Summary of dissertation

Empirical analysis of bonds with policy implications

Yasutake Homma (本間　靖健), BD20F007

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II. Summary of dissertation:

The dissertation consists of empirical studies on bonds with related policies. Chapter 2 investigates whether non-US banks engage in carry trades by issuing US dollar bonds with which many researchers have suggested the behavior contains huge risks. Chapter 3 studies TLAC (Total Loss Absorbing Capacity) bonds which are aligned with a newly introduced banking regulation and the issuers' risk-taking. Finally, chapter 4 discusses a yield premium of green bonds which has been massively issued especially after the signature of the Paris Agreement. The summary of each chapter from 2 to 4 follows.

Chapter 2: Carry trades of non-US banks with US dollar bonds[1]

A trading activity, carry trade, which is a strategy that borrows funds at a low interest rate in one currency and buys a higher-yielding asset in another, is well known. Nonetheless, many researchers have demonstrated the huge potential risks in carry trades dependent on short-term US dollar fundings. A recent study revealed that the massive carry trades with short-term US dollar fundings caused the European banking crisis. The literature has also found that the capital ratio requirement in the Basel framework might not be sufficient to avoid banks' vast investments in sovereign bonds with zero-risk weights via their carry trade activities (Acharya and Steffen 2015). Thus, a newly introduced leverage ratio requirement in the Basel III framework is designed to address banks' excessive risk-takings, backing up the capital ratio requirement (Du et al. 2018; Avdjiev et al. 2019). Not limited to the risks in the carry trade itself, other studies have shown that the dependence on short-term US dollar debts also contains systemic risks given rapid withdrawals during economic downturns (Ivashina et al. 2015; Pérignon et al. 2018). A striking fact is, despite the huge risks in banks' carry trades depending on short-term US dollar fundings and the design of regulations against the risks, none of the studies has verified that they engage in the trades with the finance of

[1] This chapter is based on a paper coauthored with Katsushi Suzuki.

short-term US dollar bonds and the ways in which they vary behavior through the regulations. Thus, this chapter aims to reveal the relation between issuances of the US dollar bonds and carry trades of non-US banks along with the implementation of the Basel framework.

I hypothesize that non-US banks issue short-term US dollar bonds for the purpose of carry trades. The analysis is an extension of Bruno and Shin (2017), who verified the carry trades of nonfinancial corporations, to financial firms. The literature uses an indicator, *Carry-to-risk*, in which the higher the indicator is, the more favorable the condition for carry trades with a currency hedge; thus, I employ the indicator as a main variable to verify the hypothesis. First, I simply test a response of issuers on *Carry-to-risk* for the amount of short-term US dollar bond issuances. In this analysis, I also observe the response in each Basel phase by the interaction terms of Basel phase dummies with *Carry-to-risk*, given my investigation of regulations. Second, I test a response on the *interest rate differential* holding the *implied volatility* in other control variables, to examine whether they engage in carry trades without a hedge. Finally, I test other proxies of favorable carry trade conditions and add a country-quarter analysis to capture carry trades as fast-moving market activity. I use a sample that comprises a total of 10,373 issuer-year data containing 364 entities that issued US dollar bonds during 2002-2017 at least once from 42 countries.

The main findings can be summarized as follows. In the first analysis, I find that in the classifications of all samples, advanced economies and emerging economies, non-US banks issue a larger amount of US dollar bonds with a maturity of less than one year in accordance with the carry trade favorable condition. The magnitude of the response is larger in advanced economies than in emerging economies. Importantly, the results of tests with the interaction terms of Basel phase dummies and *Carry-to-risk* present the coefficient without significance in the Basel III phase in advanced economies. In the tests with the *interest rate differential* instead of *Carry-to-risk*, the sample only in advanced economies obtains a positive and significant coefficient. Furthermore, the results of tests with other proxies of favorable carry trade conditions also support the hypothesis in advanced economies. Finally, as a result of the country-quarter analysis,

the coefficient on *Carry-to-risk* is positive and significant in both advanced and emerging economies but shows a larger estimate in advanced economies.

Overall, these results coherently represent that non-US banks, especially in advanced economies, could engage in carry trades by issuing short-term US dollar bonds. Yet the results do not clearly represent that they do according to the implementation of Basel III.

The first contribution of this chapter is that I complement the literature on the determinants of US dollar funding activities. Acharya and Steffen (2015) have assumed that European banks finance their carry trades by short-term US dollar fundings. Aldasoro et al. (2017), and Aldasoro and Ehlers (2018) confirmed pervasive US dollar funding among non-US banks but have not verified the use of proceeds. Ivashina et al. (2015), and Pérignon et al. (2018) presented banks' reliance on short-term US dollar debts and discussed the determinants of US dollar money-market funds, such as commercial papers or certificates of deposits issued by banks yet have not focused on bonds. Thus, the determinants of US dollar bond issuance with short-term maturity have not been empirically tested. Therefore, this chapter's study, which finds carry trades as a determinant of the bonds that have been massively issued, complements the literature.

Another contribution of this chapter is that I complement the related literature investigating a relationship of the carry trades of banks with the Basel framework. For instance, Acharya and Steffen (2015), who presented that the carry trade of European banks caused the financial crisis, concluded that the capital ratio requirement in the Basel framework could not be sufficient to alleviate the risks. Their statistical tests focused on investment assets in European banks but not on debts with global-level data. Additionally, their data were obtained prior to the Basel III phase. Thus, none of the studies has verified how profoundly banks take part in carry trades and how this varies along with the Basel III framework, which could function against the behavior. Therefore, my results, which indicate that global non-US banks could engage in carry trades but shrink this behavior in the Basel III phase, fill the gap and complement the related literature.

Finally, in the same vein of the relationship of carry trades and capital regulations, the literature has explained that unlike nonfinancial firms, financial firms could find it

difficult to implement carry trades in emerging economies. Liu et al. (2022) explained that capital controls are widely used, especially in developing nations, and thus they block carry trade transactions by financial firms. Hardy and Saffie (2019) have also mentioned that regulation and prudential supervision tend to focus primarily on banks, yet nonfinancial firms tend to be much less regulated in their financial intermediation activities and currency risk exposure. Thus, Bruno and Shin (2017) and Hardy and Saffie (2019) verified carry trades by nonfinancial corporations in emerging economies, yet they have not tested this on financial firms. My results that financial firms in emerging economies do not coherently provide significant estimates on carry trade favorable conditions could reinforce the assumption that financial firms in emerging economies are not supposed to engage in carry trades under strict capital controls, which governments typically enforce.

Chapter 3: TLAC bonds and bank risk-taking[2]

In November 2015, the Financial Stability Board (FSB) announced a "bail-in" standard called TLAC. TLAC is based on the principle that there must be sufficient loss-absorbing and recapitalization capacity available for global systemically important banks (G-SIBs) in resolution that minimizes any impact on financial stability. Each eligible G-SIB began to issue eligible bonds in 2015 to meet the requirement as of January 2019. The TLAC requirement covers the regulatory capitals (tier 1, tier 2, and additional tier 1) and the "gone-concern" capital of TLAC debts in the case of bank failure. The regulation requests that banks hold the debt capital consisting of 8% risk-weighted assets (RWA), which is equaled to the required proportion of regulatory capitals. This is the evidence that TLAC plays an important role of banking regulation similar to the regulatory capitals. Thus, this chapter aims to verify an effect of TLAC bonds, which is aligned with the newly introduced banking regulation announced in 2015 and accounts for a large part of banks' assets which equals to the proportion of

[2] This chapter is based on a paper coauthored with Katsushi Suzuki.

regulatory capitals on risk-weighted assets, but has not yet been verified on their risk-taking levels.

TLAC debts contain a new instrument in that they entail "structural subordination," which enables these debts to resolve the failure of issuers' subsidiaries. The design of the debt priority scheme is in line with the literature, which has confirmed an inverse relationship between the seniority of debt claims and debtholders' monitoring incentives (Danisewicz et al. 2018; Avdjiev et al. 2020). Thus, TLAC bond investors may put downward pressure on issuers' risks, as they hate to see the default of issuers, and thereby, I hypothesize that the amount of TLAC issuance is negatively associated with risk-taking.

In contrast, the literature (Blum 2002; Niu 2008; Chen and Hasan 2011) discusses a positive relationship between subordinated debts and risk-taking. The higher yields of TLAC (Lewrick et al. 2019) than conventional bonds would urge issuers to increase risks to the optimal level in reaction to high yields given that banks' risk-taking behavior is flexible even after they contract the rate of return for TLAC bonds. Rational bond investors anticipate this behavior and request a further high risk premium ex ante. The higher costs would again more aggravate the excessive risk-taking incentives of banks. Therefore, I hypothesize that the amount of TLAC bonds could increase risks.

The studies use a specification similar to the regression difference-in-difference employed by Favara et al. (2021), taking zero in the pretreatment period of 2014 for all sample banks but with each actual amount of TLAC issuance over RWA in the posttreatment period (2015-2021). The nonapplicable banks take zero of the focused variable in the post period. To supplementarily verify an effect of the designation, I replace the variable with an interaction term of a posttreatment dummy and a TLAC-applicable banks dummy in an additional test.

Throughout the studies, I test a dependent variable that is widely used as a bank accounting-base risk indicator, namely, the Z score, where a higher score represents a lower risk level. In addition, to confirm the channel of impact of the Z score, I also test its numerator and denominator. The numerator of the Z score is return on assets (ROA) plus the capital-to-asset ratio (CAR), which represents the one-off strength of a bank's financial soundness. The denominator is the standard deviation of ROA (σROA) with a

three-year time window, which represents the volatility of earnings standardized by total assets. I also test how they vary risk-taking levels by changing their banking activities. The studies test the amount of loan to total assets (Loans/Assets) for the volume of loans, the net-interest margin (NIM) for the efficiency of loans, and nonperforming loans to the amount of loans (NPLs/Loans) for the quality of borrowers in the same specifications.

The identification of the effect of TLAC debts on bank risk-taking faces a number of challenges. The most important challenge concerns an endogeneity problem given that TLAC-applicable banks are not selected at random. This chapter attempts to mitigate this problem by including the systemic importance indicator, the selection criteria of TLAC-applicable banks, following the methodology employed by Favara et al. (2021). Another potential bias is caused by time-variant country-specific factors, such as stress tests conducted by each jurisdiction regularly or irregularly. Thus, I add an interaction term of country and year fixed effects on the specification following Favara et al. (2021) to alleviate this problem.

The other important challenge is sample selection bias. A total of 25 TLAC-applicable banks could not be compared merely to other large banks or propensity score matched banks due to their significant impact on the world economy to verify the average treatment effect treated (ATT) of TLAC debts. There may also be country-specific regulations such as capital controls or business cultures that differ from one country to the next, which might impact risk-taking. Therefore, I select a control group consisting of 26 listed banks on the stock exchange with which the systemic importance indicator is assigned and incorporated in the same countries of G-SIB locations. Justifying the selection methods, the parallel trend tests pass.

The main findings are as follows. The results show that the volume of TLAC bond issuances is negatively associated with the Z score and positively associated with σROA. Additionally, the amount of issuance is positively associated with Loans/Assets together with NPLs/Loans. Overall, the results are consistent with the hypothesis that the issuance amount of TLAC bonds could increase risk-taking. Importantly, TLAC regulation is designed to mitigate banks' risk-taking and finally to decrease the probability of banks' failure, yet the results present the opposite trend.

This chapter contributes to a growing body of literature that examines bank risk-taking and regulations. Laeven and Levine (2009) and Ashraf (2017) showed that bank ownership structure impacts bank risk-taking. With a focus on banking regulations, Anginer et al. (2021) clarified the relationship between the quality of tier 1 capital and bank risk-taking. Kupiec (2016), Bolton and Oehmke (2018), and Acosta-Smith et al. (2021) examined the theoretical efficacy of the leverage ratio requirement and whether TLAC regulation fixes G-SIBs' too-big-to-fail (TBTF) problem. Lewrick et al. (2019) examined the risk of TLAC bonds as reflected in their pricing. Thus, although research on bank risk-taking and regulations has long been discussed, demonstrating their importance, there are few empirical studies on the relationship between TLAC debts and risk-taking. Thus, this chapter complements the literature by verifying how the newly introduced TLAC bonds impact the applicable G-SIBs' risk-taking.

Second, this chapter contributes to the literature on subordinate debts. Blum (2002), Danisewicz et al. (2018) and Avdjiev et al. (2020) indicated that subordinated debts, including contingent-convertible bonds, suppress banks' risk-taking, whereas some of the literature discusses a positive relation. However, to the best of my knowledge, this chapter is the first to focus on an effect of TLAC bonds, which contains structural subordination, by comparing the results of tests on the designation of TLAC-applicable banks. The finding that the issuance amount is associated with risk indicators complements the literature.

Chapter 4: Yield premium of green bonds and investment demands

The Paris Agreement, which sets out the target of carbon emissions, marked an important step in the world's response to the climate change but also has impacted the investment and finance in each region or country. The European Commission published the European Green Deal, which plans for a net zero target for the European Union (EU) by 2050 and facilitates investments in green projects. The Agreement also accelerates investments in the United States (US) as the Biden administration turned down the decision of the Trump administration withdrawing the US from the Agreement. In the reflection of the magnitude of regional attempts after the Paris

Agreement, the amount of green bond issuances has skyrocketed by annually 18 times on average compared to before the Agreement.

However, the issuance cost of green bonds which is measured by the yields of bonds is relevant to achieve the target signified upon the Paris Agreement. There is a simple inverse correlation between the amount issued and yields. Thus, if the yields are cheaper than non-green bonds on average given the same factors, such as maturity, bond credit ratings, and amount issued with the same economic conditions, the more issuers would be willing to issue green bonds instead of non-green bonds. On the flip side, if they recognize the yields are unexpectedly higher than non-green bonds, they would be reluctant to label "green" on their issuing bonds.

In this sense, the literature has been argued over three groups. The literature with a finding of negative premium (Baker et al. 2018; Zerbib 2019; Fatica 2021) has insisted that the strong investment demands on green bonds may have caused the premium, while the literature confirming the zero premium (Larcker and Watts 2020; Flammer 2021) has explained that investors would not want to sacrifice returns from green bonds which would be used to profitable projects. The literature with the positive premium (Karpf and Mandel 2018) has interpreted that the caution against the existence of a large specific demand for green bonds or the willingness of investors to pay for green. Although the literature attempts to find the premium, there is little empirical evidence to support the interpretations. Therefore, the purpose of this chapter is to clarify the existence of yield premium and its potential causes.

For the hypothesis setting, I consider that Karpf and Mandel (2018) presented a positive premium from 2015 and has suggested the cause of positive premium could be the weak demand or investors' perception of "willingness to pay for green." "Willingness to pay for green" could be interpreted that investors are willing to accept the lower return than that of non-green bonds. However, they would not want to bear the lower return for large quantity of investments. Thus, assuming that the investment demands on green should be stronger after the Agreement (Thompson 2021), I establish a hypothesis that the willingness to pay for green after 2015 has become weak due to the massive promotion of green bond issuance by governments, and so there could be a positive premium. The study separates the sample into pre-2015 which indicates the

year 2015 or before, and post-2015 meaning the year 2016 or after in order to verify the variation of yield premiums across these periods.

In addition, the investment demand in the primary market could be measured by a return on the secondary market (Zerbib 2019). Then, I find that a green bond index which represents an aggregated return of green bonds traded in the secondary market could be a proxy of investment demands. The index return and the demand have an inverse relationship. In detail, the higher index representing a higher return of holding green bonds equals to lower price of the green bonds meaning lower demand. Thus, I establish the other hypothesis that the higher index return, which shows the lower demand, is associated with the higher yield premium as the literature presumes the cause of yield premium could be the demand (Baker et al. 2018; Karpf and Mandel 2018; Zerbib 2019; Fatica 2021).

The biggest identification challenge to verify the yield premium of green bonds is to select comparable bonds. Following Flammer (2021) which finds no premium, I collect green bonds sourced from Bloomberg and non-green bonds of the same issuers of green bonds. As Zerbib (2019) left a concern on a possibility, other SDGs bonds such as sustainability bonds, sustainability-linked bonds, social bonds, and transition bonds might have each yield premium, I exclude these bonds from the sample. Then, the sample in month-bond data reaches 3,646 green bonds, which account for 1.2 trillion USD, and 26,879 non-green bonds, which account for 17.9 trillion USD, in total.

The study employs the ordinary-least-square (OLS) tests with green bond dummy variables and with many control variables, namely, years to maturity, the amount issued, bond credit ratings, currency dummies, option dummies, coupon-type dummies, and use of proceeds dummies, as well as issued-month and issuer fixed-effects. I focus on the coefficient of green bond dummy in the results. The study also tests a specification with an interaction term of green bond dummy and green bond index to verify the response of yield premium according to the investment demand.

The primary result of this chapter is that the yield premium of green bonds after 2015 is positive especially issued in EUR and USD with statistical significances, while there are negative premiums in pre-2015 period but with the non-significances. Furthermore, I find a positive and significant coefficient on green bond dummy in EUR

post-2015 even with controlling of EUR green bond index, but no significant estimate on green bond dummy pre-2015. Importantly, the sign of coefficient of the index is unexpectedly minus with the statistical significance. The interpretation is that the higher the investment demand on green bonds, the higher the positive premium on the bonds in EUR post-2015 compared to non-green bonds. Another notable finding is that the positive and significant coefficient on green bonds turns to non-significance in USD post-2015 once I control the USD green bond index. The sign of coefficient on the index is positive and significance. It means that the higher investment demand on green bonds is associated with negative yields as the market disciplines the pricing.

The contribution of this chapter is that I complement the growing literature researching the yield premium of green bonds, "greenium." There is a strong argument for the premium in the literature as Baker et al. (2018), Zerbib (2019), and Fatica (2021) confirm the negative premium, while Larcker and Watts (2020) and Flammer (2021) find no premium. Further, Karpf and Mandel (2018) observes the positive premium. Although the literature has referred to potential causes of the yield premium regardless of negative, zero, or positive, none of the studies has verified them. The two important findings are that there could be a positive premium after the Paris Agreement but inflated by the investment demands in EUR, and there could be no premium in USD once I control the demand but the market may discipline the pricing, could fill the gap.

Second, this study contributes to the literature on mispricing. The literature attributes the yield differential to an intangible asset creation (Flammer 2015), better risk management and mitigation (Bauer and Hann 2014), or imperfectly captured by rating agencies (Ge and Liu 2015). However, none of the literature has discussed how the investment demand impacts the yield gaps. Therefore, the study which illustrates both effects that the demand would inflate or offset the premium complements the literature.

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