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When there are not enough Baskets to put your Eggs in: A Study of a Sample Bank Bond Portfolio on the Swedish Interbank-market

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Abstract

This thesis explores the Swedish interbank-market, with empirical material from a sample bank, by conducting a qualitative interview as well as modelling probabilities of defaults in the sample bank bond portfolio. From the interview, we seek whether there is a rationale for investing in other financial institutions while also examining the effects of investing in your own industry with the modelled probabilities of defaults. By analyzing the qualitative and quantitative data, we find that the core of the rationale is that the sample bank is limited by the undiverse supply of bonds on the Swedish interbank-market, and that the financial institutions increase the risk in the portfolio in terms of probabilities of defaults. Conclusively, if the target is to minimize the risk in the portfolio, a financial institution on the Swedish interbank-market should avoid investing in other financial institutions.

Keywords: Correlation, Financial Institutions, Interbank-market, Probabilities of Defaults.

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1. Introduction

1.1 Background

The world of finance as we know it today has been formed by the framework of modern portfolio theory where the optimization of risk and return is the focus point. This core of modern portfolio theory was outlined by Markowitz (1952) after decades of work by so many brilliant researchers alongside him. As financial economics has developed and progressed, anomalies have been identified that cannot be fully explained by the original modern portfolio theory. One such anomaly occurs on the Swedish interbank-market, where banks are investing in their own industry (CFO & Vice-CFO, Interview 3rd of May 2018).

An interbank-market is a market where financial institutions exchange currencies between and among themselves (Nasdaq, 2008). These currencies come in the form of interest-bearing securities originating from either a financial institution or a large corporation that employs a financial institution to issue on their behalf. One core function of an interbank-market, according to Furfine (2002), is that a well-functioning interbank-market allocates liquidity efficiently to provide funds for institutions in need of such. Allocating liquidity efficiently is something that can be complicated considering how the Swedish interbank-market is designed today.

The access to information on the Swedish interbank-market is highly limited since there is no single intermediary clearing house on the market. The issuer of a bond makes use of one of the larger banks on the market that will underwrite and offer this bond to the market participants that the underwriter believes are interested. Thus, all investors are not given the same offers making relationships an essential part of the trades that are made (CFO & Vice-CFO, Interview 3rd of May 2018). Access to information and data on the Swedish interbank-market and a bond portfolio is provided by a sample bank that is an active participant in this market. We use the term sample bank since the sample bank has requested to remain anonymous.

According to the CFO and Vice-CFO of the sample bank (Interview 3rd of May 2018), the Swedish interbank-market has some other characteristics than the common public securities market: Firstly, there is a limited number of buyers which are entirely made up of financial institutions. Secondly, the market is lacking continuous trading meaning that liquidity is different from a classic setting and market pricing data is scarce. Finally, only interest-bearing securities are issued on this market. This setup creates new problems for financial theory to

solve and the gist of this paper is showing that a cornerstone of Markowitz's model (1952), diversification, has novel aspects on this particular market.

A solid analysis of the characteristics of the sample bank portfolio should include both a historical average setting and a crisis-setting in its construction. Analysing risk without considering the environment which is the riskiest, a crisis, makes for a positively skewed and underestimating result. Holding an optimal portfolio ex-ante could still yield negative results ex-post and not considering a crisis would worsen the ex-ante position. That is why both an average setting and a crisis-setting is of interest in this paper.

Many financial markets have experienced some sort of crisis in the past and will probably do so in the future as well. The most recent one is the 2008 crash fronted by the fall of Lehman Brothers in USA, which sent the entire world into a recession while the financial networks shivered collectively. As Brown (2012) suggest, risk managers analyse the losses in the tails of their probability distributions extensively when managing their investments since the rare crisis events are a major source of operational risk. Indeed, the risk of having one major breakdown that could bring down even healthy companies in the same sector is a problem that investors need to address. The 2008 financial crisis is one example of how an interbank-market can experience default correlation, more firms get financial problems when one firm triggers the process.

As argued by Wagner (2010), in a market with a limited amount of securities to choose from diversification might imply higher market-wide systemic risk. Indeed, it is intuitive to imagine that a spider's web would be less susceptible to collateral damage if all individual strands could move freely during heavy wind. This analogy holds on the Swedish interbank-market as there are relatively few assets to select from (CFO & Vice-CFO, Interview 3rd of May 2018). Moreover, many assets on an interbank-market are experiencing high degrees of correlation with each other (Tasca, Battiston & Deghi, 2017). Here we introduce the correlation-adjusted probabilities of defaults to examine the effects of investing in your own industry.

The probabilities of defaults provide a measure of risk that has been adapted to situations where correlation is a significant factor by Schönbucher (2000). He developed his factor models where asset value correlation is the primary driver of joint defaults which creates fat tails in the calculated probability distribution. These models have been developed by other researchers in different ways, but the expanded models are analytically complicated and take more variables

into consideration then necessary for this paper. Therefore, we provide a way of using one of Schönbucher's (2000) models in the context of the Swedish interbank-market.

Previous research, such as Luchetta (2015) and Tasca et al (2017), has discussed the problem with a concentrated interbank-market, meaning that the participants are few and interconnected. Luchetta (2015) shows that breakdowns in the market are more likely when the concentration increases and Tasca et al. (2017) discuss the risks of a highly concentrated interbank-market in a similar fashion. The relationship with our paper is the discussion of the many risks of a concentrated interbank-market. The findings of this thesis can be of importance for financial institutions in the Swedish interbank-market since we study the relationship between investments in a concentrated market and the risk this implies. Previous research has focused primarily on the interbank-market in USA but few have studied the Swedish interbank-market.

1.2 Purpose and Research Questions

The purpose of this paper is to make as general conclusions as possible regarding the effects of the concentration of the Swedish interbank-market. We draw our deductions from our results using the empirical material from the sample bank. To make this possible, this paper seeks a rationale for why the sample bank invests in other financial institutions bonds. The rationale will make a novel contribution in the area of interbank market research that could be used to understand why banks invest their excess liquidity in this manner.

Furthermore, we seek how the level of default risk in the portfolio is affected by the current investments in other financial institutions. This area of our research is of importance for risk management when analysing which bonds to invest in. Hence, we define the research questions for this thesis as follows:

1. *Is there a rational reason for why a bank invests in other financial institutions' bonds?*
2. *What does this imply for a portfolio in terms of default risk in an average setting and in a crisis-setting?*

If we find that investing in other financial institutions increases the probabilities of defaults and/or the rationale is weak, this would imply that risk managers need to address these investments and possibly exclude them from the portfolio. The opposite result of that requires a discussion in order to establish why this is the case.

1.3 Key Concepts and Structure of the Paper

We introduce some key concepts which are defined here:

- *Financial Institutions:* A firm in the financial industry exchanging capital with both consumers and other firms as its primary source of business
- *Individual probability of default:* The probability that any of the obligors' default on their bond with correlation not considered.
- *Probabilities of defaults:* The probabilities of having different numbers of defaults in the sample bank portfolio with correlation considered.
- *Benchmark ICR-correlation:* The Interest Coverage Ratio-correlation calculated from the complete sample bank portfolio.
- *Adjusted ICR-correlation:* The Interest Coverage Ratio-correlation calculated from the sample bank portfolio with financial institutions excluded.

The rest of this paper is structured as follows: Chapter 2 covers the theoretical framework, chapter 3 presents our quantitative data, chapter 4 describes our methodology, chapter 5 outlays our results, chapter 6 analyzes and discusses the results, chapter 7 aims at drawing conclusions from chapters 5 and 6 and provide suggestions for future research, chapter 8 is for references and, finally, our empirical material as an appendix.

2. Theoretical Framework

This chapter presents a brief introduction of central concepts for this paper and a section about empirical evidence of our research topic.

2.1 Discrete Probability Distribution

In order to establish the likeliness of having defaults in the sample bank portfolio and discuss the risk in the portfolio, there is a need for a probability distribution for the possible defaults. We employ a discrete probability distribution, i.e. a distribution that assigns probabilities for only specific outcomes in an interval, such as X = 1,2,3, and these outcomes should be countable (Oxfordmathcenter, 2018).

The related function that produces these values is called the probability density function. One of the more common types of discrete probability distributions is the binomial distribution, which gives the probability of observing X successes in n Bernoulli (binary) trials. (Oxfordmathcenter, 2018).

2.2 Pearson's Linear Correlation Coefficient

There is a need for a measure of the strength of the relationship between the obligors in the portfolio and between the sample bank and the obligors. In order to do so, we employ Pearson's linear correlation coefficient which measures the linear strength and direction of two variables. The values range from –1 up to +1 where –1 is a perfect negative linear relationship and +1 a perfect positive relationship. There are three key assumptions for this type of correlation coefficient which are (Statistics solutions, 2018):

- Independent observations of the two samples.
- A linear relationship exists between the two variables.
- Homoscedastic residuals.

2.3 Empirical Evidence

The connection between an interbank-market and systemic risk is a vividly researched area, which will be discussed in this section. Both old and new research explore what the characteristics of an interbank-market with few actors and assets imply in terms of diversification and systemic risk. Diversification in this setting is not as straightforward as it is on a regular capital market which previous researchers, such as Luchetta (2015) and Tasca et al. (2017), have found to induce high systemic risk.

An interbank-market has few participants by definition, as there are such specific criteria for entry, which leads to a concentrated system. This concentration is problematic as a bank can be perfectly diversified theoretically but still find themselves highly correlated with the system as Luchetta (2015) concludes. Moreover, Tasca et al. (2017) argue that full diversification on an interbank-market implies that all banks are exposed to the same shocks, making the probability of having systemic default conditional on an individual default tend to one.

Ibragimov, Jaffee and Walden (2011) developed a model for finding the *diversification threshold,* the threshold where diversification begins to have negative effects on society, that depends on five properties of the economy. Two of them are the number of asset classes and the correlation of the risks within an asset class. Ibragimov et al. (2011) find that when the risks are thin-tailed, risk-sharing is always optimal for society but when the risks are moderately heavy-tailed, risk-sharing is suboptimal for society but might still be beneficial for the individual intermediaries.

When the sample bank invests in other financial institutions bonds, they are doing what previous researchers, such as Luchetta (2015), Tasca et al. (2017) and Ibragimov et al. (2011), argue would be negative in terms of risk of multiple defaults. The question arising from this is: Is it defendable to hold these assets because of better diversification or is it purely negative if it produces higher probabilities of defaults? Our second research question seeks to answer this by gauging the probabilities of defaults of the bonds in the sample bank portfolio.

One alternative if the bank is unable to diversify appropriately is to simply refrain from investing in the interbank-market. As Furfine (2002) argues, in a crisis setting this could happen if the different market participants get uncertain regarding the counterparties creditworthiness. Having liquidity taken away from an already relatively illiquid market leads to market failure if many participants do so, making the interdependence of interbank-market actors problematic. How do you create a well-diversified portfolio if the market requires a certain degree of investments to not break down but is small and correlated?

3. Quantitative Data

In this chapter, we present our data gathered from the sample bank bond portfolio. How the collected data is used to obtain the probabilities of defaults is introduced in chapter 4, *Methodology*.

3.1 Delimitations

We use two delimitations regarding the data used in this paper.

Firstly, and as already mentioned, the data in this chapter comes from the sample bank bond portfolio only. We are required to limit the amount of data because of the complexity to get access to other bank´s portfolios. Secondly, the sample banks bond portfolio consists of two parts: Regulated liquidity and excess liquidity. The regulated liquidity must be invested in

bonds that meet certain criteria that regulators decide on regarding liquidity, credit rating and such (Bank for International Settlements, 2013). Thus, the second limitation is that we focus solely on the excess liquidity, to make the analysis about the banks own investments and not of those demanded by a regulator.

3.2 Interest Coverage Ratios and Correlation Matrix

The sample bank's portfolio consists of 47 different bonds. However, some of the bonds have the same counterpart as the issuer. Since these bonds have the same credit rating, they are agglomerated. Also, one of the bonds is excluded because of a limited amount of data. With the modifications, the portfolio is made up of 37 bonds from different obligors.

The interest coverage ratio is defined as:

$$ICR = \frac{EBIT + finanical\ incomes}{Financial\ expenses}$$

where EBIT is the earnings before interest and taxes. The data to calculate the ICRs is collected for the 37 bonds from Retriever Business and annual reports over a period of 19 years, 1999-2017, when possible and for all years a firm has existed if they have existed for shorter than 19 years. In cases when firms have unrealized changes in property values, common for real estate firms, these are excluded to improve comparability.

We set up a correlation matrix from the portfolio of bonds that the sample bank holds to investigate the degree of cross-correlation in the portfolio. The correlation matrix is constructed with the ICRs as the data inputs for calculating Pearson's linear correlation coefficients. The entire ICR-correlation matrix is found in table XII in part A of the appendix.

In table I, we present descriptive statistics for the ICR-correlation estimates. One can see how the ICR-correlations are noticeably positively skewed. Table I showcase chosen percentiles from table XII of all the ICR-correlation coefficients.

Table I

Descriptive Statistics of the ICR-Correlation Estimates

This table presents the descriptive statistics of the ICR-correlation estimates between the obligors in the portfolio. There are $(37 \times 36)/2 = 666$ ICR-correlation estimates among the 37 firms. Corr. stands for the ICR-correlation estimate expressed as a percentage. The level in the table is represented by the quantile expressed in percentiles. The median ICR-correlation estimate is 41,41% while the mean is 39.28%.

Level	1%	5%	10%	25%	50%	75%	90%	95%	99%
Corr. (%)	-47,46	-22,59	-10,31	11,99	41,41	68,44	86,37	94,28	98,76

3.3 Distribution of Bond Ratings and Bond Rating Default Rates

The bonds in the sample banks portfolio are rated by either Standard and Poor's, Moody's or has a shadow rating. We collect the historical default data from only Standard and Poor's since Moody's historical default data is not available publicly. We use the sample banks conversion table, which can be found in part C of the appendix, to translate the ratings from Moody's and the shadow ratings. The absolute majority of the bonds are rated by the rating agencies but a few have a shadow rating instead. The shadow rating is calculated very similarly to the official rating, the main difference is that the rating is not available publicly, and thus does not incur any changes to the individual probability of default (CFO & Vice-CFO, Interview 3rd of May 2018).

In table II, we present the distribution of the ratings in the sample bank portfolio. The sample bank holds bonds of only investment grade.

Table II

Distribution of Bond Ratings in Sample Bank Portfolio

This table presents the distribution of the bond ratings in the sample bank portfolio. The ratings follow Standard and Poor's rating scale, with some bonds having ratings translated into Standard and Poor's system from Moody's, from AAA to C where AAA is the highest rating and C is the lowest. The whole distribution can be found in table XIII in part A of the appendix.

	AA	A	BBB	BB
Number of bonds	6	12	17	2
Percentage	16,22%	32,43%	45,95%	5,41%

In Table III, we present the default rates of the four relevant bond ratings over the period 1999-2016 collected from the Standard and Poor's 2016 annual global corporate default study (2017). The 2017 annual global corporate default study is unavailable yet as of May 31st, 2018. One can see a sharp increase in the default rates during the crisis of 2008.

Table III

Bond Rating Default Rates

This table presents the default rate in percent each year for a certain rating. The data is from Standard and Poor's (2017).

Year	AA	A	BBB	BB
2016	0,00	0,00	0,00	0,47
2015	0,00	0,00	0,00	0,16
2014	0,00	0,00	0,00	0,00
2013	0,00	0,00	0,00	0,10
2012	0,00	0,00	0,00	0,30
2011	0,00	0,00	0,07	0,00
2010	0,00	0,00	0,00	0,58
2009	0,00	0,22	0,55	0,75
2008	0,38	0,39	0,49	0,81
2007	0,00	0,00	0,00	0,20
2006	0,00	0,00	0,00	0,30
2005	0,00	0,00	0,07	0,31
2004	0,00	0,08	0,00	0,44
2003	0,00	0,00	0,23	0,58
2002	0,00	0,00	1,01	2,89
2001	0,00	0,27	0,34	2,96
2000	0,00	0,27	0,37	1,16
1999	0,17	0,18	0,2	0,21
Average	0,03	0,08	0,19	0,67

4. Methodology

The methodology employed in this paper is a symbiosis between a quantitative data analysis and a qualitative interview. The interview is employed in finding if there is a rationale for the sample bank to invest like they do. The data analysis is used to find the correlation-adjusted probabilities of defaults in order to determine how the risk in the portfolio is affected by the choice to invest in financial institutions. We also introduce our robustness tests where we explore the viability of our quantitative model.

4.1 Interview

The interview is conducted with the primary aim of finding out if there is a rationale for the sample bank to invest in other financial institutions.

The interview is constructed in accordance with Brinkmann (2013, p. 49) where the questions asked are of a "how" type and not "how much". The reason for doing this is that we want to avoid leading questions that will end up in a simple, over-specific answer. The research question that is relevant here is also designed with Brinkmann (2013, p. 49) in mind, where he outlays that a research question with a specific causal effect in mind will require a more quantitative approach with large amounts of participants.

The analysis of the interview follows the *abduction* kind of reasoning. One can explain it as we observe X, X is an anomaly and cannot be explained by normal understanding, we seek to find Y that makes X reasonable and then we claim that Y is the plausible explanation for X (Brinkmann, 2013, p. 55). In our case, X is investing in financial institutions and Y is what the interview is supposed to find.

Since the sample bank requested to remain anonymous, the representatives are anonymized in the entire interview process. The interview is conducted in Swedish and translated into English. The sentences are directly translated if possible and adjusted only when a direct translation makes the purpose of the sentence incomprehensible. Both the interview script and related transcript can be found in part B of the Appendix.

4.2 Schönbucher Factor Model

The Schönbucher factor model is employed in finding the probabilities of defaults that gauge the risk of the sample bank bond portfolio. Schönbucher's (2000) factor models have been used as a base for expansion by other researchers, such as Boudreault, Gauthier and Thomassin (2014) and Düllmann and Trapp (2004).

The need for a theoretical model to estimate default correlations has several reasons. According to Schönbucher (2000), joint defaults are very rare and direct data on this is not available. Furthermore, if the assets are strongly correlated it is also likely that the defaults of the obligors are correlated (Schönbucher, 2000). As presented before, Damodaran (2012, p. 407) conclude that default spreads and ICRs are strongly correlated. Thereby, we argue that the correlation between ICRs is a better estimator of default correlation than asset correlation and is thus used in this paper.

The starting point is the *N* obligors in the portfolio. Every obligor has an asset value that is used as the main determinant of when an obligor is in default. When the asset value goes below a specific level, the obligor is in default. This level is called the barrier level and is originally a specific value in Schönbucher's (2000) simplified firm's value model. When there are historical data on obligors' individual probabilities of defaults available, Schönbucher (2000) presents an adaptation of the barrier level that can replicate any given individual probability of default. This barrier level that is replicating the individual probability of default in the context of the model is defined as *K* and is written as:

$$K_n = \Phi^{-1}(p_n)$$

Equation I (Schönbucher, 2000)

p_n is the individual probability of default.

Schönbucher (2000) assume a dynamic to model the asset-value which is expressed as:

$$V_n = \sqrt{\varrho}Y + \sqrt{1-\varrho}\varepsilon_n$$

Equation II (Schönbucher, 2000)

V_n is the value of the assets. Y is the standard normally distributed factor and ε_n is the idiosyncratic standard normally distributed noise component that both drives the asset value. By using this dynamic, two obligors are correlated with the linear correlation coefficient ϱ (Schönbucher, 2000).

This dynamic is adapted to our setting where we use Schönbucher's (2000) adaptation to uncertain volatility. The variance of the obligors' asset values is unknown and this adaptation will ensure realistic default probabilities. The adaptation can be viewed as it introduces stochastic volatility in the asset values (Schönbucher, 2000). The adapted formula is written as:

$$V_n = \frac{1}{t}(\sqrt{\varrho}Y + \sqrt{1-\varrho}\varepsilon_n)$$

Equation III (Schönbucher, 2000)

V_n is the value of the assets, t is the Student's t-distribution that is χ^2-distributed with $N-1$ degrees of freedom and is independent of Y and ε_n.

Also, we adapt the barrier level K to follow the t-distribution as well:

$$K_n = t^{-1}(p_n)$$

Equation IV (Schönbucher, 2000)

Next, we introduce how Schönbucher (2000) derive the distribution of the defaults in which we assume that all obligors have the same barrier level $K_n = K$. We calculate the barrier level K with the individual probability of default, which in turn is calculated in the later section 4.4, *Individual Probability of Default.*

"By the law of iterated expectations, the probability of having exactly *n* defaults is the average of the conditional probabilities of *n* defaults, averaged over the possible realisations of *Y* and weighted with the probability density function $\phi(y)dy$" (Schönbucher, 2000). This translates to:

$$P[X = n] = \int_{-\infty}^{\infty} P[X = n|Y = y]\phi(y)dy$$

Equation V (Schönbucher, 2000)

If X = n is conditional on Y = y, the probability of *n* defaults is:

$$P[X = n|Y = y] = \binom{N}{n}\big(p(y)\big)^n\big(1-p(y)\big)^{N-n}$$

Equation VI (Schönbucher, 2000)

The conditional default probability *p(y)* is the probability that the firm is in default, i.e. asset value below the barrier level *K*, given that the systematic factor *Y* takes the value *y:*

$$p(y) = \mathbf{P}\left[\sqrt{\varrho}y + \sqrt{1-\varrho}\varepsilon_n < K | Y = y\right]$$

$$= \mathbf{P}\left[\varepsilon_n < \frac{K-\sqrt{\varrho}Y}{\sqrt{1-\varrho}} \middle| Y = y\right]$$

$$= \Phi\left(\frac{K-\sqrt{\varrho}y}{\sqrt{1-\varrho}}\right)$$

Equation VII (Schönbucher, 2000)

We get the following expression after using the chosen t-distribution instead of the standard normal distribution (Schönbucher, 2000):

$$p(y) = \mathrm{t}\left(\frac{K-\sqrt{\varrho}y}{\sqrt{1-\varrho}}\right)$$

Equation VIII (Schönbucher, 2000)

Finally, with the build-up of the model explained, we can substitute equation VIII into equation VI and define our main model from equation V for correlation-adjusted probabilities of defaults with uncertain volatility as presented by Schönbucher (2000):

$$P[X = n] = \int_{-\infty}^{\infty} \binom{N}{n} \left(t\left(\frac{K-\sqrt{\varrho}y}{\sqrt{1-\varrho}}\right)\right)^n \left(1 - t\left(\frac{K-\sqrt{\varrho}y}{\sqrt{1-\varrho}}\right)\right)^{N-n} t(y)dy$$

Equation IX (Schönbucher, 2000)

N is the total number of obligors in the portfolio, *K* is the barrier level, ϱ is the linear correlation coefficient and *t* is the Student's t-distribution that is χ^2-distributed with $N-1$ degrees of freedom

To summarize, we present the build-up of the main model from Schönbucher (2000). Equation IX generates a discrete probability distribution with probabilities of zero up to N defaults in the portfolio. Two inputs, ϱ and K, are estimated from data presented in chapter 3, *Quantitative data*, and the method for doing so is introduced in the following two sections.

4.3 Linear Correlation Coefficient

To use the ICR-correlation matrix presented in section 3.2, *Interest Coverage Ratio and Correlation Matrix,* in the context of our main model, equation IX, we calculate the asset-weighted average portfolio ICR-correlation. This value is the estimation of the linear correlation coefficient ϱ in Equation IX.

There are three ways to calculate the average correlation between all the assets in a portfolio as originally presented by Tierens and Anadou (2004). Among these three alternative methods, the one used in this paper, which is also used by Blom and Warglau (2016) and S&P Dow Jones (2015), is considered the most accurate by Tierens and Anadou (2004). The formula is written as:

$$\rho_{av(1)} = \frac{2\sum_{i=1}^{N}\sum_{j>i}^{N} w_i w_j \rho_{i,j}}{1 - \sum_{i=1}^{N} w_i^2}$$

Equation X (Tierens & Anadou, 2004)

Where $\rho_{i,j}$ is the correlation between asset i and j. This produces $N(N-1)/2$ correlation coefficients, excluding diagonal elements, and N portfolio weights, i.e. a total of $N(N+1)/2$ inputs.

When the ICR-correlation estimates are processed in Tierens and Anadu's (2004) formula to estimate the linear correlation coefficient ϱ in the sample bank bond portfolio, the result is 30,34 %. In later sections, we use the term ICR-correlation instead of the linear correlation coefficient.

4.4 Individual Probability of Default

As defined in chapter 1, *Introduction,* the individual probability of default is simply how likely the single issuer is to default on their bond. The bond default rates presented in section 3.3, *Distributions of Bond Ratings and Bond Rating Default Rates,* are processed to obtain the individual probability of default. This value is used in calculating the barrier level *K* in equation IX.

The value of the individual probability of default is calculated with a weighted average using table XIII in part A of the appendix. The individual probability of default for the holdings in the sample bank bond portfolio is 0.121% for the whole period and 0.435% for 2008.

4.5 Robustness Tests

To verify that our model is viable and produces reliable results, we conduct two robustness tests. The first test determines if the ICR-correlation is a significant driver of the probabilities of defaults compared to the number of obligors as a driver. The second test finds out if removing any five random bonds from the portfolio yields a different ICR-correlation than removing the five financial institutions specifically. Moreover, the adjusted ICR-correlation is tested if it is statistically significantly different from the randomized ICR-correlation.

Both tests are conducted in the crisis-setting since the probabilities of defaults are higher there, making the test more sensitive to changes.

5. Results

This chapter presents relevant sections from the interview and the probabilities of defaults calculated with equation IX as described in chapter 4, *Methodology*.

Section 5.1 presents the relevant sections of the transcribed interview to find if there is a rationale for investing as the sample bank do. Section 5.2 highlights how ICR-correlation affects the probabilities of defaults by comparing each case against zero ICR-correlation while we establish the benchmarks that are used in section 5.3. Section 5.3 compares the portfolio without financial institutions to the relevant benchmarks established in section 5.2 to find what this implies in terms of risk in both the present and the crisis-setting. Section 5.4 presents the two robustness tests regarding the results in section 5.3 to build credibility in our quantitative results.

5.1 Interview

The aim of this section is to present relevant pieces of the transcribed interview and formulate the sample banks rationale for investing in financial institutions, if there exists such a rationale, in a concrete manner. The interview was conducted on the 3rd of May 2018 and the related transcription is found in part B of the appendix. All of the following quotes in this section are from the interview and thus all of them are jointly referred to the transcript, to avoid excessive referencing below.

The first piece of the puzzle comes from the quote "I would say that the Swedish interbank-market is very relationship intensive […]". A classic capital market is not relationship intensive since there are plenty of participants, meaning that this difference could help explain the sample banks behaviour.

Furthermore, the CFO said: "We try to avoid our own industry in the bond portfolio […]". Here, we find an indication that the sample bank does not actively seek to invest in their own industry. The vice-CFO comes back to this by saying later in the interview "If we have a choice between a financial institution or something else, we would always choose something else […]". So, the sample bank is trying to avoid financial institutions according to themselves.

The CFO explains the reason for doing this anyway in a longer discussion "We are well aware of the risks but the Swedish interbank-market is heavily underdeveloped when compared internationally. What is offered on the market is very often related to banking or financial institutions or real estate, which is also very related to banking […] On the other hand, you have to be real in terms of what is available on the market. Generally, banks are, since they are regulated, relatively low risk comparably […] The supply is the main reason and what we try to do is to find manufacturing and such with a good rating." The CFO claims that the primary reason is supply which is reinforced when the vice-CFO concurs when later saying "The supply is the major driver for having to invest in other financial institutions".

In terms of return, there are some parts of the interview that points to the return being better in bonds from financial institutions compared to other issuers: "Well, in terms of senior secured bonds they probably yield a less bad return than much else. Nothing yields well today. They are probably less bad after all. I do not think that these bonds lower returns in the portfolio. We do not have a return target in our portfolio but rather we try to secure liquidity […]". Moreover, the CFO presents that "When you try to enter this interbank-market you have to pay a bit higher dividend, the first issue is always the most expensive […] Buying something in for example Varberg's savings bank will give you a good return given the risk you take. That extra return makes those bonds attractive."

Another secondary reason as to why they invest like they do is that they could have an information advantage. "Yes, you have contact with a lot of those banks for other reasons such as pure business. And that makes you get a feeling for how that bank is doing. Some type of feeling that is more developed than for Getinge for example. That is an advantage but one should be aware of that buying other savings banks bonds is even more close to our own

business than buying for example SEB […]". Furthermore, "[…] You mitigate that risk to some degree by having a bit better information on what is happening in a savings bank than other investors do. Not that you know pure facts but having similar businesses makes for easier deductions."

Finally, the sample bank is trying to minimize risk rather than maximize returns. The quotes " […] We try to have a low risk since we take credit risk from other sources" and also "JM: So, the credit risk should not come from the portfolio but from the business model. Do you minimize risk more than you maximize returns? CFO: Without a doubt, yes" both show that the target is risk minimization rather than return maximization.

Conclusively, the sample bank rationale is divided into two parts: The main reason for buying other financial institutions bonds is the undiverse supply of bonds on the Swedish interbank-market and the secondary reason is that they have a better feeling for those holdings in terms of information.

Further, the interview indicates that:

- The Swedish interbank-market market is relationship intensive, meaning that close relationships improve the bond-buying process.
- The risk of these bonds is relatively high for the sample bank but relatively low when viewed impartially. The risk is mitigated to some degree by regulation and relations.
- The return is often higher since some of the issuing financial institutions are paying a premium for being new to the market.
- The sample bank is minimizing risk and not maximizing return.

5.2 Sample Bank Portfolio Benchmarks

The results in this section are computed with the Schönbucher (2000) factor model described in section 4.2, *Schönbucher Factor Model*. Firstly, we show how the ICR-correlation among the firms affects the probabilities of defaults in the portfolio. Secondly, we present the results on this effect during a crisis modelled from 2008. Employing equation IX, the output of the Schönbucher (2000) factor model is presented in a table-format in the following sections.

For ease of interpreting the results, we present only the cumulative probabilities of defaults since these describe the probabilities of defaults comprehensively enough. Tables with probabilities of defaults for specific numbers of obligors can be found in part D of the appendix.

The benchmark ICR-correlation in the portfolio is 30,34%, as described in section 4.3, *Linear Correlation Coefficient.* Zero ICR-correlation is simply 0%. Also, the individual probability of default in the average scenario is 0.121% and in the crisis-setting, it is 0.434%. The number of obligors is 37 and the degrees of freedom is 36.

5.2.1 Benchmark vs Zero ICR-correlation with Average Individual Probability of Default

We compare the probabilities of defaults in a scenario with the benchmark ICR-correlation and a scenario with zero ICR-correlation in accordance with the calculations from Schönbucher (2000). We do this comparison to highlight how ICR-correlation specifically affects the two different settings.

The probability of having more defaults, i.e. the tail of the distribution, increase with correlation as can be observed in table IV. The probability of having any default is larger in the zero ICR-correlation case, coming from the significantly higher probability of exactly one default. One can see it as that the ICR-correlation "steals" probability from having exactly one default and pushes it into the tail which makes it fatter, as Schönbucher (2000) suggests.

Table IV

Cumulative Probabilities of Defaults with Average Individual Probability of Default

This table presents the cumulative probabilities of defaults in the sample bank portfolio between a scenario with the benchmark ICR-correlation of 30,34% and with zero ICR-correlation. The values are presented as the cumulative probability of having n or more defaults.

Number of Defaults	Probability (Benchmark ICR-correlation)	Probability (Zero ICR-correlation)	Difference
≥ 1	3,15%	4,38%	-1,23%
≥ 2	0,419%	0,0935%	0,3255%
≥ 3	0,1128%	0,0000%	0,1128%
≥ 4	0,042%	0,0000%	0,042%
≥ 5	0,0182%	0,0000%	0,0182%

5.2.2 Benchmark vs Zero ICR-correlation with 2008 Individual Probability of Default

In the more extreme case of a financial crisis, modelled from 2008, the probability of having any default has increased substantially and pushed the cumulative probabilities higher across the board as shown in Table V.

Table V

Cumulative Probabilities of Defaults with 2008 Individual Probability of Default

This table presents the cumulative probabilities of defaults in the sample bank portfolio between a scenario with the benchmark ICR-correlation of 30,34% and with zero ICR-correlation. The values are presented as the cumulative probability of having n or more defaults.

Number of Defaults	Probability (Benchmark ICR-correlation)	Probability (Zero ICR-correlation)	Difference
≥ 1	10,36%	14,86%	-4,5%
≥ 2	2,507%	1,13%	1,377%
≥ 3	0,92%	0,0548%	0,8652%
≥ 4	0,4197%	0,0000%	0,4197%
≥ 5	0,2173%	0,0000%	0,2173%
≥ 6	0,1217%	0,0000%	0,1217%
≥ 7	0,0716%	0,0000%	0,0716%

To summarize this section, we can establish that ICR-correlation has an observable effect on the probabilities of defaults. This is most prominently observed in the tails of the distribution. We will use these results to benchmark against the portfolio with financial institutions excluded and evaluate how the probabilities of defaults change.

5.3 Sample Bank Portfolio without Bonds from Financial Institutions

In this section, we present the results derived with the sample bank portfolio without financial institutions in order to find out if such an exclusion change the probabilities of defaults in the two settings. These holdings make up 14% of the entire portfolio today, the number of obligors is now 32 and the degrees of freedom is 31.

We follow the same template here as in section 5.2, we present only the cumulative probabilities of defaults. Again, tables with probabilities of defaults for specific numbers of obligors can be found in part D in the appendix.

With the financial institutions excluded from the sample bank portfolio, the adjusted ICR-correlation is 25,56%. Moreover, the individual probability of default in the average scenario is 0,127% and in the 2008-crisis setting, it is 0,439%.

5.3.1 Portfolio with Financial Institutions Excluded vs Complete Portfolio with Average Individual Probability of Default

The probability of having any default at all in the portfolio is lower with the lower ICR-correlation. The cumulative probabilities of defaults are presented in Table VI below.

Table VI

Comparison Between Cumulative Probabilities of Default with Average Individual Probability of Default

This table presents a comparison between the cumulative probabilities of defaults for the sample bank portfolio with and without financial institutions. The values are presented as the cumulative probability of n or more defaults with the adjusted ICR-correlation of 25,56% and the benchmark ICR-correlation of 30,34%.

Number of defaults	Probability (Adjusted ICR-correlation)	Probability (Benchmark ICR-correlation)	Difference
≥ 1	3,05%	3,15%	-0,1%
≥ 2	0,299%	0,419%	-0,12%
≥ 3	0,0649%	0,1128%	-0,0479%
≥ 4	0,0227%	0,042%	-0,0193%

5.3.2 Portfolio with Financial Institutions Excluded vs Complete Portfolio with 2008 Individual Probability of Default

We find the same effect as in the previous section when using the 2008 individual probability of default. Again, the risk is lower for the portfolio with financial institutions excluded in terms of having any default in the portfolio. The cumulative probabilities of defaults are presented in Table VII below.

Table VII

Comparison Between Cumulative Probabilities of Default with 2008 Individual Probability of Default

This table presents a comparison between the cumulative probabilities of defaults for the sample bank portfolio with and without financial institutions. The values are presented as the cumulative probability of n or more defaults for the adjusted ICR-correlation of 25,56% and the benchmark ICR-correlation of 30,34%.

Number of Defaults	Probability (Adjusted ICR-correlation)	Probability (Benchmark ICR-correlation)	Difference
≥ 1	9,97%	10,36%	-0,39%
≥ 2	1,94%	2,507%	-0,567%
≥ 3	0,583%	0,92%	-0,337%
≥ 4	0,2278%	0,4197%	-0,1919%
≥ 5	0,1053%	0,2173%	-0,112%
≥ 6	0,0548%	0,1217%	-0,0669%
≥ 7	0,0312%	0,0716%	-0,0404%

5.4 Robustness Tests

We conduct two robustness tests to verify if there are other factors that affect the results rather than the specific exclusion of the five financial institutions.

First, we test if the ICR-correlation is a significant driver of the lower probabilities of defaults when financial institutions are excluded from the portfolio. We do this by keeping the number of obligors' constant and compare the probabilities of defaults with the adjusted ICR-correlation and the benchmark ICR-correlation. This leads us to a scenario where the number of obligors does not affect the results but only the ICR-correlation. The result is presented in Table VIII below:

Table VIII

Comparison between Adjusted ICR-correlation and Benchmark ICR-correlation with N=37

This table presents the probabilities of defaults for the bonds in the sample banks portfolio with the adjusted ICR-correlation of 25,56% and the benchmark ICR-correlation of 30,34%. In both scenarios, the number of obligors in the portfolio is 37. The calculations use the 2008 individual probability of default.

Number of Defaults	Probability (Adjusted ICR-correlation)	Probability (Benchmark ICR-correlation)	Difference
≥ 1	11,24%	10,36%	0,88%
≥ 2	2,433%	2,507%	-0,074%
≥ 3	0,785%	0,920%	-0,135%
≥ 4	0,3207%	0,4197%	-0,099%
≥ 5	0,1523%	0,2173%	-0,065%
≥ 6	0,0803%	0,1217%	-0,0414%
≥ 7	0,0458%	0,0716%	-0,0258%

The probabilities fall in the tail of the distribution when we only change the ICR-correlation while keeping the number of obligor's constant. This validates that the fall in probabilities of defaults in section 5.3, *Sample Bank Portfolio without Bonds from Financial Institutions,* does not only come from a lower number of obligors. However, a fewer number of obligors will, of course, have an impact on the probability of any number of defaults in the portfolio as well. This test only verifies that ICR-correlation alone can affect the tail of the distribution in a noticeable way.

We perform a second robustness test to find out if removing the five financial institutions specifically is what drives the ICR-correlation down enough to affect the probabilities of defaults or if we get the same results by randomly excluding five holdings.

We conduct the second test by setting up the following null hypothesis and the corresponding alternative hypothesis:

$$H_0: \text{Average random ICR-correlation} \leq \text{Adjusted ICR-correlation}$$

$$H_A: \text{Average random ICR-correlation} > \text{Adjusted ICR-correlation}$$

The test is conducted as: Five random firms are excluded from the portfolio to calculate the new ICR-correlation and this process is repeated 30 times. From the 30 randomized portfolios, the average ICR-correlation is 30,27%. A t-test is conducted to test the null hypothesis. We conduct the t-test in accordance with the assumptions of SPSS Tutorials (2018) to ensure the test is unbiased.

Table IX presents descriptive statistics of the ICR-correlations from the randomized portfolios. Notable is that the adjusted ICR-correlation is lower than the minimum value of the 30 randomized ICR-correlations. We use the data in Table IX to conduct the t-test presented in table X.

Table IX

Descriptive Statistics of the ICR-correlations from the Randomized Portfolios

This table presents the mean, minimum value, maximum value and standard deviation of the ICR-correlations generated by the 30 random exclusions of five obligors from the sample bank portfolio.

	Mean	**Minimum**	**Maximum**	**Standard Deviation**
Values	30,27%	25,82%	36,31%	0,028%

We find evidence of that the ICR-correlation from the randomized portfolio differs on a 99,9% confidence level with the ICR-correlation from the portfolio with financial institutions excluded. This implies that the values generated by excluding the five financial institutions do not occur by chance. This is shown in table X.

Table X

Comparison between the ICR-correlations from the Portfolio with Financial Institutions Excluded and the Randomized Portfolio

This table presents the ICR-correlations for the portfolio with financial institutions excluded and the randomized portfolio. The P-value for the ICR-correlation come from a one-sided t-test.

	Financial institutions excluded	**Randomized**	**P-value**
ICR-correlation	25,56%	30,27%	<0,00001

We reject H_0 and conclude that the adjusted ICR-correlation is statistically significantly lower than the average randomized ICR-correlation. The second robustness test shows that the significantly lower ICR-correlation in the portfolio with financial institutions excluded does not happen by chance.

We can conclude from this section that the results regarding the probabilities of defaults when excluding financial institutions are trustworthy. The effect of removing financial institutions from the sample bank portfolio is not only due to fewer obligors or has happened by chance.

6. Analysis and Discussion

This chapter analyses and discusses the results presented in chapter 5, *Results.* The purpose of this chapter is to connect the two research questions, the rationale for investing in financial institutions and what this implies in terms of risk in the average and the crisis-setting, and analyse these in the light of previous research.

The rationale that the sample bank provides for investing like they do, is primarily built on the shortcomings of the Swedish interbank-market (CFO & Vice-CFO, Interview May 3rd of May 2018). According to the CFO and vice-CFO of the sample bank (CFO & Vice-CFO, Interview 3rd of May 2018), scarce supply and a low level of diversification in the supply makes for a difficult portfolio selection. With the target of minimizing risk, relationships and information asymmetry decreasing activities are very important if the sample bank is to hold other financial institutions. The case of little supply and an un-diverse range of bonds to pick from suggests that the problems that Luchetta (2015) and Tasca et al. (2017) discuss are present on this market as well.

Since there is no way of confirming the statements that the representatives do against other market participants, we cannot make any grand general statements on the market based on the interview alone. However, Luchetta (2015) and Tasca et al. (2017) makes coherent claims in that an interbank-market that is small and experience interconnectivity has problems with diversification and systemic risk. Since we find these problems in the sample bank portfolio and from the representatives' statements, we argue that this market is at least similar to what the representatives claim it to be.

We can see from the benchmark results in section 5.2, *Sample Bank Portfolio Benchmarks,* that ICR-correlation generates higher probabilities of multiple defaults in line with Schönbucher (2000). Furthermore, the interview with the sample banks representatives indicates that the financial institutions are related to each other and that the market is narrow. This is related to Luchetta (2015) who state that an interbank-market is concentrated. Evidently, when we exclude the financial institutions from the sample bank portfolio, the ICR-correlation decreases and the probabilities of default decreases as well. Hence, there is both empirical evidence,

qualitative findings and quantitative results that point in the same direction to the core problem of concentration and correlation.

As established, in terms of the financial institutions contribution to risk in the portfolio, the reduction in ICR-correlation does lower the probability of having several defaults in the portfolio. This statement is coherent with both Schönbucher (2000), Luchetta (2015), Tasca et al. (2017) and Ibragimov et al. (2011). Having lower probabilities of defaults is always less risky than having higher probabilities of defaults, but there are other risks associated with a bond portfolio. This model does not consider shifts in interest rate, price changes of the bond and other risks. However, defaults would create the highest possible costs for the bondholder.

Ibragimov et al. (2011) found that risk-sharing is optimal for both society and the individual investors when the tails of the risk distribution are thin but not when the tails are getting fatter. Thus, one might argue that in the average setting the tails are thin enough to justify holding other financial institutions bonds since the risk for both society and the sample bank are negligible. However, in the crisis-setting the risk of multiple defaults are diminishing, when removing financial institutions, which induce that it could be better for society and not worse for the sample bank to exclude them.

In Table I of section 3.2, *Interest Coverage Ratios and Correlation Matrix,* we ranked all the ICR-correlations in the portfolio mutually. When we rank all holdings in terms of ICR-correlation with the sample bank instead, four out of the six highest correlated obligors are other financial institutions. The average ICR-correlation among all five of these is 94,19%, as shown in Table XI below. Indeed, it is not only the portfolio itself that is correlated, but also the sample bank is correlated with the holdings in the portfolio. This reinforces the argument that holding other financial institutions is suboptimal in terms of risk. Table XI shows that ICR-correlation is highly present between the sample bank and any obligor on average, indicating that the sample bank might be correlated with the system itself in line with Luchetta's findings (2015).

Table XI

ICR-Correlation Between the Sample Bank and the Obligors in the Portfolio

This table presents the ICR-correlation between the sample bank and the obligors in the portfolio. The table shows the median and mean for the portfolio with all obligors, with only the financial institutions, and with financial institutions excluded.

	Median	Mean
All obligors	74,15%	59,51%
Financial institutions	97,88%	94,19%
Financial institutions excluded	67,56%	54,09%

Hence, the results indicate that the sample bank neither should nor want to hold other financial institutions but is restricted by the market in which they invest on. What previous research has found is that this characteristic of a market is problematic since it generates higher systemic risk as Wagner (2010) suggest and increase the probability of multiple defaults in a systemic breakdown as Tasca et al. (2017) conclude. This is on the contrary of what Markowitz (1952) assumed when constructing his model, which should indicate that it is negative in terms of possibilities for risk minimization.

7. Conclusions

This thesis explores why the sample bank invests in other financial institutions and the implications of this in terms of default risk in the portfolio. Our results show that the sample bank has a rationale for investing in this manner. Furthermore, the probabilities of defaults decrease with financial institutions excluded from the portfolio.

Our contribution to this field is to enlighten the problem with the concentration of the Swedish interbank-market and show what effects this phenomenon has on the default risk in the sample bank bond portfolio. Even if there are several reasons for why the sample bank invest their excess cash in correlated firms, we argue that it does not justify investing in these financial institutions anyway.

The ICR-correlation increases the risk for simultaneous defaults and the single simple solution to this problem is to exclude financial institutions from the portfolio. That would lead to a portfolio with lower ICR-correlation between the holdings, but also less ICR-correlation with the sample banks own operation. The sample bank is minimizing risk and even though they suggest that financial institutions could yield relatively better returns, these holdings are not suitable.

The largest benefits of excluding financial institutions would be seen in a crisis-setting since the probabilities of defaults in the tails indubitably diminish. On the other hand, in the average setting, there is an argument to be made for that the risk might be worth taking if the dividends offered are large enough. The added risk is not large enough to blatantly dismiss them as unsuitable, but it the target is only risk minimization then they should not be included anyway.

Our results provide an indication of that the Swedish interbank-market is similar to the interbank-markets that Luchetta (2015), Tasca et al. (2017) and Ibragimov et al. (2011) use in their studies in terms of concentration and correlation. However, making general statements on the Swedish interbank-market is difficult with one sample bank, but since the interview with the sample bank representatives is pointing to the fact that the market structure and size is the core problem it is probable that our results would hold with more banks included.

One core issue that the sample bank CFO (Interview, 3rd of May 2018) states is that the Swedish interbank-market is underdeveloped. What would be interesting in the context of this paper is to see what would happen if the market develops and starts to provide enough alternative investments to make it possible to diversify appropriately. Possibly, the problems coming from excessive cross-correlation in the portfolio could be in part reduced by an expanding interbank-market.

Based on the finding that financial institutions increase the probabilities of defaults in the portfolio, future research on risk-adjusted return in a Swedish interbank-market bond portfolio would be of interest. The risk-adjusted return would help in deciding if the possibly higher return outweighs the higher risk. Furthermore, it would be equally interesting to expand on our framework by adding more financial institutions to the study to make the conclusions grow in generality regarding the Swedish interbank-market.

8. References

AB Volvo (2001-2017). *Annual Reports 2000-2016.* Available at: Retriever Business.

AB Volvo (2018). *Annual and Sustainability Report 2017.* Göteborg: AB Volvo. http://www.volvogroup.se/sv-se/investors/reports-and-presentations/annual-reports.html. (Last visited May 8, 2018).

Ahlsell AB (2014-2017). *Annual Reports 2013-2016.* Available at Retriever Business.

Akelius Residential Property AB (2001-2017). *Annual Reports 2000-2016.* Available at: Retriever Business.

Akelius Residential Property AB (2018). *Annual Report 2017.* Danderyd: Akelius Residential Property AB. *https://www.akelius.com/sv/finansiell-information/rapporter.* (Last visited May 8, 2018).

Apoteket AB (2001-2017). *Annual Reports 2000–2016.* Available at: Retriever Business.

Apoteket AB (2018). *Annual and Sustainability Report 2017*. Stockholm: Apoteket AB. https://www.apoteket.se/om-apoteket/finansiell-information/ekonomiska-rapporter/. (Last visited May 8, 2018).

Arla Foods amba (2002-2018). *Annual Reports 2001-2017.* Viby: Arla Foods amba. https://www.arla.com/company/investor/annual-reports/. (Last visited May 8, 2018).

Atrium Ljungberg AB (2001-2017). *Annual Reports 2000-2016.* Available at Retriever Business.

Atrium Ljungberg AB (2018). *Annual and Sustainability Report 2017.* Nacka: Atrium Ljungberg AB. http://al.se/press/finansiella-rapporter/2018/atrium-ljungbergs-arsredovisning-och-hallbarhetsredovisning-for-2017-finns-tillganglig-pa-bolagets-webbplats/. (Last visited May 8, 2018).

Bank for International Settlements, (2013). Basel III: The Liquidity Coverage Ratio and liquidity risk monitoring tools. Basel, Bank for International Settlements ISBN 92-9197- 912-0

Bank Norweigan AS (2014-2018). *Annual Reports 2013-2017.* Fornebu: Bank Norweigan AS. https://www.banknorwegian.se/OmOss/InvestorRelations. (Last visited May 8, 2018).

Blom, J., Wargclou, J. (2016). Does copula beat linearity?: Comparison of copulas and linear correlation in portfolio optimization (Master's thesis). Umeå: Department of mathematics and mathematical statistics, Umeå University. Available at: http://www.diva-portal.org/smash/record.jsf?pid=diva2%3A953735&dswid=3090

Boudreault, M., Gauthier, G. & Thomassin, T., (2012). Credit spreads, recovery rates and bond portfolio risk measures in a hybrid credit risk model. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2130851

Brinkmann, S. (2013). *Qualitative Interviewing* (Understanding Qualitative research), New York: Oxford University Press.

Brown, S. J. (2012). Quantitative measures of operational risk: an application to funds management. *Accounting & Finance*, Vol. 52(4), p. 1001-1011. doi: 10.1111/j.1467-629X.2012.00506.x

Castellum AB (2001-2017). *Annual Reports 2000-2016).* Available at Retriever Business.

Castellum AB (2018). *Annual Report 2017.* Göteborg: Castellum AB. https://www.castellum.se/investor-relations/arsredovisningar2/. (Last visited May 8, 2018).

Damodaran, A. (2012). *Investment Valuation.* John Wiley& Sons inc., US.

Düllmann, K; Trapp, M (2004): *Systematic Risk in Recovery Rates: An Empirical Analysis of US Corporate Credit Exposures*, (Discussion Paper, Series 2: Banking and Financial Supervision, No. 2004,02). Frankfurt: Deutsche Bundesbank. https://www.econstor.eu/handle/10419/19729

Fabege AB (2001-2017). *Annual Reports 2000-2016.* Available at: Retriever Business.

Fabege AB (2018). *Annual Report 2017*. Stockholm: Fabege AB. https://fabege.se/Om-Fabege/Finansiell-information/Rapporter/?id=4680. (Last visited May 8, 2018).

Fastighets AB Balder (2006-2017). *Annual Reports 2005-2016.* Available at Retriever Business.

Fastighets AB Balder (2018). *Annual Report 2017*. Göteborg: Fastighets AB Balder. https://www.balder.se/om-balder/press/rapporter/12-april-2018. (Last visited May 8, 2018).

Fastighets AB Förvaltaren (2001-2017). *Annual Reports 2000-2016.* Available at: Retriever Business.

Fastighets AB Förvaltaren (2018). *Annual and Sustainability Report 2017*. Sundbyberg: Fastighets AB Förvaltaren. https://www.forvaltaren.se/artikel/finans. (Last visited May 8, 2018)

Furfine, C. (2002). The interbank market during a crisis. *European Economic Review, 46* 809-820. doi: 10.1016/S0014-2921(01)00215-X

Hemsö Fastighets AB (2010-2017). *Annual Reports 2009-2016.* Available at: Retriever Business.

Hemsö Fastighets AB (2018). *Annual Report 2017*. Stockholm: Hemsö Fastighets AB. http://www.hemso.se/press/nyheter/2018/3/arsredovisning-hemso-2017/. (Last visited May 8, 2018).

Hexagon AB (2001-2017). *Annual Reports 2000-2016.* Available at: Retriever Business.

Hexagon AB (2018). *Annual Report 2017.* Stockholm: Hexagon AB. https://investors.hexagon.com/sv-SE/financial-information/reports-and-presentations?page=/sv/%C3%A5rsredovisning-och-h%C3%A5llbarhetsrapport-2017. (Last visited May 8, 2018).

Holmen AB (2001-2017). *Annual Reports 2000-2016.* Available at: Retriever Business.

Holmen AB (2018). *Annual Report 2017*. Stockholm: Holmen AB. https://www.holmen.com/sv/investerare-och-aktieagare/rapporter-och-presentationer/. (Last visited May 8, 2018).

Hufvudstaden AB (2001-2017). *Annual Reports 2000-2016.* Available at: Retriever Business.

Hufvudstaden AB (2018). *Annual Report 2017*. Stockholm: Hufvudstaden AB. https://www.hufvudstaden.se/finansiell-information/rapporter/arsredovisningar/. (Last visited May 8, 2018).

Husqvarna AB (2006-2017). *Annual Reports 2005-2016.* Available at: Retriever Business.

Husqvarna AB (2018). *Annual Report 2017*. Husqvarna: Husqvarna AB. http://www.husqvarnagroup.com/sv/rapporter/husqvarna-groups-arsredovisning-2017-1560118. (Last visited May 8, 2018).

Ibragimov, R., Jaffe, D., Walden, J. (2011). Diversification Disasters. *Journal of Financial Economics*, 99(2), 333-348. doi: 10.1016/j.jfineco.2010.08.015

Intrum Justitia AB (2001-2017). *Annual Reports 2000-2016.* Available at: Retriever Business.

Intrum Justitia AB (2018). *Annual Report 2017*. Stockholm: Intrum Justitia. https://www.intrum.com/en/investor-relations/reports-presentations/annual-reports/. (Last visited May 8, 2018).

Jernhusen AB (2004-2017). *Annual Reports 2003-2016.* Available at Retriever Business.

Jernhusen AB (2018). *Annual Report 2017*. Stockholm: Jernhusen AB. https://www.jernhusen.se/om-jernhusen/finansiell-information/rapporter/. (Last visited May 8, 2018).

L E Lundbergsföretagen AB (2001-2017). *Annual Reports 2000-2016.* Available at Retriever Business.

L E Lundbergsföretagen AB (2018). *Annual Report 2017.* Stockholm: L E Lundbergsföretagen AB. https://www.lundbergforetagen.se/investor_relations_press/arsredovisningar.aspx. (Last visited May 8, 2018)

Lejonfastigheter AB (2001-2017). *Annual Reports 2000-2016.* Available at Retriever Business.

Luchetta, M (2015). Does the bank risk concentration freeze the interbank system? *North American Journal of Economics and Finance, 33*. 149-166. doi: 10.1016/j.najef.2015.04.002

Markowitz, H (1952). Portfolio Selection. *The Journal of Finance, 7*(1), 77-91. doi: 10.2307/2975974

Modern Times Group AB (2001-2017). *Annual Reports 2000-2016.* Available at: Retriever Business.

Modern Times Group AB (2018). *Annual Report 2017.* Stockholm: Modern Times Group AB. https://www.mtg.com/sv/finansiella-rapporter/#2017. (Last visited May 8, 2018).

Nasdaq (2018). *Glossary: Interbank market*. Available at https://www.nasdaq.com/investing/glossary/i/interbank-market (Last visited May 31, 2018)

Oxfordmathcenter (2018). *Random variable and Discrete Probability Distribution.* Available at http://www.oxfordmathcenter.com/drupal7/node/252. (Last visited May 4, 2018).

Rikshem AB (2012-2017). *Annual Reports 2011-2016.* Available at: Retriever Business.

Rikshem AB (2018). *Annual and Sustainability Report 2017.* Stockholm: Rikshem AB. https://www.rikshem.se/om-oss/finansiell-information/rapporter-presentationer/. (Last visited May 8, 2018).

S&P Dow Jones Indices (2015). *Correlation: Interpreting Global and U.S. Correlations.* New York: S&P Dow Jones Indices.

S&P Global Ratings (2017). *Default, Transition, and Recovery: 2016 Annual Global Corporate Default Study and Rating Transitions.* New York: S&P Global Ratings.

Saab AB (2002-2017). *Annual Reports 2001-2016.* Available at: Retriever Business.

Saab AB (2018). *Annual Report 2017.* Linköping: Saab AB. https://saabgroup.com/investor-relations/reports/. (Last visited May 8, 2018).

SCA AB (2001-2017). *Annual Reports 2000-2016.* Available at Retriever Business.

Scania AB (2001-2017). *Annual Reports 2000-2016.* Available at: Retriever Business.

Scania AB (2018). *Annual and Sustainability Report 2017.* Södertälje: Scania AB. https://www.scania.com/group/en/section/investor-relations/financial-reports/annual-reports/. (Last visited May 8, 2018).

Schönbucher, P. J., (2000). Factor models for portfolio credit risk, *Bonn Econ Discussion Papers*, (16). https://www.econstor.eu/handle/10419/78427.

Sparbanken Sjuhärad (2001-2018). *Annual Reports 2000–2017.* Available upon request from Sparbanken Sjuhärad.

Sparbanken Skåne AB (2015–2018). *Annual Reports 2014–2017.* Lund: Sparbanken Skåne AB. https://www.sparbankenskane.se/om-sparbanken-skane/finansiell-information/. (Last visited May 8, 2018).

Specialfastigheter Sverige AB (2001-2017). *Annual reports 2000-2016.* Available at Retriever Business.

Specialfastigheter Sverige AB (2018). *Annual Report 2017.* Linköping: Specialfastigheter Sverige AB. https://www.specialfastigheter.se/verksamheten/ekonomisk-info-finansering/arsredovisning/. (Last visited May 8, 2018).

SPSS Tutorials (2018). *SPSS Independent Samples T-Test.* Available at https://www.spss-tutorials.com/spss-independent-samples-t-test/. (Last visited May 10, 2018).

Statistics Solutions (2018). *Pearson's Correlation Coefficient.* Available at https://www.statisticssolutions.com/pearsons-correlation-coefficient/. (Last visited May 4, 2018).

Swedish Match AB (2001-2017). *Annual Reports 2000-2016.* Available at: Retriever Business.

Swedish Match AB (2018). *Annual Report 2017.* Stockholm: Swedish Match. https://www.swedishmatch.com/sv/Investerare/Finansiella-rapporter/Arsredovisningar/. (Last visited May 8, 2018).

Södertälje kommun förvaltnings AB (2002-2017). *Annual Reports 2001-2016.* Available at Retriever Business.

Tasca, P., Battiston, S. & Deghi, A., (2017). Portfolio diversification and systemic risk in interbank networks, *Journal of Economic Dynamics and Control, 82*, 96-124. doi: 10.1016/j.jedc.2017.01.013

Tierens, I. and Anadu, M. (2004). *Goldman Sachs Quantitative Insights Research Note*, 13 April 2004. Goldman Sachs

Trelleborg AB (2001-2017). *Annual Reports 2000-2016.* Available at: Retriever Business

Trelleborg AB (2018). *Annual Report 2017.* Trelleborg: Trelleborg AB. http://www.trelleborg.com/sv/investerare/rapporter/arsredovisningar. (Last visited May 8, 2018).

Uppsalahem AB (2001-2017). An*nual Reports 2000-2016.* Available at: Retriever Business.

Uppsalahem AB (2018). *Annual and Sustainability Report 2017.* Uppsala: Uppsalahem AB. https://www.uppsalahem.se/om-oss/agare-och-organisation/ekonomi/. (Last visited May 8, 2018).

Varbergs Sparbank (2006-2018). *Annual Reports 2005-2017.* Varberg: Varbergs Sparbank AB. https://www.varbergssparbank.se/om-oss/ekonomi/. (Last visited May 8, 2018).

Vasakronan AB (2001-2017). *Annual Reports 2000-2016.* Available at: Retriever Business.

Vasakronan AB (2018). *Annual Report 2017.* Stockholm: Vasakronan AB. https://vasakronan.se/om-vasakronan/finansiell-information/finansiella-rapporter. (Last visited May 8, 2018).

Volkswagen Finans Sverige AB (2001-2017). *Annual Reports 2000-2016.* Available at: Retriever Business.

Volvofinans Bank AB (2001-2018). *Annual Reports 2000-2016.* Available at Retriever Business.

Volvofinans Bank AB (2018). *Annual Report 2017.* Göteborg: Volvofinans Bank AB. https://www.volvofinans.se/om-volvofinans/investerarrelationer/rapporter/arsredovisningar/. (Last Visited May 8, 2018).

Wagner, W (2010). Diversification at financial institutions and systemic crises. *Journal of Financial Intermediation, 19*(3), 373-386. doi: 10.1016/j.jfi.2009.07.002

Willhem AB (2012-2017). *Annual Reports 2011-2016.* Available at: Retriever Business.

ÅF AB (2001-2017). *Annual Reports 2000-2016.* Available at: Retriever Business.

ÅF AB (2018). *Annual and Sustainability Report 2017.* Stockholm: ÅF AB. http://www.afconsult.com/sv/investor-relations/finansiella-rapporter/#%C3%85rsredovisningar. (Last visited May 8, 2018).

9. Appendix

A. Collected Data

Table XII

ICR-Correlation Matrix for the Holdings in the Interbank Portfolio

This table displays all ICR-correlation coefficients in the sample bank portfolio. The holdings are named 1-37 and there are $(37 \times 36)/2 = 666$ correlation estimates among the 37 firms. The ICR-correlations are estimated from the collected ICRs among the firms.

	1	2	3	4	5	6	7	8	9	10	11	12
1	1,0000											
2	0,0331	1,0000										
3	0,0804	0,2452	1,0000									
4	0,2064	-0,0309	-0,2607	1,0000								
5	0,5423	0,3701	-0,1288	0,2829	1,0000							
6	0,6166	0,5398	0,3546	0,2670	0,6214	1,0000						
7	0,8184	0,2921	0,1253	0,1111	0,6647	0,6806	1,0000					
8	0,2376	0,5597	0,5274	-0,0583	0,3337	0,7115	0,1671	1,0000				
9	0,5937	0,1404	-0,1290	0,2262	0,2477	0,5289	0,6584	-0,0632	1,0000			
10	0,7727	0,3368	0,2785	0,3331	0,3737	0,7880	0,6425	0,4303	0,7589	1,0000		
11	0,1563	0,1139	-0,0830	0,7208	-0,2867	0,9124	0,5559	0,5137	0,9975	0,9720	1,0000	
12	0,9250	0,0989	0,1103	0,2008	0,5147	0,6705	0,7876	0,1587	0,5909	0,7837	0,5410	1,0000
13	0,7486	-0,0429	0,1219	0,1767	0,2303	0,5845	0,6520	0,2541	0,6981	0,7720	0,9265	0,7443
14	0,5840	0,0579	0,0748	-0,2964	0,5294	0,5662	0,5753	0,3667	0,3909	0,3655	0,9879	0,5179
15	0,5859	0,1797	0,0295	0,4104	0,4694	0,7972	0,6091	0,4985	0,6074	0,6625	0,9733	0,5796
16	0,7611	0,3220	-0,0950	0,1149	0,8000	0,6847	0,9004	0,3991	0,4480	0,6970	0,3986	0,7377
17	0,6301	0,5015	0,0174	-0,0065	0,6009	0,7178	0,7696	0,3088	0,5763	0,5826	0,6774	0,6697
18	0,6628	-0,1396	0,4767	-0,1308	-0,1338	0,7974	0,6859	0,6804	0,8609	0,8194	0,9259	0,7581
19	0,4013	0,1181	-0,3255	0,0969	0,2744	0,1268	0,2917	-0,2425	0,6224	0,5103	-0,5012	0,2825
20	0,6212	0,3299	-0,1128	0,3545	0,8360	0,6885	0,5774	0,4070	0,4000	0,6125	-0,2785	0,5583
21	0,8886	0,0850	0,1118	0,2596	0,5495	0,7491	0,8209	0,3505	0,6869	0,8209	0,9746	0,8666
22	0,2992	-0,1616	-0,1282	0,5284	0,1975	0,3183	0,0175	0,3032	0,2573	0,3333	0,8576	-0,0169
23	-0,0300	0,3123	0,5172	0,1448	-0,1063	0,3806	-0,0271	0,4228	-0,0545	0,3245	0,7000	0,0325
24	0,3423	0,4487	0,2926	-0,0101	0,1866	0,5120	0,5337	0,2038	0,5099	0,4563	0,9766	0,5868
25	0,3440	-0,1721	-0,2567	-0,2144	-0,6315	-0,1067	0,1051	-0,1420	0,7817	0,4933	0,9411	0,1106
26	-0,2298	0,0796	0,2673	0,4767	0,0136	0,1740	-0,2367	0,1276	-0,0654	0,1737	-0,4723	-0,1650
27	0,2883	0,2349	0,3726	0,0377	0,1226	0,4089	0,2641	0,3875	0,1206	0,4142	0,9433	0,3348
28	0,0494	0,3502	-0,0777	0,2589	0,2569	0,2281	0,3099	-0,1301	0,5523	0,3439	0,8920	0,0692
29	0,7023	0,0543	0,0161	0,1946	0,4016	0,6421	0,8215	0,4217	0,6364	0,9135	0,9618	0,7685
30	0,4801	0,0441	0,4664	0,5487	-0,2978	0,8430	0,7086	0,6572	0,8954	0,7989	0,9682	0,7343
31	0,5943	-0,0205	0,6590	0,7899	-0,2694	0,7712	0,7278	0,7968	0,8041	0,9436	0,9878	0,7298
32	0,4465	0,5030	0,3632	-0,1708	0,1944	0,5808	0,4842	0,3725	0,4407	0,5505	0,4270	0,4021
33	0,0375	0,5336	0,4473	-0,1123	0,0475	0,5380	0,1197	0,5997	0,0850	0,5183	0,9371	0,0074
34	0,0663	0,3858	0,5508	0,1632	-0,0091	0,4791	0,0847	0,6754	-0,0335	0,3003	0,2921	0,0400
35	0,4063	0,5239	0,3866	-0,3660	0,2921	0,9109	0,6938	0,7016	0,8646	0,8692	0,8546	0,5173
36	0,8043	0,1044	0,2438	0,2159	0,4570	0,7548	0,7160	0,4381	0,6554	0,8893	0,9452	0,7699
37	0,5939	0,4396	0,3943	0,1021	0,2975	0,7392	0,5622	0,5167	0,4240	0,7690	0,7751	0,6292

	13	14	15	16	17	18	19	20	21	22	23	24
1												
2												
3												
4												
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6												
7												
8												
9												
10												
11												
12												
13	1,0000											
14	0,5786	1,0000										
15	0,7519	0,5278	1,0000									
16	0,5681	0,7060	0,6806	1,0000								
17	0,6415	0,6833	0,6501	0,9069	1,0000							
18	0,9798	0,7110	0,9500	0,5458	0,5965	1,0000						
19	0,1910	0,1824	0,0107	0,1583	0,1822	-0,4688	1,0000					
20	0,3964	0,6272	0,5870	0,7660	0,5810	0,2980	0,5161	1,0000				
21	0,8700	0,6813	0,8032	0,8251	0,7796	0,9454	0,3461	0,6520	1,0000			
22	0,5908	0,1354	0,6989	0,4501	0,0917	0,6779	-0,3461	0,2892	0,4993	1,0000		
23	0,1639	-0,3623	0,2735	-0,1996	-0,1167	0,6022	-0,3885	-0,1703	0,0810	0,1794	1,0000	
24	0,2137	0,1437	0,2704	0,1392	0,4634	0,2592	0,2878	0,0868	0,3101	-0,1856	0,4041	1,0000
25	0,6311	0,1409	0,2490	0,0433	0,1473	0,9803	0,5050	-0,3505	0,3421	0,3009	-0,1029	0,0888
26	-0,0796	-0,2763	-0,0563	-0,3793	-0,3167	-0,4172	-0,0165	0,0594	-0,1470	0,0951	0,2842	-0,0464
27	0,5050	0,0845	0,4590	0,4586	0,3114	0,9940	-0,1515	0,1917	0,4151	0,2890	0,5301	0,3694
28	0,1618	-0,1645	0,0725	-0,1467	0,0913	-0,2439	0,4164	0,1091	0,0658	-0,0832	0,2094	0,4877
29	0,9326	0,7096	0,8628	0,7501	0,8027	0,9281	0,0360	0,5475	0,8854	0,8192	0,0846	-0,0099
30	0,9579	0,9875	0,9893	0,4899	0,6701	0,9656	-0,6999	-0,0103	0,9945	0,7859	0,7795	0,1102
31	0,9806	0,8315	0,9527	0,6103	0,7354	0,9361	-0,6964	0,3462	0,9733	0,9182	0,7568	-0,0127
32	0,4380	0,4140	0,3750	0,5724	0,7449	0,3888	0,0877	0,2109	0,5582	-0,0172	0,1494	0,4290
33	0,4069	0,0407	0,4849	0,3009	0,3079	0,8627	-0,4967	0,0454	0,2263	0,3691	0,7476	0,3559
34	0,0234	-0,1034	0,3049	-0,1309	-0,0396	0,1649	-0,2384	0,0439	0,1384	0,1746	0,5597	0,2351
35	0,7193	0,7466	0,7106	0,8084	0,9278	0,7058	-0,1554	0,4782	0,8468	0,1549	-0,0944	0,8390
36	0,8559	0,6674	0,7477	0,6847	0,6286	0,8698	0,4168	0,6338	0,9384	0,5013	0,2057	0,2342
37	0,5776	0,3429	0,6106	0,5689	0,5523	0,8364	0,0816	0,5109	0,6304	0,1579	0,4761	0,3586

	25	26	27	28	29	30	31	32	33	34	35	36	37
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24													
25	1,0000												
26	-0,4790	1,0000											
27	0,4470	-0,1253	1,0000										
28	-0,0515	0,4634	-0,0438	1,0000									
29	0,4838	-0,1828	0,7044	0,0174	1,0000								
30	0,9644	-0,1676	0,9696	0,8975	0,9312	1,0000							
31	0,9823	-0,0671	0,9476	-0,0414	0,9944	0,9547	1,0000						
32	0,2136	-0,2107	0,2501	-0,0070	0,3769	0,2684	0,4168	1,0000					
33	0,3229	-0,0217	0,8108	0,1851	0,5220	0,9020	0,9716	0,4213	1,0000				
34	-0,2790	0,2322	0,0803	-0,0309	-0,0221	0,6356	0,4527	0,1727	0,2636	1,0000			
35	0,7227	-0,6151	0,7076	-0,2465	0,8184	0,7660	0,8313	0,8872	0,9503	-0,3103	1,0000		
36	0,3576	0,0433	0,3662	0,1577	0,8803	0,8347	0,9606	0,5142	0,3213	0,2511	0,7490	1,0000	
37	0,4248	-0,1152	0,6044	-0,0617	0,6367	0,8957	0,8836	0,5482	0,7219	0,3734	0,8177	0,6618	1,0000

Table XIII

Rating and Market Value of the Sample Bank Portfolio

This table presents the holdings rating and how the probability of default refers to the rating. Furthermore, the market value of the bonds is presented in SEK with the associated portfolio weight as well.

Holding	Rating	Probability of Default	Market Value	Portfolio Weight
1	A	0,061	100 000 454	3,93%
2	Baa3	0,111	168 037 950	6,61%
3	Sbb+	0,367	24 999 924	0,98%
4	AA-	0,038	100 005 997	3,93%
5	Sbbb+	0,111	79 991 022	3,15%
6	SA-	0,061	100 002 860	3,93%
7	AA+	0,038	155 042 712	6,10%
8	Sbbb-	0,111	99 979 197	3,93%
9	A	0,061	100 041 422	3,93%
10	Baa2	0,111	19 996 075	0,79%
11	-		49 994 560	1,97%
12	AA-	0,038	50 021 480	1,97%
13	A3	0,061	100 007 881	3,93%
14	BBB	0,111	100 018 544	3,93%
15	A+	0,061	100 041 781	3,93%
16	BBB	0,111	49 992 920	1,97%
17	K-1	0,038	99 985 495	3,93%
18	A-	0,061	143 376 358	5,64%
19	AA-	0,038	50 039 944	1,97%
20	Sbbb	0,111	50 007 894	1,97%
21	Sbbb+	0,111	49 995 851	1,97%
22	Sa-	0,061	50 001 263	1,97%
23	BBB+	0,111	65 258 188	2,57%
24	BBB+	0,111	20 080 563	0,79%
25	BB+	0,367	50 450 742	1,98%
26	A-	0,061	75 369 851	2,96%
27	A-	0,061	13 144 937	0,52%
28	BBB+	0,111	50 438 175	1,98%
29	BBB	0,111	50 215 328	1,97%
30	Sbbb	0,111	35 215 328	1,38%
31	BBB+	0,111	44 862 483	1,76%
32	Sa-	0,061	22 074 387	0,87%
33	BBB+	0,111	20 246 687	0,80%
34	A-	0,061	45 410 917	1,79%
35	A-	0,061	76 896 583	3,02%
36	A-	0,061	31 760 671	1,25%
37	BBB	0,111	100 025 833	1,93%
Total			2 543 034 951	100,00%

B. Interview Script and Transcription

Interview script for the sample bank interview translated from Swedish

1. Describe the Swedish interbank-market in terms of liquidity, market data and so on.
2. Do you buy other financial institutions bonds?
3. Why?
4. Why don't you buy something else if you do not have to buy other financial institutions bonds?
5. What does this mean for your portfolio?
6. Do you take this into consideration in your other holdings?
7. Do you take any extra precautions to control these holdings?
8. Do you think that these holdings have a different risk then a corresponding bond outside of your own industry?
9. What is a shadow rating on a bond?

Transcription of interview on the 3rd of May 2018 with CFO, v-CFO from the sample bank translated from Swedish

JM = Johan Moberg
CFO = Sample bank CFO
v-CFO = Sample bank vice-CFO

JM: We start with question 1: Can you describe the Swedish interbank-market? Describe it as you like and I will ask follow-up questions if necessary.
CFO: When you say interbank-market, you mean bond-trading on that market?
JM: Yes precisely.
CFO: Often you refer to the interbank-market in general as STIBOR-trading which is fictive, but the focus is on bond-trading today okay. There is no exchange in that sense that it is not comparable to a stock-exchange. There is no quotation. It is about what the major banks of Sweden offers in terms of price for these bonds. For us, we receive lists daily from some of the major banks where we see their inventory of bonds.
The lists say that this bank has these bonds and we offer these prices and so on. Often, the spreads are fairly large. Often about 10 points on a given bond. From that, we trade these by making phone calls to the counterpart. When any of these banks get some bond that they feel suits just us, they call and tell us about it to offer us a trade.
JM: So, there are intensive relationships between actors compared to a classic capital market?
CFO: I would say that the interbank-market is very relationship intensive. In a normal case, we frequently trade with three major banks in Sweden. At those banks there are five-six persons we talk to.
JM: You know each other well then?
CFO: Yes, we do. We tell each other what we have done on our vacations and so on.
.
. *Unrelated talking*
.
JM: So, there are relationships on a different level then other capital markets?
CFO: Yes absolutely.
.
. *Unrelated talking*
.
v-CFO: Sometimes, the banks only offer a portion of what they have in their inventory. Moreover, the offer sheets are separated into certificates, bonds and treasury bonds. The volume is often larger in the treasury bonds then other bonds, since they are of a higher rating.
.
. *Unrelated talking*
.
CFO: A new separation that is coming more and more is green bonds.
JM: The environmental aspect is starting to come to this market as well?
CFO: Precisely.
JM: In terms of liquidity, can you sell your bonds easily? I suspect that you hold most of your bonds until maturity, right?

CFO: The majority of the bonds yes.
JM: Is it hard to sell the bonds or other interest-bearing assets?
CFO: No, it is not.
JM: There is no clearinghouse, there is no middle hand, the market is thus a pure OTC-market? You give the counterparty a call basically? Does it affect your way of trading compared to if you had access to extensive market data? Or are the relationships so strong that you trust the counterpart? That is why you have clearinghouses after all, to eliminate that risk.
v-CFO: It would of course be preferable to have market data.
CFO: Yes, it would be better. Also, it turns out that the spreads you trade are relatively high. If you trade a bond with decent liquidity, then you have approximately 10 points spread. How often do you trade the portfolio and what do you gain from that? That is something to consider. There are oligopoly-tendencies since the prices are very equal across counterparties. When you have been doing this for a while, you develop a sense of what spread is reasonable. Sometimes, you can trade within the spread. It depends on how eager we and the counterparty are to close the deal.
v-CFO: If you buy in the primary offering, you usually get better prices which is natural.
JM: Moving on, that was the general market question done. Question two: Do you buy other financial institutions bonds?
CFO: Yes, we do.
JM: Then we have question three: Why do you do this? Because that is something that finance teaches you early and is important that you should not invest in your own industry. So, the question is why do you do this?
CFO: We try to avoid our own industry in the bond portfolio. We are well aware of the risks but the Swedish interbank-market is heavily underdeveloped when compared internationally. What is offered on the market is very often related to bank or financial institutions or real estate, which is also very related to banking. In our own business, there is a large portion of real estate financing. We would have very much liked to decrease the amount of real estate and banks in the portfolio.
On the other hand, you have to be real in terms on what is available on the market. Generally, banks are, since they are regulated, relatively low risk comparably. But, if we are having difficulties than the other banks probably have that as well which can affect the prices. The supply is the main reason and what we try to do is to find manufacturing and such with a good rating. We try to have a low risk since we take credit risk from other sources.
JM: in your business model?
CFO: When we lend to the public yes. That is where the credit risk should be.
JM: So, the credit risk should not come from the portfolio but from the business model. Do you minimize risk more than you maximize returns?
CFO: Without a doubt, yes.
v-CFO: We also have secured bonds, and from a risk perspective you do not find that in a manufacturing company. In a way it is better to own a secured bond from a financial institution then Volvo or Sandvik or such.
JM: It is an interesting aspect since securing a bond does mitigate the risk taken.
v-CFO: About 20% of the portfolio is secured bonds.
JM: Is the majority of these of a high rating?
CFO: Every bond that is a secured real estate bond is of an AAA-rating.
v-CFO: Precisely.
JM: The bond gets that rating because of being secured?
CFO: A firm cannot issue secured bonds if the rating is not AAA. We need to have a portion of secured bonds to meet up with regulation, so we need between 400 million to 1,5 billion SEK in governmental, municipality or secured bonds. To ensure our banks liquidity we need that type of papers to use these as collateral against the central bank. Only those three types of bonds fulfil that requirement. Today, we have almost 2,5 billion SEK in those types of bonds.
JM: This answers the next question as well, why holding financial institutions when you do not have to? It is because the market is structured as it is so you have a hard time avoiding that type of bonds. The market is not developed enough to be able to diversify fully?
CFO: No that is right but if you have diversified across industries then there is some kind of spread of the risk in that.
JM: If we focus in the portfolio that you hold and primarily on financial institutions, do you consider those bonds to affect your portfolio in any way? Do you have a higher risk then necessary or do they give a better return than other bonds? Does it affect the way you look at your own portfolio? Or is the portfolio viewed as you have to make these investments to make the portfolio complete?
CFO: Well, in terms of senior secured bonds they probably yield a less bad return than much else. Nothing yields well today. They are probably less bad after all. I do not think that these bonds lower returns in the portfolio. We do not have a return target in our portfolio but rather we try to secure liquidity. If we were to diversify across more industries the return would probably not increase. Probably neither better nor worse.
v-CFO: If we have a choice between a financial institution or something else, we would always choose something else. We also avoid Swedbank as far as possible with our large exposure towards them in other terms.
CFO: Yes, we avoid Swedbank to not introduce more exposure towards them.
v-CFO: The supply is the major driver for having to invest in other financial institutions.

JM: Do you consider this when picking other bonds?
v-CFO: We know other savings banks better than Getinge or such, making us have a better idea of how that investment works.
JM: Coming back to the question, do you consider these investments, where you actually have to take that extra risk because of the market, when picking other bonds for the portfolio? Do you try to counter that by choosing other bonds with higher rating, lower risk, higher returns or is it unavoidable in terms of supply?
CFO: Considering senior bonds, as v-CFO said, we rather buy something else.
JM: If there is something else available, you chose that?
CFO: Yes, considering diversification and other aspects.
JM: Do you take any extra precautions to control those holdings? It probably would not be a direct precaution but by having relationships from other forums or having tighter business relations, do you think that that affects your risk in that type of holdings? Like the savings banks national organisation? That type of forum should affect the way you look at buying a bond from any of those counterparties?
CFO: Yes, you have contact with a lot of those banks by other reasons such as pure business. And that makes you get a feeling for how that bank is doing. Some type of feeling that is more developed than for Getinge for example. That is an advantage but one should be aware of that buying other savings banks bonds is even more close to our own business than buying for example SEB. Geographical concentration and such is important. That is something that we do not normally do but the last couple of years have shown that now there is five savings banks that are issuing own bonds.
When you try to enter this interbank-market you have to pay a bit higher dividend, the first issue is always the most expensive. You need to find someone willing to make you a limit and actively trade your bond and thus you pay a few more points extra. Buying something in for example Varbergs savings bank will give you a good return given the risk you take. That extra return makes those bonds attractive.
JM: Do you consider these bonds to be of a higher risk than corresponding bonds outside of your own industry? As I understand it, the risk is really not higher as long as you have a measure of control and they do yield a higher return when issuing?
CFO: There are many aspects in this of course, many of these issuers are relatively small and the bond has a poor liquidity. A bond from SEB or Investor has a better liquidity obviously. That is one aspect of the whole picture. You mitigate that risk to some degree by having a bit better information on what is happening in a savings bank than other investors do. Not that you know pure facts but having similar businesses makes for easier deductions.
JM: You have a general sense of how your own industry performs?
CFO: Yes, that is the case. Liquidity is one aspect. We do not have an ambition of holding until maturity so if we need liquidity then we will evaluate what we can sell to a fair price. Liquidity is important.
JM: Liquidity is a central question when smaller issuers issue than if a large bank would issue bonds?
CFO: Yes, that is the case.
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. *Unrelated talking*
.
CFO: Having an official rating is not that important in today's market. The premium of being unrated is small today but in a rough market that difference is dramatic. This makes us buy bonds that are rated officially. We know that if we need to sell those bonds we could.
JM: Rating means liquidity in this case?
CFO: Absolutely.
JM: A shadow rating, what is that exactly? How would you define it?
CFO: Right now, from regulatory bodies there has been a crackdown on shadow ratings which was common a few years ago. Considering the four major banks in Sweden, they do some type of credit analysis on unrated bonds. When they started calling these shadow ratings and used the same letters as Standard and Poor's do, it will be taken as very similar by an investor. There is a risk of confusion. After that, regulation has said that it is not allowed anymore. Today, it is called something else like a credit score instead. What Swedbank does, for example, is using Moody's model since they often have an employee that has been with Moody's or Standard and Poor's so they know how the model works.
They use the same model but the rating is not official. The credit risk does not have to differ. Some banks have stopped with this altogether but others keep doing it. When being an issuing bank and your task is to sell bonds, you have an interest in giving those bonds a good credit score that might be better than an official rating would be. There is a conflict of interest there. It is natural that you as the issuing bank should not produce credit ratings.
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. *Unrelated talking*
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JM: One can say a shadow rating is very similar to what you would get from the official rating institutions? So, an AA shadow rating would be the same in the official system?

CFO: Yes, that is very likely.

C. Credit Rating Conversion Table

Table XIV

Credit Rating Conversion Table

This table presents how the sample bank converts the ratings between different credit rating companies. The table was received by email from the sample bank on 23 March 2018.

FACT Rating	**Moodys's**		**S&P**		**Fitch**		
	Long-term	**Short-term**	**Long-term**	**Short-term**	**Long-term**	**Short-term**	
21	Aaa	P-1	AAA	A-1+	AAA	F1+	Prime
	Aa1		AA+		AA+		High Grade
	Aa2		AA		AA		
	Aa3		AA-		AA-		
19-20	A1		A+	A-1	A+	F1	Upper medium grade
18	A2		A		A		
	A3	P-2	A-	A-2	A-	F2	
16-17	Baa1		BBB+		BBB+		Lower medium grade
15	Baa2	P-3	BBB	A-3	BBB	F3	
14	Baa3		BBB-		BBB-		
13-12	Ba1	Not Prime	BB+	B	BB+	B	Non-investment grade speculative
11	Ba2		BB		BB		
10-	Ba3		BB-		BB-		Highly speculative
	B1		B+		B+		
	B2		B		B		
	B3		B-		B-		
	Caa1		CCC+	C	CCC	C	Substantial risk
	Caa2		CCC				Extremely speculative
	Caa3		CCC-				In default with little prospect for recovery
	Ca		CC				
	C		C		DDD	/	In default
	/		D	/	DD		
	/				D		

D. Probabilities of Defaults for Specific Numbers of Obligors

The probabilities of defaults presented in the following tables may not sum to exactly 100% because of necessary rounding of the values.

Table XV

Average Individual Probability of Default with Benchmark ICR-correlation and Zero ICR-correlation

This table presents the probabilities of defaults for the bonds in the sample bank portfolio with the benchmark ICR-correlation of 30,34% and zero ICR-correlation. The calculations are projected with the average individual probability of default of 0,121%.

Number of Defaults	Probability (Benchmark ICR-correlation)	Probability (Zero ICR-correlation)	Difference
0	96,85%	95,62%	1,23%
1	2,731%	4,286%	-1,555%
2	0,3062%	0,0935%	0,1250%
3	0,0708%	0,0000%	0,0708%
4	0,0238%	0,0000%	0,0238%
>4	0,0182%	0,0000%	0,0182%

Table XVI

Individual Probability of Default in 2008 with Benchmark ICR-correlation and Zero ICR-correlation

This table presents the probabilities of defaults for the bonds in the sample banks portfolio with the benchmark ICR-correlation of 30,34% and zero ICR-correlation. The calculations are projected with the individual probability of default during 2008 of 0,434%.

Number of Defaults	Probability (Benchmark ICR-correlation)	Probability (Zero ICR-correlation)	Difference
0	89,64%	85,14%	4,5%
1	7,853%	13,73%	-5,877%
2	1,587%	1,077%	0,51%
3	0,5003%	0,0548%	0,4455%
4	0,2024%	0,0000%	0,2024%
5	0,0956%	0,0000%	0,0956%
6	0,0501%	0,0000%	0,0501%
>6	0,0716%	0,0000%	0,0716%

Table XVII

Comparison Between the Adjusted ICR-correlation and Benchmark ICR-correlation with Average Individual Probability of Default

This table presents the probability of default for the bonds in the sample banks portfolio without financial institutions with the adjusted ICR-correlation of 25,56% and benchmark ICR-correlation of 30,34%. The values are calculated with the average individual probability of default.

Number of defaults	Probability (Adjusted ICR-correlation)	Probability (Benchmark ICR-correlation)	Difference
0	96,95%	96,85%	0,1%
1	2,751%	2,731%	0,02%
2	0,2341%	0,3062%	-0,0721%
3	0,0422%	0,0708%	-0,0286%
>3	0,0227%	0,042	-0,0193%

Table XVIII

Comparison Between the Adjusted ICR-correlation and Benchmark ICR-correlation with 2008 Individual Probability of Default

This table presents the probability of default for the bonds in the sample banks portfolio without financial institutions with the adjusted ICR-correlation of 25,56% and benchmark ICR-correlation 30,34%. The values are calculated with the 2008 individual probability of default.

Number of Defaults	Probability (Adjusted ICR-correlation)	Probability (Benchmark ICR-correlation)	Difference
0	90,03%	89,64%	0,39%
1	8,03%	7,853%	0,177%
2	1,357%	1,587%	-0,23%
3	0,3552%	0,5003%	-0,1451%
4	0,1225%	0,2024%	-0,0799%
5	0,0505%	0,0956%	-0,0541%
6	0,0236%	0,0501%	-0,0265%
>6	0,0312%	0,0716%	-0,0404%