The Relationship among Sovereign Ratings, Bank Ratings and Bank Performances, Evidence from European Commercial Banks

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Abstract

Sovereign ratings and bank entity ratings both impact bank performances but little literature studies the transmission and independence of the effects between these two kinds of ratings. We fill in this gap by considering bank ratings as a bridge between sovereign ratings and European bank performances. The scope of bank performances are extended into two aspects: bank stock returns and bank risk taking to reflect behaviours of investors who invest in banks and managers who run banks. Our findings indicate that bank ratings follow sovereign ratings and have a short-term impact on bank stock returns and a long-term impact on bank risk takings. Based on that, we further examine the dependence between sovereign ratings' and bank ratings' effects on bank performances by the means of mediation and moderation tests. We find that excluding special bank ratings variation triggered by sovereign-ceiling policy, sovereign and bank ratings independently affect bank stock returns. However, for risk takings, bank ratings partially mediate the effects of sovereign ratings.

Key words: Sovereign Ratings; Bank Ratings; Risk Takings; Mediation Effects; Moderation Effects.

JEL codes: G24; G21; G14

1. Introduction

The recent European debt crisis highlights the relationship between sovereign risks and performances of commercial banks exposed to those risks. It is commonly believed by academia (see Section 2.1) that sovereign ratings play a key role in the determination of performances of commercial banks. Literature has raised and discussed potential conduits between sovereign ratings and bank performances, such as 1) banks' funding costs are highly correlated to the government debt held by those institutions, government-backed collaterals and explicit government guarantees, which makes those costs sensitive to sovereign ratings (Panetta et al., 2011; Altavilla et al., 2017), 2) a sovereign rating collapse is a very negative signal of the fiscal condition of a country and reduces the demand of financial service on which

commercial banks highly rely (Correa et al., 2014), and 3) the bank lending is affected by sovereign ratings (Adelino and Ferreira, 2016).

However, current literature does not mention another possible conduit: the sovereign rating might (at least partially) impact individual bank performances through the channel of bank ratings. Sovereign rating changes are followed by rating changes of individual banks located in that country, which can be attributed to either a tradition or some policies. Afterwards these bank rating changes impact bank performances correspondingly. If such transmission effect exists, the seeming relationship between sovereign ratings and bank performances is not (only) caused by some factors regarding sovereign conditions but (also) is due to the existence of a channel of the bank ratings.

Furthermore, although the literature has observed that both sovereign ratings (Panetta et al., 2011) and bank ratings (Richards and Deddouche, 2003) have effects on bank performances, few studies examine the dependence of these two effects: whether sovereign ratings do not have extra effects on bank performances but via the bank ratings (mediation effects), and whether bank ratings' effects are reduced if they occur after sovereign rating changes (moderation effects).

In this paper our main aim is to seek empirical evidence, by using data on 55 European banks, to explore the conduit 'Sovereign Rating→Bank Rating→Bank Performances' and to assess the dependence between sovereign ratings' and bank ratings' effects on bank performances by testing the mediation effects and moderation effects.

An extreme case of the independence between sovereign ratings' and bank ratings' effects is the application of sovereign-ceiling policy. The sovereign-ceiling policy, commonly applied by the Big Three CRAs stipulates that, in principle, entity rating levels in a country should not be higher than the sovereign rating level of that country. The sovereign-ceiling policy is investigated by some scholars as an exogenous shock to the bank ratings (Durbin and Ng, 2005;

Borensztein et al., 2013; Adelino and Ferreira, 2016) because according to the policy, CRAs have to adjust entity ratings in the case that the sovereign rating has been changed and the entity has identical rating levels with sovereign rating levels before the sovereign rating events. Such adjustments are not related to the characteristics of the individual banks but just derived from a policy and thus viewed as exogenous. In this paper we also consider the cases where the ceiling policy triggers bank rating changes and study whether under this circumstance the effect of bank rating events is lower than normal ones to supplement the research of the mediation effects of sovereign ratings between bank ratings and bank stock returns.

We extend the scope of the concept 'bank performances'. The literature defines bank performances as either the bond spread or stock prices and study how they are affected by bank ratings. A few papers try to discuss sovereign risks impact on bank lending activities (Altavilla et al., 2017) but to our knowledge there is no previous research discussing the relationship between bank activities and credit/sovereign ratings. To fill in this gap, in this paper we apply not only stock returns, but also risk-taking indicators as bank performance measurements. The rational of this extension is that the market reactions (bond spread or stock returns) can only reflect investors' attitudes of bank ratings rather than the strategies conducted by banks themselves to respond to the rating changes. It is reasonable to predict that investors should reduce their confidence on banks after they view a negative bank rating event thus the stock returns are supposed to be negative (West, 1973). Such deterioration of secondary market conditions makes it harder for banks to raise funding from external sources and may alter the strategy of bank directors, who would take more risk by relaxing the loan granting requirements to make more profits in order to mitigate the pressure from the secondary market. Therefore, by considering the reaction of stock returns and risk-taking indicators, we show evidence of investors' and bank managers' behaviour adjustments towards sovereign/bank ratings from an empirical perspective.

A number of authors have realized the asymmetric effects of negative and positive rating events (Hand et al., 1992; Dichev and Piotroski, 2001; Jung et al., 2016). We follow those studies and conduct empirical tests separately for negative and positive cases and our findings are consistent with the literature showing that only negative events have significant effects on bank performances.

The reason for using European data is that Europe has experienced a sovereign debt crisis (since 2009) and sovereign ratings have considerately changed since then which provides us a sample of a sufficient number of sovereign rating events. Besides that, European stock markets are relatively mature so the stock returns can better reflect investors' attitudes towards banks.

In summary, this paper contributes to the literature mainly in three aspects:

1) We study the bank rating as a potential conduit by which sovereign ratings affect bank performances by taking into consideration the mediation effects of bank ratings;

2) We investigate the interacting effects between sovereign ratings and ratings on bank performances by testing the moderation effects of sovereign ratings and

3) We add bank risk takings to the scope of bank performances.

Following this Introduction, Section 2 presents results of related research conducted by other scholars and states our hypotheses. Section 3 describes the model specification in details and Section 4 introduces the data collected for running the models. Section 5 has the results of our empirical tests and robustness checks. Section 6 concludes.

2. Related Literature and Hypotheses

2.1 Related Literature

Our research contributes to the existing literature on the impact of sovereign risk on market performances implying attitudes of stakeholders to the financial market.

Sovereign default risk is investigated as a determination factor for (general) firm stock returns (Hebert and Schreger, 2017). Specifically for bank performances, Altavilla et al. (2017) study the potential transmission channel from sovereign risks to bank lending activities via the bank

entity risks although sovereign/bank ratings are not directly discussed by them. Besides that, Panetta et al. (2011), Correa et al. (2014) and Acharya et al. (2014) empirically review the channels from sovereign risk to bank performances. Scholars also examine the sovereign impact on bank behaviour such as bank lending strategy (Adelino and Ferreira, 2016) and funding flows (Kim and Wu, 2011).

Apart from sovereign risks, entity ratings have also attracted the interest of academia. Some researchers observe, identify and empirically argue that there exists an association between sovereign risk (represented by sovereign ratings in some cases) and bank ratings (Caporale et al., 2012; Williams et al., 2013; Huang and Shen, 2015 and Alsakka et al., 2014).

Several studies investigate the association between entity ratings and corresponding market performances (West, 1973; Kliger and Sarig, 2000; Hand et al., 1992; and Dichev and Piotroski, 2001)

Risk-taking of banks is a popular topic in the existing literature. Although, to our knowledge there is no research regarding the relationship between bank ratings and risk-taking, other issues about bank risk-takings are studied by many scholars. Banking competition (Boyd and De Nicolo, 2005; Boyd et al., 2006 and Jiménez et al., 2013), regulation (Black and Hazelwood, 2013; Ignatowski el al., 2014; Gropp et al., 2013 and Anginer et al., 2014) and other individual factors are considered in a number of studies.

2.2 Hypotheses

This paper aims to answer four main questions: 1) Do rating agencies tend to make changes for bank ratings after they make changes for sovereign ratings of the countries where banks are located in? 2) Do bank ratings impact bank performances (more specifically, stock returns and risk takings? 3) Do bank ratings act as a mediator between sovereign ratings and bank performances? 4) Do sovereign ratings act as a moderator between bank ratings and bank performances?

To answer these questions, we raise the corresponding hypotheses below.

Hypothesis 1:

In a certain time window (90 days), there exists an instant significant increase in the probability of rating events on banks following sovereign rating events with the same direction happening in countries where the banks are located in.

This hypothesis is derived from the current literature's research outcomes (see Section 2.1).

Hypothesis 2:

There exists a significant association between bank ratings changes and performances of banks (stock market price returns and bank risk taking).

***Hypothesis 2a**: Rating changes with more negative (positive) indications are associated with higher (lower) stock returns of banks.*

This hypothesis is derived from the current literature (see Section 2.1).

***Hypothesis 2b**: Rating changes with more negative (positive) indications of banks are associated with higher (lower) risk-taking of banks.*

There is no previous literature discussing the relationship between credit ratings and risk takings and this hypothesis is derived from the intuition as follows: after receiving negative rating announcements, the banks' performances on the secondary market get worse (stated in Hypothesis 2a) and their ability to make profits from external channels (stock markets) is reduced, which makes bank managers take more risks in the banks' operation (for example, relaxing the standards of granting loans to applicants) to maintain the bank profitability. Therefore, the risk-taking indicators of banks in the year following negative rating announcements might get higher and vice versa.

Hypothesis 3:

Sovereign rating changes and bank rating changes independently affect bank stock returns and bank risk takings without neither mediation nor moderation effects.

According to the definitions of sovereign and bank ratings, sovereign ratings and bank ratings should affect bank performances independently because sovereign ratings are assessments of a country's ability and willingness of a country to repay its government debt however the bank ratings are assessments of the probability of a bank to default or being unable to repay deposits to depositors. They should provide different aspects of information on banks to the public and therefore they should have independent effects on bank performances.

Hypothesis 3 can be detailed into two sub-hypotheses according to the type of bank performance measurements.

Hypothesis 3a*: Bank rating changes do not mediate the effect of sovereign rating changes on stock market price returns and bank risk taking.*

For Hypothesis 3a, we consider the information contents of sovereign ratings and bank ratings. By publishing sovereign ratings and individual entity ratings (of banks), credit rating agencies describe different aspects of information regarding credit risks for investors (sovereign ratings are assessments of the repayment *ability* and repayment *willingness* of the countries' *government* and bank ratings are assessments of *risks a depositor bears* when he/she deposits cash or other securities in that bank). Therefore, the effects of sovereign ratings should not be reduced after controlling bank ratings even though bank rating events usually happen following sovereign rating events (stated in Hypothesis 1). Therefore, we test the association between sovereign ratings and bank performances in the condition of keeping bank ratings constant. If such conditional association is significant, we can conclude that sovereign ratings partially affect bank performances regardless of the individual bank ratings, which reflects that other conduits regarding the sovereign ratings' effects on bank behaviours mentioned in Section 1 (funding costs, fiscal conditions and bank lending) still exists. Otherwise, if sovereign ratings' effects are insignificant controlling bank ratings (or we see a significant decrease in either the coefficient magnitude or significance of bank ratings), we can infer that the existing literature

regarding the conduits from sovereign ratings to bank performances is problematic because, in those studies, sovereign ratings only work on the bank performances via the channel of entity ratings

Hypothesis 3b*: Sovereign rating changes do not moderate the effects of bank rating changes on bank stock returns and bank risk takings unless the bank rating changes are triggered by the sovereign-ceiling policy.*

The intuition is relevant to reduction (or not) of bank ratings' impact conditional on them occurring after sovereign ratings. If sovereign and bank ratings *independently* impact bank performances, a bank rating event's impact on bank performances should not be significantly different whether this rating event occurs just after a sovereign rating event. If they do not independently impact bank performances, it may be reflected by the case that if a bank is downgraded after the country is downgraded, investors/bank managers react to this downgrade event at a lower level than if the country were not downgraded because they have received signals from the sovereign events happening prior to bank rating events so do not panic as usual. In this case, the sovereign rating events *moderate* the effect of bank rating events, evidence of *dependence* of the two types of ratings' impact on banks. Therefore, we investigate whether bank ratings' impact on bank performances significantly recedes if it occurs following a sovereign rating event in corresponding countries. The test is conducted by adding interaction terms between sovereign-rating indicators and bank-rating indicators and if estimated coefficients on interaction terms are significant it implies an existence of moderation effects. An exception is a special case of 'sovereign-ceiling policy' where a bank rating event is fully predictable because it is triggered by an exogenous rule irrelevant to bank characteristics. In this circumstance we expect a reduction of rating events' impact on bank performances if they happen after sovereign rating events.

3. Model Specification

For convenience and due to space constraints, we summarize all variable indicators and their interpretation in a single table (Table 1). In this paper we transform rating scales (including possible downgrades/upgrades) into numbers and a lower number indicates a rating of higher level: 1 indicates AAA (the highest), 2 indicates AAA with possible downgrades, 3 indicates AA+ with possible upgrades etc. The details of numeric transformation is in the online Appendix.

[Insert Table 1 here]

3.1 Model specification for Hypothesis 1

To test Hypothesis 1, we apply ordered logit/probit regressions, regressing latent variables implying the occurrence of bank rating events ($y_{i,a,t}^*$) on dummies that indicate whether sovereign rating events occur certain days before the bank rating events, including possible rating changes, *(D_/U_)* $On\_watch_{i,a,t}$ and actual rating changes, *(D_/U_)* $Sovc1_{i,a,t}$ and *(D_/U_)* $Sovc2_{i,a,t}$.

Since negative and positive rating events have different implications and impacts, we establish two models, one considering negative and positive events separately and another considering both types of events simultaneously[1].

Model (1) considering negative/positive events separately is given by

$$y_{i,a,t}^* = \beta_{1,1}\text{On\_watch}_{i,a,t} + \beta_{1,2}\text{Sovc1}_{i,a,t} + \beta_{1,3}\text{Sovc2}_{i,a,t} + \gamma\text{country}_{i,a} + u_{1i,a} \qquad (1)$$

Model (2) considering negative and positive events simultaneously:

[1] In Model (1), the order of $y_{i,a,t}$ (observed ordinal response categories) represents the ordinal level of degree of bank rating events in either a positive direction or a negative direction, from 0 (indicating no event, the lowest degree) to 3 (indicating rating changes for over two notches in the direction considered, the highest degree). In Model (2), the order of $y_{i,a,t}$ has different implications from that in the specification of Model (1): instead of indicating an ordinal magnitude of event 'degree', it indicates an ordinal level of 'positive implication' of the event. A higher value of $y_{i,a,t}$ represents a more positive situation, from 1 (indicating downgrade events for over two notches, the most negative indicator) to 4 (indicating no event) and from 4 to 7 (indicating upgrade events for over two notches, the most positive indicator).

$$y_{i,a,t}^{*} = \beta_{2,1}\text{D\_(U\_)On\_Watch}_{i,a,t} + \beta_{2,2}\text{D\_(U\_)Sovc1}_{i,a,t} + \beta_{2,3}\text{D\_(U\_)Sovc2}_{i,a,t} +$$

$$\beta_{2,4}\text{D\_(U\_)On\_Watch}_{i,a,t} + \beta_{2,5}\text{D\_(U\_)Sovc1}_{i,a,t} + \beta_{2,6}\text{D\_(U\_)Sovc2}_{i,a,t} + \gamma_2\text{country}_{i,a} +$$

$$u_{2i,a} \qquad (2)\ ,$$

where $u_{1i,a}$ and $u_{2i,a}$ are error terms and other variables are explained in Table 1.

Besides regression tests, we check the durations between each sovereign rating announcements and corresponding bank rating events to figure out whether the reaction of bank ratings is sufficiently 'instantaneous' to reflect a 'tradition' or the regulation of credit rating agencies[2].

3.2 Model Specification for Hypothesis 2

3.2.1 Model specification for Hypothesis 2a

The baseline model tests whether the variation of average bank ratings ($\text{Daily\_Bank\_Rating\_Change}_{i,t}$ in Model (3) and four dummies in Model (4)) have a significant effect on the variation of stock prices of corresponding banks ($\text{TDay Price Return}_{i,t}$) in a certain short-term testing time window.

$$\text{TDay Price Return}_{i,t} = \alpha + \beta_{3,1}\text{Daily\_Bank\_Rating\_Change}_{i,t} + \gamma_3\text{TDay Index Return}_{i,t} +$$

$$v_i + \varepsilon_{i,t} \qquad (3),$$

where v_i is the unobserved heterogeneity of bank *i* and $\varepsilon_{i,t}$is the error term and the year fixed effects are controlled in this model.

To distinguish the situations for negative events and positive ones, we design updated regressions replacing the original variable $\text{Daily\_Bank\_Rating\_Change}_{i,t}$ by various dummies indicating the changing direction of ratings shown in Model (4):

$$\text{TDay Price Return}_{i,t} = \alpha + \beta_{4,1}\text{Actual\_down}_{i,t} + \beta_{4,2}\text{Possible\_down}_{i,t} + \beta_{4,3}\text{Possible\_up}_{i,t} +$$

$$\beta_{4,4}\text{Actual\_up}_{i,t} + \gamma_4\text{TDay Index Return}_{i,t} + v_i + \varepsilon_{i,t} \quad (4)$$

[2] The assumption behind this intuition is that a very short duration between sovereign rating changes and bank rating changes in that country implies that the reaction of bank rating changes to sovereign ratings is based on the tradition or regulation of CRAs but not banks' fundamental variation because it is highly unlikely that banks' fundamental condition coincidently experiences a large change in a very short time window following the sovereign ratings change.

To deal with the imperfection of the baseline model concerning the lower frequency of the variation of bank ratings compared to that of bank stock prices and index values, we only consider observations when banks receive bank rating announcements and establish a cross-sectional dataset to conduct a similar test to Model (3).

Besides, for each individual bank we run another supplementary test, Granger causality, in order to enhance our results of Model (3) from a causality perspective.

To save space, we do not show the detailed formula of these two supplementary designs in the main context but they can be found in the online appendix.

3.2.2 Model Specification for Hypothesis 2b

Hypothesis 2b is related to two factors: bank risk-takings as explained variables and bank ratings as explanatory variables. The general format of these regressions is:

$$Bank\ Risk\ Takings \sim Bank\ Rating, Control\ Variables$$

Differently from the stock market test, the test for bank risk takings is conducted on an annual basis because 1) risk takings reflect the long-term strategy of banks thus daily data is unable to capture such strategy and 2) variables regarding bank risk takings (the left side) are established using accounting-based data whose frequency is usually on annual basis. However, variables regarding bank ratings (the right side) are on daily basis. Therefore, we transform bank-rating-related variables into annual format to avoid the problem of imbalanced data. In Section 3.2.2.1 we describe how the explained variables reflecting risk takings of banks are established. In Section 3.2.2.2 we discuss several ways to transform rating-related indicators into annual level. In Section 3.2.2.3 the control variable setting is presented.

3.2.2.1 Measurement of bank risk takings

Indicators of bank risk takings are usually established by two levels of data: loan-level data and accounting-based data. The former group includes loan-granting volume (Gropp et al., 2013; Jiménez et al. 2014), likelihood of default of granted loans (Jiménez et al. 2014) and loan

spreads (Paligorova and Santos, 2016). The other group mainly refers to 'Z score' (Boyd et al., 2006; Gropp et al.,2013; Ignatowski and Korte, 2014; Anginer et al, 2014, and Adhikari and Agrawal, 2016). Due to the fact that loan-level data is usually highly confidential and difficult to obtain, we use an accounting-based indicator, Z score, to measure bank risk takings in this paper.

Z score is commonly used in empirical papers to measure the probability of insolvency of banks. The format of time-varying Z score that we apply in our tests is,

$\mathrm{Z}_t = (\mathrm{ROAA}_t + \mathrm{CAR}_t)/\sigma(\mathrm{ROAA})_{full-period_t}$, where $ROAA_t$ (Return on Average Assets) and CAR_t (Capital-Asset Ratio) are current values in year t and $\sigma(ROAA)_{full-period}$ is the full-period variance of ROAA (time-invariant variable).

3.2.2.2 Measurement of annual bank rating changes

Regressions for risk taking cases are on an annual basis. Therefore, it is necessary to use several types of indicators to measure the bank rating changes in one year instead of only using the numeric difference of rating at time t and (t-1). In this section, we apply three types of measurement to represent the degree of bank rating changes in year *t*. Considering possible reverse-causality which may make the results biased, we take one-year lag of all the independent variables in this section.

Measurement 1: The change of average numerically-transformed rating indicators ($\mathrm{Rating\ Change}_{\mathrm{i,t-1}}$) as key independent variables to indicate the impact of bank ratings for each bank. Note that higher figures mean annual rating changes with more negative implication. The corresponding model is

$$\mathrm{Z}_{\mathrm{i,t}} = \alpha + \beta_{5,1}\mathrm{Rating\ Change}_{\mathrm{i,t-1}} + \gamma\mathrm{Control}_{\mathrm{i,t-1}} + v_i + \varepsilon_{i,t} \qquad (5),$$

where v_i is the unobserved heterogeneity of bank *i* and $\varepsilon_{i,t}$is the error term;

Measurement 2: The average number of negative/positive rating events (for the Big Three CRAs) in each year ($\mathrm{NegNo}_{i,t-1}$and $\mathrm{PosNo}_{i,t-1}$) as key independent variables to indicate the impact of bank ratings for each bank.

The corresponding model is

$$\mathrm{Z}_{i,t} = \alpha + \beta_{6,1}\mathrm{NegNo}_{i,t-1} + \beta_{6,2}\mathrm{PosNo}_{i,t-1} + \gamma\mathrm{Control}_{i,t-1} + v_i + \varepsilon_{i,t} \qquad (6)$$

Measurement 3: Four dummies to indicate the rating's impact, two of which represent small rating changes ($\mathrm{Neg1}_{\mathrm{i,t-1}}$ and $\mathrm{Pos1}_{\mathrm{i,t-1}}$) and other two of which represent large ones ($\mathrm{Neg2}_{\mathrm{i,t-1}}$ and $\mathrm{Pos2}_{\mathrm{i,t-1}}$):

The corresponding model is

$$\mathrm{Z}_{\mathrm{i,t}} = \alpha + \beta_{7,1}\mathrm{Neg1}_{\mathrm{i,t-1}} + \beta_{7,2}\mathrm{Neg2}_{\mathrm{i,t-1}} + \beta_{7,3}\mathrm{Pos1}_{\mathrm{i,t-1}} + \beta_{7,4}\mathrm{Pos2}_{\mathrm{i,t-1}} + \gamma\mathrm{Control}_{\mathrm{i,t-1}} + v_i + \varepsilon_{i,t} \quad (7)$$

3.2.2.3 Control variables setting

Three groups of control variables are collected and applied in Models (5)-(7): initial ratings at the beginning of each year, accounting-based variables and market-based variables. Initial ratings control the rating levels at the beginning of each year considering that same rating changes on different initial ratings have different meanings. Accounting-based variables reflect fundamental performances of banks in the previous year and market-based variables reflect stock market performances of banks in the previous year. Details of these three levels of control variables are in the online appendix.

3.3 Model specification for Hypothesis 3

Hypothesis 3 focuses on the independence between sovereign ratings' and bank ratings' effects on bank performances. Hypothesis 3a discusses the mediation effect and Hypothesis 3b discusses the moderation effect.

3.3.1 Model Specification for Hypothesis 3a: Mediation effect of bank ratings

The condition of a variable *M* (the hypothesized mediator) to be the mediator between *X* (independent variable) and *Y* (dependent variable) is that,

1) *M* significantly affects *Y*;

2) X significantly affects *Y* without taking *M* as the control variable;

3) If taking *M* as the control variable, *X* does not significantly affect *Y* or the magnitude of *X*'s effects are significantly reduced. To statistically examine whether the reduction of coefficients is sufficiently significant, Sobel test should be conducted to check whether the Sobel Statistics (which represents the difference between the two coefficients adjusted by the standard errors of the difference) is sufficiently large to reject the null hypothesis of no significant difference. In the context of this research, to test whether the bank rating changes (hypothesized mediator) act as a mediator between sovereign rating changes and bank performances, we follow the procedures below.

Step 1: Regress bank performance indicators (stock returns or risk takings) on both *bank rating indicators (hypothesized mediator)* and *sovereign rating indicators (the independent variable).*

Stock returns case:

$$TDay\ Price\ Return_{i,t} = \alpha + \beta_{8,1} Daily\_Bank\_Rating\_Change_{\ i,t} + \beta_{8,2} FNS\_Dummy_{i,t} + \beta_{8,3} FPS\_Dummy_{i,t} + v_i + \varepsilon_{i,t} \quad (8),$$

where $Daily\_Bank\_Rating\_Change_{\ i,t}$ is the hypothesized mediator.

Risk-taking case:

$$Z_{i,t} = \alpha + \beta_{9,1} RatingChange_{i,t-1} + \beta_{9,2} SovNegD_{i,t-1} + \beta_{9,3} SovPosD_{i,t-1} + \gamma Control_{i,t-1} + v_i + \varepsilon_{i,t} \quad (9),$$

where $RatingChange_{i,t-1}$ is the hypothesized mediator.

Step 2: Check whether $\beta_{8,1}$ and $\beta_{9,1}$ (coefficients on hypothesized mediators) are significant. If they are insignificant, we conclude that corresponding bank rating indicator is not the mediator. If they are significant, we go to Step 3.

Step 3: Regress bank performance indicators (stock returns or risk takings) on *only sovereign rating indicators.*

Stock returns case:

$$TDay\ Price\ Return_{i,t} = \alpha + \beta_{10,2} FNS\_Dummy_{i,t} + \beta_{10,3} FPS\_Dummy_{i,t} + v_i + \varepsilon_{i,t} \quad (10)$$

Risk-taking case:

$$Z_{i,t} = \alpha + \beta_{11,2} SovNegD_{i,t-1} + \beta_{11,3} SovPosD_{i,t-1} + \gamma Control_{i,t-1} + v_i + \varepsilon_{i,t} \quad (11)$$

Step 4: For the stock return case, we compare $\beta_{10,2}$ ($\beta_{10,3}$), with $\beta_{8,2}$ ($\beta_{8,3}$). If $\beta_{10,2}$ ($\beta_{10,3}$) is significant but $\beta_{8,2}$ ($\beta_{8,3}$) is not then we would conclude that Daily_Bank_Rating_Change $_{i,t}$ *is* the mediator from negative (positive) sovereign rating changes to bank stock returns. If both $\beta_{10,2}$ ($\beta_{10,3}$) and $\beta_{8,2}$ ($\beta_{8,3}$) are significant but the magnitude of $\beta_{8,2}$ ($\beta_{8,3}$) is significantly smaller than that of $\beta_{10,2}$ ($\beta_{10,3}$) supported by a rejection of null hypothesis of Sobel Test, then we would conclude that Daily_Bank_Rating_Change $_{i,t}$ *is* the mediator. In other cases, Daily_Bank_Rating_Change $_{i,t}$ *is not* the mediator.

For the risk-taking case, we compare $\beta_{11,2}$ ($\beta_{11,3}$) with $\beta_{9,2}$ ($\beta_{9,3}$). If $\beta_{11,2}$ ($\beta_{11,3}$) is significant but $\beta_{9,2}$ ($\beta_{9,3}$) is not, then we conclude that $\text{RatingChange}_{i,t-1}$ *is* the mediator from negative (positive) sovereign rating changes to bank stock returns. If both $\beta_{11,2}$ ($\beta_{11,3}$) and $\beta_{9,2}$ ($\beta_{9,3}$) are significant but the magnitude of $\beta_{11,2}$ ($\beta_{11,3}$) is significantly smaller than that of $\beta_{9,2}$ ($\beta_{9,3}$) supported by a rejection of null hypothesis in Sobel Test, then we would find evidence indicating that $\text{RatingChange}_{i,t-1}$ *is* the mediator. Otherwise, $\text{RatingChange}_{i,t-1}$ *is not* the mediator.

3.3.2 Model Specification for Hypothesis 3b: Moderation effect of sovereign ratings

To examine the existence of moderation effect, we apply difference-in-difference analysis. We consider all bank rating events in our sample as Group A, select bank rating events which follow sovereign rating events as Group B and select bank rating events which not only follow sovereign events but trigger the sovereign-ceiling policy as Group C. Then, we compare the effects of bank rating events included in Group A and Group B(C) on bank performances. Hypothesis 3b would be enhanced if the effects are not significantly different between Groups A and B while the effects are significantly different between Groups A and C.

Hypothesis 3b considers two types of bank performances, stock returns and risk takings. Original tests regarding these two types of indicators for Hypothesis 2 in Section 3.2 are designed and conducted separately. Parallelly in this section we test them respectively in Sections 3.3.2.1 and 3.3.2.2.

3.3.2.1 Stock prices

The model to test Hypothesis 3b for stock return is

$$\text{TDay Price Return}_{i,t} = \alpha + \beta_{12,1}\text{Daily\_Bank\_Rating\_Change}_{i,t} + \beta_{12,2}\text{FNS\_Dummy}_{i,t} + \beta_{12,3}\text{FPS\_Dummy}_{i,t} + \beta_{12,4}\text{Interactio\_N}_{i,t} + \beta_{12,5}\text{Interactio\_P}_{i,t} + \gamma\text{TDay Index Return}_{i,t} + v_i + \varepsilon_{i,t} \quad (12),$$

where $\beta_{12,4}$, $\beta_{12,5}$are D-I-D estimators on interaction terms, ($\text{Interactio_N}_{i,t}$ and $\text{Interactio\_P}_{i,t}$); v_i is the unobserved heterogeneity of bank *i* and $\varepsilon_{i,t}$ is the error term.

$\beta_{12,4}$ and $\beta_{12,5}$ are the difference-in-difference estimators that indicate whether bank rating changes following sovereign rating changes (Group B) or triggered by the ceiling policy (Group C) affect bank stock returns significantly and differently from all bank rating changes (Group A).

3.3.2.2 Risk takings

Considering the three measurements of annual indicators of bank rating variation, we design the models to test Hypothesis 3a for bank risk takings.

Measurement 1:

$$Z_{i,t} = \alpha + \beta_{13,1}\text{RatingChange}_{i,t-1} + \beta_{13,2}\text{SovNegD}_{i,t-1} + \beta_{13,3}\text{SovPosD}_{i,t-1} + \beta_{13,4}\text{RC\_SovNegD}_{i,t-1} + \beta_{13,5}\text{RC\_SovPosD}_{i,t-1} + \gamma\text{Control}_{i,t-1} + v_i + \varepsilon_{i,t} \quad (13),$$

where v_i is the unobserved heterogeneity of bank i and $\varepsilon_{i,t}$ is the error term.

Measurement 2:

$$Z_{i,t} = \alpha + \beta_{14,1}\text{NegNo}_{i,t-1} + \beta_{14,2}\text{PosNo}_{i,t-1} + \beta_{14,3}\text{SovNegD}_{i,t-1} + \beta_{14,4}\text{SovPosD}_{i,t-1} + \beta_{14,5}\text{NegNo\_SovNegD}_{i,t-1} + \beta_{14,6}\text{PosNo\_SovPosD}_{i,t-1} + \gamma\text{Control}_{i,t-1} + v_i + \varepsilon_{i,t} \quad (14),$$

where v_i is the unobserved heterogeneity of bank i and $\varepsilon_{i,t}$ is the error term.

Measurement 3:

$$Z_{i,t} = \alpha + \beta_{15,1}\text{NegD1}_{i,t-1} + \beta_{15,2}\text{NegD2}_{i,t-1} + \beta_{15,3}\text{PosD1}_{i,t-1} + \beta_{15,4}\text{PosD2}_{i,t-1} + \beta_{15,5}\text{SovNegD}_{i,t-1} + \beta_{15,6}\text{SovPosD}_{i,t-1} + \beta_{15,7}\text{NegD1\_SovNegD}_{i,t-1} + \beta_{15,8}\text{NegD2\_SovNegD}_{i,t-1} + \beta_{15,9}\text{PosD1\_SovPosD}_{i,t-1} + \beta_{15,10}\text{PosD1\_SovPosD}_{i,t-1} + \gamma\text{Control}_{i,t-1} + v_i + \varepsilon_{i,t} \quad (15),$$

where v_i is the unobserved heterogeneity of bank i and $\varepsilon_{i,t}$ is the error term.

The Difference-in-Difference estimators in Models (13), (14) and (15) as well as their interpretation are shown in Table 2.

[Insert Table 2 here]

3.3.2.3 Special case: sovereign-ceiling policy

This part of our study covers only daily stock returns but not annually risk-taking indicators because, to define whether the bank rating change is 'following sovereign-ceiling policy', it is necessary to collect daily data for bank rating changes given that the measurement of policy effects requires a short testing window on a daily basis.

For daily stock return dataset, the model is,

$$\text{TDay Price Return}_{i,t} = \alpha + \beta_{16,1}\text{Daily\_Bank\_Rating\_Change}_{i,t} + \beta_{16,2}\text{NCT\_dummy}_{i,t} + \beta_{16,3}\text{PCT\_dummy}_{i,t} + \beta_{16,4}\text{Neg\_Inter}_{i,t} + \beta_{16,5}\text{Pos\_Inter}_{i,t} + \gamma\text{NDay Index Return}_{i,t} + v_i + \varepsilon_{i,t} \quad (16),$$

where v_i is the unobserved heterogeneity of bank i and $\varepsilon_{i,t}$ is the error term.

$\beta_{16,4}$ and $\beta_{16,5}$ are the difference-in-difference estimators that show whether bank rating changes triggered by the sovereign-ceiling policy (Group C) affect bank stock returns significantly differently from all bank rating changes (Group A). Recall that the expected sign of $\beta_{5,1}$ is negative as stated in Section 3.2.1.2. Hence, positive $\beta_{16,4}$ and $\beta_{16,5}$ imply a reduction of the size of $\beta_{16,1}$ for the treatment group (those rating changes following the policy), which indicates that the sovereign-ceiling policy makes bank rating changes triggered by it have weaker effects on stock daily returns.

4. Data

To study the relationship among sovereign ratings, bank ratings and bank performances, we select 20 European countries according to the following criteria: 1) geographic diversity considering different regions of Europe such as Western Europe (France, UK, Belgium etc.), Central Europe (Austria, Czech Republic etc.), Northern Europe (Sweden, Denmark), Southern Europe (Spain, Portugal, Italy etc.) and Eastern Europe (Russia, Poland etc.); 2) the sovereign of the selected countries is rated by Moody's, S&P and Fitch; 3) at least one bank in the selected countries is rated by Moody's, S&P and Fitch; 4) the selection strategy applied by other scholars in existing papers[3].

For each of the selected countries, all commercial banks registered in Bloomberg are firstly considered before filtered based on the following criteria: 1) 'big' banks whose total assets are among top 30 in the corresponding countries; 2) banks who have records within the selected

[3] The selection of countries is based on the research by Arezki (2011), De Santis (2012) and Acharya et al. (2014).

time period; 3) excluding banks which are not rated by Moody's, S&P and Fitch; 4) excluding banks which are not listed in equity market thus do not have stock market prices; 5) excluding banks whose accounting information is omitted in Bloomberg database. After the five stages of the filter process, we end up with data of 55 banks between August 24th 1999 and June 30th 2016. The reason for the selection of this sample period is to guarantee that all countries are rated by at least one agency during that time. Note that not all of the 55 banks have available data in this entire period due to either some banks are established/rated/listed after August 24th 1999 or some banks are closed/withdrawn by rating agencies or delisted from the stock market before 30th 2016[4]. Bank codes, nationalities, time periods for the selected 55 banks are in the online appendix.

Historical rating records are collected from Bloomberg while historical stock prices and accounting information are collected from Datastream.

The concept 'event' is defined as a change of rating level or a possible rating change announced by at least one CRA among the Big Three. The expression of 'possible rating change' used by the three CRAs differs from one to another ('watchlist' for Moody's, 'creditwatch' for S&P and 'rating watch' for Fitch).

5. Empirical Results and Discussion

5.1 Results for Hypothesis 1

5.1.1 Ordered logit/probit regressions

Table 3 shows the result for the regressions for Models (1) and (2) using data of each of the three CRAs. Estimated coefficients, Wald-test statistics as well as statistical significance are presented.

[Insert Table 3 here]

[4] Gaillard (2011) states that the main reasons for a rating agency to withdraw a rating include 1) issuers' request, 2) rating agencies find that they lack fundamental information regarding issuers to maintain their ratings, 3) the rated securities expire and 4) some special circumstances.

According to the variable setting for Model (1) which has been described in Section 3.1 and Table 1, coefficients with positive sign can be explained as evidence to support Hypothesis 1: they imply that *the probability that a bank receives an upgrade/downgrade announcement with a higher degree is significantly higher if the country where that bank is located in receives a upgrade/downgrade announcement fewer than 90 days before.*

According to variable setting for Model (2) which has been described in Section 3.1 and Table 1, the positive coefficients on upgrade-related variables (except 'On watch upgrade' by S&P) and negative coefficients on downgraded-related variables can be interpreted in the following way: *the occurrence of a positive sovereign event is associated with the rise of the probability that a bank rating event with a more positive indication occurs in no more than 90 days*; analogously, *the occurrence of a negative sovereign event is associated with the fall of the probability that a bank rating event with a more positive indication occurs in no more than 90 days.*

Those results enhance the conclusions obtained by other scholars. The association between sovereign rating events and bank rating events observed in our research is consistent findings of Williams et al. (2013) who use emerging market data describing such relationship and of Alsakka et al. (2014) focusing on the European crisis period.

In terms of the durations between sovereign and bank rating changes, we find that for all the three CRAs, average durations do not exceed 13 days (13 days for Moody's, 13 days for S&P and 10 days for Fitch). Statistical analysis results also show that no significance differences of durations are observed either between negative and positive rating events or among different CRAs, indicating the stability of durations in different scenarios[5]. An average duration of 13 days provides evidence to show that the bank rating's reactions to sovereign ratings are instant thus can be attributed to CRAs' tradition or regulation (i.e. sovereign-ceiling policy).

[5] Details of the reaction duration is available upon requests.

5.2 Results for Hypothesis 2

5.2.1 Hypothesis 2a

The results of Model (3) are shown in Table 4.

[Insert Table 4 here]

We are interested in the sign and significance of the coefficients on $\text{Daily\_Bank\_Rating\_Change}_{i,t}$. For all testing windows ($1 \leq T \leq 10$), coefficients are consistently negative and for $T<8$ they are significantly negative, which provides evidence to show that 1) the rating changes impact stock price movements controlling market factors and a more negative/positive rating change is associated with a lower/higher return; 2) such impact gradually gets weaker with the extension of testing windows.

Table 5 decomposes the impact according to the direction of the rating changes. A key finding is that coefficients on either of variables indicating bad news ($\text{Actual\_down}_{i,t}$ and $\text{Possible\_down}_{i,t}$) are negative for all T and significantly negative for $T<7$ while coefficients on variables indicating good news ($\text{Actual\_up}_{i,t}$ and $\text{Possible\_up}_{i,t}$) are all insignificant. It implies an asymmetric effects of negative rating events and positive ones on bank stock returns: the impact concluded in Model (5) only exists for (possible) downgrade announcements rather than for (possible) upgrade announcements.

Similar asymmetric effects of negative and positive bank ratings on bank stock returns are observed by Deddouche (2003) who uses emerging market data.

[Insert Table 5 here]

Besides, two supplementary tests (cross-sectional regressions and Granger causality tests) promote the results derived from Model (3): only considering event days, estimators do not significantly change; most of the sample banks see a significant causality from rating changes to stock returns. For saving space we do not present the detailed results of these tests but they are available upon requests.

5.2.2 Hypothesis 2b

In this section we present the results of the investigation about rating changes' effects on bank risk takings, reflected by Z score in Table 6. Models (5), (6) and (7) show the results regressing Z score on a variety of measurements of annual bank rating changes along with different combinations of control variables.

[Insert Table 6 here]

For Model (5), irrespective of the selection of control-variable combinations, the coefficients on $\text{Rating Change}_{i,t-1}$ are always significantly negative, implying a significantly higher risk taking of banks (i.e. smaller Z score) with a rating change which has a more negative indication. For Model (6), coefficients on $\text{NegNo}_{i,t-1}$ are significant while those on $\text{PosNo}_{i,t-1}$ are insignificant, which indicates asymmetric effects between bad and good news. Model (7) enhances the results of Model (6): coefficients on $\text{Neg1}_{i,t-1}$ and $\text{Neg2}_{i,t-1}$ are significantly negative while neither of coefficients on $\text{Pos1}_{i,t-1}$ and $\text{Pos2}_{i,t-1}$ are significant.

To our knowledge this is the first research to study the association between rating events in one year and bank risk taking changes in the following year. This enhances our hypotheses regarding the effects of negative bank rating changes (not positive ones) on risk takings of bank managers.

5.3 Results for Hypothesis 3

5.3.1 Hypothesis 3a

For stock returns, the result of bank rating changes' mediation effect test is shown in Table 7.

[Insert Table 7 here]

Due to the space constraints we do not report the results irrelevant to the mediation effect test (including the estimation of coefficients of market index and R-square) in the table. They are not significantly different with the results of original regressions shown in Table 4.

We find that whether or not adding $Bank\ Rating\ Change$ in the regressions (compare the results of Reg1 and Reg2), both the significance and the magnitude of coefficients on sovereign

ratings remain at the same level. When T=1 for example, the Following_Negative_Dummy's (FNS_Dummy's) coefficient is -0.48 with t-statistics of -2.13 in Reg1 and the Following_Negative_Dummy's (FNS_Dummy's) coefficient remains the same (-0.48) with t-statistics only changing by 0.01 to -2.12 in Reg2. This shows that bank rating changes *do not* mediate the effects from sovereign rating changes to stock returns.

For risk-takings, the result of the mediation effect test is shown in Table 8.

[Insert Table 8 here]

We use all the three measurements of annual rating changes to test their mediation effects respectively (see different rows in 'Reg2' Panel). We also run the regressions considering three levels of control variables described in Section 3.2.2.3 (see different columns).

Initially we check the significance of coefficients for hypothesized mediators (*Lagdif* for BR Measurement-1; *NegNo* and *PosNo* for BR Measurement-2; *Neg1, Neg2, Pos1* and *Pos2* for BR Measurement-3). If they are insignificant than we reject the hypothesized mediation effect and directly output *'N.A'* in the column 'Sobel Statistics' (because we do not go to the step of Sobel test and reject the hypothesis of mediation effect before that) and output *'No'* in the column 'Judgement of mediation effect'. If significant, than we check the significance of $\mathrm{SovNegD}_{\mathrm{i,t-1}}$ and $\mathrm{SovPosD}_{\mathrm{i,t-1}}$ in Reg1 and Reg2. If the corresponding coefficients are insignificant in Reg2 but significant in Reg1 then we can directly view bank rating changes as a mediator without Sobel test so we output '*Not necessary'* in column 'Sobel Statistics' and '*Yes*' in the column 'Judgement of mediation effect'. If both in Reg1 and Reg2, the corresponding coefficients are significant then we need to run Sobel Test and report the corresponding Sobel statistics figure in the column 'Sobel Statistics'. If Sobel statistics is significantly different from 0, we judge the bank rating changes as a mediator and insert '*Yes*' in the column 'Judgement of mediation effect'; otherwise we report '*No*'.

From Table 8 we can conclude that, 1) broadly speaking, bank rating changes (*Lagdif* for Measurement 1) *are* mediators between sovereign rating changes and bank risk-takings, 2) negative bank rating changes (*NegNo* for Measurement 2 and *Neg1, Neg2* for Measurement 3) are widely seen as mediators while positive ones are not. The reason for the absence of mediation effects for positive bank rating events is that they cannot significantly affect risk-takings of banks, which is consistent with the results discussed in Section 5.2.2.

In summary, the hypothesis of no mediation effects raised in Section 2.3 is supported empirically for the case of stock returns but not for the case of risk takings.

In the stock market, investors view sovereign ratings as an indicator of information which has no overlap with the information given by individual bank ratings when they decide to buy or sell the stock of a bank. In other words, for investors, sovereign ratings reflect other information (for example, quality of government debt held by banks or possibility of government bailouts to banks) but not that of bank operations. However, for bank managers, sovereign ratings affect their behaviours partially via bank ratings which means that they focus more on sovereign rating downgrade in their country if this downgrade brings an accompanying downgrade of their own banks.

5.3.2 Hypothesis 3b

Model (12) aims at testing the moderating effects of sovereign rating changes between bank rating changes and bank stock returns. Models (13)-(15) are parallel tests of the moderating effects and Model (16) is a test on the sovereign-ceiling policy and its effects on bank stock performances. Table 9 shows the result of Model (12).

[Insert Table 9 here]

We find that $\beta_{12,4}$ (coefficient on *Interaction_N*) is not significant, which means that sovereign ratings do not have an interacting effect with bank ratings' effects on stock prices[6].

Table 10 shows the results of Models (13)-(15) testing the interacting effects of sovereign-rating variables with bank rating variables on the bank risk taking indicator, Z score.

[Insert Table 10 here]

Coefficients on interaction terms (RC_SovNegD in Model (13), NegNo_SovNegD in Model (14) and Neg1_SovNegD , Neg2_SovNegD in Model (15)) are consistently insignificant indicating that negative sovereign rating events increase bank risk takings independently from bank rating events.[7] Table 11 shows the results of Model (16) regarding the special circumstance of the sovereign-ceiling policy.

[Insert Table 11 here]

$\beta_{16,4}$ and $\beta_{16,5}$, the coefficients on the interaction terms, are typically positive. As described in Section 3.2.2, this provides empirical evidence to state that the mechanism of sovereign-ceiling policy makes the consequent bank rating changes have weaker effects on the stock market. Our findings support Hypothesis 3b of no moderation effects except in the sovereign-ceiling policy case.

[6] The case of positive sovereign events (FPS_Dummy) and their interacting effects with bank rating events ($Interaction\_P$) is different from that of negative ones. $\beta_{12,3}$ is not significant reflecting an absence of association between sovereign upgrades and price reactions. Therefore, it is straightforward to find that the interaction effects ($\beta_{12,5}$) are not significant.

[7] The situation of positive sovereign ratings' effects is not similar to that of negative ones: coefficients on SovPosD are positive but not consistently significant, which implies a weak evidence that positive sovereign events decrease risk takings controlling bank rating upgrades. Except Model (12), coefficients on PosNo_SovPosD in Model (13) and Pos1_SovPosD and Pos2_SovPosD in Model (14) are consistently insignificant and since coefficients on bank rating variables are insignificant, there does not exist interacting effects between positive sovereign events and positive bank rating events.

5.3 Robustness checks

To enhance the creditability of empirical results shown in Sections 5.1 and 5.2 we run two robustness checks, Hausman test for random effects and standard error clustering for heteroscedasticity.

Hausman test

As stated in Sections 5.1 and 5.2 we run fixed-effect models (FE) for all the panel regressions to eliminate the time-invariant factors from our estimation. However, if the data also fits random effect models which create much different results from fixed-effect ones then we need to re-consider the rationality of using fixed-effect models.

To resolve such concern, we run Hausman tests for all the panel regressions. The null hypothesis of Hausman Test is that Random Effect Model (RE) should be applied because the u_i is uncorrelated to predictors (X_i). Therefore, if we reject the null hypothesis we should use Fixed Effect Model (FE).

We conduct Hausman tests for each of all the panel regressions. If the null hypothesis is rejected, then we do nothing for that regression; if the null hypothesis is not rejected, then we run the same regression by RE and evaluate whether the results are significantly changed.

We do not show the results of Hausman tests and RE estimation (on the condition of not rejecting the null hypothesis) but they are available upon request. To summarize the results, for most of the regressions we reject the null hypothesis of Hausman test which indicates the rationality of using fixed-effect estimations as in Sections 5.1 and 5.2. For the minority of the cases where we cannot reject the null hypothesis we run RE estimations for the same datasets and do not find significant difference between the RE estimators (both estimators' sizes and statistical significance) and the original FE estimators.

Clustering standard errors

To deal with the possibly existing heteroscedasticity problem (unobserved characteristics of observations correlated with each other within same clusters, for example, same stock/bank[8], same country or same year), we cluster standard errors for all regressions in Sections 5.1 and 5.2 by three levels respectively, stock/bank level, year level and stock/bank-year level (two-way clustering). The two-way clustered standard errors are adjusted by (N-1)/(N-P)× G/(G-1),where N is the sample size, P is the number of independent variables, and G is the number of clusters (Ma, 2014). Due to space limitations we do not show the results of error-clustering estimations but they are available upon request. To summarize the results, we find that the estimated standard errors are bigger than those originally estimated without clustering, which implies that original estimations underestimate the standard errors due to the absence of consideration of heteroscedasticity. However, the majority of estimators' statistical significance does not deteriorate after standard-error-clustering so the underestimation of standard errors in our main tests is at an acceptable level.

Details of robustness check results are available upon requests.

6. Conclusion

By quantitative analysis, we find that sovereign rating changes are instantly followed by bank rating changes in the same country and the corresponding bank rating changes are significantly associated with daily stock returns and annually risk-taking indicators. Sovereign ratings and bank ratings of banks independently impact bank performances except the sovereign-ceiling policy case. But bank ratings mediate the sovereign ratings' effects on bank risk takings measured by Z score.

This research contributes to the topic of sovereign rating's impact on commercial bank performances. Our findings indicate the existence of a channel of entity ratings by which the

[8] Stock ID level for stock return cases and bank ID level for risk-taking cases.

sovereign ratings impact bank risk takings (but not stock returns). It means that discussions of the previous literature on alternative channels (holding of government debts, government guarantee, macro financial stability etc.) can be discussed further to explain the reaction of banks to sovereign rating changes.

Our research also extends the existing literature of 'credit rating-bank performance' relationship by using risk-taking indicators (Z score) as a variable explained by rating variations. We find an uplift of risk-taking following a negative bank rating variation and raise a potential explanation that negative rating news deteriorates the financial market situation of the involved banks, which have to increase their risk-takings to maintain their profitability levels given a weaker profitability from the financial market.

Our research is restricted in the following areas: a) we only consider big banks in each of the sample countries because small banks do not receive ratings from Big Three CRAs and b) only Z-scores are applied to represent risk-takings of banks while another stream of indicators, loan-level variables cannot be accessed due to confidentiality.

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Tables

Table 1 Interpretation of variables in all models

Type	Model	Variable Indicator	Interpretation
Dependent Variable	(1)	$y_{i,a,t}^*$	An unobserved latent variable linked to the observed ordinal response categories of $y_{i,a,t}$: $y_{i,a,t}$=0, if no downgrade or possible downgrade (on watch) announcements were released by CRA *a* on date t about bank i; =1, if bank i was put on possible downgrade (upgrade) watch list by CRA *a* on date t; =2, if bank i was downgraded (upgraded) by one notch by CRA *a* on date t; =3, if bank i was downgraded (upgraded) by more than two notches by CRA *a* on date t.
	(2)	$y_{i,a,t}^*$	An unobserved latent variable linked to the observed ordinal response categories by $y_{i,a,t}$: $y_{i,a,t}$=1, if bank i was downgraded by more than two notches by CRA *a* on date t; =2, if bank i was downgraded by one notch by CRA *a* at date t; =3, if bank i was put on possible downgrade watch list by CRA *a* on date t; =4, if no rating announcements were released by CRA *a* about bank *i* on date t; =5, if bank i was put on possible upgrade watch list by CRA a on date t; =6, if bank i was upgraded by one notch by CRA *a* on date t; =7, if bank i was upgraded by more than two notches by CRA *a* on date t;
	(3) (4) (8) (10) (12) and (16)	TDay Price Return$_{i,t}$	$=\frac{\text{Price}_{i,(t-1+T)}-\text{Price}_{i,(t-1)}}{\text{Price}_{i,(t-1)}}$, $Price_{i,t}$ is the price of bank i at the end of day t, T is from 1 to 10 representing the testing windows;
	(5) (6) (7) (9) (11) (13) (14) and (15)	$Z_{i,t}$	Z score of bank *i* in year *t*;
Independent Variable	(1)	$\text{On\_watch}_{i,a,t}$	Dummy equal to 1 if the country where bank i is located is listed on the watch list of possible downgrade (upgrade) by CRA a, within three months' window prior to date t, otherwise equal to 0;
		$\text{Sovc1}_{i,a,t}$	Dummy equal to 1 if sovereign rating is downgraded (upgraded) with one notch released by CRA a on the country where bank i is located within three months' window prior to date t, otherwise equal to 0;
		$\text{Sovc2}_{i,a,t}$	Dummy equal to 1 if sovereign rating is downgraded (upgraded) with more than one notches released by CRA a on the country where bank i is located within three months' window prior to date t, otherwise equal to 0;
	(2)	$\text{D\_On\_Watch}_{i,a,t}$	Dummy equal to 1 if the country where bank i is located is listed on the watch list of possible downgrade by CRA a, otherwise equal to 0;
		$\text{U\_On\_Watch}_{i,a,t}$	Dummy equal to 1 if the country where bank i is located is listed on the watch list of possible upgrade by CRA a, otherwise equal to 0;
		$\text{D\_Sovc1}_{i,a,t}$	Dummy equal to 1 if sovereign rating is downgraded with one notch released by CRA a on the country where bank i is located within three months' window prior to date t, otherwise equal to 0;
		$\text{D\_Sovc2}_{i,a,t}$	Dummy equal to 1 if sovereign rating downgraded with more than one notch released by CRA a on the country where bank i is located within three months' window prior to date t, otherwise equal to 0;
		$\text{U\_Sovc1}_{i,a,t}$	Dummy equal to 1 if sovereign rating is upgraded with one notch released by CRA a on the country where bank i is located within three months' window prior to date t, otherwise equal to 0;
		$\text{U\_Sovc2}_{i,a,t}$	Dummy equal to 1 if sovereign rating is upgraded with more than one notch released by CRA a on the country where bank i is located within three months' window prior to date t, otherwise equal to 0;
	(1) and (2)	$\text{country}_{i,a}$	Dummies indicating the country
		$u_{i,a}$	Error term
	(3) (12) and (16)	Daily_Bank_Rating_Change $_{i,t}$	$=\text{AveRating}_{i,t}-\text{AveRating}_{i,(t-1)}$
	(3) (4) (8) (10) (12) and (16)	TDay Index Return$_{i,t}$	$=\frac{\text{Index}_{i,(t-1+T)}-\text{Index}_{i,(t-1)}}{\text{Index}_{i,(t-1)}}$, $\text{Index}_{i,t}$ is the market index level of bank *i* on day *t*
		Actual_down $_{i,t}$	Equal to 1 if the bank *i* receives an announcement of downgrade on day *t*, equal to 0 otherwise;

Type	Model	Variable Indicator	Interpretation
Independent Variable	(4)	Possible_down $_{i,t}$	Equal to 1 if the bank *i* receives an announcement of possible downgrade on day *t*, equal to 0 otherwise;
		Possible_up $_{i,t}$	Equal to 1 if the bank *i* receives an announcement of possible upgrade on day *t*, equal to 0 otherwise;
		Actual_up $_{i,t}$	Equal to 1 if the bank *i* receives an announcement of upgrade on day *t*, equal to 0 otherwise.
	(5) (9) and (13)	$Rating\ Change_{i,t-1}$	Measurement 1 of bank rating changes of bank *i* in year *t*;
	(5) (6) (7) (9) (11) (13) (14) (15)	$Control_{i,t-1}$	A series of control variables (which will be discussed in 3.2.2.3) of bank *i* in year *t*;
	(6) (14)	$NegNo_{i,t-1}$	Number of negative rating events announced by Big Three CRAs in year *t-1*;
		$PosNo_{i,t-1}$	Number of positive rating events announced by Big Three CRAs in year *t-1*;
	(7) (15)	*Neg1*	Equal to 1 if the bank receives an average downgrade of 1 notch or just some possible downgrade announcements in the exact year, equal to 0 otherwise
		Neg2	Equal to 1 if the bank receives an average downgrade of over 2 notches in the exact year, equal to 0 otherwise;
		Pos1	Equal to 1 if the bank receives an average upgrade of 1 notch or just some possible upgrade announcements in the exact year, equal to 0 otherwise;
		Pos2	Equal to 1 if the bank receives an average upgrade of over 2 notches in the exact year, equal to 0 otherwise
	(8) (12)	$FNS\_Dummy_{i,t}$	($Following\ Negative\ Sovereign\ change\ Dummy$): Equal to 1 if the country which bank i is located in received a sovereign downgrade three months before day t (including day t), otherwise equal to 0;
		$FPS\_Dummy_{i,t}$	($Following\ Positive\ Sovereign\ change\ Dummy$): Equal to 1 if the country which bank i is located in received a sovereign upgrade three months before day t (including day t), otherwise equal to 0;
	(9) (11) (13) (14) (15)	$SovNegD_{i,t-1}$	$SovNegD_{i,t-1}$: Equal to 1 if the country where bank i locates in receives sovereign rating downgrades in year t-1, equal to 0 otherwise;
		$SovPosD_{i,t-1}$	$SovPosD_{i,t-1}$: Equal to 1 if the country where bank i locates in receives sovereign rating upgrades in year t-1, equal to 0 otherwise;
	(12)	$Interactio\_N_{i,t}$	$=Daily\_Bank\_Rating\_Change_{i,t} \times FNS\_Dummy_{i,t}$
		$Interactio\_P_{i,t}$	$=Daily\_Bank\_Rating\_Change_{i,t} \times FPS\_Dummy_{i,t}$
	(13)	$RC\_SovNegD_{i,t-1}$	$=RatingChange_{i,t-1} \times SovNegD_{i,t-1}$
		$RC\_SovPosD_{i,t-1}$	$=RatingChange_{i,t-1} \times SovPosD_{i,t-1}$
	(14)	$NegNo\_SovNegD_{i,t-1}$	$=NegNo_{i,t-1} \times SovNegD_{i,t-1}$
		$PosNo\_SovPosD_{i,t-1}$	$=PosNo_{i,t-1} \times SovPosD_{i,t-1}$
	(15)	$NegD1\_SovNegD_{i,t-1}$	$=NegD1_{i,t-1},\times SovNegD_{i,t-1}$
		$NegD2\_SovNegD_{i,t-1}$	$=NegD2_{i,t-1},\times SovNegD_{i,t-1}$
		$PosD1\_SovPosD_{i,t-1}$	$=PosD1_{i,t-1},\times SovPosD_{i,t-1}$
		$PosD2\_SovPosD_{i,t-1}$	$=PosD2_{i,t-1},\times SovPosD_{i,t-1}$
	(16)	$Neg\_CTD_{i,t}$	($Negative\_Ceiling\_triggered\_dummy_{i,t}$): Equal to 1 if the bank rating change satisfies all the four conditions: 1) original rating is equal to sovereign ratings before sovereign rating changes occur, 2) the bank rating change occurs within 5 days after a sovereign rating change occurs, 3) the post-change bank rating level is equal to post-change sovereign rating and 4) the rating change is a negative one, otherwise equal to 0
		$Pos\_CTD_{i,t}$	($Positive\_Ceiling\_triggered\_dummy_{i,t}$): Equal to 1 if the bank rating change satisfies the same conditions (1), (2) and (3) as $Neg\_Ceiling\_triggered\_dummy_{i,t}$ and 4) the rating change is a positive one, otherwise equal to 0
		$Neg\_Inter_{i,t}$	$=Daily\_Bank\_Rating\_Change_{i,t} \times Neg\_CTD_{i,t}$
		$Pos\_Inter_{i,t}$	$=Daily\_Bank\_Rating\_Change_{i,t} \times Pos\_CTD_{i,t}$;

Table 2 Interpretation of key Difference-in-Difference estimators in Models (14), (15) and (16)

Model	D-I-D Estimator	Interpretation
(13)	$\beta_{13,4}$	Whether negative bank rating variation in previous year affect bank risk takings significantly differently conditional on there are negative sovereign rating events in the same year
	$\beta_{13,5}$	Whether positive bank rating variation in previous year affect bank risk takings significantly differently conditional on there are positive sovereign rating events in the same year
(14)	$\beta_{14,5}$	Whether the number of negative bank rating events in previous year affect bank risk takings significantly differently conditional on there are negative sovereign rating events in the same year
	$\beta_{14,6}$	Whether the number of positive bank rating events in previous year affect bank risk takings significantly differently conditional on there are positive sovereign rating events in the same year
(15)	$\beta_{15,7}$	Whether the occurrence of slight negative bank rating events in previous year affect bank risk takings significantly differently conditional on there are negative sovereign rating events in the same year
	$\beta_{15,8}$	Whether the occurrence of large negative bank rating events in previous year affect bank risk takings significantly differently conditional on there are negative sovereign rating events in the same year
	$\beta_{15,9}$	Whether the occurrence of slight positive bank rating events in previous year affect bank risk takings significantly differently conditional on there are positive sovereign rating events in the same year
	$\beta_{15,10}$	Whether the occurrence of large positive bank rating events in previous year affect bank risk takings significantly differently conditional on there are positive sovereign rating events in the same year

Table 3

This table shows the regression result of Models (1) and (2). Model specification is the ordered logit/probit regression estimated by MLE method. The dependent variable is a dummy indicating the occurrence of bank rating events and key independent variables indicate the occurrence of sovereign rating events at most 90 days before. Definition of dependent and independent variables is in Table 1. Regressions are estimated for each rating agency and each type of rating events separately.

Model	Rating Agency	Moody's				S&P				Fitch			
	Distribution Function	Logit		Probit		Logit		Probit		Logit		Probit	
(1)	Event type	Downgrade	Upgrade	Downgrade	Upgrade	Downgrade	Upgrade	Downgrade	Upgrade	Downgrade	Upgrade	Downgrade	Upgrade
	$\beta_{1,1}$(*On_Watch*)	1.84*** (189.00)	1.75*** (74.98)	0.62*** (171.48)	0.52*** (55.86)	2.45*** (252.02)	-0.49*** (127.00)	0.77*** (210.48)	-0.27*** (134.18)	1.43*** (11.57)	1.10*** (11.08)	0.40*** (8.73)	0.33*** (9.44)
	$\beta_{1,2}$ *(Sovc1)*	1.95*** (308.15)	0.94*** (19.31)	0.64*** (266.67)	0.29*** (17.45)	1.84*** (147.91)	0.44*** (382.24)	0.56*** (134.10)	0.27*** (399.58)	2.19*** (158.49)	1.29*** (38.75)	0.66*** (138.16)	0.39*** (33.33)
	$\beta_{1,3}$ *(Sovc2)*	1.92*** (253.21)	2.25*** (164.82)	0.65*** (227.43)	0.73*** (174.12)	2.17*** (168.93)	0.33*** (106.76)	0.69*** (199.82)	0.19*** (100.48)	3.03*** (344.25)	1.68*** (51.12)	0.98*** (334.67)	0.53*** (46.39)
	Event type	All		All		All		All		All		All	
	$\beta_{2,1}$ *(D_On_Watch*)	-1.73*** (158.06)		-0.52*** (112.51)		-0.40*** (119.87)		-0.25*** (160.86)		-1.13** (6.39)		-0.29** (4.26)	
	$\beta_{2,2}$ *(D_Sovc1*)	-1.82*** (261.67)		-0.58*** (219.44)		-0.50*** (455.81)		-0.27*** (473.48)		-2.15*** (164.77)		-0.65*** (141.94)	
(2)	$\beta_{2,3}$ *(D_Sovc2)*	-1.75*** (192.90)		-0.59*** (156.29)		0.05* (3.10)		-0.01 (0.53)		-2.89*** (361.65)		-0.92*** (324.59)	
	$\beta_{2,4}$ *(U_On_Watch)*	1.59*** (66.61)		0.46*** (46.85)		-0.48*** (124.84)		-0.25*** (127.47)		1.09*** (11.37)		0.31*** (9.31)	
	$\beta_{2,5}$ *(U_Sovc1)*	0.85*** (18.53)		0.25*** (15.78)		0.42*** (355.39)		0.25*** (361.06)		1.31*** (43.98)		0.39*** (38.22)	
	$\beta_{2,6}$ *(U_Sovc2)*	2.09*** (182.22)		0.67*** (146.77)		0.31*** (99.16)		0.18*** (89.12)		1.74*** (57.73)		0.54*** (50.88)	

Figures in cells are estimated coefficients on corresponding variables shown in the 'Event Type' column;
Figures in brackets are Wald-test statistics of corresponding estimated coefficients;
***significant at 1% level
**significant at 5% level
*significant at 10% level

Table 4

This table shows the results of Models (3), designed to test the short-term reactions of bank stock returns to rating changes. The dependent variable is the stock returns and the key independent variables is numeric indictors of daily rating changes on individual banks. Regressions are run for ten different testing windows, from 1 day to 10 days. Coefficients are estimated by fixed-effect estimation.

Time window (T)	1-day	2-day	3-day	4-day	5-day	6-day	7-day	8-day	9-day	10-day
$\beta_{3,1}$ $(Bank\ Rating\ Change)$ [a]	-1.71***	-2.50***	-1.87***	-1.95***	-1.79**	-2.20**	-1.96**	-1.59	-1.21	-1.54
	(-4.37)	(-4.62)	(-2.85)	(-2.59)	(-2.08)	(-2.37)	(-1.97)	(-1.52)	(-1.10)	(-1.34)
γ (Index Return)	0.84***	0.87***	0.88***	0.89***	0.90***	0.91***	0.91***	0.91***	0.92***	0.92***
	(265.41)	(293.12)	(302.85)	(306.45)	(301.91)	(304.63)	(307.19)	(310.80)	(314.20)	(317.35)
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	25.33%	29.38%	30.86%	31.48%	30.96%	31.48%	31.98%	32.62%	33.23%	33.81%
No. of Banks	55	55	55	55	55	55	55	55	55	55
No. of days	4374	4373	4372	4371	4370	4369	4368	4367	4366	4365

a: The actual coefficients are those figures shown in the table times 10^{-3}
Figures in brackets are corresponding t-statistics
*** 1% significance level
** 5% significance level
* 10% significance level

Table 5

This table shows the regression result of Model (4) designed to test the short-term reactions of bank stock returns to rating changes with different directions. The dependent variable is the daily stock returns of banks for different time windows (T). The key independent variables are dummies indicating the occurrence of downgrade/upgrade rating events. Regressions are run for ten different testing windows, from 1 day to 10 days. Coefficients are estimated by fixed-effect estimation.

Time window (T)	1-day	2-day	3-day	4-day	5-day	6-day	7-day	8-day	9-day	10-day
$\beta_{4,1}$ $(Actual\_down)$ [a]	-5.02***	-7.79***	-8.27***	-7.57**	-3.95	-5.12	-3.81	-2.05	1.23	0.86
	(-3.28)	(-3.67)	(-3.22)	(-2.57)	(-1.18)	(-1.41)	(-0.98)	(-0.50)	(0.29)	(0.19)
$\beta_{4,2}$ $(Possible\_down)$[a]	-4.77***	-7.81***	-8.01***	-6.60***	-5.93**	-7.11**	-4.39	-4.26	-4.80	-3.54
	(-3.82)	(-4.52)	(-3.83)	(-2.74)	(-2.16)	(-2.39)	(-1.39)	(-1.28)	(-1.37)	(-1.46)
$\beta_{4,3}$ $(Possible\_up)$[a]	-0.05	0.29	3.24	1.92	0.07	2.53	2.40	0.26	2.34	1.26
	(-0.03)	(1.34)	(1.23)	(0.63)	(0.20)	(0.67)	(0.60)	(0.06)	(0.53)	(0.27)
$\beta_{4,4}$ $(Actual\_up)$[a]	-0.18	1.14	-2.90	-2.98	-2.57	-1.35	-0.36	0.86	3.96	5.65
	(-0.84)	(0.38)	(-0.81)	(-0.72)	(-0.55)	(-0.26)	(-0.07)	(0.15)	(0.66)	(0.90)
γ (Index Return)	0.86***	0.88***	0.89***	0.90***	0.90***	0.91***	0.91***	0.91***	0.92***	0.92***
	(285.50)	(302.91)	(309.28)	(311.27)	(305.67)	(307.82)	(309.99)	(313.27)	(316.43)	(319.38)
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	28.43%	30.82%	31.83%	32.20%	31.52%	31.95%	32.39%	32.98%	33.55%	34.10%
No. of Banks	55	55	55	55	55	55	55	55	55	55
No. of days	4374	4373	4372	4371	4370	4369	4368	4367	4366	4365

a: The actual coefficients are those figures shown in the table times 10^{-3}
Figures in brackets are corresponding t-statistics
*** 1% significance level
** 5% significance level
* 10% significance level

Table 6

This table shows the regression result of Models (5)-(7). The dependent variable is the annual Z-score of banks. The key independent variables are different combinations of indicators of annual rating changes. Details of different levels of control variables are applied. Coefficients are estimated by fixed-effect estimation.

Model	5			6			7		
Control Variable Combination	1	2	3	1	2	3	1	2	3
$\beta_{6,1}$ $(NegNo_{i,t-1})$	--	--	--	-0.50***	-0.63***	-0.48***	--	--	--
				(-9.49)	(-9.84)	(-7.12)			
$\beta_{6,2}$ $(PosNo_{i,t-1})$	--	--	--	0.08	-0.02	0.02	--	--	--
				(0.87)	(-0.10)	(0.12)			
$\beta_{5,1}$ $(\text{Rating Change}_{i,t-1})$	-0.09***	-0.12***	-0.08***	--	--	--	--	--	--
	(-7.01)	(-7.52)	(-5.04)						
$\beta_{7,1}(Neg1_{i,t-1})$	--	--	--	--	--	--	-0.45***	-0.46***	-0.45***
							(-4.40)	(-3.63)	(-3.47)
$\beta_{7,2}(Neg2_{i,t-1})$	--	--	--	--	--	--	-1.04***	-1.28***	-1.00***
							(-7.08)	(-7.29)	(-5.67)
$\beta_{7,3}(Pos1_{i,t-1})$	--	--	--	--	--	--	0.15	0.09	0.12
							(1.60)	(0.71)	(1.06)
$\beta_{7,4}(Pos2_{i,t-1})$	--	--	--	--	--	--	0.13	0.46*	0.36
							(0.72)	(1.82)	(1.41)
R Square	82.2%	85.8%	87.8%	83.2%	87.0%	88.6%	82.6%	85.8%	88.2%
No. of Banks	55	49	45	55	49	45	55	49	45
No. of Years	17	16	16	17	16	16	17	16	16
Initial-Rating Control	Yes	No	No	Yes	No	No	Yes	No	No
Accounting-Based Control	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Market-Based Control	No	No	Yes	No	No	Yes	No	No	Yes

Figures in brackets are corresponding t-statistics
*** 1% significance level
** 5% significance level
* 10% significance level

Table 7

This table shows the result of mediation effects of bank ratings between sovereign ratings and bank stock returns. Reg1 shows the result of regressions without hypothesized mediator, *Bank Rating Change*, while Reg2 shows the result of regressions adding hypothesized mediator, *Bank Rating Change.*

	1-day		2-day		3-day		4-day		5-day	
	Reg1	Reg2	Reg1	Reg2	Reg1	Reg2	Reg1	Reg2	Reg1	Reg2
Bank Rating Change	---	-1.74***	---	-2.54***	---	-1.93***	---	-2.04***	---	-1.89**
		(-4.43)		(-4.70)		(-2.94)		(-2.70)		(-2.16)
FNS_Dummy	-0.48***	-0.48***	-0.90***	-0.90***	-1.35***	-1.35***	-1.91***	-1.91***	-2.55***	-2.55***
	(-2.13)	(-2.12)	(-2.89)	(-2.90)	(-3.57)	(-3.57)	(-4.38)	(-4.39)	(-5.14)	(-5.15)
FNS_Dummy	0.23	0.26	0.42	0.46*	0.57*	0.60*	0.74*	0.78**	0.77*	0.81*
	(1.11)	(2.38)	(1.49)	(1.65)	(1.67)	(1.78)	(1.89)	(1.99)	(1.74)	(2.81)
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	6-day		7-day		8-day		9-day		10-day	
	Reg1	Reg2	Reg1	Reg2	Reg1	Reg2	Reg1	Reg2	Reg1	Reg2
Bank Rating Change	---	-2.32**	---	-2.09**	---	-1.72*	---	-1.35	---	-1.68
		(-2.49)		(-2.10)		(-1.65)		(-1.23)		(-1.47)
FNS_Dummy	-3.07***	-3.08***	-3.65***	-3.66***	-4.24***	-4.24***	-4.82***	-4.82***	-5.39***	-5.39***
	(-5.72)	(-5.73)	(-6.38)	(-6.38)	(-7.02)	(-7.02)	(-7.61)	(-7.61)	(-8.15)	(-8.15)
FNS_Dummy	0.84*	0.81*	0.81	0.85*	0.72	0.75	0.63	0.66	0.53	0.56
	(1.74)	(1.81)	(1.58)	(1.65)	(1.33)	(1.38)	(1.11)	(2.26)	(0.89)	(0.94)
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

For each time-window, Reg1 shows the result of regression without taking BR changes as the independent variable and the Reg2 shows the result of regressions adding BR changes as the independent variable.

Irrelevant information (Number of banks, Number of days, R-square and market index coefficient estimation) is not reported in this table. They are similar to the output in Table 10.

Figures in brackets are corresponding t-statistics

*** 1% significance level

** 5% significance level

* 10% significance level

Table 8

This table shows the result of mediation effects of bank ratings between sovereign ratings to bank Z scores.

Control Variable Combination			1			2			3		
			Coefficient Estimation	**Sobel Statistics**	Judgement of Mediation effect	Coefficient Estimation	**Sobel Statistics**	Judgement of Mediation effect	Coefficient Estimation	**Sobel Statistics**	Judgement of Mediation effect
Reg 1		$SovNegD_{i,t-1}$	-0.54*** (-5.48)	--	--	-0.63*** (-4.95)	--	--	-0.50*** (-4.19)	--	--
		$SovPosD_{i,t-1}$	0.37*** (3.82)			0.41*** (2.31)			0.35** (2.12)		
Reg 2	BR-Measurement 1	$SovNegD_{i,t-1}$	-0.41*** (-3.88)	--	--	-0.34*** (-2.46)	--	--	-0.36*** (-2.70)	--	--
		$SovPosD_{i,t-1}$	0.27*** (2.67)			0.24 (1.33)			0.29* (0.66)		
		LagDif	-0.054*** (-3.77)	**5.845*** (Neg)** **5.912***(Pos)**	Yes	-0.093*** (-5.03)	**5.988***(Neg)** ***Not necessary* for Pos**	Yes	-0.05*** (-2.70)	**4.464***(Neg)** **2.747***(Pos)**	Yes
	BR-Measurement 2	$SovNegD_{i,t-1}$	-0.27*** (-2.54)	--	--	-0.15 (-1.07)	--	--	-0.39*** (-4.88)	--	--
		$SovPosD_{i,t-1}$	0.25*** (2.57)			0.30* (1.75)			-0.027 (-0.18)		
		NegNo	-0.38*** (-6,42)	**7.809*** **	Yes	-0.55*** (-7.29)	***Not necessary***	Yes	-0.19 (-1.39)	**N.A**	No
		PosNo	0.024 (0.27)	**N.A**	No	-0.06 (-0.41)	**N.A**	No	0.29* (1.69)	***Not necessary***	Yes
	BR-Measurement 3	$SovNegD_{i,t-1}$	-0.33*** (-3.07)	--	--	-0.34** (-2.51)	--	--	-0.28** (-2.17)	--	--
		$SovPosD_{i,t-1}$	0.26*** (2.65)			0.26 (1.45)			0.23 (1.39)		
		Neg1	-0.31*** (-3.01)	**2.964*** **	Yes	-0.36*** (-2.74)	**1.814***	Yes	-0.35*** (-2.62)	**1.621***	Yes
		Neg2	-0.74*** (-4.59)	**5.307*** **	Yes	-1.03*** (-5.34)	**5.276*** **	Yes	-0.78*** (-4.03)	**4.158*** **	Yes
		Pos1	0.10 (1.10)	**N.A**	No	0.035 (0.25)	**N.A**	No	0.074 (0.55)	**N.A**	No
		Pos2	0.08 (0.46)	**N.A**	No	0.49* (1.93)	***Not necessary***	Yes	0.36 (1.39)	**N.A**	No

'Control Var Combination' shows results using different levels of control variables; BR-Measurement refers to three measurements of annual bank rating changes discussed in Section 3.2.2.2;
'Reg1' refers to the regression without bank rating change indicators as independent variables;'Reg2' refers to regressions with bank rating change indicators as independent variables;
'Coefficient Estimation' refers to the estimation of corresponding coefficients, figures in the brackets are t-statistics;
'Sobel Statistics' is 'N.A' if the hypothesized mediator is insignificant; 'Not necessary' if sovereign rating change indicators are significant in Reg1 but insignificant in Reg2; and the value of Sobel statistics if sovereign rating change indicator are both significant in Reg1 and Reg2;
*** 1% significance level
** 5% significance level
* 10% significance level

Table 9

This table shows the regression result of Model (12). The dependent variable is the daily stock returns of banks for different time windows (T). The key independent variables are daily bank rating changes, dummies indicating whether the bank rating changes occur following sovereign rating events, and interaction terms between them. Coefficients are estimated by fixed-effect estimation.

Time window (T)	1-day	2-day	3-day	4-day	5-day	6-day	7-day	8-day	9-day	10-day
$\beta_{12,1}(Bank\ Rating\ Change)$ [a]	-1.85***	-3.46***	-4.94***	-4.98***	-4.39***	-4.92***	-4.24**	-3.61*	-3.22*	-3.22
	(-2.60)	(-3.51)	(-4.14)	(-3.63)	(-2.81)	(-2.90)	(-2.35)	(-1.89)	(-1.66)	(-1.55)
$\beta_{12,2}(FNS\_Dummy)$[a]	-0.48**	-0.91***	-1.31***	-1.89***	-2.54***	-3.07***	-3.65***	-4.23***	-4.82***	-5.39***
	(-2.14)	(-2.92)	(-3.55)	(-4.36)	(-5.13)	(-5.71)	(-6.37)	(-7.01)	(-7.61)	(-8.15)
$\beta_{12,3}(FPS\_Dummy)$[a]	0.25	0.44	0.57*	0.76*	0.79*	0.86*	0.83	0.73	0.63	0.54
	(1.23)	(1.56)	(1.69)	(1.95)	(1.77)	(1.78)	(1.62)	(1.35)	(1.11)	(0.90)
$\beta_{12,4}(Interaction\_N)$[a]	-0.14	-0.16	0.31	0.60**	0.36	0.38	0.30	0.24	0.08	0.03
	(-1.15)	(-1.18)	(1.48)	(2.53)	(1.32)	(1.28)	(0.95)	(0.73)	(0.23)	(0.08)
$\beta_{12,5}(Interaction\_P)$[a]	0.06	0.22*	0.47**	0.37**	0.36*	0.37*	0.31	0.28	0.34	0.27
	(0.68)	(1.81)	(3.13)	(2.18)	(1.84)	(1.76)	(1.39)	(1.17)	(1.36)	(1.05)
γ (Index Return)	0.84***	0.87***	0.88***	0.89***	0.90***	0.91***	0.91***	0.91***	0.92***	0.92***
	(265.31)	(293.06)	(302.79)	(306.36)	(301.81)	(304.55)	(307.10)	(310.69)	(314.08)	(317.22)
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	25.33%	29.38%	30.87%	31.50%	30.98%	31.49%	31.99%	32.64%	33.25%	33.83%
No. of Banks	55	55	55	55	55	55	55	55	55	55
No. of days	4374	4373	4372	4371	4370	4369	4368	4367	4366	4365

a: The actual coefficients are those figures shown in the table times 10^{-3}
Figures in brackets are corresponding t-statistics
*** 1% significance level
** 5% significance level
* 10% significance level

Table 10

This table shows the regression result of Models (13)-(15). The dependent variable is the annual Z-score of banks. The key independent variables are different combinations of indicators of annual rating changes, sovereign-rating-change indicators and interaction terms between them. Details of different levels of control variables are applied. Coefficients are estimated by fixed-effect estimation.

Model	13			14			15		
Control Variable Combination	1	2	3	1	2	3	1	2	3
$\beta_{14,1}(\text{NegNo}_{i,t-1})$	--	--	--	-0.31***	-0.56***	-0.41***	--	--	--
				(-3.28)	(-4.19)	(-2.93)			
$\beta_{14,2}(\text{PosNo}_{i,t-1})$	--	--	--	-0.006	-0.02	-0.02	--	--	--
				(-0.06)	(-0.13)	(-0.13)			
$\beta_{13,1}(\text{Rating\_Change}_{i,t-1})$	-0.07***	-0.16***	-0.11***	--	--	--	--	--	--
	(-2.69)	(-4.09)	(-2.66)						
$\beta_{15,1}(Neg1_{i,t-1})$	--	--	--	--	--	--	-0.22*	-0.38**	-0.32**
							(-1.77)	(-2.45)	(-2.07)
$\beta_{15,2}(Neg2_{i,t-1})$	--	--	--	--	--	--	-0.41	-0.62*	-0.45
							(-1.49)	(-1.81)	(-1.38)
$\beta_{15,3}(Pos1_{i,t-1})$	--	--	--	--	--	--	0.13	0.13	0.13
							(1.14)	(0.79)	(0.81)
$\beta_{15,4}(Pos2_{i,t-1})$	--	--	--	--	--	--	-0.02	0.65**	0.53*
							(-0.07)	(2.35)	(1.82)
$\text{SovNegD}_{i,t-1}$	-0.41***	-0.38***	-0.41***	-0.21*	-0.16	-0.21	-0.14	-0.27	-0.16
	(-3.71)	(-2.67)	(-2.86)	(-1.75)	(-0.97)	(-1.27)	(-1.03)	(-1.48)	(-0.88)
$\text{SovPosD}_{i,t-1}$	0.30***	0.36**	0.17**	0.22*	0.39*	0.31	0.26**	0.46**	0.34*
	(2.89)	(1.92)	(1.98)	(1.93)	(1.79)	(1.49)	(2.16)	(2.12)	(1.69)
$\text{NegNo\_SovNegD}_{i,t-1}$	--	--	--	-0.12	0.02	0.03	--	--	--
				(-0.96)	(0.12)	(0.19)			
$\text{PosNo\_SovPosD}_{i,t-1}$	--	--	--	0.09	-0.25	-0.07	--	--	--
				(0.48)	(-0.64)	(-0.19)			
$\text{RC\_SovNegD}_{i,t-1}$	0.02	0.08*	0.07	--	--	--	--	--	--
	(0.51)	(1.74)	(1.42)						
$\text{RC\_SovPosD}_{i,t-1}$	0.53	0.25***	0.17**	--	--	--	--	--	--
	(1.14)	(2.79)	(1.98)						
$\text{Neg1\_SovNegD}_{i,t-1}$	--	--	--	--	--	--	-0.41*	0.004	-0.14
							(-1.77)	(0.01)	(-0.51)
$\text{Neg2\_SovNegD}_{i,t-1}$	--	--	--	--	--	--	-0.60*	-0.56	-0.53
							(-1.77)	(-1.31)	(-1.30)
$\text{Pos1\_SovPosD}_{i,t-1}$	--	--	--	--	--	--	-0.06	-0.44	-0.22
							(-0.30)	(-1.35)	(-0.72)
$\text{Pos1\_SovPosD}_{i,t-1}$	--	--	--	--	--	--	0.24	-1.03	-0.79
							(0.67)	(-1.57)	(-1.27)
R Square	82.89%	86.41%	88.27%	83.60%	87.13%	88.76%	83.21%	86.33%	86.59%
No. of Banks	55	49	45	55	50	46	55	50	46
No. of Years	17	16	16	17	16	16	17	16	16
Initial-Rating Control	Yes	No	No	Yes	No	No	Yes	No	No
Accounting-Based Control	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Market-Based Control	No	No	Yes	No	No	Yes	No	No	Yes

Figures in brackets are corresponding t-statistics

*** 1% significance level ;** 5% significance level ;* 10% significance level

Table 11

This table shows the regression result of Model (16). The dependent variable is the daily stock returns of banks for different time windows (T). The key independent variables are daily bank rating changes, dummies indicating whether the bank rating changes occur trigger sovereign-ceiling policy, and interaction terms between them. Coefficients are estimated by fixed-effect estimation.

Time window	1-day	2-day	3-day	4-day	5-day	6-day	7-day	8-day	9-day	10-day
$\beta_{16,1}$ (BankRatingChange)*	-1.54***	-2.22***	-2.32***	-2.69***	-2.66***	-2.78***	-2.80***	-2.30**	-2.05*	-2.46**
	(-3.68)	(-3.84)	(-3.32)	(-3.35)	(-2.91)	(-2.80)	(-2.65)	(-2.06)	(-1.76)	(-2.02)
$\beta_{16,2}$(Neg_CTD)*	-1.29**	-2.33***	-3.04***	-2.74***	-2.07*	-2.59**	-1.98	-1.67	-2.01	-2.39
	(-2.42)	(-3.15)	(-3.40)	(-2.67)	(-1.77)	(-2.04)	(-1.46)	(-1.17)	(-1.34)	(-1.53)
$\beta_{16,3}$ (Pos_CTD)*	0.32	0.26***	1.08	-1.16	-0.94	-2.23*	-2.62*	-1.69	-1.35	-0.97
	(0.59)	(3.50)	(1.19)	(-1.14)	(-0.79)	(-1.73)	(-1.90)	(-1.16)	(-0.89)	(-0.61)
$\beta_{16,4}$(Neg_Inter)*	0.57**	1.02***	1.50***	1.31***	1.32**	1.32**	1.34**	1.24*	1.47**	1.54**
	(2.26)	(2.95)	(3.57)	(2.71)	(2.41)	(2.22)	(2.11)	(1.86)	(2.11)	(2.10)
$\beta_{16,5}$(Pos_Inter)*	-0.83***	-1.24***	0.77*	1.95***	1.45***	0.96*	1.03*	0.47	0.67	1.32*
	(-3.33)	(-3.61)	(1.84)	(4.08)	(2.66)	(1.62)	(1.63)	(0.70)	(0.97)	(1.82)
γ (Index Return)	0.84***	0.87***	0.88***	0.89***	0.90***	0.91***	0.91***	0.91***	0.92***	0.92***
	(265.27)	(292.99)	(302.75)	(306.36)	(301.83)	(304.59)	(307.16)	(310.76)	(314.17)	(317.32)
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	25.33%	29.39%	30.87%	31.50%	30.97%	31.48%	31.98%	32.62%	33.23%	33.81%
No. of Banks	55	55	55	55	55	55	55	55	55	55
No. of Days	4374	4373	4372	4371	4370	4369	4368	4367	4366	4374

a: The actual coefficients are those figures shown in the table times 10^{-3}
Figures in brackets are corresponding t-statistics
*** 1% significance level
** 5% significance level
* 10% significance level