Do bank rating changes following sovereign rating changes provide extra information? Evidence from the sovereign-ceiling policy

Sheng Zhao [a], Fernando Moreira [b] and Tong Wang [b]

[a] *Xi'an Jiaotong-Liverpool University, Suzhou, P.R.China*

[b] *University of Edinburgh, Edinburgh, United Kingdom*

Sheng Zhao
International Business School Suzhou,
Xi'an Jiaotong-Liverpool University
8 Chongwen Road, Suzhou Dushu Lake Science and Education Innovation District,
Suzhou Industrial Park, Suzhou, China, 215123
E-mail address: Sheng.Zhao@xjtlu.edu.cn
Tel: +86 (0)512-88161720

Fernando Moreira
University of Edinburgh Business School
29 Buccleuch Place, Edinburgh, EH8 9JS, UK
E-mail address: Fernando.Moreira@ed.ac.uk
Tel: +44 131 651 5312
Fax: +44 131 650 8337

Tong Wang
University of Edinburgh Business School
29 Buccleuch Place, Edinburgh, EH8 9JS, UK
E-mail address: Tong.Wang@ed.ac.uk
Tel: +44 131 651 5551

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Abstract

In this paper we investigate the shock of sovereign downgrades and their relations with the performances of listed banks which are registered in the downgraded countries. Previous literature states the connection between sovereign ratings and bank performances and raises hypotheses in terms of the government debt and government guarantee to discuss the channel by which sovereign ratings impact bank performances but the factor of individual bank ratings is neglected. We fill in this gap by studying the role of bank ratings in the transmission of effects of sovereign downgrades on bank performances. We find that sovereign rating downgrades followed by bank rating changes have a stronger impact on the bank stock returns and Z scores than those which are not followed by bank rating changes. To further tease out the independent effect of sovereign and bank rating downgrades, we take advantage of the 'sovereign-ceiling policy' which creates the semi-passive bank rating downgrades when sovereign rating ceiling has been downgraded. The empirical tests of the banks downgrades triggered by the sovereign ceiling policy help us to conclude that bank rating downgrades provide extra information to the market even if they occur no more than two days after the sovereign ratings are downgraded.

1. Introduction

Does sovereign risk affect the performances of banking industry in the corresponding countries? The literature widely discusses the relationship between sovereign risks and bank performances. Caporale et al. (2012) discuss the relationship between sovereign characteristics and the individual bank performances in each country. Furthermore, to examine and measure the sovereign risk, scholars focus on an essential indicator, the sovereign ratings. As defined, the sovereign rating reflects the credit rating agency's (CRA) assessment of the government debts quality. By its nature, it is not linked to the performances of commercial banks located in the corresponding countries. However, the majority of the literature (Panetta et al., 2011; Correa et al., 2014; Acharya et al., 2014; Brunnermeier et al., 2016; Gibson et al., 2016) observes that sovereign rating significantly impacts bank behaviours and bank performances. They find a significant variation of stock/bond prices which follows the sovereign rating events occurring in corresponding countries. It suggests that investors change their attitudes towards the banks whose countries receive sovereign rating events.

Therefore, the channel by which sovereign ratings affect bank performances is investigated and explored by scholars. The mainstream literature studies the factors related to the governments of countries

encountering sovereign rating events and discusses the potential conduits by which government activities may affect the commercial banks; for instance, the government debts held by domestic banks, the quality of government guarantees for banks and so on.

In this paper, we offer another angle, the bank entity ratings, to explain the connection between sovereign ratings and bank performances. The literature discovers two phenomena (Richards and Deddouche, 2004; Williams et al., 2013; Alsakka et al., 2014): sovereign rating actions are very likely to be followed by bank rating actions and bank ratings naturally impact the market performances of the corresponding banks. We combine these two phenomena, consider the potential channel of sovereign ratings' impact on bank performances and show evidence to support the hypothesis that bank ratings play a 'middleman' role by transmitting the sovereign ratings' impact to the bank performances.

In this paper, we define 'bank performances' from two perspectives: a short-term analysis of stock return shock (on a daily basis) and a long-term analysis of insolvency risk (reflected by Z score on an annual basis).

For analysis on a daily (an annual) basis, we focus on the cases where sovereign rating events and bank rating events occur sequentially with an interval shorter than two transaction days. The reason for choosing those special cases as the analyzed sample is to reflect the relationship between sovereign ratings and bank ratings in an institutional scenario. In the scenario where bank ratings follow sovereign ratings in a short interval, the information provided by the latter may be covered by that offered by the former if bank ratings do not transmit or enhance the impact of sovereign ratings. In other words, we define 'the transmission of sovereign rating impact' by testing whether investors/bankers receive extra information from the bank rating events which follow the sovereign rating events. For the long-term analysis, we focus on rating events occurring within a calendar year to define the scenario that sovereign rating actions are followed by bank rating actions.

The hypothesis is empirically tested based on two sub-hypotheses. The first hypothesis indicates that if a sovereign rating action is followed by a bank rating action, the power of the effects of sovereign rating downgrades on bank performances would be enhanced. In other words, if a change in bank rating follows

a sovereign downgrade, the impact on the performances of the corresponding bank is stronger than if the bank ratings did not follow the sovereign downgrades. However, this finding alone does not enable us to conclude that bank ratings act as the channel because the enhancement of power may be derived from the independent impact of the bank rating downgrades rather than the effect of the 'follow' of bank ratings to sovereign downgrades.

To examine the 'channel' effect, we further explore the first hypothesis by applying an exogenous shock on the bank rating downgrades which are not related to the independent characteristics of the rated banks. We use the sovereign-ceiling policy as the shock, which regulates the CRAs to offer ratings for individual firms at a level not higher than the sovereign ratings in the corresponding countries. According to this policy, if a bank is rated at the same level as the sovereign rating and the sovereign rating is downgraded, the CRA will downgrade the bank rating following the sovereign downgrade to satisfy the requirement of the policy. Therefore, the second hypothesis is designed to test the effect of sovereign-ceiling policy on the transmission of sovereign rating downgrades' impact. We empirically test the hypothesis that bank rating downgrades, which follow the sovereign rating downgrades triggered by the sovereign ceiling policy have, on average, a weaker impact on bank performances than other bank rating downgrades following sovereign downgrades but not triggered by the policy. It enhances the hypothesis of channel effect of bank ratings: bank rating downgrades triggered by the sovereign ceiling policy (which can be viewed as passive actions by CRAs) enhance the effect of the sovereign rating downgrades at a lower degree, which shows that the active bank downgrades enhance sovereign ratings downgrades' effect besides their independent impacts.

In this research, we extend the scope of 'bank performances'. The traditional indicator, stock returns, is applied by the mainstream of literature to test the market reaction to rating changes (West, 1973; Hand et al., 1992; Kaminsky and Schmukler, 2002; Brooks et al., 2004; Gibson et al., 2016). We follow this stream of literature by testing the stock returns in ten-day time window after the occurrence of sovereign rating changes. Besides the short-term indicator, some scholars also raise some long-term indicators of the impact of rating changes, for instance, lending strategy and funding strategy (Adelino and Ferreira, 2016), or cross country bank flows (Kim and Wu, 2011). However, we consider that the function of credit ratings is to

predict the credit risks of firms or countries. Therefore, a long-term indicator of the credit risk of rated banks is selected to test the power of sovereign ratings. We use a Z score as the indicator of banks' insolvency risk, which is a reflection of the bank credit risk. We further test whether the sovereign ratings have a significant effect on the Z score change in the following year, whether such effect is enhanced by the following of bank ratings and whether the fact that the bank downgrade is triggered by the sovereign ceiling policy is related to a weaker shock.

The structure of this paper is as follows. Section 2 describes the background of the research, states the research questions and related hypotheses regarding our research topic and presents our contributions to the existing literature. Section 3 is a description of our sample, the types of sovereign rating downgrades, the considered variables and some essential indicators. Section 4 shows the regression models which are designed to test the hypotheses shown in Section 2 using the data described in Section 3. We also report the empirical results of those regression models and discuss how these results can be interpreted to support the hypotheses concerning the channel effects of bank ratings in the context of sovereign rating downgrades. Section 5 concludes this paper.

2. Background, Hypotheses and Contributions

Sovereign risk is an essential factor of observing and studying the performances and behavior of the banking sector (Panetta et al., 2011). Among the diversified measurements of sovereign risk, the sovereign rating is viewed as an essential indicator of the sovereign risk of rated countries.

The sovereign rating, on the one hand, reflects the generalized performances (of all related economic sectors) of a country. On the other hand, it releases information to the market and changes the behavior and performance of specific industries in that country. Previous research investigates how the sovereign ratings impact the economic behaviors or performances from an empirical perspective. These studies not only analyze the single market impact, such as sovereign ratings' effect on bond prices, (Kaminsky and Schmukler, 2002), stock returns (Brooks et al., 2004), CDS spreads (Ismailescu and Kazemi, 2010) and

economic cycle (Kaminsky and Schmukler, 2002), but also investigate the cross-country effect (spill-over effect) (Ferreira and Gama, 2007; Arezki et al., 2011; Abad et al., 2018).

The banking industry is one of the sectors which are sensitive to the information released by the sovereign ratings (Gibson et al., 2016). Therefore, scholars focus on the association between the sovereign ratings offered by CRAs to a country, and the reactions of banks which are located, registered or listed in that country. Based on the finding that sovereign ratings are significantly related to the bank performances, the literature discusses the potential channel by which sovereign ratings impact bank performances. The government debt held by commercial banks located in the corresponding countries is regarded as a significant conduit of the impact of sovereign ratings on bank performances (Panetta et al., 2011; Correa et al., 2014; Acharya et al., 2014). During the period of sovereign downgrades, the quality of government debt deteriorates, and it negatively affects the quality of commercial banks who hold a large number of government debts. Moreover, the low quality of government guarantees due to the sovereign rating downgrades are also regarded as a factor to transmit the impact of sovereign ratings to the bank sector (Panetta et al., 2011; Acharya et al., 2014). Government bailout is also a factor which is discussed as a potential channel of sovereign-bank relations (Fratzscher and Rieth, 2015). Davies & Ng (2011) explores the possibility that a value reduction of sovereign bonds held by domestic banks would trigger margin calls by counterparties which makes a worse situation. To summarize the mentioned channels, DeBruyckere et al., (2013) conducted a comprehensive empirical analysis using European banks to show that the validity of sovereign-bank channels is sensitive to three factors: capital buffer, funding structure and the proportion of traditional activities. They also find that the government intervene plays an essential role in the channel effect which strongly support the hypotheses that the government guarantee is a significant factor to affect the sovereign-bank channel.

Additionally, the literature mentions some other potential factors, such as the decline of service demands as a consequence of poor fiscal condition (Correa et al., 2014) and the free capital mobility (Brunnermeier et al., 2016).

The cross-country effects of sovereign risks on bank performances are also discussed by many scholars. Alter & Beyer (2014) uses sovereign CDS as an indicator of sovereign risks and find a significant link between Spanish sovereign risks and bank performances in other countries.

However, the majority of the literature does not consider another potential channel, which is the bank rating changes after the sovereign rating changes. Panetta et al. (2011) mention the possibility of bank ratings acting as the channel to enhance the impact of sovereign rating changes on bank performance, but they do not provide detailed discussion and empirical evidence to prove this. Davies & Ng (2011) also raised the potential channel of bank ratings. They believe that the sovereign rating downgrades are followed by the bank rating downgrades and the latter actions increase the funding cost or restrict the market access of commercial banks. Some researchers observe the phenomenon that bank ratings have a high likelihood of following the changes of sovereign ratings (Williams et al., 2013; Alsakka et al., 2014). Others find that bank ratings are followed by variations in bank performances (Richards and Deddouche, 2004). Since the sovereign ratings are followed by bank ratings and the bank ratings impact the performances, it is reasonable to hypothesize that bank ratings partially transmit (or enhance) the power of sovereign ratings to affect the bank performances.

To define the concept of 'bank performances', we use two indicators, a short-term one and a long-term one. For the short-term measure, we apply stock returns in a 10-day time window following the sovereign rating events to capture the effect of sovereign ratings. Stock prices reflect the expectation of investors, so the literature uses the stock returns as an essential indicator of firm performances reacting to the rating changes (Hand et al., 1992; Dichev and Piotroski, 2001; Richards and Deddouche, 2003).

For the long-term measure, we take the insolvency risk of banks as the measurement of sovereign rating impact. CRAs design credit ratings as an assessment of the rated entity's credit risks. For banks, insolvency risk is an essential indication of credit risk. Therefore, the link between sovereign ratings in the current year and the insolvency risk in the following year is regarded as a reflection sovereign ratings' predictability of bank performances. Specifically, we use the Z score as an indicator of annual bank performances in terms of insolvency risk. Z score is commonly used in empirical papers to measure the probability of banks/bank

risk takings (Boyd et al., 2006; Gropp et al., 2013; Ignatowski and Korte, 2014; Anginer et al., 2014; Adhikari and Agrawal, 2016) and insolvency (Strobel, 2011; Lepetit and Strobel, 2013; Lepetit and Strobel, 2015). From a statistical perspective, Z score is equal to the square of the upper bound of the probability of the event that the sum of ROAA (Return on Average Asset) and CAR (Capital-Asset Ratio) is equal or less than zero (Hannan and Hanweck, 1988). A higher Z score is equivalent to a lower probability of becoming insolvent, which reflects a lower insolvency risk of banks. From a mathematical perspective,

$$Z\ score = (ROAA + \mu(CAR))/(\sigma(ROAA))$$

where μ(·) and σ(·) are the mean and standard deviation respectively.

The principal objective of this research is to investigate whether bank rating (BR) enhances the power of signals released by sovereign rating (SR) downgrades (i.e., whether the BR downgrades provide extra information to the market investors/bankers besides SR downgrades leading them). We focus on the information transmission of SR-BR-Performance conduit by testing whether the information contents of SR downgrades are different in two scenarios:

Scenario 1: SR downgrades with BR downgrades followed;

Scenario 2: SR downgrades without BR downgrades followed.

Based on the definition of bank performances, to achieve our research objective of identifying the channel 'SR-BR-Performance', we focus on the impact of SR downgrades on bank stock returns (daily) and Z scores (annually). BR downgrades which occur following SR downgrades are then identified to test whether the SR downgrades in Scenario 1 impact the stock returns/Z scores at a higher degree than those in Scenario 2. However, this test alone cannot fully tease out the independent effects and enhanced effects of SR and BR. Specifically, for Scenario 1, two types of rating downgrade (SR and BR) occur simultaneously, so it cannot be directly observed whether the gap of effects for Scenario 1 and Scenario 2 is due to the enhancement of the followed bank ratings to the sovereign ratings or the independent effect of the bank ratings.

There are three sources of information to the market for the cases when a bank rating downgrade follows a sovereign downgrade:

Source 1: the information provided by SR downgrades;

Source 2: the information provided by BR downgrades;

Source 3: the information provided by the fact that the SR downgrade is followed by BR.

The information source we are interested in is 'Source 3'. It indicates the extent by which a following bank rating actions would enhance the effect of SR downgrades. Even if we obtain empirical results showing that SR downgrades fitting Scenario 1 have a greater impact on bank performances than those fitting Scenario 2, we are unable to state whether the enhancement of impact is due to Source 2 or Source 3. To extract the effect of Source 3, we apply an exogenous shock on the follow of BR downgrades to SR downgrades despite the specific bank's information.

To have a more convincing discussion, we further consider a particular case, sovereign ceiling policy, as the exogenous shock. The sovereign ceiling policy refers to the requirement that the rating level of firms in a country should not exceed the sovereign rating of that country. We acknowledge that the ceiling policy was required as a compulsory action for CRAs until 1997, when Standard & Poors firstly rated firms with a higher level than the sovereign ceiling (Borensztein et al., 2013). Since then, the ceiling policy has become a conventional policy. Although it is arguable whether CRAs have strictly followed the policy, a large body of literature believes that the ceiling policy plays a decisive role in the process of CRAs determining the firm rating levels (Borensztein et al., 2013; Almeida et al., 2017). Specific for bank ratings, Klusak et al., 2017 apply the case of disclosure of unsolicited rating status to present that the ceiling channel is a significant factor to transmit the influence of sovereign rating actions. Based on this consensus, many scholars apply the ceiling policy as a research tool to study the impact of credit ratings on the market. Their research range from the bond spreads (Durbin and Ng, 2005) to the loan supply (Adelino and Ferreira, 2016).

In this paper, we only consider the rating downgrades rather than upgrades for two reasons. Firstly, rating downgrades have a more significant impact on the market than upgrades. In other words, the market is more sensitive to bad news than to good. (Hand et al., 1992; Dichev and Piotroski, 2001; Drago and Gallo, 2016). The second reason is that only downgrades of SR may trigger the sovereign ceiling policy while upgrades are not related to the policy. According to the ceiling policy, BR has to be downgraded after the SR

downgrade occurs if the BR was at the same level with SR before SR was downgraded. Therefore, we further split Scenario 1 into two sub-categories:

Scenario 1: SR downgrades with BR downgrades followed;

Scenario 1.1: SR downgrades which trigger the sovereign-ceiling policy with BR downgrades followed;

Scenario 1.2: SR downgrades which do not trigger the sovereign-ceiling policy with BR downgrades followed;

Scenario 2: SR downgrades without BR downgrades followed.

The information source decomposition is shown in Figure 1.

[Insert Figure 1 here]

Scenario 1.1 should be viewed as semi-passive dow ngrades while Scenario 1.2 is regarded as fully-active downgrades. Scenario 1.1 (semi-passive downgrades) is associated with only a part of the information of Source 3 because the BR downgrades are announced by the CRA due to the regulation of the sovereign ceiling policy and hence are partially compulsory. Scenario 1.2 (active downgrades) is associated with all the information of Source 3 because the BR downgrades following SR downgrades are not compulsory. Therefore, if the BR following SR provides extra information, the fully-active downgrades should have an impact on stock returns/Z scores at a higher degree than semi-passive ones. In other words, the average gap of market impact on bank performances between Scenario 1.1 and Scenario 1.2 should be significant.

To summarize research objectives, we raise the research questions and corresponding hypotheses as follows.

Question 1: Do BRs enhance the power of signals released by SR downgrades?

Hypothesis 1: SR downgrades followed by BR downgrades have a stronger association with stock returns/Z scores than SR downgrades not followed by BR downgrades.

Question 2: Do active BR downgrades provide extra information to the market besides SR downgrades leading them?

Hypothesis 2: Among the SR downgrades followed by BR downgrades, the average association between SR downgrades and stock returns/Z scores is weaker if the BR downgrades are triggered by the sovereign ceiling policy.

Our research contributes to the literature as follows.

1. To our knowledge, this study is the first to specifically investigate bank entity ratings as a factor to explain the impact of sovereign ratings on bank performances. The existence of the channel 'SR-BR-Performance' shows that sovereign rating downgrades negatively impact market or management performances of banks partially by the enhancement of bank rating downgrades sequentially. We acknowledge that, even if we show evidence of the bank ratings' role of transmitting and enhancing the effect of sovereign ratings, it does not mean that the bank rating is the sole channel of that. Discussions about other potential channels described by the literature, such as the government debt, government guarantees and financial service demands are still constructive regarding this issue. The way we contribute to the literature is to provide a new angle of entity ratings to explain the 'SR-Performance' link.

2. We consider the case of sovereign-ceiling policy to further tease out the impact of sovereign rating downgrades and bank rating downgrades and solve the problem that the short duration between occurrences of these two types of rating downgrades may contaminate the analysis result. Defining the bank rating downgrades following sovereign rating downgrades triggered by the sovereign ceiling policy as 'semi-passive' and others as 'active', we apply a difference-in-difference analysis to test whether the gap of effects between semi-passive and active downgrades is significant.

3. We extend the scope of 'bank performance', from the short-term indicator (stock returns) to the long-term one (insolvency risk). The short-term impact of sovereign ratings on the stock returns reflects how the secondary market investors react to the sovereign rating events in a certain period of time. The long-term impact of sovereign ratings on the Z score reflects the predictability of credit ratings in terms of the insolvency risk of banks located in the downgraded countries. We find evidence to show that sovereign ratings have both the short-term and the long-term impacts on bank stock returns and Z scores. The impacts are both enhanced by the follow of bank rating events, which provide extra information both to the investors and on the predictability of insolvency risk.

3. Data and sample

3.1 Sample description

We collect the data of historical credit ratings (from Bloomberg), stock prices and accounting information (Thomson Reuters) of listed banks who received ratings by all the Big Three rating agencies (Moody's, S&P and Fitch). Sample banks are those who are registered and listed in five EU countries, PIIGS (Portugal, Italy, Ireland, Greece, and Spain). Since the objective of our research is to study the sovereign rating downgrade events and their effect on bank performances, it is necessary that we have a sufficient number of sovereign rating downgrades in the sample period occurring in the corresponding countries. That is why we filter out countries in the EU other than PIIGS (The sample of PIIGS is also applied by Gibson et al., 2016). The criteria 'rated by the three CRAs', 'listed on the stock market' and 'registered in the PIIGS countries' significantly reduces the number of sampled banks. In addition, to ensure the consistency of our analysis, we filter out the banks which did not exist before 2009 and the banks disappearing (for possible reasons such as M&A or bankruptcy) before 2018. After filtering, we have 25 sample banks. The sample period is Jan 1991-Jan 2018. 1991 is the year when the first downgrade event is observed for the sample banks and 2018 is when the research was conducted. The bank ID, countries, and the number of sovereign rating downgrades by each CRA is shown in Table 1.

[Insert Table 1 here]

We observe that the five countries experience a number of sovereign downgrades in the sample period. Greece is the country receiving the greatest number of sovereign downgrades because there are two rounds of debt crises in Greece (2009 and 2015). The numbers of sovereign downgrades are not significantly different among each of the three CRAs. Therefore, in the short-term analysis we do not split the sovereign rating/bank rating downgrades for each of the three CRAs but treat each of them equally in the regressions. However, for the long-term analysis, we run regression separately, using annual rating downgrades for each of the three CRAs because we can only obtain data of Z scores and accounting-based variables on an annual basis and the rating downgrades for each year are difficult to measure when we consider all the three CRAs

together. For most of the fiscal years we observe downgrades with different notches for different CRAs so it is more convenient and reasonable to measure the annual rating changes for each CRA separately.

The initial dataset we obtain is in the format of a daily basis and the number of daily observations is 187,550 (25 banks × 7502 days) including missing values (the reason for missing values is that for some dates the bank is not listed or not established) and 176,498 excluding missing values. For the dataset to be run on an annual basis (Z score case) we set a parallel dataset for Z score which has 725 observations (25 banks × 29 years).

Focusing on the sovereign rating events which are fitted to the sample banks, we examine the pair of SRD-Bank (SRD: Sovereign Rating Downgrades), where the sample banks receive sovereign rating downgrades (countries where the banks are registered and listed are downgraded by one of the three rating agencies). For the 25 sample banks, we identify 724 SR changes (both downgrades and upgrades), where 504 are downgrade cases (SRD-Bank).

In the sample of 'SRD-Bank' pairs, we further identify the 'followed by BR' cases: for the SR changes on the banks, if the bank's entity rating (issuers' rating) also changed in the same direction on the same day or one day later, we identify this case as 'followed by BR'. We identify 399 cases both satisfying the 'SRD-Bank' and 'followed by BR'.

The reasons that we choose 'no more than two days' as the criteria to define 'followed by BR' are, 1) for the distribution of duration between sovereign downgrades and bank downgrades shows that most of events occur with an interval shorter than 2 days (see Table 2.2, the ratio is 399/594=79.2%) and 2) if setting a long interval, it would be more difficult to clarify whether bank downgrades actually 'follows' the corresponding sovereign downgrades or they are independent events.

In the sample of 'SRD-Followed by BR', we further identify 'at the ceiling' cases where the BR level was equal to the SR level after the SR changes. For cases satisfying both 'SRD-Followed by BR' and 'at the ceiling', we assume that the rating agencies semi-passively downgrade BRs to maintain the condition that BR should be at a level not exceeding the SR level. We identify 119 cases of 'downgrades triggered by ceiling policy'. Table 2 shows the distribution of the identified events.

[Insert Table 2 here]

The number of sovereign downgrades is larger than that of upgrades. This indicates that during the sample period, the situation of sovereign risks of the five countries is deteriorating. It shows that PIIGS has experienced sovereign debt crisis since 2009. For sovereign downgrades, nearly 75% are followed by bank rating downgrades, which shows evidence of a strong link between sovereign ratings and firm ratings (Williams et al., 2013; Alsakka et al., 2014).

It also enhances our motivation for conducting this research: since bank ratings have a very high likelihood of following sovereign ratings, it is possible that sovereign rating downgrades impact bank performances through the channel of bank ratings. For SRD followed by BR downgrades, nearly 30% trigger the sovereign-ceiling policy. The adequate number of cases triggering the policy provides the possibility of conducting a D-i-D analysis on the trigger-policy BR downgrades following SR downgrades and testing whether the semi-passive downgrades have weaker effects on bank performances than active downgrades.

3.2 Variables in the short-term stock return analysis

The key dependent variables in the short-term analysis and the long-term analysis are stock returns and Z scores respectively.

For daily stock returns, we use time windows from 1 to 10 and another window of 20 days to test the ratings' effects on short-term market reactions. The selection of time windows (from 1 to 10 days) follows the work by Brooks et al. (2004) and the 20-day window is selected as a benchmark of the decay of shocks' effect. We recognize that 10-day window may be too long so there may be some contaminated events which would make the results biased. The most significant 'contaminated events' are the rating actions by other CRAs so in this section we regard rating events announced by each of the three CRAs as homogenous events.

Based on Hypothesis 1, we expect a significant association between sovereign ratings and stock returns for time windows from 1 to 10 and that the significance recedes or disappears for the time window of 20 days to show that the shock of sovereign ratings on stock prices occurs in a short-term period. For each day (t), we define

$$R_{i,t}[D_1, D_2] = \frac{\text{Price}_{i,D_2} - \text{Price}_{i,D_1}}{\text{Price}_{i,D_1}}$$

D_1 is the starting date of the time window and D_2 is the last day of the time window.

In details, we have a number of combinations of $[D_1, D_2]$:

$R_{i,t}[t-2, t-1]$ which measures the 1-day daily returns before the occurrence of sovereign rating downgrades. The reason that we include the time window before the event in our analysis is to use it as a benchmark and compare the results of 'before-event' return with those of 'after-event' one to intuitively present the shock of sovereign rating downgrades.

$R_{i,t}[t-1, t+T]$ where T are integers ranging from 1 to 10 and 20. It measures the daily returns after the occurrence of sovereign rating downgrades. For each day *t*, we use the last price on day (t-1) as the baseline price instead of the price on the day *t*. The reason is that to study the effect of sovereign rating downgrades on day *t*, we are unable to simply assume that the downgrade announcements are released before, during or after the transaction time of day *t* so it may cause some bias using the prices on the current day as the baseline price. However, if we take the last price on the day before the downgrade announcements as the baseline, the corresponding price returns for period [t-1, t+T] are able to capture the shock of the announcements, regardless of whether the downgrades are announced during the transaction time on day *t*. This method of measuring stock returns is derived from the work by Kaminsky, G. Schmukler (2002) and Gibson et al., (2016) who use logarithm of stock prices as the indicator of stock price reactions to rating actions. Mathematically, the logarithm of stock prices should have the same implication of the format of stock returns applied in this section.

To control the market conditions, we use the return of stock index in the respective countries in the corresponding time windows.

$$IndexR_{i,t}[D_1, D_2] = \frac{\text{Index}_{i,D_2} - \text{Index}_{i,D_1}}{\text{Index}_{i,D_1}}$$

$Index$ refers to the market index of the country where bank *i* is registered and listed in. For Greek, Spanish, Irish, Italian and Portuguese banks, we use the ASE (Athens Stock Exchange) General Index, IBEX 35,

ISEQ (Irish Stock Exchange) Overall Index, FTSE MIB and PSI (Portugal Stock Index) 20 for the index reference, respectively.

The rating level of sample banks is an essential factor to be controlled for when analysing the effect of sovereign ratings on bank stock returns. We assume that sovereign rating downgrades have different magnitudes of shock on stock prices for banks with different rating levels which have been assigned to the banks. It is reasonable to propose that sovereign ratings have a stronger shock on lower-rated banks because the sovereign risk deterioration may have a greater negative shock on investors' confidence in the banks whose credit condition is worse. Brooks et al., (2004) raised a strategy of categorizing different rating notches into four groups according to 'broad similarities'. Therefore, we categorize the rating levels into four groups: Above AA- (Aa3), AA- (Aa3) to BBB- (Baa3), BBB- (Baa3) to B- (B3) and Below B- (B3)[1]. The reason of categorizing rating levels into the four groups is to consider both the balance of number of observations for each of the groups (we try to keep the differences among the proportions of observations between any two of the groups at a level not larger than 50%) and the implication of the rating levels (Brooks et al., 2004) (BBB- or Baa3 is the threshold of investment/grade classes, B- or B3 is the threshold between 'margin to default' and others so we categorize the rating levels by taking these two specific levels as boundaries). The distribution of daily rating level categories for the sample banks by each of the three CRAs (each observation is a pair of bank-rating on a daily basis) is shown in Table 3.

[Insert Table 3 here]

As shown in Table 3, investment grade levels (Above BBB- or Baa3) take the majority of daily rating observations for all the three CRAs (over 80%). 'Margin to default' ratings take no more than 8% of the sample.

3.3 Variable in the long-term analysis on Z scores

As in Lepetit and Strobel (2015), we define Z score, $Z_{i,t}$ (bank *i* in year *t*), as the formula

$$\mathrm{Z}_{i,t} = \frac{\mathrm{ROAA}_{i,t} + \mathrm{CAR}_{i,t}}{\sigma(\mathrm{ROAA})_i}$$

[1] AA-, BBB- and B- are rating indicators applied by Moody's and Aa3, Baa3 and B3 are those applied by S&P and Fitch.

$\mathrm{ROAA}_{i,t}$: return on average assets of bank *i* in year t;

$\mathrm{CAR}_{i,t}$: Capital-Asset ratio of bank *i* in year t;

$\sigma(\mathrm{ROAA})_i$: standard deviation of return on average assets of bank *i* in the full period of the sample (1991-2017).

Data is collected from Thomson Reuters.

There are three components in the expression of Z score, ROAA, $\mu(CAR)$ and $\sigma(ROAA)$. Lepetit and Strobel (2015) point out that to make Z score time-varying, each of these three components can be established in different ways, including taking current values, using moving average/variance or full-sample average/variance. In this paper, we avoid using moving average/variance because the selection of moving length is subjective in existing papers.

The distribution of Z score (annually) is shown in Figure 2.

[Insert Figure 2 here]

The highest Z score in the sample is 7.226 and the lowest is -4.363. From the perspective of probability, a Z score of 7.226 indicates a probability of insolvency at a level very close to 0 and a Z score of -4.363 indicates a probability of insolvency at a level very close to 100%. The majority of Z scores range from 0 (50% of insolvency risk) to 3 (1.35% of insolvency risk). The shape of the distribution is right-skewed, which means that extreme values concentrate in the range of high-value Z score (low-risk region).

Naturally, the insolvency risk of a bank in the current year is also determined by the accounting behavior of the bank in the previous year. Therefore, a series of accounting-based variables regarding the risk-related performances of banks are collected. These variables control the effects of pre-year performances on the Z scores of the following year. The methods of establishing these variables are applied by Kleinow and Moreira (2016):

Firm Size: the total assets of the banks;

ROA: Return on Assets, an indicator of the profitability of the bank in the previous year;

Non-Performing Loan ratio=$\frac{\text{Non-Performing Loan Volume}}{\text{Total Loan Volume}}$, an indicator reflecting the loss derived from loan credit risks of banks in the previous year;

Deposit Ratio=$\frac{\text{Total Deposit}}{\text{Total Liability}}$ represents the leverage ratio (the capital structure) of banks in the previous year.

4. Models and Results

Our analyses are conducted in three stages for short-term stock returns and long-term Z scores respectively. The first stage is to regress the bank performances (stock returns and Z scores) on the indicators of sovereign rating downgrades to present the link between sovereign rating downgrades and bank performances. This stage is the starting point of the entire analysis by showing that sovereign rating downgrades are associated with the bank performances. The regression method of measuring stock return reactions to rating actions was applied by West (1973), Brooks (2004) and Gibson et al (2016). Specifically, the downgrades of sovereign ratings should be followed by a drop in short-term stock prices and a rise in long-term Z scores. For the second stage, we replace the sovereign rating downgrades by specific SR downgrades which are followed by bank rating downgrades to show whether the sizes of corresponding estimates are bigger than those in the first stage. The rise of estimate sizes indicates that BR downgrades enhance the power of the connection between the leading SR downgrades and the bank performances. That would show evidence for Hypothesis 1.

In the third stage, we conduct the D-i-D analysis on the SR downgrades followed by BR downgrades to investigate how the sovereign ceiling policy moderates the effects of SR downgrades on the bank performances. For the D-i-D analysis, the treatment group includes the SR downgrades followed by BR downgrades due to the sovereign ceiling policy. They are also regarded as ‘semi-passive’ downgrades because it is either the credit rating agencies’ decision or the ceiling policy that triggers the individual bank downgrades. The control group includes the SR downgrades followed by BR downgrades not triggered by the sovereign ceiling policy. They are regarded as ‘active’ downgrades because it is entirely the CRAs’

decision to downgrade the individual bank. If Hypothesis 2-2 holds, we expect a result showing that the treatment group has a weaker effect on the bank performances than the control group.

4.1 Short-term: daily stock returns (fixed-effect panel regression)

Model 1-1: SR downgrades

$$R_{i,t}[D_1, D_2] = \alpha + \beta_{1-1} SRD_{i,t} + \gamma_{1-1} RIndex_{i,t}[D_1, D_2] + \vartheta_{1-1.1} BRL_{i,t} + \vartheta_{1-1.2}(BRL_{i,t} \times SRD_{i,t}) + \vartheta_{1-1.3} Year_t + \delta_i$$

$R_{i,t}[D_1, D_2]$: daily stock return of bank *i* on day t, in the time window $[D_1, D_2]$. The definition and application of $[D_1, D_2]$ is stated in Section 3.2.

$SRD_{i,t}$:dummy equal to 1 if the country where bank *i* listed and registered is downgraded, by one of the three CRAs at day *t* and 0 if else. Corresponding estimate, β_{1-1}, captures the stock return changes between one day before and T days after the bank *i* receives a sovereign downgrade.

$RIndex_{i,t}[D_1, D_2]$: daily index return of the market where bank *i* is listed, with the same time window as $R_{i,t}(D_1, D_2)$. γ_{1-1} controls the link between the market condition and the stock returns.

$BRL_{i,t}$: dummy variables indicating the average bank rating level (of the big three) of bank *i*. $\vartheta_{1-1.1}$ and $\vartheta_{1-1.2}$ control the fixed effect of bank levels and the interaction between bank levels and SR downgrades. The aim of adding these two fixed effect controls is to consider different degrees of impact of SR downgrades on stock returns for banks with different credit conditions (reflected by bank rating levels).

$Year_t$: the year of day *t*. $\vartheta_{1-1.3}$, controls the time effect (European debt crisis etc.)

δ_i: unobservable heterogeneity of bank *i*.

Descriptive statistics are displayed in Appendix 1. The average stock returns are very close to zero (slightly less than 0 but with a relatively large standard deviation) whatever the time windows are. This is reasonable because from the overall perspective, the stock returns should not be significantly larger or smaller than zero in a very long term (over 10 years in this paper). The numeric average rating level is around 19

(equivalent to level A). It shows that for all the banks in the whole period, average rating level is above the investment grade threshold (BBB).

The result of Model 1-1 is shown in Table 4.

[Insert Table 4 here]

Estimates on SRD are significantly negative for any $R_{i,t}[t-1, t+T]$ where T range from 1 to 10. Regarding the benchmark window $R_{i,t}[t-2, t-1]$, although we find a negative estimate which shows that the stock return before the event is also negative, its magnitude (-0.63) is much smaller than the estimates for time windows [t-1, t+T] (the sizes are around -4 to -5). This indicates that, compared with the returns before the events, a bank's short-term stock returns are lower after it receives a sovereign rating downgrade. The consistent market reaction does not exist for time window longer than 20 days (The estimate is insignificant for T=20).

The short-term association between SRD and stock returns exists after we control the market index, bank rating level and its interactions with SRD. This result is consistent with the results obtained by other scholars (Brooks et al., 2004; Gibson et al., 2016).

Model 1-2: SR downgrades followed by BR downgrades

$$R_{i,t}[D_1, D_2] = \alpha + \beta_{1-2.} SRD\_Followed\_By\_BRD_{i,t} + \gamma_{1-2} RIndex_{i,t}[D_1, D_2] + \vartheta_{1-2.1} BRL_{i,t} + \vartheta_{1-2.2}(BRL_{i,t} \times SRD\_Followed\_By\_BRD_{i,t}) + \vartheta_{1-2.3} Year_t + \delta_i$$

$SRD\_Followed\_By\_BR_{i,t}$: dummy equal to 1 if the bank i receives sovereign downgrades which are followed by the bank rating downgrades (at the same day, or after 1 day) on day *t* and equal to 0 else;

The estimate on the $SRD\_Followed\_By\_BRD_{i,t}$ captures the relationship between specific sovereign rating downgrades followed by bank rating downgrades and stock returns. The result is shown in Table 5.

[Insert Table 5 here]

The estimates are insignificant for the time window [t-2, t-1] while those are consistently significantly negative for [t-1, t+T], which shows that SR downgrades are followed by a drop of stock prices within the 10-day time window (even in 20 days).

Additionally, if we compare the size of estimates of parameters on SR downgrades in Model 1-1 and Model 1-2, we find a significant trend that the sizes in Model 1-2 are always larger than those in Model 1-1 for [t-1,t+T]. This shows evidence that the degree of stock price decreases is larger if the sovereign rating downgrades are followed by bank rating downgrades.

Model 1-3: D-i-D analysis of BR downgrades triggering the ceiling policy

In this section of analysis, we focus on the cases of SRD followed by BR downgrades and identify scenarios where the BR downgrades occur when the SRD triggers the sovereign ceiling policy (the semi-passive followed BR downgrades).

$$R_{i,t}[D_1, D_2] = \alpha + \beta_{1-3.1} \times SRD\_Followed\_By\_BRD_{i,t} + \beta_{1-3.2} At\_Ceiling_{i,t} + \beta_{1-3.3}(SRD\_Followed\_By\_BRD_{i,t} \times At\_Ceiling_{i,t}) + \gamma_{1-3} RIndex_{i,t}[D_1, D_2] + \vartheta_{1-3.1} BRL_{i,t} + \vartheta_{1-3.2} BRL_{i,t} \times SRD\_Followed\_By\_BRD_{i,t} + \vartheta_{1-3.3} Year_t + \delta_i$$

$At\_Ceiling_{i,t}$: dummy equal to 1 if the bank rating level of bank i is equal to the sovereign rating level at day t and 0 else.$\beta_{1.3.3}$, the estimate on interaction term,$(SRD\_Followed\_By\_BRD_{i,t} \times At\_Ceiling_{i,t})$, is the D-i-D estimate which captures how the sovereign ceiling policy moderates such effect. The result is shown in Table 6.

[Insert Table 6 here]

$\beta_{1-3.3}$ is significantly positive for most of the T (excluding T=3,4 and 5). Since the estimates on SRD ($\beta_{1-3.1}$) are negative, the positive sign of D-i-D estimators shows that the treatment group which includes the SRD, followed by BR downgrades to obey the rule of the sovereign ceiling policy, has a weaker stock return effect than the control group (SRD followed by BR downgrades not triggering the policy). The finding shows that SRDs followed by semi-passive BR downgrades are associated with a weaker stock return reaction than those followed by active BR downgrades. This is consistent with Hypothesis 2 and indicates that the information provided by the follow of BR downgrades to SR downgrades is significant besides the information provided by the independent effect of BR downgrades.

4.2 Long-term: Z scores (fixed-effect panel regression)

Observations in the analysis of this section are on an annual basis but the rating changes occur on a daily basis. Therefore, we consider the rating level gaps (SR and BR) between the end and the beginning of each year as a proxy of 'annual rating change'. Rating changes (i.e. SR downgrades, BR downgrades, the trigger of ceiling policy) are identified, measured and considered for each of the Big Three CRAs separately.

The model set of Z score analysis is parallel to that of stock return analysis.

Model 2-1: The association between SR downgrades and Z score

$$Z_{i,t+1} = \alpha + \beta_{2-1} SRD_{i,t} + X'_{i,t}\gamma_{2-1} + \delta_i$$

$Z_{i,t+1}$ is the Z score of bank *i* in the year *(t+1)*;

$SRD_{i,t}$ dummy equal to 1 if the sovereign rating of bank *i* is downgraded in year t and 0 else. The corresponding estimate, β_{2-1} captures the association between sovereign downgrades in a year and the change of Z scores in the following year.

$X'_{i,t}$: vector of accounting-based control variables (total assets, return on assets, capital ratio, NPL (Non-performing Loan) ratio and deposit ratio). γ_{2-1} is the group of estimates on each of the control variables.

δ_i: unobservable heterogeneity of bank *i*.

Model 2-2: The association between SR downgrades followed by BR downgrades and Z score

$$Z_{i,t+1} = \alpha + \beta_{2-2} SRD\_Followed\ By\ BRD_{i,t} + X'_{i,t}\gamma_{2-2} + \delta_i$$

$SRD\_Followed\ By\ BRD_{i,t}$, dummy variable equal to 1 if the sovereign rating of bank *i* is downgraded in year *t* and the bank rating of bank *i* during year *t* changes in the same direction with sovereign rating changes and 0 else. Corresponding estimate, β_{2-2} captures the association between specific sovereign downgrades, which are followed by BR downgrades, in a year and the change of Z scores in the following year.

Model 2-3 D-i-D analysis of BR downgrades triggering the ceiling policy

$$Z_{i,t+1} = \alpha + \beta_{2-3.1} SRD\_Followed\ By\ BRD_{i,t} + \beta_{2-3.2} At\_Ceiling_{i,t} + \beta_{2-3.2}(SRD\_Followed\ By\ BR_{i,t} \times At\_Ceiling_{i,t}) + X'_{i,t}\gamma_{2-3} + \delta_i$$

$At\_Ceiling_{i,t}$: dummy variable equal to 1 if the rating level of sovereign rating of the country where bank *i* is registered and listed is the same as the rating level of bank rating of bank *i* at the end of year *t*, and equal to 0 if else.

$\beta_{2-3.2}$, the coefficient on the interaction term plays the role of D-i-D estimate which captures the effect of the sovereign ceiling policy on the link between sovereign rating downgrades and the Z scores.

We do not find previous papers which regress Z scores to credit rating variables, but the Z score is widely used as an indicator of bank risks by recent research (Chiaramonte et al., 2016; Li et al., 2017).

For Models 2-1 , 2-2 and 2-3, due to the mismatch of data frequency between the daily rating-based variables (SRD, $SRD\_Followed\ By\ BRD_{i,t}$ and

$SRD\_Followed\ By\ BR_{i,t} \times At\_Ceiling_{i,t}$) and the annual accounting-based variables (Z score, and control variables), we have to transform the rating-based variables into an annual format (i.e. measuring the rating change in whole years instead of within single days). We acknowledge that this is inconsistent with the tests for stock-return case and may introduce noises into the regressions. Results of Models 2-1 are shown in Table 7. Results of Models 2-2 and 2-3 are shown in Table 8.

[Insert Table 7 and Table 8 here]

Empirical results show that estimates on *SRD* and *SRD_Followed_by_BRD* in Models 2-1 and 2-2 are significantly negative. It means that sovereign rating downgrades, when followed by bank rating downgrades, are associated with a lower value of Z score (a higher risk of insolvency) in the following year. It indicates that sovereign ratings have predictability on the future insolvency risk of banks registered in the corresponding countries.

Comparing the sizes of estimates in Model 2-2 with those in Model 2-1, we find that sizes in Model 2-2 are greater than 2-1. This offers evidence that, on average, the link between SR downgrades and the rise of insolvency risk is stronger if the SR downgrades are followed by BR downgrades.

For Model 2-3, we find significantly positive D-i-D estimates on the interaction term. Since $\beta_{2-3.1}$, the estimates on *SRD_Followed by BRD*, is negative, the positive sign of estimates on interaction term means

that the treatment group (BR downgrades triggered by the sovereign ceiling policy) is associated with a smaller size of *SRD_Followed by BRD* estimates than the control group (BR downgrades not triggered by the sovereign ceiling policy). This indicates that SRD followed by semi-passive BR downgrades have a weaker impact on Z score than that followed by active BR downgrades. This is consistent with the Hypothesis 2 and indicates that the extra information is provided by the fact that bank downgrades follow sovereign downgrades beyond the information provided by the independent effect of BR downgrades.

Estimates on the control variables show the link between insolvency risk and bank fundamentals. From Table 7, we find that a lower Z score (a higher insolvency risk) is associated with a larger bank size, a lower return on assets, a higher NPL ratio and a higher deposit ratio.

To summarize the findings of both the short-term and long-term analyses, we describe the main empirical results as follows.

Sovereign rating downgrades are associated with the drop of stock returns within a 10-day time window and the rise of the insolvency risk of banks listed in the corresponding countries in the following year. Model 1-1 and Model 2-1 both support the statement by reporting significantly negative estimates of sovereign rating downgrades. This finding enhances the conclusions drawn by other scholars who find a strong link between sovereign ratings and bank performances and raise hypotheses based on this link (Panetta et al., 2011; Correa et al., 2014; Acharya et al., 2014; Gibson et al., 2016). The next empirical result shows that specific sovereign rating downgrades followed by bank rating downgrades have a greater impact on stock returns than those not followed by bank rating downgrades. This finding is reflected by estimates on sovereign rating downgrades in Model 1-2 and Model 2-2 with a larger size than the estimates in Model 1-1 and Model 2-1. This shows initial evidence of the role of bank ratings played in the transmission of sovereign downgrades' relationship with stock returns and Z scores. The existence of followed bank rating downgrades is statistically associated with a stronger relationship between stock returns and Z scores and sovereign rating downgrades. However, we are unable to conclude that bank ratings' following is a factor in enhancing the effect of sovereign downgrades because sovereign rating downgrades and following bank rating downgrades usually occur in a very short time interval. The

enhancement of market reaction and Z score variation may be a consequence of the independent effect of bank rating downgrades but not due to the fact the bank rating downgrades occur following a sovereign rating downgrade.

Therefore, we further split the sample of sovereign rating downgrades followed by bank rating downgrades into two groups according to whether or not they trigger the sovereign-ceiling policy. For bank rating downgrades following sovereign rating downgrades, those who trigger the sovereign ceiling policy (semi-passive) have a weaker relationship with the stock returns than those who do not trigger it (active). This finding is obtained by observing significantly positive D-i-D estimates in Model 1-3 and Model 2-3. The observation of a significant effect of sovereign-ceiling policy on the credit rating determination is consistent with the conclusions by Borensztein et al. (2013) and Almeida et al. (2017). As an exogenous shock on the occurrence of bank rating downgrades which follow sovereign rating downgrades, the sovereign ceiling policy helps us to tease out the 'follow' effects from the effects of independent bank downgrades. We find that semi-passive bank rating downgrades following sovereign rating downgrades have a weaker link with the drop of stock returns and Z scores than do active bank rating downgrades. This offers evidence that the active downgrades of bank ratings after sovereign rating downgrades provide extra information to the stock market and the predictability of insolvency risk besides the independent impact of sovereign and bank rating downgrades.

4.3 Robustness checks

We conduct three robustness tests, two for the short-term analysis and one for the long-term analysis.

For short-term analysis, we replace the time windows of [t-1, t+T] by [t, t+T] to consider the shock of sovereign ratings on the stock returns with the day when the ratings are released as the benchmark day. In the main test, we take the day before the rating change announcement day, (t-1), as the benchmark to rule out possibility that CRAs announce the rating changes after the stock transactions terminate on the announcement day. However, the cost of using [t-1, t+T] instead of [t, t+T] is that we ignore the time interval [t-1, t] and do not consider some possible market events during this interval which may also impact

the stock returns. Therefore, we analyze the cases of [t, t+T] and re-run all the regressions shown in Models 1-1, 1-2 and 1-3 to examine the consistency of the results.

To save space we do not show the regression tables in the main part but have put them in Appendix (Appendix 2). We do not find significant changes of results from the original tests using time window [t-1, t+T] in terms of the sign, size and significance of coefficients on key independent variables. This shows that the omitted events (if applicable) do not influence the estimation of the impact of sovereign ratings on the stock returns, or the role of sovereign-ceiling policy.

Another robustness check is to apply two-way clustering of standard errors to re-estimate the t-value of estimators. To deal with the possibly existing heteroscedasticity problem (unobserved characteristics of observations are correlated with each other within same clusters, for example, same stock/bank[2], same country or same year), we cluster standard errors for all regressions in Models 1-1, 1-2 and 1-3 by 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). To save space we do not show the regression tables in the main part but they are put in the Appendix (Appendix 3). The re-estimation of t-value does not change the sign or the size, but only the standard error and significance of estimators. We find a significant reduction of t-values for all of the estimates after the re-estimation, but only a few of the estimates turn to be insignificant (having been significant in the original regressions). For details, the D-i-D estimators in Model 1-3 (on the interaction term between *At_Ceiling* and $SRD\_Followed\_By\_BRD$) for the time windows of [t-1, t+2] and [t-1, t+6] are significantly positive in the original models but insignificant after we cluster the standard errors. The significance of all the other estimators except these two remain even if we use two-way clustering of the standard errors.

For the long-term analysis of Z scores, we take the robustness check of changing the format of Z scores (the dependent variable). As mentioned in the section of 'Data and Sample', we do not take the time-varying

[2] Stock level for stock return cases and bank level for Z score cases.

ROAA, CAR or σ(ROAA) into consideration when establishing the Z score indicator for analysis. In this robustness check, another two formats of Z scores, $Z(Alternative\ 1)_t$ and $Z(Alternative\ 2)_t$, also mentioned by Lepetit and Strobel (2015) are adopted to replace the dependent variables in Models 2-1. 2-2 and 2-3.

$\mathrm{Z(Alternative\ 1)_t} = \frac{\overline{\mathrm{ROAA_{t,3years}}} + \overline{\mathrm{CAR_{t,3years}}}}{\sigma(\mathrm{ROAA})_{\mathrm{t,3years}}}$;

$\mathrm{Z(Alternative\ 2)_t} = \frac{\overline{\mathrm{ROAA_{t,3years}}} + \mathrm{CAR_t}}{\sigma(\mathrm{ROAA})_{\mathrm{t,3years}}}$; where $\overline{X_{t,3years}}$ refers to the three-year moving average of variable X in year t and $\sigma(ROAA)_{y,3years}$ refers to the three-year moving standard deviation of ROAA in year *t*.

The correlations between each pair of the three Z scores are shown in Table 9.

[Insert Table 9 here]

We find that the correlation between $\mathrm{Z(Alternative\ 1)_y}$ and $\mathrm{Z(Alternative\ 2)_y}$is extremely high (99.93%) so these two substitutes can be regarded as the same one. We replace the original Z score with $\mathrm{Z(Alternative\ 1)_y}$ and re-run the regressions in Models 1-1, 1-2 and 1-3. The results of updated regressions are put in the Appendix (Appendix 4). We find that the only significant change of empirical results is for Model 2-1. The estimates on SRD are significantly negative in the original model, while after we change the format of Z scores, the estimates are still negative but not significant except in the case of S&P. However, estimates on $SRD\_Followed\_By\_BRD$ remain significantly negative. Therefore, although the results of Model 2-1 are different for different Z scores, this does not change the conclusion regarding the Hypothesis 1: the follow of bank rating downgrades enhances the power of sovereign rating downgrades.

5. Conclusion

We empirically examine the role which 'following-SR' bank ratings play in the effect channel of sovereign ratings. Twenty-five main banks from PIIGS countries which received a significant number of sovereign rating downgrades in the sample period (1991-2017) are selected as the research sample. For the sample banks, we identify 504 sovereign rating downgrade events and find that these sovereign rating downgrades

have a significant relation with the short-term performances of stock returns of those banks in time windows no more than 10-day. We further select those sovereign downgrade events which are followed by bank rating downgrades within no more than two transaction days, test the association between those specific sovereign events and the stock returns and find a significant relationship with larger magnitudes (larger sizes of estimated coefficients) than those sovereign rating downgrades not followed by bank ratings. To further rule out the effect of following bank rating downgrades, we apply the cases of bank rating downgrades following sovereign rating downgrades which trigger the sovereign-ceiling policy and hence are regarded as 'semi-passive' reactions to sovereign rating downgrades. The semi-passive bank downgrades are associated with a weaker effect on the stock returns than active downgrades, which indicates that the active bank downgrades provide extra information about the negative performances of corresponding banks to the investors as well as the independent effects of the sovereign rating downgrades and the subsequent bank rating downgrades. This finding supports our hypothesis and is consistent with the statement that bank ratings play a role of enhancing the power of sovereign rating's impact on bank performances (i.e. bank ratings partially transmit the effect from sovereign ratings to the bank performances).

We extend our analysis of short-term performances of bank stock returns to a long-term indicator, Z score, which mirrors the insolvency risk of banks on an annual basis. Z score is an indicator of banks' credit risk and the role of CRAs is to assess the credit risks of firms. Therefore, we test the association between Z score in the current year and the rating levels (both sovereign and bank ratings) at the end of the previous year to investigate the information (i.e. predictability of future credit risks) provided by sovereign ratings in two scenarios, 1) SRs are followed by BRs and 2) SRs are not followed by BRs. Parallel tests, similar to those for stock returns, are conducted on the annual dataset of Z score, sovereign rating changes and a series of accounting-based control variables. We find similar empirical results to those for the stock return analysis: sovereign downgrades have a significant link with the decrease of Z score (i.e. the increase of insolvency risk); bank downgrades following those sovereign downgrades enhance such link and provide extra information (predictability) to the Z score variations.

We acknowledge two limitations in our research. The first limitation is that we only consider downgrade cases but not upgrade ones. The reasons for ruling out upgrade scenarios are, 1) the sovereign ceiling policy only works for sovereign and entity rating downgrades and 2) the literature has concluded that investors/firms react to bad news (downgrades) more significantly. However, this reduces the number of sovereign rating changes included in our sample and leaves a gap of the effect of sovereign rating upgrades on the market. The second limitation is the selection of PIIGS but not all the EU countries because other countries received zero or very few sovereign downgrades in the sample period. However, it may also have some negative consequences on the representativeness of my sample.

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Tables and Figures

Table 1 Information of sampled banks and countries

This table shows the country and number of SRD (Sovereign Rating Downgrades) for each of the sample countries (Portugal, Italy, Ireland, Greece and Spain), offered by the three credit rating agencies (Moody's, S&P and Fitch) in the empirical analysis.

Bank Name	Country	No. of SRD		
		Moody's	S&P	Fitch
National Bank of Greece Piraeus Bank Eurobank Ergasias Alpha Bank Egnatia Bank Emporiki	Greece	14	16	14
Banco Santander Banco Bilbao Vizcaya Argentina CaixaBank Banco de Sabadell Bankia Banco Popular Espanol Bankinter Banco Espanol de Credito	Spain	9	8	5
Bank of Ireland Allied Irish Bank	Ireland	7	7	7
UniCredit Intesa Sanpaolo Banca Nazionale del Lavoro Credito Emiliano Banca Carige	Italy	9	8	7
Banco Espirito Santo Banco Comercial Portugues Banco BPI Banco Santander Totta	Portugal	7	10	4

Table 2 Distribution of sovereign rating changes in the sample

This table shows the distribution of the identified events according to the types of rating changes. 'Sovereign Change' refers to the cases when the country where the sample bank is registered in receives sovereign rating changes by at least one of the three CRAs (Moody's, S&P and Fitch). 'BR' refers to the 'Bank Ratings'. 'Ceiling policy' refers to the 'sovereign ceiling policy' according to which the firm rating levels should not be higher than the corresponding country sovereign rating levels.

SovereignChange	724			
	Upgrade	220		
	Downgrade	504		
		Not Followed by BR	105	
		Followed by BR	399	
			Triggered by Ceiling Policy (Semi-Passive)	119
			Not Triggered by Ceiling Policy (Fully Active)	280

Table 3 Rating levels (daily) distribution of the three CRAs

Category of Bank Ratings	Moody's		S&P		Fitch	
	No.	Percentage	No.	Percentage	No.	Percentage
Above_AA- (Aa3)	65416	38.76%	48740	30.00%	74328	51.53%
AA (Aa3) to BBB (Baa3)	73127	43.33%	83801	51.58%	47571	32.98%
BBB- (Baa3) to B- (B3)	17516	10.38%	19999	12.31%	16054	11.13%
Below_B (B3)	12708	7.53%	9917	6.10%	6298	4.37%
Total	168767	100%	162457	100%	144251	100%

Table 4 Regression of Stock Returns on Sovereign Rating Downgrades

This table shows the regression result of Model 1-1. The regression is run on the basis of daily bank-rating pairs. Sample banks are the listed commercial banks in the PIIGS countries (Portugal, Italy, Ireland, Greece and Spain). The dependent variable is the stock returns of the time windows [t-2, t-1] and [t-1, t+T] (T=1 to 10 and 20), where the first component is the starting day of the time window and the second component is the last day of the time window and day t indicates the day of the corresponding transaction day. The key independent variable is SRD (Sovereign Rating Downgrades), dummy equal to 1 if the country where bank i listed and registered is downgraded, by one of the three CRAs on day t and 0 if else. Index Return is the daily index return of the market where bank i is listed, with the same time window as the dependent variable. Year and Firm fixed effects are controlled. The fixed effect of bank rating levels and the interaction between bank rating levels and SR downgrades are also controlled. Figures in the brackets are corresponding t-statistics.

N refers to the number of banks and T refers to the number of observations for each of the banks in the panel regression.

*** 1% significance level

** 5% significance level

* 10% significance level

Time window [Starting day, Last day]	[t-2, t-1]	[t-1, t+1]	[t-1, t+2]	[t-1, t+3]	[t-1, t+4]	[t-1, t+5]	[t-1, t+6]	[t-1, t+7]	[t-1, t+8]	[t-1, t+9]	[t-1, t+10]	[t-1, t+20]
SRD[a]	-0.63***	-4.08***	-4.22***	-4.06***	-3.87***	-3.99***	-4.72***	-4.84***	-4.97***	-5.22***	-4.37***	-0.69
	(-2.96)	(-13.11)	(-10.95)	(-9.01)	(-7.66)	(-7.16)	(-7.81)	(-7.51)	(-7.32)	(-7.35)	(-5.89)	(-0.99)
Index Return	1.02***	1.04***	1.05***	1.06***	1.07***	1.08***	1.08***	1.09***	1.09***	1.10***	1.10***	1.12***
	(291.22)	(289.25)	(291.40)	(290.62)	(289.70)	(288.79)	(288.36)	(288.59)	(290.30)	(292.02)	(293.15)	(303.04)
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Rating Level (BRL) Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
BRL*SRD Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R2	31.27%	31.14%	31.51%	31.47%	31.40%	31.35%	31.35%	31.47%	31.82%	32.17%	32.43%	34.76%
N	25	25	25	25	25	25	25	25	25	25	25	25
T	7500	7500	7499	7498	7497	7496	7495	7494	7493	7492	7491	7482

a: The actual coefficients are those figures shown in the table times 10^{-3}

Table 5 Regression of Stock Returns on Sovereign Rating Downgrades which are followed by Bank Rating Downgrades

This table shows the regression result of Model 1-2. The regression is run on the basis of daily bank-rating pairs. Sample banks are the listed commercial banks in the PIIGS countries (Portugal, Italy, Ireland, Greece and Spain). The dependent variable is the stock returns of the time windows [t-2, t-1] and [t-1, t+T] (T=1 to 10 and 20), where the first component is the starting day of the time window and the second component is the last day of the time window and day t indicates the day of the corresponding transaction day. The key independent variable is SRD_Followed by BRD (Sovereign Rating Downgrades followed by Bank Rating Downgrades), dummy equal to 1 if the bank i receives sovereign downgrades which are followed by the bank rating downgrades (at the same day, or after 1 day) on day t and equal to 0 else. Index Return is the daily index return of the market where bank i is listed, with the same time window as the dependent variable. Year and Firm fixed effects are controlled. The fixed effect of bank rating levels and the interaction between bank rating levels and SR downgrades are also controlled. Figures in the brackets are corresponding t-statistics.

N refers to the number of banks and T refers to the number of observations for each of the banks in the panel regression.

*** 1% significance level

** 5% significance level

* 10% significance level

Time window [Starting day, Last day]	[t-2, t-1]	[t-1, t+1]	[t-1, t+2]	[t-1, t+3]	[t-1, t+4]	[t-1, t+5]	[t-1, t+6]	[t-1, t+7]	[t-1, t+8]	[t-1, t+9]	[t-1, t+10]	[t-1, t+20]
SRD_Followed by BRD[a]	-0.35	-5.38***	-5.70***	-6.01***	-5.83***	-5.87***	-5.23***	-5.43***	-5.36***	-5.71***	-5.16***	-2.16**
	(-1.50)	(-15.69)	(-13.43)	(-12.11)	(-10.43)	(-9.57)	(-7.86)	(-7.66)	(-7.17)	(-7.30)	(-6.31)	(-2.02)
Index Return	1.02***	1.04***	1.05***	1.06***	1.07***	1.08***	1.08***	1.09***	1.09***	1.10***	1.10***	1.12***
	(292.21)	(289.32)	(291.49)	(290.70)	(289.78)	(288.79)	(288.38)	(288.61)	(290.31)	(292.04)	(293.17)	(303.05)
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Rating Level (BRL) Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
BRL*SR Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R2	31.27%	31.17%	31.53%	31.49%	31.42%	31.35%	31.36%	31.47%	31.82%	32.17%	32.43%	34.76%
N	25	25	25	25	25	25	25	25	25	25	25	25
T	7500	7500	7499	7498	7497	7496	7495	7494	7493	7492	7491	7482

a: The actual coefficients are those figures shown in the table times 10^{-3}

Table 6 Regression of Stock Returns on Sovereign Rating Downgrades which are followed by Bank Rating Downgrades (triggered by Ceiling Policy or not)

This table shows the regression result of Model 1-3. The regression is run on the basis of daily bank-rating pairs. Sample banks are the listed commercial banks in the PIIGS countries (Portugal, Italy, Ireland, Greece and Spain). The dependent variable is the stock returns of the time windows [t-2, t-1] and [t-1, t+T] (T=1 to 10 and 20), where the first component is the starting day of the time window and the second component is the last day of the time window and day t indicates the day of the corresponding transaction day. The key independent variables include: SRD_Followed by BRD (Sovereign Rating Downgrades followed by Bank Rating Downgrades), dummy equal to 1 if the bank i receives sovereign downgrades which are followed by the bank rating downgrades (on the same day, or after 1 day) on day t and equal to 0 else; At_Ceiling, dummy equal to 1 if the bank rating level of bank i is equal to the sovereign rating level on day t and 0 else and the interaction term between SDR_Followed_by_BRD and At_Ceiling. Index Return is the daily index return of the market where bank i is listed, with the same time window as the dependent variable. Year and Firm fixed effects are controlled. The fixed effect of bank rating levels and the interaction between bank rating levels and SR downgrades are also controlled. Figures in the brackets are corresponding t-statistics.
N refers to the number of banks and T refers to the number of observations for each of the banks in the panel regression.
*** 1% significance level
** 5% significance level
* 10% significance level

Time window [Starting day, Last day]	[t-2, t-1]	[t-1, t+1]	[t-1, t+2]	[t-1, t+3]	[t-1, t+4]	[t-1, t+5]	[t-1, t+6]	[t-1, t+7]	[t-1, t+8]	[t-1, t+9]	[t-1, t+10]	[t-1, t+20]
SDR_Followed by BR	-0.002	-0.064***	-0.066***	-0.062***	-0.061***	-0.062***	-0.064***	-0.067***	-0.068***	-0.066***	-0.065***	-0.006
	(-1.04)	(-25.04)	(-20.73)	(-16.72)	(-14.52)	(-13.46)	(-12.83)	(-12.63)	(-12.10)	(-11.27)	(-10.56)	(-0.85)
At the Ceiling	0.031***	0.042***	0.070***	0.098***	0.100***	0.101***	0.043***	-0.0004	0.005	0.004	-0.032**	-0.041*
	(6.92)	(6.46)	(8.73)	(10.46)	(9.56)	(8.75)	(3.42)	(-0.03)	(0.25)	(0.27)	(-2.06)	(-2.04)
SDR_Followed by BR	-0.032***	0.039***	0.015*	0.017	-0.023*	-0.022	0.039***	0.038***	0.078***	0.063***	0.012***	0.040*
* At the Ceiling	(-6.26)	(5.21)	(1.65)	(1.57)	(-1.94)	(-1.64)	(2.73)	(5.44)	(4.80)	(4.32)	(6.32)	(1.83)
Index Return	1.02***	1.04***	1.05***	1.06***	1.07***	1.08***	1.08***	1.09***	1.09***	1.10***	1.10***	1.12***
	(291.19)	(292.55)	(291.82)	(290.90)	(289.98)	(289.05)	(288.56)	(288.79)	(290.47)	(292.16)	(293.29)	(303.05)
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Rating Level (BRL) Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
BRL*Followed Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R2	31.27%	31.67%	31.69%	31.60%	31.50%	31.44%	31.42%	31.53%	31.87%	32.22%	32.48%	34.76%
N	25	25	25	25	25	25	25	25	25	25	25	25
T	7500	7500	7499	7498	7497	7496	7495	7494	7493	7492	7491	7482

a: The actual coefficients are those figures shown in the table times 10^{-3}

Table 7 Regression of Z scores on Sovereign Rating Downgrades

This table shows the regression result of Model 2-1. The regression is run on the basis of annual bank-rating pairs. Sample banks are the listed commercial banks in the PIIGS countries (Portugal, Italy, Ireland, Greece and Spain). The dependent variable is the Z score in the year (t+1). The Z score of year t is calculated by the formula $\frac{\mathrm{ROAA}_{i,t}+\mathrm{CAR}_{i,t}}{\sigma(\mathrm{ROAA})_i}$. ROAA refers to the return on the average assets; CAR refers to the capital-asset ratio and σ(ROAA) refers to the standard deviation of return on average assets of bank i in the full period of sample (1991-2017). The key independent variable include: SDR (Sovereign Rating Downgrades), dummy equal to 1 if the sovereign rating of bank i is downgraded in year t and 0 else. Control variables include: Firm Size, the total assets of the firm, RoA, the return on assets, NPL (Non-performing Loan) ratio and Deposit Ratio. Firm fixed effects are controlled. The regressions are run separately for rating changes announced by Moody's, S&P and Fitch. Figures in the brackets are corresponding t-statistics.
N refers to the number of banks and T refers to the number of observations for each of the banks in the panel regression.
*** 1% significance level
** 5% significance level
* 10% significance level

Model	2-1		
Rating Agency	Moody	S&P	Fitch
SRD	-0.988***	-0.705***	-0.814***
	(-9.05)	(-7.23)	(-6.93)
Firm Size	-0.011***	-0.010***	-0.010***
	(-4.21)	(-3.82)	(-3.70)
RoA	0.086***	0.111***	0.104***
	(3.40)	(4.35)	(4.00)
NPL Ratio	-0.503*	-0.431	-0.273*
	(-1.72)	(-1.44)	(-1.88)
Deposit Ratio	-0.010**	-0.008*	-0.005**
	(-2.21)	(-1.66)	(-1.99)
Firm Fixed Effect	Yes	Yes	Yes
R2	78.81%	77.75%	77.08%
N	29	29	26
T	25	25	25

Table 8 Regression of Z scores on Sovereign Rating Downgrades followed by Bank Rating Downgrades (triggered by the ceiling policy or not)

This table shows the regression result of Models 2-2 and 2-3. The regression is run on the basis of annual bank-rating pairs. Sample banks are the listed commercial banks in the PIIGS countries (Portugal, Italy, Ireland, Greece and Spain). The dependent variable is the Z score in the year (t+1). The Z score of year t is calculated by the formula $\frac{\mathrm{ROAA}_{i,t}+\mathrm{CAR}_{i,t}}{\sigma(\mathrm{ROAA})_i}$. ROAA refers to the return on the average assets; CAR refers to the capital-asset ratio and σ(ROAA) refers to the standard deviation of return on average assets of bank i in the full period of sample (1991-2017). The key independent variable include: SRD_Followed_by_BRD (Sovereign Rating Downgrades followed by Bank Ratings), dummy variable equal to 1 if sovereign rating of bank i is downgraded in year t and the bank rating of bank i during year t changes in the same direction with sovereign rating changes and 0 else; At_Ceiling, the dummy variable equal to 1 if at the end of year t the rating level of sovereign rating of the country where bank i is registered and listed is the same as the rating level of bank rating of bank i, and equal to 0 if else and the interaction term between SRD_Followed_by_BRD and At_Ceiling. Control variables include: Firm Size, the total assets of the firm, RoA, the return on assets, NPL (Non-Performing Loan) ratio and Deposit Ratio. Firm fixed effects are controlled. The regressions are run separately for rating changes announced by Moody's, S&P and Fitch. Figures in the brackets are corresponding t-statistics.
N refers to the number of banks and T refers to the number of observations for each of the banks in the panel regression.
*** 1% significance level
** 5% significance level
* 10% significance level

Model	2-2			2-3		
Rating Agency	Moody	S&P	Fitch	Moody	S&P	Fitch
SRD_Followed by BRD	-1.064**	-1.030***	-0.967***	-0.981***	-1.102***	-1.422***
	(-8.35)	(-8.27)	(-5.75)	(-7.53)	(-8.18)	(-7.39)
At_Ceiling	--	--	--	-0.039	-0.325*	-0.320**
				(-0.29)	(-1.78)	(-2.08)
SRD_Followed by BRD * At_Ceiling	--	--	--	0.575**	0.428*	0.571**
				(2.31)	(1.63)	(2.03)
Accounting-Based Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
R2	79.41%	79.82%	78.36%	79.60%	80.91%	80.50%
N	29	29	26	29	29	26
T	25	25	25	25	25	25

Table 9 Correlation Matrix among the three proxies of Z scores

	Z (Original)	Z (Alternative 1)	Z (Alternative 2)
Z (Original)	1	0.2489	0.246
Z (Alternative 1)		1	0.9993
Z (Alternative 2)			1