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How efficient are the Nordic banks?
A DEA application for the years 2002-2003

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Abstract

How efficient are the Nordic banks? A DEA application for the years 2002-2003.

In the middle of the 1980s, the Nordic banking industry had experienced significant changes due to the financial deregulation. The oncoming financial crisis was the result of the explosion of bank credit in the beginning of the 1990s, while a large-scale restructuring of the banking system followed.

The main purpose of this study is to examine the relative efficiency of the banking industries in four Nordic countries using efficiency measures derived from Data Envelopment Analysis estimation for the years 2002/2003. The final sample consists of 33 commercial and 127 savings banks in the year 2002, while in the year 2003, 3 more units are added.

Technical and structural efficiencies are estimated by employing both the production and the intermediation approach. Correlation between profitability ratios and efficiency is also presented. Moreover, the robustness is tested to determine the strength of the results.

The empirical results reveal that the Finnish banks are the most efficient institutions while commercial banks are generally more efficient than their savings counterparts. Efficiency is generally higher in 2003 than in 2002. The study also indicates a positive relation between efficiency and profitability.

Keywords: Banking, Data Envelopment Analysis, technical efficiency, structural efficiency

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List of Abbreviations

AE	Allocative Efficiency
AMCs	Asset Management Corporations
CBGF	Commercial Bank Guarantee Fund
CDs	Certificates of Deposits
CRS	Constant Returns to Scale
DEA	Data Envelopment Analysis
DMUs	Decision Making Units
EE	Economic Efficiency
ERM	Exchange Rate Mechanism
GBF	Government Bank Investment Fund
GBIF	Government Bank Insurance Fund
GDP	Gross Domestic Product
GGF	Government Guarantee Fund
LTV	Loan-To-Value
LS	Least Squares
OECD	Organization for Economic Cooperation and Development
PPS	Production Possibility Set
PPP	Purchasing Power Parity
ROA	Return On Assets
ROE	Return On Equity
SBF	Savings Bank of Finland
SBGF	Savings Bank Guarantee Fund
SF	Stochastic Frontier
TE	Technical Efficiency
TFP	Total Factor Productivity
VRS	Variable Returns to Scale

CHAPTER 1

INTRODUCTION

The financial deregulation of the Nordic banking industry in the middle of the 1980s and the following credit expansion caused a severe financial crisis at the beginning of the 1990s. Mainly because of government intervention, the Nordic banking industry did not finally collapse. The restructuring period had the purpose of restoring the industry and making it more efficient. The impacts of the changes undertaken are still affecting the way that the operations are managed and optimized today. As a consequence, the efficiency assessment of this industry is a challenging and compelling task.

1.1 Problem Formulation

The main research problem of this study is to measure the efficiency of the Nordic banks for the years 2002 and 2003. This will be attempted by employing the non-parametric approach, Data Envelopment Analysis (DEA). The efficiency of different types of banks, commercial as well as savings banks, in different countries, namely Denmark, Finland, Norway and Sweden, is studied in this thesis. In addition, the efficiency of the commercial and the savings banking sectors is also presented.

1.2 Research Objectives

The efficiency of the Nordic banks will be measured by applying the following research objectives:

1. To estimate the technical efficiency of the commercial and the savings banks, first by including both types in the same model and then by separating them.
2. To test the robustness of the obtained efficiency results, with the purpose of investigating the trends of the efficiency scores.

3. To find the structural efficiency of the commercial banking sector, the savings banking sector and the entire industry.
4. To indicate if there is a correlation between profitability and efficiency results.

1.3 Contribution of the Thesis

According to the author's knowledge, few studies have investigated the efficiency of the Nordic banks, by employing the DEA application[1]. Furthermore, the efficiency of this industry has not been investigated for the last years. The rapid changes that this industry faces; namely the introduction of innovative banking technologies and the extensive growth of the electronic banking, make a more current study even more desirable and challenging.

1.4 Thesis Outline

This study is divided into five chapters. The first two chapters are introductory, where the purpose of Chapter 1, the Introduction, is to present the research problem and the research objectives of this study. In Chapter 2, there is an extensive presentation of the Nordic banking industry with the aim of familiarizing the reader with the transformations that this industry faced in the 1980s and also to justify the interest of investigating the efficiency of this industry.

Chapter 3 presents the methodology of this study. At the beginning, the main concepts of efficiency and productivity are discussed. In addition, the Data Envelopment Analysis approach is explained in detail in order to introduce the reader with the basic terminology that will be used in the following chapters and to justify the choice of this particular method.

Chapter 4, the Research Design, describes the production models employed in the study, and presents the summary statistics for the data.

Chapter 5 presents the empirical results and also provides concluding remarks.

[1]Examples are the article by Berg et. al. (1993) and studies by Bukh et. al. (1995) and Bergendahl (1995).

CHAPTER 2

THE NORDIC BANKING INDUSTRY

The aim of this chapter is to provide an extensive empirical background to the banking changes in the Nordic region. In particular, the emphasis is placed on presenting the effects of the deregulation in the 1980s, the oncoming financial crisis, the crisis management and the reconstructing period. This presentation is an essential part of the thesis since it serves the dual purpose of informing the reader about the transformations that the Nordic banking industry faced and, thereby, also presents the main justification for the interest in investigating the efficiency of that industry.
This section first provides general information about the deregulation process and the following financial crisis in Nordic banking industry and then, a more detailed presentation of the banking industry of each country.

2.1 Nordic Banking Industry

The financial deregulation process in the Nordic countries started at the beginning of the 1980s and lasted until the beginning of the 1990s[2].

According to Pesola (2001), financial deregulation has often been a cause of lending booms. However, extraordinarily rapid growth in bank lending can lead to a surge in loan losses later on. Dress and Pazarbasioglu (1998) state that there are two main reasons for the banking crises in the Nordic countries. First, many banks expanded their lending aggressively in order to secure their position in the new environment, taking remarkably high risk at the same time. Pesola (2001) adds that loan losses were the main source of sharply negative banking profitability. Second, the explicit deposit insurance system was not large enough to cover the losses caused by the extensive systemic crisis. As a consequence, the obvious implicit government guarantee on banking might have further increased the risk taking incentive and moral hazard.

[2] The chronologies of selected deregulated measures for each country are provided in Appendix AI.

Pesola (2001) observes that there is a close connection between the failures in the enterprise sector and the banking crisis. For instance, some three-fourths of banks' loan losses were caused by bankruptcies in the corporate sector in Norway and Sweden. Moreover, the indebtedness in the Nordic countries was generally low in the 1960s and 1970s, while in the 1980s it started to increase. The changes in indebtedness were most dramatic in Finland and the smoothest in Denmark.

The banking crisis years varied among the Nordic countries. Demirgüç-Kunt and Detragiache (1998) define the specific crisis years for each Nordic country as follows: 1991-1994 in Finland, 1987-1993 in Norway, 1990-1993 in Sweden and finally Denmark faced significant banking problems in 1987-1992. Buttwill (2004) states that Sweden, Norway and Finland have the highest number of bankruptcies during the year 1992. The author observes that the development of the Danish frequency of bankruptcy does not truly follow the same pattern as that of the other Nordic countries. The frequency of bankruptcy has a peak for the year 1993 and it has a lower fluctuation than for the other Nordic countries.

In their study, Demirgüç-Kunt and Detragiache (1998) observe a connection between the macroeconomic environment and the banking crises. They found that crises tend to erupt when the macroeconomic environment is weak; in particular when the growth of GDP is low and the inflation is high. In addition, high real interest rates are clearly associated with systemic banking sector problems[3].
Next, a detailed presentation for each of the Nordic countries is provided with the purpose of understanding the background of the current structure of the banking industry.

2.2 Sweden

Englund and Vihriälä (2003) state that before the financial deregulation, the activities of financial and other institutions were tightly regulated. First of all, they were subjected to

[3]The specific macroeconomic factors are provided in Appendix AII.

lending ceilings. Second, liquidity ratios required banks to hold a minimum proportion of their assets in government issued bonds and placement requirements put a similar restriction on the investments of insurance companies. Furthermore, interest regulation put a cap on lending rates and limited the ability of the banks to capture scarcity rents created by lending ceilings. Bank actions were also continuously supervised by the Central Bank. In addition, the real interest rates were negative for a long period of time since the regulated interest rates were low relative to the inflation rate. As a result there was a constant excess demand for credit. Finally, lack of competition and interest rate regulation protected banks' interest margins while banks' profitability varied among banks. In particular, savings banks were the weakest institutions among the different types of financial institutions.

Gjirja (2004) points out that by the middle of the 1980s, it had become clear that the regulations had lost their effectiveness, mainly because of the financial innovation and the introduction of the new financial instruments. The Swedish financial market needed to adjust to the more liberal international financial markets.

Impact of the deregulation

Englund (1999) presents two main effects of deregulation. First, over the period 1986-1990, lending increased by 136 per cent. The institutions most directly affected by regulation, now expanded most rapidly, namely banks by 174 per cent and mortgage institutions by 167 per cent. Then, higher risk was taken by institutions. It is worthwhile to mention that the loan-to-value (LTV) ratio for mortgage loans to owner-occupied housing was constant at 75 per cent for 3 years after deregulation while in 1988 the LTV ratio increased to 90 per cent. Second, a dramatic increase in commercial and residential real estate value supports the claim that the deregulation initiated a price bubble.

Apart from that, Andersson and Viotti (1999) state that the deregulation of financial markets led to increased competition between banks. However, banks entered into this competition despite the fact that they were unfamiliar with doing business in a deregulated environment and lacked adequate knowledge and procedures to make proper

credit assessment. In addition to that, bank management lowered credit standards in their struggle for larger market shares. Heikensten (1998) believes that in the earlier environment, banks had had little incentive to develop a sophisticated credit culture, involving comprehensive evaluations of debtors, projects and collateral. He adds that one of the major faults in credit decisions in Sweden was that banks lent to customers, projects and geographical areas that they did not have sufficient knowledge about.

Financial Crisis

According to Englund (1999), as a consequence of the price boom, investment in real estate had nearly doubled; the average for 1988-1990 was 88 per cent above the average for 1983-1985. Difficulties in finding tenants at the current price levels were reported while the stock market reacted rapidly. In particular, by the end of 1990, the real estate index had fallen by 52 per cent from the peak level. Simultaneously, the Swedish economy was subjected to sharply increasing interest rates. Especially, the real after-tax interest rate jumped from 1 per cent in 1989 to plus 5 per cent in 1991. Credit losses had also increased and over the period 1990-1993 accumulated losses came to a total of nearly 17 per cent of lending.

The crisis coincided with a sharp downturn of the real estate market. According to Gjirja (2004), a consequence of the failing property values, together with decreasing inflation and rising unemployment, was that banking institutions started reporting considerable amount of loan losses. Eventually, what had initially been a financial crisis caused by the sectoral price decline on the real estate market relatively rapidly took the character of a general economic crisis. Viotti (2000) reports that first, finance companies quickly collapsed and then the banks were dragged into the crisis by the rapid growth in non-performing loans. Gjirja (2004) mentions that the number of bankruptcies increased quickly causing a growth of the bank credit losses.

Furthermore, Swedish economy faced a currency crisis in the autumn of 1992. Mlima (1999) states that there were aggressive, but ultimately unsuccessful actions to bolster the Swedish krona against speculators, who raised interbank rates to unprecedented level.

Englund (1999) reports that the Swedish krona had been depreciated by 20 per cent by the turn of the year.

Crisis management

A number of measures were taken in order to handle the crisis once it had erupted. Heikensten (1998) presents the most important component of the solution for the financial sector. First, the government issued an unlimited guarantee stating that no depositors or other counterparties to Swedish credit institutions would experience any losses. Viotti (2000) believes that a guarantee of this kind was considered necessary to prevent lenders from recalling the Swedish banks' loans in the international interbank market in panic. In addition, Vihriälä (1997) mentions that the Swedish parliament had adopted an unprecedented resolution in which it undertook to guarantee the deposits and to meet the contractual commitments on time. The author states that the resolution was a radical measure since there was no formal deposit insurance scheme in Sweden.

Second, the Bank Support Authority (Bankstödsnämnden) was formed with the purpose of supporting banks in distress. Andersson and Viotti (1999) mention that the crisis was too large to be handled by the Ministry of Finance and as a solution the new separate organization was formed. The banks, which were interested in getting financial support, had to report their real and expected credit losses, suspended interest rate payments, liabilities and securities. It is worth mentioning that among the major Swedish banks; only Svenska Handelsbanken did not apply for support[4].

Third, a common framework of measures was constructed to support the banking system. A strategy for deciding which banks to reconstruct and which to liquidate was developed and explained to the general public. Viotti (2000) explains that this was essential for retaining confidence in the viability of the Swedish banking system in international financial circles as well as for keeping the Swedish public aware of what was happening.

[4] According to Englund and Vihriälä (2003), Skandinaviska Enskilda Banken entered into discussions with the Bank Support Authority, but these never resulted in any direct support. The private owners invested new equity capital in the bank to ensure that capital requirements were fulfilled.

Moreover, strict valuation rules were used from the beginning of the crisis in order to restore confidence. In particular, all bank assets had to be marked-to-market even if the market was exceptionally weak, especially that for real estate. This led to higher bank losses and a weaker financial position compared to if more flexible valuation rules had been adopted.

Last but not least, Asset Management Corporations (AMCs) focused on splitting a problematic bank into a financially sound one and transferring the "bad" assets to the AMCs. Then, the asset was carefully assessed, regrouped and improved in order to become attractive to potential buyers. As soon as a reasonable price could be obtained, the asset was sold. In general, Viotti (2000) concludes that the Swedish strategy for handling the banking crisis proved a success.

Andersson and Viotti (1999) study the initial reason of the financial crisis and support the idea that neither the banking sector nor the supervisory authorities were prepared to handle the new situation, which was caused by the rapid deregulation of the financial system.

Restructuring period

The banking crisis led to large scale reorganizations of the banking system. Gjirja (2004) states that as banks were trying to cut cost and to improve efficiency, a number of mergers and acquisition were performed. Moreover, Englund and Vihriälä (2003) point out that while the number of branch offices declined by over a third, the number of employees declined only marginally. The authors also mention that the introduction of modern banking technologies resulted in that, with the exception of Finland, the Swedish banking sector employed the least personnel compared to the countries in the European Union. Finally, Gjirja (2004) states that now banks focus on increased profitability rather than expansion and volume growth.

2.3 Finland

Vihriälä (1997) summarizes the impact of regulation in the Finnish financial markets until the early 1980s. Capital imports and exports were tightly controlled by the Central bank. Interest rates on bank loans and deposits were regulated at low levels. As inflation was often high relative to regulated lending rates, regulation resulted in an excess demand for credit for long periods of time. Moreover, there was a highly bank-centered financial system, in which even large corporations relied on banks as the major source of external financing. Bank legislation in the middle of 1980s distinguished between four types of specialized banks: commercial, savings, cooperative and state-owned post office banks. Finally, all types of bank deposits were fully covered by deposit insurance, provided by the "security funds" of the commercial, savings and cooperative banks, where the participation of the security fund was compulsory.

Englund and Vihriälä (2003) add that while banks were not required to invest in government issued bonds like in Sweden, they were subject to a reserve requirement. In addition, although real interest rates were negative, depositors were willing to deposit in banks due to the absence of alternatives.

Vihriälä (1997) points out that the major implication of regulation was that the banks were induced to compete through quality of services and especially through branch office network, where costs of operation were considered as high and the profitability was weak.

Impact of the deregulation

According to Kostela and Uusitalo (2004), both the abolition of regulation of domestic bank lending rates and the lifting of restrictions on private borrowing from abroad, led to an explosion of bank credit and large capital inflows. At the same time, according to Englund and Vihriälä (2003), capital requirements were lower after deregulation, 4 per cent for commercial banks and 2 per cent for savings and cooperative banks. High inflation combined with interest payments being tax-deductible made borrowing

attractive. Vihriälä (1997) observes that in the years 1987-1990, there is a significantly increased indebtedness for both firms and households, where the first invested heavily in capacity in retail trade, hotels, restaurants and recreational facilities while the second mainly invested in dwellings, durable goods and services.

Englund and Vihriälä (2003) point out that both banks and non-bank intermediaries expanded rapidly. The most aggressive players were the savings banks. Vihriälä (1997) mentions that while aggregate bank credit roughly doubled from the year 1986 to 1990, the growth rate for the savings banks were 120 and 300 per cent, respectively. However, they were also the weakest, in terms of capital and underlying profitability.

In addition, Vihriälä (1997) also mentions that the domestic demand was increased by buoyant demand in the western export markets in the years 1988-1989. The GDP growth exceeded 5 per cent in both 1988 and 1989 and the unemployment rate was slightly over 3 per cent in early 1990. However, the external balance weakened and inflation was accelerating because of a weakening of the goods and services account and an increased expenditure on the rising foreign debt. In 1989, stock prices and housing prices reached the peak whereas credit growth started to decelerate. On a year-by-year basis, economic activity also decelerated rapidly and in 1990 no growth was reported. At the same time, eastern exports collapsed with the political turmoil in the Soviet Union. As a result, GDP declined by over 7 per cent in 1991. Finally, Englund and Vihriälä (2003) state that the supervisory authorities were rather passive while no major reform of these authorities took place during the years of liberalization.

Financial Crisis

According to Vihriälä (1997), in 1989 the banking crisis started to emerge, when higher short-term interest rates resulted in declining asset prices, while weaker credit growth and increased credit losses weakened bank profitability. Englund and Vihriälä (2003) point out that in September 1991, the Central bank of the savings banks, Skopbank, could not even obtain overnight funding.

Vihriälä (1997) states that in November 1991 the exchange rate came under repeated speculative attacks causing the devaluation of the Finnish markka by 12.6 per cents. In 1991, borrowers' income declined dramatically and as a consequence their capacity to service debt was reduced. Higher short-term rates increased the nominal debt service burden for many borrowers. In addition, since banks depended on the two-thirds of the credit risk of the private sector, their loan stocks became increasingly non-performing. Many guarantee obligations were activated and a great amount of loans had to be written off. The currency depreciation continued and in February 1993, a trade-weighted basket of foreign currencies cost 36 per cent more than prior to the 1991 devaluation.

Englund and Vihriälä (2003) state that as the banking crisis erupted, GDP continued to decline, industrial production was declining, estimated public deficit increasing, bankruptcies and unemployment increasing. Kostela and Uusitalo (2004) report that the unemployment rate increased rapidly in the early 1990s, from 3 per cent to 18 per cent in just four years.

Crisis management

According to Vihriälä (1997), the severe crisis of confidence in the money market forced the government to announce a programme of action consisting of two major support measures. First, the government offered the Finnish deposit banks an aggregate capital injection. Englund and Vihriälä (2003) point out that the instrument "preferred capital certificates" was specially designed to be included in Tier 1[5] capital while avoiding direct government ownership. This instrument is a Finnish innovation. Second, the Government Guarantee Fund (GGF) was created, in April 1992, to safeguard the stable functioning of the deposit banks and the claims of the depositors. Englund and Vihriälä (2003) add that GGF was authorized to use up to 20 billion markka for supporting operations.

Vihriälä (1997) states that in 1992, the situation deteriorated rapidly in many savings banks, which were close to collapse. GGF intervened by merging both problematic and financially sound banks, forming the Savings Bank of Finland (SBF). The existing capital

[5] Tier I (Core capital) includes common shareholders' equity, qualifying cumulative and noncumulative perpetual preferred stock and minority interest in equity accounts of consolidated subsidiaries.

was fully written off to cover the losses and the SBF was transformed into a joint-stock company under government ownership. Furthermore, the author points out that the confidence in the Finnish economy weakened considerably in the winter of 1992/1993. The credit ratings of Finnish banks and nonfinancial corporations had been lowered several times during 1992, while the rate premium on Finnish government debt in foreign currency rose to almost 1 percentage point by the end of the year. In February 1993, to decelerate the crisis of confidence in the banking system, Parliament announced that it undertook to guarantee that the Finnish deposit banks would be able to meet their contractual commitments on time. At the same time, the government bank support was doubled and reached the 40 billion markka. Although the situation stabilized in 1993, banks continued to report substantial losses and the government decided to sell the SBF's assets to the four major domestic competitors in October 1993. Even though the overall economic situation improved, banks still reported substantial losses both in 1994 and 1995.

Summing up, according to Vihriälä (1997), without the massive government intervention, most if not all banks would have failed. The total bank support commitment of the authorities, including capital injection and guarantees, estimated to be over 80 billion markka and the final cost of the support operations for the public sector has been estimated at between 45 and 55 billion markka. Englund and Vihriälä (2003) point out that relative to the annual GDP at the beginning of the crisis, in 1991, the support paid amounted to 13.9 per cent.

Restructuring period

After the extensive banking crisis, a large-scale restructuring of the banking system followed. According to Englund and Vihriälä (2003), the most important restructuring action was the split-up and sale of the Savings Bank of Finland. The "bad" assets transferred to an asset management company and the "good" assets to the four domestic competitors in equal shares. In particular, all branch offices were sold to the buying banks and as a consequence, most of the savings bank sector disappeared overnight. Second, Vihriälä (1997) adds that the two major commercial banks, Kansallispankki (KOP) and

Union Bank of Finland (SYP), merged into the Merita Bank in 1995. Then, the priority of all banks was substantial cost cutting. Englund and Vihriälä (2003) state that this was mainly achieved by reducing the number of both bank employees and branch offices by a half. As a result, innovative banking technologies were introduced at the end of the 1990s and the Finnish banking sector employed the least personnel relative to population in the whole European Union.

2.4 Norway

According to Ongena et. al. (2003), before deregulation, banks were limited with respect both to the quantity and the rates at which they provide loans. Vale (2004) states that these kinds of regulations had been applied since 1945 combined with controls on capital inflows abroad. Ongena et. al. (2003) add that banks had to invest in government bonds while state-owned banks set direct controls on lending and facilitated the rationing of credit at artificially low loan rates. Furthermore, Vale (2004) reports that during the regulatory regime, banks had been exposed to a little credit risk due to a relatively stable macroeconomic development and lending restrictions.

Steigum (2004) mentions that borrowing incentives for households were strong because of favourable tax rules while Vale (2004) states that businesses had favourable rules for capital depreciation in the corporate tax law. However, when inflation and marginal tax rates increased in the 1970s, nominal interest rate was lagging behind. The dramatic decline of the real after-tax rate generated strong incentives to channel credit policy outside the regulated credit market. At the same time, the large commercial banks gained better access to international money markets while the growth of the eurokrone market and financial innovations made it difficult for the government to constrain the underlying market forces by credit regulations. The author believes that this problem might be the main reason why government decided to remove credit regulations in the fall of 1983.

Impact of deregulation

According to Steigum (2004), the main idea behind the deregulation was to replace quantitative credit regulations by indirect measures, namely liquidity reserve requirements. However, such requirements, although reducing bank profitability, were not sufficient to prevent lending boom. In particular, Vale (2004) mentions that between December 1984 and September 1986, the real 12-month growth in bank loans stayed above 20 per cent while the lending boom was observed in both residual and non-residual real estate loans. As a result, real estate prices increased significantly. Eitrheim et. al. (2004) believe that the expansionary lending behaviour of banks might also be related to the increased competition from foreign-owned banks, credit companies, and insurance companies. Furthermore, Vale (2004) states that, in real terms, the private consumption grew 10 per cent in 1985 and 5 per cent in 1986. The author connects this fact with a large drop in the households' net financial investment at the same period of time.

Steigum (2004) states that the deregulation of the authorization to establish branches increased the competition in the customer market for credit. Banks opened branches in new geographic areas and within the period 1983-1986, commercial banks increased their number of branches by 15 per cent and the savings banks by 5.5 per cent. In addition to that, in the same period, the number of employees increased by 19 per cent in commercial banks and 28 per cent in savings banks.

Vale (2004) reports that after four decades of strict quantitative regulations, neither bank managers nor supervisors had any experience of competitive credit markets. Steigum (2004) observes that the two largest commercial banks, Den norske Creditbank and Christiania Bank, competed in which would grow faster. As a result, a significant change in behaviour occurred in both banks, with strong incentives to sell new loans, while internal control and credit evaluation broke down.

Financial Crisis

According to Sjøvoll (1999), there is a debate regarding the exact timing of the banking crisis in Norway. Ongena et. al. (2003) report that in March 1988 Sunnmørsbanken, a

relatively small commercial bank, issued an earnings report warning that it had lost all its equity capital. The authors believe that this event marked the beginning of the Norwegian banking crisis, a four-year period, in which 13 banks representing over 95% of the total commercial bank assets in the country, either failed or were seriously impaired.

Ongena et. al. (2003) mention that during 1986, the price of North Sea Brent Blend crude oil fell from $27 a barrel to $14.5 a barrel. Vale (2004) states that in the oil-dependent Norwegian economy, the current account shifted from a surplus of 4.8 per cent of nominal GDP in 1985, to a deficit of 6.2 per cent in 1986. This led to pressure on the local currency and as a result, Steigum (2004) reports that the Norwegian krone was inevitably devaluated by 9 per cent, in May 1986, whereas inflation and interest rates increased. In addition to that, Ongena et. al. (2003) mention a sharp decline in asset values and existing loans came into jeopardy. Moreover, the Persian Gulf crisis created uncertainty while weaknesses in global financial markets and the economic downturns in Sweden and Finland diminished the ability of Norwegian banks to borrow abroad.

According to Ongena et. al. (2003), bank loan losses began to accumulate in 1987. Steigum (2004) states that finance companies were the first financial institutions that reported significant losses in 1986 and 1987 while, Den norske Creditbank was the first commercial bank that reported losses in 1987. It is worth mentioning here that in 1990, Den norske Creditbank merged with Bergen Bank creating the Den norske Bank, the largest commercial bank in Norway, which then was rescued and nationalized by the government in 1991. Ongena et. al. (2003) mention that early in December 1990, Fokus bank, the third-largest commercial bank, reported large losses due to the poor performance of its loan portfolio while, later in December, Christiania Bank, the second-largest commercial bank, announced an unexpected upward adjustment in loan losses. After that, Den norske Bank also announced an upward revision of its loan loss estimates.

Steigum (2004) points out that many commercial and savings banks had probably been influenced by the aggressive lending behaviour of the largest commercial banks believing that this was the most appropriate way to survive in the new competitive environment.

However, the survivors were, in the end, the smaller and more conservative savings banks that did not follow the aggressive lending behaviour. Furthermore, Ongena et. al. (2003) add that during the crisis period, bank stocks lost most of their equity value, falling 84 per cent between 1988 and 1991. Last, but not least, Steigum (2004) reports that the unemployment rate was close to 6 per cent in 1993, which was considered high by Norwegian standards.

Crisis management

According to Ongena et. al. (2003), at the beginning of the crisis, the government had no formal plan to support the troubled banks financially, nor did it sponsor any form of deposit insurance. Instead, the banking industry managed its own deposit insurance programmes, namely the Commercial Bank Guarantee Fund (CBGF) and Savings Bank Guarantee Fund (SBGF). It was these programmes that first injected capital into the troubled banks. Steigum (2004) mentions that in the period 1988-1989, a large number of relatively small banks faced financial problems and had to either be merged with larger banks or receive capital injections from the two guarantee funds in order to survive. However, by the end of 1990, the guarantee funds had lost much of their capital and it became evident that the government had to intervene.

Sandal (2004) states that in January 1991, the government established a crisis management institution, the Government Bank Insurance Fund (GBIF), with a capital of 5 billion kroner, which equals to 0.6 per cent of GDP in 1991. The purpose of that institution was to secure the interests of depositors and to bolster the general confidence in the banking industry; see Steigum (2004). In addition, Sandal (2004) points out that the initial role of the institution was to provide loans to the two private guarantee funds and enable them to perform. However, in the autumn of 1991, the three largest commercial banks reported significant loan losses and according to Steigum (2004), the government injected another 6 billion kroner into the GBIF. Furthermore, the government established a new fund, the Government Bank Investment Fund (GBF), with a capital of 4.5 billion kroner. According to Ongena et. al. (2003), the government also adjusted existing laws in

order to be able to force each supported bank to write down its equity capital and allowed the government to step in and take control of the banks.

Sandal (2004) points out that it was soon realized that the three largest commercial banks needed more capital and that private investors were unwilling to invest. Steigum (2004) explains that the risk was considered significantly high for potential private investors. Sandal (2004) further states that the banks received a substantial capital infusion from the GBIF at the end of 1991, while conditions were set concerning the balance sheet restructuring/downsizing, cost cuts and other measures with the purpose of improving the results. Moreover, equity capital was written down to cover estimated losses. Ongena et. al. (2003) report that in late 1991, the total size of the government's guarantee funds reached the amount of 20 billion kroner and as a result the government completely took over Fokus and Christiania banks and also gained control of 55 per cent of Den norske Bank. In 1992, only eight domestic commercial banks remained in operation and 85 per cent of the country's commercial bank assets were under government control, according to Ongena et. al. (2003). In addition to that, most large savings banks, mortgage and finance companies had also experienced significant losses. In 1993 the largest insurance provider was under government control. Finally, Vale (2004) states that depositors did not lose money during the Norwegian banking crisis and only in the case of one small, newly established, commercial bank lenders lost their money.

Restructuring period

After the banking crisis, the government has gradually sold its bank shares. According to Sandal (2004), in the autumn of 1995, all the shares of the Fokus Bank were sold in a public issue and later, Danske Bank from Denmark bought the bank. The shares in both Christiania Bank and Den norske Bank were sold gradually. Concerning the former, the government's policy was to keep at least one-third of the shares. However, in 2000, an offer from the pan-Nordic group Nordea for the remaining shares was eventually accepted and Christiania became part of this group. The government now holds 34 per cent of the shares in DnB NOR (the result of a merger between Den norske Bank and

Union Bank in late 2003/early 2004). GDP and bank solvency recovered rapidly, after the banking crisis; see Vale (2004).

To emphasize the most important elements of the preceding analysis, a short presentation of the facts that distinguish the Norwegian banking crisis from the ones in Sweden and Finland is provided below.

According to Vale (2004), the banking crisis in Norway started before the crises in Sweden and Finland and peaked one year prior to the other two. Schwierz (2004) reports that compared to Norway, the overall economic crisis was more severe in Sweden and Finland. In particular, the decrease in GDP, the increase in the unemployment rate, the cumulative fall in bank lending and the public fiscal support for the banks in Sweden and Finland were more intense compared Norway. Vale (2004) adds that the two Norwegian bank-owned guarantee funds handled most of the failures in smaller banks by capital injections and guarantees. The distinguishing factor here is that, unlike deposit insurance funds in the other Nordic countries, these funds had a fairly wide mandate. In addition, the Norwegian government support was based on strict requirements, for instance, existing shareholders had to accept a depreciation to cover losses to the extent possible. Furthermore, no asset management companies were established; neither were blanket guarantees for banks' liabilities issued as happened in Sweden and Finland. Finally, Schwierz (2004) points out that the recovery of the banking sector in Sweden and in Finland took longer than in that in Norway.

2.5 Denmark

Between 1987-1992, the Danish economy experienced significant problems in the banking sector; see Demirgüç-Kunt and Detragiache (1998). However, Hansen (2003) states that the Danish banking sector, in contrast to that of the other three Nordic countries, did not experience a systemic financial crisis. Pesola (2001) provides a number of reasons that explain this difference. First, the deregulation process started earlier in

Denmark and it was not as radical as in the other Nordic countries. Second, the Danish banks were more used to operating in a competitive market. Moreover, Denmark avoided the currency crisis that the neighbouring countries experienced in the early 1990s. The author believes that one reason for this might have been that the Danish krone was pegged in the Exchange Rate Mechanism (ERM) to the German currency, the Deutschemark. Finally, a relatively moderate increase in indebtedness might have contributed to the resulting more favourable economic situation in Denmark.

Hansen (2003) adds that the credit expansion started rapidly in the middle of the 1980s. In particular, credit growth was 32 per cent in 1986, before falling to 10 and 2 per cent in the following two years. The author believes that one reason for the rapid drop in credit expansion was a tax reform, which reduced the deductibility on interest payments. In contrast to the other Nordic countries, economic growth was stable in the period 1987-1993 while a number of individual banks reported financial problems during the years 1984-1993. However, according to Vale (2004), no major bank failures were reported. Hansen (2003) believes that the earlier and much more gradual deregulation process resulted in the Danish banking sector being in a different development state, when the first signs of recession were observed in the other Nordic countries. In addition to that, Vale (2004) mentions that capital requirements in Denmark were much stricter than in Norway. As a result, the Danish banks had a relatively large capital buffer that helped them to cover the significant loan losses in 1991.

Chapter 3

METHODOLOGY

The purpose of this chapter is first to introduce the reader to the concepts of efficiency and productivity, and to the basic methods of studying these concepts. Then, there is an extensive presentation of the Data Envelopment Analysis approach in order to explain the connection with my research objectives and, as a result, to support the choice of this particular method.

3.1 The Efficiency Concept

The efficiency concept is used to characterize the utilization of resources. According to Førsund and Hjalmarsson (1974), efficiency is a statement about the performance of processes transforming a set of inputs into a set of outputs. The authors point out that efficiency is a relative concept, where the performance of an economic unit must be compared with a standard unit. The identification of a standard should involve value judgment about the objectives of the economic activities.

The efficiency measures are based on the distance of an observation to a best practice of efficiency frontier. This distance can be measured in a number of ways, nevertheless it can be restricted to either the horizontal or the vertical direction. When measuring horizontally, the observed input usage is compared to the input bundle, with observed input ratios, needed with frontier technology at observed output levels. Measuring vertically, the observed outputs are compared with potential outputs at the frontier for observed inputs, keeping the relative composition of outputs as observed; see e.g. Berg et. al. (1991). A more detailed presentation of the efficiency measures is provided in the following section.

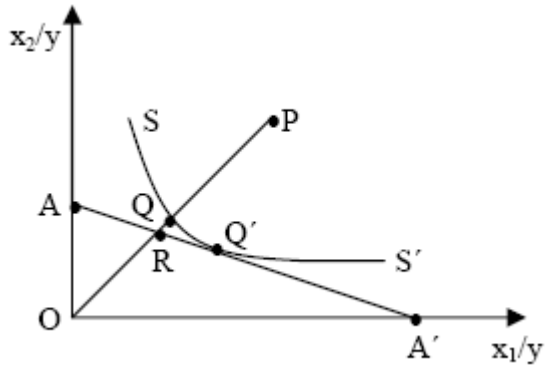
The choice of the specific efficiency measures depends on the purpose of measuring. In general, efficiency measures are applied on the following three levels. Firstly, the macro level, where efficiency measures are used at an aggregate level with the purpose of indicating allocative efficiency. In particular, the economic performance of an observed allocation of resources to different sectors is compared with the result of some ideal allocation. Secondly, the industrial level, where the purpose is to measure the relative performances of the firms within an industry and as a result to give the picture of the structure of the industry. Finally, the micro level, where the efficiency measurement is concentrated on the utilization of resources within a firm; see e.g. Førsund and Hjalmarsson (1974). This study focuses on the efficiency measures on the industrial level, i.e. the relative efficiency of different banks.

3.2 Efficiency Measurement According to Farrell

The efficiency measurement discussion begins with Farrell (1957) who, based on the work of Debreu (1951) and Koopmans (1951), defined a simple measure of firm efficiency that could account for multiple inputs. Farrell (1957) proposed that the efficiency of a firm consists of two components namely, technical and price efficiency (or allocative efficiency). The first component reflects the ability of a firm to obtain maximal output from a given set of inputs while the second reflects the ability of a firm to use the inputs in optimal propositions, given their respective prices and the production technology. The combination of these two measures provides a measure of total economic efficiency (or overall efficiency).

Farrell's categories are best illustrated by using a simple example involving firms which use two inputs (x_1 and x_2) to produce a single output (y), under the assumption of constant returns to scale.

Figure 1: Farrell Efficiency



Knowledge of the unit isoquant of fully efficient firms, represented by SS′ in Figure 1, permits the measurement of technical efficiency[6]. If a given firm uses quantities of inputs, defined by the point P, to produce a unit of output, the technical inefficiency of that firm could be represented by the distance QP. The distance QP is the amount by which all inputs could be proportional reduced without a reduction in outputs. This is usually expressed in percentage terms by the ratio QP/OP, which represents the percentage by which all inputs need to be reduced to achieve technically efficient production. The technical efficiency (TE) of a firm is most commonly measured by the ratio OQ/OP. TE will take a value between zero and one, and thus provides an indicator of the degree of technical inefficiency. A value of one indicates the firm is fully technical efficient. In Figure 1, the point Q is technically efficient since it lies on the efficient isoquant SS′.

In addition, it is also important to measure the extent to which a firm uses the various factors of production in the best proportion, considering their prices. In Figure 1, the input price ratio is represented by the slope of the isocost line AA′ and allocative efficiency (AE) can also be calculated. AE of the firm operating at P is defined to be the ratio OR/OQ, since the distance RQ represents the reduction in production costs that

[6] According to Coelli et. al. (1998), the production frontier of fully efficient firms is not known in practice, and thus it must be estimated from the observations on a sample of firms in the concerned industry. In this study, production frontier is estimated by employing DEA.

would occur if production were to occur at the allocatively (and technically) efficient point Q´, instead of at the technically efficient, but allocatively inefficient point Q.

The total economic efficiency (EE) is defined to be the ratio OR/OP, where the distance RP can also be interpreted in terms of a cost reduction. The production of the technical and allocative efficiency measures provides the measure of the overall economic efficiency.

However, factor prices are often difficult to find, and Farrell recommends the technical efficiency concept.

It is worth mentioning here that the preceding analysis is based on the input-oriented technical efficiency measure. A more explicit presentation of the input and output oriented concepts is provided in Section 3.5.

3.3 The Productivity Concept

Grosskopf (1993) gives the following definition of productivity: *"By worrying about efficiency as a component of productivity I obviously have a particular definition of productivity in mind. Although many consider productivity growth and technical progress as synonymous, I belong to a small but growing group who distinguish the two concepts. I define productivity growth as the net change in output due to change in efficiency and technical change, where the former is understood to be the change in how far an observation is from the frontier of technology and the latter is understood to be shifts in the production frontier"*.

This is the view adopted in this study. Although productivity growth is beyond the scope of this thesis, it is important to have a clear understanding of the differences between the efficiency concept and the productivity concept.

3.4 Studying Efficiency

According to Coelli et. al. (1998), four principal methods are considered for studying efficiency and productivity analysis, namely least-squares (LS) econometric production models, total factor productivity (TFP) indices (Tornqvist/Fisher), data envelopment analysis (DEA) and stochastic frontier (SF). A summary of the properties of the four methods is presented in Appendix BI. DEA is the method that will be employed in this study.

The DEA production frontier is not determined by a specific functional form, but it is generated from the actual data of the Decision Making Units (DMUs) under review, while the required assumptions are minimal. These characteristics are regarded by many researchers as the main advantages of this method over the parametric approaches, namely stochastic frontiers; see e.g. Casu and Molyneux (2003), Coelli et. al. (1998). In addition, Berg et. al. (1991) argue that the DEA approach of fitting facets as close as possible to the observations seems more appropriate when the knowledge of the underlying technologies is weak. Furthermore, it is easy to accommodate multiple input and multiple output models, where the inputs and the outputs can be expressed in different units, and it does not rely on price information as in the parametric frontier cases; see e.g. Berg et. al. (1991). DMUs are directly compared against the peer or a combination of peers and Coelli et. al. (1998) conclude that while the efficiency is generally measured using either DEA or SF methods, the DEA approach may be often the optimal choice.

3.5 Data Envelopment Analysis

Data Envelopment Analysis (DEA) is a mathematical programming production frontier approach and relative efficiency is measured in relation to the constructed frontier. The DEA frontier is formed as the piecewise linear combination that connects the set of "best-practice observations" in the data set under analysis, yielding a convex Production Possibility Set (PPS).

Charnes, Cooper and Rhodes in 1978, first used the term Data Envelopment Analysis. Their approach applied the efficiency concept outlined by Farrell. Since then there has been a large number of studies that have applied and extended the methodology.

The technical inefficiency can be identified by either using the input or the output oriented specification. By using the input specification, technical inefficiency is measured as a proportional reduction in input usage, with output level held constant, while when using the output specification, it is possible to identify the technical inefficiency as a proportional increase in output production, with input level held fixed. The two measures provide the same value under constant return to scale (CRS), but differ when variable return to scale (VRS) is assumed. Furthermore, the returns to scale concept reflects the degree to which a proportional increase in all inputs increases output, in the long-term. Constant returns to scale occurs when a proportional increase in all inputs results in the same proportional increase in output. Increasing returns to scale occurs when a proportional increase in all inputs results in a more than a proportional increase in output, while decreasing returns to scale exists when a proportional increase in all inputs results in a less than proportional increase in output; see e.g. Coelli et. al. (1998), Heffernan (2005). There are many reasons why a particular firm may posses certain returns to scale properties. The most commonly used example relates to a small firm exhibiting increasing returns to scale because it can gain by having additional staff specialize in particular tasks. One possible reason for decreasing returns to scale is the case where a firm has become so large that the management is not able to exercise close control over all aspects of production process.

Analysts have tended to select input-oriented models because many firms have a particular order to fill and as a result the input quantities appear to be the primary decision variables. However, this argument may not be applicable to all industries. In particular, in some industries, the firms may be given a fixed quantity of resources and asked to produce as much as possible. In this case, an output orientation would be more appropriate. In general, the main criterion of choosing the orientation should be based

upon the quantities (inputs or outputs) that managers have most control over. Nevertheless, in many cases, the choice of orientation has only a minor influence on the obtained scores; see e.g. Coelli et. al. (1998).

Charnes et. al. (1978) present a model that has an input orientation and assume CRS; Barker et. al. (1984) suggest an extension of the CRS DEA model to account for the VRS situation. In general, CRS is appropriate when all DMUs are operating at an optimal scale. Factors like imperfect competition and financial constraints may cause a DMU not to be operating at optimal scale; see e.g. Casu and Molyneux (2003). As a consequence, the use of the CRS specification, when some DMUs are not operating at optimal scale, will result in measures of technical efficiency that are confounded by scale efficiency. Berg et. al. (1993) add that the VRS may seem to be the most natural assumption.

However, specifying the VRS, most large banks might appear as fully efficient, possibly because of the lack of truly comparable efficient banks; see e.g. Berg et. al. (1991), Berg et. al. (1993). The CRS assumption allows comparing large banks with much smaller banks and thus avoiding having them appear as artificially efficient. Since each specification has its proper uses, this study employs each specification depending on the context.

According to Coelli et. al. (1998), the CRS linear programming problem, under the input orientation, can be defined as:

$$\min_{\theta,\lambda} \theta,$$
$$-y_i + Y\lambda \geq 0,$$
$$\theta x_i - X\lambda \geq 0,$$
$$\lambda \geq 0$$

where θ is a scalar, λ is a Nx1 vector of constants, N1 is an Nx1 vector of ones. The obtained value of θ will be the efficiency score for the i-th firm. In accordance with Farrell (1957), the value of θ will be less than or equal to one, where the value one indicates a point on the frontier and as a consequence technical efficiency.

The CRS linear programming problem can be easily modified to account for VRS by adding the convexity constraint: N1´λ= 1. The VRS technology forms a convex hull of intersecting planes which envelopes the data points more tightly than the CRS conical hull. Furthermore, technical efficiency scores are provided, which are greater than or equal to those obtained using the CRS model. The authors observe that the VRS specification has been the most commonly used in the 1990s[7].

The CRS linear programming problem, under the output orientation, can be defined as:

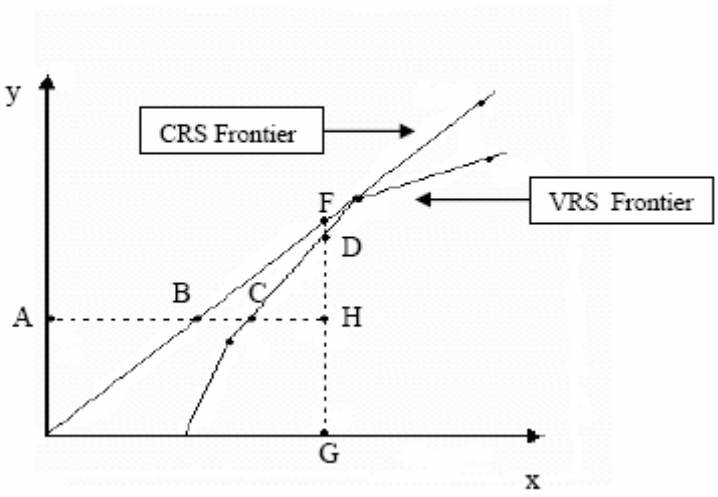
$$\max_{\varphi, \lambda} \Phi,$$
$$-\varphi y_i + Y\lambda \geq 0,$$
$$x_i - X\lambda \geq 0,$$
$$\lambda \geq 0$$

where $1 \leq \varphi < \infty$, and $\varphi - 1$ is the proportional increase in outputs that could be achieved by the i-th firm, with input quantities held constant. Once again, the CRS linear programming problem can be modified to account for VRS by adding the convexity constraint: N1´λ= 1.

In Figure 2 the efficiency measures using one input (x) and one output (y), are illustrated by presenting both CRS and VRS DEA frontiers.

[7] Given that the technology is VRS, scale efficiency measures may be obtained for each firm by conducting both a CRS and a VRS DEA. Then, TE scores, which are obtained from the CRS DEA, can be decomposed into scale inefficiency and pure technical inefficiency. If there is a difference in the CRS and VRS TE scores for a particular firm, this will indicate that the firm has scale inefficiency. In addition to that, the scale inefficiency can be calculated from the difference between the VRS and CRS TE scores.

Figure 2: Calculation of the efficiency measures



Input Oriented: TE_{CRS}= AB/AH

TE_{VRS}=AC/AH

Output Oriented: TE_{CRS}= GH/GF

TE_{VRS}= GH/GD

where TE is the technical efficiency of a specific unit, Unit H.

As mentioned above, these measures are bounded by zero and one.

3.6 Potential Weaknesses

One of the main criticisms faced by researchers using DEA method, and non-parametric methods in general, is the difficulty of drawing statistical inference; see e.g. Casu and Molyneux (2003). However, the more recent literature has been fairly successful in finding ways to overcome this problem[8]. Furthermore, DEA does not usually measure any random error. As a result, any random error that does exist may be counted as differences in efficiency since all deviation from the frontier indicates inefficiency; see e.g. Bauer et. al. (1998). Berger and Humphrey (1997) point out that any of these errors in one of the units on the efficient frontier may alter the measured efficiency of all the units that are compared either to this unit or to the linear combination involving this unit.

[8] See Grosskopf (1996).

In addition to that, DEA inefficiency estimations are unable to separate the noise component from technical inefficiency; see e.g. Lozano-Vivas et. al. (2002). As mentioned above, the DEA frontier is sensitive to extreme observations, see e.g. Berg et. al. (1993)[9].

3.7 Structural Efficiency

Farrell (1957) suggests a measure of technical efficiency of an entire industry, namely a measure of structural efficiency, by simply taking a weighted average (by output) of the technical efficiencies of the production units. Structural efficiency measures the extent to which an industry keeps up with the performance of its own best production unit. Førsund and Hjalmarsson (1979) extend the analysis of Farrell and elaborate several other measures of structural efficiency. In this study, a measure of structural efficiency will be obtained by constructing an average plant and calculate, the input saving efficiency for this constructed average unit. In particular, the average plant is constructed by taking the arithmetic average of each input and output variable.

To sum up, in this study, the input orientation is chosen since one of the fundamental goals of the Nordic banking industry is cost minimization. Technical efficiency is estimated, and structural efficiency for the entire industry and for the two different banking sectors, i. e. commercial and savings, will be presented

As a conclusion, it is worth mentioning the fact that the DEA approach has been applied to numerous studies concerning different sectors and industries, namely the airline industry, hospitals, the agricultural sector, education, electricity distribution utilities, the insurance industry and many more[10]. The diversification of the DEA application verifies the widespread popularity that this method has gained.

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[9] The interested reader is encouraged to refer to Coelli et. al. (1998), Charnes et. al. (1994) for more comprehensive treatment of the material introduced in this chapter.

[10] Gattoufi et. al. (2002) present a long list of efficiency studies, including a complete bibliography of DEA applications.

Chapter 4

RESEARCH DESIGN

The intention of this chapter is to describe the production models employed in this study. First, the sample of this study and the sources of the data collection are presented. Then, the selected variables of the production models are discussed and the summary statistics are also provided.

4.1 Sample and Sources of Data Collection

The 431 commercial and savings banks of the Nordic region were drawn from the London-based International Credit Analysis Ltd's *"Bankscope"* database. In spite of the high reliability that this database provides, the annual reports for a number of banks are also employed for two main reasons. First, to verify the consistency of the data that *"Bankscope"* offers and second, to fill the lack of information when that is needed.

Following the research design that Casu and Molyneux (2003) proposed, the specialized financial institutions, the subsidiaries of foreign banks and the central institutions were excluded. Moreover, the data were extracted from non-consolidated balance sheet and income statement data corresponding to the years 2002-2003, excluding the year 2004. The main argument for this elimination is that this year was not reported in the database for a great number of savings banks, when the data collection was made (July 2005) and it proved impossible to find the missing information. Furthermore, banks, whose financial statements were not updated after 2002, were excluded by the sample. Last but not least, since it is assumed that the banks produce homogenous outputs, the observations, with missing values were also excluded from the final sample. By narrowing down the initial sample of 431, the final number of 160 banks in 2002 and 163 banks in 2003 is the sample of this study[11].

[11] The names of the banks, the type and the origin are presented in Appendix CI.

Since, the accounting data are reported using the local currencies, there is a need for converting the data into a common currency. Euro is used as the reference currency and data are in 2003 terms. In particular, the data conversion has been made by using the official exchange rates of 2003[12]; see Appendix CII. Next, the descriptive statistics of the sample are presented.

Table 1: Number of banks by country and type

	Commercial		*Savings*	
Country	2002	2003	2002	2003
Denmark	18	19	27	27
Finland	5	5	1	3
Norway	5	5	33	33
Sweden	5	5	66	66

In Table 1, the number of commercial and savings banks in each country is presented. The minor differences in the numbers are due to the lack of information on the specific variables.

It is evident that the number of commercial banks in Denmark is considerably greater than that in the other three Nordic countries, where the number of commercial banks is identical. Moreover, the high number of Swedish savings banks is noticeable. The number is considerably higher than the total number of savings banks in the other three countries[13].

[12] According to Berg et. al. 1993, to convert values in local currencies into a common currency, someone may use either the official exchange rate or the purchasing power parity (PPP) rate as computed by the OECD. The two approaches seem to yield to very similar results.

[13] Possible explanations for the great variation in the number of commercial and savings banks, among the four Nordic countries, are provided in Chapter 2.

Table 2: Descriptive statistics, bank size (total assets) in million Euros, 2003

Bank type	No. of banks	Mean	Std. Dev.	Minimum	Maximum
Commercial	34	24 516.4	39 684.4	143.8	15 9802
Savings	129	515	1 037.8	2.7	6 467
Country					
Denmark	46	6 273	25 417	16.2	159 802
Finland	8	16 261	32 012	102	93 921
Norway	38	4 475	14 257	136.3	84 776
Sweden	71	4 384	18 032	2.7	105 921

	Commercial				*Savings*			
Country	Mean	Std. Dev.	Min.	Max.	Mean	Std. Dev.	Min.	Max.
Denmark	14 815	38 520	144	159 802	263	237	16.2	864
Finland	25 198	39 056	429	93 921	1 365	1 872	102	3 516
Norway	25 046	35 337	843	84 776	1 359	1 678	136	6 467
Sweden	60 168	38 793	3 388	105 921	158	231	2.7	1 444

Table 2 shows descriptive statistics of the sample. The average size of commercial banks is close to fifty times larger than that of their savings counterparts. Moreover, the differences in average size are substantial between Finland and the other three Nordic countries. A possible explanation is that the sample only contains of 8 Finnish financial institutions, 5 of these being commercial banks. Since the size of the total assets of commercial banks is significantly greater than that of the savings banks, this variation is not unexpected. In addition, the largest as well as the smallest banks in terms of average assets are located in Sweden. Lindblom (2001) presents similar findings for the years 1995-1999. The Swedish commercial banks are dominant amongst the commercial banks, while the Swedish savings banks are only about one-half of the size of the Danish savings banks and one-tenth of the size of their Finnish and Norwegian counterparts.

4.2 Production Process Model

In order to measure the efficiency of the banking sector, it is necessary to develop a model of the production process. In particular, the inputs and the outputs of the production process have to be determined. However, there is no all-encompassing theory of the banking firm and as a result there is no agreement on the explicit definition and measurements of a bank's inputs and outputs, mainly because of the nature and functions

of financial intermediaries. In particular, the most debated issue is the role of deposits because they can be treated either as input or as output to the production process; see e.g Casu and Molyneux (2003). According to Berger and Humphrey (1997), deposits have input characteristics since the payments made, are part of the interest expenses, while the raised funds provide the institution with raw material of investible funds. On the other hand, the output characteristics of deposits are associated with a substantial amount of liquidity, safekeeping and payment services provided to depositors. The first option corresponds to the so-called *intermediation* approach while the second one corresponds to the so-called *production* approach.

Furthermore, under the intermediation approach, banks are regarded as deposit-taking institutions which raise retail deposits and/or borrow wholesale funds in order to be transform these into loans and other earning assets. Outputs are defined as the value of the various categories of interest bearing assets on the balance sheet, while deposits and borrowed funds are included with capital and labour as inputs[14]. In addition to that, total interest costs are included in total costs. On the other hand, under the production approach, banks are characterized as producers of services associated with individual loan and deposit accounts, where these services are produced by utilizing capital and labour[15]. Therefore, the different categories of loans and deposits are generally considered as outputs, while capital and labour are treated as inputs. Interest costs are excluded from total operating costs; see e.g. Drake (2001).

Thanassoulis (1999) points out that the production and intermediation approaches are not mutually exclusive but complementary. Berger and Humphrey (1997) mention that neither of the two approaches are perfect because they do not fully capture the dual roles of financial institutions, namely providing transactions/documents processing services and being financial intermediaries that transfer funds from savers to investors. The authors conclude that it would be best to employ both models. Consequently, this study employs both approaches when measuring Nordic bank efficiency.

[14] See Sealey and Lindley (1977), Drake and Weyman-Jones, T. G. (1996) , Miller and Noulas (1996)
[15] See Ferrier et. al. (1993), Berg et. al. (1993)

In accordance with the above mentioned studies, the following variables are chosen.

The production models and selected variables are presented below. Model 1 corresponds to the intermediation approach while Model 2 corresponds to the production approach.

Model 1:
Y1=Loans Y2=Investment Securities
X1=Personnel Expenses, X2=Total Cost (interest expenses and non-interest expenses, excluding personnel cost), X3=Deposits

Model 2:
Y1= Loans, Y2=Investment Securities, Y3=Deposits
X1=Personnel Expenses, X2=Total Cost (interest expenses and non-interest expenses, excluding personnel cost)[16]

In some studies, the number of employees is considered as the labour input instead of the personnel cost. However, it is a common practice to use personnel cost due to lack of number of employees[17].

The main criticism that the two approaches attract may be summarized by Heffernan (2005) who states that no account is taken to the different risks attached to each loan, or to the reputation of the bank in terms of the perceived probability of failure. In addition, the maturity structure of loans and deposits is ignored.

Next, short definitions of the selected variables are provided. This part is based primarily upon Chapter 13 in Cornett and Saunders (2004).

Loans are the major items on a bank's balance sheet and generate the largest flow of revenue income. However, loans are also the least liquid item and the major source of

[16] A detailed presentation of the specific accounts that each selected variable includes is provided in Appendix CIII (Tables C1, C2).
[17] See e.g. Lozano-Vivas et. al. (2002).

credit and liquidity risk for most banks. Loans are usually categorized either by their type or by their maturity. By employing the database *"Bankscope"*, loans are classified by their maturity in the Danish, Finnish and Swedish balance sheets while in the Norwegian statements, loans are categorized by their type. This difference limits a more detailed investigation with the purpose of finding the effect of the maturity structure on bank efficiency.

Investment Securities consist of items such as Treasury bills, securities issued by public bodies, government securities and other debt and equity securities. These securities generate some income for the bank and are used for liquidity risk management purposes. In general, investment securities are highly liquid, have low default risk and can usually be traded in secondary markets. Banks generally maintain significant amounts of these securities to ensure that they can easily meet liquidity needs that arise unexpectedly. However, because the revenue generated from investment securities is low compared to that from loans, many banks attempt to minimize the amount of investment securities they hold. Investment securities and loans are the bank's earning assets.

Deposits are the major items in a bank's liabilities. The various types of deposit accounts are used to fund the investments and loans on the asset side of the balance sheet. In particular, demand deposits are transaction accounts held by individuals, corporations, partnerships and governments that pay no explicit interest. Time deposits are savings accounts or certificates of deposits (CDs) held by a bank for a fixed term or with the understanding that customers can withdraw only by giving advanced notice[18].

Total Cost consists of interest expenses and non-interest expenses. More specifically, interest expense is one of the major categories on a bank's income statement. Interest expenses items come directly from the liability section of the balance sheet, namely interest on deposits from customers, from financial institutions and debt instruments. Non-interest expenses items consist mainly of personnel expenses, administrative

[18] http://www.investorwords.com/4977/time_deposit.html (15-7/2005)

expenses and expenses of fixed assets, such as depreciation and real estate rental expenses.

Descriptive statistics are provided in Appendix CIV; see Tables C3 and C4. However, comments are necessary to be made here.

First of all, the Swedish commercial banks hold the largest amount of total loans, while their Danish counterparts possess the smallest amount, in terms of average values. A possible explanation could be that since the Swedish commercial banks are dominant, while the Danish institutions are the minor among the commercial banks, in terms of average total assets, a positive relation between the value of total assets and the value of the total loans is expected. In addition to that, a positive relation is also observed between the value of the total assets and the value of deposits, in average terms. Furthermore, it is clear that the Danish commercial banks hold the highest amount of investment securities relative to the average value of their total assets. This could be explained by the fact that the Danish institutions have to meet more strict capital requirements compared to their counterparts. Final, Norwegian and Swedish commercial banks experience higher total cost while their Danish counterparts present the lowest total cost. However, this conclusion may not be safe since the number of banks under review is significantly greater in Denmark compared to the other three countries.

Similar findings are observed for the savings banks. Since the Finnish and the Norwegian institutions are the largest among the savings banks, in terms of average total assets, they show higher values for total loans, investment securities and deposits compared to their Danish and their Swedish counterparts. In addition, the value of the total cost is considerably higher in the Norwegian savings banks, but once again this conclusion may be misleading because the number of savings banks in each country differs significantly. The positive relation between the total assets and the selected variables is easily shown by providing the correlation coefficients; see Appendix CV.

If, at the stage of designing the model, highly correlated variables are identified among inputs and outputs and these highly correlated variables appear in the same input or output group, certain authors argue that these should be omitted from the model with the intention of keeping the model's discrimination power high; see e.g. Halkos and Salamouris (2004). However, Rhodes and Southwick (1993) and Charnes et. al. (1994), argue that highly correlated inputs or outputs can remain in the DEA models without distorting the efficiency scores at the expense of lower discrimination power. As a result, the high correlation coefficients among the selected variables are not a barrier to run a DEA model due to the non-parametric nature of DEA, which is supposed to mitigate this effect.

In recent DEA studies, there is an attempt to include environmental factors in the basic DEA formulation. Environmental variables are these that explain the particular features of each country's banking sector. In particular, these features include macroeconomic and regulatory conditions as well as accessibility of banking services. The main argument for including these features is that the basic formulation of the DEA model is unable to compare the different banking systems on an equal basis since it does not automatically take into account the cross-country differences in regulation, as well as in economic and demographic conditions, factors beyond the control of bank's managers; see e.g. Lozano-Vivas et. al. (2002). The efficiency scores, derived from the basic DEA estimation, may be regressed upon environmental variables, by using the Tobit regression model approach. The sign of the coefficients of the environmental variables indicate the direction of the influence while standard hypothesis testing can be used to assess the strength of the relationship. However, the determinants of bank efficiency, which are drawn from non-bootstrapped regression analysis, may be biased and misleading; see e.g. Casu and Molyneux (2003), Simar and Wilson (2003). Dealing with different approaches to modeling environmental factors is, however, beyond the scope of this study.

Chapter 5

BANKING EFFICIENCY - EMPIRICAL RESULTS

The aim of this chapter is to present empirical results, in particular, the banking efficiency is estimated by first assuming constant returns to scale (CRS) and then variable returns to scale (VRS) is utilized with the purpose of testing the robustness of the results. The efficiency distribution and the efficiency rankings are presented next. Structural efficiency is estimated while the chapter concludes by discussing the correlation between profitability and the efficiency.

5.1 Efficiency Results under CRS

Since size differences are observed in the sample, the CRS specification will be first employed. In particular, the average size of commercial banks is close to fifty times larger than that of their savings counterparts. By running the DEA model including both banking sectors and assuming that technology is characterized by CRS, large banks are compared with proportional blow-ups of smaller banks. Consequently, this process avoids large banks appearing artificially efficient due to the lack of comparable truly efficient banks; see e.g. Berg et. al. (1993). This process is considered as Step 1 of estimating the Nordic banking efficiency. Tables 3 and 5 show the resulting efficiency scores under the production and intermediation approaches.

Below each table, the corresponding structural efficiency, S1, is presented. The interpretation of the structural efficiency measure used in this study, is the relative reduction in the amount of inputs needed to produce the observed average industry/sector outputs with frontier production technology, with the observed average factor proportions and size of plant see e.g. Førsund and Hjalmarsson (1979).

Table 3: Efficiency, Production approach, by sector and country

2002	*Commercial*					*Savings*				
Country	Obs	Mean	Std.Dev.	Min.	Max.	Obs	Mean	Std.Dev.	Min.	Max.
Denmark	18	.582	.087	.467	.843	27	.611	.11	.425	.933
Finland	5	.647	.226	.406	1	1	-	-	-	-
Norway	5	.45	.079	.313	.508	33	.514	.03	.463	.592
Sweden	5	.649	.036	.601	.696	66	.697	.1	.431	1
2003										
Country	Obs	Mean	Std.Dev.	Min.	Max.	Obs	Mean	Std. Dev.	Min.	Max.
Denmark	19	.672	.148	.27	1	27	.68	.133	.424	1
Finland	5	.696	.264	.282	.902	3	.779	.225	.549	1
Norway	5	.535	.109	.372	.659	33	.667	.083	.512	1
Sweden	5	.797	.07	.735	.918	66	.827	.107	.483	1

Table 4: Structural Efficiency, Production approach, by sector

	CRS	VRS
Commercial	.795	.795
Savings	.58	.703

Under the production approach, there is an indication of higher mean efficiency for the Swedish and Finnish commercial banks, while their Norwegian counterparts are the most inefficient. Especially, in 2002, the average inputs for the Swedish and Finnish institutions could be potentially reduced by 35% without affecting the level of the outputs, while the potential input saving for Danish and Norwegian counterparts is 42% and 55% respectively. In 2003, the obtained efficiency scores are higher than in the previous year. The potential input saving is 20%, 30%, 33% and 46% for the Swedish, Finnish, Danish and Norwegian commercial banks respectively. In addition, it is worth noting that there is only one fully efficient unit each year 2002 and 2003.

Regarding the savings banks, the obtained average efficiency scores are higher than those of the commercial banks. Once again, the Swedish units are on average, the most efficient in both years while their Norwegian counterparts are the least efficient. It is noticeable that all countries have fully efficient banks in 2003. With the exception of Sweden, where the fully 5 efficient units are, each country has 1 fully efficient unit.

Concerning the structural efficiency, the input saving potential for the commercial banks is 20.5 per cent in both CRS and VRS specifications. Regarding their savings counterparts, the input saving potential is 42 per cent under CRS and 30 per cent under VRS specification.

Table 5: Efficiency, Intermediation approach, by sector and country

2002	*Commercial*					*Savings*				
Country	Obs	Mean	Std.Dev.	Min.	Max.	Obs	Mean	Std. Dev.	Min.	Max.
Denmark	18	.533	.171	.248	1	27	.499	.117	.334	.863
Finland	5	.624	.214	.493	1	1	-	-	-	-
Norway	5	.555	.123	.402	.745	33	.604	.083	.436	.911
Sweden	5	.379	.089	.287	.52	66	.529	.127	.317	1
2003										
Country	Obs	Mean	Std.Dev.	Min.	Max.	Obs	Mean	Std. Dev.	Min.	Max.
Denmark	19	.603	.175	.299	1	27	.567	.118	.401	1
Finland	5	.669	.226	.397	1	3	.655	.095	.547	.726
Norway	5	.589	.139	.383	.761	33	.678	.088	.518	1
Sweden	5	.454	.116	.298	.583	66	.609	.119	.309	1

Table 6: Structural Efficiency, Intermediation approach, by sector

	CRS	VRS
Commercial	.649	.677
Savings	.63	.667

The picture changes drastically when the intermediation approach is employed. While under the production approach, the Swedish commercial banks are, on average, the most efficient banks, they are the most inefficient ones under the intermediation approach. In particular, for the year 2002, the potential average input saving is 37%, 44%, 46% and 62% for the Finnish, Norwegian, Danish and Swedish commercial banks respectively. For the year 2003 the obtained efficiency scores are higher and consequently, the potential input saving is lower for each country. There are 2 fully efficient commercial banks each year.

Contrary results are also obtained for the savings banks. By employing the production approach, the Norwegian units are, on average, the least efficient, while under the intermediation approach they are the most efficient. For the year 2003, the potential input

saving is 32%, 34%, 39% and 43% for the Norwegian, Finnish, Swedish and Danish savings banks. For the year 2002, 2 banks are fully efficient, while for the year 2003 there are 4 efficient units[19].

In this case, the input saving potential for the commercial banks is 35 per cent and 32 per cent, while, once again, this percentage is higher for the savings banks, equals to 37 per cent and 33 per cent under the CRS and VRS specification.

When investigating the efficiency by sector, the savings banks are, on average, always more efficient than the commercial banks, see Table 7.

Table 7: Efficiency, Production and Intermediation approach, by sector

2002	*Production Approach*					*Intermediation Approach*			
Sector	Obs	Mean	Std.Dev.	Min.	Max.	Mean	Std. Dev.	Min.	Max.
Commercial	33	.582	.124	.313	1	.527	.171	.248	1
Savings	127	.631	.117	.425	1	.543	.12	.317	1
2003									
Commercial	34	.674	.166	.27	1	.588	.175	.298	1
Savings	129	.75	.134	.424	1	.619	.117	.309	1

Table 8: Structural Efficiency, Production and Intermediation approach, entire industry

	CRS	VRS
Production Approach	.57	.77
Intermediation Approach	.52	.646

Finally, employing the production approach, the input saving potential for the entire industry is 43 per cent under CRS and 23 percent under VRS specification. On the other hand, under the intermediation approach, the overall input saving potential is 48 per cent and 35 per cent under CRS and VRS respectively.

5.2 Robustness of the Efficiency Results

In Step 1, the efficiency results are estimated by including both banking sectors, commercial as well as savings banks, in the DEA model and the CRS specification is

[19] The efficient banks by approach and country are presented in Appendix DI, Table D1.

utilized due to the size differences of the sample. However, assuming that technology is characterized by CRS is a severe restriction that affects the results.

In Step 2, the sample is divided according to the two size groups, namely commercial and savings banks, and the efficiency results of each banking sector are calculated separately. By employing this process, the size differences are not substantial in the DEA model and consequently, the flexible VRS specification can be utilized. An indication of the robustness of the efficiency results is obtained when comparing the results of Step 1 and Step 2, under the VRS specification. Therefore, the consistency of the results is examined and stronger argument for the VRS specification is formulated. In particular, the general trends of efficiency and the "truly" efficient units are studied next.

5.2.1 General Trends

The findings of Step 2 are compared with those from Step 1, under the VRS specification, with the purpose of investigating the general trends of the efficiency results. It should, however, be noted that actual figures are not comparable between the two steps.

Table 9: Efficiency, Production approach, commercial banks, by country

2002		*Step 1*				*Step 2*			
Country	Obs	Mean	Std.Dev.	Min.	Max.	Mean	Std. Dev.	Min.	Max.
Denmark	18	.707	.136	.477	1	.804	.114	.67	.804
Finland	5	.844	.125	.655	1	.877	.09	.773	.877
Norway	5	.788	.146	.601	.982	.824	.138	.619	.824
Sweden	5	.935	.09	.802	1	.936	.091	.802	.936
2003									
Country	Obs	Mean	Std.Dev.	Min.	Max.	Mean	Std. Dev.	Min.	Max.
Denmark	19	.794	.154	.403	1	.9	.083	.761	1
Finland	5	.864	.259	.404	1	.892	.198	.543	1
Norway	5	.848	.167	.585	1	.873	.16	.616	1
Sweden	5	1	0	1	1	1	0	.73	.918

First of all, under the production approach, mean efficiency clearly increases over time according to Step 1 as well as Step 2. Swedish commercial banks are most efficient. In

2002, they are followed by Finnish, the Norwegian and the Danish commercial banks, while in 2003, the efficiency scores are rather similar for these three countries.

Table 10: Efficiency, Production approach, savings banks, by country

2002		*Step 1*				*Step 2*			
Country	Obs	Mean	Std.Dev.	Min.	Max.	Mean	Std.Dev.	Min.	Max.
Denmark	27	.639	.121	.431	.939	.661	.149	.431	1
Finland	1	-	-	-	-	-	-	-	-
Norway	33	.733	.106	.545	1	.791	.123	.545	1
Sweden	66	.724	.114	.494	1	.729	.111	.509	1
2003									
Country	Obs	Mean	Std.Dev.	Min.	Max.	Mean	Std. Dev.	Min.	Max.
Denmark	27	.716	.141	.458	1	.739	.16	.487	1
Finland	3	.835	.248	.55	1	.85	.259	.55	1
Norway	33	.839	.102	.645	1	.863	.112	.645	1
Sweden	66	.848	.104	.576	1	.857	.099	.614	1

Concerning the savings sector, the obtained average efficiency results for Norwegian, Swedish and Finnish banks are similar, while their Danish counterparts are the least efficient in both years, see Table 10.

Table 11: Efficiency, Intermediation approach, commercial banks, by country

2002		*Step 1*				*Step 2*			
Country	Obs	Mean	Std.Dev.	Min.	Max.	Mean	Std. Dev.	Min.	Max.
Denmark	18	.646	.213	.249	1	.824	.124	.583	1
Finland	5	.77	.167	.539	1	.805	.152	.616	1
Norway	5	.762	.204	.466	.953	.808	.193	.478	.953
Sweden	5	.576	.164	.407	.835	.616	.134	.501	.853
2003									
Country	Obs.	Mean	Std.Dev.	Min.	Max.	Mean	Std. Dev.	Min.	Max.
Denmark	19	.72	.2	.3	1	.901	.101	.67	1
Finland	5	.859	.261	.399	1	.895	.181	.582	1
Norway	5	.818	.204	.501	1	.869	.213	.51	1
Sweden	5	.68	.217	.43	.931	.719	.175	.531	.931

Under the intermediation approach, the general technical efficiency results indicate that the commercial banks in Finland and Norway are the more efficient than their Swedish

counterparts. Regarding the Danish institutions, a general conclusion can not be made since the general efficiency ranking differs between the two steps.

Table 12: Efficiency, Intermediation approach, savings banks, by country

2002	*Step 1*					*Step 2*			
Country	Obs	Mean	Std.Dev.	Min.	Max.	Mean	Std. Dev.	Min.	Max.
Denmark	27	.529	.126	.345	.872	.604	.194	.345	1
Finland	1	-	-	-	-	-	-	-	-
Norway	33	.687	.096	.462	.975	.785	.129	.482	1
Sweden	66	.582	.166	.32	1	.598	.168	.32	1
2003									
Country	Obs	Mean	Std.Dev.	Min.	Max	Mean	Std. Dev.	Min.	Max.
Denmark	27	.61	.131	.414	1	.693	.193	.414	1
Finland	3	.744	.185	.554	.924	.812	.166	.683	1
Norway	33	.8	.117	.519	1	.836	.12	.529	1
Sweden	66	.658	.146	.376	1	.675	.149	.376	1

For the savings banks, the trend indicates that the Norwegian banks are the most efficient; their Finnish counterparts follow, while the Swedish and Danish institutions are relatively the least efficient.

There are few comparable previous studies of the efficiency of the Nordic banks. Berg et. al. (1993) and Bukh et. al. (1995) investigated the banking efficiency of three Nordic countries, i.e. Finland, Norway and Sweden. They found that the Swedish banks were the most efficient, while the least efficient were their Finnish counterparts, in average terms. Bukh et. al. also included Denmark in their study. Bergendahl (1995) has a slightly different focus[20].

5.2.2 "Truly" Efficient Units

The fully efficient units, which are obtained in Step 1, are also identified as fully efficient in Step 2. However, the number of fully efficient units increased in Step 2. For these additional units, when the efficiency scores differ significantly, the investigation of the peers is regarded as mandatory in order to discover if these units are "truly" efficient or if

[20] The purpose is to develop a composite reference bank. The approach is more directed towards studying what may be possible rather than actually presenting achieved efficiency.

these are artificially presented as fully efficient due to the lack of comparable units. The intermediation model is first investigated and then the production model.

In Step 1, the total number of fully efficient commercial banks, under the VRS specification, is 10. In Step 2, the obtained fully efficient units are 16. Among the 6 additional efficient units, 4 units present considerable differences in the efficiency scores between the two models. After investigating the peers, it is found that these units are artificially presented as fully efficient, since they are compared with banks from the different sector, namely savings banks, in Step 1. As a consequence, not surprisingly, the 4 commercial banks are classified as fully efficient units in Step 2 due to the lack of comparable units. Therefore, the "truly" efficient commercial banks under the intermediation approach are 12.

Regarding the savings banks, 13 units are presented as fully efficient in Step 1, while this number is doubled in Step 2. In this case, the investigation of the peers is not compulsory, since the efficiency scores are similar between the two Steps. As a result, this study considers 26 "truly" efficient savings banks.

The same process is applied to the production approach. Step 1 indicates 15 fully efficient commercial banks, while this number is increased by 7 more units in Step 2. After investigating the peers, 3 commercial banks are found as "truly" efficient while the rest are artificially efficient. Therefore, 17 commercial banks are the final number of the "truly" efficient units. Similarly, the "truly" efficient savings banks are 28[21].

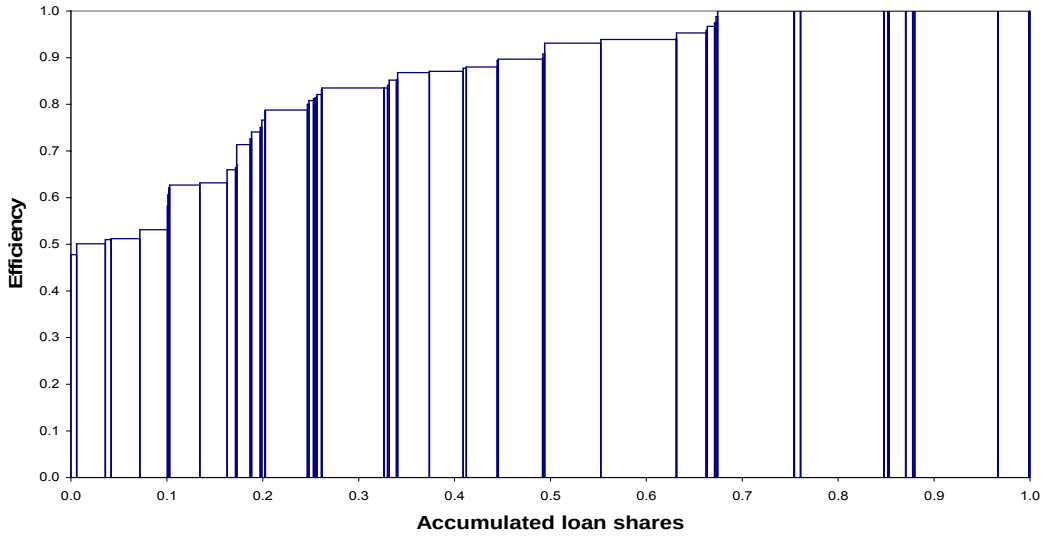
5.2.3 Efficiency Distribution and Bank Size

The efficiency distribution may be clearly presented by using Salter diagrams. The two banking sectors are presented separately under the different approaches, i.e. production and intermediation. The banks of all countries are grouped together and sorted according to ascending value of the efficiency results. Each histogram represents an individual bank

[21] The complete list of the efficient banks, in both steps, is presented in Appendix DI, Tables D1-D3.

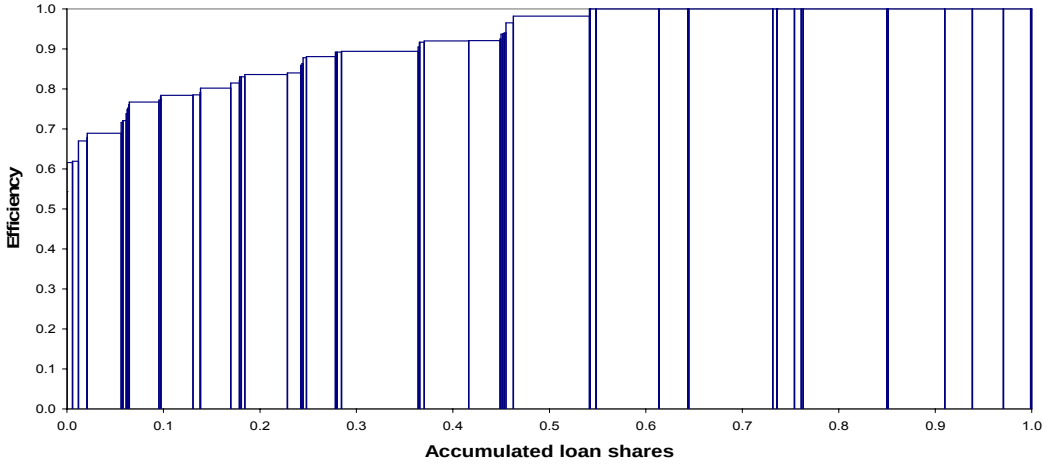
and the size of each bank, measured by accumulated loan shares, is proportional to the width of each histogram; see e.g. Berg et. al. (1991) and Berg et. al. (1993). The efficiency is measured on the vertical axis and the accumulated loan shares, measured in million Euros, are on the horizontal axis.

Figure 3: Efficiency distribution, commercial banks (intermediation approach)



The results for the commercial banks under the intermediation approach are presented in Figure 3. Figure 3 reveals that approximately 33 per cent of total loans are produced by banks being fully efficient. In particular, 5 large banks and clusters of small banks are found to be fully efficient. Regarding the inefficient banks, both large and small banks are distributed over the interval 0.47 to 0.97.

Figure 4: Efficiency distribution, commercial banks (production approach)



Employing the production approach, 46 per cent of total loans are produced by fully efficient commercial banks; see Figure 4. In this case, 9 large banks and clusters of small banks are fully efficient. The inefficient banks, both large and small, are now distributed over the interval 0.62 to 0.98. It is worth mentioning that under the production approach, the efficiency differences are smaller than under the intermediation approach.

Figure 5: Efficiency distribution, savings banks (intermediation approach)

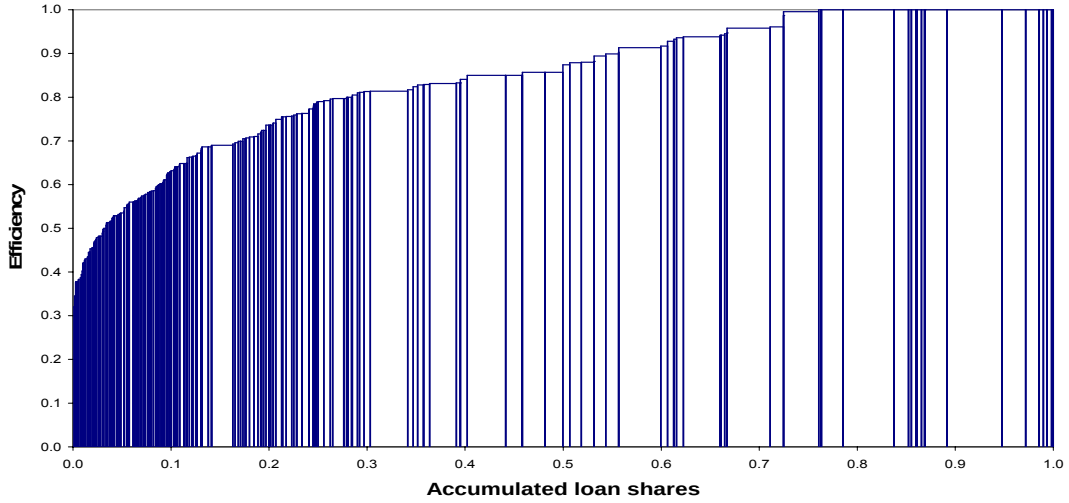
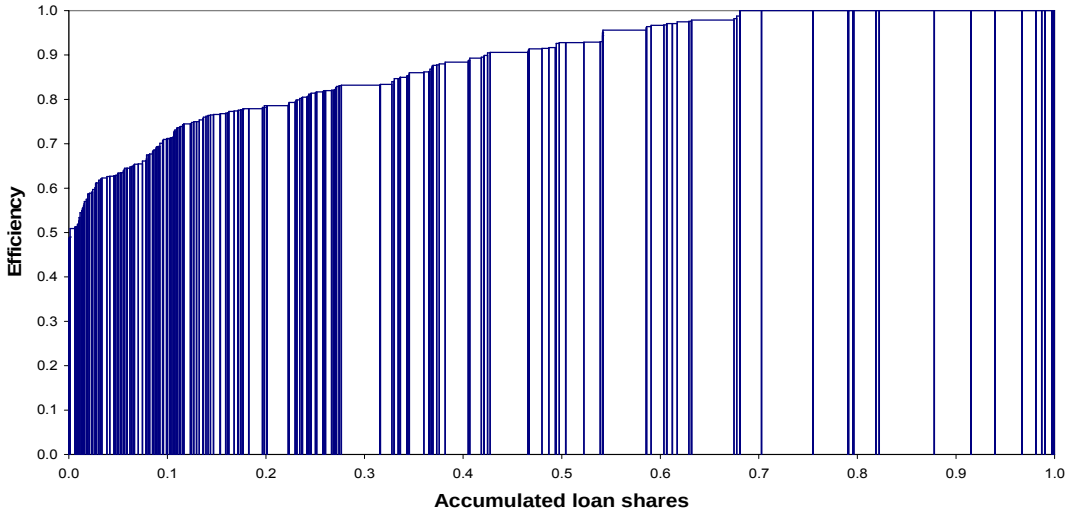


Figure 6: Efficiency distribution, savings banks (production approach)



The results for the savings banks are presented in Figures 5 and 6. Specifying the intermediation approach, the efficiency distribution shown in Figure 5 exhibits a low share of efficient units. In particular, only 23 per cent of loans are given by efficient

banks. There are 7 large efficient banks and clusters of small banks. The left-hand tail of inefficient banks shows a concentration of small ones at the start and then small and large banks evenly distributed over the interval 0.34 to 0.99.

Specifying the production approach in Figure 6, the share of efficient units is higher. 30 per cent of loans are given by efficient banks. Moreover, large banks are mainly fully efficient, 9 to be exact, and only a few small banks are efficient. Once again, the left-hand tail of inefficient banks presents a concentration of small ones and then small and large banks evenly distributed over the interval 0.48 to 0.98.

5.2.4 Efficiency Ranking

Comparing the efficiency rankings of Step 2, under the two approaches, leads to the following conclusions. First, the two approaches do not identify the same number of fully efficient banks. Under the intermediation approach, 12 commercial banks are found fully efficient, while under the production approach, this number is 17. However, only 9 commercial banks are fully efficient in both approaches. Similar findings are observed for the savings sector. While the number of efficient banks is 26 and 28 under the intermediation and production approach respectively, only 16 savings banks are fully efficient in both cases.

Second, the two approaches do not identify the same least efficient banks. Among the 10 commercial banks with the lowest scores in the two approaches, only 2 are the same. Regarding the savings banks, among the 20 least efficient in both cases, only 11 are the same[22].

The correlation between the rankings of the banks under the two approaches is 0.43 and 0.70 for the commercial and savings banks respectively. These results are statistically significant and confirm that the rankings depend on the approach.

[22] The finding of the efficiency ranking in presented in Appendix DI, Tables D1-D4.

5.3 Profitability and Efficiency

What, if anything, can be said about the relation between profitability and efficiency? Consider profit indicators estimated by the return on equity (ROE) and the return on assets (ROA). ROE is defined as income over total equity capital, while ROA is defined as income over the total assets. ROE and ROA can be estimated either on before tax basis or on after tax basis. Lindblom (2001) argues that the before tax measure is preferable when a cross-country analysis is conducted, since there are differences in the tax rules and the marginal tax levels. However, the after tax basis is also employed in other studies; see e.g. Denmarks Nationalbank. In this study, both the before and the after tax basis are used in estimating the profit indicators.

ROE measures the overall profitability of the bank per Euro of equity while ROA measures the profitability linked to the asset size of the banks. In general, bank shareholders prefer ROE to be high. However, it is possible that an increase in ROE indicates increased risk. For instance, ROE increases if total equity capital decreases relative to net income. A large drop in equity capital may result in a violation of minimum regulation capital standards and an increased risk of insolvency for the bank. Moreover, an increase in ROE may simply result from an increase in a bank's leverage, namely an increase in its debt-to equity ratio; see e.g. Cornett and Saunders (2004).

Under the before tax basis, a positive correlation between efficiency and profitability is found, and also under the after tax basis, positive, although lower, correlation is indicated[23].

[23] A detailed presentation of the correlation between the efficiency scores and the profitability indicators is provided in Appendix DIII.

Conclusions

In this study, an attempt is made to shed light on the efficiency of the Nordic banking industry. Since there is not a generally accepted theory on how to measure the flows of the services provided by financial institutions, both the production and intermediation approaches have been employed. However, the obtained empirical results are diverse and consequently, general conclusions are difficult formulated.

Nevertheless, after employing the two approaches, this study supports the sentiment that the intermediation approach might be more appropriate when the efficiency of large institutions, namely the commercial banks, is investigated. In particular, large financial institutions regarded as being financial intermediaries that transfer funds from suppliers of funds to users of funds. On the other hand, the production approach might be preferable when the efficiency of smaller institutions, such as the savings banks, is estimated. In this case, small financial institutions are considered as producers of transaction services associated with individual loan and deposit accounts. Consequently, the following concluding remarks can be made.

First, the Danish, Finnish and Norwegian commercial banks have similar general efficiency results, while their Swedish counterparts are the least efficient institutions. Regarding the savings banks, the obtained average efficiency results for the institutions in Norway, Sweden and Finland are almost identical, while the Danish banks are the least efficient. On a country level, the efficiency results in both approaches indicate that the Finnish institutions, on average, are the most efficient institutions. However, the least efficient institutions differ between the two approaches. The production approach points out the Danish institutions as the least efficient, while the intermediation approach indicates their Swedish counterparts. Moreover, by comparing the efficiency scores by sector, the commercial banks received higher average efficiency than their savings counterparts. Irrespective of approach and type of bank, this study finds that efficiency generally is higher in 2003 than in 2002.

A look at the efficiency distribution reveals that large, as well as, small institutions are fully efficient in both banking sectors. Therefore, the size of each institution is not a determinative factor for achieving efficiency in the Nordic banking industry. Furthermore, the study indicates that the commercial banks, on average, are somewhat more efficient than the savings banks. Finally, the study indicates a positive relation between bank profitability and efficiency.

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Internet Source

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APPENDICES

Appendix AI: Chronology of selected deregulation measures

Sweden

1978: Ceilings on bank deposit interest rates were abolished. However, interbank agreement linking deposit rates on the discount rate continued for some years.

1980: Ceilings on issuing rates for private sector bonds were lifted. Controls on lending rates for insurance companies were removed. A tax on bank issues of certificates of deposits was removed. Foreigners were allowed to hold Swedish shares.

1982: Ceilings on new bond issues by private companies were removed.

1983: Requirements on banks to hold government and housing bonds to meet liquidity quotas were abolished. Use of liquidity ratios to guide bank lending was discontinued and replaced by recommended growth rates for lending.

1985: Ceilings on bank loan rates were lifted.

1986: Placement ratios for banks and insurance companies were abolished. Foreign banks were allowed to establish subsidiaries in Sweden.

1986-1988: Foreign exchange controls on stock transactions were relaxed.

1988-1989: Swedish residents were allowed to buy foreign shares.

1989: Foreigners were allowed to buy interest-bearing assets denominated in Swedish kronor. Remaining foreign exchange controls were removed.

1988–1991: Cash reserve requirements were introduced for finance companies in 1988 and abolished in 1991.

1990: Foreign banks were allowed to operate through branch offices and were entitled to participate in the Riksbank's clearing system on the same terms as Swedish banks.

Source: Drees and Pazarbasioglu (1998)

Finland

1982: Foreign banks were permitted to open subsidiaries.

1983: Relaxation of lending rate regulation and entry of foreign banks into the call money market.

1984: Banks were allowed to lend abroad and to invest in foreign securities.

1985: Call money deposits rate separated from credit rate.

1986: Regulation on average bank lending rates was abolished.
The average bank lending rate was permitted to exceed by 1.75 percentage points the Bank of Finland base rate or by 50 basis points the average deposits rate on markka deposits. Long-term foreign borrowing by manufacturing and shipping companies was exempted from exchange control regulation.

1987: The Bank of Finland began to open market operations in bank CDs in the money market. Helbor money market rates were introduced. Credit guidelines were discounted. Requirements on down payments on housing loans and consumer loans were eliminated. Restrictions on long-term foreign borrowing by corporations were lifted.

1988: Floating rates were allowed on all loans. Banks were permitted to use long-term market rates as loans reference rates.

1989: A supplementary reserve requirement linked growth was introduced. Remaining regulations on foreign currency loans were abolished, except for households.

1990: Prime rates were allowed as loan reference rates.

1991: Cross-border short-term capital movements were liberalizes. Private households were allowed to raise foreign-currency-denominated loans.

Sources: Drees and Pazarbasioglu (1998), Vihriälä (1997)

Norway

1980: The rates for individual loans were not regulated; rather the average level was regulated through interest rate declarations from the Ministry of Finance. Foreign borrowing by banks was liberalized. Under the new foreign exchange legislation, foreign currency exposure limits were established on banks; however, because the Norges Bank provided currency swaps, this measure imposed no constraint on banks' foreign borrowing.

1984: Supplementary reserve requirements were removed.

1985: Interest rate declarations were removed and interest rate monitoring was introduced. The bond investment requirement was phased out.

1986: Supplementary reserve requirements were reintroduced. The limits on the commercial and savings bank borrowing facility at the Norges Bank were increased markedly. Foreign banks were permitted to open subsidiaries.

1987: The supplementary reserve requirements were removed. Perpetual subordinate capital was excluded from the limitations on approved loan capital. The Banking, Insurance, and Securities Commission issued guidelines for assessing nonperforming loans and entering them in accounts.

1989–1991: Remaining foreign exchange controls were removed.

1990: Foreign banks were allowed to operate through branch offices.

Source: Drees and Pazarbasioglu (1998)

Denmark

1981: The banks have been unrestricted in their choice of lending rates.

1987: The Danish Parliament adopted the law regarding deposit insurance.

1988: The foreign exchange regulation was removed after a gradual liberalization during the 1960s, 1970s and 1980s.

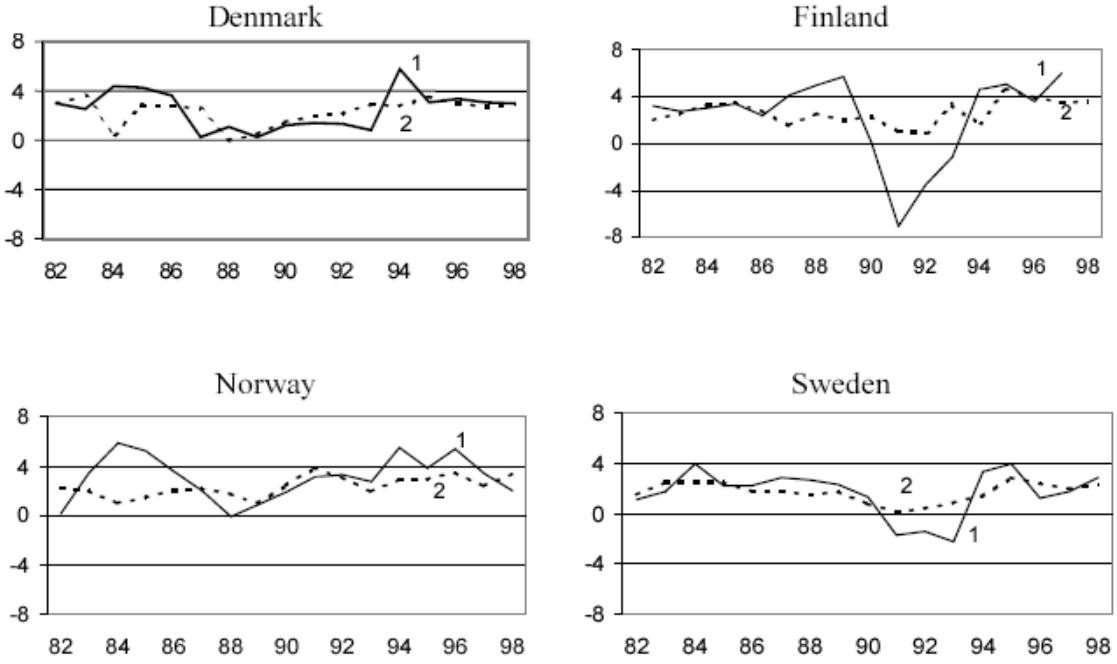
1991: The international capital rules (own fond directive) were implemented in Danish legislation. The deregulation increased the competition among Danish banks but did not cause an explosive development in credit growth compared to the situation in other Nordic countries. There are mainly two reasons for this. First, the deregulation was not as radical compared to the deregulation in other Nordic countries. Second, the Danish banks were more accustomed to operating in a competitive market than were the banks in the other Nordic countries.

1993: The restrictions for international capital flows inside the European Union were removed.

Source: Pesola (2001)

Appendix AII: Macroeconomic Factors

Chart 1: GDP volume percentage change and OECD forecast, 1982–1998.

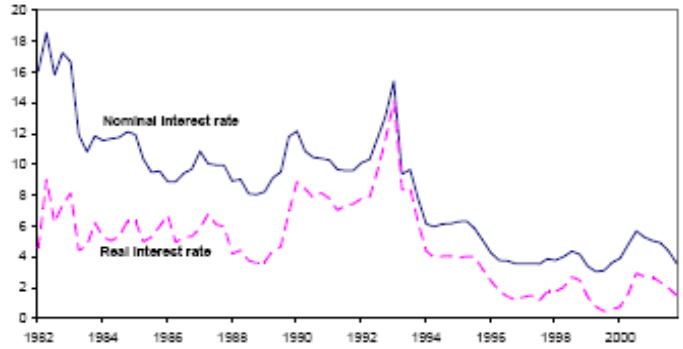


1. GDP volume percentage change
2. OECD forecast

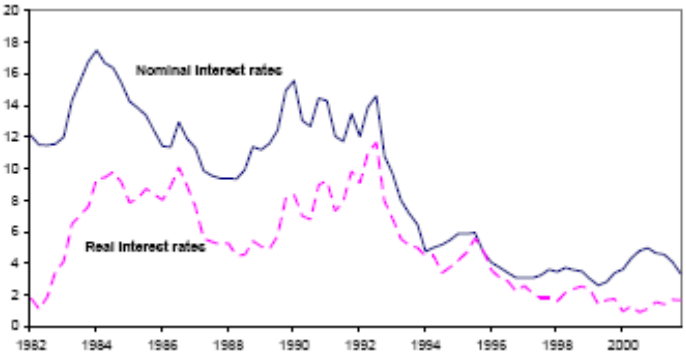
Source: Pesola (2001)

Chart 2: Nominal and Real interest rates, 1982-2000.

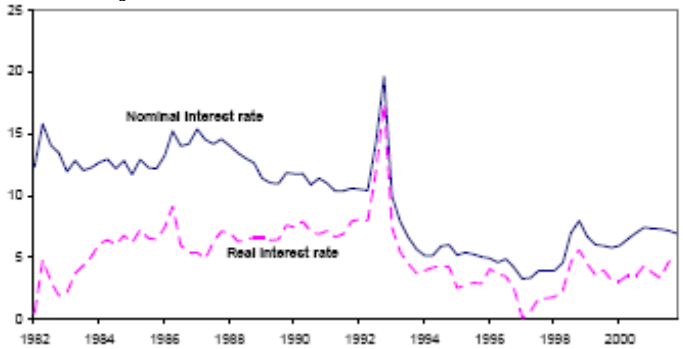
Denmark



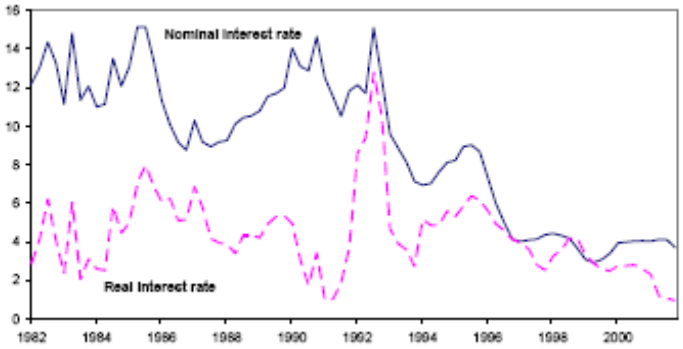
Finland



Norway



Sweden



Source: Hansen (2003)

Appendix B: Summary of the properties of the four principal methods

Property

Method	*Parametric or Non-parametric*	*Account for noise*	*Assume all firms are efficient*
LS	Parametric	Yes	Yes
TFP	Non- parametric	No	Yes
DEA	Non-parametric	No	No
SF	Parametric	Yes	No

Method	*Data required*	*Method is used to measure*
LS	Inputs and output quantities Output quantities and input prices Profit and input and output prices	Technical change Scale economies
TFP	Input and output quantities and prices	TFP changes
DEA	Inputs and output quantities Input and output quantities and input prices Input and output quantities and output prices Input and output quantities and prices	Technical efficiency Scale efficiency Allocative efficiency Congestion efficiency Technical change and TFP change
SF	Same as for LS	Technical efficiency Scale efficiency Allocative efficiency Technical change and TFP change

Method	*Behavioural Assumptions*	*Type of analysis*
LS	Productions function Cost minimization Profit maximization	Time series, cross-sectional and panel data
TFP	Cost minimization Revenue maximization	Same as for LS
DEA	None	Cross-sectional and panel data
SF	Same as for LS	Same as for DEA

Source: Coelli et. al. (1998) pp. 243-245

Appendix CI: Sample

Denmark

Commercial Banks	*Savings Banks*
Amagerbanken	Sparekassen Kronjylland
Arbejdernes Landsbank A/S	Foroya Sparikassi - Faroe Isla
Bankaktieselskabet Alm. Brand Bank	Sparekassen Sjaelland
Carnegie Bank A/S	Sparekassen Lolland
Danske Bank A/S	Sparekassen Himmerland
DiBa Bank A/S	Morsoe Sparekasse
Egnsbank Han Herred	Den Jyske Sparekasse
Fionia Bank A/S (AMTSSPAREKASSEN)	Sparekassen SparTrelleborg
Jyske Bank A/S	Middelfart Sparekasse
Nordea Bank Danmark A/S	Sparekassen Thy
Nordfyns Bank	Sparekassen Hobro
Roskilde Bank	Sparekassen Ostjylland
Nykredit Bank A/S	Froes Herreds Sparekasse
Spar Nord Bank	Sparekassen Farsoe
Sparekassen Faaborg A/S	Dronninglund Sparekasse
Svendborg Sparekassen	Sparekassen i Skals
Sydbank A/S	Broerup Sparekasse
Vestjysk Bank A/S	Dragsholm Sparekasse
	Vorbasse Hejnsvig Sparekasse
	Vivild og Omegns Sparekasse
	Langaa Sparekasse
	Thyholm Sparekasse
	Suduroyar Sparikassi
	Folkesparekassen
	Fuur Sparekasse
	Soeby-Skader-Halling Spare- og
	Hunstrup-Oesterild Sparkasse

Finland

Commercial Banks	*Savings Banks*
Alandsbanken Abp - Bank of Aland Plc	Aktia Sparbank Abp - Aktia Savings Bank plc
Evli Bank Plc	Optia Savings Bank - Säästöpankki Optia (2003)
Nordea Bank Finland Plc	Nooa Savings Bank Ltd - Nooa Säästöpankki Oy (2003)
OKO Osuuspankkien Keskuspankki Oyj	
Sampo Bank Plc	

Norway

Commercial Banks	*Savings Banks*
DnB NOR Bank ASA	Sparebank 1 Rogaland SR-BANK
Fokus Bank ASA	Sparebanken Vest
Nordea Bank Norge ASA	Sparebank 1 Nord-Norge
Nordlandsbanken ASA	Sparebanken Midt-Norge
Romsdals Fellesbank	Sparebanken More
	Sparebanken Hedmark
	Sparebanken Sor
	Sparebanken Ost
	Sparebanken Pluss
	SpareBanken Vestfold - SpareBank 1 Vestfold
	Rygge-Vaaler Sparebank
	Totens Sparebank
	Helgeland Sparebank
	Sandsvaer Sparebank
	Sparebanken Sogn og Fjordane
	Fana Sparebank
	Sparebanken Rana
	Gjerpen og Solum Sparebank
	Sparebanken Grenland
	Sparebank 1 Ringerike - Ringerikes Sparebank
	Modum Sparebank 1
	Halden Sparebank
	Time Sparebank
	Nottero Sparebank
	Sparebanken Jevnaker Lunner
	Melhus Sparebank - MelhusBanken
	SpareBank 1 Gudbrandsdal
	Eidsberg Sparebank
	Selbu Sparebank
	Kvinesdal Sparebank
	Berg Sparebank
	SpareBank 1 Hallingdal
	Sparebank 1 Nordvest

Sweden

Commercial Banks

FoereningsSparbanken - Swedbank
Nordea Bank Sweden AB (publ)
Skandinaviska Enskilda Banken AB
Svenska Handelsbanken
Länsförsäkringar Bank AB (Publ)

Savings Banks

Sparbanken Finn
Kristianstads Sparbank
Sörmland Sparbank
Sparbanken Nord
Sparbanken Alingsas
Sparbanken Syd
Westra Wermlands Sparbank
Falkenbergs Sparbank
Roslagens Sparbank Roslagsbank
Sparbanken i Enköping
Sparbanken i Karlshamn
Sparbanken Västra Mälardalen
Ulricehamns Sparbank
Orusts Sparbank
Sala Sparbank
Laholms Sparbank
Hudiksvalls Sparbank
Leksands Sparbank
Nordals Härads Sparbank
Skurups Sparbank
Södra Dalarnas Sparbank
Sparbanken Tanum
Sölvesborg-Mjällby Sparbank
Sparbanken Tranemo
Tidaholms Sparbank
Kinda Sparbank
Tjörns Sparbank
Ivetofta Sparbank i Bromölla
Fryksdalens Sparbank
Atvidabergs Sparbank
Vinslövs Sparbank
Häradssparbanken Mönsteras
Ase Och Visite Härads Sparbank
Markaryds Sparbank
Valdemarsviks Sparbank
Vadstena Sparbank
Alems Sparbank
Lekebergs Sparbank
Snapphanebygdens Sparbank
Högsby Sparbank
Sidensjö Sparbank
Tyringe Sparbank
Norrbärke Sparbank
Virserums Sparbank
Almundsryds Sparbank
Kyrkhults Sparbank
Bjursas Sparbank
Glimakra Sparbank
Ydre Sparbank
Langasjö Sockens Sparbank
Skatelövs och Västra Torsås Sp
Älmeboda Sparbank
Eskelhems Sparbank
Tuna-Vena Sparbank
Skanes Fagerhults Sparbank
Sparbanken i Ingelstorp
Hishults Sparbank
Göteryds Sparbank
Farstorps Sparbank
Lönneberga Sparbank
Attmars Sparbank
Närs Sparbank
Burs Pastorats Sparbank
Garda-Lau Sparbank
Frenninge Sparbank
Dalhems Sparbank

Appendix CII: Data Conversion

Months	DKK	SEK	NOK	FIM	Trading Days	DKK weighted average	SEK weghted average	NOK weighted average	FIM weighted average
January	7.432	9.173	7.34385	5.945764	21	156.072	192.633	154.22085	124.861044
February	7.433	9.149	7.54957	5.94573	19	141.227	173.831	143.44183	112.96887
March	7.428	9.223	7.85447	5.94573	21	155.988	193.683	164.94387	124.86033
April	7.427	9.157	7.82321	5.945738	22	163.394	201.454	172.11062	130.806236
May	7.424	9.151	7.87247	5.94573	21	155.904	192.171	165.32187	124.86033
June	7.426	9.118	8.1814	5.94573	21	155.946	191.478	171.8094	124.86033
July	7.435	9.197	8.28674	5.94573	22	163.57	202.334	182.30828	130.80606
August	7.433	9.236	8.26249	5.94573	21	156.093	193.956	173.51229	124.86033
September	7.428	9.057	8.1962	5.94573	21	155.988	190.197	172.1202	124.86033
October	7.428	9.01	8.23405	5.94573	22	163.416	198.22	181.1491	130.80606
November	7.437	8.991	8.20091	5.94573	18	133.866	161.838	147.61638	107.02314
December	7.443	9.024	8.25479	5.945741	22	163.746	198.528	181.60538	130.806302
					251	7.431115538	9.124793	8.0086059	5.94573451

Note: By employing the database "*Bankscope*", the financial statements of the Finnish institutions are still reported in Finnish markka.

Appendix CIII: Specification of the selected variables

Table C1: Specification of the selected variables in Denmark and Finland

Variables	*Denmark*	*Finland*
Loans	Loans and advances: - On demand - Up to 3 months - Over 3 months and up to 1 year - Over 1 year and up to 5 years - Over 5 years	Loans to the public and public sector: - On demand - Up to 3 months - Over 3 months and up to 1 year - Over 1 year and up to 5 years - Over 5 years
Investment Securities	Bond: - Listed on Copenhagen stock exchange - Listed on other stock exchanges - Other, own bonds etc	Debt securities: - Certificates of deposits - Commercial paper - Treasury bills - Local authority paper - Subordinated debt securities - Convertible bonds - Bonds with equity warrants - Others
Deposits	- On demand - At notice - Time - Special categories	Deposits from the public and public sector entities: - On demand - At notice - Time - Special categories
Personnel Expenses	Staff costs	Wages and Salaries Pension Social securities Other
Total Cost (excluding Personnel Cost)	Interest expenses: - Credit institutions - Deposits - Issued bonds - Subordinated debt - Other Non-interest expenses - Administrative expenses Depreciation: - Tangible assets, Intangible assets, goodwill	Interest expenses: - Credit institutions - The public and public sector - Debt securities - Subordinated liabilities - Preferred capital investment Non-interest expenses - Administrative expenses - Depreciation - Real estate rental expenses - Capital losses on sales of real estate - Other

Table C2: Specification of the selected variables in Norway and Sweden

Variables	*Norway*	*Sweden*
Loans	Overdraft and working capital facilities Building and Construction loans Installment/Repayment loans Factoring Credit card loans Leasing Other Loans	Loans to the public and public sector: - On demand - Up to 3 months - Over 3 months and up to 1 year - Over 1 year and up to 5 years - Over 5 years
Investment Securities	Treasury bills Certificates of deposits Negotiable certificates Bond: - Short-term - Long term Short-term investment in shares Other Securities	Bonds and other securities – issued by public bodies Bonds and other securities – issued by other Total Government securities Other securities
Deposits	- On demand - Time - Certificates of deposits - Other short-term borrowing	Deposits from the public and banks: - On demand - Up to 3 months - Over 3 months and up to 1 year - Over 1 year and up to 5 years - Over 5 years
Personnel Expenses	Salaries, fees and other personnel expenses	Personnel cost Pension cost
Total Cost (excluding personnel expenses)	Interest expenses: - On deposits from customer - On deposits from financial institutions - On certification of deposits, bonds etc - Subordinated debt and others Non-interest expenses - Administrative expenses - Ordinary depreciation - Operating expenses on real estate - Other	Interest expenses: - On deposits from customers - On deposits from financial institutions - On debt instruments - On subordinated debt - Other Non-interest expenses - Property expenses - Administrative costs - Depreciation (real estate, machinery and equipment) - Goodwill

Appendix CIV: Summary statistics of the selected variables

Table C3: Summary statistics of the Commercial banks, in million Euros.

	Danish Banks (18, 19)				*Finnish Banks* (5, 5)			
Variables	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Loans_02	5 621	13 405	26	54 418	9 091	12 343	10	30 171
Loans_03	5 590	14 052	10	59 537	10 007	12 924	36	31 558
Securities_02	3 564	9 403	8.4	38 817	2 419	2 622	25	6 478
Securities_03	4 067	11 190	12	47 166	1 928	2 065	7	4 994
Deposits_02	5 483	13 081	98	53 116	8 413	12 337	341	29 171
Deposits_03	5 790	14 512	48	61 175	8838	13 101	203	31 169
Total Cost_02	401	953	5.5	3 804	632	897	21	2 191
Total Cost_03	320	777	5	3 182	533	763	19	1 861
Personnel Cost_02	120	260	3	1 029	130	179	16	429
Personnel Cost_03	120	263	3.3	1 068	134	184	17	445

	Norwegian Banks (5, 5)				*Swedish Banks* (5, 5)			
Variables	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Loans_02	16 612	22 378	717	53 959	21555	15512	637	4 426
Loans_03	17 754	24 850	756	59 471	20 359	13 911	772	4 008
Securities_02	1 977	2 900	62	6 908	7 115	5 623	55	13 265
Securities_03	2 250	3 349	64	8 061	7 604	5 772	136	14 249
Deposits_02	13 002	18 591	606	44 758	36 568	21 511	1 663	56 293
Deposits_03	13 132	19 234	705	46 144	35 873	20 118	2 018	53 055
Total Cost_02	1 318	1 730	50	4 240	1 898	1 180	97	3 221
Total Cost_03	1 065	1 441	40	3 528	1 395	855	121	2 307
Personnel Cost_02	192	246	7.5	586	455	256	8.8	629
Personnel Cost_03	205	260	6.9	610	456	255	9.5	615

Note: The numbers in brackets refer to the number of observations for the year 2002/2003.

Table C4: Summary statistics of the Savings banks, in million Euros

	Danish Banks (27, 27)				*Finnish Banks* (1, 3)			
Variables	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Loans_02	147	141	6.2	535	-	-	-	-
Loans_03	161	150	6.3	523	940	1258	60	2381
Securities_02	50	50	3	192	-	-	-	--
Securities_03	55	56	2	238	179	278	7	500
Deposits_02	172	157	12	566	-	-	-	-
Deposits_03	184	165	12	610	860	1091	70	2106
Total Cost_02	8	7.4	0.6	28	-	-	-	-
Total Cost_03	8	7.1	0.5	27	36	50	4	94
Personnel Cost_02	4.8	4.5	0.14	20	-	-	-	-
Personnel Cost_03	5.3	5	0.14	22	13	18	1.6	34
	Norwegian Banks (33, 33)				*Swedish Banks* (66, 66)			
Variables	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Loans_02	1117	1389	108	5503	112	187	0.8	1 210
Loans_03	1 223	1 518	125	5 916	120	194	2	1244
Securities_02	81	105	0.3	384	9.2	15	0.06	77
Securities_03	85	108	0.4	358	13	21	0.06	92
Deposits_02	830	1047	36	3902	110	164	0.2	1 035
Deposits_03	846	1 030	33	3 720	120	170	2.4	1025
Total Cost_02	75	95	6.8	365	5.6	9	0.06	56
Total Cost_03	60	75	6	278	5	8	0.09	52
Personnel Cost_02	11	13	1	44	2.1	3	0.01	18
Personnel Cost_03	12	14	1.2	50	2.3	3.2	0.02	19

Note: The numbers in brackets refer to the number of observations for the year 2002/2003.

Appendix CV: Correlation Coefficient

	Total assets_02	Loans_02	Investment Securities_02	Deposits_02	Total Cost_02	Personnel Cost_02
Total assets_02	1					
Loans_02	.954	1				
Investment Securities_02	.916	.828	1			
Deposits_02	.969	.938	.805	1		
Total Cost_02	.957	.987	.809	.965	1	
Personnel Cost_02	.977	.95	.892	.964	.954	1

	Total assets_03	Loans_03	Investment Securities_03	Deposits_03	Total Cost_03	Personnel Cost_03
Total assets_03	1					
Loans_03	.95	1				
Investment Securities_03	.882	.799	1			
Deposits_03	.969	.936	.805	1		
Total Cost_03	.959	.985	.791	.959	1	
Personnel Cost_03	.974	.943	.873	.975	.951	1

Appendix DI: Efficiency Ranking

Table D1: Step 1, Efficient Banks

Production approach	2002	2003
Commercial	OKO Bank (FI)	Nykredit Bank (DK)
Savings	Eskelhems Sparbank (SE)	Dragsholm Sparekasse (DK) Optia Savings Bank (FI) SpareBank 1 Hallingdal (NO) Orusts Sparbank (SE) Vinslövs Sparbank (SE) Kyrkhults Sparbank (SE) Eskelhems Sparbank (SE) Garda-Lau Sparbank (SE)
Intermediation apprach		
Commercial	Carnegie Bank (DK) OKO Bank (FI)	Nykredit Bank (DK) OKO Bank (FI)
Savings	Mjöbäcks Sparbank (SE) Eskelhems Sparbank (SE)	Dragsholm Sparekasse (DK) SpareBank 1 Hallingdal (NO) Orusts Sparbank (SE) Eskelhems Sparbank (SE)

Table D2: Step 2,"Truly" efficient Commercial banks

Production approach

2002	***2003***
Carnegie Bank A/S (DK)	*Danske Bank (DK)*
OKO Bank (FI)	*Nykredit Bank (DK)*
Svenska Handelsbanken (SE)	*Sampo Bank Plc (FI)*
Skandinaviska Enskilda Banken (SE)	*OKO Bank (FI)*
Länsförsäkringar Bank (SE)	*Alandsbanken (FI)*
	DnB NOR Bank ASA (NO)
	Romsdals Fellesbank (NO)
	Svenska Handelsbanken (SE)
	Skandinaviska Enskilda Banken (SE)
	Länsförsäkringar Bank (SE)
	FoereningsSparbanken (SE)
	Nordea Bank Sweden (SE)

Intermediation approach

2002	***2003***
Danske Bank (DK)	*Danske Bank (DK)*
Carnegie Bank A/S (DK)	*Nykredit Bank (DK)*
OKO Bank (FI)	Carnegie Bank A/S (DK)
	Sampo Bank Plc (FI)
	OKO Bank (FI)
	Alandsbanken (FI)
	DnB NOR Bank ASA (NO)
	Nordea Bank Norway (NO)
	Romsdals Fellesbank (NO)

Note: The efficient banks common to both approaches are in *Italics*.

Table D3: Step 2,"Truly" efficient Savings banks

Production approach

2002	***2003***
Dragsholm Sparekasse (DK)	*Sparekassen Kronjylland (DK)*
Aktia Sparbank Abp (FI)	*Dragsholm Sparekasse (DK)*
Sparebank 1 Rogaland SR-BANK (NO)	*Soeby-Skader-Halling Spare (DK)*
Sparebanken Midt-Norge (NO)	Optia Savings Bank (FI)
Eskelhems Sparbank (SE)	*Sparebank 1 Rogaland SR (NO)*
Dalhems Sparbank (SE)	Sparebanken Midt-Norge (NO)
Kräklingbo Sparbank (SE)	*Sparebanken More (NO)*
	Sparebanken Hedmark (NO)
	Sparebanken Pluss (NO)
	Sandsvaer Sparebank (NO)
	SpareBank 1 Hallingdal (NO)
	Kristianstads Sparbank (SE)
	Orusts Sparbank (SE)
	Vinslövs Sparbank (SE)
	Kyrkhults Sparbank (SE)
	Eskelhems Sparbank (SE)
	Burs Pastorats Sparbank (SE)
	Närs Sparbank (SE)
	Garda-Lau Sparbank (SE)
	Dalhems Sparbank (SE)
	Frenninge Sparbank (SE)

Intermediation approach

2002	***2002***
Sparekassen Lolland (DK)	*Sparekassen Kronjylland (DK)*
Dragsholm Sparekasse (DK)	Sparekassen Lolland (DK)
Aktia Sparbank Abp (FI)	*Dragsholm Sparekasse (DK)*
Sparebank 1 Rogaland SR-BANK (NO)	Folkesparekassen (DK)
Sparebanken Ost (NO)	*Soeby-Skader-Halling Spare (DK)*
SpareBank 1 Hallingdal (NO)	Aktia Sparbank Abp (FI)
Sörmland Sparbank (SE)	*Sparebank 1 Rogaland SR (NO)*
Mjöbäcks Sparbank (SE)	*Sparebanken More (NO)*
Eskelhems Sparbank (SE)	*Sparebanken Pluss (NO)*
Dalhems Sparbank (SE)	Sparebank 1 Nordvest (NO)
Kräklingbo Sparbank (SE)	*SpareBank 1 Hallingdal (NO)*
	Sörmland Sparbank (SE)
	Orusts Sparbank (SE)
	Eskelhems Sparbank (SE)
	Dalhems Sparbank (SE)

Note: The efficient banks common to both approaches are in *Italics*.

Table D4: Least efficient banks

Production approach	**Intermediation approach**
10 Least Efficient Commercial Banks	***10 Least Efficient Commercial Banks***
Evli Bank Plc (FI, 03)	*Fokus Bank ASA (NO, 02)*
Fokus Bank (NO, 03)	Skandinaviska Enskilda Bank (SE, 02)
Fokus Bank (NO, 02)	Fokus Bank ASA NO, 03)
Jyske Bank ((DK, 02)	Nordea Bank Sweden (SE, 02)
Egnsbank Han Herred (DK, 02)	Skandinaviska Enskilda Bank (SE, 03)
Nordea Bank Danmark (DK, 02)	*Evli Bank Plc (FI, 03)*
Amagerbanken (DK, 02)	Länsförsäkringar Bank (SE, 02)
DiBa Bank (DK, 02)	Evli Bank Plc (FI, 02)
Spar Nord Bank (DK, 02)	Länsförsäkringar Bank (SE, 03)
Roskilde Bank (DK, 02)	FoereningsSparbanken (SE, 02)
20 Least Efficient Savings Banks	***20 Least Efficient Savings Banks***
Folkesparekassen (DK, 02)	*Sparbanken i Enköping (SE, 02)*
Fuur Sparekasse (DK, 03)	*Sparekassen Farsoe (DK, 02)*
Sparekassen Farsoe (DK, 02)	Sparbanken i Ingelstorp (SE, 03)
Fuur Sparekasse (DK, 02)	Sparbanken i Enköping (SE, 03)
Sörmland Sparbank (SE, 02)	*Vivild og Omegns Sparekasse (DK, 02)*
Vorbasse Hejnsvig Sparekasse (DK, 02)	Sala Sparbank (SE, 02)
Sala Sparbank (SE, 02)	*Folkesparekassen (DK, 02)*
Dronninglund Sparekasse (DK, 02)	*Middelfart Sparekasse (DK, 02)*
Froes Herreds Sparekasse (DK, 02)	*Laholms Sparbank (SE, 02)*
Vivild og Omegns Sparekasse (DK, 02)	*Dronninglund Sparekasse (DK, 02)*
Laholms Sparbank (SE, 02)	Atvidabergs Sparbank (SE, 02)
Selbu Sparebank (NO, 02)	*Vivild og Omegns Sparekasse (DK, 03)*
Broerup Sparekasse (DK, 02)	Tidaholms Sparbank (SE, 02)
Folkesparekassen (DK, 03)	*Fuur Sparekasse ((DK, 02)*
Nooa Savings Bank Ltd (FI, 03)	Södra Dalarnas Sparbank (SE, 02)
Dronninglund Sparekasse (DK, 03)	Sparbanken Tanum (SE, 02)
Vivild og Omegns Sparekasse (DK, 03)	Sparbanken Västra Mälardalen (SE, 02)
Broerup Sparekasse (DK, 03)	Valdemarsviks Sparbank (SE, 02)
Vorbasse Hejnsvig Sparekasse (DK, 03)	*Dronninglund Sparekasse (DK, 03)*
Middelfart Sparekasse (DK, 02) }	Sparekassen Farsoe (DK, 03) }
Sparbanken i Enköping (SE, 02) }	*Vorbasse Hejnsvig Sparekasse (DK, 02)* }
Same efficiency scores	*Same efficiency scores*

Note: The least efficient banks common to both approaches are in *Italics*.

Appendix DII:

Efficiency, Production and Intermediation approach, by country

2002		*Production Approach*				*Intermediation Approach*			
Country	Obs	Mean	Std.Dev.	Min.	Max.	Mean	Std. Dev.	Min.	Max.
Denmark	45	.599	.101	.425	.933	.512	.14	.248	1
Finland	6	.649	.202	.406	1	.622	.192	.493	1
Norway	38	.506	.044	.313	.592	.598	.089	.402	.911
Sweden	71	.694	.097	.431	1	.518	.13	.287	1
2003									
Country	Obs	Mean	Std.Dev.	Min.	Max.	Mean	Std. Dev.	Min.	Max.
Denmark	46	.677	.138	.27	1	.582	.149	.299	1
Finland	8	.727	.237	.282	1	.663	.178	.397	1
Norway	38	.65	.097	.371	1	.665	.098	.383	1
Sweden	71	.825	.105	.483	1	.598	.124	.298	1

When investigating the general efficiency results by country, the following conclusion can be made. Under the production approach, the Swedish institutions are in both years, the most efficient, while their Norwegian counterparts are the least efficient. Under the intermediation approach, the Finnish and Norwegian institutions are the most efficient, while the general efficiency results for their Swedish and Danish counterparts are lower in both years.

Appendix DIII:

Correlation between Efficiency Scores and Profitability Indicators

Intermediation	ROE_before tax	ROA_before tax	ROE_after tax	ROA_after tax
CRS	.107	.099	.117	0.06
VRS	.311	.009	.28	-
Production				
CRS	.167	.184	.163	.094
VRS	.244	.011	.195	-