Internet Appendix

Reaching for Yield in the ABS Market: Evidence from German Bank Investments*

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Appendix

A Stylized Portfolio Model

The following example illustrates the effect of regulation on the portfolio allocation when risk weights are coarse and, hence, not proportional to expected returns. I simplify the general model in (1) in two ways. First, I assume a single-factor model in which only systematic risk is compensated and in which the risk-free rate is set to zero. The return R_i of security i is normally distributed and given by

$$R_i = \beta_i R_S + \epsilon_i \quad \text{with} \quad \mathbb{E}(\epsilon_i) = \mathbb{E}(\epsilon_i R_S) = \mathbb{E}(\epsilon_i \epsilon_j) = 0 \tag{1}$$

where R_S denotes the return of the systematic factor explaining ABS returns.[1] The expected return μ_i, variance σ_i^2, and covariance $\sigma_{i,j}$ follow as

$$\mu_i = \beta_i \mu_S \ , \quad \sigma_i^2 = \beta_i^2 \sigma_S^2 + \sigma_{\epsilon,i}^2 \ , \quad \sigma_{i,j} = \beta_i \beta_j \sigma_S^2 \ . \tag{2}$$

Second, I assume that there are only three securities $i = 1, 2, 3$ with betas $0 < \beta_1 < \beta_2 < \beta_3$. Security 3 has a high risk weight w_h whereas securities 1 and 2 have a low risk weight w_l, which satisfies $0 < w_l < w_h$. Note that the non-discriminatory treatment of securities 1 and 2 by the regulator allows the bank to increase the expected portfolio return without incurring higher capital requirements. The bank can simply invest more of the capital allocated to the w_l-bucket into security 2 and less of it into security 1.

Proposition 1 *Reaching for Yield. The bank increases investment x_2 relative to x_1 if the regulatory constraint is binding ($\kappa = w'x$).*

[1] As returns are normally distributed, the optimal solution in (2) maximizes the expected utility of an investor with utility function $U(W) = -exp\{-\gamma W\}$. Constant absolute risk aversion γ ensures that higher bank equity affects the relative mix of securities in the portfolio only through a higher κ in the regulatory constraint but not through the bank's preferences.

Proof. It suffices to check whether the derivative $\partial\left(\frac{x_2}{x_1+x_2}\right)/\partial\lambda$ is positive. This is indeed true for $\mu_S > 0$:

$$\frac{\partial\left(\frac{x_2}{x_1+x_2}\right)}{\partial\lambda} = \frac{(\beta_2-\beta_1)\sigma_{\epsilon,3}^2\mu_S w_{low}}{Denom.} \cdot \left[\left(\beta_1^2\sigma_{\epsilon,2}^2\sigma_{\epsilon,3}^2 + \beta_2^2\sigma_{\epsilon,1}^2\sigma_{\epsilon,3}^2 + \beta_3^2\sigma_{\epsilon,1}^2\sigma_{\epsilon,2}^2\right)\sigma_S^2 + \sigma_{\epsilon,1}^2\sigma_{\epsilon,2}^2\sigma_{\epsilon,3}^2\right] \tag{3}$$

where the denominator is given as

$$Denom. = \Big\{-\left(\beta_2\sigma_{\epsilon,1}^2 + \beta_1\sigma_{\epsilon,2}^2\right)\sigma_{\epsilon,3}^2 \cdot \mu_S \; + \; \lambda \cdot \Big[\left(\sigma_{\epsilon,1}^2 + \sigma_{\epsilon,2}^2\right)\sigma_{\epsilon,3}^2 \cdot w_{low} + \; w_{high}\sigma_S^2 \cdot \left(-\beta_3\left(\beta_2\sigma_{\epsilon,1}^2 + \beta_1\sigma_{\epsilon,2}^2\right) + w_{low}\left(\beta_3^2\left(\sigma_{\epsilon,1}^2 + \sigma_{\epsilon,2}^2\right) + (\beta_1 - \beta_2)^2\sigma_{\epsilon,3}^2\right)\right)\Big]\Big\}^2. \tag{4}$$

The bank reaches for yield in the low risk weight category w_{low} if the regulatory constraint is binding ($\lambda > 0$). □

A binding regulatory constraint limits the total size of the portfolio and, in particular, the position x_3 in security 3 with the highest risk weight w_h and the highest expected return. To partly compensate for the reduced portfolio return, the bank invests less of the capital allocated to the w_l-bucket into security 1 and more of it into security 2.

Although the bank can exploit the coarseness of the w_l-bucket, which treats securities 1 and 2 the same, regulation still achieves some reduction of portfolio risk. For sufficiently large w_h, the portfolio beta β_{PF} is strictly lower if the regulatory constraint is binding $\left(\frac{\partial\beta_{PF}}{\partial\lambda} < 0\right)$.[2] However, regulation can only curtail risk taking as long as securities are correctly classified into risk weight categories and risk weights are non-decreasing in systematic risk. To illustrate how the misclassification of securities can make regulation ineffective, I now assume that security 2 with the low risk weight w_l and not security 3 has the highest beta ($0 < \beta_1 < \beta_3 < \beta_2$).

[2]See Proof to Proposition 2.

Proposition 2 *Misclassification of ABS and Portfolio Risk. For $\beta_2 >> \beta_3$, the portfolio beta β_{PF} is higher if the regulatory constraint is binding and $\kappa = w'x$.*

Proof. The portfolio beta is defined as

$$\beta_{PF} = \frac{x_1\beta_1 + x_2\beta_2 + x_3\beta_3}{x_1 + x_2 + x_3} \ . \tag{5}$$

Its derivative with respect to λ is

$$\begin{aligned} \frac{\partial \beta_{PF}}{\partial \lambda} \ &= \ \underbrace{\frac{\mu_S \cdot \left[\left(\beta_1^2\sigma_{\epsilon,2}^2\sigma_{\epsilon,3}^2 + \beta_2^2\sigma_{\epsilon,1}^2\sigma_{\epsilon,3}^2 + \beta_3\sigma_{\epsilon,1}^2\sigma_{\epsilon,2}^2\right)\sigma_S^2 + \sigma_{\epsilon,1}^2\sigma_{\epsilon,2}^2\sigma_{\epsilon,3}^2\right]}{Denominator}}_{>0} \\ &\quad \underbrace{\begin{aligned} \cdot \ \ &\left[\left(\beta_3(\beta_3-\beta_2)\sigma_{\epsilon,1}^2 + \beta_3(\beta_3-\beta_1)\sigma_{\epsilon,2}^2 + (\beta_1-\beta_2)^2\sigma_{\epsilon,2}^2\right)\cdot w_{low} \right. \\ &\qquad \left. - \ \ \left(\beta_2(\beta_3-\beta_2)\sigma_{\epsilon,1}^2 + \beta_1(\beta_3-\beta_1)\sigma_{\epsilon,2}^2\right)\cdot w_{high}\right] \end{aligned}}_{\gtreqless 0} \end{aligned} \tag{6}$$

where the positive denominator is omitted for brevity. It follows that $\frac{\partial \beta_{PF}}{\partial \lambda}$ is negative whenever

$$w_{high} > \frac{\beta_3(\beta_3-\beta_2)\sigma_{\epsilon,1}^2 + \beta_3(\beta_3-\beta_1)\sigma_{\epsilon,2}^2 + (\beta_1-\beta_2)^2\sigma_{\epsilon,2}^2}{\beta_2(\beta_3-\beta_2)\sigma_{\epsilon,1}^2 + \beta_1(\beta_3-\beta_1)\sigma_{\epsilon,2}^2} \cdot w_{low} \ . \tag{7}$$

Note that the right hand side of Inequality (7) is strictly larger than w_{low} for $0 < \beta_1 < \beta_2 < \beta_3$. Hence, for sufficiently large w_{high}, the bank will choose a lower portfolio-beta if its regulatory constraint is binding.

This result changes when securities are misclassified. In Proposition 2, I assume that security 2 has the highest beta so that $0 < \beta_1 < \beta_3 < \beta_2$. Provided that the difference in systematic risk between securities 2 and 3 is sufficiently large so that

$$\beta_3 < \frac{\beta_2^2\sigma_{\epsilon,1}^2 + \beta_1^2\sigma_{\epsilon,2}^2}{\beta_2\sigma_{\epsilon,1}^2 + \beta_1\sigma_{\epsilon,2}^2} < \beta_2 \ , \tag{8}$$

then a bank with a binding regulatory constraint chooses a higher portfolio-beta than an unconstrained bank. To see this, note that (8) implies that $\beta_2(\beta_3-\beta_2)\sigma^2_{\epsilon,1}+\beta_1(\beta_3-\beta_1)\sigma^2_{\epsilon,2}$ in (6) is negative. It follow that derivative $\frac{\partial\beta_{PF}}{\partial\lambda}$ is now positive if Inequality (7) is satisfied. At the same time, (8) also implies that the right hand side of Inequality (7) is now smaller than w_{low}. As w_{high} must be larger than w_{low}, it follows that Inequality (7) is always satisfied and that $\frac{\partial\beta_{PF}}{\partial\lambda}$ is, hence, always positive provided Inequality (8) is true. If the regulatory constraint is binding and misclassification of securities 2 and 3 is as pronounced as in Inequality (8), the bank chooses a *higher* portfolio-beta.

Similarly, it can be shown that total investment in all three securities together is higher if the regulatory constraint is binding and securities are misclassified ($\beta_2 >> \beta_3$). To see this, it suffices to compute $\frac{\partial(x_1+x_2+x_3)}{\partial\lambda}$ which is positive if (8) is satisfied. To sum up, whenever (8) is satisfied and security 2 has a much higher beta than security 3, a bank with a binding regulatory constraint will build a *larger* ABS portfolio with a *higher* portfolio-beta. □

When the regulatory constraint is binding, the bank increases the portfolio share of security 2 whose beta is highest and whose risk weight is unjustifiably low. As long as security 2 exhibits sufficiently higher systematic risk than security 3 ($\beta_2 >> \beta_3$ and $w_2 < w_3$), a bank with a binding regulatory constraint will have a higher portfolio beta.

Propositions 1 and 2 are formulated for banks with *binding* regulatory constraints. Yet, the predictions are made for banks with *tight* regulatory constraints.[3] Broadening the analysis to banks with tight but unbinding constraints is necessary because, in reality, banks rarely operate with binding regulatory constraints and "want to hold a buffer of capital so that they will still meet regulatory requirements following an earnings shock (Boyson, Fahlenbrach, and Stulz, 2016)."

[3]In a dynamic model I could also analyze regulatory arbitrage by banks with tight but unbinding regulatory constraints. However, writing a dynamic model goes beyond the scope of this section.

B Identifying Risk Weight Categories

I determine the appropriate risk weight category *RWC* of a bond using Table I, Column (3), and introduce dummies for rating buckets with the same IRB-RBA base risk weights. Choosing the IRB-RBA base risk weights for all bonds and all banks has two disadvantages. First, I implicitly assume that all banks use the IRB approach and not the SA, although the data do not allow me to verify this assumption. However, as I only consider large sophisticated institutions with assets worth more than €10bn and discard local cooperative and savings banks, this assumption is likely to be satisfied for most banks in the sample. Furthermore, as risk weight categories are coarser under the SA than under the IRB-RBA, I can only *underestimate* regulatory arbitrage by banks that use the SA. To see this, consider a bank that uses the SA and chooses between *AAA* and *AA* rated ABS in the 20% risk weight category of the SA (Table I, column 1). If the bank seeks high yields, it will acquire more *AA* than *AAA* rated bonds without incurring higher capital requirements under the SA. But because I control for the IRB-RBA base risk weights, which are different for *AAA* and *AA* rated securities, I cannot identify such risk-shifting from *AAA* to *AA* rated securities. I only identify reaching for yield within the *AAA* and within the *AA* category.

The second disadvantage of applying the IRB-RBA base risk weights to all ABS is that some securities might be senior or backed by non-granular collateral pools and hence deserve risk weights from Table I, Columns (2) or (4). The data offers no clear-cut way to identify these securities. However, the large majority of senior tranches in structured debt deals carry a *AAA* rating, which I control for with a binary dummy variable. In some specifications I control for the combined face value of subordinated deal tranches that are junior to a given ABS. To the extent that larger collateral pools tend to be less granular, I proxy collateral granularity by the control variable *Log Bond Size*.[4]

[4]The additional distinction between securitization and resecuritization exposures under Basel II.5

References

Boyson, Nicole M., Rüdiger Fahlenbrach, and René M. Stulz, 2016, Why don't all banks practice regulatory arbitrage? evidence from usage of trust-preferred securities, *Review of Financial Studies* .

concerns only the 2.6% of the ABS in the sample that were issued after the compliance date for Basel II.5. I control for resecuritization with a dummy variable, which is 1 for CDOs/CLOs.