react to the new information by including the number of days that elapse between the publication of ST results and the first rating update (*Days*) and the number of agencies that monitor the credit risk of the bank *i* at τ (*#Agencies*).

The second group includes financial characteristics of banks that inform about their risk profile and financial health. Following the literature (see Ahnert et al., 2020, for instance), we include the degree of indebtedness, as measured by the ratio of debt to equity (*Leverage*); the excess of TIER 1 capital over the regulatory minimum in each test (*CAP*); the percentage of non-performing assets over TIER 1 regulatory capital (*AQ*), which is inversely related to asset quality[14]; *Net Margin* (*NM*), as an indicator of expected return. We collect annual data on these variables from the *Refinitiv Worldscope Fundamentals* database. Finally, we include a binary variable equal to 1 for banks considered systemic by the Financial Stability Board at date τ and 0 otherwise (*GSIB*). In the European case, we also include the variable *AQR*, which equals 1 for the ST programs implemented after the Asset Quality Review came into force in 2014 and 0 otherwise, to account for the possible effect of this regulatory change in the information disclosed by the ST result.

To determine the best estimation method for model (6), we test for heteroscedasticity with the Breusch-Pagan (BP) test to detect unobservable individual effects and select between the fixed effects (FE) and the random effects (RE) model using the Hausman test (H). The tables report the estimation of the final model selected and the results of these tests. We estimate three versions of Eq. (6), depending on the set of covariates considered: those characterising the discrepancy between agencies (Mod1), those describing the bank's financial situation in the pre-ST disclosure period (Mod2), and both simultaneously (Mod3).

Tables 3 and 4 report the estimation of Mod1 for the STs conducted in the US between 2009 and 2019 and those undertaken in the EU between 2010 and 2018. We estimate a model for each opacity measure. The first column of Table 3 shows the results for Split. The Breusch-Pagan test rejects the null hypothesis, and the Hausman test led us to select the random effects panel data model.[15] The coefficient of *ST* is significant and negative, indicating that the ST result disclosure reduces the opacity more for the participating banks than the non-tested banks.

The second column of Table 3 presents the results for the opacity measured as the Euclidean distance (ED). Overall, the results we obtain for the split measure hold. The opacity of stress-tested banks reduces after the publication of ST results with respect to those of banks in the control group. Columns 3 to 4 show the estimation results for opacity measured by the Euclidean distance to the worst (EDW) and Euclidean distance to the best rating (EDB). The main effects observed in the split case hold for the EDB measure. The observed impact of ST publication on opacity is pervasive across opacity measures.

We observe that none of the coefficients is significant regarding the effect of the variables that account for the inter-agency discrepancies. The days until the first rating adjustment and the number of agencies seem to have no relevance in explaining the opacity response.

Table 4 shows the results of the estimation of Mod1 for the STs conducted in the EU between 2010 and 2018. In this case, The Breusch-Pagan test does not reject the null hypothesis, and the pooled model seems more appropriate. The first noteworthy result is that, in contrast to the US case, the publication of ST results only reduces the opacity of stress-tested banks when opacity is proxied by split or EDB. To pass or not pass the test does not appear to be a distinct effect associated with the ST result disclosure for European banks independently of the opacity measure. This result is weak evidence that ST contributes to mitigating divergences between rating agencies when assessing the credit risk of European banks. In other words, the information disclosed by ST is not clearly relevant, as it certainly does not allow the agencies to draw from it an unambiguous signal to reduce information asymmetry and make their credit ratings more aligned.

Concerning the control variables, we find scarce evidence that they affect the change in opacity after the ST result disclosure. The opacity after the publication of the ST results is smaller when Moody's assigns the best rating. Still, the effect is only significant for two

[13] Damak (2021) compares the Big Three agencies through the study of methodologies practised based on publicly available information and finds that Moody's is usually the most severe and uses more relevant factors than the other agencies. Abad et al. (2020) show that Moody's gives the best (worst) rating at a lower (higher) percentage of times than S&P and Fitch. Kladakis et al. (2020) find higher disagreement concerning Moodys.

[14] See Ahnert et al. (2020) for details.

[15] We have estimated Fixed-Effects (FE), Random-Effects (RE) and Pooled (P) panel data models in all cases (Mod1, Mod2 and Mod3) and all cases (for EU and US regions, all opacity measures and sets of covariates) with qualitatively similar results. For the FE model, we have included year and bank fixed effects. In the case of the EU banks, we also have estimated the models with country effects. Results are available upon request.

Table 3
Opacity response to ST results publication Mod1: US case.

	ΔSplit	ΔED	ΔEDW	ΔEDB
Const.	0.997	0.124	0.498	−0.712
	(0.218)	(0.919)	(0.597)	(0.372)
ST	−0.905*	−1.137*	−0.915	−1.129**
	(0.091)	(0.089)	(0.120)	(0.021)
Pass	0.801	0.799	0.622	0.953
	(0.205)	(0.316)	(0.382)	(0.203)
Rating	−0.139	−0.175	−0.138	−0.106
	(0.227)	(0.301)	(0.317)	(0.404)
Moodys	−0.007	0.046	−0.05	0.474
	(0.983)	(0.920)	(0.902)	(0.208)
Days	−0.005	−0.002	−0.003	−0.001
	(0.109)	(0.606)	(0.341)	(0.847)
# Agencies	0.006	0.226	0.157	0.357
	(0.976)	(0.445)	(0.584)	(0.219)
Model	RE	RE	RE	RE
BP-p value	(0.001)	(0.0005)	(0.0003)	(0.009)
H-p value	(0.121)	(0.085)	(0.099)	(0.494)
R2	0.049	0.035	0.035	0.052
F Stat.	8.297	5.781	5.852	8.718

Covariance matrix robust to heteroscedasticity, autocorrelation, and cross-sectional dependence, p-values in parentheses. ***, ** and * denote significance at 1%, 5% and 10% respectively. The number of observations is 167. ST is 1 for tested banks, 0 otherwise; Pass is 1 for banks that pass the test, 0 otherwise. Moodys is 1 when Moodys gives the less severe rating and 0 otherwise. Rating is the average credit rating prior to disclosure (standardized values). Days is the number of days that precede the first rating adjustment; #Agencies is the number of agencies that rate the bank/issue. FE/RE/P indicates Fixed-Effects, Random-Effects or Pooled model, BP-p value and H-p values are the p values of the Breusch-Pagan and the Haussman test respectively.

Table 4
Opacity response to ST results publication Mod1: EU case.

	ΔSplit	ΔED	ΔEDW	ΔEDB
Const.	1.117	1.407	1.418	1.099
	(0.246)	(0.222)	(0.217)	(0.267)
ST	−0.207*	0.058	0.13	−0.363**
	(0.078)	(0.801)	(0.425)	(0.028)
Pass	0.153	−0.002	−0.325	0.508
	(0.460)	(0.995)	(0.231)	(0.137)
Rating	0.094*	0.114	0.194*	−0.003
	(0.095)	(0.471)	(0.065)	(0.981)
Moodys	−0.605*	−0.783	−0.733*	−0.698
	(0.084)	(0.120)	(0.089)	(0.143)
Days	−0.001	−0.003	−0.002	−0.002
	(0.793)	(0.541)	(0.704)	(0.698)
# Agencies	−0.122	−0.071	−0.138	−0.077
	(0.240)	(0.379)	(0.223)	(0.248)
Model	P	P	P	P
BP-p value	(0.183)	(0.298)	(0.164)	(0.306)
H-p value	(0.002)	(0.005)	(0.005)	(0.004)
R2	0.013	0.014	0.018	0.012
F Stat.	0.318	0.333	0.440	0.298

Covariance matrix robust to heteroscedasticity, autocorrelation, and cross-sectional dependence, p-values in parentheses. ***, ** and * denote significance at 1%, 5% and 10% respectively. The number of observations is 152. ST is 1 for tested banks, 0 otherwise; Pass is 1 for banks that pass the test, 0 otherwise. Moodys is 1 when Moodys gives the less severe rating and 0 otherwise. Rating is the average credit rating prior to disclosure (standardized values). Days is the number of days that precede the first rating adjustment; #Agencies is the number of agencies that rate the bank/issue. FE/RE/P indicates Fixed-Effects, Random-Effects or Pooled model, BP-p value and H-p values are the p values of the Breusch-Pagan and the Haussman test respectively.

opacity measures (Split and EDW). In line with Kladakis et al. (2020) and Morgan (2002), we observe that the rating level of banks is important in determining the opacity change. We observe a higher opacity change in these opacity measures for banks with a higher credit rating before the ST result disclosure.

Tables 5 and 6 show the results of estimating the second version of Eq. (6), which includes banks' financial situation before the ST program. As the previous model, Breusch-Pagan and Hausman's tests select the random effect model for the US and pooled model for the EU. Table 5 depicts the results for US ST programs. The previous result maintains for all the opacity measures. The disclosure reduces the opacity for tested banks regardless of the opacity measure. The estimated parameter of *Pass* is positive and significant for all opacity measures, pointing to differences in the relevance of information disclosed by ST results for banks that pass than banks that

Table 5
Opacity change after ST results publication - Mod2: US case.

	ΔSplit	ΔED	ΔEDW	ΔEDB
Const.	3.015***	4.101***	3.338***	2.811***
	(0.010)	(0.007)	(0.002)	(0.005)
ST	−0.548*	−0.901**	−0.678*	−1.269***
	(0.080)	(0.035)	(0.092)	(0.007)
Pass	1.117**	1.437**	1.191**	1.215*
	(0.047)	(0.026)	(0.038)	(0.065)
Rating	−0.736**	−0.954*	−0.756**	−0.511
	(0.047)	(0.053)	(0.045)	(0.159)
GSIB	−0.417	−0.563	−0.435	−0.296
	(0.315)	(0.299)	(0.358)	(0.582)
Leverage	−0.400***	−0.553***	−0.438***	−0.371**
	(0.000)	(0.000)	(0.000)	(0.013)
NM	0.048***	0.072***	0.051***	0.047*
	(0.000)	(0.000)	(0.000)	(0.084)
CAP	−0.131*	−0.194	−0.156*	−0.109
	(0.097)	(0.115)	(0.060)	(0.171)
AQ	0.024*	0.039*	0.034*	0.034**
	(0.092)	(0.057)	(0.076)	(0.023)
Model	RE	RE	RE	RE
BP-p value	(0.001)	(0.0003)	(0.01)	(0.00001)
H-p value	(0.703)	(0.636)	(0.506)	(0.285)
R2	0.177	0.206	0.192	0.136
F Stat.	23.891***	28.818***	26.406***	17.430**

Covariance matrix robust to heteroscedasticity, autocorrelation, and cross-sectional dependence, p-values in parentheses. ***, ** and * denote significance at 1%, 5% and 10% respectively. The sample size is 120 observations. ST is 1 for tested banks and 0 otherwise. Pass is 1 for banks that pass the test, 0 otherwise. Rating is the average credit rating prior to disclosure (standardized values). GSIB is 1 for systemic banks and 0 otherwise. Leverage is the leverage ratio, NM is the Net Margin, CAP is the excess of TIER1 capital over the regulatory minimum, and AQ is the ratio of NPL loans over TIER1. Covariates are measured the year prior ST programs. FE/RE/P indicates Fixed-Effects, Random-Effects or Pooled model, BP-p value and H-p values are the p values of the Breusch-Pagan and the Haussman test respectively.

Table 6
Opacity change after ST results publication - Mod2: EU case.

	ΔSplit	ΔED	ΔEDW	ΔEDB
Const.	−0.85	−0.891	−0.863	−0.847
	(0.387)	(0.537)	(0.457)	(0.529)
ST	0.155	0.478	0.64	−0.004
	(0.496)	(0.274)	(0.119)	(0.989)
Pass	0.288	0.14	−0.404	0.828
	(0.484)	(0.846)	(0.461)	(0.209)
Rating	−0.062	−0.112	0.073	−0.266
	(0.635)	(0.572)	(0.491)	(0.307)
GSIB	−0.408	−0.568	−0.172	−0.734
	(0.543)	(0.525)	(0.817)	(0.381)
Leverage	0.06	0.021	0.066	0.021
	(0.708)	(0.928)	(0.729)	(0.919)
AQR	0.352	0.37	0.475	0.369
	(0.628)	(0.672)	(0.517)	(0.692)
CAP	0.036	0.073	0.032	0.052
	(0.529)	(0.406)	(0.596)	(0.504)
AQ	0.0002	−0.0001	0.0005	−0.0004
	(0.819)	(0.928)	(0.672)	(0.813)
Model	P	P	P	P
BP-p value	(0.74)	(0.842)	(0.782)	(0.838)
H-p value	(0.125)	(0.277)	(0.146)	(0.23)
R2	0.01	0.011	0.01	0.015
F Stat.	0.154	0.177	0.160	0.235

Covariance matrix robust to heteroscedasticity, autocorrelation, and cross-sectional dependence, p-values in parentheses. ***, ** and * denote significance at 1%, 5% and 10% respectively. The sample size is 134 observations. ST is 1 for tested banks, 0 otherwise. Pass is 1 for banks that pass the test, 0 otherwise. Rating is the average credit rating prior to disclosure (standardized values).GSIB is 1 for systemic banks and 0 otherwise. Leverage is the leverage ratio, NM is the Net Margin, CAP is the excess of TIER1 capital over the regulatory minimum, and AQR is equal to 1 after the Asset Quality Review comes into effect in 2014 and 0 in previous years. Covariates are measured in the year prior to ST programs. FE/RE/P indicates Fixed-Effects, Random-Effects or Pooled model, BP-p value and H-p values are the p values of the Breusch-Pagan and the Haussman test respectively.

fail the tests. The Rating parameter is significantly different from zero and negative, indicating that the banks whose ratings before the ST result disclosure are above the average reduce their opacity more after the test. Kladakis et al. (2020) state that more vulnerable banks have higher split ratings because of agency-related incentives and borrower opacity.

The analysis of bank-specific covariates gives remarkable insights. First, we observe that the opacity decreases more for banks with a higher leverage ratio (*Leverage*). The most indebted banks before the ST date (i.e., those in a riskier financial situation) appear to reduce the opacity more than less indebted banks. Second, we observe that banks with more excess of TIER1 capital (i.e., higher CAP) appear to reduce the opacity more. Third, a higher expected return (i.e., higher NM) in the bank smoothest opacity reductions after the ST result disclosure. Fourth, a lower bank's asset quality (i.e., higher AQ value) smoothest opacity reduction too. Fifth, the information disclosed by the ST reduces the opacity less in the case of banks with a higher proportion of non-performing assets to TIER1. These effects are pervasive across opacity measures.

Table 6 depicts the results for EU ST programs when including the bank's financial situation variables. We do not find that the *ST* and *Pass* variables have any effect on the bank opacity. There is no evidence that the publication of the ST results, nor the result achieved by the bank, affects the level of bank opacity. So, the difference with respect to the US case remains. No bank-specific covariate seems relevant to explain the opacity response to the ST results publication. In the European case, we also consider the regulatory change to include the asset quality review in the ST program from 2014 onwards. However, the *AQR* variable has no significant effect. The results maintain for all the opacity measures. This finding suggests that the introduction of qualitative and quantitative analysis was ineffective in reducing the information opacity of banks.

We finally estimate the Mod3 version of Eq. (6) in which we include both groups of covariates: variables related to the discrepancy across agencies and the financial situation of banks. Results are presented in Tables 7 and 8 for the US and EU regions, respectively. The

Table 7
Opacity response to ST results publication - Mod3: US case.

	ΔSplit	ΔED	ΔEDW	ΔEDB
Const.	4.236*	4.735*	4.069*	3.477
	(0.053)	(0.084)	(0.063)	(0.113)
ST	−0.717**	−1.111**	−0.922**	−1.316***
	(0.021)	(0.014)	(0.026)	(0.003)
Pass	1.373**	1.617**	1.417**	1.348*
	(0.041)	(0.029)	(0.038)	(0.082)
Rating	−1.271*	−0.856	−1.162	−0.939
	(0.076)	(0.109)	(0.131)	(0.176)
Moodys	−0.427	−0.581	−0.720*	−0.147
	(0.110)	(0.127)	(0.061)	(0.602)
Days	−0.006*	−0.005	−0.006	−0.003
	(0.073)	(0.339)	(0.212)	(0.479)
# Agencies	−0.085	−0.002	0.009	−0.063
	(0.706)	(0.994)	(0.972)	(0.849)
GSIB	−0.590**	−0.854**	−0.777**	−0.329
	(0.025)	(0.030)	(0.014)	(0.432)
Leverage	−0.431***	−0.577***	−0.462***	−0.388**
	(0.003)	(0.000)	(0.000)	(0.026)
NM	0.059***	0.081***	0.062***	0.053*
	(0.000)	(0.000)	(0.000)	(0.085)
CAP	−0.106	−0.141	−0.093	−0.104
	(0.195)	(0.250)	(0.259)	(0.249)
AQ	0.027**	0.042**	0.037**	0.036**
	(0.032)	(0.032)	(0.038)	(0.014)
Model	FE	RE	FE	FE
BP-p value	(0.00003)	(0.00002)	(0.0004)	(0.00001)
H-p value	(0.002)	(0.141)	(0.008)	(0)
R2	0.211	0.22	0.222	0.146
F Stat.	2.627***	30.456***	2.797***	1.678*

Covariance matrix robust to heteroscedasticity, autocorrelation, and cross-sectional dependence, p-values in parentheses. ***, ** and * denote significance at 1%, 5% and 10% respectively. The sample size is 120 observations. *ST* is 1 for tested banks, 0 otherwise. *Pass* is 1 for banks that pass the test, 0 otherwise. *Moodys* is 1 when Moodys gives the less severe rating and 0 otherwise. Rating is the average credit rating prior to disclosure (standardized values). *Days* is the number of days that precede the first rating adjustment; *#Agencies* is the number of agencies that rate the bank/issue. *GSIB* is 1 for systemic banks and 0 otherwise. *Leverage* is the leverage ratio, NM is the Net Margin, *CAP* is the excess of TIER1 capital over the regulatory minimum, and *AQ* is the ratio of NPL loans over TIER1. Covariates are measured in the year prior to ST programs. FE/RE/P indicates Fixed-Effects, Random-Effects or Pooled model, BP-p value and H-p values are the p values of the Breusch-Pagan and the Haussman test respectively.

Table 8
Opacity change after ST results publication - Mod3: EU case.

	ΔSplit	ΔED	ΔEDW	ΔEDB
Const.	0.054	−0.028	0.431	−0.204
	(0.976)	(0.990)	(0.834)	(0.919)
ST	0.089	0.39	0.546	−0.062
	(0.751)	(0.371)	(0.193)	(0.816)
Pass	0.225	0.094	−0.496	0.777**
	(0.127)	(0.851)	(0.171)	(0.045)
Rating	0.032	0.003	0.207***	−0.172
	(0.669)	(0.961)	(0.000)	(0.224)
Moodys	−0.608	−0.711	−0.869*	−0.561
	(0.199)	(0.244)	(0.095)	(0.340)
Days	−0.002	−0.004	−0.002	−0.003
	(0.766)	(0.556)	(0.719)	(0.681)
# Agencies	−0.115	−0.037	−0.167	−0.031
	(0.621)	(0.869)	(0.483)	(0.880)
GSIB	−0.283	−0.468	0.006	−0.661
	(0.695)	(0.624)	(0.994)	(0.464)
Leverage	0.089	0.086	0.106	0.065
	(0.553)	(0.666)	(0.553)	(0.721)
AQR	0.44	0.43	0.602	0.422
	(0.542)	(0.625)	(0.406)	(0.652)
CAP	0.015	0.051	0.001	0.034
	(0.853)	(0.648)	(0.987)	(0.739)
AQ	0.001	0.0003	0.001	0.00002
	(0.531)	(0.800)	(0.332)	(0.991)
Model	P	P	P	P
BP-p value	(0.486)	(0.648)	(0.463)	(0.672)
H-p value	(0.007)	(0.015)	(0.009)	(0.013)
R2	0.021	0.022	0.03	0.021
F Stat.	0.237	0.250	0.343	0.237

Covariance matrix robust to heteroscedasticity, autocorrelation, and cross-sectional dependence, p-values in parentheses. ***, ** and * denote significance at 1%, 5% and 10% respectively. The sample size is 134 observations. *ST* is 1 for tested banks, 0 otherwise. *Pass* is 1 for banks that pass the ST, 0 otherwise. *Moodys* is 1 when Moodys gives the less severe rating and 0 otherwise. Rating is the average credit rating prior to disclosure (standardized values). *Days* is the number of days that precede the first rating adjustment; *#Agencies* is the number of agencies that rate the bank/issue. *GSIB* is 1 for systemic banks and 0 otherwise. *Leverage* is the leverage ratio, NM is the Net Margin, *CAP* is the excess of TIER1 capital over the regulatory minimum, AQ is the ratio of NPL loans over TIER1, and AQR is equal to 1 after the Asset Quality Review comes into effect and 0 in previous years. Covariates are measured in the year prior to ST programs. FE/RE/P indicates Fixed-Effects, Random-Effects or Pooled model, BP-p value and H-p values are the p values of the Breusch-Pagan and the Haussman test respectively.

Breusch-Pagan and Hausman's tests select different models in the US depending on the opacity measurement (see Table 7). Both tests led us to select a fixed effect panel model when the dependent variable is Split, EDW or EDB. In contrast, a random variable panel model seems more appropriate when ED is the dependent variable. As with previous models of the EU, the pooled model is the most suitable. Previous inferences are confirmed with the most comprehensive model. Table 7 shows that the coefficients of the variables of interest (*ST* and *Pass*) are significant and maintain the same signs for the US ST result disclosure. The results concerning both types of covariates are also broadly held.

In the European case (Table 8), we observe again no evidence of any impact of the ST programs and weak evidence of a positive impact for banks that fail the ST. Additionally, there are scarce effects of all kinds of covariates considered.

5.1. Further analyses

In this section, we explore to what extent the results obtained reflect other factors not considered in our design research. First, we examine whether our main findings are sensitive to the time horizon we use to measure changes in opacity after the ST result disclosure. In our previous evidence, we compute opacity changes from the first rating change in the six months window. However, whether the rating adjustments that occur near the end of the six months are due to the information revealed by the ST result disclosure or reflect other factors is questionable. If so, they could be biasing the results. To ensure the results are robust, we compute the change in opacity in equation (5), discarding the rating changes of the last two months, i.e., using a shorter window of four months.

Table 9
Opacity response to ST results publication - Mod3: US case.

	ΔSplit	ΔED	ΔEDW	ΔEDB
Const.	10.084**	12.004***	11.676***	11.938**
	(0.022)	(0.009)	(0.002)	(0.034)
ST	−2.936***	−4.036**	−3.176***	−6.120***
	(0.009)	(0.011)	(0.003)	(0.000)
Pass	4.844*	5.407*	4.468*	5.482*
	(0.091)	(0.089)	(0.087)	(0.061)
Rating	−1.175	−1.577	−1.022	−0.133
	(0.223)	(0.208)	(0.331)	(0.883)
Moodys	−0.449	−0.24	−1.198	0.517
	(0.497)	(0.692)	(0.106)	(0.568)
Days	0.003	0.004	−0.017	0.01
	(0.874)	(0.870)	(0.287)	(0.671)
# Agencies	−0.249	0.178	−0.79	−0.313
	(0.774)	(0.878)	(0.415)	(0.700)
GSIB	−1.899	−2.318	−1.64	−0.351
	(0.196)	(0.208)	(0.225)	(0.871)
Leverage	−0.555***	−0.724***	−0.664***	−0.643**
	(0.001)	(0.000)	(0.000)	(0.027)
NM	0.045**	0.069**	0.045**	−0.006
	(0.049)	(0.027)	(0.021)	(0.932)
CAP	−0.713*	−1.022*	−0.478	−0.797
	(0.075)	(0.056)	(0.188)	(0.116)
AQ	0.048	0.072	0.072	0.079
	(0.446)	(0.452)	(0.294)	(0.307)
Model	P	P	P	P
BP-p value	(0.109)	(0.099)	(0.157)	(0.066)
H-p value	(0.991)	(0.991)	(0.999)	(0.769)
R2	0.376	0.381	0.386	0.306
F Stat.	0.931	0.951	0.971	0.682

Covariance matrix robust to heteroscedasticity, autocorrelation, and cross-sectional dependence, p-values in parentheses. ***, ** and * denote significance at 1%, 5% and 10% respectively. The sample size is 29 observations. The opacity response is the value of opacity after the first rating change in the four months following the publication of the test results and the value of opacity on the day before the test results were published. *ST* is 1 for tested banks, 0 otherwise. *Pass* is 1 for banks that pass the test, 0 otherwise. *Moodys* is 1 when Moodys gives the less severe rating and 0 otherwise. Rating is the average credit rating prior to disclosure (standardized values). *Days* is the number of days that precede the first rating adjustment; *#Agencies* is the number of agencies that rate the bank/issue. *GSIB* is 1 for systemic banks and 0 otherwise. *Leverage* is the leverage ratio, NM is the Net Margin, *CAP* is the excess of TIER1 capital over the regulatory minimum, and *AQ* is the ratio of NPL loans over TIER1. Covariates are measured in the year prior to ST programs. FE/RE/P indicates Fixed-Effects, Random-Effects or Pooled model, BP-p value and H-p values are the p values of the Breusch-Pagan and the Haussman test respectively.

Tables 9 and 10 present the results of the Mod3 estimation for the US and the EU ST, respectively. We observe that the results hold, i.e., larger informative effects on the disclosure of US ST results and no effect on EU statistics. This shows that our main conclusion is not due to the choice of the window used to construct the opacity measures.

A second check considers whether the opacity response to the ST result disclosure depends on the sector credit risk level before the disclosure. A usual result is that the STs are more useful in times of turmoil. Schuermann (2014) argues that bank-specific disclosure is necessary during times of crisis, while during regular times, aggregated information may be enough. Goldstein and Leitner (2022) find that during regular times no disclosure is optimal, while during bad times, some disclosure is necessary. We control for banking sector risk in our model to alleviate this concern. We proxy the aggregated credit risk at the sector level by the DataStream 5 years CDS banking sector index for each region that we gather from *Refinitiv DataStream* and include it in Mod3.

The results of models that include the CDS spread level of the US (the EU) banking sector are depicted in Table 11 (Table 12). As both tables show, the main findings are similar to our earlier results. The US ST result disclosure reduces the opacity for tested banks, but the reduction is higher when the bank fails the test. Table 11 also shows that the credit risk level of the US banking sector is relevant to explain the change in opacity after the ST result disclosure, as the parameter of *CDS Sector* is significant and positive. The STs implemented when the credit risk in the banking sector is higher are associated with higher opacity after the disclosure. In the case of the EU, the scarce effect of the disclosure maintains independent of the credit risk situation of the banking sector (see Table 12).

A third concern relates to banks' incentives to self-disclosure when they anticipate the results of the TS. Some banks would be interested in voluntarily disclosing information similar to the ST results (self-disclosure) prior to the official publication by supervisors.

Table 10
Opacity change after ST results publication - Mod3: EU case.

	ΔSplit	ΔED	ΔEDW	ΔEDB
Const.	−2.469	−3.264	−0.939	−4.064
	(0.545)	(0.508)	(0.808)	(0.425)
ST	0.455	1.343	1.475	0.339
	(0.624)	(0.252)	(0.220)	(0.720)
Pass	−0.459	−1.029	−1.973**	0.434
	(0.707)	(0.314)	(0.045)	(0.756)
Rating	0.555	0.262	0.68	0.156
	(0.250)	(0.662)	(0.246)	(0.790)
Moodys	−2.098**	−2.603*	−2.320**	−2.505
	(0.041)	(0.073)	(0.030)	(0.126)
Days	0.035*	0.052*	0.043*	0.042*
	(0.053)	(0.075)	(0.058)	(0.065)
# Agencies	−0.484	−0.342	−0.673	−0.224
	(0.318)	(0.638)	(0.248)	(0.731)
GSIB	0.797	0.487	1.733	−0.171
	(0.476)	(0.763)	(0.117)	(0.916)
Leverage	−0.178	−0.49	−0.385	−0.274
	(0.569)	(0.324)	(0.316)	(0.509)
AQR	1.681	2.112	1.877	2.243
	(0.201)	(0.208)	(0.159)	(0.218)
CAP	0.286	0.411	0.261	0.35
	(0.350)	(0.357)	(0.397)	(0.372)
AQ	0.006	0.006	0.006	0.005
	(0.129)	(0.255)	(0.148)	(0.197)
Model	P	P	P	P
BP-p value	(0.328)	(0.244)	(0.225)	(0.414)
H-p value	(0.742)	(0.854)	(0.929)	(0.617)
R2	0.21	0.226	0.258	0.181
F Stat.	0.896	0.979	1.171	0.742

Covariance matrix robust to heteroscedasticity, autocorrelation, and cross-sectional dependence, p-values in parentheses. ***, ** and * denote significance at 1%, 5% and 10% respectively. The sample size is 49 observations. The opacity response is the value of opacity after the first rating change in the four months following the publication of the test results and the value of opacity on the day before the test results were published. *ST* is 1 for tested banks, 0 otherwise. *Pass* is 1 for banks that pass the ST, 0 otherwise. *Moodys* is 1 when Moodys gives the less severe rating and 0 otherwise. Rating is the average credit rating prior to disclosure (standardized values). *Days* is the number of days that precede the first rating adjustment; *#Agencies* is the number of agencies that rate the bank/issue. *GSIB* is 1 for systemic banks and 0 otherwise. *Leverage* is the leverage ratio, NM is the Net Margin, *CAP* is the excess of TIER1 capital over the regulatory minimum, AQ is the ratio of NPL loans over TIER1, and AQR is equal to 1 after the Asset Quality Review comes into effect and 0 in previous years. Covariates are measured in the year prior to ST programs. FE/RE/P indicates Fixed-Effects, Random-Effects or Pooled model, BP-p value and H-p values are the p values of the Breusch-Pagan and the Haussman test respectively.

Credit rating agencies could use this prior information to update their credit ratings if they find it novel, affecting the opacity before the ST disclosure. To address this concern, we consider whether there is a rating adjustment before disclosure by defining the variable *Anticipate*, equal to one if the participating bank is re-rated by any credit rating agency the month before ST result disclosure and zero otherwise.

Tables 13 and 14 display the results of the extended Mod3 with *Anticipate* for each opacity measure in the US STs and the EU STs programs, respectively. The impact of the ST result disclosure on opacity measures remains consistent even when considering the potential anticipation of information by participating banks. The US ST result disclosure reduces the opacity for tested banks, while the EU ST disclosure has a negligible effect. The results also confirm a more significant opacity reduction for failing US banks (see Table 13). Interestingly, in the US case, the opacity reduction is more evident for participating banks that receive a rating adjustment the month before the ST result disclosure, as the coefficient estimates on the *Anticipate* dummy are significant and negative.

In summary, the above additional checks confirm the robustness of our primary findings. There is clear, robust evidence of a reduction in the opacity of banks assessed in the ST after the publication of US ST results, more substantial for banks that fail to pass the test. In Europe, the publication of the ST results does not affect the tested bank opacity, regardless of whether they pass or fail the test.

Finally, we further examine the European evidence to understand better the possible incidence of the ST program characteristics in the results. We take advantage of a change from 2016: the regulator no longer publishes which bank passes or fails the test and only provides aggregated information.[16] Literature shows no consensus on this point. The model of Chakravarty et al. (2021) indicates that this kind of regulator's behaviour will reduce the informativeness of ST to the markets. Bouvard et al. (2015) model shows that full disclosure by regulators enhances the financial system's stability only during crises. The model of Banerjee and Maier (2016) shows the effect of more granularity of information on bank runs.

[16] Banks have access to the assessment of their results during the QA phase, after which final results are endorsed by the European Central Bank Single Supervisory Mechanism. Results for banks in the EBA sample are made public (see Baudino et al., 2018, for details).

Table 11
Opacity response to ST results publication - Mod3: US case.

	ΔSplit	ΔED	ΔEDW	ΔEDB
Const.	3.220**	3.515*	3.076*	2.664**
	(0.036)	(0.088)	(0.058)	(0.040)
ST	−0.995*	−1.436**	−1.194**	−1.539**
	(0.059)	(0.040)	(0.050)	(0.027)
Pass	1.747*	2.064**	1.782**	1.647
	(0.052)	(0.044)	(0.049)	(0.157)
Rating	−1.836**	−1.256**	−1.713*	−1.39
	(0.030)	(0.041)	(0.053)	(0.195)
Moodys	−0.662**	−0.854**	−0.949**	−0.335
	(0.022)	(0.035)	(0.015)	(0.254)
Days	−0.007*	−0.005	−0.006	−0.003
	(0.053)	(0.314)	(0.177)	(0.474)
# Agencies	−0.068	0.012	0.025	−0.05
	(0.701)	(0.960)	(0.902)	(0.864)
GSIB	−0.420**	−0.656**	−0.611**	−0.194
	(0.029)	(0.045)	(0.020)	(0.604)
Leverage	−0.499***	−0.668***	−0.529***	−0.443**
	(0.002)	(0.000)	(0.000)	(0.046)
NM	0.104***	0.136***	0.106***	0.088
	(0.000)	(0.000)	(0.000)	(0.211)
CAP	−0.150**	−0.193*	−0.135*	−0.139
	(0.043)	(0.087)	(0.072)	(0.124)
AQ	0.035**	0.052**	0.045**	0.043**
	(0.030)	(0.026)	(0.028)	(0.049)
CDS Sector	0.009**	0.010**	0.008**	0.007
	(0.021)	(0.030)	(0.029)	(0.378)
Model	FE	RE	FE	FE
BP-p value	(0.00001)	(0.00001)	(0.0003)	(0)
H-p value	(0)	(0.118)	(0)	(0.019)
R2	0.249	0.251	0.253	0.162
F Stat.	2.959***	35.881***	3.017***	1.723*

Covariance matrix robust to heteroscedasticity, autocorrelation, and cross-sectional dependence, p-values in parentheses. ***, ** and * denote significance at 1 %, 5 % and 10 % respectively. The sample size is 120 observations. *ST* is 1 for tested banks, 0 otherwise. *Pass* is 1 for banks that pass the test, 0 otherwise. *Moodys* is 1 when Moodys gives the less severe rating and 0 otherwise. Rating is the average credit rating prior to disclosure (standardized values). *Days* is the number of days that precede the first rating adjustment; *#Agencies* is the number of agencies that rate the bank/issue. *GSIB* is 1 for systemic banks and 0 otherwise. *Leverage* is the leverage ratio, NM is the Net Margin, *CAP* is the excess of TIER1 capital over the regulatory minimum, and *AQ* is the ratio of NPL loans over TIER1. Covariates are measured in the year prior to ST programs. CDS Sector denote the average value of the CDS spread of the banking sector 6 months before TS. FE/RE/P indicates Fixed-Effects, Random-Effects or Pooled model, BP-p value and H-p values are the p values of the Breusch-Pagan and the Haussman test respectively.

The EU change in the disclosing policy could reduce the informative content of ST for participating banks. To conduct this investigation, we include in Mod3 new variables that identify participating banks in the tests implemented from 2016 onwards (*STx2016*) and banks that have passed these tests implemented from 2016 onwards according to the value of their CET1 capital level in the adverse scenario (*Passx2016)*. The latter banks could be more affected by this regulatory change, as the regulator no longer gives the market a positive signal about its solvency. Table 15 shows the results. We find that the coefficient of the *Passx2016* variable is positive and significant, indicating a higher opacity of strong-performing banks for the ST implemented after the change in the disclosure policy than for those implemented before. In other words, those tests in which the pass/fail result was disclosed for each bank (EBA 2010 to 2014) allowed for a greater reduction in opacity than the ST in which an aggregate disclosure of results is made (EBA 2016 and 2018). Although we cannot consider this exercise as a full test of the importance of test design in reducing the opacity of the participating banks and should be interpreted with caution, this latter evidence (Table 15) points in that direction.

5.2. Summary and discussion

The evidence found for the ST conducted in the US supports hypothesis 1 and 2, which states that the ST programs help to mitigate the asymmetric information problems and to increase transparency in the banking sector. Their relevance is more important for the weaker performing banks in the test, although they also help to reduce the opacity of the participating banks that pass the US ST. The result is observed across all opacity measures studied. It is robust to the inclusion of covariates reflecting the situation of banks before

Table 12
Opacity change after ST results publication - Mod3: EU case.

	ΔSplit	ΔED	ΔEDW	ΔEDB
Const.	0.577	0.769	1.073	0.395
	(0.698)	(0.625)	(0.516)	(0.803)
ST	0.102	0.41	0.562	−0.047
	(0.701)	(0.321)	(0.166)	(0.847)
Pass	0.176	0.019	−0.556	0.721**
	(0.136)	(0.965)	(0.101)	(0.039)
Rating	0.096	0.101	0.286**	−0.099
	(0.523)	(0.490)	(0.024)	(0.642)
Moodys	−0.609	−0.713	−0.871	−0.563
	(0.211)	(0.263)	(0.108)	(0.354)
Days	−0.002	−0.004	−0.002	−0.002
	(0.771)	(0.560)	(0.725)	(0.686)
# Agencies	−0.119	−0.042	−0.171	−0.035
	(0.569)	(0.826)	(0.409)	(0.847)
GSIB	−0.348	−0.566	−0.073	−0.735
	(0.596)	(0.510)	(0.916)	(0.376)
Leverage	0.087	0.083	0.104	0.063
	(0.566)	(0.682)	(0.569)	(0.731)
AQR	0.451	0.447	0.615	0.435
	(0.529)	(0.608)	(0.392)	(0.639)
CAP	0.001	0.031	−0.015	0.019
	(0.984)	(0.746)	(0.835)	(0.833)
AQ	0.001	0.0004	0.001	0.0001
	(0.520)	(0.770)	(0.347)	(0.962)
CDS Sector	−0.002	−0.003	−0.003	−0.003
	(0.431)	(0.429)	(0.348)	(0.529)
Model	P	P	P	P
BP-p value	(0.567)	(0.724)	(0.544)	(0.745)
H-p value	(0.005)	(0.028)	(0.001)	(0.017)
R2	0.022	0.024	0.032	0.022
F Stat.	0.230	0.246	0.332	0.227

Covariance matrix robust to heteroscedasticity, autocorrelation, and cross-sectional dependence, p-values in parentheses. ***, ** and * denote significance at 1 %, 5 % and 10 % respectively. The sample size is 134 observations. *ST* is 1 for tested banks, 0 otherwise. *Pass* is 1 for banks that pass the ST, 0 otherwise. *Moodys* is 1 when Moodys gives the less severe rating and 0 otherwise. Rating is the average credit rating prior to disclosure (standardized values). *Days* is the number of days that precede the first rating adjustment; *#Agencies* is the number of agencies that rate the bank/issue. *GSIB* is 1 for systemic banks and 0 otherwise. *Leverage* is the leverage ratio, NM is the Net Margin, *CAP* is the excess of TIER1 capital over the regulatory minimum, AQ is the ratio of NPL loans over TIER1, and AQR is equal to 1 after the Asset Quality Review comes into effect and 0 in previous years. Covariates are measured in the year prior to ST programs. CDS Sector denote the average value of the CDS spread of the banking sector 6 months before TS. FE/RE/P indicates Fixed-Effects, Random-Effects or Pooled model, BP-p value and H-p values are the p values of the Breusch-Pagan and the Haussman test respectively.

the ST program implementation and characterising the rating disagreement among credit rating agencies. They also hold after the consideration of the credit risk situation of the banking sector and the possibility of voluntary disclosures by participating banks before the ST results publication. These results are consistent with the main literature pointing to the informative role of ST programmes in finding abnormal returns after the ST disclosure (Morgan et al., 2014; Flannery et al., 2017; Bird et al., 2020, among others). Our new evidence provides a plausible reason for these return effects: the reduction of information opacity.

The evidence found for the European ST programs differs significantly from that of the US ST programs. In this case, results support hypothesis 3, which states that the information provided by the ST is redundant or unclear enough to reduce the opacity. We find that the publication of the ST results in the EU does not provide information that helps to reduce the opacity of banks and the information asymmetry problem, or it does so only to a limited extent. When we analyse a regulatory change that reduces the amount of bank-specific information of ST by disclosing only aggregated results, we observe that the opacity is higher than for ST that give individual pass/fail banks result. The literature on abnormal returns in the European case is more divergent than for the US ST. The EU ST evidence is inconclusive, pointing to opposite directions about the informative content of EU ST programs (Alves et al., 2015; Georgescu et al., 2017; Petrella and Resti, 2013, for instance). Our results may make sense of contradictory evidence, as we find hardly any reduction in opacity related to the disclosure of ST results.

The rationale for the different opacity responses between the two regions is the differences in the banking sector structure and the design and methodology of ST programs in both regions. The US ST programs are more extensive and comprehensive, and the

Table 13
Opacity response to ST results publication - Mod3: US case.

	ΔSplit	ΔED	ΔEDW	ΔEDB
Const.	3.763**	4.254*	3.574*	2.903
	(0.044)	(0.079)	(0.054)	(0.111)
ST	−0.609**	−0.981**	−0.801**	−1.215***
	(0.029)	(0.022)	(0.045)	(0.003)
Pass	1.273**	1.532**	1.314**	1.240*
	(0.024)	(0.015)	(0.022)	(0.057)
Rating	−0.554	−0.708	−0.49	−0.322
	(0.126)	(0.160)	(0.208)	(0.390)
Moodys	−0.514**	−0.685*	−0.812**	−0.261
	(0.049)	(0.069)	(0.035)	(0.345)
Days	−0.008**	−0.007	−0.007*	−0.005
	(0.012)	(0.169)	(0.071)	(0.266)
# Agencies	0.052	0.16	0.158	0.097
	(0.799)	(0.551)	(0.497)	(0.752)
GSIB	−0.669**	−0.927**	−0.860**	−0.411
	(0.026)	(0.022)	(0.014)	(0.306)
Leverage	−0.375***	−0.511***	−0.402***	−0.317**
	(0.002)	(0.000)	(0.000)	(0.031)
NM	0.051***	0.072***	0.053***	0.043
	(0.000)	(0.000)	(0.000)	(0.128)
CAP	−0.084	−0.121	−0.07	−0.079
	(0.264)	(0.313)	(0.347)	(0.349)
AQ	0.022**	0.036**	0.031*	0.030**
	(0.049)	(0.045)	(0.057)	(0.018)
Anticipate	−1.772***	−1.956***	−1.904***	−2.014**
	(0.000)	(0.000)	(0.000)	(0.017)
Model	FE	RE	FE	FE
BP-p value	(0.00001)	(0.00001)	(0.0001)	(0)
H-p value	(0.013)	(0.169)	(0)	(0.005)
R2	0.248	0.247	0.259	0.178
F Stat.	2.942***	35.019***	3.121***	1.925**

Covariance matrix robust to heteroscedasticity, autocorrelation, and cross-sectional dependence, p-values in parentheses. ***, ** and * denote significance at 1 %, 5 % and 10 % respectively. The sample size is 120 observations. *ST* is 1 for tested banks, 0 otherwise. *Pass* is 1 for banks that pass the test, 0 otherwise. *Moodys* is 1 when Moodys gives the less severe rating and 0 otherwise. Rating is the average credit rating prior to disclosure (standardized values). *Days* is the number of days that precede the first rating adjustment; *#Agencies* is the number of agencies that rate the bank/issue. *GSIB* is 1 for systemic banks and 0 otherwise. *Leverage* is the leverage ratio, NM is the Net Margin, *CAP* is the excess of TIER1 capital over the regulatory minimum, and *AQ* is the ratio of NPL loans over TIER1. Covariates are measured in the year prior to ST programs. Anticipate is 1 when the credit rating of the participating banks change in the period of 30 days before the ST disclosure. FE/RE/P indicates Fixed-Effects, Random-Effects or Pooled model, BP-p value and H-p values are the p values of the Breusch-Pagan and the Haussman test respectively.

methodology is more complete. In addition, the test result is binding for the capital actions that banks need to undertake. In contrast, they do not have this conditionality in the EU as they are part of a larger structure. In addition, there is higher heterogeneity in the banking systems of the countries that belong to the EU. The size of banks assessed in the US is systematically larger. The EU ST programs seek to ensure national banking systems' representativeness, and the size of banks has been varying over time. This heterogeneity could affect the implementation of the ST program at the country level, thereby mending the information conveyed in the ST result disclosure. Moreover, the European regulator is reluctant to distribute all the information generated by the tests, as shown by its decision not to publish individual information on tested banks from 2016 onwards. According to Banerjee and Maier (2016), Gaballo (2016) and Goldstein and Sapra (2014), this incompleteness in the disclosure could increase information asymmetry. Also, as the model of Chakravarty et al. (2021) indicates, this kind of regulator's behaviour will reduce the informativeness of ST to the markets.

6. Conclusions

This paper studies how the publication of the banks' stress test results implemented in the United States and the European Union between 2009 and 2019 has affected banks' information opacity. We measure opacity from the information about banks' credit risk by using a set of measures of the discrepancies in the ratings given by different credit rating agencies to the same issue/issuer. We focus on the ratings of long-term senior debt and issuer ratings.

Table 14
Opacity change after ST results publication - Mod3: EU case.

	ΔSplit	ΔED	ΔEDW	ΔEDB
Const.	0.026	−0.134	0.369	−0.269
	(0.989)	(0.952)	(0.859)	(0.894)
ST	0.121	0.513	0.617	0.013
	(0.726)	(0.346)	(0.244)	(0.969)
Pass	0.221	0.078	−0.505	0.767**
	(0.117)	(0.870)	(0.154)	(0.041)
Rating	0.031	0.001	0.206***	−0.174
	(0.684)	(0.988)	(0.000)	(0.236)
Moodys	−0.622	−0.764	−0.9	−0.594
	(0.211)	(0.230)	(0.102)	(0.330)
Days	−0.002	−0.004	−0.003	−0.003
	(0.760)	(0.549)	(0.711)	(0.673)
# Agencies	−0.104	0.008	−0.141	−0.004
	(0.685)	(0.976)	(0.600)	(0.989)
GSIB	−0.289	−0.49	−0.007	−0.675
	(0.696)	(0.620)	(0.994)	(0.466)
Leverage	0.094	0.107	0.118	0.078
	(0.500)	(0.559)	(0.471)	(0.653)
AQR	0.434	0.405	0.587	0.407
	(0.541)	(0.640)	(0.404)	(0.660)
CAP	0.013	0.045	−0.002	0.03
	(0.871)	(0.686)	(0.978)	(0.770)
AQ	0.001	0.0001	0.001	−0.0001
	(0.600)	(0.936)	(0.427)	(0.941)
Anticipate	−0.206	−0.791	−0.458	−0.488
	(0.736)	(0.432)	(0.629)	(0.477)
Model	P	P	P	P
BP-p value	(0.494)	(0.626)	(0.516)	(0.611)
H-p value	(0.01)	(0.016)	(0.01)	(0.014)
R2	0.021	0.026	0.032	0.022
F Stat.	0.221	0.267	0.333	0.231

Covariance matrix robust to heteroscedasticity, autocorrelation, and cross-sectional dependence, p-values in parentheses. ***, ** and * denote significance at 1 %, 5 % and 10 % respectively. The sample size is 134 observations. *ST* is 1 for tested banks, 0 otherwise. *Pass* is 1 for banks that pass the ST, 0 otherwise. *Moodys* is 1 when Moodys gives the less severe rating and 0 otherwise. Rating is the average credit rating prior to disclosure (standardized values). *Days* is the number of days that precede the first rating adjustment; *#Agencies* is the number of agencies that rate the bank/issue. *GSIB* is 1 for systemic banks and 0 otherwise. *Leverage* is the leverage ratio, NM is the Net Margin, *CAP* is the excess of TIER1 capital over the regulatory minimum, AQ is the ratio of NPL loans over TIER1, and AQR is equal to 1 after the Asset Quality Review comes into effect and 0 in previous years. Covariates are measured in the year prior to ST programs. Anticipate is 1 when the credit rating of the participating banks change in the period of 30 days before the ST disclosure. FE/RE/P indicates Fixed-Effects, Random-Effects or Pooled model, BP-p value and H-p values are the p values of the Breusch-Pagan and the Haussman test respectively.

We find more substantial informational effects from the US ST result disclosure than the EU ST. There is clear evidence of a reduction in the opacity of banks assessed in the US ST after the disclosure, more substantial for banks that fail the test. These results support the hypothesis that the ST programs help to mitigate the opacity of the US banking sector, mainly in the case of banks that fail the test. Well-capitalized banks will probably disclose their low credit risk information before being evaluated, while banks with a weaker capitalisation have incentives not to disclose this information. Then, the ST result disclosure may offer more novel information for the second bank group.

In Europe, results suggest that the publication of the ST results does not seem to improve the banking system's transparency. The design of the EBA programs and the more heterogeneous and complex structure of the banking sector in the EU could be behind this result. Due to this complexity, the information produced by the EBA programs may not be transparent enough or may give rise to subjective interpretations, having weak evidence of effects on the banking industry's information opacity.

The results obtained have different implications. On the one hand, financial market regulators and policymakers aim to reduce information asymmetry to encourage efficient price formation and proper risk assessment, incentivising banks to reinforce their financial strength. They will be interested in ensuring that the ST result disclosure conveys fresh, relevant information to the various parties in the market. Our findings show that this objective is achieved in the United States rather than the European Union. For Europe, the ST programs are not serving these purposes. A redefinition of the procedure would be necessary for the ST to improve the

Table 15
Opacity change after ST results publication - Mod3: EU case.

	ΔSplit	ΔED	ΔEDW	ΔEDB
Const.	0.879	1.524	1.244	1.185
	(0.669)	(0.552)	(0.577)	(0.612)
ST	0.448	0.468	0.64	0.305
	(0.218)	(0.227)	(0.122)	(0.397)
Pass	−0.444*	−0.577	−0.899***	−0.115
	(0.091)	(0.238)	(0.009)	(0.775)
Rating	0.066**	0.133	0.269***	−0.089
	(0.050)	(0.315)	(0.006)	(0.499)
Moodys	−0.585	−0.719	−0.869*	−0.543
	(0.208)	(0.232)	(0.092)	(0.348)
Days	−0.002	−0.005	−0.003	−0.003
	(0.705)	(0.482)	(0.665)	(0.588)
# Agencies	−0.256	−0.301	−0.306	−0.268
	(0.386)	(0.329)	(0.271)	(0.379)
GSIB	−0.395	−0.624	−0.08	−0.828
	(0.606)	(0.539)	(0.920)	(0.389)
Leverage	0.053	0.02	0.071	0.005
	(0.726)	(0.921)	(0.689)	(0.977)
AQR	0.412	0.479	0.618	0.415
	(0.569)	(0.582)	(0.398)	(0.656)
CAP	0.007	0.025	−0.011	0.016
	(0.914)	(0.797)	(0.882)	(0.852)
AQ	0.0003	0.0003	0.001	−0.0003
	(0.768)	(0.830)	(0.320)	(0.811)
ST × 2016	−0.715**	−0.05	−0.14	−0.688
	(0.043)	(0.946)	(0.824)	(0.205)
Pass × 2016	1.352***	1.287***	0.785*	1.775***
	(0.005)	(0.005)	(0.062)	(0.001)
Model	P	P	P	P
BP-p value	(0.248)	(0.406)	(0.338)	(0.392)
H-p value	(0.022)	(0.045)	(0.032)	(0.056)
R2	0.03	0.035	0.036	0.033
F Stat.	0.288	0.332	0.342	0.319

Covariance matrix robust to heteroscedasticity, autocorrelation, and cross-sectional dependence, p-values in parentheses. ***, ** and * denote significance at 1%, 5% and 10% respectively. The sample size is 134 observations. *ST* is 1 for tested banks, 0 otherwise. *Pass* is 1 for banks that pass the ST, 0 otherwise. *Moodys* is 1 when Moodys gives the less severe rating and 0 otherwise. Rating is the average credit rating prior to disclosure (standardized values). *Days* is the number of days that precede the first rating adjustment; *#Agencies* is the number of agencies that rate the bank/issue. *GSIB* is 1 for systemic banks and 0 otherwise. *Leverage* is the leverage ratio, NM is the Net Margin, *CAP* is the excess of TIER1 capital over the regulatory minimum, AQ is the ratio of NPL loans over TIER1, and AQR is equal to 1 after the Asset Quality Review comes into effect and 0 in previous years. Covariates are measured in the year prior to ST programs.2016 is 1 for EBA 2016 and EBA 2018 and 0 for other EU ST. FE/RE/P indicates Fixed-Effects, Random-Effects or Pooled model, BP-p value and H-p values are the p values of the Breusch-Pagan and the Haussman test respectively.

European banking system's transparency. On the other hand, our results help better understand the role of rating agencies as information providers, which is more relevant for banks with a higher probability of failing the ST.

Lastly, additional research is needed to further evaluate the effectiveness of ST programs in reducing opacity in the banking sector. We leave for future research to extend the analysis by adding other direct proxies of opacity.

CRediT authorship contribution statement

Pilar Abad: Conceptualization, Supervision, Formal analysis. **M.-Dolores Robles:** Conceptualization, Supervision, Formal analysis. **Carlos Alonso Orts:** Data curation, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix

Table A1
US tested (ST) and control (C) banks by stress test program.

	SCAP								
	2009	2012	2013	2014	2015	2016	2017	2018	2019
Ally Financial Inc	ST	C	C	C	C	C	C	C	ST
Bank of America Corp	C	C	C	C	C	C	C	C	C
Bank of New York Mellon Corp	C	C	C	C	C	C			
Canadian Imperial Bank of Commerce	ST	ST	ST	ST	ST	ST	ST	ST	
Charles Schwab Corp	ST	ST	ST	ST	ST	ST	ST	ST	ST
CIT Group Inc	ST								
Comerica Inc	ST	ST	ST	C	C	C	C	ST	ST
Discover Financial Services	ST	ST	ST	C	C	C	C	C	ST
Fifth Third Bancorp	C	C	C	C	C	C	C	C	ST
First Horizon Corp		ST	ST						
First Midwest Bancorp Inc		ST	ST	ST	ST	ST	ST	ST	ST
Jefferies Financial Group Inc	ST	ST	ST	ST	ST				
JPMorgan Chase & Co	C	C	C	C	ST	C	ST	ST	
KeyCorp	C	C	C	C	C	C	C	C	ST
M&T Bank Corp	ST								
Morgan Stanley	C	C	C	C	C	C	C	C	C
Northern Trust Corp	ST	ST	ST	C	C	C	C	C	C
PNC Financial Services Group Inc		C	C	C	C	C	C	C	C
State Street Corp						C	C	C	C
Toronto-Dominion Bank	ST	ST	ST	ST	ST	C	C	C	
Truist Financial Corp	ST								
U.S. Bancorp	C	C	C	C	C	C	C	C	C
Webster Financial Corp	ST	ST	ST	ST	ST	ST	ST	ST	ST
Wells Fargo & Co	C	C	C	C	C	C	C	C	C
Tested banks	12	10	10	6	7	4	5	6	8
Control banks	8	10	10	13	12	15	13	12	7
Total	20	20	20	19	19	19	18	18	15

Table A2
EU tested (ST) and control (C) banks by stress test program.

	EBA2010	EBA2011	EBA2014	EBA2016	EBA2018
Aareal Bank AG				C	C
ABN Amro Bank NV	ST	ST	ST	ST	ST
AIB Group plc					C
Aktia Bank Abp				C	
Alpha Bank SA	ST	ST			
Banca Monte dei Paschi di Siena SpA	ST	ST	ST	ST	
Banca Piccolo Credito Valtellinese SpA	C		ST	C	C
Banco Bilbao Vizcaya Argentaria SA	ST	ST	ST	ST	ST
Banco Comercial Portugues SA			ST	C	
Banco de Sabadell SA	ST	ST	ST	ST	ST
Banco Santander SA	ST	ST	ST	ST	ST
Bank of Ireland					ST
Bankinter SA	ST	ST	ST	C	C
Banque Internationale a Luxembourg SA	C	C	C	C	C
Barclays PLC			ST	ST	ST
BNP Paribas SA	ST	ST	ST	ST	ST
Bper Banca SpA		C	ST		
Caixabank SA		C	C	C	ST
Close Brothers Group PLC	C	C			
Commerzbank AG	ST	ST	ST	ST	ST
Danske Bank A/S	ST	ST	ST	ST	ST

(*continued on next page*)

Table A2 (*continued*)

	EBA2010	EBA2011	EBA2014	EBA2016	EBA2018
Deutsche Bank AG	ST	ST	ST	ST	ST
Deutsche Pfandbriefbank AG	C	C	st		
Erste Group Bank AG	ST	ST	ST	ST	ST
HSBC Holdings PLC	ST	ST	ST	ST	ST
ING Groep NV	ST	ST	ST	ST	ST
Intesa Sanpaolo SpA	C	C	C	C	C
KBC Groep NV	ST	ST	ST	ST	ST
Lloyds Banking Group PLC	ST	ST	ST	ST	ST
National Bank of Greece SA			ST		
Natwest Group PLC	ST		ST	ST	ST
Nordea Bank Abp			ST	ST	ST
Raiffeisen Bank International AG	ST	ST	ST	ST	ST
Skandinaviska Enskilda Banken AB	ST	ST	ST	ST	
Societe Generale SA	ST	ST	ST	ST	ST
Sparebank 1 SR Bank ASA	C	C	C	C	C
Standard Chartered PLC	C	C	C	C	
Swedbank AB	ST	ST	ST	ST	ST
UniCredit SpA	ST	ST	ST	ST	ST
Tested banks	22	21	28	22	22
Control banks	7	8	5	10	7
Total	29	29	33	32	29

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