Risk Differentiated Premiums for the Swedish Deposit Insurance Scheme

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Abstract

The purpose of this paper was to investigate the current state of the Swedish deposit insurance scheme and in particular discuss how to price the premium paid by credit institutions. The paper explained the theoretical background and need for risk-adjustments to the deposit insurance and the legal framework in Sweden and the European Union as well as general global developments. We then moved onward to discuss different premium pricing models, their benefits and drawbacks. The second part of the paper presented a quantitative overview of the Swedish deposit insurance scheme and the implementation of a credit rating based model and an option pricing based model on the Swedish four major banks, Handelsbanken, SEB, Nordea and Swedbank for the years 2008 to 2012. Our main finding, from both pricing models, is that the current flat rate model greatly overprices the the four banks but that the results are sensitive to change in input parameters. We suggest implementing a proprietary credit rating model for risk-adjusting premiums focusing on simplicity and proper incentives while still holding fees fair relative to risk. This means that parameter absolute risk should be abandoned from the pricing model. Financial institutions that are "too big to fail" should be moved to the Stability fund and priced under the assumption of going concern, to avoid pricing deposit insurance of firms that will never be allowed to go bankrupt.

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1 Introduction

The Swedish deposit insurance is based on a EU directive and was first implemented 1996 and currently insures customer deposits up to 100 000 euro per person and financial institute. All financial institutions that are allowed to receive customer deposits are mandated to participate in the national deposit insurance scheme, and consequently contribute with ex ante premium payments to a deposit insurance fund. The current premium is calculated as a percentage (0.06 % to 0.14 %) of deposits adjusted for individual capital adequacy ratio. For all intents and purposes, the deposit insurance has worked well externally, i.e. between financial institutions and end depositors. However, there has been some questioning of the amount of financing needed for the deposit insurance fund and the distribution of its financing.

In the aftermath of the financial crisis in 2007-2008, the Swedish government established a stability fund, which would internalize future costs of financial crises. The Swedish government started the fund by putting in SEK 15 billion, but further financing would be borne by financial institutions. The final aim was that the stability fund, together with the deposit insurance fund, would reach the size of 2.5% of GDP within 15 years (i.e. by year 2023). The stability fund now coexists alongside the deposit insurance fund and financial institutions make separate payments to each of these two funds.

The current fee structure of the deposit insurance fund, which is almost completely flat, entails several issues. The main issue is moral hazard which encourages financial institutions to take on more risk since the downside risk is limited for the institution and externalized to the deposit insurance fund. Another issue regards fairness between financial institutions. The current landscape of financial institutions in Sweden, consists of four major Swedish banks with lots of diversified mortgage lending, which are relatively safer, against many smaller credit institutes which engage in high margin credit lending.

If the deposit insurance fund is supposed to cover the expected cost of future defaults, then safer banks will be subsidizing riskier banks rather than only paying for its own share of the costs incurred to the deposit insurance fund. In, SOU 2005:16 it was recommended that the current premium system should be replaced by a system that better covers the risk of individual institutes (Statens Offentliga Utredningar, 2005). SOU 2013:16 recommends that the deposit insurance premium should be set so that administrative costs and insurance costs are covered over time. The costs are allocated to the financial institutions by their score in a rating system. The need for a better risk adjusted premium has become more topical due to the following factors (Statens Offentliga Utredningar, 2013): increased deposit volume; higher deposit amounts guaranteed; riskier financial institutions taking deposits and that

banks to a bigger extent use their assets as collateral for their own borrowing.

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1.1 Outline of Study

The aim of this paper is to make a suggestion of a fee structure for the Swedish deposit insurance fund which coexists alongside a national financial stability fund. The suggestion should be rooted in the legal framework in Sweden and the European Union as well as and inquiries by Riksgälden (The Swedish National Debt Office) and other stakeholders. Two pricing models will be implemented to estimate self-financed risk-adjusted deposit guarantee premiums for the four major Swedish banks using data from 2008 to 2012.

This paper will consist of two parts. The first part will give a qualitative investigation of the situation of the Swedish deposit insurance and the second part will implement two different methods of pricing the deposit insurance fees for the four biggest and most important Swedish financial institutions. Section one will begin with some background on the Swedish deposit insurance and the reports and considerations from the Swedish National Debt Office. Further perspectives will be added by looking at fee structures implemented in other countries and from a summary on the theoretical background of the deposit insurance. Section one will end with an academic foundation of advantages and disadvantages of different pricing models. Following, in section two the theory and method of implementing an option based and a credit based insurance premium model will be covered. Section three continues with presenting the data and section four and five will analyze and discuss the results. The paper will end by summarizing and concluding our results.

1.2 Background

1.2.1 Legal Framework of the Current Financing of the Swedish Deposit Insurance

The Swedish deposit insurance is still being regulated by the legislation that came with its implementation in 1996. The paragraphs relevant to this paper are 12-15 regarding fees to the deposit insurance fund and are included below. The following paragraphs are translated (by the authors) directly from the law 1995:1571 on deposit insurance:

§12 Every financial institution that is included in the deposit insurance scheme shall pay

an annual fee to the administrative authority. The size of the fee will be based on the deposit amount at year end of the previous year, to the extent of inclusion of the deposits in the deposit insurance scheme. The total fees paid by the financial institutions shall amount to 0.1 percent of the deposit amount.

The stipulation in the first section is not applicable when the fee for a specific financial institution is 1) regulated in §14, 2) case specifically handled in the administrative law (1986:223 §27), or, 3) overturned by the general administrative court according to law (2007:1433).

§13 The administrative authority shall on an annual basis decide the amount each financial institution shall pay; the fee is due one month after the decision date.

The fee shall amount to the size of the deposit, to the extent of their inclusion in the deposit insurance scheme, multiplied by a factor ranging from 0.6 to 1.4 times the basis stipulated in §12. The fee shall be adjusted depending on the capital adequacy ratio of the financial institution, calculated according to 2nd chapter §1 of the law on capital adequacy ratio and big exposures (2006:1371).

An interest charge is set for delayed payments, unless there are extenuating causes. The interest charge is based on the reference rate set by the Swedish central bank, plus 8 percentage points according to the interest rate law (1975:635 §9).

§14 If the deposit insurance scheme is initiated for a financial institution during a calendar year, the fee for that year will be adjusted to the part of the calendar year in which the deposit insurance scheme was active. The fee shall be based on the deposit amount and otherwise calculated in the same manner as stated in §13.

If the deposit insurance is deactivated for a financial institution, the fee for that calendar year shall consider only the part of the calendar year in which the deposit insurance scheme was active and otherwise calculated in the same manner as stated in §12 and §13. Law (2000:95).

§14a The administrative authority may charge a fee for an application to be included in the deposit insurance scheme according to §3a. The Swedish government or the administrative authority that the government selects may announce provisions of the fees. Law (2011:829)

§15 The administrative authority shall deposit paid fees in interest bearing accounts with the Swedish treasury or in sovereign Swedish debt instruments. From the deposit insurance

funds the administrative authority may deduct costs for managing the deposit insurance fund and the costs that the approval commission incurred from advising financial institutions on the deposit insurance scheme.

To the extent that paid fees do not cover insurance payments the administrative authority may borrow money from the Swedish treasury. Law (2011:829).

1.2.2 Fee Structures Mentioned by the Swedish Treasury

1.2.2.1 Pricing Based on Credit Rating The use of credit rating for evaluating credit risk is a common practice, and it often extended to financial guarantees (e.g. the deposit insurance). The credit rating can be applied to a financial institution as a whole or to specific debt contracts. Credit ratings are usually made by external independent institutions, likely Standard & Poor's, Moody's Investors Service and Fitch Ratings, seeing as the industry is top heavy and mostly dominated by these three institutions. It is mostly the subject company that wants to take on debt that orders a credit rating of itself, to give potential investors an insight to what kind of credit risk they are dealing with. It has been extensively discussed whether this poses too big of a conflict of interest for the credit rating companies.

The credit rating is made considering both qualitative and quantitative factors. Among the qualitative factors, analysts reviews the competitive position of the company within its industry, sensitivities to technology developments, personnel satisfaction at the work place, changes in regulation, qualities of the management and propensity of owners to put up more money in case of financial distress. When it comes to quantitative factors the analysts review the balance sheet, profitability, capital ratio, specific asset quality, liquidity and overall stability.

Mainly the four major Swedish banks are utilizing international capital markets for its financing and opt to purchase the service of being credit rated. The ratings show fairly little variation between institutions; Svenska Handelsbanken places itself one step ahead of the other three banks (Swedbank, Skandinaviska Enskilda Banken (SEB) and Nordea), but all four are deemed well above investment grade level (Statens Offentliga Utredningar, 2005).

1.2.2.2 Pricing Based on Credit Markets Financial institutions that have securities issued to the capital markets can be evaluated on risk through the market prices of their securities. However, some of these securities are trading in ways that are not suitable for risk analysis purposes. The daily interbank market does not differentiate on risk and the four major banks all pay the same rate. Bank certificates (loan terms up to one year) trade on a small and illiquid market, and are mainly issued by mortgage subsidiaries which are disconnected from the division which handles customer deposits. Though it can be argued

that the credit rating of the sizable mortgage division is an approximation of whatever credit rating the whole bank should have, e.g. the interest spread for between Stadshypotek AB (mortgage subsidiary of Svenska Handelsbanken) and SEB bolån (mortgage loans) was 0.3% annually on a five year term, displaying a credit spread can be the basis for risk analysis.

The biggest market is the interest rate swap-market. An interest-rate swap is a contract where two parties enter into positions of exchanging a fixed interest rate for a floating interest rate. The contract hinges on the counterparty being able to honor its commitment with the corollary that a credit risk premium is included in the contract. However, the credit premium is not solely based on the individual financial institution, but also relies more on an overall price of risk of the banking system, This can be exemplified by the spikes in the interest rate swap-market rates due to crises like LTCM, Russia's sovereign debt default in 1998 and the Lehman Brothers bankruptcy in 2008. Another issue with using swap rates is the new market practice of continuously posting collateral to either side that is holding a net positive present value position due to the swap agreement. This diminishes the credit risk premium part of the swap rate (Statens Offentliga Utredningar, 2005).

1.2.2.3 Pricing Based on Option Models The equity can be seen as a call option on the company assets. This implies that the economic value of a company to its shareholders can be used to price company assets. For a deeper understanding of the theory, refer to section two. This method of corporate valuation was first presented by the Nobel prize winner Robert Merton in 1970s, and is frequently used in the finance industry. There are even credit ratings based on option pricing provided by prominent credit rating institutions, e.g. Moody's KMV, Risk Metrics and Kamakura Corporation. Bankruptcy risk is related to the amount of assets in relation to the size of company debt. The likelihood of default comes down to three factors: 1) share price and volatility, 2) distance to default (in units of standard deviations and 3) profitability of default based on "distance to default". Some adjustments can be made to fit the specifications of the deposit insurance, such as the chosen (Statens Offentliga Utredningar, 2005).

1.2.2.4 Pricing Based on Simulation Models Simulation models differ from option pricing in the sense that they are proprietary built and can be uniquely tailored to the target firm. Simulation models generally requires less simplifications than option pricing and it is more flexible to model certain events and idiosyncratic company traits (Statens Offentliga Utredningar, 2005).

1.3 General Considerations

1.3.1 Deposit Insurance Globally

Since USA first implemented a deposit insurance system (DIS) in 1934 following the banking crisis, the banking system in most of the developed countries is now supported by an explicit insurance. As of 31 mar. 2011, 111 countries report having implemented a deposit insurance, and in some countries, such as Canada, Germany and Italy, several deposit insurance systems co-exist.

Deposit insurances can be divided into two categories, funded and unfunded. A funded insurance means that member institutes pay a periodical premium which pools into a common fund. In case of bankruptcy, money from the fund will be used to fund the deficits. An unfunded system will to the contrary have its members contribute to the fund after a bankruptcy. The majority of the deposit insurance systems are funded. In 2003, 14 of the 88 deposit insurance were left unfunded and most of these were in European countries (Demirgüç-Kunt et al., 2005). Of the funded DISs some implement risk-adjusted premiums. At 1995, United States was the first to implement such a system. As of 2002 there were 29 countries implementing risk-adjusted premiums of varying complexity. Table 11 in the appendix shows a list of the those 29 countries and how each country implements the premium pricing (Laeven, 2002). As the table shows, there is a wide variety in the use of premium systems. Some use the U.S. CAMEL-rate system which is highly influenced by qualitative components while others opt for more quantitative methods such as solvency ratio or non-performing loans. Since 2002, some countries have developed more complex systems. Canada developed in 2004 a system containing 13 separate quantitative and qualitative measures while United States has developed separate systems for small and large institutions (International Association of Deposit Insurers, 2011).

1.3.2 Recent Developments in the European Union

The European Union directive 94/19/EC requires union members to implement a deposit guarantee scheme that insures at least 90% of deposits. The directive did however not specify how premiums should be calculated. In a 2006 review it was suggested that contributions should, voluntarily, be risk-adjusted. After the recent financial crisis the European Commission published a proposal for a new Deposit Guarantee Scheme. Though one of the objectives was to rationalize and harmonize, funding was also of great importance and a new suggestion was to establish mutual borrowing between deposit guarantees. It also stresses the importance of implementing harmonized risk-based premiums. The directive proposes that premiums should consist of a non-risk based part, which should be calculated from

covered deposits, and a risk-based part. Individual institutions should in total be made to pay a premium that is no less than 75 % or more than 200 % of that of the average insurance member (European Commission, 2010).

As for the details of the risk-based part of the premium, the directive refers to a report by the European Joint Research Centre investigating different risk-based models. The report lists a number of characteristics a model should have and find two models that fulfill their requirements satisfactorily. The first one is a simple Single Indicator Model, where a single measure, such as capital adequacy ratio, is used to adjust for risk. The second is a Multiple Indicator Model where a number of accounting measures of capital adequacy ratio, asset quality, profitability and liquidity are used to sort member institutions risk categories (European Commision, Joint Research Center, 2009).

If a common European Union Deposit insurance guarantee system is implemented, as suggested in the proposed directive, member unions will be legally required to enforce this. Because of this, Riksgälden is currently waiting for a clear answer from the European Union before deciding to further develop their own suggestion (Barr and Hamren, 2013-04-15).

1.3.3 Stability Fund

Shortly after the Lehman Brother crash, the 20th of October 2008, the Swedish Government proposed a response, "Stabilitetsplanen". It was quickly approved by the parliament and later used when Riksgälden took control of Carnegie later that year. In short terms the main objective of the new legislation, "Stödlagen (2008:814)", was to give the state the power to on short notice support financial institutions by injecting capital or guaranteeing payments when the overall systematic stability is deemed to be at risk. This was believed important in order to insure ongoing financing to Swedish corporations and households. In a longer perspective, the goal of Stödlagen was to create a fund, financed by the financial sector, that would internalize the costs of future financial crises. While the state initially contributed with SEK 15 billion, by collecting yearly fees from credit institutes, the fund is supposed to reach 2.5 % of the Swedish GDP by 2023.

All banks and credit institutions are by Stödlagen required to pay a yearly fixed fee of 0.036 % of total debt excluding some debt guaranteed by state guarantee programs. The percentage structure implies as with the deposit insurance that the majority of fund fees are from the four big banks. There has been an ongoing discussion as to how the stability fund relates to the deposit insurance as both guarantee programs concern financial stability. The Financial Stability Board has proposed to investigate a coordination of the stability fund and the deposit insurance. If a failing financial institute is deemed to jeopardize the overall stability of the financial system, the state is likely to intervene using funds from

the stability fund and for such institutions the deposit insurance will not be called. In a government report SOU 20013:6, the Financial Crisis Committee recommended that the stability fund and deposit insurance fund be merged into a banking crisis reserve but that fees should be collected separately. They also suggest that while the deposit insurance fee should be required of all institutes taking deposits, only those eligible for support from the stability fund should pay the stability fund fee. Such a scheme should with regard to the current development in the European Union be compatible with the proposed EU directive on deposit guarantee schemes (Statens Offentliga Utredningar, 2013).

If risk-adjusted pricing of the deposit insurance is implemented, it is important to investigate whether the model takes into account the stability fee. Option pricing methods for example, prices the total risk of an institution. With such a method, the stability fund fee could be subtracted. Other methods such as credit ratings can be designed to take into account the likelihood of a government bailing-in an institution. It should then be possible to price the deposit insurance separately.

1.4 Academic Research

1.4.1 General Issues

1.4.1.1 Moral Hazard We begin our framework in the article by Douglas W. Diamond and Philip H. Dybvig, Bank runs, deposit insurance, and liquidity. In this article, the authors establish a simplified model to explain the utility created by the bank as a financial institution, to provide liquidity to the small retail investor and at the same time engage in asset transformation (pooling small deposits to invest in illiquid long term investments). They move on to demonstrate the damage that bank runs inflict on the immediate financial institution and then the additional damage caused by contagion. The demand deposit contract inherently has a bank run equilibrium. Among the several options they go through, the deposit insurance is the one that best allows banks to engage in asset transformation, while preventing bank runs. Their model ends at the statement that moral hazard and introduction of risky assets are two interesting factor that can be included in their model (Diamond and Dybvig, 1983).

It does not seem controversial to say that deposit insurance is a source of moral hazard. Financial institutions' ability to attract deposits becomes disconnected from the asset portfolio they hold. Depositors no longer have any incentive to discriminate between which financial institution they entrust their money. This leaves the financial institution in a situation where the financing is fixed in regards to risk, while the choice of risky assets can be driven by bonuses and other types of remuneration. This asymmetry is the root cause of the

problem, even though issues like financial liberalization, regulatory failure and misconduct take some space in the debate. If we accept that deposit insurance as the optimal solution to rule out the bank run equilibrium, we could have any number of solutions to remedy or minimize moral hazard that includes the construction of the deposit insurance, financial regulation, civil law etc. We will for the purpose of this paper limit the considerations to the deposit insurance, more specifically the construction of the fee system. It needs to be risk adjusted to the extent that the government in expectation does not incur any losses. Also as secondary effect, that the gains made by the financial institution by choosing a riskier portfolio is paid for properly. At the same time there is reduction of the negative externality that a risky financial institution can pose to the entire system, as shown by the financial crisis that started in 2007, where no bank could trust the solvency of a counterparty due to asset value uncertainty.

Suggestions that combine different tools that we have encountered in the literature might sound better, but e.g. demanding a high capital ratio affects the cost of financing (as market are not perfectly rational) and in turn the cost of financing for society as a whole. It is the impression that limiting the adjustments to the fees of the deposit insurance simplifies a great deal without rendering the solution a substantially uncompetitive one. In some ways it is practically even more feasible; as this can be implemented by the Swedish treasury alone, without the cumbersome coordination of several institutions (Demirgüç-Kunt and Detragiache, 2002).

1.4.1.2 Business Cycle and Financial Sector Pro-cyclicality Financial cyclicality was shown to be extremely topical during the financial crisis. There was a depositor bank run on Northern Rock in the United Kingdom. There was also a global freeze up of liquidity in the banking system created by the mistrust. Then there were instances of asset fire sales, where financial institutions had to sell assets to cover their liquidity shortage or because assets had their credit rating downgraded, forcing some firms to sell their holdings. Liquidity shortage and credit rating downgrades continued to compound turning it into a system wide deleveraging cycle with major harmful turbulence. Behind all of this is this was the fear that any counterparty a financial institution had, could be holding toxic assets and potentially be insolvent. The interbank market saw much lower volumes and liquidity became a scarcity for any financial institution, regardless of solvency. The trust was gone in the entire system (Greenbaum and Thakor, 2007).

"The idea that the financial sector can amplify the business cycle (the concept of pro-cyclicality adopted here) dates back at least to Fisher (1933)" (Panetta et al., 2009). In the general economy, the financial pro-cyclicality works asymmetrically through credit avail-

ability. In worsening economic climate, assets of households, mainly property, decline and become less valuable as collateral for mortgage loans. Oppositely, when an economy expands the assets of households appreciate and can be used as collateral to a greater extent, expanding credit availability. This positive correlation for asset prices and the business cycle is pro-cyclical as credit contraction and expansion feeds back to the economy in the form of investments and consumption, i.e. economic growth. While this pro-cyclicality goes on in the household part of the economy, the financial sector experiences a similar influence. Balance sheets of banks suffer the same asset appreciations and deprecations. When assets go down in value, equity erodes which effectively increases leverage. A bank can then do two things, 1) acquire more funding or 2) sell asset. Banks would naturally like to sell assets as the prevailing economic climate is scarce of funding. The sell-off of assets has the negative externality of pushing down asset prices further for other financial institutions; this pushes more banks over the edge which forces then to perpetuate the problem.

A modern phenomenon which complicates this matter is securitization and credit ratings. The bundling of financial assets into more complex products with more opaque cash flow structures has forced investor and the entire financial system to rely more on credit ratings. These credit ratings directly affect the practical valuation of the assets in balance sheets of banks. In worsening times, besides asset fire sales, there is also the problem of credit downgrades which effectively decreases the value of which banks can mark their assets into their books. These credit downgrades force banks to sell off these products to maintain a higher leverage ratio. In the financial crisis of 2008, many investors seriously questioned the validity of the credit ratings of securitized assets. It was not necessarily that regulation forced higher leverage through revaluation of assets on banks, but rather it was the extreme risk aversion of investors towards these products that was the driving factor of the deleveraging of banks (Greenbaum and Thakor, 2007; Panetta et al., 2009).

On the back of this, all of the mentioned risk adjusted fee models that have been mentioned in this paper are naturally sensitive to financial statements, interest rate levels and general indebtedness of the firms. This makes them cyclical to the extent that in economic downturns and economic upswings, and these metrics fluctuate with the general economy. As it stands it becomes necessary to do some kind of adjustment to the total sum levied on the guaranteed financial institutions. One idea mentioned could be to have the input not look at the expected value of the loss carried by the deposit insurance on an annual basis, but rather model a business cycle expected value of the loss imposed on the deposit insurance fund. This would mean a small complication of any suggested model, there could for instance be a business cycle smoothing factor multiplied to the fee. Cyclicality issues are extra relevant for financial institutions that rely heavily on institutional depositor financing

and when relatively little liquid assets are held (Chen and Hasan, n.d.).

1.4.2 Using Data from US Banks

When using data from US banks one has to consider that there can be distorting differences. For example, the way of practicing business, the accounting, the regulation and the institutional practice of the governments when it comes to interventions might differ. All of the aforementioned can create bias in any direction. Starting off with business practices, one can just look at the commercial landscape of financial institutions against the same in Sweden. Sweden has a relatively consolidated bank market with a structure of few very big banks and numerous smaller financial institutions. In both countries the concentration is a result from the top heaviness of the biggest banks compared to the others. The business practice of the banks should be reflected in the financial and operational metrics of the firm (in the financial reports). Both IFRS and US GAAP are generous when it comes to information and should any metrics be constructed in different ways it should still be possible to retrieve the underlying components and reconstruct a comparison metric. The only worrisome areas are when component figures are reported in different ways or not disclosed at all. It is even more difficult to discern whether credit portfolios are reported in a fundamentally reasonable manner This will have a huge impact as financial institutions today are in the business of having high leverage. A potential fee system needs to have input on debt seniority, which might not be the case if one uses existing external credit ratings (PwC, 2012).

When it comes to regulation, there is first the everyday business regulation, and then the institutional environment should the bank at risk pose a substantial threat to the system. It is not in the subject matter to discuss the first part at length, as it is different on a country basis, but many of the differences will be reflected in the operational or financial metrics. However it is worth mentioning that in Swedish banks, deposits are junior debt and are not posted against any specific collateral. In case of insolvency deposits will suffer haircuts to the same extent as other junior debt. In the US, it is in most cases the same, but it can be set up in other ways in individual cases. The seniority of the debt is crucial to the expected value imposed on the FDIC and how high the premium a financial institution should pay (Blair and Kushmeider, 2012). The second part is more important. In Sweden there is now the Stability fund to step in and govern troubled banks that pose systemic risk. The US does not have the same explicit system, but the financial crisis was clear evidence that there is in fact a implicit safety net. The Federal Reserve had liquidity lines to their domestic financial institution, but also, it extended to various international banks to protect the intricate and interconnected financial system. In fact, the Swedish Riksbank also partook in a currency swap extended by the US Federal Reserve. The purpose was to

ensure the availability of liquidity in US dollars to large Swedish banks who conduct much of their financing in international financial markets. When US financial institutions got liquidity from the financial institutions they had to post collateral. The collateral was of much lower quality than the general market conditions at that time would have required. This should definitely be seen as an intervention action (Board of Governors of the Federal Reserve System, 2011).

Additionally, there was a TARP program (troubled asset relief program). The TARP program was the US government's measure to address the financial crisis, by insuring or directly buying equity in the banks themselves, up to the amount of $ 700 billion. The purpose was to recapitalize and hopefully stabilize the financial sector. The inclination and propensity of the USA to implement such a system in future is dependent on the government which commands much discretion in regard to timing and size of such an action. This will have effect on safety of deposits as these actions tend to turn things around quickly and in a rather binary fashion, i.e. all or nothing (Shull, 2010; Black and Hazelwood, 2012).

1.4.3 Benefits and Drawbacks of Different Models

When the Swedish treasury was given the task to suggest a new pricing model for the deposit insurance, they created a list of important considerations (Riksgälden, 2007). A translation of that list is provided below.

1. Fair relative measurement of risk – financial institutions with higher credit risk should be debited with a higher premium.

2. Proper incentives – the model should provide the member financial institutions with the correct incentives that make them to lower their credit risk.

3. Non-cyclical fees – the fees to be included in the deposit insurance should not be pro-cyclical and enforce even stronger economic fluctuations.

4. Completeness – the model should be able to include all variables that are relevant to the measurement of credit risk, both qualitative variables and quantitative variables.

5. Objectivity – the model should be replicable by external parties without substantial deviations in the results.

6. Simplicity and transparency – the model should be comprehensible to the paying financial institution and to other parties. That includes the variables as well as the result.

7. Flexibility – replacement of input variables or change of the weighting of the current variables should be practically achievable when it is motivated. Changes will be made based on the criteria: to achieve the highest explanatory value of the model.

8. Independent credit risk assessment – the results from the model should give a satisfying portrayal of the current risk profile of the entire deposit insurance scheme. It should give an absolute measure of risk that lays the foundation for levying a fee that is reflected on that risk.

9. Cost efficiency – the model should take into consideration the quality of the input variables and analysis foremost. As a secondary notion it should take consideration to reasonable cost efficiency.

The Swedish treasury has itself communicated the following three criteria as the most prioritized ones (in the presented order):

1. Fair relative measurement of risk – financial institutions with higher credit risk should be debited with a higher premium.

2. Non-cyclical fees – the fees to be included in the deposit insurance should not be pro-cyclical and enforce even stronger economic fluctuations.

3. Independent credit risk assessment – the results from the model should give a satisfying portrayal of the current risk profile of the entire deposit insurance scheme. It should give an absolute measure of risk that lays the foundation for levying a fee that is reflected on that risk.

1.4.3.1 Flat Rate A flat rate might seem too simplified and almost irresponsible, however, the model that has been used in Sweden implements an almost flat fee. The unfairness is not something that is wildly objected, which otherwise could have been one of the biggest arguments against it. The other obstacle would be the size of the flat fee, whether or not the subjected financial institutions think they are unreasonable. To address some of the other benefits from the considerations of the Swedish treasury, it should be noted that a flat fee is simple for both the Swedish treasury and for the banks. It enables scenario modeling as any firm would immediately know what nominal fee would correspond to changes in deposit amounts and it is cheap to implement. The fact that financial institutions would pay a arbitrary fee is not as bad as it seems in this instance. Sweden has had very few straight up defaults of deposit taking financial firms. Most often there are industry consolidations taking place to avoid defaults. This makes it hard to get data or statistically model the break

even cost of the deposit insurance fund. The immediate and practical drawback is that it offers no governing effect and gives no incentives to firms to take less risk. A more indirect drawback is that it distorts the market as safer banks would be in a sense subsidizing riskier firms (Statens Offentliga Utredningar, 2005).

1.4.3.2 Credit Rating Credit ratings from the major agencies Standard & Poor, Moody's and Fitch have for a long time been widely used and accepted for calculating credit worthiness and likelihood of default. They are flexible and usually into account a wide variety of factors. Using external rating agencies creates a measure of objectivity. They are however subject to some discretion and might be too complex too properly incentivize institutions.

Large corporations usually buy credit rating services from one or several of the major agencies but a large number of the smaller institutions currently has no available credit rating. this problem can be solved by:

- Give institutions without external credit rating a standardized value. A problem with this is that the smaller institutions have a higher variability in riskiness (Barr and Hamren, 2013-04-15).
- By regulation force members of the deposit insurance system to buy rating services. Smaller institutions might however find the costs of buying external rating services too high.
- The insurer develops a credit rating model based on information from member institutions. The deposit insurer might however not have the capabilities or experience to create such a model. This also prevents the insurer from using the wide acceptance of the external credit rating agencies. To create and maintain such a rating system might also, depending on the complexity, be quite expensive.

1.4.3.3 Credit Market The modern credit market has more securities than the traditional bond, there is also interest rate swaps and credit default swaps. All of the above securities should in theory offer a way of pricing the credit risk using financial markets, be it a financial institution or non-financial firm. At first glance it seems like an obvious place to go for pricing of credit risks. However, it should be noted that there is a difference in usage when it comes to the debt instruments depending whether it is a financial firm or not. Non-financial corporates might issue asset backed debt, but it is much more common to issue debt on the firm as an entity. Banks on the other hand are in the business of debt and quite often might raise debt to fund certain projects or assets. Those kinds of debt instruments

do not reflect credit risks of the entity, but more specifically the risk of the assets behind the particular covered bond.

When it comes to interest rate swaps, non-financial firm are often heavily skewed toward the end that trades floating interest rate against fixed interest rate. The purpose is strictly to lower the financial risk and consequently the total business risk. Financial institutions are typically brokering these deals, which mean that they charge for the service and the prices observed are partly set by the financial firm itself. There are two additional problems when it comes to interest rate swaps as a medium to deduce credit risk, 1) the interest rate swap market is partly done over-the-counter and 2) the practice of posting collateral with higher frequency.

For over-the-counter trading, it is much harder to get data and the data is often and understandably not as well kept as exchange traded securities. Since over-the-counter trading basically is a contract between firms, there can in theory, exist trading volume between any two legal entities in the business universe. Though in more practical terms, it is quite reasonable to assume that big established investment banks will be involved in most of the deals. The financial sector is quite consolidated in that business segment, thus lowering the number of data sources. Most of the trading activity would be covered by collecting data from those sources. The interest rate swap is usually struck between to counterparties, with the initial value being zero to both sides (excluding any commission fees). The subsequent market movements then increase the value of one side and symmetrically decrease the value on the other side. This leaves the side that has a net positive value with an exposure to the counterparty. The counterparty might fail to honor its contractual obligation.

In the early history of interest rate swaps, that kind of possible credit risk exposure was covered by including it in the rate terms struck in the contract. The modern solution to this problem is the continuous posting of collateral by both sides. If the interest rate moves to the favor of one side to a predetermined amount, the other side starts posting collateral. This reduces the uncertainty and exposure of the deal, which means that there is no or a much smaller need to incorporate the credit risk into the initial rate terms (Cont and Yu, 2011; Liang, 2007).

Credit default swaps also suffer from the fact that they are traded over the counter. In one respect, there is a fundamental difference from interest rate swaps. Interest rate swaps trade in notional amounts much bigger than the global GDP. Since many non-financial corporates are involved and it is a way to conduct business for them, the liquidity is abundant. The same cannot always be said for credit default swaps. At first, the credit default swap can seem like an insurance against corporate default, but it is widely used by parties that have no risk in the underlying firm of the credit default swap. Credit default swaps have partly

become financial securities for speculative purposes, and although a functional market yields a reliable credit risk price, there are systematically times when they are not functional. The suspension of credit default swaps and shorting in financial institutions were frequently discussed and even implemented at times during the financial crisis. Politicians were accusing the financial markets of predatory herd behavior, and were speaking with short trades and credit default swaps in mind.

A credit default swap is basically the same as shorting a bond; it is a derivative instrument which can be replicated by shorting the underlying debt instrument. In that way, a financial institution can synthetically create the security and sell it without taking the other side of the trade. When some firm buys a credit default swap from a bank, that bank has to short sell the bond. If the bond trades lower the financing costs of the firm goes up. This means that the buyer of the credit default swap is actively affecting the financing cost and default probability in a way through his purchase. This creates a controversial relationship which in media has been phrased like buying fire insurance on someone else's house and then setting that house on fire (Longstaff et al., 2005).

1.4.3.4 Option Model A strong advantage of using an option model to price the premium is the firm academic background and that the underlying theory is widely known and understood. This creates both objectivity and transparency in the sense that anyone with access to market data can study and implement the model. Another advantage is that for a given set of input variables, the model gives an absolute measure of the insurance premium value, improving objectivity. The fact that it only uses publicly available data and that evaluation of the model is very straight forward, implies low administrative costs.

The main drawback is that the general option pricing model is only applicable to publicly traded institutions. There have been attempts to expand the theory to also include privately held institutions as by Falkenheim and Pennacchi (2003). They try to find a relationship between financial institution's accounting information and market derived risk characteristics to predict risk of privately held banks. A problem with this and other similar approaches is the inability to use information from financial markets. Another disadvantage is the abstract nature of the model. Equity volatility, being a driving variable, might be perceived by banks as difficult to control in comparison to for example capital adequacy ratio.

2 Methodology

In this and coming sections we will compare the current deposit insurance premiums to those suggested by two alternative absolute pricing methods. We will first cover the theory of option pricing to in order to reach an implementable model. We will then attempt to create a simplified implementation of a rating model as suggested by Riksgälden. The implementation will involve only banks traded on the market. This is due to availability of market data for the option pricing and external credit rating for the rating pricing method.

2.1 Option Pricing Model

2.1.1 Model

Using the Black-Scholes model to price the deposit insurance was first suggested by Merton (1977). Though there are other implementation such as Marcus and Shaked (1984), we will follow implementation as suggested by Ronn and Verma (1986). For a full derivation of the model, refer to the original paper. In this setting, the deposit insurance is modeled as a put option on the bank, where

- B_1, insured deposits
- B_2, debt other than insured deposits so that total debt, B=B_1+B_2
- V$\sim$(r,σ_v^2) is bank assets, following a geometric Brownian motion.
- r, drift of asset value, risk-free interest rate
- σ_v, instantaneous standard deviation of V under risk neutral probability
- T, maturity date. The time the bank will be audited.
- δ, dividend divided by assets, paid n times per period.
- N($\cdot$), Cumulative density of a standard normal random variable.

In a simplified setting, where $B = B_1$, i.e. debt is exclusively insured deposits, the put option can easily be explained. If $V(T) \geq B(T)$, the bank can continue running and the value of the deposit insurance is zero. If however $V(T) < B(T)$, the bank will default and the value of the deposit insurance is $B(T) - V(T)$. The value function can thereby be defined as $Max[0, B(T) - V(T)]$. If on the other hand $B_2 \neq 0$, the condition derived in the simplified setting should hold as long as B_1 and B_2 has equal seniority. In practicality, equal seniority is not strictly necessary as long as the bailing-out practice is assumed to extend to all liabilities

of an insured bank (Ronn and Verma, 1986). This has been observed historically in Sweden for example in the financial crisis in 1992 where the Swedish government issued an unlimited guarantee for depositors and other counterparties to Swedish credit institutions (Heikesten, 1998).

In the Merton (1977) model, the maturity date of the option (deposit insurance), should be the expiry date of the deposits. As deposits by definition are continuously rolled over, the maturity is instead interpreted as the time to the next bank audit, which is effectively when the option, in case deposits are not covered, would be called. Another assumption is that the insurance is risk-free, i.e. the insurer will completely cover all claims on deposits with certainty. This effectively creates risk-free deposits which implies the interest rate paid on deposits should equal the risk-free rate.

If the bank assets follow a geometric Brownian motion

$$d\ \ln(V) = (r - \frac{1}{2}\sigma_2^2)dt + \sigma_V dW_V(t)$$

Using the standard Black and Scholes assumptions, the per dollar deposit insurance premium, d, can be derived to be (Ronn and Verma, 1986)

As in the standard Black-Scholes model, the risk-free rate does not enter the pricing function directly. This is due to the assumption of the debt being risk-free which causes the face value of the debt to equal the discounted strike price of the debt. The risk-free rate can however indirectly effect the deposit insurance through the value of assets or the volatility of the value of assets.

2.1.2 Estimation

Estimating the option pricing is problematic as the values of V and σ_v are not observable. A first thing to note is that as insurers are interested in modeling future asset value and volatility, we want to estimate V and σ_V after insurance has been implemented. Ronn and Verma (1986) interprets the value of assets after insurance as

$$V = V' + I - C$$

where V' is value before insurance, I value added from insurance and C is decreased value due to competition. If $C = I$, the value added from the deposit insurance is fully eliminated by competition. If else $I > C$, banks will keep part of the value as a subsidy and the deposit insurance will be mispriced. We will simply assume that the competition fully eliminates the added value so that $V = V' = E + B$, where E is equity of the bank..

Regarding volatility of assets, σ_V, Ronn and Verma use the standard Black-Scholes model to price bank equity

$$E = VN(x) - \rho BN(x - \sigma_V\sqrt{T})$$

where

$$x \equiv (ln(V/\rho B) + \sigma_V^2 \frac{T}{2})/(\sigma_V\sqrt{T})$$

and

$$\sigma_V = \frac{\sigma_E E_t}{VN(x)}$$

where σ_E is the instantaneous standard deviation of the return on equity which can be observed from market data (Ronn and Verma, 1986). This creates an equation system with two unknowns, σ_V and V, and two equations which can be solved numerically. Ronn and Verma estimates σ_E from daily equity return in contrast to the Merton (1977) paper where it is a stochastic parameter. Duan and Simonato (2002) for example, attempted to implement a maximum likelihood valuation of σ_E consistent with the Merton's theoretical framework. For simplicity, we will use the method implemented by Ronn and Verma. They also recognize that for sufficiently small value losses, deposit insurers might choose to inject capital rather than liquidating the bank. To counter for this they introduce ρ, a percentage value so that ρB is the limit when the deposit insurer would choose to liquidate the bank. A problem with this parameter is the difficulty to estimate it as it is more a less a policy variable. It is also not very likely to be a static variable but rather dependent on the systematic risk of the financial institution in question and aggregate economic conditions.

2.2 Rating Model

One of the main advantages of a rating method is the possibility of incorporating a wide array of quantitative and qualitative factors. These factors are often proprietary information and therefore only available to regulators under confidentiality agreements (Statens Offentliga Utredningar, 2005). For this reason, this paper will implement a simplified model based on the probability of default and loss given default framework. This model specifies that the expected loss if a firm defaults is

$$L = PD \cdot LGD \cdot Exposure$$

where PD is probability of default and LGD is loss given default and both are numbers ranging from zero to one. $Exposure$ is in this model a measure of amount of deposits and depending on what assumptions you use, can be either total deposits or only insured deposits.

As we argue in the option pricing section, the Swedish government has historically promised coverage of all deposits. There total deposits will be used in the implementation. Expected loss should measure the expected loss to the deposit insurer and thus the cost of the deposit insurance. There are several ways to measure these factors but in this simplified model we will use information from credit ratings of rating agencies to calculate probability of default as proposed by Laeven (2002). An advantage of using credit ratings from credit rating agencies is that we can emulate the first step of the model as proposed by Riksgälden. As the probability of default is calculated by a rating model calibrated with the external rating agencies models, it should give similar results. Laeven (2002) proposes that the probability of default can be approximated by the 1-year default rate. Luckily, there has not been enough defaults in Swedish banks to estimate the loss given default. We will therefore proxy by using data from the Federal Deposit Insurance Corporation (FDIC) on defaults of American banks. American banks might not be very representative of Swedish banks which might bias our estimate and the cause and effects of this will be discussed later on.

3 Data

The Swedish Banking market is relatively consolidated and a majority of deposits comes from the four big banks, Handelsbanken, Svenska Enskilda Banken (SEB), Nordea and Swedbank. Since the 1990s, some smaller banks such as Skandiabanken, Länförsäkringar Bank, Ikano Bank and ICA Banken have gained market share. A recent development is that stock broking firms such as Avanza and Nordnet have started offering banking and deposit services (Svenska Bankföreningen, 2013).

Table 1: Share of total Swedish deposit market as of Dec 2012

	Handelsbanken	**SEB**	**Nordea**	**Swedbank**	**Others**
Share	17 %	12 %	16 %	21 %	34 %

The four Swedish big banks are well diversified with operations in for example borrowing & lending, insurance, investment banking and fund management. Table 2 shows the simplified balance sheets for the four Swedish major banks (Handelsbanken; SEB, Skandinaviska Enskilda Banken; Nordea; Swedbank)

Table 2: Simplified balance sheets of Swedish Banks from 2008 to 2012 (all values in SEK Billion).

	Handelsbanken				**SEB**			
	Deposits	Debt	Equity	Assets	Deposits	Debt	Equity	Assets
2008	284	2084	75	2159	121	2427	84	2511
2009	320	2040	83	2123	104	2209	100	2308
2010	332	2065	88	2154	89	2080	100	2180
2011	353	2360	95	2454	135	2257	103	2359
2012	371	2281	107	2388	134	2344	110	2453
	Nordea				**Swedbank**			
	Deposits	Debt	Equity	Assets	Deposits	Debt	Equity	Assets
2008	328	4887	191	5077	324	1725	86	1812
2009	326	4924	228	5152	356	1705	90	1795
2010	317	4907	216	5123	392	1621	95	1716
2011	287	6238	236	6474	380	1759	98	1857
2012	289	5525	240	5765	455	1741	106	1847

The Swedish deposit insurance has 141 member institutes as of 2013-04-22 (Riksgälden,

2013*a*). Since the implementation of the Swedish deposit insurance scheme in the 1990s, it has been used twice for defaulting Swedish credit institutes. In 27 January 2006, the Swedish Financial Supervisory Authority, Finansinspektionen, recalled the license to run a credit business from Custodia Kredit AB. The business model of Custodia was to pay higher rates on deposits than the major Swedish banks and also lend at higher rates to investments that might not have been founded otherwise. Finansinspektionen found the internal credit rating lacking and decided to revoke their license which forced Custodia to liquidate the business within half a year. Custodia appealed the sentence which led them temporarily regaining their license but defaulted a few months later 28 August 2006. More than half a year later, 28 February 2007 the repayments were finished and the total payments amounted to SEK 134.1 million to 1282 depositors (Riksgälden, 2011*b*).

The second default was that of the credit institution Allmänna Kapital the 17 November 2006. This came as a verdict from Stockholms Tingsrätt after months of major disturbances in the firm. Evaluating repayments was much faster in this particular case and in 22 December of 2006 The Swedish deposit guarantee had paid a total of SEK 39.6 million (Riksgälden, 2011*a*).

Table 3: Overview of aggregate fees paid to and value of the Swedish deposit insurance fund from 1998 to 2012 (all values in SEK million).

	Income from fees	**Average fee as a percentage**	**Total guaranteed deposits**	**End of year total value**	**Value-to-deposits ratio**
1998	1,947	0.5%	392,000	5,500	1.40%
1999	1,993	0.5%	399,000	7,600	1.90%
2000	1,996	0.5%	399,000	10,300	2.58%
2001	389	0.1%	389,000	11,000	2.83%
2002	429	0.1%	429,000	12,300	2.87%
2003	455	0.1%	455,000	13,300	2.92%
2004	475	0.1%	475,000	14,500	3.05%
2005	490	0.1%	490,000	15,700	3.20%
2006	527	0.1%	527,000	16,300	3.09%
2007	579	0.1%	578,600	17,200	2.97%
2008	639	0.1%	638,800	19,800	3.10%
2009	886	0.1%	886,000	21,000	2.37%
2010	948	0.1%	948,000	22,600	2.38%
2011	1,100	0.1%	1,100,000	26,600	2.42%
2012	1,200	0.1%	1,200,000	28,300	2.36%

Table 3 shows yearly data of fees and market value of the deposit insurance guarantee fund taken from the yearly financial accounts of Insättningsgarantinämnden for the years

1998 to 2007 and Riksgälden from 2008 to 2012 (Insättningsgarantinämnden; Riksgälden) . For the first years, the fees were set so that the total would amount to about 0.5 % of the total guaranteed deposits and in 2001 and onward, this was decreased to 0.1 %. An important thing to note is that insured deposits since 1998 have grown with more than 200 % in comparison to the Swedish GDP which only increased by around 75 % (Statistiska Centralbyrån, 2013). The majority of the growth started in 2008 and is partly due to an expansion of total deposits but also due to legal changes increasing the coverage limit from SEK 250 000 to 500 000 in 2008 and later to €100 000 between 2009 and 2010 (Riksgälden, 2013*b*). The right-most column shows the ratio of market value of the deposit insurance fund to total guaranteed deposits. The ratio was consistently increasing until late 2000s when total insured deposits started increasing rapidly.

3.1 Option Model

For the option model we use yearly accounting data on deposits, debt and assets from the financial reports of the respective institutions. For data on dividend yield we calculated yearly divided per stock with the yearly average number of stocks as specified in the financial reports. To estimate the instantaneous volatility of equity, high-frequency data would have been desirable but we could only find data on a daily basis. Table 4 shows dividends and dividend yields for the major Swedish banks from 2008 to 2012 (Handelsbanken; SEB, Skandinaviska Enskilda Banken; Nordea; Swedbank). Note that the dividends of Nordea are denominated in Euro.

Table 4: Annual dividend and dividend yields of the four major Swedish banks as a percentage of total assets for the years 2008 to 2012.

	Handelsbanken		**SEB**	
	Dividend (SEK million)	**Dividend yield**	**Dividend (SEK million)**	**Dividend yield**
2008	6,756	0.31 %	6,027	0.24 %
2009	6,075	0.29 %	3,839	0.17 %
2010	5,599	0.26 %	3,291	0.15 %
2011	4,986	0.20 %	1,906	0.08 %
2012	4,363	0.18 %	0	0
	Nordea		**Swedbank**	
	Dividend (EURO million)	**Dividend yield**	**Dividend (SEK million)**	**Dividend yield**
2008	1,370	0.19 %	10,880	0.60%
2009	1,048	0.18 %	6,151	0.34 %
2010	1,168	0.22 %	2,433	0.14%
2011	1,006	0.16 %	0	0
2012	519	0.09 %	0	0

3.2 Rating Model

Credit ratings for the four big banks have been collected from the annual financial statements of Handelsbanken. Table 5 shows the long-term credit rating for the years 2008 to 2012 from Standard & Poor (S&P), Moody's and Fitch ratings. Handelsbanken and Nordea consistently show higher rating than those of SEB and Swedbank. While the ratings of Fitch and S&P are relatively stable, the ratings of Moody show rating downgrades on all four banks.

The credit rating agencies annually post reports on statistics of corporate defaults. Table 6 shows historical default rates over a 1 year period taken from the respective rating agency (Moody's Investor Service; Fitch Ratings; Standard&Poor's). As the Swedish deposit insurance premium is determined and paid on a yearly basis, these averages should be interpreted as an estimate for the probability that the insurance is called in a 1 year period. An important thing to note is that the definition of default used by credit rating agencies does not perfectly coincide with the event that would lead to the calling of a deposit insurance.

A problem with the statistics is that for a number of credit ratings, the estimated default rate is zero. We believe this is a problem of available information. From publicly available sources, we could only find information of limited precision. We have seen that other research have used data with higher precision and it would definitely be of relevance to this paper as quite a few observations in our data set leads to zero probabilities. To tackle this, we have assumed that each credit rating firm has rounded their probabilities to a specific number of

Table 5: Long term credit ratings of the four major Swedish banks from Standard & Poor's, Moody's and Fitch rating agencies for the years 2008 to 2012.

	Handelsbanken			**SEB**		
	S&P	**Moody**	**Fitch**	**S&P**	**Moody**	**Fitch**
2008	AA-	Aa1	AA-	A	Aa2	A+
2009	AA-	Aa2	AA-	A	A1	A+
2010	AA-	Aa2	AA-	A	A1	A+
2011	AA-	Aa2	AA-	A+	A1	A+
2012	AA-	Aa3	AA-	A+	A1	A+
	Nordea			**Swedbank**		
	S&P	**Moody**	**Fitch**	**S&P**	**Moody**	**Fitch**
2008	AA-	Aa1	AA-	A	Aa3	A+
2009	AA-	Aa2	AA-	A	A2	A+
2010	AA-	Aa2	AA-	A	A2	A
2011	AA-	Aa2	AA-	A+	A2	A
2012	AA-	Aa3	AA-	A+	A2	A

significant figures. S&P and Fitch for report probabilities to an accuracy of a hundredth of a percent while Moody's reports to an accuracy of a thousandth of a percent. With those assumptions we can calculate an upper limit of the reported zero percentages to 0.005 % and 0.0005 % respectively. For our estimates of probability of defaults, we have decided to use this method when calculating averages across firms. Tables 12 and 13 in the appendix show results with zero-probabilities disregarded for reference.

It is also problematic that using Fitch rating, an upgrade from A+ to AA- would actually lead to a higher expected default probability. This in turn would lead to firms that increase their credit rating, which implies a decrease in riskiness, would actually have to pay a higher deposit insurance.

Table 6: Historical average 1-year default probabilities corresponding to different credit ratings from Standard & Poor's, Moody's and Fitch rating agencies.

S&P	Average 1981-2011	**Moody's**	Average 1983-2010
Credit Rating	**1 year default rate in %**	**Credit Rating**	**1 year default rate in %**
AAA	0.00	Aaa	0.00
AA+	0.00	Aa1	0.00
AA	0.03	Aa2	0.00
AA-	0.06	Aa3	0.048
A+	0.06	A1	0.061
A	0.08	A2	0.065
A-	0.11	A3	0.058

Fitch	Average 1990-2012
Credit Rating	**1 year default rate in %**
AAA	0
AA+	0
AA	0
AA-	0.06
A+	0
A	0.06
A-	0.18

In addition to credit rating data, we have also collected data from the U.S. deposit insurer, Federal Deposit Insurance Corporation (FDIC) on bank defaults. The data set contains information on deposits, assets and estimated loss from defaults on 1652 American commercial banks from 1986 to 2011. Table 7 compares some aggregated statistics of Swedish and American banks. A first thing to notice is the difference in sizes between the two samples. The Swedish major banks are, with a rough approximation of the exchange rate, bigger by a factor of 10^3. From this data the average LGD was calculated for all banks and then only for the commercial banks. For all banks the LGD percentage was 24.8%; and for commercial banks the corresponding number was 23.7%. Also, due to the history of bank separation in the United States, American banks keep a much higher deposits-to-assets ratio. This is likely to create a bias when estimating the expected loss of a default.

Table 7: Comparison of average deposits, assets and deposits-to-assets ratio between the four Swedish major banks from 2008 to 2012 and American commercial banks defaulting during the years 1986 to 2011.

	Domestic Deposits	**Assets**	**Deposits-to-assets ratio**
Swedish banks (billion SEK)	285	2 985	12 %
American banks (million Dollars)	210	250	96 %

4 Results

4.1 Option Model

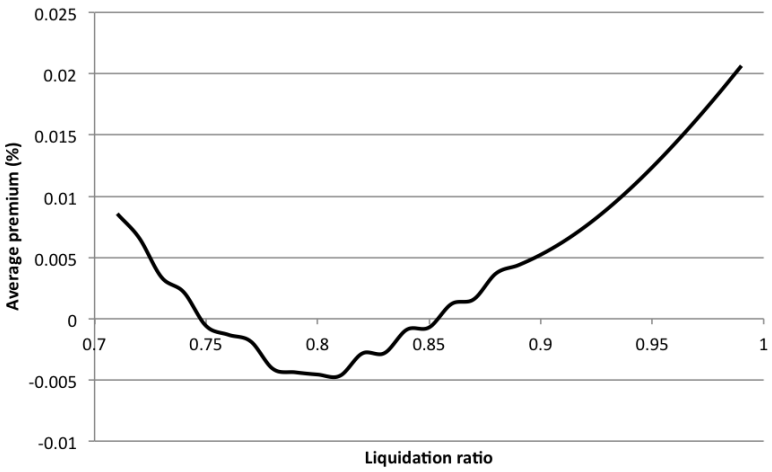
Table 8: Results from implementing an option pricing model of the deposit insurance for the four major Swedish banks for the years 2008 to 2012. $\rho = 0.97$

Handelsbanken	σ_E	σ_V	**Value, millions**	**Deposit insurance, percentage of deposits**	**Deposit insurance, nominal terms in millions**
2008	0.032	0.058	2158784	0.011%	31.24
2009	0.033	0.070	2122843	0.013%	41.60
2010	0.015	0.075	2153530	0.015%	49.80
2011	0.018	0.068	2454366	0.013%	45.89
2012	0.014	0.085	2387858	0.017%	63.07
SEB					
2008	0.047	0.055	2510702	0.010%	12.12
2009	0.048	0.081	2308227	0.016%	16.72
2010	0.020	0.088	2179821	0.017%	15.05
2011	0.025	0.082	2359381	0.016%	21.53
2012	0.017	0.085	2453456	0.016%	21.47
Nordea					
2008	0.033	0.066	5077333	0.012%	39.33
2009	0.037	0.084	5151572	0.016%	52.13
2010	0.018	0.078	5123000	0.015%	47.50
2011	0.023	0.063	6474484	0.011%	31.62
2012	0.016	0.077	5764844	0.015%	43.40
Swedbank					
2008	0.044	0.094	1811690	0.020%	64.81
2009	0.044	0.100	1794687	0.021%	74.79
2010	0.021	0.116	1715681	0.024%	94.15
2011	0.026	0.108	1857065	0.022%	83.63
2012	0.015	0.122	1846941	0.025%	113.83

Table 8 shows the results of implementing the option model for the Swedish major banks. The average deposit insurance as a percentage of deposits for all years and banks is 0.01629 %. It is also important to note that for all observations, the result gives a lower premium than the average of the current Swedish flat rate model of 0.1 %. This goes with the expectations according to Riksgälden, that using risk-adjusted pricing would decrease premiums for the big banks (Barr and Hamren, 2013-04-15). Handelsbanken, Nordea and SEB all seem to have a similar risk profile with premiums around 0.010 to 0.017 % of deposits. This is in contrast to Swedbank with a premiums between 0.020 % to 0.025 %. Another observation

is that estimated risk seem to be increasing during the period.

Figure 1: Average deposit premiums (in percentage of deposits) of the four major Swedish banks for the years 2008 to 2012 as a function of the liquidation ratio parameter, ρ



The table above shows deposit insurance premiums with $\rho = 0.97$. To evaluate the sensitivity of the model to changes in ρ we calculate and display premiums averaged over banks and years as a function of ρ, the ratio of value to debt at which the insurer will step in and liquidate the institution. Figure 1 shows a non-linear relation with increasing steepness as ρ reaches one. The high sensitivity to changes in ρ and the problems of estimating it is a problem for the option model. Positively however, the relative sizes of premiums seem consistent over changing liquidation ratio.

4.2 Rating Model

Table 9: Results from implementing a credit rating model of the deposit insurance for the four major Swedish banks for the years 2008 to 2012.

Handelsbanken	**Average 1-year default rate (%)**	**Expected loss on deposits, flat structure (%)**	**Expected loss deposits given seniority structure (%)**	**Expected loss to assets (%)**
2008	0.0402%	0.0095%	0.0127%	0.0092%
2009	0.0402%	0.0095%	0.0134%	0.0092%
2010	0.0402%	0.0095%	0.0137%	0.0092%
2011	0.0402%	0.0095%	0.0136%	0.0092%
2012	0.0560%	0.0133%	0.0194%	0.0128%
SEB				
2008	0.0285%	0.0068%	0.0080%	0.0065%
2009	0.0487%	0.0115%	0.0137%	0.0112%
2010	0.0487%	0.0115%	0.0138%	0.0112%
2011	0.0420%	0.0100%	0.0119%	0.0096%
2012	0.0420%	0.0100%	0.0120%	0.0096%
Nordea				
2008	0.0402%	0.0095%	0.0111%	0.0092%
2009	0.0402%	0.0095%	0.0113%	0.0092%
2010	0.0402%	0.0095%	0.0114%	0.0092%
2011	0.0402%	0.0095%	0.0113%	0.0092%
2012	0.0560%	0.0133%	0.0164%	0.0128%
Swedbank				
2008	0.0443%	0.0105%	0.0137%	0.0102%
2009	0.0500%	0.0118%	0.0172%	0.0115%
2010	0.0683%	0.0162%	0.0229%	0.0157%
2011	0.0617%	0.0146%	0.0209%	0.0141%
2012	0.0617%	0.0146%	0.0216%	0.0141%

Table 9 shows the results from implementing the credit rating approach. The focus is on the part with debt differentiated in terms of seniority since the Swedish deposits do not have any seniority in case of bankruptcy. The average deposit insurance fee level for all years and banks is estimated to 0.0145%. For each individual bank, in the order of Handelsbanken; SEB; Nordea; Swedbank, the minimum and maximum values are as follows: [0.0127-0.0194%], [0.0080-0.138%], [0.0111-0.0164%], [0.137-0.0229%]. It is very noteworthy to see that Handelsbanken does not place itself as the safest bank here. There is a big discrepancy when differentiating the liabilities on seniority. When looking into the differences, it is discernible that Handelsbanken and Nordea have acquired a higher fraction of their liabilities in debt paper with a more senior structure. They are also the two banks with lowest percentage risk to their assets in total. The payment levels estimated with this credit rating approach suggest a substantially reduced premium level for the four biggest banks. There is a slight deterioration in credit ratings over the period leading to somewhat higher

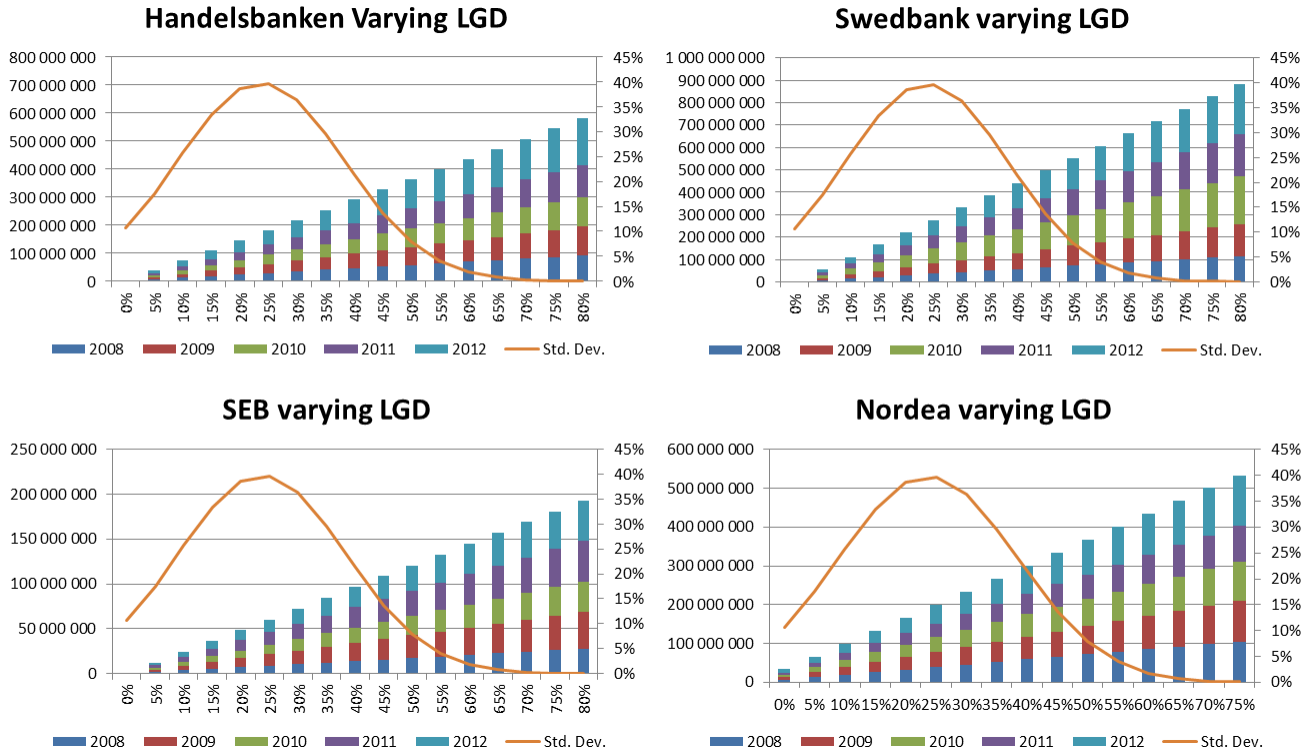
suggested premium fees.

Table 10: Expected loss in nominal terms from implementing a credit rating model of the deposit insurance for the four major Swedish banks for the years 2008 to 2012.

Handelsbanken	Expected loss deposits, flat structure (SEK)	Expected loss deposits, seniority structure (SEK)	Expected loss Assets (SEK)
2008	27,025,718	36,119,621	198,801,575
2009	30,451,513	42,929,716	195,491,782
2010	31,593,445	45,367,543	198,317,736
2011	33,591,825	47,981,653	226,021,605
2012	49,221,523	72,141,850	306,578,264
SEB			
2008	8,185,484	9,658,243	164,053,260
2009	12,046,349	14,356,179	257,546,086
2010	10,207,921	12,243,934	243,218,872
2011	13,386,800	15,954,958	227,191,566
2012	13,353,207	16,044,743	236,250,318
Nordea			
2008	31,186,727	36,334,454	467,569,569
2009	31,004,874	36,766,457	474,406,215
2010	30,131,582	36,234,517	471,775,065
2011	27,356,117	32,597,168	596,232,715
2012	38,387,481	47,486,213	740,151,185
Swedbank			
2008	34,034,190	44,496,484	184,144,652
2009	42,188,218	61,383,900	205,732,810
2010	63,510,441	89,708,159	268,790,543
2011	55,534,537	79,540,061	262,556,283
2012	66,520,505	98,219,277	261,124,928

Table 10 shows the results in nominal terms and are the actual amount that the model suggests that the banks pay. The data of actual paid amounts over this period was not available. There were a few data points declared in the annual reports of the banks, but it did not cover the entire period for any of the banks. Handelsbanken only disclosed the payments to the deposit insurance fund lumped together with the payment to the stability fund, with no way to discern how much to each, which is why there was no point in trying to construct a column for actual payments to portray the difference.

Figure 2: A bar chart sensitivity analysis of the deposit insurance premiums using a credit rating model for the four major Swedish banks as a function of loss given default (LGD). Left hand column shows the amount of deposit insurance premium and the right hand column the percentage for a normal distribution on the LGD.



The graphs in figure 2 show the change in premiums when assuming different LGD. A sensitivity portrayal of this sort is relevant as the LGD is more likely to vary over different systems than the credit ratings seeing as they should be done with the overall risk to the credit instruments in mind. LGD was subjected to this approach as the best approximation from the available data. The premium level using this model is suspected to be centered under the normal distribution.

5 Discussion

5.1 The Results

The results from applying both pricing models on the Swedish four big banks show a pricing that is substantially lower than the fee that is charged today. However, before the results are accepted or used for argumentation there are some concerns that need to be raised. The option pricing model that was used here was based on the assumption of a flat volatility across the entire range of stock prices. This was also the common practice of pricing options since the inception of option theory. Later on, following the high frequency and magnitude of the following crises, it was found irreconcilable with general observations to price options that way. Statistically speaking the crises should have been impossible. Today the financial markets price options with volatility skews and volatility smiles. With access to historical option prices the volatility at different levels could have been extracted and applied to this option model. Without this correction we know that the option pricing is biased to a lower value. The rather big distance to the 0.1% charged of banks today seems like a valid indication that the big banks are paying too much.

Furthermore, the Ronn & Verma model has the value ρ that has to be set as an input parameter. This introduces one aspect of discretion that is not desirable according to the list of considerations by Riksgälden. The problem could be remedied by actually stating a level where government intervention is taken. An explicit level would most likely be carefully considered by the authorities and include the opinions from the banks. The ρ value is a reminder that the option model could by tailored to reflect the institutional environment for Swedish financial firms. In such cases the input values should be explicitly communicated, both the number and the reasoning behind them.

The credit rating results are more unclear in terms of potential biases. If one accepts the credit rating methodology, then there should not be a huge problem with the probability of default. The credit rating industry is consolidated to a few big firms with vast experience. Their output should be consistent in terms of approach. It is only the default data verification that might not be applicable to other countries than the US (where quality data is most likely to be available). The default probability does not have a systemically known bias. The other factor when using credit rating is loss given default. In the same way as US default data might not be applicable to other countries, the loss given default might also be affected. Although there are not any known biases, it should be that some allowance is kept for an uncertainty range around the values taken from the US FDIC data. The results here are interpreted without the knowledge of any known biases in any direction. The big difference to the target fee of 0.1% and the credit rating suggested fee of 0.0145% is reassuring against

the noise that might come from across country application. It is surprising that the banks have not objected to the fees more vividly or been putting more pressure on the authorities to push for a risk adjusted system. The banks have communicated that they are very safe and should almost pay nothing for the deposit insurance. The results do point in that direction although it is a stretch to call it nothing.

5.2 The Fee System of the Deposit Insurance

While the current Swedish flat rate unarguably does not produce a fair or absolutely priced fee structure, evaluating the risk-adjusted models proposed in the empirical section is inherently difficult. Though the models give an absolute measure of the value of the deposit insurance, the low number and variations of bank defaults in Sweden makes it difficult to compare the estimated models with empirical data. There is a large amount of data on for example American banks, but the general difference of the banking systems makes comparison problematic. This coupled with the displayed sensitivity to hard-to-estimate input variables such as the ρ of option model and LGD in our credit rating model, makes the absoluteness of the results somewhat arbitrary. While we acknowledge the benefits from having a model that accurately prices the risk of all individual institutions as well as of the system as a whole, the inherent difficulty of creating such a model might make policy makers lose track of other important characteristics. Without data to actually compare the results any discussion of fairness becomes compromised. All the models have their principles and reasoning, but the fact remains that the choice and construction of the final model chosen introduces a high level of discretion. In addition, the completeness requirement which states the inclusion of qualitative factors is arguably not mathematically fair to begin with.

The introduction of more risk adjusted fees in itself removes the moral hazard problem. In this regard the relative fairness of the fees does not matter. If the metrics to any model reflects risk to a high degree and the output fee in fact does increase with risk, then the moral hazard problem is overall removed. It is important that the system produces this relationship and that it is transparent in this regard, letting firms know the costs related to taking on more risk. Other fields of academic research covers the property of entrenched management and that individuals at financial institutions might be bonus oriented or have myopic incentives. We feel that this is not something that the deposit insurance should touch upon at all. Those problems need to be directed with more specific instrumental laws.

Another characteristic that Riksgälden deemed important is that fees should be non-cyclical. This is also rather problematic. All models that are driven by present data should to some extent be pro-cyclical. It would appear that this requirement conflicts with that fees

should give an absolute measure of the riskiness of a institution as it is hard to argue against financial risk increasing in economic downturns. One of the main arguments for using a non-cyclical model is that burdening credit institutions with extra fees in recessions or economic crises could actually create a deposit insurance scheme that increases financial instability. We propose that, instead of focusing on finding a non-cyclical model, to implement a post-model adjustment to take into account the current economic conditions. If, for example, institutes face liquidity problems, one could let them pay an average of the most recent years to smooth out payments. This separation relieves the underlying model of the burden to produce non-cyclical premiums. This would permit the implementation of more data intensive models, like option pricing or credit market pricing, which uses higher frequency data. These should otherwise inherently hold a higher cyclicality. We believe this construct creates more freedom to adjust the pricing model.

A concern with this and other cyclical adjustments is that the model loses some of its responsiveness. However, this is not an objection to any specific model, rather it is a fundamental conflict between responsiveness and non-cyclicality. Should this balance be included in the model then the overall applicability of the models will be affected by this metric. A separation of this metric would clearly allow a better optimization of all the other metrics first, and then leave an open choice for how responsive and how non-cyclical the system should be. In response to Riksgälden, we would like to present an alternative short list of the most prioritized criteria that a deposit insurance model should fulfill. We want to move emphasis from absolute accuracy to a model that properly incentivizes institutes to not take on excess risk and create a robust financial system. For this, we have three characteristics of extra importance:

1. Fair relative measurements of risk – While absolute measures being difficult to estimate, it is still important that institutions find fees fair in a relative sense. Banks that are perceived as more risky should pay a higher fee. The underlying factors in which any bank is judged upon must be transparent and understandable, in order to convey the "fairness".

2. Proper incentive – It is not enough that the underlying factors are transparent, they should also be within the locus of control of every financial institution that is included in the system. We believe this is achievable with the introduction of the stability fund. The effects from saving "too big to fail bank" and other firms critical to the stability of the financial sectors can be accounted for separately, and the deposit insurance can only focus on the expected value of the insurance given no government intervention. As we said before, the expected value is affected by which model is chosen. But in this

way, the chosen model will not have to depend on whether or not a financial institution is included into a privileged group. The concept of relative risk would still be intact.

3. Simplicity and cost – The model should consider the cost of operations and collection of data. The data needed should be reliable and internal. The usage of market data, especially option data which considers skewness of volatility, relies on fractioned markets and the selling of transaction data by various different parties. There would be some problems with harmonizing the data and potentially it could suffer from inconsistencies. The cooperation with other Swedish institutions, like Finansinspektionen (the Swedish equivalence to the US SEC), would allow access to cheap and vast amount of data. As it is highly likely that companies will continue to report financial statements to Finansinspektionen, it is a convenient data source.

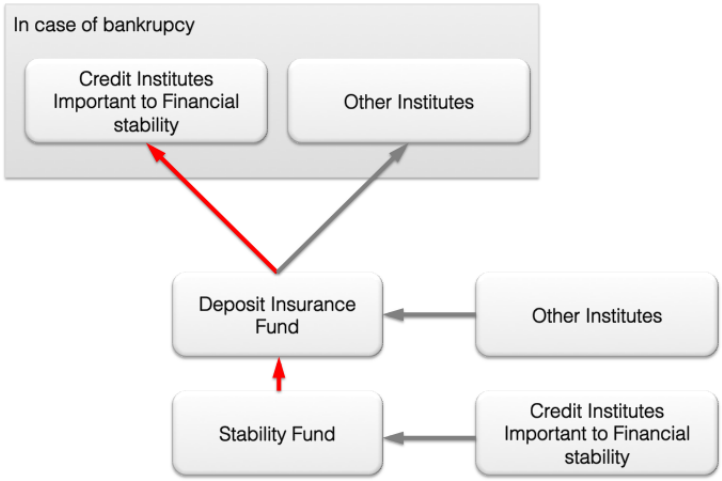
Another issue is the tendency to intervene in banks before defaults are imminent. Stödlagen from 2008 creating the Stability fund is one example of this. Many models used to price deposit guarantee schemes are built by estimating some kind of default probability. It is not clear how to handle the assumption that banks would never be allowed to go bankrupt as this would change the entire premise of the models. One might even argue that for such a system, taking fees from banks to finance a deposit insurance guarantee scheme is unnecessary as the insurance will never be called upon. In a Diamond-Dybvig setting, there should however still be value in having a deposit insurance system to avoid bank runs if the government can not step in to support the banks fast enough. In this respect, the current Swedish system with credit institutions required to pay a stability fund fee and deposit insurance fund fee separately would seem like a hastily thought compromise.

From the data on fees and Swedish bank defaults as presented in section 4, it is clear that historical repayments are small relative to accumulated fees. For example, the two defaults from 2006 of SEK 134.1 and 39.6 million respectively is only around 30 % of fees from that year and only 1 % of the total value of the deposit insurance fund at the end of the same year. Given the assumption that the government is not very likely to let any of the big credit institutions fail, the probability of the insurance fund getting exhausted would seem slight. In response to this we suggest an alternative solution.

On a yearly basis, the responsible agency would identify a set of credit institutions that are considered crucial to overall financial stability. These will typically be larger institutions such as the four big banks in Sweden. This set would fall under the regulation of Stödlagen and required to pay a fee priced with the going-assumption that these institutes will not be allowed to go bankrupt. The remaining credit institutions would go under the regulation of the deposit insurance guarantee scheme where pricing methods as discussed earlier in

this paper could be implemented. The remaining firms would still have the locus of control on factors that affect their deposit insurance fees. The separation of some firms into the Stability fund scheme does have some advantages. Theoretically, "too big to fail" firms would be saved and in expectation, not incur losses on their deposits. The problem of pricing deposit insurance for such firms is solved by completely handling their premiums in the Stability fund. When deposits are not saved in exclusivity there is really no need for inclusion in the deposit insurance fund. Under the Stability fund scheme, those firms can instead be priced with a going concern assumption. This means that not only deposit liabilities have to be honored, but all liabilities need to be honored. The pricing within the two funds would be internally consistent with this setup. Statens Offentliga Utredningar (2013) proposes two fees paid to one fund. We propose two funds and two fees. We think that the deposit insurance fund has high awareness and for practical reasons it should be kept intact toward the end depositor. This means that when a financial firm, that is deemed crucial to the system, goes bankrupt, it is still the deposit insurance fund that covers the deficit of deposits. Afterwards, the Stability fund compensates for the amount paid out. For all the depositor knows, there might as well just exist a deposit insurance fund. For a schematic overview of our proposal, please see figure 3 below.

Figure 3: Schematic overview of the proposed relationship between the stability fund, the deposit insurance fund and the different kind of credit institutes.



The legal framework for the Swedish deposit insurance scheme was hastily drafted after a financial crisis in the 1990s. The state of financial markets and the process of inception of

the stability fund were similarly hasty. The deposit insurance law is fairly simplistic when it comes to the pricing of premiums. It is stated in a few relatively independent paragraphs and could likely be rewritten without a manifold of legal conflicts, leaving the heart of the law intact. The synchronization of the deposit insurance law with the stability fund regulation requires some more work. The changes need to be made simultaneously to create a robust system from the start.

There is an element of uncertainty since the EU is still in the midst of drafting a recommendation for the union and that might limit the possibilities for the Swedish system. The contemplation of a system with all the above information can still be started and worked upon. All the models can be applied with a secondary adjustment - where they are capped in range and desensitized to cyclicality. This is a kind of modularity that can be used in many possible scenarios of the proposed directive. The normalized range of fees between 75-200% of an average premium is quite problematic. We feel that an upper range for firms reintroduces moral hazard. Or, an upper range of fees could be used in combination with other types of regulation that limits financial institutions to operate at all at such high risk levels. The limitations on how much firms should pay relative to other firms is an element that conflicts directly with moral hazard and incentives to reduce risk. It does not ruin the risk adjustments, but as the names suggests it caps the adjustments and the principals behind them. We can relate this limitation to the independent credit risk assessment requirement. If some firms are limited to this range, then all the other firms have to be shifted to maintain the aggregated correct self financing fee. This should not be too hard to apply in a second adjustment, just like the non-cyclicality separation, but it is a serious conflict with many of the other requirements, that have been mentioned. We do not see any need for outliers on either side to be averaged out and pulled toward the middle. High risk takers should be penalized with the proper risk differentiated premium and very defensive financial institutions should not have to have their operations penalized by the risk level of the majority.

Between the four models mentioned by Riksgälden, we agree that the internal credit rating should be the most appropriate one. Credit markets, option model and partly simulation models based on market data are not controlled by the financial institutions themselves and would be a too indirect way of incentivizing them to lower risk. This is a major setback for those models. The fact that Finansinspektionen already receives data from these companies through regular financial reports does make the option of using that type of information much more convenient and reliable. The data collection channel can always be slightly altered should the need for other specific data arise. It is more dependable and fast to use inter-authority relationship with one source than several external private counterparties.

We agree with Riksgälden that a self made credit rating model is the best option, but

like to point out a few pitfalls that needs to be avoided. First of all, the corroboration of the output values against the credit ratings made by the big credit institutes do suffer from the same potential biases as in the credit pricing done earlier. The official ratings done today are mainly done on senior credit which is of higher seniority than deposits, which needs to be accounted for in some way. Secondly, the smaller institution do not have official credit ratings and the model will be applied to those without a valid output check. Furthermore, a credit rating model can be made as simple and as complex as one wants to. While the flexibility is useful, the decided model needs to be communicated to the involved financial institutions. This is a process that should be done before the launch, to gather their opinions and before any future changes to the model. The general model can be open for everyone to see and then Riksgälden can take the individual discussion with the actual input number in the model with each financial institution should they have any inquiries. This satisfies the objectivity requirement on an individual basis, which is good in terms of non-disclosure to competitors.

6 Conclusions

The purpose of this paper was to investigate the current state of the Swedish deposit insurance scheme and in particular discuss how to price the premium paid by credit institutions. The paper explained the theoretical background and need of risk-adjustment of the deposit insurance and the legal framework in Sweden and the European Union as well as general global developments. We also addressed the concerns of how the deposit guarantee scheme relates to the 2008 stability fund and the issue of cyclicality. We then moved onward to discuss different premium pricing models and their benefits and drawbacks. The second part of the paper presented a quantitative overview of the Swedish deposit insurance scheme and the implementation of a credit rating based model and an option pricing based model on the Swedish four major banks, Handelsbanken, SEB, Nordea and Swedbank for the years 2008 to 2012.

Our main finding is that the current flat rate model greatly overprices the the four banks in our data set which together comprise about three fourths of the total payments to the deposit insurance fund. An issue however, is that the results of the option model is sensitive to a hard-to-estimate policy variable and that our implementation of the credit rating model is dependent on data from American banks.

We believe that two of the criteria from the list of important factors as proposed by Riksgälden, i.e. non-cyclicality and absolute credit risk measurement, should be reconsidered. Non-cyclicality does not have to be inherent to the model and can be adjusted for afterward and absolute credit risk measurement is difficult due to the discretion of models and lack of empirical evidence. Instead, we propose focusing on simplicity and proper incentives while still holding fees fair relative to risk. This is best accomplished with the credit rating model proposed by Riksgälden as long as simplicity and transparency is ensured.

The implementation of the Stability fund in 2008 has also sparked discussion. As both fees relate to the risk of the bank there are some concern as to what is actually priced in the models. It is also unclear how to think of the deposit insurance for banks that will not likely be allowed to default. A proposed solution is to separate the fees and funds so that the stability fund collects fees from institutions of critical importance to overall financial system stability. These will then be priced with the going assumption that they will be rescued before default. The remaining firms can then be priced using classical deposit insurance models discussed in this paper.

7 Further Research

A continuing problem in this paper has been that of data. The rarity of bank defaults in Sweden forced us to use data from American markets where real and legal settings differ greatly. Since it is not possible or desirable to wait for Swedish data points in the subject matter, one has to turn to other countries for insight. In this paper data from the US was used out of simplicity, as it is better both in terms of availability and amount. However, a deeper knowledge into specific country implementations and of the various financial systems should point to countries of higher similarity. It is likely that Denmark and Norway are more similar to the Swedish system. The matter of getting data is probably much easier should Riksgälden ask for it. If the number of defaults are low there, then the countries could benefit from pooling their data. In general there is a need to further understand the differences between banking markets across the world and how this changes the nature of risks and what parameters are important to measure the risk of a bank. This should be especially important for developing markets where the nature of risks should differ from both Swedish and American markets.

Another issue that has many openings for further research is the theory of option pricing. We have addressed some of the concerns earlier in this paper. One is the fact that the model assumes constant volatility. As this has a tendency to under price options it would be interesting to investigate of contemporary theory used to adjust for this problem also can be implemented on the option theory of deposit insurance. One can here adhere to theory and use modernized theory that adjusts for volatility skews or smiles. Another possibility is to turn to the market and check how the market prices either only bank share options or market wide skew. There might be a conflict between robustness and applicability depending on how many data series one wishes to base the volatility estimate on. A second problem is that of the policy parameter ρ. Neither we or the original authors, Ronn and Verma, have found efficient ways of estimating it and the sensitivity it poses to the model causes some concern of the model as a whole. Though there are many implementations of the original Merton model from 1977, there is yet one that can be fully implementable in a believable way.

The relatively modern trend of bailing out, i. e. the government stepping in to rescue credit institutions before apparent defaults also poses some difficulties to future deposit insurance schemes. As many of the pricing models are based on the assumption that credit institutions default and the deposit insurance be called upon. It is still unclear how the bailing out trend affects these models. The support to failing banks from government is likely to happen much earlier than the default event usually assumed. This should likely

have implications on both the probability of government action and the loss incurred by such events. This is for example a problem with the model suggested by Riksgälden which uses the Expected loss framework where loss given default, probability of default and exposure of default are the three deciding factors.

Riksgälden suggests the use of a completely proprietary credit rating system. The replication made here is based on the credit rating of the big firms, which was viable because Riksgälden intended to synchronize so that the output results turned out fairly similar to the existing and official credit ratings. Though, the construction of a completely new credit rating system would introduce perspectives that is unknown now. However, that is somewhat of an excessive feat given that the European recommendation is still pending and pricing of the deposit insurance premiums to that detail could be made obsolete.

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8 Appendix

Table 11: Global overview of implemented risk-adjusted deposit insurance systems (Laeven, 2002).

Country	**Premium Structure**
Argentina	CAMEL-like ratios and risk assets
Cameroon	Non-performing loans
Canada	CAMEL-like ratios, asset concentration, regulatory rating and adherence to standards
Central Afr. Rep.	Non-performing loans
Chad	Non-performing loans
Colombia	Independent rating (is pending)
Congo, Rep. of	Non-performing loans
Ecuador	Risk rating
El Salvador	Sub-standard securities
Eq. Guinea	Non-performing loans
Finland	Solvency ratio
France	CAMEL-like ratios
Gabon	Non-performing loans
Germany	Risk category and length of membership
Hungary	Capital adequacy ratio
Italy	CAMEL and maturity transformation
Kazakhstan	CAMEL-like ratios
Macedonia	CAMEL-like ratios
Mexico	Determined by ministry of finance
Norway	Risk-weighted assets
Peru	Determined by supervisor
Poland	Risk-weighted assets
Portugal	CAMEL-like ratios
Romania	CAMEL-like ratios
Sweden	Capital adequacy ratio
Switzerland	Earnings and some discretion
Taiwan	CAR and early warning system
Turkey	Capital adequacy ratio
United States	CAMEL-like ratios

Table 12: Results from implementing a credit rating model of the deposit insurance for the four major Swedish banks for the years 2008 to 2012. In this implementation, default probabilities were calculated by the alternative method as described in section 3.2

Handelsbanken	**Average 1-year default rate (%)**	**Expected loss on deposits, flat structure (%)**	**Expected loss deposits given seniority structure (%)**	**Expected loss to assets (%)**
2008	0.0600%	0.0142%	0.0190%	0.0138%
2009	0.0600%	0.0142%	0.0200%	0.0138%
2010	0.0600%	0.0142%	0.0204%	0.0138%
2011	0.0600%	0.0142%	0.0203%	0.0138%
2012	0.0560%	0.0133%	0.0208%	0.0128%
SEB				
2008	0.0800%	0.0190%	0.0168%	0.0183%
2009	0.0705%	0.0167%	0.0169%	0.0162%
2010	0.0705%	0.0167%	0.0171%	0.0162%
2011	0.0605%	0.0143%	0.0169%	0.0139%
2012	0.0605%	0.0143%	0.0171%	0.0139%
Nordea				
2008	0.0600%	0.0142%	0.0166%	0.0138%
2009	0.0600%	0.0142%	0.0169%	0.0138%
2010	0.0600%	0.0142%	0.0171%	0.0138%
2011	0.0600%	0.0142%	0.0169%	0.0138%
2012	0.0560%	0.0133%	0.0176%	0.0128%
Swedbank				
2008	0.0640%	0.0152%	0.0186%	0.0147%
2009	0.0725%	0.0172%	0.0207%	0.0166%
2010	0.0683%	0.0162%	0.0201%	0.0157%
2011	0.0617%	0.0146%	0.0204%	0.0141%
2012	0.0617%	0.0146%	0.0210%	0.0141%

Table 13: Expected loss in nominal terms from implementing a credit rating model of the deposit insurance for the four major Swedish banks for the years 2008 to 2012. In this implementation, default probabilities were calculated by the alternative method as described in section 3.2

Handelsbanken	Expected loss deposits, flat structure (SEK)	Expected loss deposits, seniority structure (SEK)	Expected loss Assets (SEK)
2008	40,370,367	53,954,621	296,965,008
2009	45,487,737	64,127,377	292,020,919
2010	47,193,528	67,768,943	296,242,261
2011	50,178,660	71,673,838	337,625,635
2012	52,737,346	77,294,839	328,476,712
SEB			
2008	17,232,599	20,333,143	345,375,285
2009	14,851,664	17,699,399	317,522,572
2010	12,585,108	15,095,261	299,858,884
2011	19,124,000	22,792,797	324,559,380
2012	19,076,010	22,921,062	337,500,454
Nordea			
2008	46,585,982	54,275,533	698,444,169
2009	46,314,335	54,920,849	708,656,586
2010	45,009,832	54,126,250	704,726,239
2011	40,863,909	48,692,865	890,638,081
2012	41,129,444	50,878,085	793,019,127
Swedbank			
2008	46,061,309	60,220,806	249,218,326
2009	50,625,862	73,660,680	246,879,372
2010	55,765,265	78,768,140	236,011,209
2011	54,033,604	77,390,330	255,460,167
2012	64,722,654	95,564,702	254,067,497