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BANKRÄNTOR OCH AVKASTNINGSKURVAN

– EN STUDIE AV RELATIONEN MELLAN BANKERS IN-OCH UTLÅNINGSRÄNTOR MOT AVKASTNINGSKURVANS RÄNTOR

Filosofie magisteruppsats inom finansiell ekonomi

Nationalekonomi 61-80p

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BANK RATES AND THE YIELD CURVE

- A STUDY ON THE RELATIONSHIP BETWEEN BANKS' DEPOSIT AND LENDING RATES TO TREASURY YIELD RATES

Master's Thesis within Financial Economics

Economics 61-80p

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Sammanfattning

Syftet med denna uppsats är att studera hur banker följer ränteutvecklingen på statsskuldväxlar och statsobligationer när de sätter sina in- och utlåningsräntor. Bankerna som undersöks i denna uppsats är Handelsbanken (SHB) och Föreningssparbanken (FSB) mellan åren 1995 och 2003.

Tanken som ligger till grund för uppsatsen är att skillnaden mellan inlåningsräntan och den korta marknadsräntan – funding spread – samt skillnaden mellan bankens utlåningsränta och den långa marknadsräntan – credit risk spread – fungerar som finansieringskällor för banken. Strukturen av dessa ”spreads” visar hur viktiga de är för banken som finansieringskälla.

Denna uppsats konkluderar att relationen mellan bankernas inlåningsränta och den korta markandsräntan har ett svagare samband än relationen mellan bankernas utlåningsränta och den långa markandsräntan. Detta kan bero på att det idag finns fler sparalternativ på markanden samt att de låga inlåningsräntorna inte skapar incitament för att hålla pengar på kontot – detta bekräftar Baumol-Tobins transaktionsmodell om efterfrågan på pengar. Den starkare relationen mellan bankernas utlåningsränta och den långa marknadsräntan kan bero på att ”the credit risk spread” kan användas som ett prisdiskriminerande verktyg för att knyta kunder till banken. För att detta skall vara möjligt måste bankens ränta ligga närmre marknadsräntan.

Master's Thesis within Financial Economics

Title:	Bank Rates and the Yield Curve – A Study on the Relationship Between Banks' Deposit and Lending Rates to Treasury Yield Rates
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Abstract

The purpose of this thesis is to investigate how well Swedish banks' follow the interest rate development of Swedish Treasury Bills and Swedish Government Bonds when they are determining the levels for their deposit and lending rates. Individuals' deposits in a bank serves as one of the banks main assets in the balance sheet, and the spread between the bank's deposit rate and the short-term market rate is a large source of funding for the bank. If there is a strong relationship of this spread over time, one may assume that this spread is of great importance for financing of the banking firm. The spread between the bank's lending rate and the long-term market rate – credit risk spread – also serves a large source of interest income for the bank, and if this relationship is strong over time, one may assume that this spread is of great importance for financing of the banking firm as well.

The banks subjected for investigation in this paper are Handelsbanken (SHB) and Föreningssparbanken (FSB). This paper finds a weaker relationship between the banks' deposit rates and the short-term market rates, than for the lending rates and the long-term market rates. This indicates that the credit risk spread is of greater importance for financing of the banking firm than the funding spread. The weaker relationship between the banks' deposit rates and the short-term market rate may be due to the great variability of savings alternatives offered in the market place today. The fact that banks today have deposit-deficit may also explain the weaker relationship, which may be explained by the Baumol-Tobin transaction model – where the higher the interest rate, the greater amount is being kept in the account. The stronger relationship between the banks' lending rate and the long-term market rate may be due to the nature of the credit risk spread to function as a price-discrimination tool between lending clients.

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1 Background – Banking Industry and Interest Rates

This section of the paper will present the general role of the bank, and further provide some previous studies and comments on the intended research question for this thesis.

The financial flow in an economy is based on surplus of funds and deficit of funds from different actors in the market. Basically one can illustrate the flow as financial savings by surplus units to financial needs from deficit units. The surplus units constitutes of depositors that lend money to the bank in return for interest earnings, and on the other side borrowers that borrow funds at an interest rate cost. This make up the role of the financial institution, or bank, to act as an agent to efficiently directing the flow of funds between lenders and borrowers.

Since the banking industry is characterised as a service industry it might be useful to gain an understanding of the differences between producers of goods and producers of services. The majority of the differences may be described as; intangibility, inseparability, heterogeneity, and perishability.[1] Intangibility refers to the fact that services does not necessarily take on physical shape. Based on this, clients look for tangible clues surrounded by the service such as, the appearance of the personnel, furniture, etc. Second, inseparability relates to the interconnection between the provider of the service and the client. In general, the service provider and the client connect face-to-face, where the client is directly involved in the production process, in contrast to a producer of a good in a factory that rarely interact with the client. Thirdly, heterogeneity is the difficulty of quality control – meaning that it might be too late to implement quality-control measures before the service reaches the client. Basically it implies that it is very difficult for a service institution to achieve 100% perfect quality on an ongoing basis. Of course, similar problems can be found within manufacturing producers of goods as well. However, they might be able to isolate errors and correct them over time – if errors reoccur at the same points in the process. Finally, perishability relates to the problem that services cannot be stored as inventory – meaning that a service that is not used when available cease to exist.

Ho and Saunders (1981), describes the banking process as banks paying for funds (deposits) at one price – which they denotes as a "bid" price – and lending funds at another – the "ask" price. The spread between the cost of funds and the funds lent out must be large enough to cover the costs of operating the bank, as well as providing a satisfying return on equity. The funds secured by banks in the form of time deposits, demand deposits, and ownership claims are invested in a wide variety of earning assets. According to Klein (1971), this revenue constitutes the main source of bank income.

Ho and Saunders (1981), found a significant correlation between government bonds and the variability of bank lending and borrowing rates. However, Lerner (1981) raises the question to Ho and Saunders findings whether government securities are good proxies for the variability of bank lend-

[1] Hoffman and Bateson, pp. 24-36, (1997)

ing and borrowing rates, since when interest rates drops, unrealised gains and losses are neglected from the income statement of the bank.

The impact of the Treasury Bill rate on bank profit has been tested both by Flannery (1981) and Hancock (1985), where the former finds that the rate of U.S. Treasury Bills has no significant impact on the net profits for thirteen of the fifteen banks examined. Hancock on the other hand, finds that increases in interest rates have a positive effect on the variable profit of the bank.

Klein (1971) finds that the optimal loan policy of a bank would be to *increase* loans to the point where the marginal expected return on loans equals the expected return on Government securities. However, Pringle (1973) argues that the optimum is where the marginal expected return on loans is higher by the amount of the risk premium required by the bank's equity holders, and hence not purely equals the expected return from Government securities.

Flannery (1982) argues that a production process where customer-specific costs are shared by both the client and the bank can explain both long-term customer relationship, and also the tendency to deposit rates to lag behind the market rates – both on the upside and on the downside. Further, Santomero (1984), states that in a simple neoclassical model, deposit rates should move in accordance with market rates. However, Weber (1966) suggested that bank rates will move more slowly for firms with long-lived assets, this is based on the inability of the firm to achieve satisfactory increase in the asset yields from its portfolio – the bank will be forced to adjust its deposit rates more slowly to overall market forces. Also, in Berlin and Mester (1999) it is cited that loan rates appear to move in a smoother fashion than what market interest rates do.

A European Central Bank monthly report (2001) discusses that bank rates follow the market interest rates, but not on a one-to-one basis.

Mishkin and Eakins (1998) argue that it in recent years it has become more difficult in managing financial institutions due to greater uncertainty in the economic environment. Furthermore, they argue that the default on loans have climbed dramatically in recent years. The economic uncertainty and the increased default risk makes financial managers even more concerned about managing the banks interest rate risk and credit risk.

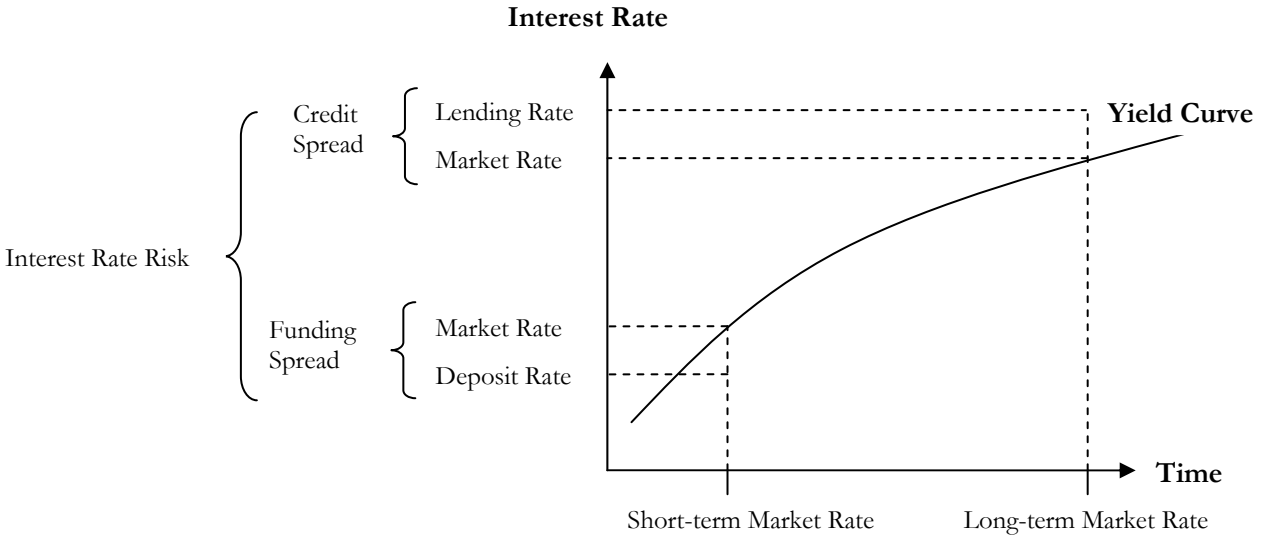
The above paragraphs have briefly described how authors and researches have found different answers to whether the there exits a relationship between the banks rates and the market interest rate, and also the impact on the banks' rates to the overall profit of the banking firm. These notes will be used for outlining the purpose of this paper in the next section of this paper.

2 Purpose and Problem

This section of the paper will outline and specify the focus of the research question for which this paper aims to investigate. Further, this section will outline the limitations for the scope of this paper.

In general, banks offer to lend money at a rate that is higher than the corresponding long-term market rate. Also, banks take on deposits to a rate that is lower than the short-term market rate. Rather than issue short-term debt to the public at the short-term market interest rate, the bank accept deposits at a rate that is lower than the corresponding short-term market interest rate – the spread between the market rate and the deposit rate constitutes the banks funding spread. Further, the bank may refrain from investing in debt instruments at the long-term market interest rate, and lend money to a rate that exceeds the long-term market rate. Since the bank have the possibility to discriminate between borrowing clients, this spread constitutes the banks credit spread. The spreads and their relation to the relevant market interest rates are illustrated in figure 2-1 below.

Figure 2-1 The Credit Spread and the Funding Spread



The interest rates spreads on deposits and lending are major sources for financing the bank and its operations, and this thesis will aim to investigate how well the banks set their deposit and lending rates in accordance with the relevant government treasury yield rates. Basically, the purpose of the paper it is to investigate how well the banks follow the interest rate development of Swedish Treasury Bills and Swedish Government Bonds when they are setting their deposit and lending rates. Thus,

- If there is a low relationship of the spreads over time, one may assume that the spreads are of low importance for financing of the banking firm.
- If there is a strong relationship of the spreads over time, one may assume that the spreads are of greater importance for financing of the banking firm.

2.1 Main Focus and Limitations

The deposit rates used for the investigation in this paper will be that of general savings accounts for short-term savings[2]. The short-term market rate used for comparison is the 12-month market interest rate on Swedish Government Treasury Bills[3].

In general, most loans by private clients from banks are housing loans with duration on approximately 30 years. The interest rate set on the 30-year loan is generally re-negotiated on a 2-year, 5-year or 8-year basis. This thesis will use the 5-year mortgage interest rate as lending rate for housing loans and compare it to the 5-year market interest rate on Swedish Government Bonds.

Since the banks' rates does not change on a daily basis as treasury yield rates do, monthly average means will be used for the estimation processes. Thus,

- Monthly means of deposit rates and monthly average means of short-term market rates
- Monthly means of lending rates and monthly average means of long-term market rates

Data ranging from 1995 to 2003 will be used, which will provide 108 observations for the regression analysis (9 years; 12 periods). Since the banks' rates are held constant over certain time periods this will be regarded as a sufficient break-down in sample-size. This paper aims to compare the deposit and lending rates for two of the main banks in Sweden, namely, Föreningssparbanken (FSB) and Handelsbanken (SHB)[4]. This will make way not only for an investigation of how well the rates correspond to the market rates, but also how it may differ among the competing banks in Sweden.

2.2 Outline of the Paper

The previous sections presented the purpose of this thesis and a general introduction to the research topic in the form of some previous research related to that. Section 3 will provide a theoretical framework of the bond market and the yield curve, further it will present some topics of the banks' financing structure. In section 4 the statistical models used for testing the data will be derived and explained. Following this, section 5 will present and analyse the findings, and chapter 6 will present conclusions of the findings, and also some suggestions for further research.

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[2] Initially this paper aimed to use either savings accounts with limited free-of-charge withdraws, or fixed maturity accounts, but due to difficulties in obtaining data and sufficiently long data-series for the empirical analysis, general savings accounts – associated with the lowest interest rate – were chosen.

[3] The reason for chosing the 12-month interest rate is due to that interest rate for deposits are accumulated on a 12-month basis.

[4] The author is deeply grateful for the support of Mr. Claes Ericsson at Handelsbanken, Jönköping and Mr. Tomas Rosén at Föreningssparbanken, Jönköping, for supplying bank interest rate data, and meeting with me to develop my knowledge of the banking industry. Skandinaviska Enskilda Banken (SEB) were initially supposed to be investigated as well, but due to lack of data supply they have been excluded from the paper.

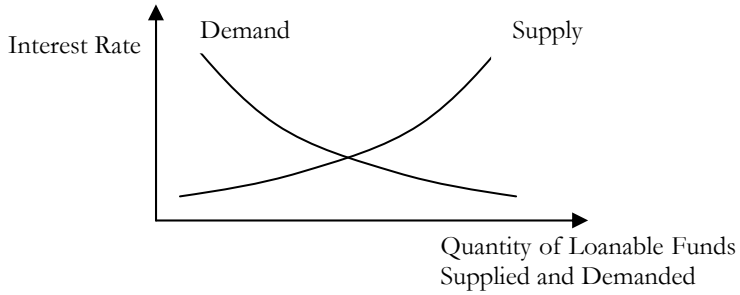
3 Frame of Reference

The section will initially present some fundamental theories of the bond market and the yield curve. Further it will describe the basic structure of the banking firm within society today. Concluding this section will be on the assets and liabilities that constitutes the balance sheet of the bank.

3.1 Loanable Funds Theory

The loanable funds theory views the interest rate determination from a number of factors that affect the supply and demand for loanable funds. The amounts of loanable funds supplied in the market increases as the market interest rate increases, since the reward for supplying funds gets higher.

Figure 3-1 Loanable Funds – Supply and Demand



The largest supplier of loanable funds in the economy is the household sector, who deposits their excess income into a bank where it can be used for lending purposes by corporations and other individuals. The amount of funds supplied is not only determined by the general level of interest rates, but also on the risk of securities investments. Other factors that affect the supply of funds are the investment time-horizon and the liquidity need for the supplier.

Saunders and Cornett (2004), as well as Mishkin and Eakins (1998), lists several factors that affect the supply and demand of loanable funds – or bonds.

Shifts in the supply of bonds:	Change	Supply
• Expected profitability of investment opportunities	↑	↑
• Expected inflation	↑	↑
• Government activities	↑	↑

A firm is willing to increase or take on more debt if it expects to make profitable investments. When expected inflation increases, the real cost of borrowing decreases, thus implying that the amount of bonds supplied will increase at any given bond price and interest rate. As the govern-

ment budget deficit increases, the amount of debt issued by the government increases the supply of bonds and T-bills in the market.[5]

Shifts in the demand for bonds:	Change	Demand
• Wealth	↑	↑
• Expected returns on bonds relative to alternative assets	↑	↓
• Risk of bonds relative to alternative assets	↑	↓
• Liquidity of bonds relative to alternative assets	↑	↑

As the total wealth of financial market participants' increase as a consequence of economic growth, the amount of bonds demanded at each bond price increases. Expectation of higher interest rates in the future, decreases the demand for long-term bonds and consequently decreases the demand. On the other hand, expectations of lower future interest rates increase the demand for long-term bonds. An increase in the risk of bonds will ultimately cause a fall in demand for bonds. If the liquidity of bonds increase, the amount of bonds demanded in the market will increase.[6]

3.2 The Demand for Money – Inventory Theoretical Approach[7]

There is a trade-off between the amount of interest an individual give up in order to hold money and the costs and inconvenience of holding a small amount of money[8]. If the interest rate on a savings account is high, an individual makes more transactions; this implies that the larger the amount of trips to the bank, the greater is the interest earnings in the savings account. This is based on the Baumol-Tobin transaction demand model for money. Assume an individual receiving a monthly payment Y that is spent at an even rate during the month. The individual earns an interest rate i per month in the savings account, and has a cost of tc for moving between bonds and money. The number of transactions is denoted n. If each trip to the bank costs tc, the combined cost of the trip plus the interest foregone is;

$$Total\ cost = (n \times tc) + i\left(\frac{Y}{2n}\right) \tag{3.2.1}$$

Choosing n to minimise costs and computing the implied average money holdings, yields the Baumol-Tobin formula of demand for money;

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[5] Mishkin and Eakins, pp. 106-108, (1998)

[6] Mishkin and Eakins, pp. 102-106, (1998)

[7] The inventory-theoretical approach for money demand is generally associated with Baumol (1952) and Tobin (1956).

[8] Dornbusch, Fisher and Startz, p. 360, (2001)

$$\frac{M}{P} = \sqrt{\frac{tc \times Y}{2i}} \tag{3.2.2}$$

Where (M/P) is the demand for money. An increase in the interest rate will ultimately decrease the demand for holding money in favour for the increased interests earning in the savings account. Recall the total cost of cash management in equation (3.2.1) above. The optimum number of transactions $(n*)$ is found by minimising total cost with respect to n. Thus;

$$n* = \sqrt{\frac{iY}{2tc}} \tag{3.2.3}$$

As initially stated at the beginning of section 3.2, the higher the interest rate on the savings account, the greater the number of transactions being carried out[9]. This is easy to see why; the more cash kept in the account, the greater is the interest earnings for the individual. So, rather than withdrawing a large amount and keep it in the pocket, a smaller amount is withdrawn causing the individual to make more trips to the bank.

3.3 Fixed Income Securities and the Yield Curve

Basically, the yield curve is the plotted combinations of outstanding debt with equivalent credit quality and different maturities[10]. This plotted relationship is also called the term structure of interest rates and the curve may take on different shapes and curvatures. Three basic theories describe the shape of the yield curve[11]:

Liquidity Premium Theory: states that long-term interest rates should be higher than short-term interest rates due to the greater liquidity of shorter maturities. Therefore, investors who are investing at a longer maturity demands a higher yield.

Segmentation Theory: states that the securities market is divided into market segments by different actors in the market that fits their specific liquidity needs. For example, chartered banks prefer short-term maturities to fit their lending strategies, whilst pension funds prefer longer maturities to fit their investment plans.

Expectations Hypothesis: describe the yields of long-term securities to be a function of short-term securities. Basically this implies that long-term interest rates reflect the average of expected short-term interest rates over the time-period that the long-term security is outstanding.

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[9] Dornbusch, Fisher and Startz, pp. 371-372, (2001)

[10] Fabozzi, p. 525, (1999)

[11] Block, Hirt and Short, pp. 191-192, (2003)

Since longer maturities demand a higher yield, the yield curve is normally upward sloping. However, depending on different market conditions and expectations, the yield curve's slope may change and even become inversely related.[12]

Most fixed income securities – in the form of bonds and T-bills – issued by the government are zero-coupon bonds (or pure discount bonds) where the holder only receives the principal (or face value) upon maturity. A coupon-bearing bond (or level-coupon bond) pays out coupons on semi-annual or annual basis depending on the bond's structure. There is also a third kind of bond, called a perpetuity (or consol), that also pays out coupons but does not have a maturity date; thus it has an infinite life. The pricing structure on the different forms of bonds differs;

Price of a zero-coupon bond: $$PV = FVe^{-rT} \tag{3.3.1}$$

Price of a coupon-bearing bond: $$PV = \frac{C}{r}\left[1 - e^{-rT}\right] + FVe^{-rT} \tag{3.3.2}$$

Price of a coupon-bearing perpetuity: $$PV = \frac{C}{r} \tag{3.3.3}$$

Where PV is the present value of the bond, FV is the face value received upon maturity, r is the applicable market interest rate, and T is time to maturity. C is simply the coupons that are being paid-out at different times during the life of the bond. Note that upon maturity, the holder of the bond receives both a coupon payment and the principal. The price of a bond is inversely related to its yield, so if interest rates are increasing the price of the bond will decrease.

3.4 Theory of the Banking Firm

The bank has two main sources of funds; the equity originally invested in the firm, and the borrowed funds that are tied into the firm through various types of deposits. Santomero (1984) describes Klein's (1971) model of banks profit maximisation as a function of the asset categories (A_i), liability categories (D_j), the stochastic return on assets (r_{Ai}), and the stochastic cost for deposits (r_{Dj}):

$$\max \pi = \sum_i r_{Ai} A_i - \sum_j r_{Dj} D_j \tag{3.4.1}$$

Santomero (1984), generalise the above condition and impose that the condition is also subject to the cost (c_j) and service charge for each transaction (k_j). Thus,

$$\pi = \sum_i r_{Ai} A_i - \sum_j r_{Dj} D_j - \sum_j \left[\left(c_j - k_j\right) n_j\left(D_j\right)\right] \tag{3.4.2}$$

Where (n_j) is the number of transactions using the deposit account. Now the bank needs to consider the return on deposits, the cost of the deposit services, and the interrelationship between the

[12] Shim and Siegel, p. 322, (2001)

two. Based on this, an increase in explicit payments on deposits may either increase or decrease the implicit payment depending on the relationship $n_j(D_j)$[13].

To easier understand the above discussion, consider the simplified balance sheet below which lists the assets and liabilities of all Swedish banks for 2003[14].

Table 3-1 Balance Sheet of a Bank

Assets	SEK billion	Liabilities	SEK billion
Lending to Swedish public	993	Deposits from the Swedish public	1005
Lending to foreign public	344	Deposits from foreign public	291
Lending to foreign banks	404	Foreign banks	611
Lending to Swedish financial institutions	493	Swedish financial institutions	223
Interest bearing securities	508	Issued interest bearing securities	350
Other assets	539	Other liabilities	675
Total	3280	Equity capital	125
		Total	3280

The sources obtained by the bank – in the form deposits – are listed under liabilities, and the use of these funds are denoted under assets. The assets obtained by the bank are invested in securities and in loans. One may then denote liabilities as the source of funds for the bank, and the assets – which in practice is issued liability by the bank – uses of funds, as the issued liability generate an interest income which enable the bank to make a profit[15].

3.5 The Balance Sheet – Loans and Deposits as Assets and Liabilities

Loans and deposits from the public accounted for nearly 39% of the balance sheet for Swedish banks at the end of 1998[16]. This has decreased to be around 30% at the end of 2003[17]. The main item on banks' assets-side is lending to the public, and with an international expansion of the banks' this has come to include lending to the foreign public as well; at the end of 2003 domestic and foreign lending accounted for approximately 41% of the total assets for Swedish banks'[18]. The remaining that is needed to finance the banks' lending is obtained by raising capital in both domestic and international money and capital markets – which under normal conditions do not impose any great danger, but in the case that a bank faces solvency problems, they may find it difficult to obtain financing from these sources[19]. The banking system in Sweden – as well as in other countries – has a

[13] Santomero (1984), cites Mitchell (1979) on this relationship.

[14] Den svenska finansmarknaden, p. 78; Sveriges Riksbank (2004)

[15] Mishkin and Eakins, pp. 322-325, (1998)

[16] The Swedish Bankerss Association, p. 26 (1999)

[17] The author's own calculations from balance sheets obtained from *Den svenska finansmarknaden* (2001), (2002) and (2003) issued by the Central Bank of Sweden. Calculations are given in Appendix 3.

[18] Den svenska finansmarknaden, p. 84; Sveriges Riksbank (2004)

[19] Finasiell Stabilitet 2004:2, p. 83, Sveriges Riksbank (2004)

deficit of deposits that consequently does not cover the expense of lending. This gap is also financed through the interbank market and securities market.

The financing of the major banks consist of approximately 80% interest bearing liabilities, where 40% of these interest bearing liabilities are deposits from the public and the remaining 60% are raised in the money and capital markets. The deposits from the public is to be considered a secure source of financing due to the deposit guarantee[20], since the clients incentives to withdraw its holdings in the case of banks' solvency problems are limited.[21]

3.6 The Swedish Credit Market

During the 1980's most OECD countries faced a de-regulation of the financial system, as did Sweden. At first the monetary policy was deregulated and the requirement of banks to purchase government debt was abolished in 1983. Interest rate control and credit regulation were abolished in 1985. It was at this time that banks independently could set their lending and borrowing rates, and decide to whom to lend money. However, from the issue that the increasing government debt no longer could be forced upon banks the government had to increase interest rates in order to convince investors to invest their surplus funds in government debt; from this, modern money and capital market emerged in the 1980's.[22]

Following the deregulation of the credit market in the mid 80's a number of take-overs and mergers followed. The bank-crisis in the beginning of the 90's reduced the number of finance companies and increased the number of mergers and acquisitions leading to fewer banks with subsidiaries. For example, during the second half of the decade Nordbanken AB merged with Merita Abp, Svenska Handelsbanken AB merged with Stadshypotek AB. Föreningssparbanken AB was established through the merger between Swedbank (Sparbanken Sverige AB) and Föreningsbanken AB.[23]

The financial system in Sweden is supervised by The Swedish Financial Supervisory Authority (Finansinspektionen) and the Central Bank of Sweden (Sveriges Riksbank). The latter has the responsibility for monetary and exchange rate policy as well as managing the issuance of notes and coins. The Central Bank of Sweden also acts as the lender of last resort, which basically means that they will provide financial aid in case of liquidity difficulties for banks. Banks may also make overnight deposits at the central bank or make overnight loans. The interest rate on these deposits and loans are subjected to an interest rate corridor – where banks "pay" at the ceiling rate for overnight loans, and "receive" at the floor rate for overnight deposits. It is between the ceiling and the floor that the

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[20] *Insättningsgaranti* – amount up to SEK 250 000 per individual and per bank is protected in the event of bankruptcy. This deposit guarantee came in place 1996 following an EU directive. The Swedish Bankerss Association, p. 26 (1999)

[21] Finasiell Stabilitet 2004:2, p. 44, Sveriges Riksbank (2004)

[22] Södersten (Ed.), p. 232, (2000)

[23] The Swedish Financial Market, pp. 12-13 (1997)

central bank's repo rate is allowed to fluctuate.[24] Before 1992 the central bank's main instrument – the discount rate – was set purely by traditional means of monetary control policy. After 1992 the discount rate is set in accordance with the interest rate development during the previous quarter. Through the discount rate the central bank may influence a current account[25] deficit, by raising interest rates and strengthen the exchange rate of the SEK.

The main objective of Finansinspektionen is to make sure that banks maintain sufficient solvency and follow the regulations and laws of the European Union.

3.7 Banking Structure in Sweden

There are basically three types of banks in Sweden: liability banks, savings banks and co-operative banks. The main limited liability banks are Handelsbanken, Föreningssparbanken, SEB, and Nordea, together they account for approximately 85% of the total credit market in Sweden[26]. A savings bank – in contrast to liability banks – has no equity capital and consequently no shareholders. Profits attained by the savings bank are therefore not distributed among any shareholder, but instead retained within the bank. A co-operative bank is an economic association that conducts banking on behalf of its members. Profits are retained within the bank, but may be distributed as dividends among its members.[27]

[24] The Swedish Bankers' Association, p. 19 (1999)

[25] The current account constitutes a country's exports minus imports, and is a part of the Balance of Payments equation.

[26] Den svenska finansmarknaden, p. 84; Sveriges Riksbank (2001)

[27] The Swedish Financial Market, pp. 36-37, (2004)

4 The Models

This section will describe the statistical models used for testing the hypothesis, and the methods used to detect and adjust for possible errors in the data-set.

4.1 Test Model I – Deposit Rates and 12-month Market Rate

The test model is an Ordinary Least Square (OLS) regression that contains the bank's deposit rate (BDR) as the dependent variable and the short-term market rate (SMR) as the independent variable. Thus,

$$BDR_t = \alpha_i + \beta_i SMR_t + \varepsilon_t \tag{4.1.1}$$

where:

$\alpha_i =$ is the intercept parameter, *BDR* = is the bank's deposit rate, *SMR* = is the 12-month market rate, and $\varepsilon_t =$ is the error term.

The above model[28] is subject to the null-hypothesis that $\beta = 1$, hence there is a perfect one-to-one relationship between the bank's deposit rate and the short-term market rate. The alternative hypothesis where $\beta \neq 1$, is when one rejects the null-hypothesis and accept the estimated beta-coefficient from the regression. Due to the nature of the null-hypothesis the t-stat and p-value from the regression output are ineffective[29]. Instead the model is subjected to the following critical t-test;

$$t_{CALC} = \frac{\hat{\beta} - H_0}{SE(\hat{\beta})} \tag{4.1.2}$$

where H_0 is set to 1, following the above null-hypothesis, and $SE(\hat{\beta})$ is the standard error for the estimated beta-coefficient from the OLS regression. If the calculated t-stat is greater than the tabulated t-stat, one may reject the null-hypothesis and claim that the estimated coefficient is significantly different from 1. The null-hypothesis is subjected to a two-tailed t-test – with 5% and 120 observations (no interpolation will be made).

4.1.1 Checking for Normality

There is a great deal of information "getting lost" when running a regression since one cannot take all existing variables into account in the estimation process. All this unexplained variance in the de-

[28] In real life, most relationships are determined through an infinite number of explanatory variables. It is important to keep this in mind when working with quantitative statistical methods. The problem with inserting too many explanatory variables of the equivalent character, is that one risk to obtaining multicollinearity (inter-correlation between the explanatory variables) which might cause false parameter estimates in the sense of wrong sign-estimates etc. Though, one may still "trust" the outcome from a univariate model, but keeping in mind that several other factors may also affect the dependent variable.

[29] The t-stat and p-value obtained from the MS Excel regression outputs assumes a null-hypothesis where beta is equal to – or alternatively – different from zero. Due to this one needs to calculate a new t-stat that relates to the relevant null-hypothesis.

pendent variable is captured in the residuals. Due to this one wants the residuals to be normally distributed. Checking for normality is done by estimating the kurtosis and skewness on the distribution of the residuals. In general, for the distribution to be considered normally distributed, the kurtosis should be around 3, and the skewness to be around 0[30]. A further technique to check the residuals for normality is to perform a Jarque-Bera (JB) test, which is based on the kurtosis and skewness measures. The JB test is defined as follows[31];

$$JB = \frac{T}{6}\left(S^2 + \frac{(k-3)^2}{4} \right) \tag{4.1.3}$$

where T is the number of observations, S is the skewness, and k is the kurtosis. If the calculated JB statistic exceeds the critical value from the χ^2 distribution with 2 *df*, one may reject the null-hypothesis that the residuals are normally distributed.

4.1.2 Testing for Unit Root

Most data used for statistical estimation and testing contains errors which may influence the result and contaminate the analysis and interpretation, in other words, an analyst takes the risk of making interpretations on results that in fact are false. For instance, if one uses non-stationary[32] data in a regression one takes the risk to obtain a spurious – or false – regression result. In other words, one takes the risk to obtain a significant result between two variables that in fact is false. To test if the data is stationary or not, a unit root test will be performed.

The unit root test for Model I is conducted by using the first difference as the dependent variable, and the first lag as the explanatory variable. Thus,

the AR(1) process for the time series of *BDR* is:

$$\Delta BDR_t = \mu + \gamma BDR_{t-1} + e_t \tag{4.1.4}$$

$$H_0 : \gamma = 0 \text{ and } BDR_t \text{ has a unit root}$$
$$H_1 : \gamma < 0 \text{ and } BDR_t \text{ is stationary}$$

Similar test will be made on the SMR variable. The AR(1) process for the time series of *SMR* is:

$$\Delta SMR_t = \mu + \gamma SMR_{t-1} + e_t \tag{4.1.5}$$

$$H_0 : \gamma = 0 \text{ and } SMR_t \text{ has a unit root}$$
$$H_1 : \gamma < 0 \text{ and } SMR_t \text{ is stationary}$$

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[30] Time Series Analysis, p. 30, Lab 1 (Spring 2004)

[31] Hill, Griffiths and Judge, p. 139, (1996)

[32] A stationary time-series is one whose mean, variance or autocorrelation function do not change over time. A non-stationary time-series is one whose mean, variance or autocorrelation function change over time, Hill, Griffiths and Judge, pp. 335-336, (1996)

The regression is tested using a Dickey-Fuller t-statistic distribution. If the calculated t-value is greater than the critical t-value of the Dickey-Fuller statistic, one *cannot* reject the null-hypothesis and vice versa. If one fails to reject the null-hypothesis, one can conclude that the variable is non-stationary and follows a random walk.

4.1.3 Test for Order of Integration

Sometimes regressions on non-stationary data may not be spurious results after all. When that is the case, the time-series are said to be cointegrated (this will be further explained in section 4.1.4). To be able to perform a cointegration test, both time-series has to be integrated of the same order. To determine the order of integration the following procedure is performed;

If the initial AR(1) model;

$$\Delta BDR_t = \mu + \gamma BDR_{t-1} + \varepsilon_t$$

proves to be non-stationary, one continues to differentiate the model and then regress it. Proceed as follows;

$$\Delta BDR_t = \left(BDR_t - BDR_{t-1}\right) = DBDR_t \tag{4.1.6}$$

Take the first difference of $DBDR_t$;

$$\Delta DBDR_t = \left(BDR_t - BDR_{t-1}\right) - \left(BDR_{t-1} - BDR_{t-2}\right) \tag{4.1.7}$$

Run the following model;

$$\Delta DBDR_t = \mu + \gamma DBDR_{t-1} + \varepsilon_t \tag{4.1.8}$$

with the hypothesis:

$H_0 : \gamma = 0$ *and* $DBDR_t$ *has a unit root*

$H_1 : \gamma < 0$ *and* $DBDR_t$ *is stationary*

If the time-series still is non-stationary, one simply continues to differentiate until the series is stationary. If the above model yields that the time-series is stationary, one may conclude that the variable is integrated of order 1, i.e. I(1). If the time-series still is non-stationary it is said to be integrated of I(2), I(3) or a higher order, I(d). The same procedure is implemented on SMR.

4.1.4 Cointegration Test[33]

If both the dependent and independent variable are non-stationary and I(1)[34], but the error term is stationary and I(0), then BDR and SMR are said to be cointegrated, i.e. they exhibit a long-run relationship in which the residuals do not diverge too far from each other over time[35]. This indicates that the initial OLS is not spurious and may be used after all. If BDR and SMR are non-stationary and I(1), one can assume that any linear combination of them to be that as well. To test whether BDR and SMR are cointegrated one can perform a Dickey-Fuller test on the estimated residuals from the original OLS Model. The following regression will be estimated:

$$\Delta\hat{\varepsilon}_t = \alpha + \gamma\hat{\varepsilon}_{t-1} + v_t \tag{4.1.9}$$

where the hypothesis is;

$H_0 : \gamma = 0 \rightarrow \varepsilon_t$ is non-stationary and BDR and SMR are not cointegrated.

As mentioned earlier, non-stationary data should not be used. However, if it turns out that the residuals in the time-series – from the cointegration test – are non-stationary, and also that BDR and SMR are I(1), one still have a possibility of using the data for regression analysis. Since a differentiated form of BDR and SMR are stationary, a difference model can be set up and estimated. If on the other hand, the residuals are stationary, I(0), one may trust the result from the initial OLS model. But before that, one still has to check the residuals for autocorrelation, or serial correlation.

4.1.5 Test for Autocorrelation

In time-series data the observations follow a natural chronological ordering through time, and there is always the possibility that the error terms will be correlated with each other[36]. Based on this, one may then relax the basic OLS assumption that the error terms (ε_t) in the linear regression model are uncorrelated random variables with mean zero, and constant variance. The most commonly procedure is to use a Durbin-Watson (DW) test to detect autocorrelation, but since the D-W test is a weak test in time-series analysis[37], this paper will use the Breusch-Godfrey (BG) test (also known as a Lagrange Multiplier test). The BG test is based on considering an AR(p) model for the residuals. Recall the initial OLS model;

$$BDR_t = \alpha_i + \beta_i SMR + \varepsilon_t$$

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[33] The theory of conintegration was developed by Granger (1981), and further elaborated by Engle and Granger (1987).

[34] Both the dependent and the independent variable has to be integrated of the same order to be able to conduct a cointegration test.

[35] Hill, Griffiths and Judge, pp. 346-347, (1996)

[36] Hill, Griffiths and Judge, p. 258, (1996)

[37] The DW test assumes that the values from the regressors are fixed in repeated sampling. This assumption is normally difficult to maintain in models of time-series data. In this view, a BG test, which includes lagged values and non-stochastic regressors, is a more appropriate test. Gujarati (2003).

Important to note here is that if the time-series in the above model are non-stationary, one should use the residuals from the differentiated time-series in which they have become stationary. However, there is an exception to this; if the variables are cointegrated, the initial OLS is not spurious and one should use the residuals from the initial OLS to perform the BG test.

Assume that the error term ε_t follows the *p*th-order AR(p), then the distributed lag-model looks as follows;

$$\varepsilon_t = \rho_1 \varepsilon_{t-1} + \rho_2 \varepsilon_{t-2} + \ldots + \rho_p \varepsilon_{t-p} + \upsilon_t \quad (4.1.10)$$

where υ_t is a white noise error term. This model is simply an extension of the AR(p) scheme, with the following null-hypothesis;

$H_0 : \rho_1 = \rho_2 = \ldots = \rho_p = 0$ and there is no serial correlation, or autocorrelation, of any order.

Estimate the model below against the above null-hypothesis;

$$\hat{\varepsilon}_t = \alpha_1 + \alpha_2 SMR_t + \hat{\rho}_1 \hat{\varepsilon}_{t-1} + \hat{\rho}_2 \hat{\varepsilon}_{t-2} + \ldots + \hat{\rho}_p \hat{\varepsilon}_{t-p} + \upsilon_t \quad (4.1.11)$$

Use the R^2 from this regression and multiply it with $(n-p)$. Breusch and Godfrey have shown that if $(n-p)R^2 \sim \chi^2$ exceeds the critical value of the chi-square distribution, with $p = df$, one can reject the null-hypothesis – in which at least one ρ is statistically significant different from zero.

The number of lags included in equation 4.1.11 above is determined using the Schwarz Information Criterion (SIC); which is subject to minimize the following function;

$$SIC = \ln \tilde{\sigma}^2 + m \ln n \quad (4.1.12)$$

from using the following model;

$$BDR_t = \alpha + \beta_1 SMR_t + \beta_2 SMR_{t-1} + \beta_3 SMR_{t-2} + \beta_3 SMR_{t-3} + \ldots + \beta_m SMR_{t-m} + \varepsilon_t \quad (4.1.13)$$

Where $\tilde{\sigma}^2$ is the maximum likelihood estimate of $\sigma^2 (= RSS/n)$, m is the lag length, and n is the number of observations. Basically, one regress several models using several lagged values $(= m)$ and chooses that value of m that minimizes the value of SIC[38]. Since this paper uses average monthly data, the initial number of lags will be 12, and the appropriate number of lags included in the chosen model will be based on the lowest SIC.

4.1.6 Generalised Difference Model

If there is no autocorrelation, one simply uses a differentiated model – i.e. the first difference of BDR and SMR – for the regression analysis. However, if it turns out that the residuals have autocorrelation, one need to adjust the data in order to avoid spurious regressions. In order to obtain a valid result of Model I – in which both variables are non-stationary and not cointegrated, and the

[38] Gujarati, p. 632, (1995)

residuals suffers from autocorrelation – one needs to transform the error term into v_t. This will yield an error term that is adjusted for autocorrelation. To proceed the estimation process the following generalized difference model is derived and set up[39];

$$BDR_t = \beta_1 + \beta_2 SMR_t + \varepsilon_t$$

where,

$$\varepsilon_t = \rho\varepsilon_{t-1} + \upsilon_t$$

Substitue,

$$BDR_t = \beta_1 + \beta_2 SMR_t + \rho\varepsilon_{t-1} + \nu_t$$

To eliminate ε_{t-1}

$$\varepsilon_{t-1} = BDR_{t-1} - \beta_1 - \beta_2 SMR_{t-1}$$

Continue to work the algebra yields the generalised difference model,

$$\begin{aligned} & BDR_t = \beta_1 + \beta_2 SMR_t + \rho(BDR_{t-1} - \beta_1 - \beta_2 SMR_{t-1}) + \nu_t \\ & (BDR_t - \rho BDR_{t-1}) = \beta_1(1-\rho) + \beta_2(SMR_t - \rho SMR_{t-1}) + \nu_t \\ & \Rightarrow \\ & BDR_t^* = \beta_1^* + \beta_2 SMR_{t2}^* + \nu_t \end{aligned} \qquad (4.1.14)$$

Where,

$$BDR_t^* = (BDR_t - \rho BDR_{t-1}) \text{ and, } \beta_1^* = \beta_1(1-\rho) \text{ and, } SMR_{t2}^* = (SMR_t - \rho SMR_{t-1})$$

where ρ is defined and estimated as;

$$\varepsilon_t = \rho\varepsilon_{t-1} + \nu_t \qquad (4.1.15)$$

The difference model will present a corrected estimation of the relationship between the banks rates and the market rates. Also, the model has been adjusted for autocorrelation.

4.2 Test Model II – Lending Rates and 5-year Market Rate

$$BLR_t = \alpha_i + \beta_i LMR_t + \varepsilon_t$$

Where:

$\alpha_i =$ is the intercept parameter, *BLR*=is the banks lending rate, *LMR*=is the long-term market rate, and $\varepsilon_t =$ is the error term.

The above model is subject to the null-hypothesis that $\beta = 1$, hence there is a perfect one-to-one relationship between the bank's lending rate and the long-term market interest rate. The alternative

[39] The model is derived using Quantitative Analysis lecture notes # 3, (2004)

hypothesis where $\beta \neq 1$, is when one rejects the null-hypothesis and accept the estimated coefficient from the regression.

All tests derived in section 4.1 are also applicable for Model II with the banks lending rates and the long-term government market rate.

4.3 The Data Used in the Paper

The data in this paper is quantitative time-series data of deposit and lending rates for Föreningssparbanken and Handelsbanken. Also, interviews have been carried out with representatives from each bank with insight in the interest rate policy in order to help the author of gaining insight in how banks manage their interest rate policy. The banks' interest rates have exclusively been supplied by the banks, and the market interest rates have been obtained from the database EcoWin at Jönköping University Library. All calculations and statistical estimations has been made using MS Excel. The following interest rates are used in this paper;

Handelsbanken – (SHB)

- Deposit rate: Savings Account (*Sparkonto; < SEK 100 000*) – monthly average means; 1995-2003
- Lending rate: 5-year fixed mortgage rate (*Stadshypotek*) – monthly average means; 1995-2003

Föreningssparbanken – (FSB)

- Deposit rate: Savings Account (*Sparandekonto; < SEK 100 000*) – monthly average means; 1995-2003
- Lending rate: 5-year fixed mortgage rate (*Spintab*) – monthly average means; 1995-2003

Government rates

- 12-month Swedish Government Treasury Bill rate – monthly average means; 1995-2003
- 5-year Swedish Government Bond rate – monthly average means; 1995-2003

5 Empirical Results and Analysis

This section will present the statistical results in summarised tables for each model and give some interpretation on the results. Concluding remarks on the analysis is left for the final section is this paper.

5.1 Handelsbanken's Deposit Rates and the 12-month Rate

The first statistics presentation concerns Handelsbanken's deposit rate to the short-term market rate. It is presented in a summarised table where the left column refers to what is being tested for, the middle column refers to which test-method that is being used, and the right-hand side column yields the result and outcome of each test. More thorough outputs are given in Appendix 1.

Table 5-1 Statistics – Handelsbanken's Deposit Rate and the 12-month Rate

Initial OLS – Model I	$BDR_t = \alpha_i + \beta_i SMR + \varepsilon_t$	Calculated t-stat = 1.394 Critical t-stat = 1.980** Fail to reject the null-hypothesis ***Significant at 5%*
	OLS Residuals	Kurtosis = -0.2445 Skewness = 0.201 Jarque-Bera Statistic = 48.099 > 5.991 *Non-normal distribution*
Unit Root Test	Handelsbanken Deposit Rate (BDR) 12-month Gov't T-bill Rate (SMR)	Non-stationary – I(1) Non-stationary – I(1) *Initial OLS is spurious*
Cointegration Test	$\Delta\hat{\varepsilon}_t = \alpha + \gamma\hat{\varepsilon}_{t-1} + v_t$	Non-stationary – I(1) *BDR and SMR are not cointegrated. Initial OLS is spurious.*
Test for Autocorrelation	Schwarz Information Criterion Breusch-Godfrey Test	Lowest SIC is for 1 lag 13.114 > 3.841 – autocorrelation *Calculated value is greater than the critical chi-square value.*
Generalised Difference Model *(Adjusted for autocorrelation)*	$BDR_t^* = \beta_1^* + \beta_2 SMR_{t2}^* + \upsilon_t$ $\rho = 0{,}926$	Calculated t-stat = -4.995 Critical t-stat = 1.980** Reject the null-hypothesis β = 0.647 ***Significant at 5%*

The initial OLS estimation of Model I for Handelsbanken and the 12-month rate fails to reject the null-hypothesis, and one may assume that it holds. The two-tailed critical t-stat for 108 observations

with 5% is approximately 1.980 (in fact; 1.980 is for 5% and 120 observations – no interpolation has been made to fit 108 observations). Failing to reject the null-hypothesis might be a Type II error – where one decides to *not* reject the null-hypothesis when in fact it is false.

The residuals for the OLS model on BDR and SMR also suffer from non-normal distribution, based on the kurtosis and skewness measures. This is further supported by the Jarque-Bera statistic that exceeds the chi-square distribution of 5% and 2 *df*. A plot of the residuals given in Appendix 2 further supports this.

The unit-root tests for BDR and SMR indicates that the time-series are non-stationary and I(1), based on this one may conclude that the initial OLS is spurious, and one may not trust the outcome from the initial OLS. This also supports the fact of the Type II error.

The cointegration test on the estimated residuals yields that BDR and SMR are not cointegrated, which further support the fact that the initial OLS is spurious.

The residuals suffer from autocorrelation based on the BG-test with 1 lag. The estimated ρ =0.926 is used in the generalised difference model to produce an estimate of the model which is adjusted for autocorrelation.

The generalised difference model yields that SMR is significantly different from 1 and one may trust the estimate of 0.647. Interpreting this indicates that if the 12-month market interest rate changes by one unit, Handelsbanken's deposit rate changes by approximately 0.65 units. This is a significant relationship, but far weaker than one would assume it to be.

5.2 Handelsbanken's Lending Rates and the 5-year Rate

Table 5.2 below presents a summary of the statistics calculations applied to Handelsbanken's lending rate (BLR) and the 5-year Government Bond rate (LMR).

Table 5-2 Statistics – Handelsbanken's Lending Rate and 5-year Rate

Initial OLS – Model II	$BLR_t = \alpha_i + \beta_i LMR + \varepsilon_t$	Calculated t-stat = -5.669 Critical t-stat = 1.980** Reject the null-hypothesis ***Significant at 5%*
	OLS Residuals	Kurtosis = -0.264 Skewness = 0.059 Jarque-Bera Statistic = 47.118 > 5.991 *Non-normal distribution*
Unit Root Test	Handelsbanken Lending Rate (BLR) 5-year Gov't Bond Rate (LMR)	Non-stationary – I(1) Non-stationary – I(1) *Initial OLS is spurious*
Cointegration Test	$\Delta\hat{\varepsilon}_t = \alpha + \gamma\hat{\varepsilon}_{t-1} + v_t$	Stationary – I(0) *BLR and LMR are cointegrated.* *Initial OLS is not spurious.*
Test for Autocorrelation	Schwarz Information Criterion Breusch-Godfrey Test	Lowest SIC is for 1 lag 60.025 > 3.841 – autocorrelation *Calculated value is greater than the critical chi-square value.*
Generalised Difference Model *(Adjusted for autocorrelation)*	$BDR_t^* = \beta_1^* + \beta_2 SMR_{t2}^* + v_t$ $\rho = 0{,}755$	Calculated t-stat = -2.066 Critical t-stat = 1.980** Reject the null-hypothesis β = 0.952 ***Significant at 5%*

The critical t-stat in the initial OLS model rejects the null-hypothesis, and one may conclude that LMR is significantly different from 1. The residuals for the OLS model on BLR and LMR, also suffer from non-normal distribution, based on the kurtosis and skewness measures, and the Jarque-Bera statistic. A plot of the residuals given in Appendix 2 further supports this.

As in the previous section both variables are non-stationary in their level form, but their first difference is stationary, hence they are both I(1). This implies that the initial OLS is spurious. The cointegration test indicates that the residuals are stationary and I(0), which bring the conclusion that the

variables are cointegrated and share the same stochastic trend and exhibit a long-run equilibrium. Based on this, the initial OLS model is valid and *not* spurious as previously suspected i.e. one may conclude that LMR is significantly different from 1, and one might trust the beta-estimate from the initial OLS model. However, investigation of suspected autocorrelation indicates that the model suffers from autocorrelation. Note here that the Breusch-Godfrey test has been carried out in level form and not in difference form since the variables are cointegrated. The estimated ρ =0.755 is used in the generalised difference model to produce an estimate of the model which is adjusted for autocorrelation

After all tests have been carried out, one may now trust the outcome from the generalized difference model – which present a result that has been adjusted for autocorrelation – and conclude that Handelsbanken's lending rate has a close relationship with the long-term market rate. If the market rate changes by one unit, Handelsbanken's lending rate will change by approximately 0.95 units.

5.3 Föreningssparbanken's Deposit Rates and the 12-month Rate

The following two presentations will deal with Föreningssparbanken's deposit and lending rates, with the former being presented first.

Table 5-3 Statistics – Föreningssparbanken's Deposit Rate and 12-month Rate

Initial OLS – Model I	$BDR_t = \alpha_i + \beta_i SMR + \varepsilon_t$	Calculated t-stat = 1.932 Critical t-stat = 1.980** Fail to reject the null-hypothesis ***Significant at 5%*
	OLS Residuals	Kurtosis = 0.281 Skewness = 0.439 Jarque-Bera Statistic = 36.746 > 5.991 *Non-normal distribution*
Unit Root Test	FSB Deposit Rate (BDR) 12-month Gov't T-bill Rate (SMR)	Non-stationary – I(1) Non-stationary – I(1) *Initial OLS is spurious*
Cointegration Test	$\Delta\hat{\varepsilon}_t = \alpha + \gamma\hat{\varepsilon}_{t-1} + v_t$	Non-stationary – I(1) *BDR and SMR are not cointegrated. Initial OLS is spurious.*
Test for Autocorrelation	Schwarz Information Criterion Breusch-Godfrey Test	Lowest SIC is for 1 lag 0.154 < 3.841 – no autocorrelation *Calculated value is less than the critical value for 5% and 4 df.*
Differentiated OLS Model	$\Delta BDR_t = \alpha + \beta\Delta SMR_t + \varepsilon_t$	Calculated t-stat = -5.199 Critical t-stat = 1.980** Reject the null-hypothesis β = 0.502 ***Significant at 5%*

The initial OLS estimation of Model I for Föreningssparbanken and the 12-month rate fails to reject the null-hypothesis, and one may assume that it holds. Once again, failing to reject the null-hypothesis might be a Type II error – where one decides to *not* reject the null-hypothesis when in fact it is false.

The residuals for the OLS model on BDR and SMR also suffer from non-normal distribution, based on the kurtosis and skewness measures. This is further supported by the Jarque-Bera statistic

that exceeds the chi-square distribution of 5% and 2 *df*. A plot of the residuals given in Appendix 2 further supports this.

As in the previous sections both variables are non-stationary in their level form, but their first difference is stationary, hence they are both I(1). Based on this one may conclude that the initial OLS is spurious, and one may not trust the outcome from the initial OLS. This also supports the fact of the Type II error.

The cointegration test indicates that the residuals are non-stationary and I(1), which bring the conclusion that the variables are *not* cointegrated and the initial OLS model is spurious as previously suspected.

Investigation of suspected autocorrelation proved to be false. The Breusch-Godfrey test with 1 lag failed to reject the null-hypothesis of no autocorrelation.

Since there was no autocorrelation and that the variables are stationary in their difference form, one may trust the outcome form the differentiated OLS model which estimates a coefficient that is significantly different from 1. This means that if the short-term market rate changes by one unit, Föreningssparbanken's deposit rate changes by approximately 0.5 units. This is approximately the same as Handelsbanken whose parameter was estimated to be 0.65.

5.4 Föreningssparbanken's Lending Rates and the 5-year Rate

This final presentation deals with Föreningssparbanken's lending rate and the 5-year market rate.

Table 5-4 Statistics – Föreningssparbanken's Lending Rate and 5-year Rate

Initial OLS – Model II	$BLR_t = \alpha_i + \beta_i LMR + \varepsilon_t$	Calculated t-stat = -5.633 Critical t-stat = 1.980** Reject the null-hypothesis ***Significant at 5%*
	OLS Residuals	Kurtosis = -0.322 Skewness = 0.186 Jarque-Bera Statistic = 49.819 > 5.991 *Non-normal distribution*
Unit Root Test	FSB Lending Rate (BLR) 5-year Gov't Bond Rate (LMR)	Non-stationary – I(1) Non-stationary – I(1) *Initial OLS is spurious*
Cointegration Test	$\Delta\hat{\varepsilon}_t = \alpha + \gamma\hat{\varepsilon}_{t-1} + v_t$	Stationary – I(0) *BLR and LMR are cointegrated. Initial OLS is not spurious.*
Test for Autocorrelation	Schwarz Information Criterion Breusch-Godfrey Test	Lowest SIC is for 1 lag 59.496 > 3.841 – autocorrelation *Calculated value is greater than the critical chi-square value.*
Generalised Difference Model *(Adjusted for autocorrelation)*	$BDR_t^* = \beta_1^* + \beta_2 SMR_{t2}^* + \upsilon_t$ $\rho = 0{,}752$	Calculated t-stat = -2.541 Critical t-stat = 1.980** Reject the null-hypothesis β = 0.943 ***Significant at 5%*

The initial OLS model rejects the null-hypothesis, and one may conclude that LMR is significantly different from 1. The residuals for the OLS model on BLR and LMR also suffer from non-normal distribution, based on the kurtosis and skewness measures, and the Jarque-Bera statistic. A plot of the residuals given in Appendix 2 further supports this.

As in the previous section both variables are non-stationary in their level form but their first difference is stationary, hence they are both I(1). This implies that the initial OLS is spurious. The cointegration test indicates that the residuals are stationary and I(0), which bring the conclusion that the variables are cointegrated and share the same stochastic trend and exhibit a long-run equilibrium. Based on this, the initial OLS model is valid and *not* spurious as previously suspected i.e. one may

conclude that LMR is significantly different from 1, and one may trust the beta-estimate from the initial OLS model. However, investigation of suspected autocorrelation indicated that the model suffer from autocorrelation. Note here that the Breusch-Godfrey test has been carried out in level form and not difference form, since the variables are cointegrated. The estimated ρ =0.752 is used in the generalised difference model to produce an estimate of the model which is adjusted for auto-correlation.

After all tests have been carried out, one may now trust the outcome from the generalized difference model – which present a result that has been adjusted for autocorrelation – and conclude that Föreningssparbanken's lending rate has a close relationship with the long-term market rate. If the market rate changes by one unit, Föreningssparbanken's lending rate will change by approximately 0.94 units. This is approximately the same as for Handelsbanken whose parameter estimate was 0.95.

6 Summary and Conclusion

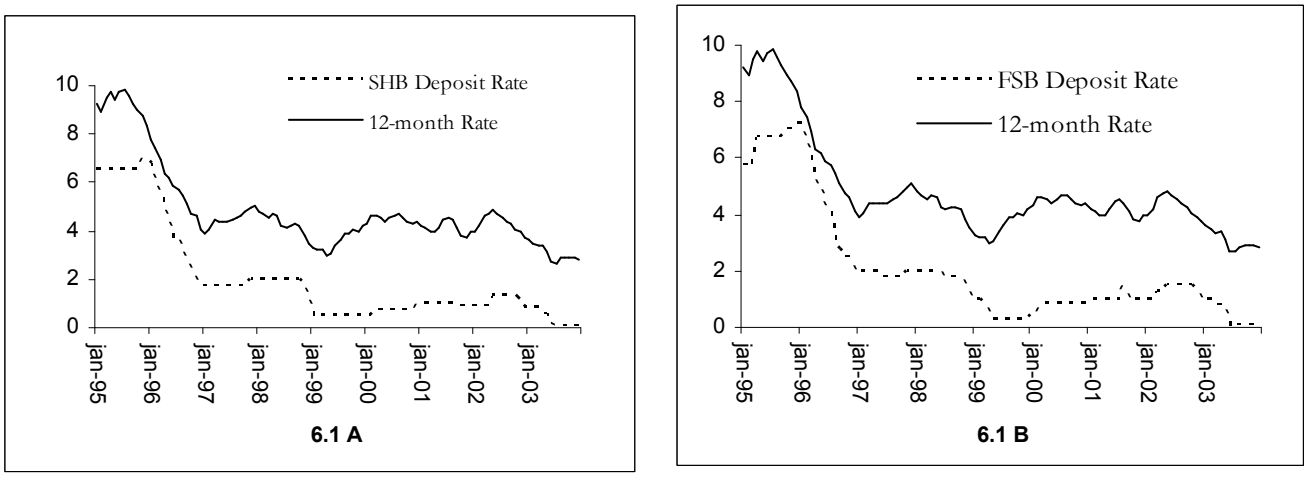
This last section of the paper will summarise the findings from the statistical tests conducted in section 5 and interpret them and make concluding remarks in accordance with the previous research and the theories discussed in section 3.

Both banks' deposit rates seem to follow the short-term market rate in a relatively similar fashion. However, even though that the statistical tests indicate a significant relationship, the presence of unit-roots in all data-series might lessen the probability that the conclusion is correct.

In accordance with the findings of Ho and Saunders (1981), this paper finds a significant relationship between government securities and bank lending and deposit rates – though with a stronger relationship between the banks' lending rates and the long-term market rate. The lower relationship between the deposit rates and the short-term market rate also coincides with Flannery's (1982) argument that deposit rates lag behind the market rates. However, it somewhat contradict the findings of Santomero (1984) that deposit rates move in accordance with market rates. Even if the deposit rates move in accordance with the market rates, it is on a relatively weak basis. This paper also contradicts the finding from Berlin and Mester (1999) – that loan rates would move smoother than market rates – with findings of a strong relationship between the banks' lending rates and the market interest rate.

Regarding the relationship between the banks deposit rates and the short-term market rate it is somewhat lower than what one would suspect (SHB 0.65; FSB 0.5). It may be due to larger competition among savings alternatives offered in the market place today; rather than putting your savings in an interest bearing account, individual's might choose the invest in various fund portfolios that yields a higher return. Interest rates today are at an extreme low, which might be another explanation for the weaker relationship.

Figure 6-1 BANK DEPOSIT RATES AND 12-MONTH MARKET RATE



Source: the author's own production using data obtained from the individual banks and database EcoWin.

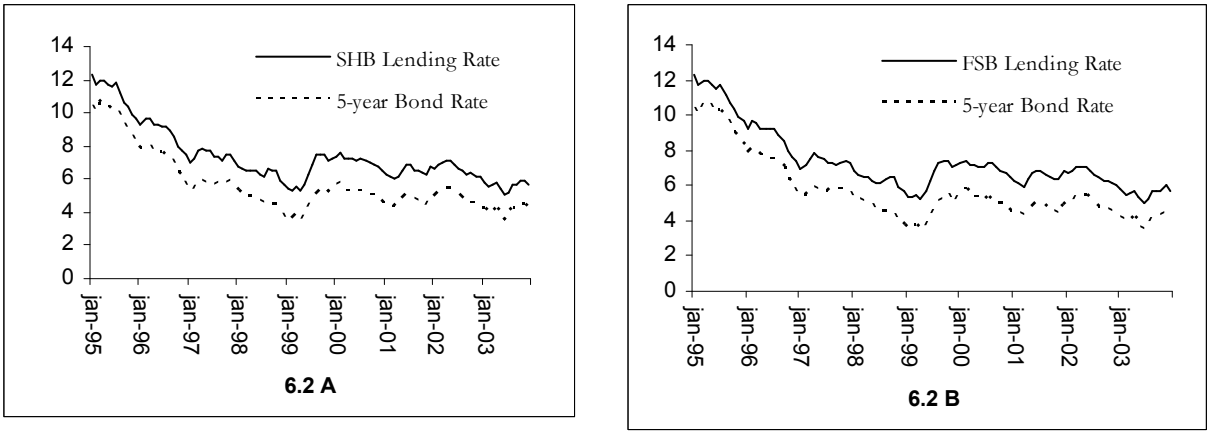
Recall the Baumol-Tobin inventory approach in section 3.2, where the higher the interest rate on the savings account, the less cash is being demanded. Due to this, banks' may be reluctant to follow a continuous decrease in interest rates, since it will decrease the total amount being deposited into

the bank – which will decrease the banks' asset-side – and the banks' then have to turn to the more expensive money and capital markets for financing. The fact that most banks' today faces a deposit deficit might also be explained by the Baumol-Tobin approach.

There is a significant relationship, but from a bank-financing perspective it is a weaker than initially assumed. However, this paper will not rule out the importance of the funding spread for financing of the banking firm, but conclude – that with the current term structure – banks have to use the securities markets and capital markets to obtain full financing.

Since banks lend more to the public than what the public deposit, it put the banks in a position to manage the lending rates with a tighter control; this could be an explanation of the much closer relationship between the banks' lending rates and the long-term market rate (SHB 0.95; FSB 0.94). Also noteworthy is the almost equivalent parameter-estimate for both Handelsbanken and Föreningssparbanken. The tighter relationship might be explained by the fact that lending to the public affects the credit risk exposure from the banks perspective. If the spread were to deviate too much over time it would make if more difficult for the bank to manage their credit risk exposure.

Figure 6-2 BANK LENDING RATES AND 5-YEAR MARKET RATE



Source: the author's own production using data obtained from the individual banks and database EcoWin.

Another explanation of the strong relationship might be how the credit risk spread is used. Basically there are two considerations that dominate a bank's decision whether to approve a mortgage loan application or not; (i) the client's ability and willingness to make timely interest and principal repayments and (ii) the value of the client's collateral. If the bank is confident that the client will be able to fulfil its obligation, the bank may use the credit risk spread to discriminate between clients. If a client is offered a certain interest rate on a loan from one bank and a competing bank offers a lower rate for the equivalent loan, the latter bank has then used its credit risk spread to price-discriminate in order to acquire the client. This approach is confirmed by the Branch Manager, Claes Ericsson at Handelsbanken in Jönköping who describes a client-related flexibility on their lending rates. The Branch Credit Manager, Tomas Rosén at Föreningssparbanken in Jönköping, also proclaim that they monitor their competitors when deciding the level of lending rates. Interpreting this may stipulate that banks may conduct a price-discriminating policy in order to acquire a client. Based on this, one may assume that this spread has an important role to play in generating interest income to the bank.

In sum, the main findings of this paper are:

- Deposit rates relies less on market interest rates than do lending rates.
- The credit risk spread has a relatively greater importance for financing of the banking firm than do the funding spread.
- Banks might use the credit risk spread to discriminate between clients.
- The Baumol-Tobin approach seem to hold in the sense that decreasing deposit rates seems reluctant to follow the short-term market rate on a one-to-one basis, which might explain the deposit deficit that banks faces today.

An interesting feature – which falls outside the frame of this paper – is that the weaker relationship might indicate that there is too little competition in the banking market, which enable banks to keep deposit rates at low level. Further research of the banking market structure would focus more thorough on the tools that banks use to acquire clients Moreover, further research would with pleasure follow Flannery (1981) and Hancock (1985) and examine the impact on net profits for banks' subjected to the fall in the Swedish interest rates. Especially interesting would be to examine Hancock's findings that increasing interest rates positively affected net profits for banks. This would be due to that banks' in Sweden in recent years have had increasing net profits and at the same time faced decreasing interest rates. Another interesting topic would be to conduct a test similar as done in this paper, but rather choose to investigate whether there are any differences between small niche banks and larger banks.

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Interviews

2005-03-08 Claes Ericsson – Branch Manager , Handelsbanken Jönköping

2005-03-10 Tomas Rosén – Branch Credit Manager, Föreningssparbanken Jönköping

Appendix 1 – Statistical Outputs and Interpretation

Note that the individual testing on the 12-month market rate (SMR) and the 5-year market rate (LMR) is applicable for Handelsbanken and Föreningssparbanken. They will be presented along with the testing on Handelsbanken.

Handelsbanken Deposit Rate and 12-month Market Rate

An initial OLS estimation of Model I for Handelsbanken present the following output for Handelsbanken's deposit rate and the short-term market rate.

OLS MODEL – HANDELSBANKEN DEPOSIT RATE AND 12-MONTH RATE

	Coefficients	*Standard Error*
Intercept	-3.156	0.168
SMR	1.063	0.032

Recall the discussion in section 4 of how to calculate the t-stat for testing the null-hypothesis that beta is equal to 1, and alternatively different from 1. The calculated t-stat is equal to 1.934, which falls within the critical t-values (-1.980; +1.980). This leads to that one fails to reject the null-hypothesis and one may conclude that null-hypothesis holds.

However, to determine the validity of the regression, one needs to consider the estimated residuals. There is a great deal of information "getting lost" when running a regression since one cannot take all existing variables into account in the estimation process. All this unexplained variance in the dependent variable is captured in the residuals. Due to this one wants the residuals to be normally distributed and not correlated with one another, called autocorrelation. Checking for normality is done by estimating the kurtosis and skewness on the distribution of the residuals.

CHECKING FOR NORMALITY OF OLS RESIDUALS

Kurtosis	-0.246
Skewness	0.201

Jarque-Bera Statistic	48.099
Chi-square, 2 df and 5%	5.991

The above kurtosis and skewness measures indicate that the residuals are non-normally distributed. The JB test also confirms non-normality, and one may reject the null-hypothesis of normal distribution, since the calculated JB statistic exceeds the critical chi-square value. A plot of the residuals given in Appendix 2 further supports this.

However, the time-series has not yet been tested if it's stationary or non-stationary. A unit-root test is done by running a regression on the first difference of the BDR-variable $[\Delta BDR_t = DBDR_t]$ and using it as the dependent variable, and further use the first lag [BDR(t-1)] as the explanatory variable. Doing this for Handelsbanken (BDR) yields the following;

UNIT-ROOT TEST (DICKEY-FULLER) ON BDR – SHB

	Coefficients	*Standard Error*	*t-stat*
Intercept	0.029	0.027	1.098
BDR(t-1)	0.015	0.009	1.569

The calculated t-stat is compared to the Dickey-Fuller test statistic of -2.86 (for 5%). The calculated t-stat of 1.569 is less than the critical DF-value of -2.86 and one *cannot* reject the null-hypothesis. Based on this one can conclude that the time-series is non-stationary and has at a unit-root. Recall the derivation in section 3 of how to determine the order of integration of BDR. The following regression on the first difference of $DBDR_{t-1}$ is used as the explanatory variable, and the first difference of the first difference [$\Delta DBDR_t$] is used as the dependent variable. Running this regression yields;

ORDER OF INTEGRATION TEST ON BDR – SHB

	Coefficients	*Standard Error*	*t-stat*
Intercept	0.029	0.018	1.630
DBDR(t-1)	-0.470	0.083	-5.625

The calculated t-stat of -5.625 is less than the DF t-stat of -2.86, which lead to the decision of rejecting the null-hypothesis and conclude that the time-series is stationary and integrated of order 1.

The same procedure is done for the 12-month market rate (SMR), and yields;

UNIT-ROOT TEST (DICKEY-FULLER) FOR SMR

	Coefficients	*Standard Error*	*t-stat*
Intercept	-0.015	0.063	-0.238
SMR(t-1)	0.016	0.012	1.261

Once again the t-statistic is compared to the critical DF-value of -2.86. As one can see, the calculated t-stat of 1.261 is less than the critical DF-value -2.86, and one can conclude that the time-series of SMR is non-stationary and has a unit-root, since the null-hypothesis cannot be rejected. However, once again for determining the order of integration of SMR, a regression on the first difference $DSMR_{t-1}$ is used, with $\Delta DSMR_t$ as the dependent variable. Running this regression yields;

ORDER OF INTEGRATION TEST ON SMR

	Coefficients	*Standard Error*	*t-stat*
Intercept	0.032	0.020	1.606
DSMR(t-1)	-0.523	0.087	-6.029

The t-stat of -6.029 is less than the critical DF t-stat of -2.86, and one can conclude that the time-series is stationary and integrated of order 1.

As both time-series has been proved to be non-stationary and integrated of the same order, I(1), a cointegration test will be performed. The estimated residuals from the OLS regression will be used, and thus yield;

COINTEGRATION TEST ON BDR AND SMR - SHB

	Coefficients	*Standard Error*	*t-stat*	*p-value*
Intercept	0.004	0.022	0.164	0.870
e-hat(t-1)	0.074	0.037	2.014	0.047

The calculated t-value of 2.014 is greater than the critical t-value of -3.34 and one *cannot* reject the null-hypothesis. Hence one may conclude that the variables are *not* cointegrated, and the residuals are non-stationary. This further support the suspicion that the initial OLS model is spurious.

Recall the discussion regarding autocorrelation in section 4 on how to determine if the residuals suffer from autocorrelation using a distributed lag-model and selecting the model which minimizes the SIC. As mentioned in section 4, the initial number of lags chosen is 12 based on the fact that the data is monthly average means. Table 5-8 presents the distributed lag-models and the corresponding SIC. Since the initial time-series BDR and SMR proved to be non-stationary, their first difference – in which they became stationary – have been used in the process for estimating the SIC. Thus, the SIC for the various lag-orders are as follows;

SCHWARZ INFORMATION CRITERION – SIC

Number of lags included	SIC
12	51.089
11	46.682
10	42.247
9	37.759
8	33.295
7	28.775
6	24.241
5	19.668
4	15.099
3	10.486
2	5.852
1	1.198

As one can see in the table above a model including one lag should be used since it holds the lowest SIC. Based on this the BG test for autocorrelation will contain one lag. Once again the first difference of $[\Delta SMR_t]$ will be used since the initial SMR_t were non-stationary, and the former stationary.

Running the BG test for detecting autocorrelation in the residuals – with ΔSMR and $\rho\hat{\varepsilon}_{t-1}$ as explanatory variables and $\hat{\varepsilon}_t$ as the dependent variable – yields the following output;

BREUSCH-GODFREY TEST FOR AUTOCORRELATION

	Coefficients	*Standard Error*	*t-stat*	*p-value*
Intercept	-0.005	0.017	-0.287	0.774
SMRt-SMR(t-1)	-0.081	0.076	-1.056	0.293
e-hat(t-1)	0.369	0.096	3.834	0.000

Recall the test statistic $(n-p)R^2 \sim \chi^2$, where there is autocorrelation if the calculated value exceeds the critical chi-square value. The estimated R^2 from the above BG-test is equal to 0.1249, where *n* is 106 and *p* is 1. Thus the calculated value is equal to 13.114 which is greater than the critical value of 3.841 for 5% and 1 *df*. This brings the conclusion that one fails to reject the null-hypothesis of no autocorrelation, and one may conclude that the residuals have autocorrelation.

To correct the estimated coefficients from the errors and obtain a result that is not spurious, the generalized difference model will be estimated. Recall the derivation of the model and ρ from section 4. The estimated rho-coefficient was calculated to 0.926 and then inserted in the generalised difference model from section 4. Running a regression on the generalised difference model yields the following result;

GENERALISED DIFFERENCE MODEL – BDR AND SMR – SHB

	Coefficients	*Standard Error*
Intercept	-0.065	0.035
SMR-rhoSMR(t-1)	0.647	0.071

The above output yields a result that has been corrected for the errors in the time-series; also the model has been adjusted for autocorrelation. Recall the initial OLS model where one failed to reject the null-hypothesis – the calculated t-stat for the difference model is -4.995 against the two-tailed critical values of (-1.980; +1.980). The calculated t-stat falls outside the acceptance area, which leads to a rejection of the null-hypothesis, and one may trust the observed beta-coefficient from the difference model.

If the short-term market rate would change by one unit, Handelsbanken's deposit rate would change by approximately 0.65 units.

Handelsbanken Lending Rate and 5-year Market Rate

An initial OLS estimation of the relationship between Handelsbanken's lending rate (BLR) and the 5-year Government Bond rate (LMR), yields the following output;

OLS MODEL – HANDELSBANKEN LENDING RATE AND 5-YEAR RATE

	Coefficients	*Standard Error*
Intercept	2.013	0.062
LMR	0.941	0.010

The calculated t-stat is equal to -5.669, which falls outside the critical t-values (-1.980; +1.980). This leads to that one may reject the null-hypothesis and conclude that LMR is significantly different from 1.

The residuals for the OLS model on BLR and LMR, also suffer from non-normal distribution; thus the kurtosis and skewness measure are presented below;

CHECKING FOR NORMALITY OF OLS RESIDUALS

Kurtosis	-0.264
Skewness	0.059

Jarque-Bera Statistic	47.118
Chi-square, 2 df and 5%	5.991

The above kurtosis and skewness measures indicate that the residuals are non-normally distributed. The JB test also confirms non-normality; and one may reject the null-hypothesis of normal distribution since the calculated JB statistic exceeds the critical chi-square value. A plot of the residuals given in Appendix 2 further supports this.

As in the previous section, one need to check weather the time-series are stationary or not. Recall the derivation in section 4.1 of how to test the time-series for stationarity. Testing $[BLR_{t-1}]$ for unit-root yields the following output;

UNIT-ROOT TEST (DICKEY-FULLER) FOR BLR – SHB

	Coefficients	*Standard Error*	*t-stat*	*p-value*
Intercept	-0.112	0.119	-0.931	0.354
BLR(t-1)	0.024	0.016	1.477	0.143

Once again the t-statistic is compared to the critical DF-value. As one can see, the calculated t-stat of 1.477 is greater than the critical DF-value -2.86, and one can conclude that the time-series of SMR is non-stationary and has a unit-root. However, once again for determining the order of integration of BLR, a regression on the first difference $DBLR_{t-1}$ is used, with $\Delta DBLR_t$ as the dependent variable. Running this regression yields;

ORDER OF INTEGRATION ON BLR – SHB

	Coefficients	*Standard Error*	*t-stat*	*p-value*
Intercept	0.044	0.026	1.676	0.097
DBLR(t-1)	-0.717	0.095	-7.523	0.000

The calculated t-stat of -7.523 is less than the DF-value -2.86, so one may conclude that the first difference of BLR is stationary, and integrated of order 1.

The same procedure is conducted on the 5-year Government Bond rate (LMR). Running the initial unit root test on LMR yields the following result;

UNIT-ROOT TEST (DICKEY-FULLER) FOR LMR

	Coefficients	*Standard Error*	*t-stat*	*p-value*
Intercept	-0.070	0.080	-0.872	0.385
LMR(t-1)	0.023	0.014	1.668	0.098

The calculated t-stat of 1.668 is greater than the DF of -2.86, so one may conclude that LMR is non-stationary. For determining the order of integration of BLR, a regression on the first difference $DLTR_{t-1}$ is used, with $\Delta DLTR_t$ as the dependent variable. Running this regression yields;

ORDER OF INTEGRATION ON LMR

	Coefficients	*Standard Error*	*t-stat*	*p-value*
Intercept	0.039	0.024	1.655	0.101
DLMRt-1	-0.679	0.093	-7.278	0.000

The calculated t-stat of -7.278 is less than the DF-value -2.86, so one may conclude that the first difference of LMR is stationary, and integrated of order 1.

As both time-series has been proved to be non-stationary and integrated of the same order, I(1), a cointegration test will be performed to see weather they share the same stochastic trend, and exhibit a long-run equilibrium. The estimated residuals from the OLS regression will be used, and thus yield;

COINTEGRATION TEST ON BLR AND LMR

	Coefficients	*Standard Error*	*t-stat*	*p-value*
Intercept	0.006	0.012	0.459	0.647
e-hat(t-1)	-0.245	0.065	-3.778	0.000

The calculated t-stat of -3.778 is less than the critical DF-value of -3.34 which rejects the null-hypothesis of no cointegration between BLR and LMR. Hence, then one may conclude that they share the same stochastic trend and that the exhibit a long-run equilibrium. Based on this, the initial OLS is valid and not spurious as previously suspected. Even though, one might trust the initial OLS, one still has to investigate weather the residuals suffer from autocorrelation or not. Recall the

discussion on selecting the best distributed lag-model using SIC. Thus, the SIC for BLR and LMR are as follows;

SCHWARZ INFORMATION CRITERION - SIC

Number of lags included	SIC
12	51.109
11	46.668
10	42.235
9	37.773
8	33.282
7	28.744
6	24.232
5	19.732
4	15.174
3	10.575
2	5.941
1	1.310

As one can see in the table above a model including one lag should be used since it holds the lowest SIC. Based on this the BG test for autocorrelation will contain one lag. The first difference of $[\Delta LMR_t]$ will be not used in the BG test since the cointegration test proved the initial model not to be spurious. Instead the test uses the level form of LMR_t.

Running the BG test for detecting autocorrelation in the residuals – with LMR and $\rho\hat{\varepsilon}_{t-1}$ as explanatory variables and $\hat{\varepsilon}_t$ as the dependent variable – yields the following output;

BREUSCH-GODFREY TEST FOR AUTOCORRELATION

	Coefficients	*Standard Error*	*t-stat*	*p-value*
Intercept	-0.023	0.041	-0.561	0576
LMRt	0.005	0.007	0.733	0.465
e-hat(t-1)	0.758	0.065	11.651	0.000

Recall the test statistic $(n-p)R^2 \sim \chi^2$, where there is autocorrelation if the calculated value exceeds the critical chi-square value. The estimated R^2 from the above BG-test is equal to 0.566, where *n* is 107 and *p* is 1. Thus the calculated value is equal to 60.025 which is greater than the critical value of 3.84 for 5% and 1 *df*. One may then reject the null-hypothesis and conclude that the model suffers from autocorrelation.

Even though that the initial OLS proved to be sufficient, one still has to adjust the model for autocorrelation by estimating ρ and running a generalized difference model.

GENERALISED DIFFERENCE MODEL – BLR AND LMR

	Coefficients	*Standard Error*
Intercept	0.483	0.035
LMR-rhoLMR(t-1)	0.952	0.023

The calculated t-stat is equal to -2.066, which falls outside the critical t-values (-1.980; +1.980). This leads to that one may reject the null-hypothesis and conclude that LMR is significantly different from 1, and one may trust the observed beta-coefficient from the difference model.

If the long-term market rate would change by one unit, Handelsbanken's lending rate would change by approximately 0.95 units.

Föreningssparbanken (FSB) Deposit Rate

Recall that the short-term market rate (SMR) is applicable to both banks' and has already been investigated above together with Handelsbanken's deposit rate.

OLS MODEL – FÖRENINGSSPARBANKEN DEPOSIT RATE AND 12-MONTH RATE

	Coefficients	*Standard Error*
Intercept	-3.123	0.189
SMR	1.071	0.037

The calculated t-stat is equal to 1.932 which falls within the two-tailed critical t-values (-1.980; +1.980). This leads to that one *cannot* reject the null-hypothesis that SMR is significantly different from 1.

Investigating the residuals for normality indicates non-normal distribution around the mean.

CHECKING FOR NORMALITY OF OLS RESIDUALS

Kurtosis	0.281
Skewness	0.439

Jarque-Bera Statistic	36.747
Chi-square, 2 df and 5%	5.991

The above kurtosis and skewness measures indicate that the residuals are non-normally distributed. The JB test also confirms non-normality; one may reject the null-hypothesis of normal distribution, since the calculated JB statistic exceeds the critical chi-square value. A plot of the residuals given in Appendix 2 further supports this.

Testing the time-series if it is stationary or non-stationary. Performing a unit-root test of Föreningssparbanken (BDR) by running $\left[\Delta BDR_t = DBDR_t\right]$ as the dependent variable against the first lag [BDR(t-1)] as the explanatory variable, yields the following;

UNIT-ROOT TEST (DICKEY-FULLER) ON BDR – FSB

	Coefficients	*Standard Error*	*t-stat*
Intercept	0.045	0.034	1.319
BDR(t-1)	0.004	0.012	0.324

The calculated t-stat of 0.324 is greater than the critical DF-value of -2.86, and one *cannot* reject the null-hypothesis. Based on this one can conclude that the time-series is non-stationary and has at a unit-root. Recall the derivation in section 3 of how to determine the order of integration of BDR. The following regression on the first difference of $DBDR_{t-1}$ is used as the explanatory variable,

and the first difference of the first difference [$\Delta DBDR_t$] is used as the dependent variable. Running this regression yields;

ORDER OF INTEGRATION TEST ON BDR – FSB

	Coefficients	*Standard Error*	*t-stat*
Intercept	0.041	0.024	1.704
DBDR(t-1)	-0.773	0.095	-8.093

The calculated t-stat of -8.093 is less than the DF t-stat of -2.86, which lead to the decision of rejecting the null-hypothesis and conclude that the time-series is stationary and integrated of order 1.

As both Föreningssparbanken's deposit rate and the 12-month rate has been proved to be non-stationary and integrated of the same order, I(1), a cointegration test was performed. The estimated residuals from the OLS regression was used which yielded;

COINTEGRATION TEST ON BDR AND SMR

	Coefficients	*Standard Error*	*t-stat*	*p-value*
Intercept	0.011	0.024	-0.437	0.663
e-hat(t-1)	-0.059	0.036	-1.655	0.101

The calculated t-value of -1.655 is greater than the critical t-value of -3.34 and one cannot reject the null-hypothesis. Hence one may conclude that the variables are not cointegrated, and the residuals are non-stationary. This further support the suspicion that the initial OLS model is spurious.

Since the initial time-series BDR and SMR proved to be non-stationary, their first difference – in which they became stationary – have been used in the process for estimating the SIC. Thus, the SIC for the various lag-orders are as follows;

SCHWARZ INFORMATION CRITERION – SIC

Numer of lags included	SIC
12	51.406
11	47.032
10	42.603
9	38.139
8	33.638
7	29.154
6	24.638
5	20.068
4	15.494
3	10.890
2	6.278
1	1.633

As one can see in the table above a model including one lag should be used since it holds the lowest SIC. Based on this the BG test for autocorrelation will contain one lag. Once again the first difference of $[\Delta SMR_t]$ will be used since the initial SMR_t were non-stationary, and the former stationary.

Running the BG test for detecting autocorrelation in the residuals – with ΔSMR and $\rho\hat{\varepsilon}_{t-1}$ as explanatory variables and $\hat{\varepsilon}_t$ as the dependent variable – yields the following output;

BREUSCH-GODFREY TEST FOR AUTOCORRELATION

	Coefficients	*Standard Error*	*t-stat*	*p-value*
Intercept	0.001	0.022	0.054	0.774
SMRt-SMR(t-1)	-0.012	0.101	-0.115	0.293
e-hat(t-1)	0.040	0.104	0.389	0.000

Recall the test statistic $(n-p)R^2 \sim \chi^2$, where there is autocorrelation if the calculated value exceeds the critical chi-square value. The estimated R^2 from the above BG-test is equal to 0.001, where *n* is 106 and *p* is 1. Thus the calculated value is equal to 0.154 which is less than the critical value of 3.84 for 5% and 1 *df*. This brings the conclusion that one fails to reject the null-hypothesis i.e. there is no autocorrelation.

Since there is no autocorrelation one may simply use a differentiate model to estimate the relationship between Föreningssparbanken and the 12-month market rate. Thus estimating the following model $\Delta BDR_t = \alpha + \beta\Delta SMR_t + \varepsilon_t$ yields the following;

DIFFERENCE MODEL – BDR AND SMR

	Coefficients	*Standard Error*
Intercept	0.023	0.022
SMR-SMR(t-1)	0.502	0.096

Recall the initial OLS model where one failed to reject the null-hypothesis. The calculated t-stat for the above difference model is -5.199 and tested against the two-tailed critical values of (-1.980; +1.980). The calculated t-stat falls outside the acceptance area, which leads to a rejection of the null-hypothesis, and one may conclude that the observed beta-coefficient from the difference model is significantly different from 1.

Since both time-series are stationary in their difference form and there is no autocorrelation - the result from this regression may hold. There is a significant relationship of 0.5 between FSB's deposit rate and the short-term market rate. This is approximately the same as for SHB. Both banks follow the market rate to a relatively similar extent on deposit rates.

Föreningssparbanken Lending Rate

The initial OLS on Föreningssparbanken's lending rate and the 5-year government bond rate produces the following results.

OLS MODEL – FÖRENINGSSPARBANKEN LENDING RATE AND 5-YEAR RATE

	Coefficients	*Standard Error*
Intercept	1.969	0.060
LMR	0.943	0.010

The calculated t-stat is equal to -5.633 which falls outside the two-tailed critical t-values (-1.980; +1.980). This leads to that one may reject the null-hypothesis, and claim that LMR is significantly different from 1.

The residuals for the OLS model also suffer from non-normal distribution; thus the kurtosis and skewness measure are presented below;

CHECKING FOR NORMALITY OF OLS RESIDUALS

Kurtosis	-0.322
Skewness	0.186

Jarque-Bera Statistic	49.819
Chi-square, 2 df and 5%	5.991

The above kurtosis and skewness measures indicate that the residuals are non-normally distributed. The JB test also confirms non-normality; one may reject the null-hypothesis of normal distribution since the calculated JB statistic exceeds the critical chi-square value. A plot of the residuals given in Appendix 2 further supports this.

Testing $[BLR_{t-1}]$ for unit-root, yields the following output;

UNIT-ROOT TEST (DICKEY-FULLER) FOR BLR – FSB

	Coefficients	*Standard Error*	*t-stat*	*p-value*
Intercept	-0.124	0.112	-1.109	0.269
BLR(t-1)	0.026	0.015	1.704	0.091

The calculated t-stat of 1.704 is greater than the critical DF-value -2.86, and one can conclude that the time-series of SMR is non-stationary and has a unit-root. However, once again for determining the order of integration of BLR, a regression on the first difference $DBLR_{t-1}$ is used as the independent variable, and $\Delta DBLR_t$ as the dependent variable. Running this regression yields;

ORDER OF INTEGRATION ON BLR – FSB

	Coefficients	*Standard Error*	*t-stat*	*p-value*
Intercept	0.038	0.024	1.591	0.115
DBLR(t-1)	-0.638	0.092	-6.916	0.000

The calculated t-stat of -6.916 is less than the DF-value -2.86, so one may conclude that the first difference of BLR is stationary, and integrated of order 1.

As both time-series has been proved to be non-stationary and integrated of the same order, I(1), a cointegration test will be performed to see weather they share the same stochastic trend, and exhibit a long-run equilibrium. The estimated residuals from the OLS regression will be used, and thus yield;

COINTEGRATION TEST ON BLR AND LMR

	Coefficients	*Standard Error*	*t-stat*	*p-value*
Intercept	0.006	0.012	0.507	0.613
e-hat(t-1)	-0.248	0.065	-3.803	0.000

The calculated t-stat of -3.803 is less than the critical DF-value of -3.34, which rejects the null-hypothesis of no cointegration between BLR and LMR. Hence, then one may conclude that they share the same stochastic trend and that the exhibit a long-run equilibrium. Based on this, the initial OLS is valid and not spurious as previously suspected. Even though, one might trust the initial OLS, one still has to investigate weather the residuals suffer from autocorrelation or not.

SCHWARZ INFORMATION CRITERION – SIC

Number of lags included	SIC
12	50.965
11	46.522
10	42.099
9	37.659
8	33.170
7	28.646
6	24.162
5	19.658
4	15.096
3	10.503
2	5.901
1	1.249

As one can see in the table above a model including one lag should be used since it holds the lowest SIC. Based on this the BG test for autocorrelation will contain one lag. The first difference of $[\Delta LMR_t]$ will not be used since the cointegration test proved the initial OLS not to be spurious. Instead the test uses the level form of LMR_t.

Running the BG test for detecting autocorrelation in the residuals – with LMR and $\rho\hat{\varepsilon}_{t-1}$ as explanatory variables and $\hat{\varepsilon}_t$ as the dependent variable – yields the following output;

BREUSCH-GODFREY TEST FOR AUTOCORRELATION

	Coefficienter	*Standard Error*	*t-stat*	*p-value*
Intercept	-0.019	0.039	-0.459	0.647
LMR	0.004	0.007	0.641	0.523
e-hat(t-1)	0.755	0.065	11.533	0.000

Recall the test statistic $(n-p)R^2 \sim \chi^2$, where there is autocorrelation if the calculated value exceeds the critical chi-square value. The estimated R^2 from the above BG-test is equal to 0.561, where *n* is 107 and *p* is 1. Thus the calculated value is equal to 59.469 which is greater than the critical value of 3.84 for 5% and 1 *df*. One may then reject the null-hypothesis and conclude that the model suffers from autocorrelation.

Even though that the initial OLS proved to be sufficient, one still has to adjust the model for autocorrelation by estimating ρ and running a generalized difference model.

GENERALISED DIFFERENCE MODEL – BLR AND LMR

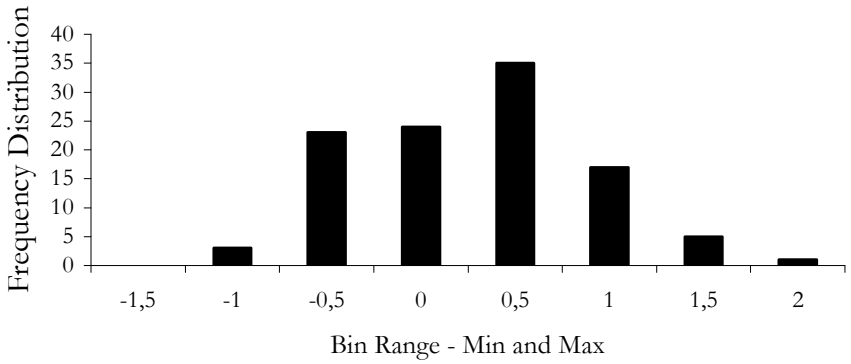
	Coefficients	*Standard Error*
Intercept	0.495	0.035
LMR-rhoLMR(t-1)	0.943	0.023

The calculated t-stat is equal to -2.541, which falls outside the critical t-values (-1.980; +1.980). This leads to that one may reject the null-hypothesis and conclude that LMR is significantly different from 1, and one may trust the observed beta-coefficient from the difference model.

If the long-term market rate would change by one unit, Föreningssparbanken's lending rate would change by approximately 0,94 units.

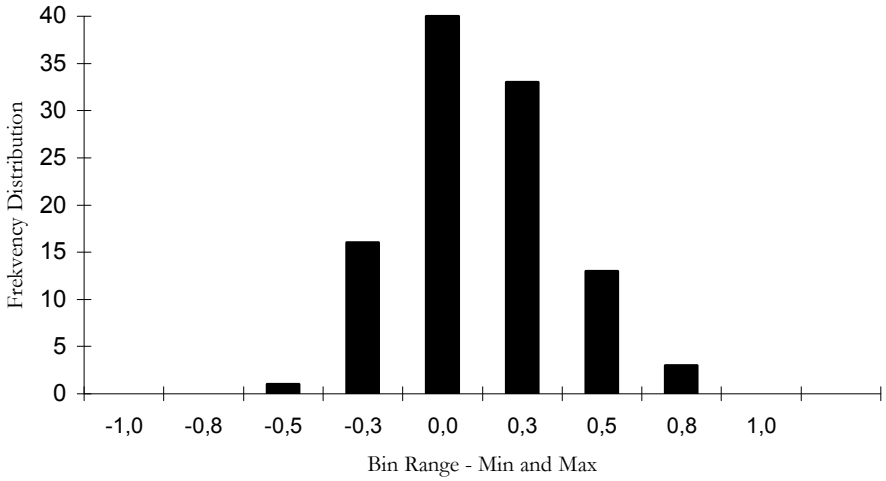
Appendix 2 – Plotted OLS Residuals

OLS Model - Handelsbanken (BDR) and 12 Month Market Rate (SMR)



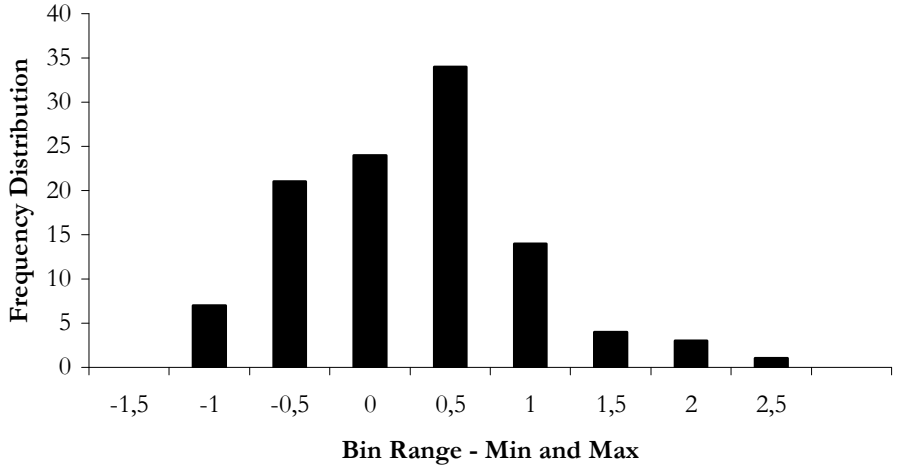
Plotted residuals for the OLS regression on Handelsbanken deposit rate (BDR) and the 12-month short-term government Treasury Bill rate. The residual are not normally distributed, which is supported by the Kurtosis measure of -0,246 (should be around 3), and the Skewness measure of 0,201 (should be around 0). Further, one can visually see that the histogram does not have bell-shaped distribution.

OLS Model - Handelsbanken (BLR) and 5-year Market Rate (LMR)



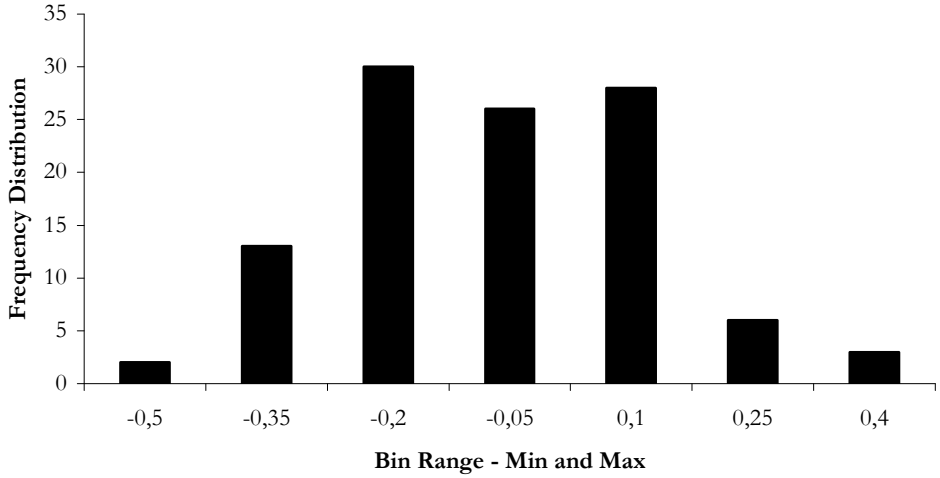
Below are the plotted residuals for the OLS regression on Handelsbanken lending rate (BLR) and the 5-year Government Bond rate (LMR). As one can see, the histogram does not take on a bell-shaped curvature, which indicates that the residuals are not normally distributed. This is further supported by the Kurtosis measure of -0,264, and a Skewness measure of 0,059.

OLS Model - Föreningssparbanken (BDR) and 12-month Market Rate (SMR)



Above are the plotted residuals from the initial OLS regression on Föreningssparbanken's deposit rate and the 12-month rate. The histogram does not take on a bell-shaped distribution which indicates that the sample is non-normal distributed. Also indicated by the skewness and kurtosis measures the sample is not normally distributed.

OLS Residuals - Föreningssparbanken Lending Rate and 5-year Market Rate (LMR)



Above are the residuals from the OLS regression on FSB's lending rate and the long-term market rate. As one can see the histogram does not take on a bell-shaped curvature which indicates that the sample is non-normally distributed. This is also supported by the kurtosis and skewness measures.

Appendix 3 – Swedish Banks' Balance Sheets

The balance sheets below display a summary of all Swedish banks' assets and liabilities. The balance sheets are obtained from *Den svenska finansmarknaden* (2001, 2002 and 2003) issued by the Central Bank of Sweden and the Swedish Bankers' Association (1999).

Banks' Assets as of end of 1998

Assets	SEK billion
Cash and claims on credit institutions	655
Government securities and bonds	452
Lending to the public	*920*
Other assets	381
Total	2,408

Banks' Liabilities as of end of 1998

Liabilities and Equity	SEK billion
Liabilities to financial institutions	729
Deposits and loans from the public	*926*
Securities	241
Other liabilities	397
Equity capital and untaxed reserves	115
Total	2,408

Banks' Assets as of end of 2001

Assets	SEK billion
Lending to Swedish public	*951*
Lending to foregin public	359
Lending to foreign banks	367
Lending to Swedish financial institutions	563
Interest bearing securites	425
Other assets	468
Total	3133

Banks' Liabilities as of end of 2001

Liabilities	SEK billion
Deposits from the Swedish public	*894*
Deposits from foregin public	271
Foreign banks	660
Swedish financial institutions	302
Issued interest bearing securities	393
Other liabilities	504
Equity capital	109
Total	3133

Banks' Assets as of end of 2002

Assets	SEK billion
Lending to Swedish public	*994*
Lending to foregin public	365
Lending to foreign banks	363
Lending to Swedish financial institutions	538
Interest bearing securities	469
Other assets	548
Total	3277

Banks' Liabilities as of end of 2002

Liabilities	SEK billion
Deposits from the Swedish public	*964*
Deposits from foregin public	277
Foreign banks	668
Swedish financial institutions	239
Issued interest bearing securities	378
Other liabilities	635
Equity capital	116
Total	3277

Banks' Assets as of end of 2003

Assets	SEK billion
Lending to Swedish public	*993*
Lending to foregin public	344
Lending to foreign banks	404
Lending to Swedish financial institutions	493
Interest bearing securities	508
Other assets	539
Total	3280

Banks' Liabilities as of end of 2003

Liabilities	SEK billion
Deposits from the Swedish public	*1005*
Deposits from foregin public	291
Foreign banks	611
Swedish financial institutions	223
Issued interest bearing securities	350
Other liabilities	675
Equity capital	125
Total	3280

Percentage distribution of deposits to total liabilities from the Swedish public

1998 – Deposits from the Swedish public; $\left(\frac{926}{2408}\right)*100 = 39\%$

2001 – Deposits from the Swedish public; $\left(\frac{894}{3133}\right)*100 = 29\%$

2002 – Deposits from the Swedish public; $\left(\frac{964}{3277}\right)*100 = 29\%$

2003 – Deposits from the Swedish public; $\left(\frac{1005}{3280}\right)*100 = 31\%$

Percentage distribution of lending to total assets from the Swedish public

1998 – Lending to the Swedish public; $\left(\frac{655}{2408}\right)*100 = 38\%$

2001 – Lending to the Swedish public; $\left(\frac{951}{3133}\right)*100 = 30\%$

2002 – Lending to the Swedish public; $\left(\frac{994}{3277}\right)*100 = 30\%$

2003 – Lending to the Swedish public; $\left(\frac{993}{3280}\right)*100 = 30\%$