



**HAL**  
open science

# Predicting European Banks Distress Events: Do Financial Information Producers Matter?

Quentin Bro de Comères

► **To cite this version:**

Quentin Bro de Comères. Predicting European Banks Distress Events: Do Financial Information Producers Matter?. 2022. hal-03752678v1

**HAL Id: hal-03752678**

**<https://hal.science/hal-03752678v1>**

Preprint submitted on 17 Aug 2022 (v1), last revised 4 Oct 2022 (v3)

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# Working Paper – March 2022

## Predicting European Banks Distress Events: Do Financial Information Producers Matter?

QUENTIN BRO DE COMÈRES\*

---

\* CRIEF, Université de Poitiers (2 rue Jean Carbonnier – bât. A1 – 86073 Poitiers Cedex 9). *E-mail address:* [quentin.bro.de.comeres@univ-poitiers.fr](mailto:quentin.bro.de.comeres@univ-poitiers.fr), *Phone number:* +33 5 49 45 48 77. The author thanks Anne-Gaël Vaubourg (CRIEF) and Sophie Brana (BSE, Université de Bordeaux) for their very helpful insights, as well as Thomas Maurice (CRIEF), Matthew Fontes Baptista, Hannah Schlosser, Clotilde Maral and participants at CRIEF Seminar in Poitiers and 2021 workshop on the Production of Financial Information on Banks in Bordeaux. This work has received the financial support of Région Nouvelle-Aquitaine (AAPR2020-2019-8316410). All remaining errors are the author's own.

## Abstract

This article assesses the predictive power of sell-side stock analysts and credit rating agencies on the prevision of European banks distress events by introducing their respective disclosures into a logit early-warning system over the 2000-2019 period. As direct bank failures are rare in Europe, we construct a dataset accounting for direct failures and state and private sector interventions. The model is calibrated to minimize the loss of a decision-maker committed to prevent impending distress events and is estimated in a real-time fashion. We also control for bank- and macro-level data. We find both financial information producers' disclosures to display informative and predictive performance on bank distress risk up to two years in advance.

**JEL Classifications:** E44, F37, G21, G24

**Keywords:** Bank Distress, Early Warning Systems, Financial Analysts, Credit Rating Agencies

# 1 Introduction

While [Lo Duca, Koban, Basten, Bengtsson, Klaus, Kusmierczyk, Lang, Detken, and Peltonen \(2017\)](#) found the output losses of previous banking crisis to average 9% of GDP for European countries, more than EUR 5.02 trillion have been granted as stabilization aid by European Union member states over the 2008–2019 period<sup>1</sup> (30% of the E.U.-28 2019 GDP) to avoid a systemic collapse and ensure a proper financing of the economy. This has highlighted the usefulness of early-warning systems (EWS) for regulators, investors and bank creditors to limit the occurrences of distress events.

The aim of EWS is to prevent the failure of financial institutions (bank-level) or the incidence of systemic events such as banking or financial crises (macroeconomic level) to allow decision-makers<sup>2</sup> to identify vulnerabilities at the bank- or macroeconomic-level and to take preventive action. Most bank-level models focus on U.S. financial firms given the scarcity of direct bank failures in the E.U. These models aim to detect underlying vulnerabilities of banks to assess their probability of being distressed. They principally rely on accounting (e.g., [DeYoung and Torna \(2013\)](#)), market (e.g., [Beltratti and Stulz \(2012\)](#), [Avino, Conlon, and Cotter \(2019\)](#)), and macroeconomic data (e.g., [Demirgüç-Kunt and Detragiache \(1998\)](#), [Betz, Oprică, Peltonen, and Sarlin \(2014\)](#), [Constantin, Peltonen, and Sarlin \(2018\)](#)). Following [Kaminsky and Reinhart \(1999\)](#), a decision rule is extracted from

---

<sup>1</sup> [https://webgate.ec.europa.eu/comp/redisstat/databrowser/view/AID\\_FI\\_USED/default/table](https://webgate.ec.europa.eu/comp/redisstat/databrowser/view/AID_FI_USED/default/table)

<sup>2</sup> That term refers principally to policy-makers, bank supervisors and regulators deemed to be concerned about the failure of financial institutions and able to take relevant action. We use both decision- and policy-maker terms indistinctly. However, that approach could also be relevant for investors and bank creditors, being part of the monitoring component of market discipline ([Flannery and Bliss \(2019\)](#)).

the results to set the optimal moment for a decision-maker to act to prevent an impending distress event by warning financial market participants and regulators or by intervening directly (Davis and Karim (2008)). However, the early identification of bank-level vulnerabilities is constrained by the lack of reliable information given the opacity of these institutions (Morgan (2002), Iannotta (2006), Morgan, Peristiani, and Savino (2014)).

Financial information producers—in the remainder, sell-side stock analysts and credit rating agencies (CRAs; S&P, Moody’s, and Fitch)—are acknowledged to improve information efficiency in capital markets (Bolton, Freixas, and Shapiro (2012), Iannotta, Nocera, and Resti (2013), Anolli, Beccalli, and Molyneux (2014)). The data they release on banks *via* their stock recommendations and credit ratings act as a synthesis of public and private data and is valuable for uncovering negative news on the financial health of firms that managers are less likely to disclose (Flannery (2010)), which is relevant to identify whether a bank enters a state of vulnerability. Both are deemed to be reactive to the disclosure of news on firms and flexible in their evaluation methods. That reactivity is relevant as distress events require a prompt intervention from authorities to prevent negative spillovers. The aim of this article is to assess the information content and predictive power of these two types of financial information producers’ disclosures by integrating them in a logit EWS framework for European banks in 25 countries over the 2000–2019 period. The model is calibrated to minimize the loss a policy-maker would suffer in case of bank distress sufficiently in advance to allow him to act to prevent such outcomes. To overcome the data limitation problem linked to the scarcity of direct distress events in Europe, we construct a dataset of bank distress events accounting for direct failures as well as state and private support granted to banks.

Numerous studies focused on CRAs (e.g., [Bannier and Hirsch \(2010\)](#), [Bar-Isaac and Shapiro \(2013\)](#)) and stock analysts (e.g., [Clarke, Ferris, Jayaraman, and Lee \(2006\)](#), [Cheng and Subramanyam \(2008\)](#), [Brown, Call, Clement, and Sharp \(2015\)](#) or [Ramnath, Rock, and Shane \(2008\)](#) for a literature review) to identify their information content. Given their specific characteristics, financial firms were almost always excluded from previous studies, notably on stock analysts. Among exceptions are [Flannery \(2010\)](#), [Anolli \*et al.\* \(2014\)](#) and [Premti, Garcia-Feijoo, and Madura \(2017\)](#). While focusing on the information content of financial information producers' disclosures, to our knowledge, none has intended to integrate them into an EWS framework to evaluate their usefulness in the monitoring of the health of financial institutions. None has also intended to take advantage of other types of disclosures, such as outlooks, watchlist additions and EPS forecasts on that matter. Therefore, this article contributes to two streams of the literature by evaluating the respective information content of financial information producers on the identification and prevision of bank vulnerabilities and assessing the usefulness a policy-maker would derive from their introduction into an EWS.

We find predicted distress probabilities of the EWS including financial information producer's disclosures to be in line with actual ones up to two years preceding the distress event, meaning that both CRA ratings and stock analyst recommendations are informative on the risks of European banks entering a state of distress. In particular, they contain additional information on such risks with regard to public accounting- and macro-level variables used in previous EWS studies. Consequently, we find that a decision-maker who fears missing crises would derive usefulness from the introduction of such variables into an EWS to identify impending distress events. More precisely, rating and recommendation

levels perform better in distress prevision than their variations, as well as outlooks, watchlist additions, and EPS forecasts. We also find that performance of such disclosures in terms of distress prevision lowers along with the size of banks, meaning that the largest institutions are more difficult to monitor while being the most important to. Despite not being their main objective, performance of financial analysts in terms of distress event prevision tend to be equivalent to that of CRAs. It finally derives from this study that the monitoring of financial institutions by both financial information producers is valuable in identifying risks of distress for European banks.

Section 2 reviews the literature related to our topic, Section 3 presents our bank distress events dataset and our variables of interest, Section 4 displays the estimation framework and Section 5 the results for our baseline model, Section 6 and Section 7 our extensions and robustness checks while Section 8 concludes.

## 2 Literature Review

### 2.1 Predicting Bank Distress Events

Given the cost and complexity of examining banks, on-site examinations are complemented by off-site monitoring, that is, EWS. EWS intend to generate predictions of crises *via* an early-warning model (EWM) according to a definition of a distress event set *ex ante* to provide decision-makers a set of methods to identify vulnerabilities at the bank- or macroeconomic-level to take preventive action.

Most of the EWS literature relies on the binary-choice analysis developed by [Martin](#)

(1977) at the bank level. Probabilities of distress are extracted from discrete choice models regarding a decision threshold. A structured framework was developed by [Demirgüç-Kunt and Detragiache \(2000\)](#) who introduced a loss function for the decision-maker that considers the costs for preventive actions, given his relative preferences between missing crises (Type I errors) and false alarms (Type II errors)—the relative costs of each type of error for him. That framework was extended by [Alessi and Detken \(2011\)](#) who computed a usefulness measure to consider the loss of disregarding the signals of the model and applied to a multivariate logit model by [Lo Duca and Peltonen \(2013\)](#). [Sarlin \(2013\)](#) refined it by reintroducing unconditional probabilities of the crisis events to account for differences in crisis and tranquil period frequencies (as in [Demirgüç-Kunt and Detragiache \(2000\)](#)). He also developed a measure of relative usefulness captured by the model as the proportion of the usefulness the decision-maker would have derived if the model performed perfectly to facilitate comparisons. Finally, his framework incorporates observation-specific weights to account for the relative relevance of banks for the decision-maker.

Despite the scarcity of direct bank failures in Europe, an increasing number of studies have dealt specifically with European banks in recent years (notably, [Gropp, Vesala, and Vulpes \(2006\)](#), [Ötke and Podpiera \(2010\)](#), [Betz \*et al.\* \(2014\)](#), [Constantin \*et al.\* \(2018\)](#), [Lang, Peltonen, and Sarlin \(2018\)](#), [Avino \*et al.\* \(2019\)](#)). The early identification of bank vulnerabilities is limited by the lack of reliable information on them given their opacity ([Morgan \(2002\)](#), [Iannotta \(2006\)](#), [Morgan \*et al.\* \(2014\)](#)) and increasing complexity, which highlighted the relevance of forward-looking information ([Flannery \(2010\)](#)). Most models rely on accounting ratios, particularly proxies for CAMELS<sup>3</sup> ratings. Their predictive

---

<sup>3</sup> The capital adequacy, assets, management capability, earnings, liquidity, sensitivity to market risk



performance is improved by the introduction of variables that account for evolutions in their activity, which increased their sensitivity to many types of risks, such as the structure of income from nontraditional activities (DeYoung and Torna (2013)). However, accounting data are produced periodically, are backward-looking and sensitive to choices in accounting procedures (Moses (1990)). Considering the increase in the share of market-price assets and liabilities in bank balance sheets, other studies introduced market indicators such as stock returns (Beltratti and Stulz (2012)), debt and equity pricing (Gropp *et al.* (2006)) and CDS (Ötke Robe and Podpiera (2010), Avino *et al.* (2019)). These variables are deemed to be more reactive than financial ratios while being forward-looking and available at higher frequencies. Finally, several studies introduced macroeconomic factors to reflect country-level imbalances (Betz *et al.* (2014), Lang *et al.* (2018)) or contagion mechanisms linked to bank interconnections among countries (Constantin *et al.* (2018)). These factors have been the main determinants of past banking crises (Demirgüç-Kunt and Detragiache (1998)). Still, no consensus has been reached over the best model and variables to predict whether a financial firm will become distressed.

## 2.2 Information Content of Financial Information Producers'

### Disclosures

Given their monitoring activity, stock analysts and CRAs contribute to limit information asymmetries on capital markets (Cheng and Subramanyam (2008), Bannier and Hirsch (2010), Barber, Lehavy, and Trueman (2010), Bar-Isaac and Shapiro (2013), Bolton

---

(CAMELS) ratings system was developed in the 1970s by the U.S. supervisory authorities to assess bank soundness.

*et al.* (2012), *Iannotta et al.* (2013), *Anolli et al.* (2014)), which is notably valuable for riskier and more opaque banks (*Premti et al.* (2017)). Their disclosures are widely considered by financial market participants that rely on them to follow their decisions (*Becker and Milbourn* (2011)). This prompts them to be reactive to the disclosure of news on the financial health of the firms they follow. That reactivity is relevant to identify potential distress events in advance and avoid the negative spillovers such occurrences could lead to. Stock analysts have been found more reactive to the disclosure of news than CRAs (*Ederington and Goh* (1998), *De Franco, Vasvari, and Wittenberg-Moerman* (2009)) given the commitment of the latter to rating stability. However, their extensive use of instruments other than ratings, such as watchlist additions, allow them to improve their reactivity (*Bannier and Hirsch* (2010)) without altering ratings. Both analysts and CRAs take public macro- (financial, regulatory and operating environment) and bank-specific factors (financial ratios) into account to derive their reports, as well as private data and qualitative nonfinancial factors (*Jorion, Liu, and Shi* (2005), *Ramnath et al.* (2008)). CRAs still benefit from insider information (e.g., financial projections, minutes of boards) whose access has been reduced to analysts owing to regulation<sup>4</sup>. However, *Cheng and Subramanyam* (2008) documented that collectively, stock analysts acquire more information than that available to credit raters, reflected in the information content of both levels and changes in their

---

<sup>4</sup> Since 2000, regulation in the U.S. such as the Regulation Fair Disclosure have efficiently curbed biases and conflicts of interests of analysts but reduced their access to information (*Gintschel and Markov* (2004)). Similar pieces of regulation have been implemented in Europe since 2003 (MAD and MiFID I and II and the Regulation (EC) No 1060/2009 on CRAs), with mixed effects (e.g., *Dubois, Fresard, and Dumontier* (2013)).

recommendations ([Barber et al. \(2010\)](#)).

By monitoring financial institutions and disseminating forward-looking information on the markets, financial information producers contribute to facilitate the identification of vulnerable entities. While ratings are explicitly probabilities of distress, stock analyst recommendations are fundamentally assessments of the investment value of a stock provided to investors. However, they draw on issues linked to valuation and profitability of firms that are related to their probability of being distressed. Analysts and CRAs interact with each other and benefit from reciprocal disciplinary effects that improve the quality of the data they disclose. Thus, [Ederington and Goh \(1998\)](#) found Granger-causality between Moody's ratings and stock analysts EPS estimates to flow both ways over the 1984–1990 period. [Fong et al. \(2014\)](#) indicated that a drop in analysts' coverage reduces the quality of ratings owing to the reduction of information efficiency linked to analysts' coverage and competition. Indeed, the latter tends to improve the accuracy of their previsions ([Hong and Kacperczyk \(2010\)](#)). Yet, both financial information producers are subject to self-selection concerns ([Lang and Lundholm \(1996\)](#)), the influence of the economic environment and biases<sup>5</sup> that could hinder their performance. By introducing their disclosures into an EWS, we therefore assess whether they display an informative value on distress likelihood for banks.

---

<sup>5</sup> In particular, both CRAs and stock analysts tend to overreact to positive news (e.g., [Becker and Milbourn \(2011\)](#), [Bolton et al. \(2012\)](#) for CRAs, [Galanti and Vaubourg \(2017\)](#) for stock analysts).

## 3 Data

Section 3.1 presents the bank distress events dataset from which our dependent variable is extracted. Variables related to financial information producers and controls are presented in Section 3.2 and Section 3.3, respectively. Construction of variables is detailed in Table 6 (page 42) in Appendix A.

### 3.1 Distress Events Dataset

Ideally, the evaluation of an EWS performance would rely on the comparison of distress probabilities predicted by the model to actual distress probabilities (Bussière and Fratzscher (2006)). As the latter are not directly observable, we replace them by actual occurrences of distress events to derive an *ex post* predistress variable. Given that direct bank failures are rare in Europe, we follow the methodology developed by Betz *et al.* (2014) to construct a dataset of bank distress events. We cover the 2000Q1–2020Q4 period and 29 European countries<sup>6</sup>. We take into account direct bank failures (bankruptcies, liquidations and defaults<sup>7</sup>), state support (capital injection by the state or participation to asset protection, asset guarantees and liquidity support programs) and private sector support (mergers in distress—a parent receives state aid within 12 months after the merger or the coverage ratio<sup>8</sup> of one of the merged banks is negative within 12 months before the

---

<sup>6</sup> Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Faroe Islands, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Liechtenstein, Lithuania, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, and the United Kingdom.

<sup>7</sup> Default ratings by CRAs are not accounted for to prevent endogeneity issues.

<sup>8</sup> Capital equity and loan reserves minus nonperforming loans to total assets (González-Hermosillo (1999)).

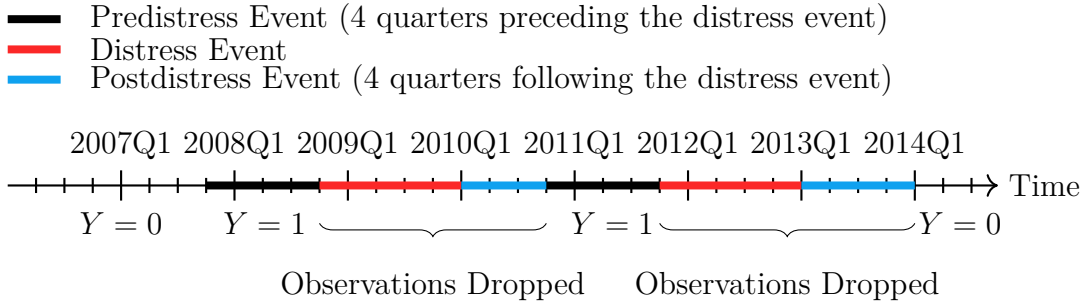
merger—and takeovers and liquidity providing from private entities)<sup>9</sup>. Events begin when the program, failure or merger is announced (or the coverage ratio of the bank falls below 0 within 12 months) and end when it occurs. Our approach to distress events leads to 134 bank occurrences with a 452-quarter duration (Table 8, page 44 in Appendix B). As the categories are not mutually exclusive, the sum of distress events in each category outstrips the total number of distress events. Predistress events are defined as the 4 quarters preceding distress events to keep a sufficiently long period of time to allow the policy-maker to take preventive action once a distress signal has been issued while restraining the incidence of a likely reverse causality bias. That bias could be owed to a panic caused by a downgrade in the rating or recommendation of a bank, the negative impact of such an event on its financing terms or a correction owed to market discipline mechanisms. Thus, we aim to ensure that the evolution of the rating or recommendation is not the main cause of the distress event, which is supported by the fact that most distress events in our sample occurred during crisis periods. We create a binomial variable  $Y$  that takes the value of 1 if it occurs 4 quarters before the distress event, otherwise 0 (PREDISTRESS\_4Q). We also exclude distress and postdistress periods (set to 4 quarters following the distress period) to account for crisis and postcrisis biases (Bussière and Fratzscher (2006)). For instance, the construction of our dependent variable for Dexia N.V./S.A. is presented in Figure 1 (page 13).

---

<sup>9</sup> Data for distress events are extracted from the European Commission, the ECB, European countries central banks, the BIS, Eikon Refinitiv and academical papers (Betz *et al.* (2014), Kerlin, Malinowska-Misiąg, Smaga, Witkowski, Nowak, Kozłowska, Wiśniewski, and Iwanicz-Drozdowska (Ed.) (2016), Lo Duca *et al.* (2017), Constantin *et al.* (2018)).

Figure 1: Binomial Predistress Variable Construction

Dexia N.V./S.A.



## 3.2 Financial Information Producers

Section 3.2.1 presents CRAs-related variables and Section 3.2.2 financial analysts ones.

### 3.2.1 Credit Rating Agencies

For all three CRAs, we consider long-term issuer ratings that are opinions of the ability of a bank to honor current and future senior unsecured debt and debt like obligations and incorporate explicit and implicit external support, extracted from Eikon Refinitiv and FitchConnect. For each agency, we convert the last rating of the quarter to a numerical value going from 1 (S&P, Fitch AAA/Moody's Aaa) to 21 (Default) to get an intuitive measure of default risk<sup>10</sup>. For each quarter  $t$  and bank  $i$ , we compute the average of all available ratings over the number of agencies that maintain an active rating at that date (AVERAGE\_RATINGS and NUMBER\_RATINGS).

All three agencies supplement their rating services by providing additional

<sup>10</sup>Quarters with more than one rating for the same agency were extremely rare. Thus, by construction, the number of agencies is equivalent to the number of ratings each quarter.

information with outlooks and watchlists that are informative on future rating variations. Outlooks reflect the agency’s opinion on the development of the likely rating direction over the medium term, while watchlists focus on a shorter time horizon (on average three months). Both are used by CRAs to be more reactive to news without altering rating stability (Banner and Hirsch (2010)). To each positive outlook and agency we associate the value of 1 to construct an ordered variable ranking from 0 to 3. We do the same for stable and negative outlooks, positive and negative watchlist additions, upgrades and downgrades (POS, STA, NEG\_OUTLOOKS, WATCHLISTS; UP, DOWN\_RATINGS, OUTLOOKS, WATCHLISTS).

### 3.2.2 Financial Analysts

We focus on sell-side equity analyst recommendations. We consider the consensus estimates extracted from Thomson Financial’s Institutional Brokers Estimate (I/B/E/S), which is computed as the mean of a standard set of analyst recommendations. To obtain quarterly data, we use the last value available for each quarter. Each numerical value is rounded to the nearest integer and labelled by I/B/E/S as 1 = *Strong buy*, 2 = *Buy*, 3 = *Hold*, 4 = *Sell*, 5 = *Strong sell*, which means that *in fine* values from 1 to 1.49 correspond to *Strong buy*, 1.5 to 2.49 to *Buy* and so on (AVERAGE\_REC). We integrate consensus downgrade and upgrade dummies to account for the change in recommendations each quarter (UP, DOWN\_REC). We introduce the former as both recommendation levels and variations can send opposite signals. We also introduce the quarterly number of

recommendations<sup>11</sup> (NUMBER\_REC). In further analysis, we replace the recommendation consensus by current fiscal year (FY1) EPS forecasts, found to convey information on default risk by [Moses \(1990\)](#), though on nonfinancial firms.

### 3.3 Additional Variables

To test whether our variables of interest retain an information content *vis-à-vis* other data sources and to capture a wide range of potential risk factors, we add additional controls to our baseline equation. Macroeconomic controls are presented in Section 3.3.1 and banking sector- and bank-level ones are in Section 3.3.2 and Section 3.3.3, respectively. Data are extracted from Datastream, FitchConnect and Eurostat.

#### 3.3.1 Macroeconomic Controls

To control for macro imbalances we add country-specific macroeconomic variables to our model and a global market factor. The idea is also to account for the economic cycle, given that it has an impact on the performance of financial analysts and CRAs as uncertainty and bank opacity rise in downturn periods ([Bar-Isaac and Shapiro \(2013\)](#), [Anolli et al. \(2014\)](#), [Premti et al. \(2017\)](#)).

Regarding the economic cycle, we consider the annual real GDP growth rate (REAL\_GROWTH\_GDP) which has a direct impact on the vulnerability of banks ([Demirgüç-Kunt and Detragiache \(1998\)](#)). In depression periods, the interest income and average asset quality of banks tend to decrease along with investment and household income

---

<sup>11</sup>The number of recommendations is not equivalent to the number of analysts as the same analyst sometimes issues more than one recommendation in a given quarter, but both are very close.



and corporate profitability, which also weighs on credit risk given the increase in nonperforming loans (Mody and Sandri (2012), Altavilla *et al.* (2018)). The inflation rate (INFLATION) proxies for macroeconomic mismanagement (Demirgüç-Kunt and Detragiache (1998)), which adversely affects the economy and the banking system. Rises in inflation impact the vulnerability of banks by favoring an increase in their leverage.

The annual 10-year sovereign bond yield proxies for macroeconomic imbalances (10Y\_BOND\_YIELD). An increase in that yield reflects a depreciated opinion of investors over the riskiness of the country. Such events also lead to a drop in the price of sovereign bonds that weighs on the profitability of domestic banks if they hold quantities of them with short maturity in their balance sheets. Higher yields may also prompt fiscal consolidation that weighs on GDP and bank profitability (Mody and Sandri (2012)). To account for the orientation of monetary policy and interest rate risk, we add a composite variable constructed as the Wu-Xia shadow rate for the Euro Area and the UK and the actual policy rate when values are missing. Beyond its effects on credit and investment growth, a restrictive monetary stance impedes bank profitability by compressing their interest margin (Davis and Karim (2008)) and weighing on credit risk (COMPOSITE\_RATE).

The private sector credit flow to GDP ratio measures the exposition of the banking sector to the nonfinancial private sector (CREDIT\_FLOW\_GDP). Demirgüç-Kunt and Detragiache (1998) displayed evidence that the more exposed to the private sector, the more vulnerable the banking sector given the rise in credit risk in downturn periods.

Finally, to account for market risk we add the VIX index that measures the implied volatility of the S&P 500 stock market options as a global factor (VIX). We only consider one market control as these variables tend to have a short horizon of prediction. Given the

interconnection of the U.S. and European markets, it appears a good predictor of volatility changes in Europe (Sarwar (2020)) and allows us to include securities market instability that matter for banks given the increase in the share of market-price assets and liabilities in their balance sheets<sup>12</sup>.

### 3.3.2 Banking Sector Controls

To control for country-level imbalances in banking systems, we introduce the following three variables. First, the ratio of total assets to GDP controls for the relative size of the banking sector and the evolution of bank balance sheets to identify lending boom episodes (TOTAL\_ASSETS\_GDP). Moreover, as noted by Kaminsky and Reinhart (1999), banking problems often arise from the asset side rather than the liability side of balance sheets, owing to a deterioration in asset quality e.g., following a collapse in real-estate prices. The next two ratios reflect the building up of banking sector vulnerabilities. The ratio of debt securities to liabilities accounts for securitization, which exposes banks to interest and macroeconomic risks owing to changes in the valuation of the securities they hold (DEBT\_SECURITY\_LIAB). This was particularly relevant for European countries during the Sovereign Debt Crisis as sovereign debt accounts for two-thirds of securities held by banks in the E.U., the latter representing 15 to 20% of their balance sheets (Altavilla *et al.* (2018)). Finally, we proxy banking sector leverage by the ratio of loans to deposits

---

<sup>12</sup>We also tested the EURO STOXX 50 Volatility Index (VSTOXX) in another specification as that index is more relevant in the European case. However, we achieved lower performance while the variable was insignificant and negatively associated to distress risk. Thus, we consider the VIX instead. Still, both indexes are strongly correlated, particularly during crises (Shu and Chang (2019)).

(LOANS\_DEPOSITS\_M). The more leveraged the banking sector, the less room it has to maneuver in downturn periods.

### 3.3.3 Accounting Ratios

With regard to the extensive literature on the topic, we consider widely used proxies for CAEL ratings. We proxy the capital adequacy (C) of the bank by the leverage—equity to assets—ratio (EQUITY\_TO\_ASSETS). A higher level of capital acts as a buffer to financial losses and reduces a bank’s probability of distress. Return on assets (ROA)—an indicator of profitability—proxies for asset quality (A)<sup>13</sup> As an indicator of financial performance, return on equity (ROE) proxies for earnings risks (E). Finally, we proxy the liquidity risk (L) by the loans to deposits ratio following [Anolli \*et al.\* \(2014\)](#), which displays the ability of a bank to cover loan losses or face sudden massive withdrawals (LOANS\_DEPOSITS).

We control by the size of the bank as the natural logarithm of its total assets (SIZE). Theoretically, larger banks are less prone to be distressed as they are more likely to receive external support when identified as vulnerable, are most cost-efficient and take advantage of more investment opportunities. Yet, [Boyd and Runkle \(1993\)](#) found that larger banks are not less likely to be distressed as they are systematically more highly leveraged and less profitable in terms of assets returns. The size of the bank also allows us to control for bank opaqueness following [Premti \*et al.\* \(2017\)](#) as [Iannotta \(2006\)](#) indicated that opacity increases

---

<sup>13</sup>Widely used proxies for asset quality also include the share of nonperforming loans to total loans, nonperforming assets to total assets and loan-loss provisions to total loans. We tested all three specifications but achieved similar to lower performance, with substantial restrictions in estimation samples. Consequently, we did not keep them.

with bank size. Still, the effect of size on that matter remains ambiguous. While a large bank may receive more coverage from analysts and CRAs and benefit from a greater dissemination of information, that is, an increased probability of being rescued in a timely manner, it has more opportunities to expand into nontraditional or complex activities and to become more difficult to monitor.

## 4 Methodology

The modeling framework is presented in Section 4.1 and the estimation procedure in Section 4.2.

### 4.1 Modeling Framework

Our modeling framework is similar to that of [Sarlin \(2013\)](#) and reproduces the decision problem faced by a decision-maker that can be summarized as classifying the banks into vulnerable and nonvulnerable categories. We assume that the decision-maker has the ability and concern to act to prevent bank distress events. The evaluation criterion must account for the fact that distress events occur rarely and are often costly. We consider a decision-maker with relative preferences ( $\mu \in [0, 1]$ )—related to his degree of risk aversion—between Type I (missing crises) and Type II (false alarms) errors and the usefulness he gets by considering the model for making his decisions over disregarding it. Both types of errors are costly for him owing to the cost of crises, and the damaging effects on his credibility and the cost of taking preventive actions, which is internalized into his preferences. Let  $Y_i^h \in \{0, 1\}$ ,  $i \in \llbracket 1, N \rrbracket$  be a binary state variable that represents the

occurrence of a predistress event for a bank  $i$ , with  $h$  a forecast horizon to define predistress events.  $Y_i^h = 1$  during predistress periods and 0 otherwise. Let  $p_i$  be the probability of being in a predistress state ( $Y_i^h = 1$ ) estimated using a discrete-choice model. To classify observations into vulnerable and nonvulnerable states,  $p_i$  is turned into a binary (warning) signal  $P_i \in \{0, 1\}$  that equals 1 if  $p_i$  exceeds a threshold  $\lambda \in [0, 1]$ , otherwise 0. The correspondence between  $P_i$  and  $Y_i^h$  is derived from the contingency matrix displayed in Table 1 (page 20).

Table 1: Contingency Matrix

		Actual Class ( $Y_i^h$ )	
		Predistress period (1)	Tranquil period (0)
Predicted Class ( $P_i$ )	Signal (1)	Correct call <i>True positive (TP)</i>	False alarm <i>False positive (FP)</i>
	No signal (0)	Missed crisis <i>False negative (FN)</i>	Correct silence <i>True negative (TN)</i>

For a time horizon  $h$ , the decision-maker chooses a threshold  $\lambda$  given probabilities  $p_i$  to minimize his loss with regard to his relative preferences  $\mu$  between missing crises and false alarms. Type I errors ( $T_1(\lambda)$ ) are the probabilities of not receiving a warning signal conditional on a crisis occurring, estimated with in-sample (IS) frequencies as the proportion of missed crises over the number of crises. Similarly, Type II errors ( $T_2(\lambda)$ ) are the probabilities of receiving a warning signal conditional on no crisis occurring, estimated with in-sample frequencies as the proportion of false alarms over the number of calm periods.

Formally,  $T_1(\lambda) \in [0, 1] = P(p_i \leq \lambda | Y_i^h = 1) = FN / (FN + TP)$  and

$T_2(\lambda) \in [0, 1] = P(p_i > \lambda | Y_i^h = 0) = FP / (FP + TN)$ . To enhance the framework we

introduce observation-specific differences in costs that are linked to the systemic relevance of banks for the decision-maker, which impacts misclassification costs (e.g., spillovers following the failure of a systemic bank are more important than those of a small bank). We define  $w_i$  as bank-specific weights that approximate the importance of correctly classifying observation  $i$  for the policy-maker, and  $TP_i, FP_i, TN_i, FN_i$  binary vectors of combinations of predicted and actual classes. Weighted Type I and Type II errors are

$$T_{w1}(\lambda) \in [0, 1] = \sum_{i=1}^N w_i FN_i / (\sum_{i=1}^N w_i FN_i + \sum_{i=1}^N w_i TP_i) \text{ and}$$

$T_{w2}(\lambda) \in [0, 1] = \sum_{i=1}^N w_i FP_i / (\sum_{i=1}^N w_i FP_i + \sum_{i=1}^N w_i TN_i)$ . We compute weights as the share of total assets of a bank relative to the sum of total assets of all banks in the sample for each quarter. To gauge the loss of the decision-maker,  $T_1$  ( $T_{w1}$  in the weighted case) and  $T_2$  ( $T_{w2}$ ) are weighted by his preferences parameter between missing crises ( $\mu$ ) and issuing false alarms ( $1 - \mu$ ). Finally, to account for class-imbalance issues we consider the unconditional

probabilities of predistress and tranquil periods:  $P_1 = P_i(Y_i^h = 1)$  and

$P_2 = P_i(Y_i^h = 0) = 1 - P_1$ . The loss function is given in equation (1).

$$(1) \quad L(\mu, \lambda) = \mu T_1(\lambda) P_1 + (1 - \mu) T_2(\lambda) P_2.$$

When weights are introduced, the function becomes:

$L(\mu, \lambda, w_j) = \mu T_{w1}(\lambda) P_1 + (1 - \mu) T_{w2}(\lambda) P_2$ ,  $j \in \{1, 2\}$ . If the decision-maker chooses to ignore the model by always signaling a crisis when  $P_1 \geq 0.5$  or equivalently, never signaling it when  $P_2 > 0.5$  (a coin toss), given his preferences he can achieve a loss of  $\min(\mu P_1, (1 - \mu) P_2)$ . Thus, his absolute usefulness ( $U_a$ ) is defined as the loss suffered when

ignoring the model minus the loss suffered when considering it (equation (2)):

$$(2) \quad U_a(\mu, \lambda) = \min(\mu P_1, (1 - \mu)P_2) - L(\mu, \lambda).$$

Finally, the relative usefulness ( $U_r$ ) is the percentage of absolute usefulness to the maximum possible usefulness the policy-maker could derive from the model (i.e.,  $L(\mu, \lambda) = 0$  as the model is performing perfectly,  $T_1 = T_2 = 0$ ) to obtain a more interpretable measure that allows the comparison of models for decision-makers with different sets of preferences  $\mu$  (equation (3)).

$$(3) \quad U_r(\mu, \lambda) = \frac{U_a(\mu, \lambda)}{\min(\mu P_1, (1 - \mu)P_2)}.$$

In the weighted case, we get  $U_a(\mu, \lambda, w_j)$  and  $U_r(\mu, \lambda, w_j)$ . The decision-maker's preferences  $\mu$  are exogenous as they depend on his degree of risk-aversion and the relative cost of a crisis *vis-à-vis* the cost of taking preventive actions. Once given, [Bussière and Fratzscher \(2008\)](#) showed that both the time horizon  $h$  and the threshold  $\lambda$  are uniquely determined. We set the former to 4 quarters. Then, there exists a unique optimal threshold  $\lambda^*$ , which we obtain post estimation by minimizing equation (1).

For each estimated model, we compute the receiver operating characteristics (ROC) curve and the area under the ROC curve (AUC). Both measure the performance for all combinations of preferences  $\mu \in [0, 1]$  and thresholds  $\lambda$  while the usefulness is only computed for a given threshold  $\lambda$ —a unique point on the ROC curve. For each  $\lambda$ , the ROC curve displays the trade-off between the benefits (True Positive Rate) and costs (False Positive

Rate) of a given classifier model. The AUC measures the probability that a randomly chosen predistress event ( $Y = 1$ ) is ranked higher than a randomly chosen tranquil period ( $Y = 0$ ) by the model. A perfectly performing model would display an AUC of 1. However, both measures are limited in that the AUC includes situations that are not policy relevant while ROC curves do not account for misclassification costs and class imbalance issues.

## 4.2 Estimation Procedure

We consider a discrete-choice logit model. As predistress events are less frequent than calm periods, they are better modelled by a logit model than by a probit one owing to the former's assumption of more fat-tailed error distribution (van den Berg, Candelon, and Urbain (2008)). Pooled logits are preferred to panel ones by the literature (e.g., Lo Duca and Peltonen (2013), Betz *et al.* (2014), Constantin *et al.* (2018)) for increasing the number of observations so as to capture a wide variety of distress events whose occurrences are rare in individual countries. Fuertes and Kalotychou (2006) also documented that using time- and country-fixed effects models weighs on the predictive out-of-sample (OOS) performance while improving in-sample fit. Still, in our model, country-fixed effects are to a certain extent taken into account by the country- and banking sector-specific independent variables while time effects are considered by global factors. Our logit EWM is displayed in equation (4).

$$(4) \quad P(Y_{i,t}^h = 1 | X_{i,t}) = p_{i,t} = \frac{e^{X'_{i,t}\beta}}{1 + e^{X'_{i,t}\beta}}, \quad i \in \llbracket 1, N \rrbracket, t \in \llbracket 1, T \rrbracket.$$

With  $p_{i,t}$  the probability of bank  $i$  to be in a vulnerable state within forecast horizon  $h$  at quarter  $t$  (thus,  $(Y_{i,t} = 1)$   $h$  quarters before the distress event),  $\beta$  a vector of coefficients and



$X_{i,t}$  a vector of an intercept and independent variables. To replicate a real-time information structure, independent variables are lagged by two quarters for financial statements, and one quarter for macroeconomic and banking sector variables. We assume that financial information producers' disclosures, the VIX, the shadow and policy rates and the 10-year sovereign bond yield are known at least within the quarter of their implementation. Therefore, we do not apply lags to them.

We follow the strategy of [Betz \*et al.\* \(2014\)](#) by estimating our model on recursive increasing windows for the in-sample period and one-quarter rolling windows for the out-of-sample period to test the model performance in real-time use. We estimate our model each quarter  $t \in \llbracket 1, T \rrbracket$  on all information available up to that quarter, we evaluate the signals to set an optimal threshold  $\lambda$  and estimate the current vulnerability state of each bank with it. Formally, we estimate the model with in-sample data that would have been available from the beginning of the sample to quarter  $t$  (excluded), we collect the probabilities of the model for the in-sample period and compute the usefulness for all thresholds  $\lambda \in [0, 1]$ . Then, we choose the threshold  $\lambda^*$  that maximizes in-sample usefulness, estimate distress probabilities for the out-of-sample data (quarter  $t$ ) and apply the threshold to obtain the signals given by:  $P_{i,t} = 1$  if  $\hat{p}_{i,t} > \lambda^*$ , 0 otherwise. Finally, we set  $t = t + 1$  and reestimate the model from the first step at each quarter  $t$  until  $t = T$ .

## 5 Results

Summary statistics are displayed in Section 5.1, followed by results from our main estimations in Section 5.2.

## 5.1 Summary Statistics

We perform our estimations over the 2000Q3-2019Q4 period owing to lags in control variables. Our predictions draw on an increasing window for the in-sample part (2000Q3–2019Q3) and one-quarter rolling windows for the out-of-sample part, starting in 2008Q3 until 2019Q4 to get half of the precrisis observations in the initial in-sample part. Data are winsorized at the 1<sup>st</sup> and 99<sup>th</sup> percentiles to limit the incidence of outliers. Our initial dataset covers 204 European banks covered by financial information producers in 29 countries. Summary statistics are displayed in Table 2 (page 38). The size variable reveals that our sample is mostly composed of systemic institutions. On average, banks benefit from 7.56 recommendations per quarter but less than one CRA rating as most of them were not covered every quarter over the estimation period. Pearson’s correlation coefficients<sup>14</sup> remain globally moderate. Of particular interest are the size and number of recommendations and ratings that are positively correlated.

[Insert Table 2 (page 38) here]

## 5.2 Estimation

Our baseline model introduces both our variables of interest and macro-financial controls to capture a wide variety of risks while keeping a sufficient number of observations. Given the proportion of missing values for ratings and recommendations the baseline sample accounts for 147 of 204 banks (72% of the sample or roughly 50% of quarter-distress

---

<sup>14</sup>All untabulated results in the remainder are available from the author upon request.

events)<sup>15</sup>, but country distribution remains stable over time and countries (Figure 5, page 44 and Table 7, page 43 in Appendix B), except for Denmark and the Netherlands. Total sample refers to the observations remaining following the removal of distress and postdistress periods (204 banks in 29 countries).

Table 3 (page 39) presents the in-sample estimated coefficients of the baseline regression and out-of-sample performance measures for a decision-maker with preferences  $\mu \in [0.6, 0.95]$  obtained for each quarter over the out-of-sample time period (2008Q3–2019Q4). Considering that early-warning signals at the bank-level would primarily lead to an in-depth review of fundamentals and peers of the bank predicted to be distressed rather than to a direct corrective action, that is, more costly, the loss in credibility for the decision-maker would remain limited whether the signal turned out to be false (Betz *et al.* (2014)). Thus, it is plausible for him to be strongly more concerned about missing bank distress events than issuing false alarms. However, despite performance of our model being generally maximized for  $\mu = 0.95$  we disregarded that value considering policy-maker preferences would be too skewed toward missing crises—in-depth reviews are still expensive—while  $\mu = 0.9$  remains more plausible. Model (1) (column 1 in Table 3) is our baseline case<sup>16</sup>. Accounting ratios are removed in Model (2), and ratings and recommendations are in Model (3) to assess their respective added value. In Models (4) and (5), ratings and recommendations are introduced independently from each other.

---

<sup>15</sup>Banks in that subsample are covered on average by 1.5 CRAs and 15.4 analysts. Statistics for other variables are broadly similar.

<sup>16</sup>VIF where computed and revealed the absence of severe multicollinearity with no value above 5 and a 2.37 average.

[Insert Table 3 (page 39) here]

In the baseline case (Model (1)), both coefficients for rating and recommendation averages are strongly significant with a positive influence on the likelihood of a bank entering a predistress state. Hence, as expected, an increase in the rating or recommendation for a bank is linked to an increase in its distress risk. This result means CRA disclosures effectively reflect distress risk as they are expected to by financial markets participants. Despite not being their primary concern, analyst recommendations are useful alike on that matter. The number of agencies is negatively significant, while the number of analysts is in Models (2) and (5), what [Cheng and Subramanyam \(2008\)](#) explain by improvements in the information environment of widely covered firms owed to competition among analysts and mutual interactions between analysts and agencies.

Regarding macroeconomic controls, an increase in real GDP growth tends to reduce the risk of entering a predistress state, while rises in inflation, the 10-year sovereign bond yield, the policy rate and private sector credit flow to GDP all tend to increase distress risk. Among banking sector controls, the total assets to GDP ratio is significantly positive whereas other variables are not significant. Thus, the larger the banking sector, the higher the probability of banks entering a predistress state. This is relevant given that the size of banks has a positive influence on their distress risk. Finally, all accounting variables are significant with signs in line with related literature ([Betz \*et al.\* \(2014\)](#), [Constantin \*et al.\* \(2018\)](#)). Banks benefiting from higher capital ratios and return on equity (ROE) are less likely to be distressed. The size of the bank finally turns out to have a positive influence on distress risk, which means that bigger banks are more likely to be distressed as in [Boyd and Runkle \(1993\)](#)

or [Jin, Kanagaretnam, and Lobo \(2011\)](#). The loans to deposits ratio is positively related to bank distress given that the more elevated this ratio, the less the ability of the bank to cover loan losses and withdrawals. As both ROA and loans to deposits were found negatively correlated with the size variable, the positive effect of the size of the bank on distress risk is likely to be owed to lukewarm asset returns for European banks. Variations present marginal changes only, except that the consensus recommendations is insignificant in Model (5), while securitization tends to limit the risk of a bank entering a state of predistress in Models (3) and (4). In short, in-sample results reveal that both ratings and recommendations convey information on distress risk, particularly when considered simultaneously. When introduced alone, ratings remain more informative than recommendations.

Turning to out-of-sample performance, in terms of classification accuracy, reflected by the AUC, the best performing model is Model (1), followed by Models (4) and (2) with AUCs over 0.87. Models including ratings tend to perform better in classification accuracy. Regarding the relative usefulness<sup>17</sup> a decision-maker could get *vis-à-vis* disregarding the model with preferences  $\mu = 0.9$ , in the nonweighted case, the best performing model is the (1) with a relative usefulness of 39%—39% of the usefulness that would be derived from a perfectly performing model—while the worst performing is Model (3). Interestingly, the insignificance of the coefficient for recommendation consensus in Model (5) does not translate into lower out-of-sample performance *vis-à-vis* Model (4), except for the AUC. The picture is less clear-cut in the weighted case, as all models tend to display similar performance for  $\mu = 0.95$ . Model (3)—including accounting variables—performs best for lower values of  $\mu$ . Hence, a decision-maker more concerned by systemic institutions would derive relatively

---

<sup>17</sup>Negative usefulness is normalized to 0.

more usefulness from models that include ratings only than those that include both ratings and recommendations, except if his preferences are strongly skewed toward missing crises. On the contrary, for more balanced sets of preferences, a policy-maker would sometimes optimally disregard the EWM. The general decrease in usefulness when weights are included highlights that predicting distress risk is more difficult for larger—and more complex and opaque (Iannotta (2006))—banks. Thus, from a policy-maker’s point of view, financial information producers’ disclosures appear not to be more informative when opacity rises as evidenced by Iannotta *et al.* (2013) and Anolli *et al.* (2014), which offsets the positive effect of an increase in their coverage on the information environment of banks, reflected in the negative influence of the number of CRAs and analysts on distress risk. This is particularly true when both types of disclosures are introduced simultaneously, as CRA ratings tend to perform slightly better than analyst recommendations overall. Finally, keeping only macro- and banking-sector wide variables yielded performance close to that of Model (3).

Variations in the number of observations are important among the samples owing to missing values going from 5,082 (Model (1)) to 9,983 (Model (3)), which hinders comparability. All regressions are reproduced on the baseline sample of 5,082 observations in Section 7.2 and yield similar results. Our results highlight that financial information producers complement accounting and macro-level variables in- and out-of-sample and are useful to detect distress risk in advance. Thus, their monitoring on financial institutions do has an influence on distress risk. The coefficient associated to analyst recommendations is significant only when ratings are taken into account, which is reflected in a lower classification accuracy but do not translate into lower out-of-sample performance from a policy-maker’s point of view. In terms of usefulness, by considering the model instead of

disregarding it, both ratings and recommendations tend to be complementary in distress prevision. That relation weakens when the systemic relevance of banks is taken into account. In that case, they tend to become substitutes with a slightly equivalent performance. Therefore, both CRA ratings and analyst recommendations could usefully be introduced into an EWM in complement or substitute accounting variables to obtain more parsimonious models if necessary. Yet, 27% of banks are lost in the baseline sample, which means that such models could only be applied to a limited number of systemic institutions<sup>18</sup>, that are also more difficult to monitor. Finally, performance achieved tends to highlight a redundancy between accounting data and financial information producers disclosure, though at the expense of a significant loss of observations when opting for the latter case.

## 6 Further Analysis

This Section presents further analysis by introducing other types of financial information producers' disclosures, from CRAs (Section 6.1) and financial analysts (Section 6.2).

### 6.1 Ratings, Outlooks, Watchlists

Table 4 (page 40) introduces other types of CRA disclosures. To assess their respective performance, analyst recommendations are excluded from the regressions<sup>19</sup>.

Variations in ratings are introduced in Model (1) and complemented by outlooks and

---

<sup>18</sup>Mean and median size are significantly different among samples (17.99 and 17.77 for the reduced sample, and 17.03 and 16.83 in the whole sample, respectively).

<sup>19</sup>Results including the latter are broadly unchanged, with relative usefulness only slightly higher.

watchlist levels and variations in Models (2), (3) and (4). Among all specifications, coefficients for downgrades in ratings and stable and negative outlooks are positively significant. That is, they convey additional information on distress risk *vis-à-vis* rating levels. That result may highlight both the incidence of an optimism bias and the fact that CRAs are effectively deemed by market participants as discovering negative news. On the contrary, as they are likely to reflect a piece of information already disclosed to the markets or an overreaction to that piece of information, upgrades appear not to be informative on distress risk. Regarding out-of-sample performance, results are equivalent to those of Model (4) in Table 3 (page 39), meaning that introducing these other types of disclosures in the model is not crucial from a decision-maker's point of view.

## 6.2 Recommendations and EPS Forecasts

We replicate the same exercise for analyst recommendations in Model (5) of Table 4 (page 40), following [Barber \*et al.\* \(2010\)](#) and [Premti \*et al.\* \(2017\)](#) who found both recommendation levels and variations to convey information for investors. Only the number of analysts and downgrades in recommendations are significant. The picture is similar to that of ratings. The recommendation consensus is still insignificant<sup>20</sup>. Relative usefulness keeps pace with those of Model (5) in Table 3 (page 39). Therefore, the introduction of recommendation variations is not crucial for a policy-maker. Replacing the number of analysts by the number of recommendations and the recommendation consensus (mean) by the median in untabulated analyses yielded similar results. Finally, as EPS forecasts convey

---

<sup>20</sup>It becomes significant when ratings are introduced while the coefficient for downgrades in recommendations loses its significance in additional estimations.



relevant information on the distress risk of (nonfinancial) firms (Moses (1990)), we substituted the average and number of FY1 EPS forecasts to the recommendation consensus and number of analysts in the baseline model of Table 3 (page 39) and introduced upgrades and downgrades in EPS. Only coefficients for the latter turned out to be significantly positive, which is unexpected in the upgrade case. Hence, EPS do not appear as a straightforward indicator of distress while displaying lower out-of-sample performance. All in all, rating and recommendation levels appear to be more informative than any other specification. A policy-maker would only marginally benefit—and sometimes suffer—from the introduction of the latter.

[Insert Table 4 (page 40) here]

## 7 Robustness Checks

This Section presents our robustness checks. Case studies on individual banks are displayed in Section 7.1 while our main regressions are reproduced on a fixed-sample and using a 8-quarter predistress event dependent variable in Section 7.2 and Section 7.3, respectively. Finally, an alternative  $\lambda$ -setting method is displayed in Section 7.4.

### 7.1 Case Studies

Figure 2 (page 33) presents in- and out-of-sample predicted distress probability for Dexia N.V./S.A. with regard to predistress and distress events for a policy-maker with preferences  $\mu = 0.9$ . The model performs reasonably well by issuing an early-warning signal before and during most distress events. We repeat the same exercise for Intesa Sanpaolo SpA

Figure 2: Predicted Distress Probability – Dexia N.V./S.A. ( $\mu = 0.9$ )

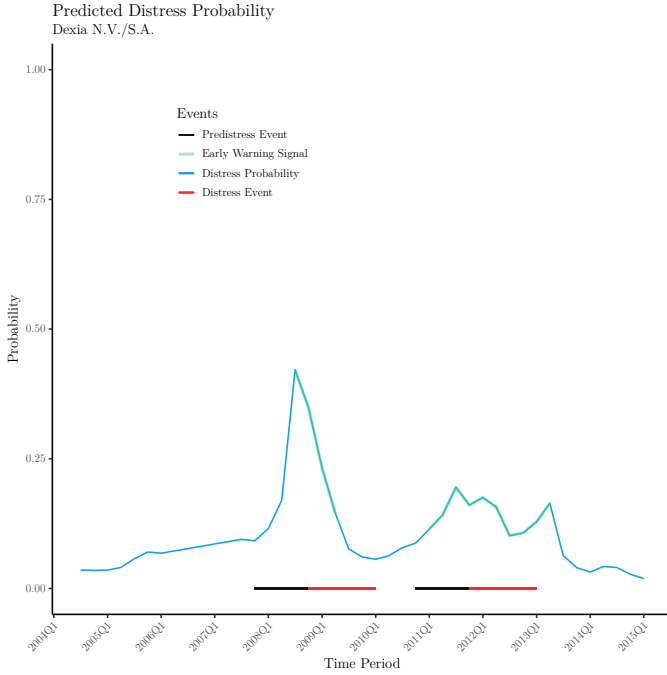
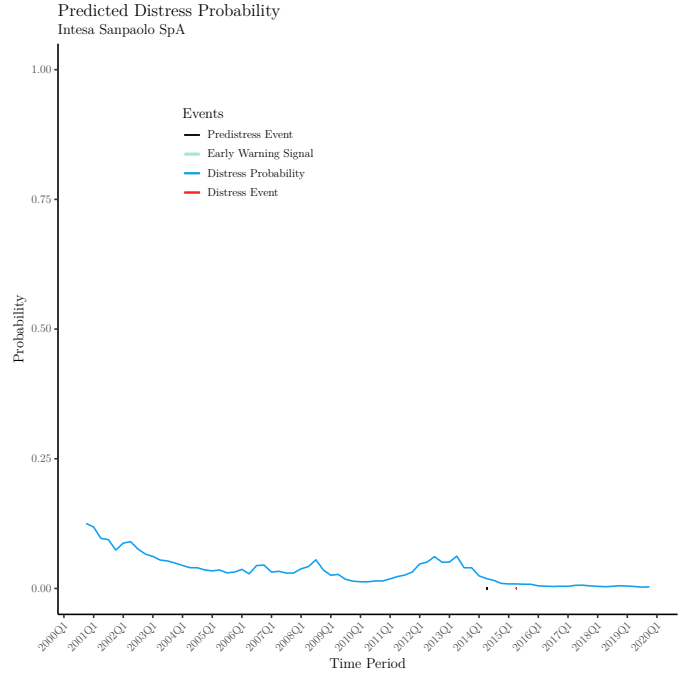


Figure 3: Predicted Distress Probability – Intesa Sanpaolo SpA ( $\mu = 0.9$ )



in Figure 3 (page 33). As expected, as the bank did not experience any distress event, the model does not issue any early-warning signal with low predicted distress probabilities.

## 7.2 Fixed Dataset

Baseline regressions of Table 3 (page 39) display significant variations in the number of observations among the samples owing to missing values, which hinders comparability<sup>21</sup>. We get broadly similar results when performing all estimations on the baseline sample (5,082 observations). Notably, the coefficient for recommendation consensus becomes significantly positive in Model (5). For preferences  $\mu = 0.9$ , Model (1) displays a 39% gain in usefulness *vis-à-vis* disregarding the model, while Models (4) and (5) both achieve 40%. The worst

<sup>21</sup>T tests and F tests revealed significant differences in means and variances.

performing model is Model (2) (32%). Models (4) and (5) perform particularly well when the systemic relevance of banks is accounted for. In that case, both CRAs' ratings and stock analyst recommendations turn out to be almost perfect substitutes in both the unweighted and weighted cases rather than complementary.

### 7.3 8-Quarter Predistress Events Variable

Following [Betz \*et al.\* \(2014\)](#) and [Constantin \*et al.\* \(2018\)](#), we set the predistress event time horizon to 8 quarters to assess to what extent our EWS performance holds when estimated on a longer period preceding distress events and reproduce estimations of Table 3 (page 39). The results are fairly similar, except for the VIX, which displays a unexpected negative and significant coefficient. Similarly, the overall out-of-sample performance is slightly lower. Model (3) performs worse than the others, except when bank-specific weights are introduced. Notably, the best model for preferences  $\mu = 0.9$  is now Model (2), which is also the worst performing one in the weighted case<sup>22</sup>. All in all, financial information producers' disclosure are informative on distress risk up to two years in advance. Figure 4 (page 35) displays that performance of both baseline Models (1) are close and better than a coin toss (the bisector) for each  $\lambda$ , even though the model of Table 3 (page 39) is slightly better than the other estimated over 8 quarters.

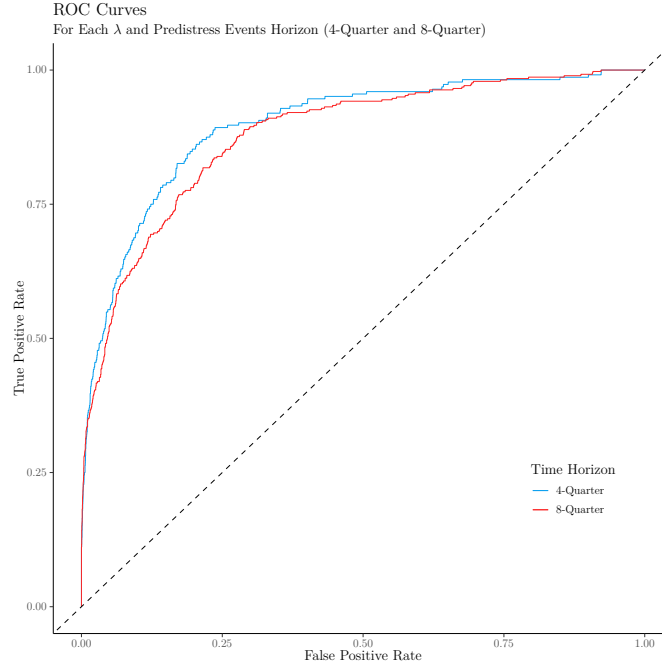
### 7.4 Variations in the Sets of Preferences

Setting the threshold *ex post* as displayed in Section 4 can lead to sub-optimal results in terms of policy guidance and weigh on out-of-sample performance ([Fuertes and Kalotychou](#)

---

<sup>22</sup>Results are similar when reproduced on the fixed baseline dataset.

Figure 4: ROC Curves (Model (1))



(2006)). When the model is estimated recursively, the threshold is reoptimised each time and may vary accordingly, which impacts policy guidance that should be driven by changes in the vulnerability of banks only. Sarlin and von Schweinitz (2021) provided an alternative *ex ante* method by using the long-term optimal threshold which equalizes total costs from false negatives and false positives for the decision-maker, that is,  $\lambda^\infty = 1 - \mu$ . Table 5 (page 41) presents performance for the baseline model of Table 3 (page 39) for both methods and all sets of preferences  $\mu$ . Outcomes using one or the other method are very close. In both cases, the policy-maker gets additional relative usefulness ( $U_r$ ) by considering the model but it is optimal for him to disregard the model when the systemic relevance of banks is accounted for ( $U_r(w)$ ) until  $\mu = 0.85$ . Alternative measures are presented, such as the True Positive Rate (TPR, or recall positives, banks correctly classified as having failed) and the False Negative Rate (FNR, banks classified as not having failed whereas they have a missed crisis) which a

perfectly performing model would minimize. Again, the results are similar for both methods.

[Insert Table 5 (page 41) here]

## 8 Summary and Conclusions

In this article we estimate an EWS in a real-time fashion from a policy-maker viewpoint in 29 European countries over the 2000Q3–2019Q4 period. We find both CRA ratings and stock analyst recommendations to display an informative value on distress risk in- and out-of-sample up to two years in advance. Both disclosures profitably complement accounting, market and macroeconomic data used into EWS, particularly when introduced simultaneously but at the expense of a significance loss in observations. While subsequent improvements in performance are valuable to prevent banks entering a state of distress more accurately and in a more timely manner, such models would still be skewed towards systemic banks owing to the uneven coverage of financial information producers. These institutions are both the most important to monitor and the most difficult to as shown by the overall lowering in performance when accounting for the relevance of banks. Both rating and recommendation levels are more informative on distress risk than other specifications, including variations, outlooks, watchlist additions, and EPS forecasts, except for downgrades. That latter result may be owed either to the incidence of an optimism bias or to the reluctance of management to disclose negative news on bank soundness. Finally, our results show that a policy-maker would benefit from the introduction of such disclosures in an EWS, provided his preferences are hedged towards missing crises. It derives from this study that the monitoring of financial institutions by financial information producers—the indirect

component of market discipline ([Flannery and Bliss \(2019\)](#))—appears to be useful to prevent bank distress events, along with the one of regulators. Given the scarcity of papers on the topic, analysing further the influence of financial information producers—notably stock analysts—on the financial health of banks would be insightful for further research.

Table 2: Summary Statistics (Post 1% Winsorization)

	Mean	StDev	Median	25 <sup>th</sup> Pct	75 <sup>th</sup> Pct	Min	Max	Skew	Kurtosis	N
AVERAGE_RATINGS	7.29	3.22	7.00	5.00	8.50	1.00	21.00	1.56	3.49	9,766
NUMBER_RATINGS	0.79	0.83	1.00	0.00	1.00	0.00	3.00	0.84	0.03	17,136
POS_OUTLOOKS	0.10	0.33	0.00	0.00	0.00	0.00	3.00	3.66	14.33	17,136
STA_OUTLOOKS	0.69	0.78	1.00	0.00	1.00	0.00	3.00	0.80	-0.23	17,136
NEG_OUTLOOKS	0.30	0.58	0.00	0.00	0.00	0.00	3.00	1.97	3.42	17,136
POS_WATCHLISTS	0.11	0.38	0.00	0.00	0.00	0.00	3.00	4.31	22.61	17,136
NEG_WATCHLISTS	0.34	0.57	0.00	0.00	1.00	0.00	3.00	1.51	1.38	17,136
UP_RATINGS	0.02	0.16	0.00	0.00	0.00	0.00	3.00	7.47	62.57	17,136
UP_OUTLOOKS	0.03	0.19	0.00	0.00	0.00	0.00	2.00	5.72	34.15	17,136
UP_WATCHLISTS	0.00	0.07	0.00	0.00	0.00	0.00	2.00	18.60	384.49	17,136
DOWN_RATINGS	0.04	0.20	0.00	0.00	0.00	0.00	2.00	5.81	36.49	17,136
DOWN_OUTLOOKS	0.04	0.22	0.00	0.00	0.00	0.00	3.00	5.22	29.99	17,136
DOWN_WATCHLISTS	0.00	0.06	0.00	0.00	0.00	0.00	2.00	17.94	337.94	17,136
AVERAGE_REC	2.68	0.66	2.62	2.23	3.00	1.00	5.00	0.57	1.09	9,803
NUMBER_REC	7.56	10.24	2.00	0.00	13.00	0.00	47.00	1.32	0.70	17,136
UP_REC	0.21	0.41	0.00	0.00	0.00	0.00	1.00	1.44	0.08	17,136
DOWN_REC	0.22	0.41	0.00	0.00	0.00	0.00	1.00	1.35	-0.19	17,136
REAL_GROWTH_GDP	1.48	3.05	1.80	0.52	3.19	-10.80	8.33	-1.31	3.37	17,041
INFLATION	1.89	1.69	1.70	0.80	2.70	-1.35	9.50	1.42	4.46	17,117
COMPOSITE_RATE	0.86	3.94	1.34	-0.75	3.50	-7.68	13.30	-0.10	0.53	17,122
10Y_BOND_YIELD	3.41	2.10	3.71	1.76	4.70	-0.46	10.79	0.44	0.79	16,941
CREDIT_FLOW_GDP	5.53	7.52	4.40	0.90	9.20	-12.00	35.50	0.97	2.49	16,020
VIX	20.11	8.65	17.54	13.97	23.69	9.45	57.06	1.70	3.50	17,136
TOTAL_ASSETS_GDP	945.41	465.53	845.20	620.50	1220.10	258.30	2634.40	1.10	1.57	16,472
LOANS_DEPOSITS <sup>m</sup>	123.62	62.32	100.51	82.71	125.62	65.41	342.32	1.69	2.05	15,836
DEBT_SECURITIES_LIAB	15.68	12.85	12.98	6.34	21.59	0.20	70.40	1.38	2.45	15,657
SIZE	17.11	1.96	16.91	15.80	18.42	12.10	21.33	0.10	-0.28	14,532
EQUITY_TO_ASSETS	7.51	4.26	6.57	4.65	9.47	0.37	25.29	1.39	2.90	14,416
ROA	0.92	1.10	0.87	0.47	1.38	-3.91	5.17	-0.34	6.01	13,680
ROE	7.21	17.00	9.10	4.71	14.07	-106.31	34.78	-4.07	22.91	14,104
LOANS_DEPOSITS	148.31	99.83	125.50	94.14	166.97	18.20	752.04	3.24	14.73	13,660

Table 3: Baseline Models (2000Q3–2019Q3 — OOS 2008Q3–2019Q4)

*Note:* \*p<0.1; \*\*p<0.05; \*\*\*p<0.01, Brackets: Standard Errors and Weighted  $U_r$ .

<i>Dependent Variable: PREDISTRESS_4Q</i>					
	1	2	3	4	5
AVERAGE_RATINGS	0.295*** (0.045)	0.226*** (0.039)		0.273*** (0.036)	
NUMBER_RATINGS	-0.390** (0.161)	-0.314** (0.153)		-0.404*** (0.149)	
AVERAGE_REC	0.493*** (0.142)	0.654*** (0.131)			0.069 (0.119)
NUMBER_REC	-0.001 (0.012)	-0.023** (0.012)			-0.015 (0.011)
REAL_GROWTH_GDP	-0.074** (0.036)	-0.139*** (0.033)	-0.082*** (0.026)	-0.083*** (0.031)	-0.073** (0.032)
INFLATION	0.175*** (0.061)	0.157*** (0.056)	0.175*** (0.042)	0.224*** (0.051)	0.203*** (0.052)
COMPOSITE_RATE	0.276*** (0.046)	0.273*** (0.042)	0.242*** (0.032)	0.303*** (0.040)	0.213*** (0.036)
10Y_BOND_YIELD	0.276*** (0.046)	0.268*** (0.041)	0.254*** (0.031)	0.300*** (0.040)	0.225*** (0.036)
CREDIT_FLOW_GDP	0.027** (0.011)	0.035*** (0.010)	0.009 (0.008)	0.031*** (0.010)	0.008 (0.009)
VIX	0.009 (0.011)	0.009 (0.010)	0.007 (0.008)	0.014 (0.010)	0.003 (0.009)
TOTAL_ASSETS_GDP	0.002*** (0.0002)	0.001*** (0.0001)	0.001*** (0.0001)	0.001*** (0.0001)	0.001*** (0.0002)
LOANS_DEPOSITS_M	-0.004 (0.002)	-0.001 (0.002)	0.001 (0.001)	0.0005 (0.002)	-0.003 (0.002)
DEBT_SECURITIES_LIAB	-0.003 (0.013)	0.009 (0.012)	-0.037*** (0.009)	-0.018* (0.011)	-0.015 (0.011)
SIZE	0.547*** (0.101)	0.761*** (0.089)	0.224*** (0.040)	0.521*** (0.067)	0.323*** (0.076)
EQUITY_TO_ASSETS	-0.261*** (0.048)		-0.100*** (0.023)	-0.171*** (0.035)	-0.153*** (0.033)
ROA	0.428*** (0.135)		-0.004 (0.087)	0.098 (0.117)	0.121 (0.116)
ROE	-0.027*** (0.006)		-0.025*** (0.004)	-0.023*** (0.005)	-0.033*** (0.006)
LOANS_DEPOSITS	0.005*** (0.001)		0.001*** (0.001)	0.004*** (0.001)	0.002** (0.001)
CONSTANT	-18.910*** (2.177)	-23.106*** (1.816)	-9.276*** (0.920)	-16.608*** (1.527)	-11.516*** (1.532)
Observations	5,082	5,263	9,983	6,968	6,852
Log Likelihood	-602.212	-696.611	-1,200.087	-780.709	-844.552
Akaike Inf. Crit.	1,242.424	1,423.222	2,430.173	1,595.418	1,723.104
AUC	0.897	0.878	0.836	0.882	0.856
McFadden's $R^2$	0.344	0.293	0.237	0.311	0.278
Number of Banks	149	154	195	172	180
Number of Countries	25	25	29	28	27
$U_r(\mu = 0.6)$	10%(0%)	0%(0%)	7%(0%)	3%(0%)	12%(0%)
$U_r(\mu = 0.7)$	19%(0%)	16%(0%)	17%(9%)	21%(0%)	18%(0%)
$U_r(\mu = 0.8)$	24%(0%)	24%(1%)	22%(19%)	26%(12%)	26%(9%)
$U_r(\mu = 0.85)$	33%(9%)	27%(14%)	26%(27%)	31%(22%)	30%(18%)
<b><math>U_r(\mu = 0.9)</math></b>	<b>39%(32%)</b>	<b>38%(23%)</b>	<b>29%(32%)</b>	<b>35%(33%)</b>	<b>33%(34%)</b>
$U_r(\mu = 0.95)$	52%(49%)	51%(43%)	37%(44%)	43%(46%)	44%(42%)



Table 4: Ratings and Analysts Extensions (2000Q3–2019Q3 — OOS 2008Q3–2019Q4)

Note: \*p<0.1; \*\*p<0.05; \*\*\*p<0.01, Brackets: Standard Errors and Weighted  $U_r$ .

<i>Dependent Variable: PREDISTRESS_4Q</i>					
	1	2	3	4	5
AVERAGE_RATINGS	0.261*** (0.036)	0.278*** (0.037)	0.271*** (0.036)	0.266*** (0.037)	
NUMBER_RATINGS	-0.488*** (0.154)	-0.641*** (0.156)	-0.454*** (0.166)	-0.743*** (0.176)	
UP_RATINGS	-0.964 (0.621)			-0.981 (0.619)	
DOWN_RATINGS	0.775*** (0.187)			0.713*** (0.203)	
POS_OUTLOOKS		0.228 (0.255)		0.339 (0.257)	
STA_OUTLOOKS		0.617*** (0.135)		0.667*** (0.136)	
NEG_OUTLOOKS		0.840*** (0.173)		0.804*** (0.175)	
UP_OUTLOOKS		-0.190 (0.344)		-0.461 (0.358)	
DOWN_OUTLOOKS		0.127 (0.226)		0.110 (0.236)	
POS_WATCHLISTS			-0.168 (0.225)	-0.225 (0.230)	
NEG_WATCHLISTS			0.188 (0.132)	0.141 (0.137)	
UP_WATCHLISTS			-12.158 (321.680)	-11.939 (314.437)	
DOWN_WATCHLISTS			0.696 (0.716)	0.600 (0.729)	
AVERAGE_REC					0.048 (0.122)
NUMBER_REC					-0.021* (0.011)
UP_REC					0.266 (0.236)
DOWN_REC					0.404* (0.229)
REAL_GROWTH_GDP	-0.088*** (0.032)	-0.070** (0.032)	-0.085*** (0.031)	-0.081** (0.033)	-0.074** (0.032)
INFLATION	0.209*** (0.052)	0.188*** (0.054)	0.217*** (0.052)	0.174*** (0.054)	0.207*** (0.052)
COMPOSITE_RATE	0.304*** (0.039)	0.309*** (0.040)	0.311*** (0.040)	0.323*** (0.040)	0.225*** (0.036)
10Y_BOND_YIELD	0.164** (0.065)	0.203*** (0.066)	0.181*** (0.066)	0.165** (0.066)	0.357*** (0.061)
CREDIT_FLOW_GDP	0.033*** (0.010)	0.027*** (0.010)	0.033*** (0.010)	0.029*** (0.010)	0.007 (0.009)
VIX	0.009 (0.010)	0.019** (0.010)	0.014 (0.010)	0.013 (0.010)	0.002 (0.009)
TOTAL_ASSETS_GDP	0.001*** (0.0001)	0.001*** (0.0001)	0.001*** (0.0001)	0.001*** (0.0001)	0.001*** (0.0002)
LOANS_DEPOSITS_M	0.0001 (0.002)	-0.002 (0.002)	-0.001 (0.002)	-0.002 (0.002)	-0.002 (0.002)
DEBT_SECURITIES_LIAB	-0.025** (0.011)	-0.015 (0.011)	-0.020* (0.011)	-0.022** (0.011)	-0.014 (0.011)
SIZE	0.504*** (0.067)	0.468*** (0.068)	0.502*** (0.068)	0.438*** (0.070)	0.319*** (0.077)
EQUITY_TO_ASSETS	-0.174*** (0.035)	-0.190*** (0.036)	-0.172*** (0.035)	-0.192*** (0.036)	-0.152*** (0.033)
ROA	0.107 (0.117)	0.027 (0.117)	0.107 (0.118)	0.051 (0.118)	0.112 (0.116)
ROE	-0.022*** (0.005)	-0.016*** (0.005)	-0.023*** (0.005)	-0.016*** (0.005)	-0.033*** (0.006)
LOANS_DEPOSITS	0.004*** (0.001)	0.005*** (0.001)	0.004*** (0.001)	0.004*** (0.001)	0.002** (0.001)
CONSTANT	-15.847*** (1.541)	-16.224*** (1.544)	-16.134*** (1.553)	-15.207*** (1.578)	-11.543*** (1.543)
Observations	6,968	6,968	6,968	6,968	6,852
Log Likelihood	-771.329	-763.708	-777.524	-752.328	-842.884
Akaike Inf. Crit.	1,580.657	1,571.417	1,597.049	1,560.657	1,723.768
AUC	0.885	0.891	0.884	0.895	0.857
McFadden's $R^2$	0.319	0.326	0.314	0.336	0.279
Number of Banks	172	172	172	172	180
Number of Countries	28	28	28	28	27
$U_r(\mu = 0.85)$	32%(17%)	23%(3%)	25%(17%)	26%(7%)	30%(22%)
$U_r(\mu = 0.9)$	<b>36%(28%)</b>	<b>32%(17%)</b>	<b>35%(20%)</b>	<b>31%(19%)</b>	<b>33%(29%)</b>
$U_r(\mu = 0.95)$	42%(47%)	45%(41%)	44%(42%)	45%(43%)	46%(45%)

Table 5: Baseline Model Detailed Performance Measures

*Note:* Performance Measures: L = Loss,  $U_a$  = Absolute Usefulness,  $U_r$  = Negative Usefulness, TP = True Positives, FP = False Positives, TN = True Negatives, FN = False Negatives, Precision Positives =  $TP/(TP+FP)$ , Recall Positives =  $TP/(TP+FN)$ , Precision Negatives =  $TN/(TN+FN)$ , Recall Negatives =  $TN/(TN+FP)$ , Accuracy =  $(TP+TN)/(TP+TN+FP+FN)$ , FPR =  $FP/(TN+FP)$ , FNR =  $FN/(TP+FN)$ .  $P_1 = 0.04$ ,  $P_2 = 0.96$ . Negative Usefulness is Normalized to 0.

$\mu$	Positives				Negatives				Accuracy	FPR	FNR	L	$U_a$	$U_a(w)$	$U_r$	$U_r(w)$
	TP	FP	FN	TN	Precision	Recall	Precision	Recall								
<b>Logit Optimised Threshold</b>																
0	20	0	114	3,296	1.00	0.15	0.97	1.00	0.97	0.00	0.85	0.00	0.00	0.00	NaN	NaN
0.1	20	0	114	3,296	1.00	0.15	0.97	1.00	0.97	0.00	0.85	0.00	0.00	0.00	0.15	0.00
0.2	20	3	114	3,293	0.87	0.15	0.97	1.00	0.97	0.00	0.85	0.01	0.00	0.00	0.06	0.00
0.3	28	9	106	3,287	0.76	0.21	0.97	1.00	0.97	0.00	0.79	0.01	0.00	0.00	0.05	0.00
0.4	35	14	99	3,282	0.71	0.26	0.97	1.00	0.97	0.00	0.74	0.01	0.00	0.00	0.10	0.00
0.5	41	30	93	3,266	0.58	0.31	0.97	0.99	0.96	0.01	0.69	0.02	0.00	0.00	0.08	0.00
0.6	46	48	88	3,248	0.49	0.34	0.97	0.99	0.96	0.01	0.66	0.02	0.00	0.00	0.10	0.00
0.7	55	70	79	3,226	0.44	0.41	0.98	0.98	0.96	0.02	0.59	0.02	0.01	0.00	0.19	0.00
0.8	57	100	77	3,196	0.36	0.43	0.98	0.97	0.95	0.03	0.57	0.02	0.01	0.00	0.24	0.00
0.85	68	137	66	3,159	0.33	0.51	0.98	0.96	0.94	0.04	0.49	0.02	0.01	0.00	0.33	0.09
0.9	73	190	61	3,106	0.28	0.54	0.98	0.94	0.93	0.06	0.46	0.02	0.01	0.01	0.39	0.32
0.95	86	305	48	2,991	0.22	0.64	0.98	0.91	0.90	0.09	0.36	0.02	0.02	0.02	0.52	0.49
1	134	3,285	0	11	0.04	1.00	1.00	0.00	0.04	1.00	0.00	0.00	0.00	0.00	NaN	NaN
<b>Logit Set Threshold (<math>\lambda^\infty = 1 - \mu</math>)</b>																
0	0	0	134	3,296	NaN	0.00	0.96	1.00	0.96	0.00	1.00	0.00	0.00	0.00	NaN	NaN
0.1	18	0	116	3,296	1.00	0.13	0.97	1.00	0.97	0.00	0.87	0.00	0.00	0.00	0.13	0.06
0.2	21	3	113	3,293	0.88	0.16	0.97	1.00	0.97	0.00	0.84	0.01	0.00	0.00	0.07	0.00
0.3	26	6	108	3,290	0.81	0.19	0.97	1.00	0.97	0.00	0.81	0.01	0.00	0.00	0.09	0.00
0.4	35	15	99	3,281	0.70	0.26	0.97	1.00	0.97	0.00	0.74	0.01	0.00	0.00	0.09	0.00
0.5	37	22	97	3,274	0.63	0.28	0.97	0.99	0.97	0.01	0.72	0.02	0.00	0.00	0.11	0.00
0.6	43	35	91	3,261	0.55	0.32	0.97	0.99	0.96	0.01	0.68	0.02	0.00	0.00	0.15	0.00
0.7	50	52	84	3,244	0.49	0.37	0.97	0.98	0.96	0.02	0.63	0.02	0.01	0.00	0.21	0.00
0.8	60	103	74	3,193	0.37	0.45	0.98	0.97	0.95	0.03	0.55	0.02	0.01	0.00	0.26	0.00
0.85	69	136	65	3,160	0.34	0.51	0.98	0.96	0.94	0.04	0.49	0.02	0.01	0.01	0.34	0.19
0.9	76	187	58	3,109	0.29	0.57	0.98	0.94	0.93	0.06	0.43	0.02	0.01	0.01	0.41	0.29
0.95	87	330	47	2,966	0.21	0.65	0.98	0.90	0.89	0.10	0.35	0.02	0.02	0.02	0.52	0.46
1	134	3,296	0	0	0.04	1.00	NaN	0.00	0.04	1.00	0.00	0.00	0.00	0.00	NaN	NaN

# A Appendix – Construction of Variables

Table 6: Construction of Variables

Variable	Construction	Source
AVERAGE_RATINGS	Average of ratings (sum ratings/number of agencies for each quarter), 1 = AAA/Aaa, 21 = default, assumed to hold until modified or withdrawn	Eikon, FitchConnect
NUMBER_RATINGS	Number ratings issued over the quarter (1-3)	Eikon, FitchConnect
POS, STA, NEG_OUTLOOKS, WATCHLISTS	1 for each positive, stable, negative outlook or watchlist addition by agency over the quarter (1-3), otherwise 0, assumed to hold until modified or withdrawn	Eikon, FitchConnect
UP, DOWN_RATINGS, OUTLOOKS, WATCHLISTS	1 if upgrade (downgrade) for each agency over the quarter (1-3), otherwise 0	Eikon, FitchConnect
AVERAGE_REC	Recommendation consensus (average), 1 = <i>Strong buy</i> , 5 = <i>Strong sell</i> , assumed to hold until modified or withdrawn	I/B/E/S
NUMBER_REC	Number of recommendations issued over the quarter	I/B/E/S
UP, DOWN_REC	1 if upgrade (downgrade) in recommendation consensus, otherwise 0	I/B/E/S
REAL_GROWTH_GDP	Annual real GDP growth	Datastream
INFLATION	Annual HIPC (Harmonized Index of Consumer Prices) rate	Datastream
COMPOSITE_RATE	Wu-Xia Shadow rate (UK for the UK, Euro Area for the Euro Area), domestic central bank or ECB policy rate when not available (prior to 2004 for Euro Area countries and for non-Euro Area countries)	Datastream
10Y_BOND_YIELD	10-year sovereign bond yield	Datastream
CREDIT_FLOW_GDP	Private sector credit flow to GDP	Datastream
VIX	Chicago Board Options Exchange Market Volatility Index (USD)	Datastream
TOTAL_ASSETS_GDP	Total assets/GDP, country aggregates	Eurostat
LOANS_DEPOSITS_M	Total loans/total deposits, country aggregates	Datastream
DEBT_SECURITIES_LIAB	Debt securities/total liabilities	Datastream
SIZE	Natural logarithm of total assets (EUR thousands)	Datastream
EQUITY_TO_ASSETS	Total common equity/total assets	Datastream
ROA	Return on assets	Datastream
ROE	Return on equity	Datastream
LOANS_DEPOSITS	Total loans/total deposits (bank level)	Datastream
TIER_1	Tier 1 capital/risk-weighted assets	Datastream
AVERAGE_EPS	Average current fiscal year (FY1) EPS forecasts deflated by the last available stock price	I/B/E/S
NUMBER_EPS	Number of current fiscal year (FY1) EPS forecasts over the quarter	I/B/E/S
UP, DOWN_EPS	1 if upgrade (downgrade) in EPS estimates, otherwise 0	I/B/E/S
GROWTH_TOTAL_ASSETS	Annual growth rate of total assets	Datastream
WEIGHTS	Total assets of the bank/total assets in the sample for each quarter (EUR thousands)	Datastream

## B Appendix – Banks and Country Distribution

Table 7: Predistress Event-Country Distribution

*Note:* <sup>s</sup> for baseline subsample (5,082 obs), otherwise total sample (17,136 obs). Predistress events numbers are given in quarters.

Country	Number Banks	Number Banks <sup>s</sup>	Number Predistress	Number Predistress <sup>s</sup>
Austria	7	4	20	4
Belgium	3	2	16	12
Bulgaria	3	1	4	0
Croatia	1	0	0	0
Cyprus	3	3	19	14
Czech Republic	3	2	0	0
Denmark	10	3	34	0
Faroe Islands	1	0	0	0
Finland	3	3	4	4
France	14	8	16	15
Germany	14	11	22	9
Greece	10	6	78	43
Hungary	2	1	8	0
Iceland	5	4	16	10
Ireland; Republic of	4	4	29	20
Italy	26	23	34	28
Liechtenstein	2	2	0	0
Lithuania	2	0	4	0
Netherlands	6	4	24	0
Norway	14	12	0	0
Poland	13	10	0	0
Portugal	5	4	28	8
Romania	2	2	0	0
Slovak Republic	1	0	0	0
Slovenia	2	1	16	4
Spain	12	11	38	19
Sweden	4	3	12	8
Switzerland	13	10	8	0
United Kingdom	19	15	52	26
Total	204	151	482	224

Figure 5: Predistress Event-Time Distribution (2000Q1-2020Q4)

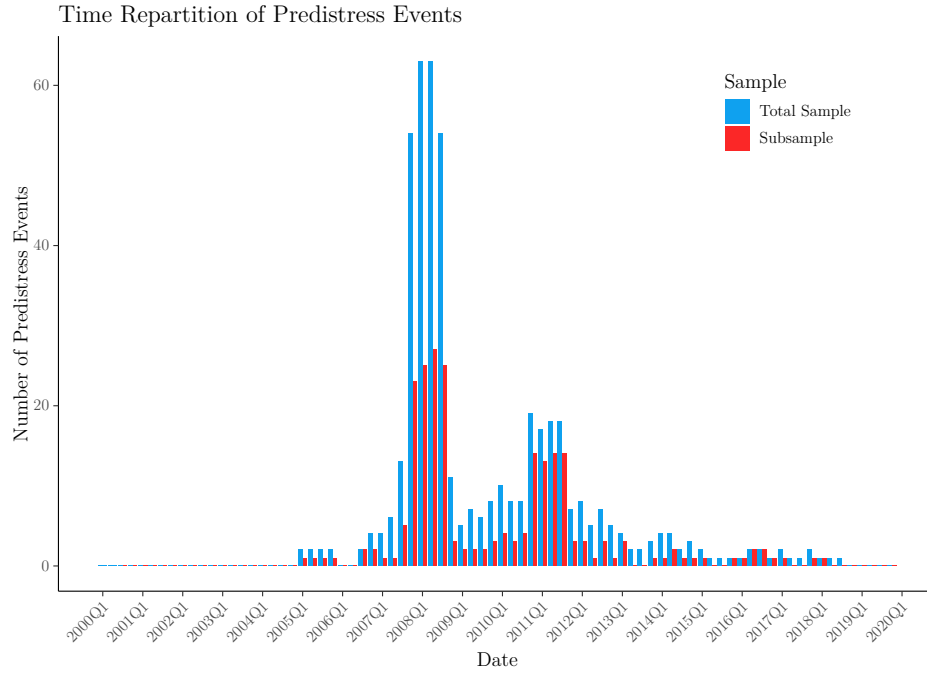


Table 8: Distress Event Distribution

Distress Event	Frequency
<i>Direct Failure</i>	23
Bankruptcy	1
Liquidation	16
Default	8
<i>State Support</i>	106
Capital Injection	85
Nationalization	19
Relief/Guarantee Program	30
<i>Private Sector Support</i>	34
Private Liquidity Support	6
Distressed Merger	28
Other	1
<i>Total</i>	134

## Bibliography

- Alessi, L. and C. Detken (2011, September). Quasi Real Time Early Warning Indicators for Costly Asset Price Boom/Bust Cycles: A Role for Global Liquidity. *European Journal of Political Economy* 27(3), 520–533.
- Altavilla, C., M. Boucinha, and J.-L. Peydró (2018, October). Monetary Policy and Bank Profitability in a Low Interest Rate Environment. *Economic Policy* 33(96), 531–586.
- Anolli, M., E. Beccalli, and P. Molyneux (2014, March). Bank Earnings Forecasts, Risk and the Crisis. *Journal of International Financial Markets, Institutions & Money* 29, 309–335.
- Avino, D. E., T. Conlon, and J. Cotter (2019, June). Credit Default Swaps as Indicators of Bank Financial Distress. *Journal of International Money and Finance* 94, 132–139.
- Bannier, C. E. and C. W. Hirsch (2010, December). The Economic Function of Credit Rating Agencies: What does the Watchlist Tell Us? *Journal of Banking & Finance* 34(12), 3037–3049.
- Bar-Isaac, H. and J. Shapiro (2013, April). Ratings Quality Over the Business Cycle. *Journal of Financial Economics* 108(1), 62–78.
- Barber, B. M., R. Lehavy, and B. Trueman (2010, June). Ratings Changes, Ratings Levels, and the Predictive Value of Analysts’ Recommendations. *Financial Management* 39(2), 533–553.
- Becker, B. and T. Milbourn (2011, September). How did Increased Competition Affect Credit Ratings? *Journal of Financial Economics* 101(3), 493–514.
- Beltratti, A. and R. M. Stulz (2012, July). The Credit Crisis Around the Globe: Why Did Some Banks Perform Better? *Journal of Financial Economics* 105(1), 1–17.
- Betz, F., S. Oprică, T. A. Peltonen, and P. Sarlin (2014, August). Predicting Distress in European Banks. *Journal of Banking & Finance* 45, 225–241.
- Bolton, P., X. Freixas, and J. Shapiro (2012, February). The Credit Ratings Game. *The Journal of Finance* 67(1), 85–111.
- Boyd, J. H. and D. E. Runkle (1993, February). Size and Performance of Banking Firms: Testing the Predictions of Theory. *Journal of Monetary Economics* 31(1), 47–67.
- Brown, L. D., A. C. Call, M. B. Clement, and N. Y. Sharp (2015, March). Inside the ‘Black Box’ of Sell-Side Financial Analysts. *Journal of Accounting Research* 53(1), 1–47.
- Bussière, M. and M. Fratzscher (2006, October). Towards a New Early Warning System of Financial Crises. *Journal of International Money and Finance* 25(6), 953–973.
- Bussière, M. and M. Fratzscher (2008, January). Low Probability, High Impact: Policy Making and Extreme Events. *Journal of Policy Modeling* 30(1), 111–121.

- Cheng, M. and K. R. Subramanyam (2008, December). Analyst Following and Credit Ratings. *Contemporary Accounting Research* 25(4), 1007–1044.
- Clarke, J., S. P. Ferris, N. Jayaraman, and J. Lee (2006, March). Are Analyst Recommendations Biased? Evidence from Corporate Bankruptcies. *Journal of Financial and Quantitative Analysis* 41(1), 169–196.
- Constantin, A., T. A. Peltonen, and P. Sarlin (2018, April). Network Linkages to Predict Bank Distress. *Journal of Financial Stability* 35, 226–241.
- Davis, E. P. and D. Karim (2008, June). Comparing Early Warning Systems for Banking Crises. *Journal of Financial Stability* 4(2), 89–120.
- De Franco, G., F. P. Vasvari, and R. Wittenberg-Moerman (2009, December). The Informational Role of Bond Analysts. *Journal of Accounting Research* 47(5), 1201–1248.
- Demirgüç-Kunt, A. and E. Detragiache (1998, March). The Determinants of Banking Crises in Developing and Developed Countries. *Staff papers - International Monetary Fund* 45(1), 81–109.
- Demirgüç-Kunt, A. and E. Detragiache (2000, May). Monitoring Banking Sector Fragility: A Multivariate Logit Approach. *The World Bank Economic Review* 14(2), 287–307.
- DeYoung, R. and G. Torna (2013, July). Nontraditional Banking Activities and Bank Failures During the Financial Crisis. *Journal of Financial Intermediation* 22(3), 397–421.
- Dubois, M., L. Fresard, and P. Dumontier (2013, June). Regulating Conflicts of Interest: The Effect of Sanctions and Enforcement. *Review of Finance* 18(2), 489–526.
- Ederington, L. H. and J. C. Goh (1998, December). Bond Rating Agencies and Stock Analysts: Who Knows What When? *Journal of Financial and Quantitative Analysis* 33(4), 569–585.
- Flannery, M. J. (2010). Market Discipline in Bank Supervision. In A. N. Berger, P. Molyneux, and J. Wilson (Eds.), *The Oxford Handbook of Banking*, Volume 1, Chapter 15, pp. 377–405. Oxford: Oxford University Press.
- Flannery, M. J. and R. R. Bliss (2019). Market Discipline in Regulation: Pre and Post Crisis. In A. N. Berger, P. Molyneux, and J. Wilson (Eds.), *The Oxford Handbook of Banking*, Volume 3, Chapter 23, pp. 736–775. Oxford: Oxford University Press.
- Fong, K., H. Hong, M. Kacperczyk, and J. Kubik (2014, August). Do Security Analysts Discipline Credit Rating Agencies? In *AFA 2013 San Diego Meetings Paper*.
- Fuertes, A.-M. and E. Kalotychou (2006, November). Early Warning Systems for Sovereign Debt Crises: The Role of Heterogeneity. *Computational Statistics & Data Analysis* 51(2), 1420–1441.

- Galanti, S. and A. G. Vaubourg (2017, December). Optimism Bias in Financial Analysts' Earnings Forecasts: Do Commissions Sharing Agreements Reduce Conflicts of Interest? *Economic Modelling* 67, 325–337.
- Gintschel, A. and S. Markov (2004, September). The Effectiveness of Regulation FD. *Journal of Accounting & Economics* 37(3), 293–314.
- González-Hermosillo, B. (1999, March). Determinants of Ex-Ante Banking System Distress: A Macro-Micro Empirical Exploration of Some Recent Episodes. Working Paper No. 99/33, International Monetary Fund, New York.
- Gropp, R., J. Vesala, and G. Vulpes (2006, March). Equity and Bond Market Signals as Leading Indicators of Bank Fragility. *Journal of Money, Credit and Banking* 38(2), 399–428.
- Hong, H. and M. Kacperczyk (2010, November). Competition and Bias. *The Quarterly Journal of Economics* 125(4), 1683–1725.
- Iannotta, G. (2006, December). Testing for Opaqueness in the European Banking Industry: Evidence from Bond Credit Ratings. *Journal of Financial Services Research* 30(3), 287–309.
- Iannotta, G., G. Nocera, and A. Resti (2013, December). Do Investors Care about Credit Ratings? An Analysis through the Cycle. *Journal of Financial Stability* 9(4), 545–555.
- Jin, J. Y., K. Kanagaretnam, and G. J. Lobo (2011, November). Ability of Accounting and Audit Quality Variables to Predict Bank Failure During the Financial Crisis. *Journal of Banking & Finance* 35(11), 2811–2819.
- Jorion, P., Z. Liu, and C. Shi (2005, May). Informational Effects of Regulation FD: Evidence from Rating Agencies. *Journal of Financial Economics* 76(2), 309–330.
- Kaminsky, G. L. and C. M. Reinhart (1999, June). The Twin Crises: The Causes of Banking and Balance-of-Payments Problems. *The American Economic Review* 89(3), 473–500.
- Kerlin, J., E. Malinowska-Misiąg, P. Smaga, B. Witkowski, A. Nowak, A. Kozłowska, P. Wiśniewski, and M. Iwanicz-Drozdowska (Ed.) (2016). *European Bank Restructuring During the Global Financial Crisis*. Basingstoke: Palgrave Macmillan UK.
- Lang, J. H., T. A. Peltonen, and P. Sarlin (2018, October). A Framework for Early-Warning Modeling With an Application to Banks. Working Paper Series 2182, European Central Bank.
- Lang, M. H. and R. J. Lundholm (1996, October). Corporate Disclosure Policy and Analyst Behavior. *The Accounting Review* 71(4), 467–492.
- Lo Duca, M., A. Koban, M. Basten, E. Bengtsson, B. Klaus, P. Kusmierczyk, J. H. Lang, C. Detken, and T. A. Peltonen (2017, July). A New Database for Financial Crises in European Countries. Occasional Paper Series 194, European Central Bank.



- Lo Duca, M. and T. A. Peltonen (2013, July). Assessing Systemic Risks and Predicting Systemic Events. *Journal of Banking & Finance* 37(7), 2183–2195.
- Martin, D. (1977, November). Early Warning of Bank Failure: A Logit Regression approach. *Journal of Banking & Finance* 1(3), 249–276.
- Mody, A. and D. Sandri (2012, April). The Eurozone Crisis: How Banks and Sovereigns Came to be Joined at the Hip. *Economic policy* 27(70), 199–230.
- Morgan, D. P. (2002, August). Rating Banks: Risk and Uncertainty in an Opaque Industry. *The American Economic Review* 92(4), 874–888.
- Morgan, D. P., S. Peristiani, and V. Savino (2014, October). The Information Value of the Stress Test. *Journal of Money, Credit and Banking* 46(7), 1479–1500.
- Moses, O. D. (1990). On Analysts' Earnings Forecast for Failing Firms. *Journal of Business Finance & Accounting* 17(1), 101–118.
- Premti, A., L. Garcia-Feijoo, and J. Madura (2017, January). Information Content of Analyst Recommendations in the Banking Industry. *International Review of Financial Analysis* 49, 35–47.
- Ramnath, S., S. Rock, and P. Shane (2008, January). The Financial Analyst Forecasting Literature: A Taxonomy with Suggestions for Further Research. *International Journal of Forecasting* 24(1), 34–75.
- Sarlin, P. (2013, April). On Policymakers' Loss Functions and the Evaluation of Early Warning Systems. *Economics Letters* 119(1), 1–7.
- Sarlin, P. and G. von Schweinitz (2021, January). Optimizing Policymakers' Loss Functions in Crisis Prediction: Before, Within or After? *Macroeconomic Dynamics* 25(1), 100–123.
- Sarwar, G. (2020, April). Interrelations in Market Fears of U.S. and European Equity Markets. *The North American Journal of Economics and Finance* 52, 101136.
- Shu, H.-C. and J.-H. Chang (2019, April). Spillovers of Volatility Index: Evidence from U.S., European, and Asian Stock Markets. *Applied Economics* 51(19), 2070–2083.
- van den Berg, J., B. Candelon, and J.-P. Urbain (2008, October). A Cautious Note on the Use of Panel Models to Predict Financial Crises. *Economics Letters* 101(1), 80–83.
- Ötoker Robe, I. and J. Podpiera (2010, June). The Fundamental Determinants of Credit Default Risk for European Large Complex Financial Institutions. Working Paper No. 10/153, International Monetary Fund, New York.