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Do macroeconomic variables improve credit loss forecasting?

Emma Axelsson

20958@alumni.hhs.se

Rebecka Vredin

21290@alumni.hhs.se

ABSTRACT

This thesis studies the relationship between the macroeconomic environment and banks' credit losses, examining whether macroeconomic variables can improve credit loss forecasting. By using quarterly data between 1993-2010 for the four largest Swedish banks, we have estimated models for the banks' credit loss levels (CLL) contingent on five selected macro economic factors. The estimated models have been used to produce out-of-sample forecasts, which have been evaluated against the forecasting ability of a simple AR(1) model. The obtained results suggest that adding macro variables to a simple AR(1) model in order to forecast the CLL does not improve the forecasting ability. The results show that the AR(1) models in most cases have a lower RMSE than the models including macro variables. It is therefore probable that other factors of today, disregarded in the forecasting models, might have higher explanatory power of tomorrow's CLL. These factors could be bank specific variables, such as credit portfolio characteristics and geographical exposures. The findings support the use of bank specific models and detailed calculations over simplified top-down methods to forecast CLL.

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1. Introduction

The recent financial crisis has created several debates about the financial system's resilience towards disruptions and the banks' ability to continue to operate and function when the financial climate worsens. The concept of credit losses has been in focus of the discussions and an increasing number of institutes, researchers and politicians have put more emphasis on how the risk of unexpectedly high credit losses can be tested for than before the financial crisis. This leads us into the area of stress-testing.

A stress-test is used as a conditional prognosis of a bank's financial strength given a stressed macroeconomic scenario. Credit risk, the risk associated with default by borrowers, is the most fundamental risk that the stress-test methodology is built upon in the financial industry from a historical perspective and the major individual risk that influence the stress-test outcome. Basically, a negative macroeconomic event is presumed to affect the rate of default among the bank's borrowers, which consequently affect the bank's credit losses.

However, the relationship between the macroeconomic environment and default by borrowers is not obvious and neither is the effect of the macroeconomic environment on lenders credit loss rates. The banks' stress-tests and credit loss models are to a large extent estimated based on bank specific information that external researchers, trying to map the above mentioned relationships, do not have access to.

Still, we ask ourselves how strong the relationship is between the macroeconomic environment and the banks' credit losses and if macroeconomic variables could improve credit loss forecasting. This is what we aim to investigate in this thesis.

The objective of our thesis is to examine whether we are able to forecast next quarter's credit loss level (CLL) by constructing a model based on today's CLL and current and historical levels of macroeconomic variables. We investigate this by studying if the forecasting ability improves when adding macroeconomic variables to a simple AR(1) model.

Our secondary objective is to interpret what our results imply for credit loss forecasting in reality and to study how the macroeconomic aspects are considered in the stress-testing and credit risk models used by the major Swedish banks and the Swedish Central Bank, the Riksbank.

2. Background

In order to provide a better understanding of the subject of our thesis we will present and explain the relevant background of the topic. We start by presenting credit losses, how credit losses are related to credit risk and how the effect of an adverse macro scenario on credit losses could be used in the process of stress-testing according to the literature.

In reality the stress-testing process is highly influenced by the regulatory framework, which is established to improve banks' resilience against the risk of unexpectedly high losses and thus we will explain the existing regulations. We have also included the findings from the interviews with three of the major Swedish banks and the Riksbank.

2.1 Credit Losses

A bank's credit losses can be defined as the credit-related losses that are reported in the financial statements and derived from borrowers' inability to meet their obligations.

Credit losses could be modeled by a structural model, the true model, attempting to capture all parameters that affect the credit losses in one certain period. Credit losses could also be estimated using a forecasting model of the variables that are believed to have an impact on the credit losses in the next period and the estimated impact of these variables. An example of a forecasting model is the simple AR(1) model which have the lagged dependent variable as the only explanatory variable. If the AR(1) and the structural model would be the same, adding variables to the AR(1) model would not increase the amount of information captured in the model.

Thus, credit loss models could be used for forecasting credit losses (i.e. calculating expected losses) as well as calculating a bank's credit risk exposure (i.e. the probability that credit losses exceeds a certain level) and for conducting stress-tests (how large the credit losses would be given a certain crisis scenario).

Expected credit losses (EL) are on micro level commonly divided into a measure of Probability of Default (PD) and an estimate of Loss Given Default (LGD). Expected credit losses are incorporated in the banks' cost component and could be considered as included in the price paid for borrowing money (interview bank 1).

$$EL \equiv PD \, x \, LGD$$

2.2 Credit risk

Credit risk is in general the bank's dominating risk exposure and is defined by an interviewed analyst (interview bank 1) as the risk of losses given that an obligator is unable to fulfill its obligations towards the bank.

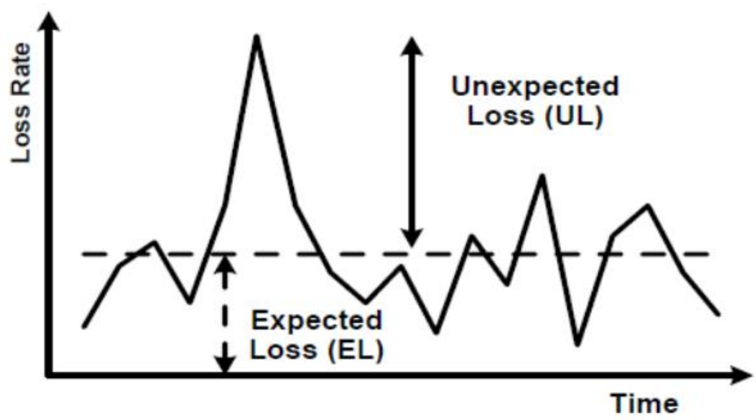
Credit risk is defined by Kimmo and Virolainen (2004) as changes of portfolio value associated with unexpected changes in credit quality (down- or upgrades in credit rating) or the possibility of having unexpected losses from counterparty defaults. In the stress-testing process the risk of unexpected credit losses (UL) is essential when measuring a bank's ability to remain stable when the financial climate worsens. This is the rationale why we have chosen to explain credit risk by using probability of UL.

Since the UL would be zero under the expected economic conditions, UL is not incorporated in the banks' cost component and not included in the price paid for borrowing money. The bank naturally expects the total credit losses to equal the EL. Therefore the credit risk could be labeled as the probability that UL are above a certain acceptable level, x, and thus that total credit losses exceed EL. This is illustrated in figure 1.

$$UL \equiv Total\ Loss - EL$$
$$E\ (UL) \equiv 0$$

$$Credit\ risk \equiv Prob.\ (UL > x)$$

Figure 1



Source: Internal material bank 1

By better assessing the macroeconomic conditions prevailing, banks might be able to forecast credit losses with a higher accuracy and thereby create a model with lower variance of UL (i.e. lower forecasting errors). In sum, realized credit losses comprise both of UL and EL but the UL is generated in the occurrence of an unexpected event end hence not reflected in the forecasts.

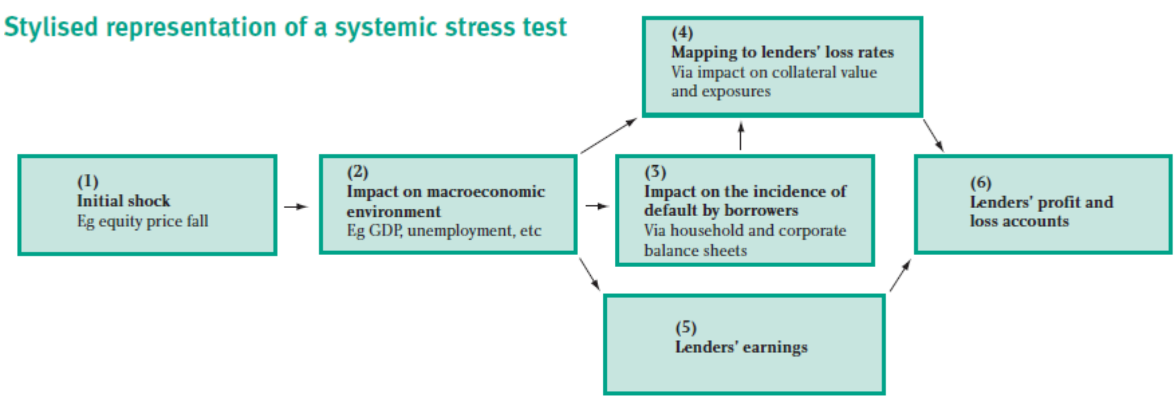
2.3 Stress-testing

Given the credit loss model, we can estimate credit losses under different assumptions for the development of macroeconomic scenarios. An expected change in the macro economy could thereby induce a change in the EL. A stress-test is a conditional forecast, testing the impact on banks be given the event of a crisis.

Stress-testing is a tool to scrutinize the robustness of the financial system and in particular, test if banks hold enough capital to manage a potential but not likely adverse macro event.

Features of a stress-test can be illustrated by Figure 2 - "Stylized representation of a systematic stress-test" by Bunn et al. (2005). The stress-test can be described as dual process: one part where the macro stress-test scenario is constructed and another part where the outstanding loans in the portfolio are risk classified dependent on the impact the scenario has on the default for the banks' borrowers. The two processes produce an estimate of how large the lender's credit losses for the tested assets will be if the stressed scenario occurs. Finally, the stress-test calculates the impact of the default by borrowers on the lender's profit and loss accounts. In total, the stress-test provides a forward-looking framework for analyzing key linkages between financial system and the real economy.

Figure 2



Source: Bunn et al.(2005)

Measuring the impact of various shocks on the balance sheet and income statement of financial institutions can be made by either a "*bottom-up*" or "*top-down*" approach. A bottom up approach is performed from a portfolio perspective in order to understand how a portfolio's value would change in response to changes in a selected macroeconomic scenario. The macroeconomic scenario constitutes of credit risk factors, which subsequently are mapped towards all instruments in the portfolio to be able to summarize the effect. This approach is common among private institutions that have access to detailed portfolio data. (Jones, 2004)

The top-down approach is the main test method conducted by central banks in order to observe how changes in the economic environment affect the financial system as a whole and not just a particular financial institution. The test therefore involves a single scenario with a large amount of aggregated data. The aggregation and comparison of heterogeneous portfolios is though a limitation for such tests, since each portfolio in reality is based on different methods and calculations, which can cause misleading conclusions on an aggregated level. In addition, with this method the linkages between changes in the economy and changes in risk factors are modelled in a less precise manner. (Enoch, 2006)

2.4 The regulatory framework

Banks are a crucial part of an economy's infrastructure, providing services and functions such as payment services, capital raising, risk transformation etc. Banks have permission to perform these functions and services and e.g. hold central depositary guarantees for their cash deposits. For most of the banks central services there are no substitutes. Turbulence in the financial industry would harm all other industries and the economy as a whole and therefore regulation of financial institutes and the banking system, is of great importance. However, in order to maximize utility, the cost of the regulations should not exceed the gain in value from the them (FI 2001:1).

For securing a bank's resilience towards the risk of unexpectedly high credit losses regulatory directives for the Tier 1 Capital Ratio[1] have been implemented by the banks. The Tier 1 Capital Ratio can be used as a measure for regulators and other stakeholders to perceive how well capitalized a bank is and what level of capital the bank would need in the event of a stressed scenario. The capital a bank hold in accordance with the capital ratio requirements is hence held for protection towards UL. (FI 2001:1) Further explanations of the Tier 1 Capital ratio can be found in the Appendix A.1.

[1] The Tier 1 capital ratio is the Tier 1 capital (sv primärkapitalet) divided by the bank's Risk-Weighted Assets (RWA) which is a measure of assets that takes credit, market and operational risk into account.

The Basel rules

Today's international regulation of the banking and capital markets sector, Basel II, originates from the former Basel I rules established 1988. Basel I had two primary objectives: to promote safety and soundness of the financial system and to establish similar competitive environments for international banks. To achieve the objectives, minimum requirements were formed to determine how much capital a bank needed as a buffer to handle the risks within its business. (FI 2002:8) The minimum Tier 1 Capital ratio was by the Basel Committee set to, and is still, 8 per cent. (FI 2005:8).

The rationale behind the development of Basel II emerged from the need of a modernization of the regulations to improve the risk sensitivity in the banking system and allow for a more efficient usage of risk capital. The development of modern financial techniques had given banks the opportunity to at a relatively low cost sidestep the regulations in different and complex forms which could impose new unfamiliar risks, a problem which the regulators tried to solve by the new directives in Basel II. (FI 2002:8) The main characteristics of Basel II is described in Appendix A.2.

The recent financial crisis showed that the current regulations were not comprehensive enough. The Basel committee on banking supervision therefore developed Basel III (which will be gradually implemented between 2013-2019) in order to strengthen the regulation, supervision and risk management of the banking and capital markets sector further. (Bank of International Settlements)

2.5 The reality review

We have performed interviews with analysts from three of the four major Swedish banks and from the Financial Stability Department at the Riksbank in order to examine how credit loss forecasting, credit risk modeling and the process of stress-testing works in reality. The intention by gathering this type of information was to make a qualitative contribution to the thesis by finding out how the macro economy affects credit losses and the parameters of credit losses in the banks' models. However, we were through the interviews unable to obtain detailed information about how the relationship between credit losses and the macro economy is modeled. Our interviewees put more emphasis on how default rates are mapped to credit losses and used to estimate the capital requirement, i.e. the micro level of calculating credit-losses and stress-testing.

We do find the interviews interesting, since they provided alternative perspectives of the purpose and challenges of the stress-testing methodology and credit risk modeling. By putting the theories, the regulations and the possible objectives into a practical context we can compare and better understand how the situation differs between the banks and the Riksbank with respect to access to data, modeling and overall procedure and in the end form a better discussion from our results. In the Appendix A.3, a summary of the interviews with the three banks and the Riksbank is presented.

3. Previous Research

The research literature on stress-testing and credit risk modeling does not reveal much about the banks' practical implementation of credit loss models. However, there are papers describing the general process of stress-testing which we have used to understand the procedure without having access to bank internal information.

The literature about the relationship between the macroeconomic environment and default by borrowers has been the most relevant for our main objectives in this thesis. Åsberg and Shahnazarian's study on the long-term relationship between aggregate EDF and the macroeconomic development has functioned as our reference paper.

3.1 Models of stress-testing

Overall, the process and the purpose of calculating credit losses under a stressed scenario is described in a similar manner throughout the literature. Bunn et al. (2005) define stress-testing as a what-if analysis practice, measuring what the effect might be on the financial system or on individual firms given certain volumes and types of risks. The aim is to test the robustness of financial systems with implications of both systematic and idiosyncratic risk to inform discussions and generate a decision base for how much capital that is needed to cover risks (Bunn et al. 2005). The model by Bunn et al. (figure 2) stretches from the "initial shock" to "lender's profit and loss accounts" via "impact on macroeconomic environment", "lenders' earnings", "mapping to lenders' loss rates" and "impact on the incidence of default by borrowers".We find this model as the best to describe the stress-testing procedure and we have used it when we in the quantitative part of this thesis have tried to create what could be seen as a short-cut version model of the credit loss forecast procedure.

The stress-test model by Blanksche et al. (2001) is similar to the model of Bunn et al. in the sense that it includes a scenario and a portfolio of assets to be shocked. They present a decision sequence that begins with deciding which risk to stress (e.g. credit risk or market risk), which shock to apply and which type of scenario to use (such as historical or hypothetical). Moreover, they determine which type of assets to shock, what time horizon to look at and the size of the shock. By using this model it is possible to reveal if it is necessary to take on changes in the underlying portfolio in order to cope with the shock that is tested for.

3.2 Studies on aggregated portfolios

The choice between performing the test for credit losses on an aggregated credit portfolio of several banks or let each bank perform analysis of their credit portfolio by using own models is subject to methodological challenges.

Aggregation across a diverse sample of portfolios induces large measurement errors due to different choices of risk measurement methods of the individuals, especially since there is a lack of commonly accepted methodology for valuing certain complex financial products. An option is to provide banks with detailed scenarios and modeling assumptions and make them implement these on their own portfolio. Blanksche is arguing that aggregation of the results of individually performed stress-tests is likely to provide the most informative picture of risks and vulnerabilities of a financial system. (Blanksche et al. 2001)

A study by Jones et al. (2004) focuses on testing the vulnerabilities of the financial system as a whole by applying a uniform approach to the assessment of risk exposures across institutions given a forward looking macroeconomic perspective. They find that a system stress-test could thereby complement individual stress-tests and act as cross-checking tool to the micro tests. This gives regulatory institutions a broader understanding of risk, which may result in an improved knowledge of the link between the financial sector and the macro economy.

3.3 Studies of time horizon

A number of methodical challenges remain and need to be overcome when conducting macro stress-tests. Sorge (2004) considers the most severe concerns to be: correlation of market and credit risk over time and across institutions (which could cause unknown dispersion of contagious risks), the limited length of the applied time horizons for the analysis and the possible instability of all reduced form[2] parameter estimates caused by feedback effects.

Chan-Lau (2004) also stresses the need of data series that span over at least one business cycle when using macroeconomic-based models to forecast default probabilities from the projected behavior of the explanatory economic variables over time.

Describing the theories and desire to use longer time horizons both Sorge and Chan-Lau make references to Lucas critique[3] in the sense that the models used include parameters and functional forms that are unlikely to stay stable and that future behavior might not follow historical patterns.

3.4 Studies of the link between the macroeconomic environment and default by borrowers

The previous studies with the highest relevance to our thesis are those conducted about the link between the macroeconomic environment and default by borrowers.

Carling et al. (2006) examine the impact that macroeconomic conditions have on business defaults. They estimate a duration model for a major Swedish bank between 1994 – 2000 to explain the survival time to default for borrowers in the business loan portfolio, by using a model that takes both firm specific characteristics and current macroeconomic conditions into account. Carling et al. find that the output gap, the yield curve and consumers' expectations of future economic development have significant explanatory power on business defaults.

Kimmo and Virolainen (2004) conduct an assessment of macro stress-tests with a macroeconomic credit risk model for Finland. They test the explanatory power of different macroeconomic factors on the default rate but also find that the relationship between corporate sector default rates and banks' loan losses is obvious, something that is highly relevant for our thesis (since we will consider credit losses directly).

Jacobson et al. (2005) study the interaction and feedback between the macro environment and financial position on aggregated data. Their main findings include that the aggregate default

[2] *Reduced-form* models assume an exogenous functional form for the relationship between default probabilities and a number of primary, possibly correlated, risk factors whose evolution over time follows data-driven stochastic processes.

[3] Lucas (1976) "Given that the structure of an econometric model consists of optimal decision rules of economic agents, and that optimal decision rules vary systematically with changes in the structure of series relevant to the decision maker, it follows that any change in policy will systematically alter the structure of econometric models."

frequency is an important link from the financial to the real side of the economy and that macroeconomic variables are important for explaining a time-varying default frequency. The macro data applied covers both domestic and foreign quarterly data on the output-gap, the nominal interest rate, the inflation rate and the exchange rate.

Pesaran et al. (2005) propose a model of credit losses contingent on the global macro economy, considered with a channel for modeling default correlations that is able to distinguishing between defaults caused by firm specific or systematic shocks. They find that default probabilities are driven primarily by how firms are tied to business cycles, both domestic and foreign, and how business cycles are linked across countries.

Castrén (2006), stresses that another fundamental factor to take into account in the stress-test model is global effects. In his study he models the link between global macro-financial factors and firms' default probabilities by using a global vector auto regressive model (GVAR) linking the Expected Default Frequency (EDF) of different euro area corporate sectors to a set of macroeconomic and financial variables. He puts forward that firms use credit available outside their home countries and thus both national and international shocks affect balance sheet measures.

3.5 Reference study

The study that has served as our main source of inspiration is "Interdependencies between Expected Default Frequency and the Macro Economy" by Åsberg and Shahnazarian (2009). They assess the link between corporate default rates and the macro economy by using a vector error-correction model (VECM). The model is used to forecast the median EDF. They find that the model yields low forecast errors and that the short-term interest rate variable has the strongest impact on EDF. A lower short-term interest rate decreases the EDF and diminishes the marginal cost for corporate investments and household consumption.

Åsberg and Shahnazarian's first objective is to explore whether the development over time of aggregate EDF for listed companies can be explained by the macroeconomic development. However, we are interested in testing if it is possible to forecast banks' credit loss level given specific macroeconomic conditions directly rather than first estimate companies' expected default frequencies. Åsberg and Shahnazarian's second objective is to use their model to conduct a stress-test of aggregate EDF. In our study we have not tested our model on a specifically stressed scenario, although we assume that a well estimated model could be used for such purpose.

Inspired by Åsberg and Shahnazarian we have estimated a model and evaluated the forecasting capability of the model through out-of-sample forecasts that we have compared to the forecasts of a simple AR(1) model.

4. Data

We have used data that contain both bank specific data for the four largest Swedish banks on credit losses and lending and data on macroeconomic variables. The estimations are based on quarterly data from the time period of 1993-2010.

4.1 Bank specific data

The data of each of the four largest Swedish banks' credit losses and total lending have been provided by the department for Financial Stability at the Riksbank. All of the data is obtained on quarterly basis for the time period 1993 – 2010, thus we have 70 observations for each bank, 58 within our sample period and we have 12 forecast observations within our out-of-sample period.

The quarterly CLL is calculated as the banks' the reported credit loss after tax divided by the average quarterly outstanding loans. We use the CLL rather than the absolute numbers for credit losses to be able to obtain a relative measure of credit losses.

4.2 Macro data

Data on five macroeconomic variables have been collected from the Monetary Policy Report of the Riksbank from MPR 2008:2 and 2010:2 and SCB. We have 70 observations for each macro variable, whereas 58 observations is within our sample period that we base each banks original model on and 12 observations that we use to make our CLL forecasts within the out-of-sample period. The observations in the sample period and out-of-sample period increase respectively decrease as we lengthen the sample period.

In the following section we will explain the macroeconomic variables.

GDP gap

A measure for the state of the business cycle is necessary for our model. In the choice between using GDP or unemployment we have been inspired by Carling et al (2002) who find the output gap to have a significant explanatory power on firms' default risk. The output gap could in the model function as an indicator of demand conditions.

We have chosen to measure the current real economic activity relative to trend by using the GDP gap as a percentage of deviation from HP trend[4]. We believe the chosen measure is more likely to have effects on loan-losses than the growth of actual GDP. High growth in GDP is often not synonymous with a peak of the business cycle (and vice versa) whereas a large deviation from the HP-trend could be more indicative of the current state of the economy.

Interest rate

The interest rate is the price or interest investors have to pay when borrowing money. As a higher interest rate affects corporate expenditures on corporate loans we expect a positive relation between the interest rate level and loan-losses. According to Åsberg and Shahnazarian (2009), measuring the interdependencies between EDF and the macro economy, the short-term interest rate had the strongest effect. We would like to test if the effect is similar substituting EDF to loan-losses. We are using the short-term (3 month) interest rate of the Swedish state as the relevant measure of the interest rate.

Inflation

The inflation rate is a measure of how fast prices are rising (Mankiw 2007). For countries where the monetary policy includes setting the interest rate to keep inflation at a target level it is possible to see a link between inflation, EDF and the interest rate. Higher inflation might be treated with a higher interest rate, which also implies higher EDF. At the same time higher factor prices caused by higher inflation leads to increased production costs which tend to be passed on to customers, decreasing their liquidity as well as it harms credit quality of all borrowers and hence increase EDF directly. (Åsberg and Shahnazarian, 2009) Therefore we find it meaningful to include a measure of inflation into our model and we use CPI (annual percentage change) as our measure for domestic inflation.

[4] The HP trend is in practice an exponential trend in a times series is captured by modeling the natural logarithm of the series as a linear trend i.e. separate the cyclical component from the raw data. (Woolridge, 2006)

Exchange rate

The exchange rate is the rate which a country makes exchanges in the world market. The real exchange rate is also referred to as a country's terms of trade and is the relative price of the goods of two countries, affecting a country's trade balance.(Mankiw 2007)

We have chosen to use the real TCW (Total Competitiveness Weights) index as our proxy for the exchange rate. The real TCW index measures the Swedish krona against a basket of other currencies (our main trading markets) adjusted for different price levels.[5] (riksbank.se)

Oil Price

The oil price reflects sensitivity to fluctuations in the use and access of oil as a widespread and highly important global commodity. An increase in the oil price directly raises the prices for petroleum products and the costs for energy-using industries often causing its product prices to increase (Krugman 2006). The oil price reflects and correlates closely with the insecurity of the current state of the economy and political stability.

Castrén (2006) states that a shock to the oil price is an example of a global shock that does not originate from any specific country. Hence, including oil price (Brent) denominated in USD contributes with a global perspective to our model compared to the other variables.

4.3 Descriptions of the data

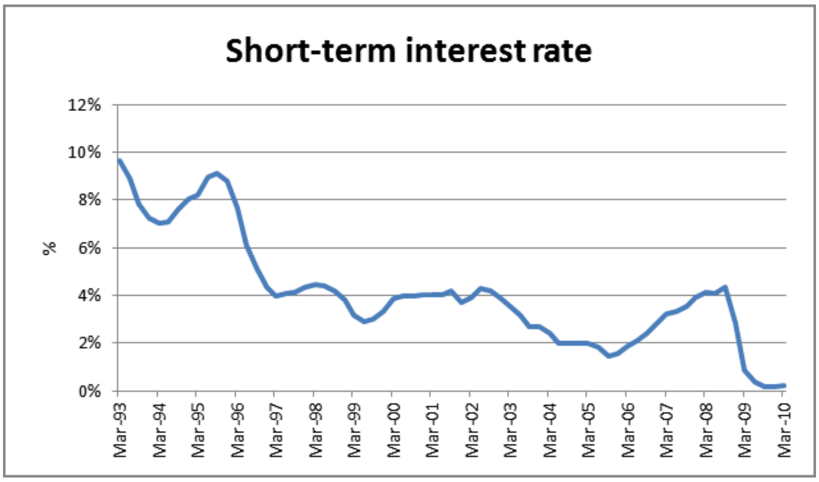
Illustrations for the statistics of the macroeconomic variables over the time period 1993-2010 can be found in figure 3 below. The *short-term interest rate* displays an overall decreasing trend from very high levels in the beginning of the 90s until the end of 2005, followed by an increase until the beginning of 2008 when the trend turns downwards again. The *oil price* trend has a positive development from 1993 experiencing a steeper development beginning in mid-2003 with a peak in 2008, followed by a steep decrease until the end of 2008 when it starts to increase again. The development of the annual percentage change in *CPI* is volatile over the entire time period. The *real exchange rate* is relatively stable over the time period, reaching its highest level in the end of 2008. The *GDP-gap* is initially at a negative level, recovering by 1995 and remaining mostly at positive levels until the 2001. After 2000 the GDP gap drops to negative levels until early 2004

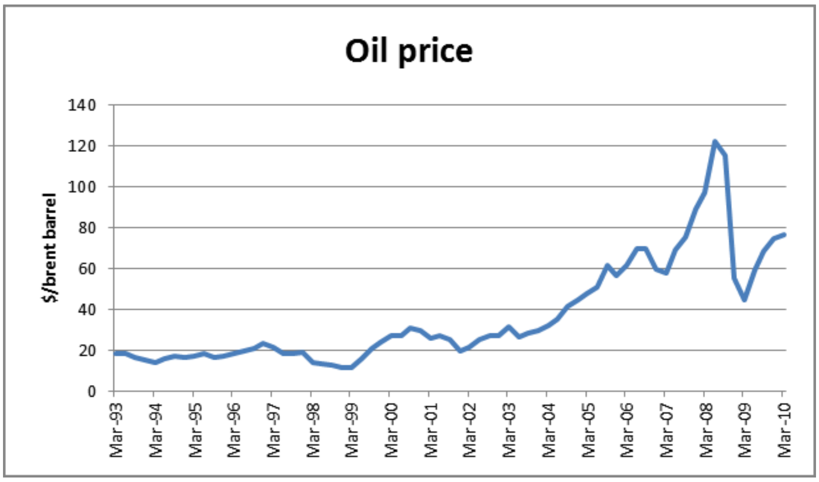
[5] The measure is based on flows calculated by IMF of processed goods through exports, imports and third country effects for 21 countries. The starting date of the index is 18 November 1992. (riksbank.se)

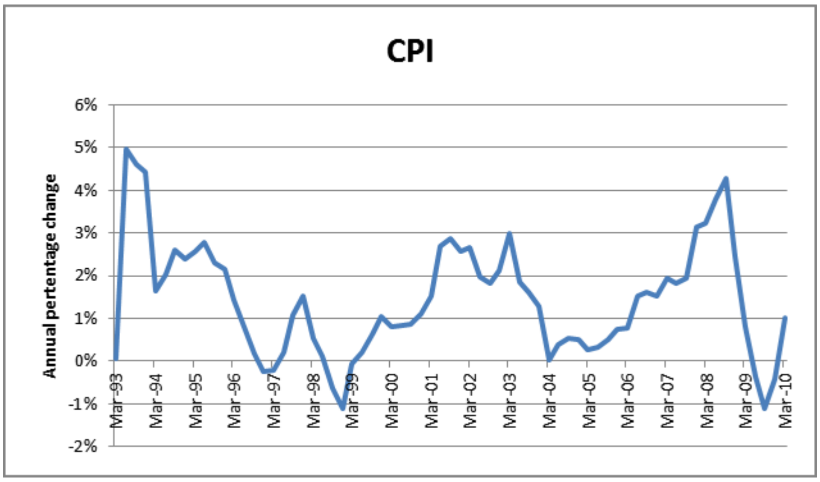
when it turns to positive levels and peaks by end of 2007. After the end of 2007 the GDP-gap experiences a steep plunge into negative levels until the end of the time period.

A common feature for all macroeconomic variables is that they peak during 2008 followed by a sharp decrease. The exceptional economic climate during the beginning of the 90’s is viable for all variables. All the variables have their highest or lowest levels during this first part in the sample period, except the real exchange rate.

Figure 3: Quarterly development of the GDP-gap, the short term interest rate, the CPI, the oil price and the real exchange rate.






CPI
Annual pertentage change
6%
5%
4%
3%
2%
1%
0%
-1%
-2%
Mar-93
Mar-94
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
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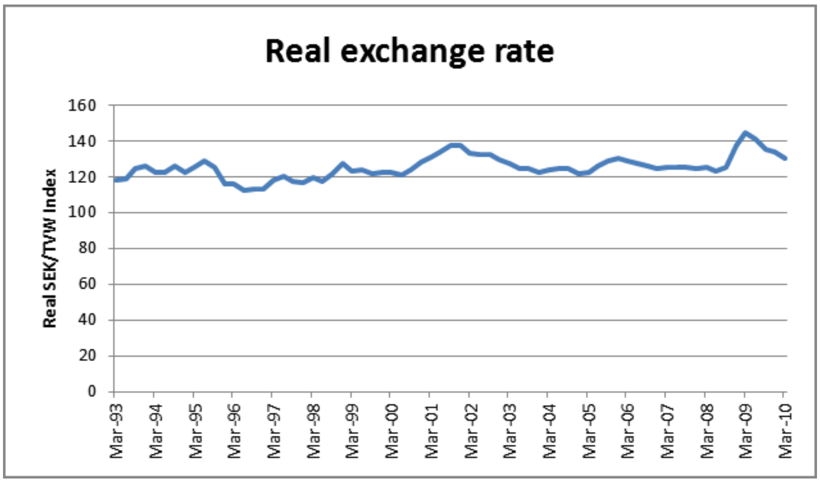
Mar-08
Mar-09
Mar-10


Real exchange rate
Real SEK/TCW Index
160
140
120
100
80
60
40
20
0
Mar-93
Mar-94
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03
Mar-04
Mar-05
Mar-06
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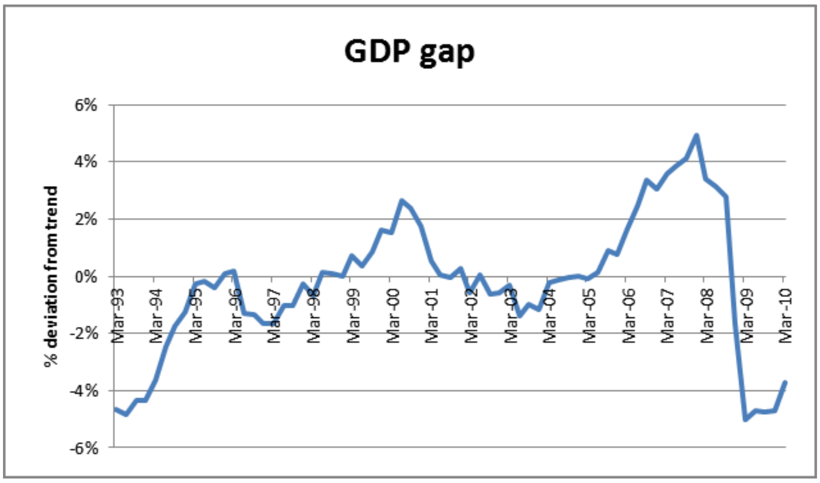
Mar-08
Mar-09
Mar-10


GDP gap
% deviation from trend
6%
4%
2%
0%
-2%
-4%
-6%
Mar-93
Mar-94
Mar-95
Mar-96
Mar-97
Mar-98
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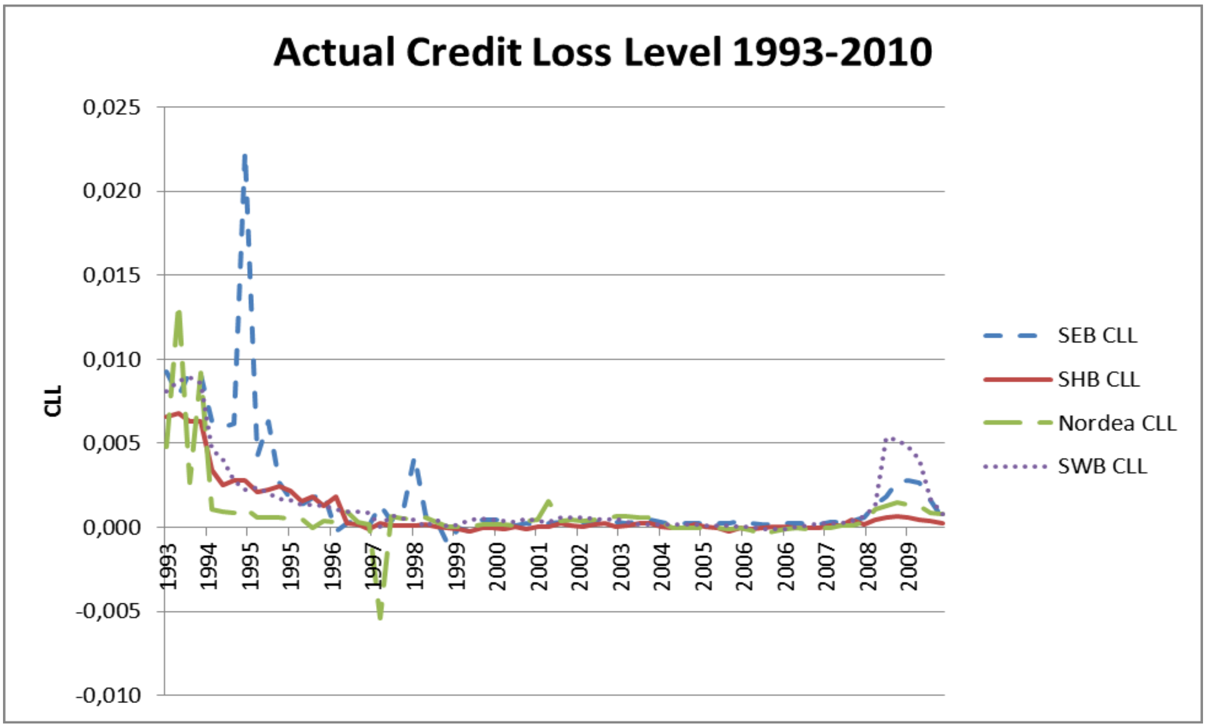
Mar-09
Mar-10

Comparing the levels of the macro variables between the crisis in the early 90's and the crisis during 2008 (which highly characterizes our out-of-sample period), the features of the macro variables are different. As can be seen in the graphs above, the short term interest rate and the CPI is high during the crisis in the early 90's but low during the 2008 crisis, the opposite holds for the oil price being low during the early 90's and high in 2008. The real exchange rate is remains at a stabile level for the whole sample period although having its spike during the crisis 2008. The GDP gap is low during both of the crises and higher during the period between the crises. The fact that the macro variables develop differently under the two crises (not following historical patterns) is likely to have an effect on our CLL forecasts for the out- of-sample period since the CLL forecasts are calculated from a model estimated on historical states of the economy.

Illustrations for the banks' CLLs can be found in Figure 4. The data for the CLL is mainly characterized by the high levels of CLL in the beginning of the sample period, 1993-1995. Initially, the CLL is highest for Nordea but from mid-1994 until the end of 1995, SEB has the highest CLL. After 1996 the CLL for all banks remain at a stable level with a few deviations for some individual banks. From 2008 there is an increase in CLLs, although to modest levels compared to the CLL in the early 90's.

Figure 4: Quarterly development of the credit loss level in SHB, SEB, Swedbank and Nordea between 1993 and the first quarter 2010.



5. Methodology

From the previous research we learned that there are studies investigating the link between corporate EDFs and the macroeconomic environment, but as we are aware of there is an absence of studies focusing directly on the link between the CLL and macro factors. Åsberg and Shahnazarian (2009) study EDFs contingent on the macroeconomic environment in order to create a forecasting model which "can be used as one of a number of instruments for forward assessments of banks' credit risks". In line with our objectives of this thesis we aim to construct a forecasting model for the CLL, using the previous quarter's CLL and five key macroeconomic variables, to investigate if adding macro variables improve the forecasting of CLL compared to a simple AR(1) model.

In order to answer our question, we have proceeded as follows: (i) To estimate models for CLLs contingent on the selected macroeconomic variables, we have used quarterly data for the time period from the first quarter 1993 until the first quarter 2007 on CLLs and macro variables. (ii) We have used the estimated models to calculate out-of sample forecasts. (iii) The forecasting ability of our models has been evaluated against the forecasting ability of a simple AR(1) model.

5.1 Time series and Panel data approaches

The sample period used for estimating the models is from the first quarter 1993 until the first quarter 2007. Two other sample periods are used to re-estimate the coefficients and constants of the selected models; from the first quarter 1993 to the first quarter 2008 and from the first quarter 1993 to the first quarter 2009. By using three sample periods to estimate the models we check whether the models make better forecasts if we are lengthening the sample period.

With a time series approach, a model for each bank has been estimated to observe the effect that the macro environment has on individual banks' CLL. With a panel data approach, data for all four banks during each time period have been used to estimate a homogenous model, assuming that changes in the macroeconomic environment affect all four banks equally. Quarterly time fixed effects and individual bank fixed effects (only for the panel data approach) have been controlled for by using dummies for each quarter and for each bank (affecting the bank specific intercepts). The lagged dependent variable is also as a bank specific factor.

The reason why we chose to use a panel data approach in addition to the more intuitive time series approach is that we wanted to assess if some macro economic effects appear or disappear on an aggregated level when using a larger amount of observations.

5.2 OLS regressions

In contrast to Åsberg and Shahnazarian we do not use the VECM (vector error correction model) as our forecasting model. Instead, the model used is a single equation OLS regression model with CLL as the dependent variable. The explanatory variables tested when estimating the model are the five macro variables previously described in the data chapter: the GDP gap, the short-term interest rate, the growth in CPI, the oil price and the real TCW weighted exchange rate. We assume these variables to be exogenous.

By including only five macroeconomic variables in our forecasting model, our results could be subject to omitted variable bias if too much information is left unobserved in the error term (Wooldridge, 2006). However, we believe we have included some of the most relevant explanatory variables in the data set.

In line with Sorge and Virolainen's (2006) argument that macroeconomic shocks create small first year effects, lagged variables for one, two, three and four quarters back in time for each macro variable have been used and thus we started with 5 * 4 = 20 macro variables in total when estimating the model. The CLL from the previous quarter (one lag) was used as an explanatory variable to enable the comparison with the simple AR(1) model.

By including lags we take into consideration that macro variables are likely to affect the CLL in future periods. Furthermore, including lags of the dependent variable is a measure against the presence of serial correlation.

Since presence of serial correlation in the error term would make all of the OLS estimators inconsistent (Wooldridge, 2006) no model including serial correlation has been accepted. Serial correlation has been tested by using a Breusch-Godfrey test, an asymptotically justified test allowing for lagged dependent variables as well as other regressors that are not strictly exogenous (Wooldridge, 2006). No test is performed for serial correlation in the panel data model in the panel data approach. Instead we test for serial correlation by testing the model on each bank with a time series approach and assume that results hold for the panel data model as well.

In addition, heteroskedasticity would violate the underlying assumption of an OLS model, i.e. that the variance of the error term is constant. Heteroskedasticity has therefore been tested for using White's test, which involves regressing the squared OLS residuals on the OLS fitted values and on the squared fitted values (Wooldridge, 2006), on each model. We observed no significant indications of heteroskedasticity in our models.

When selecting the relevant variables for each model (in the time series as well as the panel data approach) the highest possible level of R^2- adjusted (from here denoted by R^2) was required. Further, all explanatory macro variables had to be significant on a ten percent level, and preferably on a five percent level, to be included in the model. The model was chosen based on the data in the first out-of-sample period (first quarter 1993 – first quarter 2007) and since we use the same model when rolling out the out-of-sample period until the first quarter 2008 and the first quarter 2009 respectively, it is not certain that all the selected variables were still significant through all three forecasting periods.

The dummies were kept in the models even if not sufficiently significant.

5.3 Model specification

5.3.1 Time series

The time series model for each bank is the same through all three forecasting periods. Each model is the best model on the requisites, as discussed above, of no serial correlation, highest possible degree of R^2 and most statistically significant explanatory variables. This reasoning resulted in the following models for the four banks in our sample:

The model includes *t* time periods and one sole firm.

Handelsbanken (SHB):

$$CLL_t = -\beta_0 + \beta_1 CLL_{t-1} + \beta_2 bill_{t-1} + \beta_3\, realexr_{t-1} - \beta_4 tbill_{t-2} + \beta_5 oilprice_{t-2}$$
$$+ \beta_6 realexr_{t-2} + \beta_7 tbill_{t-3} + \beta_8 realexr_{t-3} - \beta_9 gdpgap_{t-4} + \delta_0 q_1 + \delta_1 q_2 + \delta_2 q_3 + \varepsilon_t$$

SEB:

$$CLL_t = \beta_{0-} + \beta_1 CLL_{t-1} + \beta_2 cpi_{t-1} + \beta_3 tbill_{t-2} - \beta_4 realexr_{t-2} - \beta_5 cpi_{t-3}$$
$$- \beta_6 tbill_{t-3} - \beta_7 gdpgap_{t-4} + \beta_8 cpi_{t-4} + \delta_0 q_1 + \delta_1 q_2 + \delta_2 q_3 + \varepsilon_t$$

Swedbank:

$$CLL_t = -\beta_0 + \beta_1 CLL_{t-1} - \beta_2 cpi_{t-1} + \beta_3 tbill_{t-1} + \beta_4 cpi_{t-2} - \beta_5 tbill_{t-2}$$
$$+ \beta_6 tbill_{t-3} - \beta_7 gdpgap_{t-4} + \delta_0 q_1 + \delta_1 q_2 + \delta_2 q_3 + \varepsilon_t$$

Nordea:

$$CLL_t = -\beta_{0\,-}\, \beta_1 CLL_{t-1} + \beta_2 realexr_{t-1} + \beta_3 oilprice_{t-2} + \beta_4 cpi_{t-4} -$$
$$\beta_5 oilprice_{t-4} + \delta_0 q_1 + \delta_1 q_2 + \delta_2 q_3 + \varepsilon_t$$

5.3.2 Panel data

The model estimated for the panel data is the same through all three forecasting periods and based on observations for all four banks in each period. The model is the best model on the requisites, as discussed above, of no serial correlation, highest possible degree of R^2 and most significant explanatory variables.

The model includes *t* time periods and *i* number of banks.

$$CLL_{it} = \beta_{i0} + \beta_1 CLL_{it-1} + \beta_2 gdpgap_{t-1} - \beta_3 gdpgap_{t-2} + \beta_4 cpi_{t-1} - \beta_5 cpi_{t-3}$$
$$+ \beta_6 cpi_{t-4} + \beta_7 tbill_{t-1} - \beta_8 tbill_{t-2} - \beta_9 oilprice_{t-1} + \beta_9 oilprice_{t-4} - \beta_9 realexr_{t-3}$$
$$+ \beta_9 realexr_{t-4} + \delta_0 q_1 + \delta_1 q_2 + \delta_2 q_3 + \delta_4 i_1 + \delta_5 i_2 + \delta_6 i_3 + \varepsilon_t$$

5.3.3 AR(1)

The model is estimated for the credit loss level in period *t*, contingent on the CLL in period *t-1*.

Time series AR(1) (for each bank):

$$CLL_t = \beta_0 + \beta_1 \times CLL_{t-1} + \delta_0 q_1 + \delta_1 q_2 + \delta_2 q_3 + \varepsilon_t$$

Panel data AR(1):

$$CLL_{it} = \beta_{i0} + \beta_1 CLL_{it-1} + \delta_0 q_1 + \delta_1 q_2 + \delta_2 q_3 + \delta_4 i_1 + \delta_5 i_2 + \delta_6 i_3 + \varepsilon_t$$

where:

CLL: Credit Loss Level

gdpgap: Percentage deviation from HP-trend

cpi: Annual change in Consumer Price Index

tbill: Short-term interest rate

oilprice: Oil price (Brent) denominated in USD

realexr: Real SEK/TCW index

Dummy variables:

q1: =1, if quarter 1, otherwise 0

q2: =1, if quarter 2, otherwise 0

q3: =1, if quarter 3, otherwise 0

i1: = 1, if SHB, otherwise 0

i2: = 1, if SEB, otherwise 0

i3: =1, if Swedbank, otherwise 0

5.4 The Forecasting model

We have chosen to use only "known" variables of today to make our CLL forecast and thus, our model aims to answer the question: "*Is it possible to forecast next quarter's CLL by constructing a model based on today's CLL and current and historical levels of the macroeconomic variables?*" rather than applying a structural model describing what truly affects the CLL, based on information that is only available tomorrow.

From the estimated models with time series and panel data respectively CLLs are forecasted based on the actual outcome of the explanatory variables between the second quarter 2007/2008/2009 and the first quarter 2010. Hence, we imagine that we are standing in a particular quarter, making a CLL forecast one quarter ahead by using observed values for the macro variables and not forecasted macro values.

5.5 Evaluation of the model

To evaluate the forecasting ability of our model we compare the forecasted CLLs to the actual outcome. To further evaluate if macroeconomic variables improve CLL forecasting we compare our results to the forecasts from simple AR(1) models for the same time periods. To be able to compare our models to the AR(1) models we use the measure Root Mean Square Error (RMSE). This method is common when evaluating forecasting models and is the method used by Åsberg and Shahnazarian. The RMSE formula can be found in Appendix B A.6.

6. Results

In this section we start by presenting the empirical findings from our OLS regressions (6.1) followed by the out-of-sample forecasts (6.2). In section 6.3 we present the evaluation of our forecasting model from the RMSE results.

6.1 OLS - empirical findings

After estimating the optimal original model for each bank in the first forecasting period, using the procedure explained above, we re-estimate the model for the next two forecasting periods for each bank (to observe if we make better forecasts if we lengthen the sample period). Hence, we obtain three sets of coefficients, standard deviations and t-statistics for each bank's original model, which we use to make the CLL forecasts for each bank for the three forecasting periods.

6.1.1 Time series

From the time series approach, the coefficients, standard deviations and t-statistics for each bank and each forecasting period (noted by starting year) are displayed below in table 1:

Table 1

2007																			
SHB	Coefficient	Std dev	Impact	T-stat	**SEB**	Coefficient	Std dev	Impact	T-stat	**SWB**	Coefficient	Std dev	Impact	T-stat	**Nordea**	Coefficient	Std dev	Impact	T-stat
q1	-0,00029	0,4443	-0,00013	-3,29	q1	-0,00055	0,4443	-0,00024	-0,64	q1	0,0002	0,4443	0,00007	1,81	q1	0,00052	0,4443	0,00023	1,71
q2	-0,00017	0,4343	-0,00007	-1,93	q2	-0,0003	0,4343	-0,00013	-0,35	q2	0,0001	0,4343	0,00003	0,82	q2	0,00039	0,4343	0,00017	1,25
q3	-0,00031	0,4343	0,00014	-1,53	q3	0,00034	0,4343	0,00015	-0,39	q3	0,0001	0,4343	0,00003	0,78	q3	0,00058	0,4343	0,00025	1,86
con	-0,00282			-3,07	con	0,01841			1,61	con	-0,0004			-3,39	con	-0,00518			-2,02
cll_1	0,31842	0,0018	0,00058	4,49	cll_1	-0,02454	0,0038	-0,00009	-0,19	cll_1	0,421	0,0022	0,00094	9,33	cll_1	-0,08691	0,0023	-0,0002	-1,01
tbill_1	0,00032	2,2556	0,00072	2,87	cpi_1	0,00135	1,3355	0,0018	2,71	cpi_1	-0,0001	1,3355	-0,00014	-1,80	realexr_1	0,00004	5,6196	0,00023	1,94
realexr1	0,00002	5,6196	0,00014	2,07	tbill_2	0,00219	2,2644	0,00495	2,7	tbill_1	0,0003	2,2556	0,00074	2,82	oilprice_2	0,00005	14,6567	0,00066	1,67
tbill_2	-0,00033	2,2644	-0,00074	-1,69	realexr_2	-0,00015	5,6713	-0,00085	-1,65	cpi_2	0,0001	1,3478	0,00019	2,57	cpi_4	0,00053	1,3732	0,00073	5,41
oilprice_2	0,00001	14,6567	0,00017	3,57	cpi_3	-0,00227	1,3602	-0,00308	-3,82	tbill_2	-0,0004	2,2644	-0,00099	-2,19	oilprice_4	-0,00007	12,2654	-0,00082	-2,05
realexr2	-0,00004	5,6713	-0,00022	-2,32	tbill_3	-0,00221	2,2666	-0,00502	-2,70	tbill_3	0,0002	2,2666	0,00054	2,16	R2	0,1987			
tbill_3	0,00028	2,2666	0,00063	2,4	gdpgap_4	-0,00093	1,6256	-0,00151	-3,18	gdpgap_4	-0,0001	1,6256	-0,0001	-2,09					
realexr3	0,00003	5,7183	0,00016	2,42	cpi_4	0,00233	1,3732	0,0032	4,17	R2	0,949								
gdpgap_4	-0,00013	1,6256	-0,00021	-3,92	R2	0,6049													
R2	0,9501																		

2008																			
SHB	Coefficient	Std dev	Impact	T-stat	**SEB**	Coefficient	Std dev	Impact	T-stat	**SWB**	Coefficient	Std dev	Impact	T-stat	**Nordea**	Coefficient	Std dev	Impact	T-stat
q1	-0,00029	0,4435	-0,00013	-3,53	q1	-0,00067	0,4435	-0,0003	-0,85	q1	0,00015	0,4435	0,00006	1,81	q1	0,00049	0,4435	0,00022	1,69
q2	-0,00016	0,4342	-0,00007	-2,00	q2	-0,00042	0,4342	-0,00018	-0,53	q2	0,00007	0,4342	0,00003	0,8	q2	0,0004	0,4342	0,00017	1,35
q3	-0,00011	0,4342	-0,00005	-1,42	q3	-0,00041	0,4342	-0,00018	-0,52	q3	0,00007	0,4342	0,00003	0,85	q3	0,00055	0,4342	0,00024	1,84
con	-0,00276			-3,18	con	0,01915			1,99	con	-0,00034			-3,44	con	-0,00466			-1,90
cll_1	0,32697	0,0018	0,00058	4,95	cll_1	-0,01524	0,0037	-0,00006	-0,13	cll_1	0,43572	0,0022	0,00095	10,35	cll_1	-0,07879	0,0023	-0,00018	-0,95
tbill_1	0,00032	2,1932	0,00069	3,06	cpi_1	0,00134	1,3111	0,00176	3	cpi_1	-0,00011	1,3111	-0,00015	-2,03	realexr_1	0,00004	5,4322	0,0002	1,8
realexr1	0,00002	5,4322	0,00013	2,15	tbill_2	0,0022	2,211	0,00486	2,86	tbill_1	0,00034	2,1932	0,00075	3,08	oilprice_2	0,00002	17,2681	0,00043	1,23
tbill_2	-0,00032	2,211	-0,0007	-1,74	realexr_2	-0,00016	5,4788	-0,00085	-2,03	cpi_2	0,00015	1,3043	0,00019	2,84	cpi_4	0,00029	1,3251	0,00038	3,13
oilprice_2	0,00001	17,2681	0,0002	3,93	cpi_3	-0,00221	1,3143	-0,00291	-3,96	tbill_2	-0,00045	2,211	-0,00099	-2,32	oilprice_4	-0,00004	15,5615	-0,00061	-1,73
realexr2	-0,00004	5,4788	-0,00021	-2,44	tbill_3	-0,00223	2,2267	-0,00497	-2,95	tbill_3	0,00023	2,2267	0,00052	2,18	R2	0,1841			
tbill_3	0,00026	2,2267	0,00059	2,46	gdpgap_4	-0,00089	1,8267	-0,00162	-4,00	gdpgap_4	-0,00005	1,8267	-0,00008	-1,83					
realexr3	0,00003	5,5239	0,00016	2,54	cpi_4	0,00232	1,3251	0,00308	4,61	R2	0,9494								
gdpgap_4	-0,00013	1,8267	-0,00023	-4,38	R2	0,6117													
R2	0,9512																		

2009																			
SHB	Coefficient	Std dev	Impact	T-stat	**SEB**	Coefficient	Std dev	Impact	T-stat	**SWB**	Coefficient	Std dev	Impact	T-stat	**Nordea**	Coefficient	Std dev	Impact	T-stat
q1	-0,00026	0,4429	-0,00011	-3,22	q1	-0,00051	0,4429	-0,00022	-0,68	q1	0,00043	0,4429	0,00019	1,48	q1	0,00047	0,4429	0,00021	1,74
q2	0,00013	0,4341	0,00006	-1,66	q2	-0,00047	0,4341	-0,0002	-0,62	q2	0,0002	0,4341	0,00009	0,67	q2	0,00035	0,4341	0,00015	1,29
q3	-0,00011	0,4341	-0,00005	-1,40	q3	-0,00031	0,4341	-0,00013	-0,41	q3	0,00041	0,4341	0,00018	1,4	q3	0,00051	0,4341	0,00022	1,84
con	-0,00275			-3,27	con	0,02059			2,39	con	-0,00065			-1,89	con	-0,00484			-2,09
cll_1	0,34601	0,0017	0,00059	5,43	cll_1	-0,00482	0,0036	-0,00002	-0,04	cll_1	-0,01861	0,0022	-0,00004	-0,21	cll_1	-0,08061	0,0022	-0,00018	-1,00
tbill_1	0,00026	2,133	0,00055	2,96	cpi_1	0,00127	1,365	0,00174	3,17	cpi_1	-0,00022	1,365	-0,0003	-1,05	realexr_1	0,00004	5,5162	0,0002	1,95
realexr1	-0,00003	5,5162	-0,00023	2,85	tbill_2	0,00222	2,1404	0,00475	2,97	tbill_1	0,00029	2,133	0,00062	0,8	oilprice_2	0,00003	25,3209	0,00075	1,92
tbill_2	-0,00021	2,1404	-0,00044	-1,31	realexr_2	-0,00017	5,3046	-0,00089	-2,45	cpi_2	0,00039	1,3719	0,00053	2,09	cpi_4	0,00031	1,3189	0,00041	3,66
oilprice_2	0,00001	25,3209	0,00023	4,45	cpi_3	-0,00199	1,3394	-0,00266	-3,75	tbill_2	-0,00069	2,1404	-0,00148	-1,12	oilprice_4	-0,00004	20,4509	-0,00086	-2,14
realexr2	-0,00042	5,3046	-0,00225	-2,72	tbill_3	-0,00229	2,1578	-0,00493	-3,10	tbill_3	0,00049	2,1578	0,00105	1,4	R2	0,2116			
tbill_3	0,00019	2,1578	0,00042	1,89	gdpgap_4	-0,00081	2,0735	-0,00168	-4,18	gdpgap_4	0,00007	2,0735	0,00014	0,96					
realexr3	0,00003	5,3463	0,00015	2,61	cpi_4	0,00228	1,3189	0,00301	4,68	R2	0,0772								
gdpgap_4	-0,00013	2,0735	-0,00026	-4,63	R2	0,598													
R2	0,9464																		

We start analyzing the output from our regressions by using the R^2 measure to evaluate how well CLLs are likely to be predicted by each bank's original model. The model for SHB has the highest R^2 (0,95) while the model for Nordea has the lowest R^2 (0,20). This indicates that the model for SHB is better at explaining CLLs than the model for Nordea. Comparing the explanatory power between the three forecasting periods the R^2s for each bank are similar, except for a large divergence in the R^2 level for Swedbank in the third forecasting period. The statistical significance level for the macro variables for Swedbank in the third period diverge remarkably from the significance levels in the previous forecasting periods and consequently the R^2 for Swedbank is considerably lower in the third forecasting period. This indicates that there are macro economic influences not included in the model for Swedbank in the third forecasting period, e.g. exposure to macro economic development outside Sweden (such as in the Baltics). The relatively low number of explanatory variables included in the model for Nordea could be a reason for the poor fit of the model. We presume that other macro variables explain the CLL of Nordea better than the variables we have included in the model.

For the third forecasting period the model has a weaker fit compared to previous forecasting periods. This is most likely an effect of the characteristics of the data added (June 2008 – March 2009), when lengthening the sample period since the sample period thereby include the macro conditions in the beginning of the financial crisis. This period include the extreme macro variables that were a consequence of the financial crisis.

No variable is included in all of the banks' models with all time lags, although some variables are included more frequently than others. For example, all models include the short-term interest rate (with different time lags) and the GDP gap_{t-4}, except the model for Nordea. From an economic perspective we do not believe it is not reasonable to exclude the short-term interest rate from the model, although for Nordea there was no model that included the short-term interest rate without presence of serial correlation.

Some macro variables are included with different time lags in the same model. However, the different lags of the same macro variable often have different coefficients, either negative or positive, thereby reducing the total effect of changes in the macro variable. In order to calculate the total effect of the macro variable on the CLL, it is important to take all the variables' time lags into consideration.

To be able to observe the impact of each explanatory variable on the CLL in the models, the explanatory variable's coefficient has been multiplied with the standard deviation of the variable. From the results in table 1 we observe that the impact of the lagged dependent variable differs significantly between the banks. The CLL of yesterday seems to affect today's CLL to a larger extent for SHB and for the two first forecasting periods for Swedbank, than in the model for SEB and Nordea. The coefficient of the lagged dependent variable for Nordea is negative, implying a negative relation between today's CLL and the forecasted CLL of tomorrow. This is not realistic and should be considered as a weakness of the model.

Given each banks' optimal model we also observe which of the macro variables that have the largest impact on the CLL. Table 1 shows that the banks' CLLs are sensitive to changes in different macro variables and there is no single macro variable that outperforms the others (i.e. having the largest effect on CLL). This is in contrast to the findings by Åsberg and Shahnazarian, who found that the EDFs were especially sensitive to changes in the short-term interest rate.

SHB's CLL is mainly driven by changes in the short term interest rate, SEB's CLL is mainly driven by changes in the CPI and GDP gap, Swedbank's CLL is mainly driven by changes in the short term interest rate and Nordea is mainly driven by changes in the CPI and the oil price. The fact that the banks' CLLs are driven by changes in different macro variables is not surprising, and most likely due to the different compositions of their credit portfolios and different geographical and sector exposure. By knowing what historically has driven the CLL development for each bank we can easier understand the outcomes of our forecasting models.

The quarterly dummies, included to consider possible quarterly fixed effects, differ in significance- and impact level between the banks and between the forecasting periods. The constant, which includes the effect of the fourth quarter, is statistically significant (on at least a five per cent level) in all the banks' models and forecasting periods except for SEB's first forecasting period. For SHB, the first quarter dummy variable is statistically significant (on a one per cent level) through all three forecasting periods.

6.1.2 Panel data

From the panel data approach, the coefficients, standard deviations and t-statistics for each bank and each forecasting period (noted by starting year) are displayed below in table 2:

Table 2

2007

	Coefficient	Std dev	Impact	T-stat	SHB	Coefficient	Std dev	Impact	T-stat	SEB	Coefficient	Std dev	Impact	T-stat	SWB	Coefficient	Std dev	Impact	T-stat	Nordea	Coefficient	Std dev	Impact	T-stat
cllevel_1	0,25100	0,002679	0,0007	3,92	i1	0,00017	0,43397	0,00007	0,54	i3	0,00091	0,43397	0,00040	2,91	i2	0,00041	0,43397	0,00018	1,35					
gdpgap_1	0,00073	1,794857	0,0013	5,22	q1	-0,00004	0,44132	-0,00002	-0,11	q1	-0,00004	0,44132	-0,00002	-0,11	q1	-0,00004	0,44132	-0,00002	-0,11	q1	-0,00004	0,44132	-0,00002	-0,11
gdpgap_2	-0,00073	1,785394	-0,0013	-5,55	q2	0,00014	0,43140	0,00006	0,43	q2	0,00014	0,43140	0,00006	0,43	q2	0,00014	0,43140	0,00006	0,43	q2	0,00014	0,43140	0,00006	0,43
cpi_1	0,00034	1,31883	0,0004	1,70	q3	-0,00025	0,43140	-0,00011	-0,80	q3	-0,00025	0,43140	-0,00011	-0,80	q3	-0,00025	0,43140	-0,00011	-0,80	q3	-0,00025	0,43140	-0,00011	-0,80
cpi_3	-0,00063	1,32466	-0,0008	-2,94	cons	0,00263			0,60	cons	0,00263			0,60	cons	0,00263			0,60	cons	0,00263			0,60
cpi_4	0,00067	1,327617	0,0009	3,66																				
tbill_1	0,00056	2,235591	0,0012	2,93																				
tbill_2	-0,00041	2,23787	-0,0009	-2,41																				
oilprice_1	-0,00009	15,36319	-0,0014	-5,11																				
oilprice_4	0,00012	14,79345	0,0018	7,28																				
realexr_3	-0,00019	5,568748	-0,0011	-4,41																				
realexr_4	0,00016	5,577207	0,0009	3,66																				
R2	0,6109																							

2008

	Coefficient	Std dev	Impact	T-stat	SHB	Coefficient	Std dev	Impact	T-stat	SEB	Coefficient	Std dev	Impact	T-stat	SWB	Coefficient	Std dev	Impact	T-stat	Nordea	Coefficient	Std dev	Impact	T-stat
cllevel_1	0,163000	0,0026045	0,0004	2,39	i1	0,00011	0,43390	0,00005	0,35	i3	0,00095	0,43390	0,00041	2,93	i2	0,00042	0,43390	0,00018	1,34					
gdpgap_1	0,000008	2,031333	0,0000	0,05	q1	0,00004	0,44079	0,00002	0,11	q1	0,00004	0,44079	0,00002	0,11	q1	0,00004	0,44079	0,00002	0,11	q1	0,00004	0,44079	0,00002	0,11
gdpgap_2	-0,000262	2,011159	-0,0005	-1,83	q2	0,00002	0,43151	0,00001	0,07	q2	0,00002	0,43151	0,00001	0,07	q2	0,00002	0,43151	0,00001	0,07	q2	0,00002	0,43151	0,00001	0,07
cpi_1	0,000353	1,308848	0,0005	1,78	q3	-0,00020	0,43151	-0,00009	-0,62	q3	-0,00020	0,43151	-0,00009	-0,62	q3	-0,00020	0,43151	-0,00009	-0,62	q3	-0,00020	0,43151	-0,00009	-0,62
cpi_3	-0,000423	1,309821	-0,0006	-1,83	cons	0,00354			0,82	cons	0,00354			0,82	cons	0,00354			0,82	cons	0,00354			0,82
cpi_4	0,000460	1,312418	0,0006	2,24																				
tbill_1	0,000972	2,171396	0,0021	4,62																				
tbill_2	-0,000690	2,175644	-0,0015	-3,58																				
oilprice_1	-0,000003	19,92249	-0,0001	-0,25																				
oilprice_4	0,000037	19,33776	0,0007	3,30																				
realexr_3	-0,000135	5,387296	-0,0007	-2,90																				
realexr_4	0,000089	5,397959	0,0005	1,96																				
R2	0,5309																							

2009

	Coefficient	Std dev	Impact	T-stat	SHB	Coefficient	Std dev	Impact	T-stat	SEB	Coefficient	Std dev	Impact	T-stat	SWB	Coefficient	Std dev	Impact	T-stat	Nordea	Coefficient	Std dev	Impact	T-stat
cllevel_1	0,18500	0,003	0,0005	3,07	i1	0,00016	0,43385	0,00007	0,56	i3	0,00086	0,43385	0,00037	3,05	i2	0,00045	0,43385	0,00019	1,63					
gdpgap_1	0,00008	2,126652	0,0002	0,62	q1	0,00007	0,44032	0,00003	0,24	q1	0,00007	0,44032	0,00003	0,24	q1	0,00007	0,44032	0,00003	0,24	q1	0,00007	0,44032	0,00003	0,24
gdpgap_2	-0,00049	2,128046	-0,0010	-3,65	q2	-0,00005	0,43160	-0,00002	-0,16	q2	-0,00005	0,43160	-0,00002	-0,16	q2	-0,00005	0,43160	-0,00002	-0,16	q2	-0,00005	0,43160	-0,00002	-0,16
cpi_1	-0,00013	1,351978	-0,0002	-0,81	q3	-0,00019	0,43160	-0,00008	-0,69	q3	-0,00019	0,43160	-0,00008	-0,69	q3	-0,00019	0,43160	-0,00008	-0,69	q3	-0,00019	0,43160	-0,00008	-0,69
cpi_3	-0,00022	1,345864	-0,0003	-1,22	cons	-0,00273			-0,77	cons	-0,00273			-0,77	cons	-0,00273			-0,77	cons	-0,00273			-0,77
cpi_4	0,00034	1,34144	0,0005	2,13																				
tbill_1	0,00042	2,146661	0,0009	2,56																				
tbill_2	-0,00013	2,148705	-0,0003	-0,97																				
oilprice_1	0,00001	29,9372	0,0002	0,60																				
oilprice_4	0,00003	28,43707	0,0010	4,71																				
realexr_3	-0,00006	5,839717	-0,0004	-2,01																				
realexr_4	0,00007	5,85023	0,0004	2,09																				
R2	0,5984																							

The explanatory power of the panel data model (R^2) is similar for all of the three forecasting periods, although the highest R^2 (0,61) is obtained in the first forecasting period. Given the substantial differences between the banks in in the time series models, we could expect less explanatory power for the homogenous panel data model compared to the time series models. This holds for all banks, except for Nordea, for which the CLLs are better explained by the panel data model.

All our five macro variables are included in the panel data model with at least two time lags (three lags for the CPI variable). As for the time series the lagged variables have a neutralizing effect (one positive coefficient, one negative) on each other when considering the total effect of each macro variable. None of the time series models include all macro variables, in opposite to the panel data model. This means that the number of significant explanatory macro variables is increased when adding more observations to the data set.

From table 2 we observe which of the explanatory variables that have the largest impact (calculated as the variable's coefficient multiplied by its standard deviation) on CLL. The lagged dependent variable has the largest impact on CLL only in the first forecasting period.

Due to the use of a homogenous model, each bank's CLL is assumed to be equally sensitive to changes in the macro variables in the same forecasting period. In the first forecasting period we observe that the CPI together with the oil price are the main macro variables affecting the CLL using the panel data approach. In the third forecasting period the CLL is mainly driven by changes in the oil price and the GDP gap. As for the time series models, this contradicts the results in our reference study by Åsberg and Shahnazarian where the short-term interest rate had the largest effect on EDF. However, in the second forecasting period the CLL is mainly driven by changes in the short-term interest rate, together with a significant effect from changes in the oil price.

Regarding the firm fixed effects (i), only the SEB dummy is statistically significant in all three forecasting periods. This indicates that SEB differs from the other banks (which is difficult to distinguish geographically though). Unlike the time series, none of the quarterly dummies (q) are statistically significant with the panel data approach, showing no signs of quarterly fixed effects.

6.1.2 AR(1)

The model coefficients for each bank and each year are displayed below:

Table 3: AR(1) Time series

2007											
SHB	Coefficient	T-stat	**SEB**	Coefficient	T-stat	**SWB**	Coefficient	T-stat	**Nordea**	Coefficient	T-stat
q1	-0,000578	-3,80	q1	-0,001991	-1,73	q1	-0,000062	-0,30	q1	-0,000147	-0,18
q2	-0,000119	-0,78	q2	-0,000816	-0,71	q2	0,000065	0,31	q2	0,000572	0,69
q3	-0,000148	-0,97	q3	-0,000666	-0,58	q3	0,000040	0,19	q3	-0,000252	-0,30
con	0,000212	1,91	con	0,001546	1,84	con	0,000002	0,02	con	0,000353	0,60
cll_1	0,877821	29,34	cll_1	0,578182	5,38	cll_1	0,880737	26,51	cll_1	0,365505	2,90
R2	**0,9405**		**R2**	**0,3272**		**R2**	**0,9275**		**R2**	**0,0916**	
2008											
SHB	Coefficient	T-stat	**SEB**	Coefficient	T-stat	**SWB**	Coefficient	T-stat	**Nordea**	Coefficient	T-stat
q1	-0,000551	-3,86	q1	-0,001863	-1,73	q1	-0,000055	-0,29	q1	-0,000130	-0,17
q2	-0,000119	-0,84	q2	-0,000764	-0,71	q2	0,000063	0,33	q2	0,000526	0,69
q3	-0,000144	-1,01	q3	-0,000631	-0,59	q3	0,000045	0,23	q3	-0,000238	-0,31
con	0,000207	1,99	con	0,001450	1,86	con	0,000005	0,03	con	0,000328	0,6
cll_1	0,877295	30,52	cll_1	0,581645	5,64	cll_1	0,879975	27,74	cll_1	0,369392	3,05
R2	**0,9410**		**R2**	**0,3344**		**R2**	**0,9289**		**R2**	**0,1593**	
2009											
SHB	Coefficient	T-stat	**SEB**	Coefficient	T-stat	**SWB**	Coefficient	T-stat	**Nordea**	Coefficient	T-stat
q1	-0,00053	-3,85	q1	-0,00174	-1,73	q1	-0,00013	-0,18	q1	-0,00013	-0,18
q2	-0,00011	-0,81	q2	-0,00076	-0,76	q2	0,00044	0,61	q2	0,00044	0,61
q3	-0,00017	-1,23	q3	-0,00063	-0,63	q3	-0,00027	-0,37	q3	-0,00027	-0,37
con	0,00022	2,18	con	0,00142	1,94	con	0,00037	0,71	con	0,00037	0,71
cll_1	0,87514	30,95	cll_1	0,58170	5,85	cll_1	0,37106	3,18	cll_1	0,37106	3,18
R2	**0,9387**		**R2**	**0,3365**		**R2**	**0,1002**		**R2**	**0,1002**	

For all banks except Swedbank the explanatory power (R^2) of the time series AR(1) models are similar through all three forecasting periods. The explanatory power is high for SHB (0,94), while low for SEB (0,33-0,34) and very low for Nordea (0,09-0,16). This indicates that the AR(1) model for SHB is better for predicting CLLs than the model for Nordea and that the CLL of Nordea today is less dependent on yesterday's CLL compared to the CLL of SHB. For Swedbank the explanatory power is high (0,93) for the first two forecasting periods and very low (0,10) for the last forecasting period. In total, this also means that the impact of macro variables would be more evident for SEB and Nordea than for SHB and Swedbank.

For both SEB and Nordea the R^2 values are considerably lower in the time series AR(1) models compared to the models including macro variables. For SHB and Swedbank the R^2 values are approximately the same.

As for the time series models including macro variables, a significant quarterly fixed effect can be observed in the first quarter in the time series AR(1) model for SHB.

Table 4: AR(1) Panel data

2007														
	Coefficient	T-stat	**SHB**	Coefficient	T-stat	**SEB**	Coefficient	T-stat	**SWB**	Coefficient	T-stat	**Nordea**	Coefficient	T-stat
cllevel_1	0,599	11,25	i1	-0,00003	-0,07	i3	0,00049	1,23	i2	0,00022	0,57			
			q1	-0,00033	-0,84	q1	-0,00033	-0,84	q1	-0,00033	-0,84	q1	-0,00033	-0,84
			q2	-0,00006	-0,16	q2	-0,00006	-0,16	q2	-0,00006	-0,16	q2	-0,00006	-0,16
			q3	-0,00028	-0,71	q3	-0,00028	-0,71	q3	-0,00028	-0,71	q3	-0,00028	-0,71
			cons	0,00047	1,25	cons	0,00047	1,25	cons	0,00047	1,25	cons	0,00047	1,25
R2	0.3684													
2008														
	Coefficient	T-stat	**SHB**	Coefficient	T-stat	**SEB**	Coefficient	T-stat	**SWB**	Coefficient	T-stat	**Nordea**	Coefficient	T-stat
cllevel_1	0,606	11,88	i1	-0,00002	-0,06	i3	0,00046	1,23	i2	0,00021	0,57			
			q1	-0,00031	-0,85	q1	-0,00031	-0,85	q1	-0,00031	-0,85	q1	-0,00031	-0,85
			q2	-0,00007	-0,18	q2	-0,00007	-0,18	q2	-0,00007	-0,18	q2	-0,00007	-0,18
			q3	-0,00027	-0,72	q3	-0,00027	-0,72	q3	-0,00027	-0,72	q3	-0,00027	-0,72
			cons	0,00044	-1,25	cons	0,00044	-1,25	cons	0,00044	-1,25	cons	0,00044	-1,25
R2	0,3774													
2009														
	Coefficient	T-stat	**SHB**	Coefficient	T-stat	**SEB**	Coefficient	T-stat	**SWB**	Coefficient	T-stat	**Nordea**	Coefficient	T-stat
cllevel_1	0,633	13,16	i1	-0,00003	-0,08	i3	0,00049	1,23	i2	0,00026	-0,77			
			q1	-0,00031	-0,93	q1	-0,00033	-0,93	q1	-0,00033	-0,93	q1	-0,00033	-0,93
			q2	-0,00010	-0,29	q2	-0,00006	-0,29	q2	-0,00006	-0,29	q2	-0,00006	-0,29
			q3	-0,00029	-0,84	q3	-0,00028	-0,84	q3	-0,00028	-0,84	q3	-0,00028	-0,84
			cons	0,00043	1,33	cons	0,00047	1,33	cons	0,00047	1,33	cons	0,00047	1,33
R2	0,4110													

The explanatory power is similar through the three forecasting periods for the panel data AR(1) model. In addition, the panel data AR(1) has lower explanatory power in all three forecasting periods compared to the panel data model including macro variables.

As for the panel data model including macro variables, no quarterly fixed effect can be observed in the panel data AR(1) model and is no significant firm fixed effect.

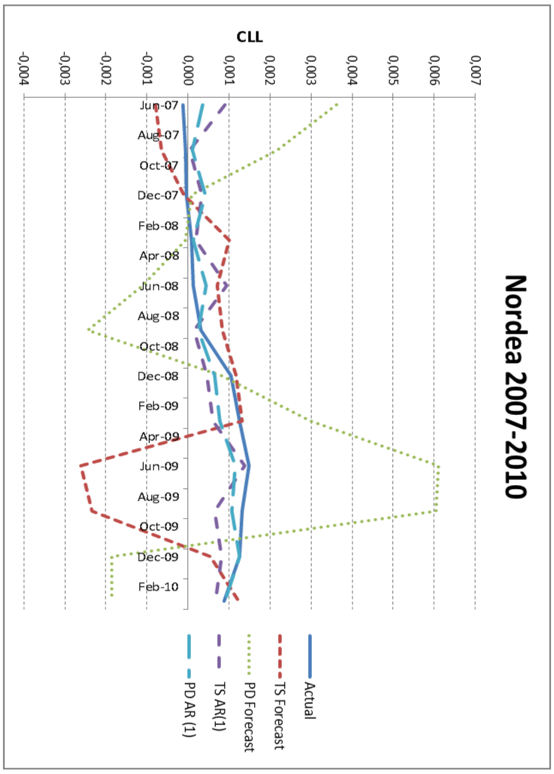
To summarize the results of our empirical findings we find that the explanatory power of the estimated models varies between the banks and between the three forecasting periods and hence, the banks' CLLs seem to be sensitive to changes in different macro variables. Consistently we obtain a lower or the same explanatory power in the AR(1) models compared to the models where the macro variables are included. In the time series model including macro variables the model for SHB has the highest explanatory power and the model for Nordea the lowest. The explanatory power in the panel data model is lower than the explanatory power in the time series models for all banks, except for Nordea.

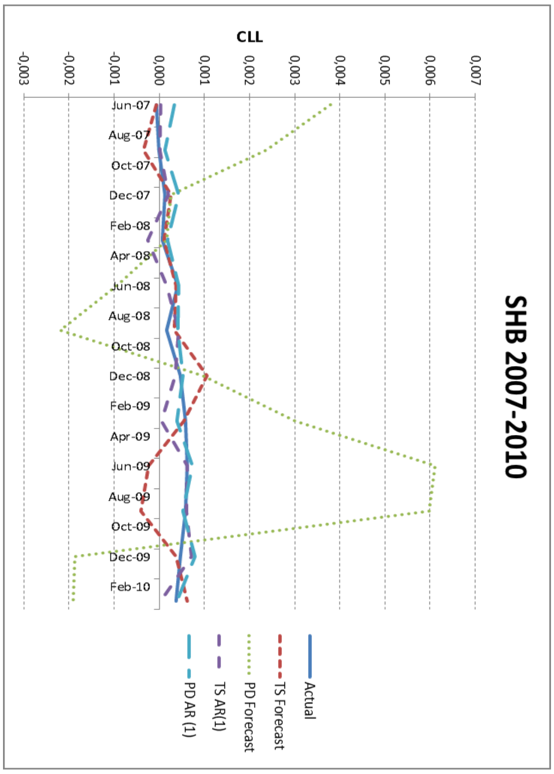
The impact of the lagged dependent variable, CLL_{t-1}, on today's CLL differs significantly between the banks and the forecasting periods. None of the explanatory macro variables stand out as the most significant variable to include in each banks original model. Although, changes in the oil price has a significant impact in all three forecasting periods for the panel data model, which according to our reasoning in the data section imply an increased sensitivity to global macro changes in the panel data model.

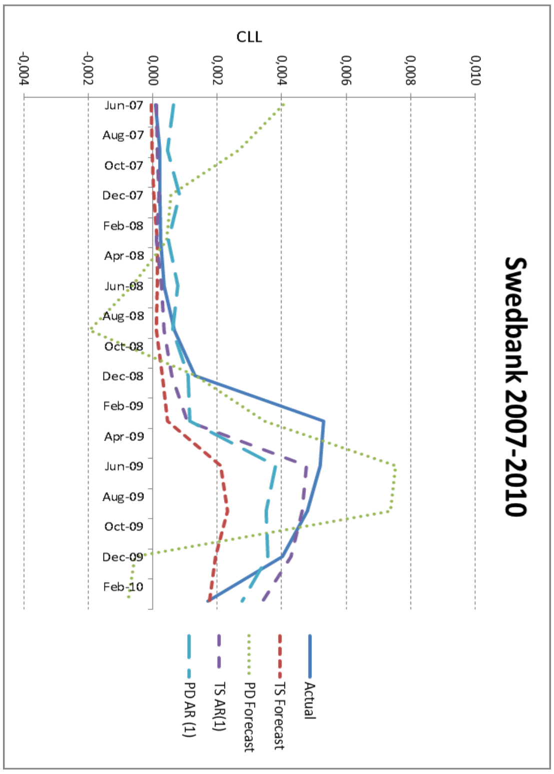
6.2 Out-of-sample forecasts for credit loss level

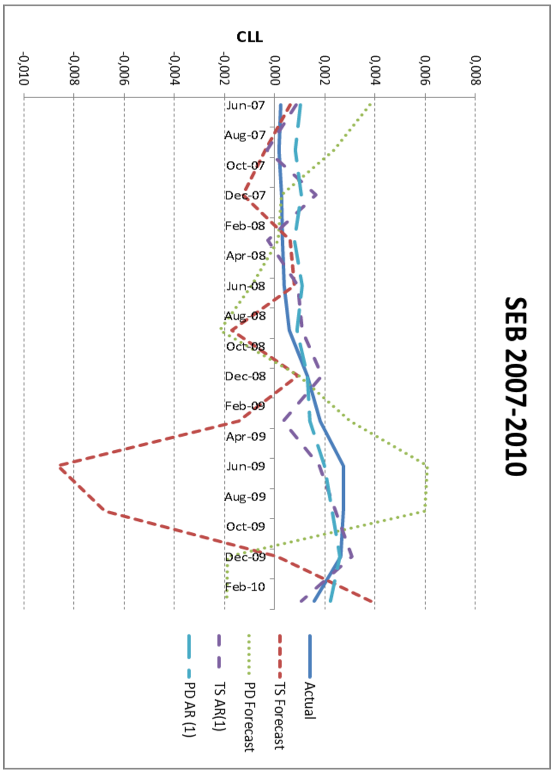
Figure 5: The first forecasting period 2nd quarter 2007 to 1st quarter 2010

The calculations underlying the CLL graphical illustrations is displayed in the appendix A.4.









The overall trend for all banks' actual CLL in the out-of-sample period is a stable close to zero between the second quarter 2007 and the third quarter 2008, when the actual CLL starts to increase to reach a peak between the first and the second quarter 2009. During the out-of sample period, second quarter 2007 until the first quarter 2010, Swedbank experiences the highest actual CLL and SHB the lowest. SHB's CLL remains at a relatively low level even after the third quarter 2008.

From the previous section (OLS - empirical findings) we learned what macro variable(s) that primarily drive each bank's CLL forecasting model. With this knowledge we are able to compare the development of each bank's CLL to the development of the driving macro variable for the same time period. Since different explanatory variables have different degree of impact in the time series and panel data models we have obtained different developments of the forecasted CLL trends for the banks.

Negative CLLs would mean write-backs of former credit loss reservations. It is not likely though, that the CLLs would be as negative as our results imply, in figure 5.

Time series forecasts

The CLLs forecasted by the time series models for each bank develop similarly to the banks' actual CLL until the last quarter 2008 where the actual and the forecasted CLLs take off in opposite directions. The forecasted CLL for SEB varies the most and also deviates the most from the actual CLL. The forecasted CLL for SEB reaches its lowest levels and has its larges deviation from actual CLL in the second quarter 2009 at a forecasted CLL of -0,008 implying negative credit losses, between the first and third quarter 2009, i.e. values far from the actual positive CLL.

As we know from the estimation of each bank's original model, SEB's CLL is mainly driven by the development of CPI. The deep plunge in SEB's CLL could hence be derived from the similar development of the CPI during the same point in time. The CPI and SEB's CLL is positively related and as the CPI has its most severe drop in the beginning of 2009, turning into negative levels, SEB's CLL has the similar experience. From figure 3 we know that the CPI during the crisis in the 90's was at much higher levels than during the recent financial crisis. Hence, the CPI during the out-of-sample period does not develop as it did during the past crises in our sample period and the time series forecasting model is therefore unable to foresee the higher CLL. This could be a reason to why our CLL forecast for SEB deviates from SEB's actual CLL.

The development for SHB's and Nordea's CLLs are similar to SEB's, with an increase from the third quarter 2008, followed by a distinct dip between the first and third quarter of 2009. A possible explanation could be that Nordea's forecasted CLLs are, beside CPI, primarily driven by the oil price and that SHB's forecasted CLLs are primarily driven by the short-term interest rate. Both the oil price and the short-term interest rate experience a downward development during the out-of-sample period, similar to the development of CPI during this period.

The time series forecasted CLL for Swedbank is the only CLL forecast that develops similar to the actual CLL outcome.

Panel data forecasts

The panel data CLL forecasts display similar trends for all four banks for the forecasting period, since they are equally sensitive to changes in the macroeconomic environment according to the model. From the first year (first quarter 2007 until first quarter 2008) in the out-of-sample period, the panel data forecast positive CLL levels, following negative levels until the third quarter 2008. Comparing panel data CLL forecasts to the actual CLL, the panel data forecasts clearly differ from the actual CLLs from 2007 until the third quarter 2008. After this point the panel data forecasts follow the overall actual CLL trends for Swedbank and SEB until the forecasts reach negative levels by the last quarter of 2009.

In summary, the trends for time series forecasted CLLs and panel data forecasted CLLs develop in direct opposite directions (except for Swedbank) from the last quarter 2008, with the panel data forecasts being closer to the development of the actual CLL for Swedbank and SEB. A possible explanation to this could be that our panel data model includes more explanatory macro variables than the time series model and therefore captures the sensitivity to changes in the macroeconomic climate following the financial crisis better for these two banks, starting in the third quarter 2008. On the other hand, the time series model makes forecasts closer to the actual CLLs for all banks before the financial crisis, which implies that the time series models, which are individualized for each bank, are more suitable in a stable economic climate.

AR(1) forecasts

Both the time series and panel data AR(1) CLL forecasts are similar to the actual CLL outcome for the entire out-of-sample period and thus outperforms both the time series forecasting models and the panel data forecasting model. Generally, the time series AR(1) CLL forecasts are much more volatile e.g. for SEB and Nordea than the panel data AR(1) forecasts.

Figure 6: The second forecasting period 2nd quarter 2008 to 1st quarter 2010

The calculations underlying the CLL graphical illustrations is displayed in the Appendix A.5.

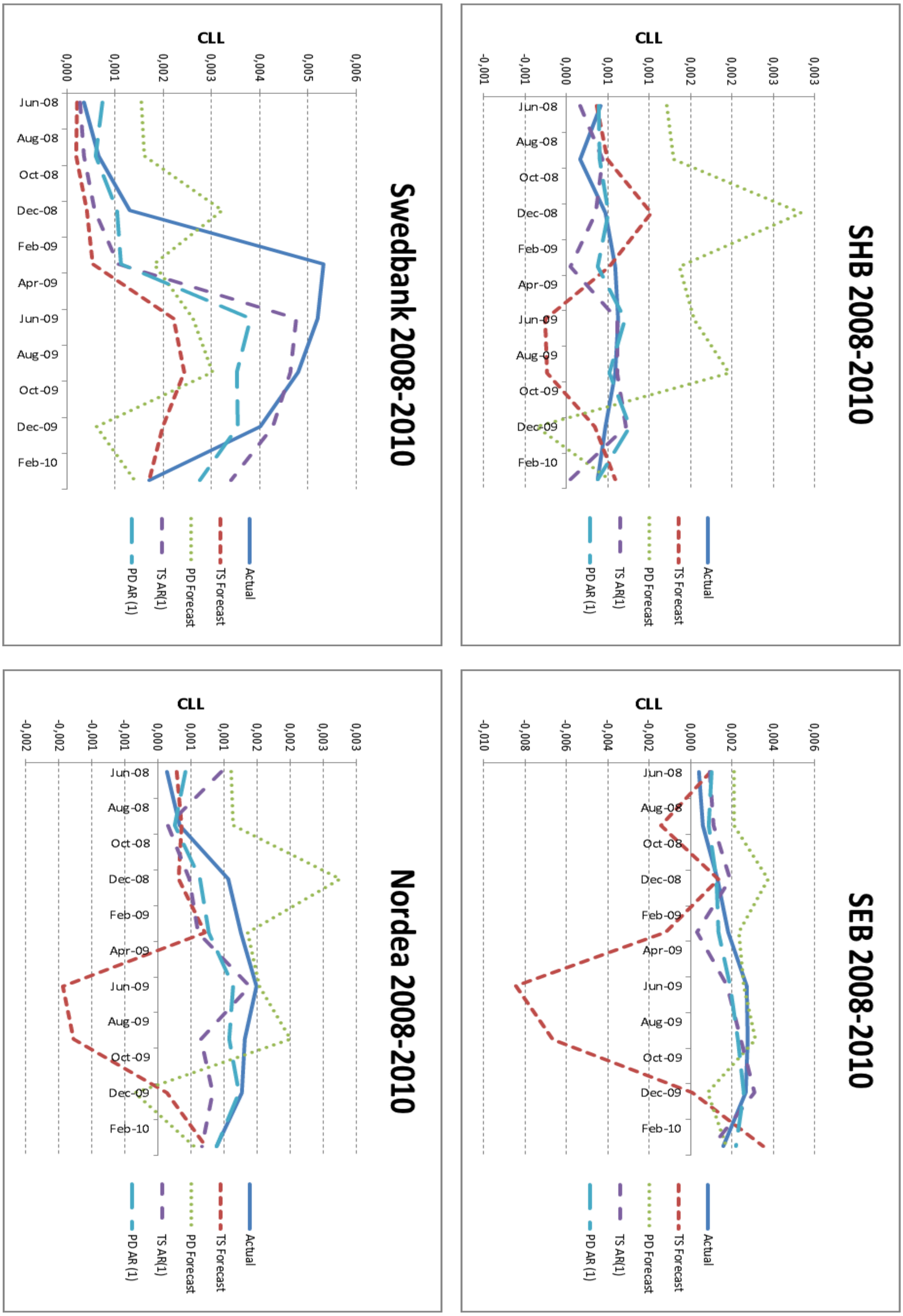
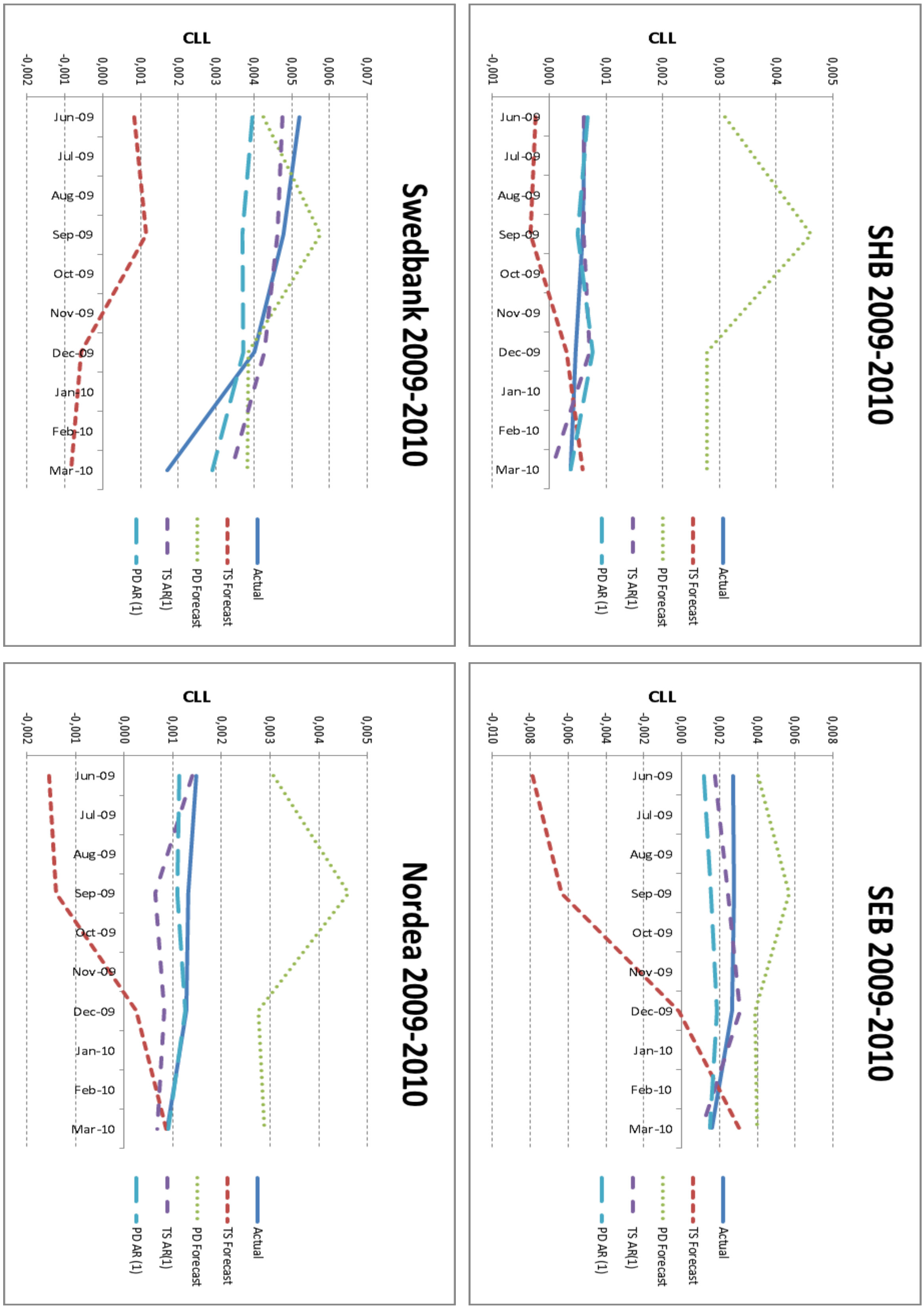


Figure 7: The third forecasting period 2nd quarter 2009 to 1st quarter 2010

The calculations underlying the CLL graphical illustrations is displayed in the Appendix A.6.



For the time series CLL forecasts several banks develop smoother in the second and third forecasting period compared to the trends in the first forecasting period, e.g. the dip between the first and the last quarter 2009 for Nordea is less severe in the second forecasting period than in the first. In total the forecasts from the time series models are similar throughout the three forecasting periods, i.e. they develop in similar directions and with the same magnitude. SEB generally has the most volatile trend and SHB the smoothest, reflecting the fact that SEB according to our model is more sensitive to changes in the macroeconomic environment.

The panel data CLL forecasts in the second and the third forecasting period differs from the CLL forecasts in the first forecasting period since the differences between the banks' CLL are large in these periods. An explanation for this could be that the actual lagged dependent variables during these periods, that we plug in the models, differ more between the banks than in the first period (the banks differed more in their actual CLLs between the second quarter 2008 and the first quarter 2009 than between the second quarter 2007 and the first quarter 2008).

As the extreme values during the beginning of the financial crisis are reflected in the model re-estimations, there is a smoother development for both the time series forecasting models.

In summary, time series forecasted CLLs are similar between the three forecasting periods while the panel data forecasted CLLs varies between the forecasting periods. This indicate that the panel data model is more sensitive to changes in the macroeconomic environment, most likely due to a larger number of variables included in the panel data model.

6.3 RMSE

RMSE values for all CLL forecasts from the time series models, the panel data model and the AR(1) models are displayed below in table 5.

Table 5

	SHB				SEB				SWB				Nordea			
2009	PD	TS	PD AR (1)	TS AR (1)	PD	TS	PD AR (1)	TS AR (1)	PD	TS	PD AR (1)	TS AR (1)	PD	TS	PD AR (1)	TS AR (1)
RMSE y1	0,00289	0,00064	0,00016	0,00021	0,00214	0,00711	0,00071	0,00059	0,00123	0,00387	0,00104	0,00088	0,00223	0,00210	0,00022	0,00041
2008	PD	TS	PD AR (1)	TS AR (1)	PD	TS	PD AR (1)	TS AR (1)	PD	TS	PD AR (1)	TS AR (1)	PD	TS	PD AR (1)	TS AR (1)
RMSE y2	0,00121	0,00049	0,00016	0,00028	0,00137	0,00545	0,00112	0,00074	0,00223	0,00231	0,00168	0,00165	0,00098	0,00148	0,00030	0,00053
RMSE y1	0,00143	0,00033	0,00016	0,00034	0,00169	0,00182	0,00131	0,00087	0,00214	0,00244	0,00111	0,00216	0,00106	0,00050	0,00022	0,00062
2007	PD	TS	PD AR (1)	TS AR (1)	PD	TS	PD AR (1)	TS AR (1)	PD	TS	PD AR (1)	TS AR (1)	PD	TS	PD AR (1)	TS AR (1)
RMSE y3	0,00294	0,00044	0,00021	0,00025	0,00279	0,00455	0,00104	0,00077	0,00246	0,00194	0,00199	0,00135	0,00277	0,00165	0,00031	0,00053
RMSE y2	0,00206	0,00025	0,00017	0,00027	0,00219	0,00155	0,00084	0,00085	0,00204	0,00177	0,00210	0,00153	0,00198	0,00053	0,00035	0,00059
RMSE y1	0,00226	0,00044	0,00017	0,00018	0,00269	0,00455	0,00075	0,00083	0,00234	0,00194	0,00039	0,00008	0,00219	0,00165	0,00035	0,00055

In general, the RMSE for the AR(1) forecasting models (AR(1) time series and AR(1) panel data) are lower and thus better than the RMSE for the forecasting models including macro variables.

The RMSE for the time series forecasts including macro variables outperform the RMSE for the time series AR(1) forecasts four of twenty four times in the three forecasting periods. The RMSE for the time series forecasts including macro variables for SHB and Nordea is better than the RMSE for AR(1) forecasts in year 2 in the first forecasting period and in year 1 in the second forecasting period. This means that the time series forecasts that include macro variables yield better forecasts for 2008, than the AR(1) forecast in both forecasting period one and two.

The RMSE for the panel data forecasts including macro variables is only better than the AR(1) panel data RMSE for Swedbank in year 2 in the first forecasting period (year 2008).

To conclude, the time series and panel data forecasts that include macro variables are only better than the respective AR(1) model in 2008 for Nordea and SHB in the first and second forecasting period (using the time series forecasting models) and in 2008 for Swedbank in the first forecasting period (using the panel data forecasting model).

7. Analysis

7.1 Do macro economic variables improve credit loss forecasting?

In five of twenty four cases, adding macro variables to an AR (1) model in order to forecast tomorrow's CLL improve the forecasting ability. The results in table 5 show that the AR(1) models in almost all forecasting periods have a lower RMSE than the models that include macro variables. In the CLL graphs figure 5, 6 and 7 is also apparent that the CLL forecasts by the AR(1) models for all banks are more similar to the actual CLLs compared to the CLL forecasts from the models including macro variables.

A reason why the simple AR(1) models outperform the models including macro variables when forecasting CLL could be that the out-of-sample period we aim to forecast is characterized by an extreme macro economic environment due to the financial crisis. The historical sample period that the models are estimated from is characterized by a different macroeconomic climate and different drivers behind CLL. Since the models including macro variables are estimated on historical relations between the explanatory variables and the CLL, the impact the macro variables will have on the CLL is expected to follow historical patterns. In reality however, we learn from previous experiences. After the Swedish banks had suffered great losses during the crisis in the early 90's, substantial structural changes were implemented and regulations were revised and more stringently designed. Further, the monetary and fiscal policies were amended to prevent the history from repeating itself. The data set from which we have estimated our models includes the crisis in the early 90's and thus, the relations between the CLL and the macro variables are characterized by the previous financial crisis. As the macro economic context has changed significantly from 1993 until today, the relationship between the CLL and the macro variables has most likely changed.

Another explanation to why simple AR(1) models outperform our forecasting models including macro variables is that the macro variables we have included are not the major explanatory variables to CLL. Instead, our findings indicate that there are other factors, disregarded in our model, that have higher explanatory power. This could be variables representing the macro economic development outside Sweden or bank specific variables of the characteristics of each bank's credit exposure. If we explain the recent financial crisis by bank specific issues related to the financial crisis, such as the exposure of some banks to the Baltics, rather than the macro development in Sweden, this reason seem even more convenient than the first one (stated in the above paragraph).

However, there are five exceptions in the RMSE evaluation where adding macroeconomic variables actually improve the forecasting ability. We do not find any clear explanation to why these five exceptions appear for SHB and Nordea in the period between the third quarter 2008 until the third quarter 2009 in the time series forecasting model and for Swedbank in the same time period but for the panel data forecasting model.

Furthermore, we do not find it possible to determine whether models based on a time series or panel data approach has superior forecasting ability in this case from evaluating the RMSE values. Graphically, we can observe that using a time series approach generates superior CLL forecasts from the third quarter 2007 to the third quarter 2008. From the third quarter 2008 and onwards though, using models estimated by a panel data approach outperforms the CLL forecasting ability of the models estimated by a time series approach for two of four banks, SEB and Swedbank. The reason why the panel data forecasting model for some banks in certain time periods outperform the time series forecasting models could be that our panel data model makes more accurate forecasts in periods when several macro variables change simultaneously in an unusual way. It includes more explanatory variables and estimates based on a larger sample of observations (and can thereby easier capture extreme events). The model based on a time series approach is instead estimated for one single bank, taking greater concern to bank specific characteristics, and seems to be better suited in times when the macro economy develop similar to the period for which the estimates are based upon.

We cannot make any general conclusions of the impact of macro variables on credit loss forecasting from our study. It is not possible to prove any clear relationship, using our models, between the macro variables today and the CLL of tomorrow, even though previous research and our interviews indicate that such relationship exist indirectly (a negative macro event increases default by borrowers, which in turn raises banks' credit losses). Our simple model would thereby not be appropriate for macro stress-testing purposes.

7.2 What do our findings imply for credit loss forecasting in reality?

In the interviews conducted there was an unanimous opinion that banks should take the development of the macro environment into account when estimating resilience towards credit losses. The macro scenario's effect on borrowers default frequency is according to our interviewees calculated on one hand using a credit loss model, and on the other hand adjusted by a qualitative judgment. The fact that all models used by the banks are internal, restricts us from being able to understand how the sensitivity measure of default frequencies are estimated to respond to changes in different macroeconomic variables and hinders us to compare the methods used between the banks and the Riksbank.

Stress-testing is an activity that requires heavy allocation of resources, but from an external perspective the use of internal stress-testing models makes the utility from these activities hard to measure and value. The calculations of possible credit losses under an adverse economic scenario are performed to ensure that banks hold enough capital to manage an economic downturn. By using more advanced and resource intensive methods of calculation the banks aim to achieve a lower level of capital required. There is a clear trade off for each bank between the gain from a lower capital requirement and the cost from achieving it by investments and model development.

The supervisory authorities' intentions with the capital adequacy regulations is to ensure an enhanced competitive environment, improved consumer protection and decrease the cost for taxpayers if the financial stability is threatened. But since each bank uses different internal calculation methods and different risk classifications of assets and liabilities (although approved by the Financial Supervisory Authorities), the transparency is reduced and the extent of comparison between the banks is distorted.

An alternative to the bottom-up approach with advanced calculations used today by most large banks, would be the use of simplified models applied through a top-down approach. Such model would require less resources and the comprehensibility and basis for comparison for external parties would increase. However, this would result in increased generalisations in the calculations and including fewer bank specific details. Our results from trying to create a simple top-down model explaining the CLL of tomorrow by today's CLL and today's and historical macro factors show that the use of a simple model implies a risk of disregarding important factors explaining the CLL.

Since the stress-testing method used by the Riksbank is built upon a top-down method, we suggest that compared to the banks, using non-transparent methods and having high dependency on bank specific data, the possible danger with the models of the Riksbank is the oversimplifications that these methods could result in.

In one way, this reasoning supports the thought that a qualitative judgment should be added to the quantitative model when making CLL forecasts, to include other aspects that cannot be quantified, such as regulations, political linkages and economic shocks. In another way it also suggests that CLLs are not only, and perhaps not even primarily, affected by changes in the macro economic development. Therefore it is important to include bank specific variables such as credit portfolio characteristics and geographical exposure when building CLL forecast models. From our findings we can thereby confirm that calculating credit risk exposure and trying to foresee future credit losses is a complex and far from straight forward process, which cannot easily be simplified e.g. in the stress-testing process.

8. Conclusion & Summary

A bank's credit losses can be defined as the credit-related losses that are reported in the financial statements and derived from the borrowers' inability to meet their obligations. In this thesis we have studied the relationship between the macroeconomic environment and banks credit losses and if macroeconomic variables can improve credit loss forecasting.

By using quarterly data between 1993-2010 for the four largest Swedish banks, we have estimated models for the banks' CLLs contingent on five selected macro economic factors. We have used the estimated models to calculate out-of-sample forecasts and evaluated the forcasting ability of our models against the forecasting ability of a simple AR(1) model.

From the results we can conclude that adding macro variables to a simple AR(1) model in order to forecast the CLL does not improve the forecasting ability. The results show that the AR(1) models in almost all forecasting periods have a lower RMSE than the models that include macro variables.

Based on this we argue that there are other factors, disregarded in our model, that might explain the CLL of tomorrow in a better way. This could be for example bank specific variables such as credit portfolio characteristics and geographical exposures.

Hence, our findings suggest the use of bank specific models and detailed calculations rather than a simplified top-down approach to forecast CLL.

Further we have found indications that different models could be appropriate under different macroeconomic conditions. Our panel data forecasting model made forecasts somehow closer to the actual outcome during times of financial turmoil compared to our time series forecasting model, which made better forecasts during normal conditions.

9. Limitations

A limitation of our study is the choice of sample period that our in-sample estimations are based upon. Part of the financial crisis during the 90's is included in the sample period and our estimations are therefore highly characterized by the extreme macro development during this period. If we had lengthened the time horizon and extended the sample period over several business cycles our models might have forecasted less volatile CLLs.

The risk of having omitted factors is also considerable, since we have only included five macro variables at the most in our models. Besides including other macro variables, adding at least one bank specific variable would have made the difference between the banks easier to detect and explain. This is especially evident for the panel data, which is built on the relatively strong assumption that the macro variables affect the CLL for each bank equally.

Moreover, the fact that our model is not restricted to exclude negative values of CLLs in some cases creates forecasts implying high levels of write-backs (which is not likely). The fact that the RMSE evaluation does not capture whether the forecasted CLLs are positive or negative could also cause a misperceptions of the results.

Lastly, as a consequence of the chosen sample period and the explanatory variables included for a certain bank, unrealistic model parameters have occurred and been used to make CLL forecast. An example is the negative coefficient for the lagged dependent variable for Nordea.

10. Suggestions for further research

Our thesis has studied if macro economic variables improve credit loss forecasting We have addressed this question through a quantitative analysis using regression models. Our study could be used as a basis trying to answer our question through a qualitative approach or judgment. But it could also function as a basis for other financial forecasting research. For further research we suggest a comparison of the CLL forecasts in this study to CLL forecasts made by other actors, such as banks and the Riksbank, in order to relate the level of accuracy and the underlying models. Our results depend on the sample period as well as the out-of-sample time period, thus it would be intriguing to examine whether the affect in the results by using another time period, perhaps in a less volatile context. Due to the fact that there are an infinite number of explanatory variables to choose from, testing for other explanatory variables in combination with bank specific variables would be interesting. Finally, we suggest further research to examine the use of other forecasting models.

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Interviews

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Bank 2 2010-12-01

Bank 3 2010-12-07

Riksbanken 2010-12-14

Appendix A: Further background explanations

A.1 Further explanations of the Tier 1 Capital ratio.

The Tier 1 capital (sv primärkapitalet) primary consists of shareholders' equity and disclosed reserves and has to constitute of at least 50 per cent of a banks' capital base. Credit losses would reduce a bank's Tier 1 capital. (FI 2001:1)

The RWA are calculated from formulas based on estimates of a bank's EL and the bank's Exposure at Default (EAD). EAD is a measure of potential exposure (in currency) to a counterparty in the event of the counterparty's default. When estimating the RWA under adverse business conditions, conditional EL are used. This means that the original average PD and LGD are recalculated to what their values would be during worse business conditions, i.e. in a stressed scenario. A new conditional PD and a new conditional LGD are then generated from which the conditional EL is calculated. (internal material bank 1)

A.2 Description of the main characteristics of Basel II

Basel II is structured on three pillars:

Pillar 1 - Minimum capital requirement

The differences in Pillar I from Basel I is that banks must in addition to credit risk also include market and operational risks when calculating capital required. Another difference is the allowance for the banks to use internal-based methods in order to estimate RWA as an option to the standardized method in Basel I.

With the standardized method, all banks used the same the risk weights set by the Basel I regulations. The risk-weights are assigned to certain asset classes dependent on whom the counterpart is in a credit transaction. The estimations of RWA are thereby highly generalized and mechanical. (FI 2001:1)

Basel II allow the banks to choose which method to use for estimating RWA, a method that is based on internal information when calculating risks, i.e. internal rating based (IRB) methods. Using the IRB-method are conditional on a higher level of information sharing from the bank to the regulatory authorities (the FSA) and the financial markets. The aim of the new IRB-methods is to get a better view of the link between the capital requirement and the actual risks taken by the bank (FI 2001:1). Which method that is applied by the bank usually depends on the complexity of the bank's operations since it requires extensive investments and data availability to fulfill the requirements for using the IRB-method. Using the IRB-methods allows for a higher degree of individual fit of the capital requirement and can hence both lower and increase a bank's capital requirement; consequently the IRB-method is not a guarantee for a more favorable level of capital requirement.

Pillar 2 - Supervisory review

The supervisory review is an individually adjusted evaluation for each bank to complement the requirements in Pillar 1. It contains requisites that each bank must have a strategy and method on how to achieve and maintain the capital requirement that needs be published in accordance with ICAAP regulations (Internal Capital Adequacy Assessment Process). (FI 2005:8)

The supervisory authorities' task is to scrutinize the stress-tests conducted by individual banks (on request from the FSA) and the evaluation of the banks assessment of their complete capital need and if necessary force changes in basic assumptions of the banks' stress-test or extent of the capital buffer.

Pillar 3 – Market discipline

Pillar 3 emphasizes the requirements on banks to publicly release information on risks, capital and risk management. By receiving all relevant information, stakeholders should be able to judge the banks financial position and risk profile. This will create incentives for the banks to take on less risk, which will result in lower risk for the whole system (systematic risk). (FI 2002:8)

A.3 Summary of the interviews with the three banks and the Riksbank.

The interviews are divided into three sections; the purpose of stress-testing, the modeling and the challenges to stress-testing and credit risk-modeling.

The interviews with the banks

Purpose

Stress-tests are used as a tool to assess how a stressed situation would affect a bank's financial position. All the banks agree that stress-testing today is given more attention and is of greater importance in the banks' capital and strategy planning than before the previous financial crisis. The banks perform official stress-test on a regular basis in accordance with the Basel regulations (ICAAP-reports) and also when the Swedish FSA (FI) requires a test. On an internal basis the banks only perform a stress-test if an unusual event occurs, if the economic environment changes or if the top-management or the board of the bank demand a report on the financial resilience, rather than on regularly basis. This is because it is both costly and time consuming to undertake a stress-test.

The stress-testing process

The structure and procedures of the stress-tests are very similar between the banks and can be related to the model previously described by Bunn et al. The test is physically divided into (i) the economic research division constructing the scenario and interpreting its effect on various macroeconomic variables and (ii) the credit risk division applying the scenario on the credit portfolio and the following sub-credit portfolios, consequently reporting the effect on the bank's tier 1 capital ratio and hence profit and loss statement.

How the economic research division constructs the scenarios deviates between the banks. The most common methods are historical, probabilistic or reversal engineering[6]. The base case for most scenarios starts from a historical event, but since the likelihood of an exactly similar event occurring again is small, the scenario is adjusted into a probabilistic scenario. One of the banks use reversal engineering to create some of their scenarios while one other bank will soon start to conduct the reversal engineering method due to regulation requirements. The representative for one of the banks believes that the scenarios applied do not diverge much between the banks since they operate in the same context.

The credit risk divisions apply the scenario given by the economic research division on the credit portfolio. The banks use different models for this convergence process, models that are non-public and probably differ a lot between the banks. One main difference could emerge from the degree of usage of qualitative methods or quantitative models to map the impact of the macro economy on credit losses. A qualitative method is the case where the effects of a change in the macro variables is interpreted and analyzed by experts while a quantitative model uses

[6] Reversal Engineering: Starting by determining the value of the final outcome to measure how much that will change the value of the underlying variables' and thus the thresholds of the underlying variables to be able to capture signals that might make the final outcome exceed a certain level.

macroeconomic variables to affect the components of the credit portfolio in a predetermined manner.

The credit portfolio consists of many sub-portfolios dependent on e.g. industry and geography. The classification of the sub-portfolios is similar between the banks but differs in terms of sub-portfolio construction and on what detail loans and portfolios are given individual PD and LGD which are used to calculate EL. The bank's estimates of PD and LGD also varieties with the bank's degree of implementation of IRB-methods on their different sub-portfolios.

Challenges

All the banks mention similar challenges to the stress-testing process and how to converge the scenario onto the credit risk model. The main issue seems to be the uncertainty of the credit risk models used to make reliable forecasts for credit losses of stressed conditions, since the models are usually constructed during normal conditions and that relevance under a stressed scenario is therefore hard to verify. The banks further stress the possible measurement errors of the factors included in the test and the design and interpretation of relevant scenarios are challenges in the stress-testing process.

Interview with the Riksbank

Purpose

The stress-tests performed by the Swedish Central Bank, the Riksbank, aim to test the resilience of the Swedish banks in the event of a crisis with large unexpected credit losses, as well as the soundness and stability of the financial system. One reason for the tests is to publish an autonomous stress-test and judgment of the present risks for investors.

The stress-testing process

The Riksbank calculates the banks' loan losses for two scenarios: *main scenario* (the likely scenario) and the *stressed scenario*. The Division for Monetary Policy (APP) produces the main scenario for next coming years whereas the stressed scenario is produced by the Division for Financial Stability (AFS).

The Riksbank initiates the stress-testing process by calculating how the banks credit losses will develop given the main scenario for the macroeconomic environment. When applying the scenario on the banks' credit portfolios, the loan portfolios are divided on both geographic and industry-based affiliation. Information of the banks' portfolios is obtained from their quarterly and annual reports.

The Riksbank mainly uses Expected Default Frequency (EDF) as a proxy for PD when calculating EL, as opposed to the banks which use Non Performing Loans[7] (NPL), a broader measure than EDF. The Riksbank gives each industry a common EDF (median value). Data a EDFs is obtained from KMV Moody's, data which is available for the Riksbank as well as for other actors and institutions. When calculating the EL, the Riksbank compensate for the fact that the EDF gives a lower estimation of the PD value than the NPL, by adjusting the LGD to a higher level compared to the banks' actual LGD levels. In addition, the Riksbank benchmark their values of LGD for the corporate part of the credit portfolio to Moody's LGD values.

To estimate the impact the macro environment has on the factors included in the credit loss model the Riksbank use quantitative methods to model this relationship complemented by a qualitative judgement.

The main scenario is applied in the credit loss models to make prognostications for the development of PD and EAD under the most likely conditions and is then complemented by a qualitative expert evaluation before the development of the banks' credit losses is produced.

When formatting the stressed scenario, data for historical PD is used as a basis to calculate the stressed EDF and EAD. To control if the values of the calculated stressed EDF and EAD, the model for EDF is used in order to examine what effects the stressed factors would have on e.g. GDP or interest rate. If the macro values that come out of the model not comport with what could be accepted as a stressed scenario, the Riksbank adjust the EDF and LGD by qualitative judgment. Using this method, i.e. checking against a reasonable benchmark gives the Riksbank a perception about the relevance of the scenario.

Another possible difference between the stress-tests performed by the Riksbank and the banks is how the effect of a stressed scenario on the banks' profits is calculated. The Riksbank use a consensus measure[8] of net income and subtract 15 per cent of the bottom line of net income as

[7] Loans that are in default or close to being in default.
[8] From SME Direct

credit losses. The next step addressing this is for the Riksbank to develop their own model to include changes in earnings given a stressed scenario.

When the Riksbank stress-tests the Tier 1 Capital Coverage Ratio, the RWA are assumed to increase by 5 per cent annually, and hence they do not estimate RWA in the same way as the banks.

Challenges

The main challenges that the Riksbank mentions regarding the stress-testing practice are: that the possible feedback effects of a stressed scenario is not taken into account in their current models. This raises the question of how the Riksbank could create stress-test models that generate predictions closer to the actual outcome. During the recent financial crisis the reality turned out even worse than the Riksbank's stressed scenario. Now, the Riksbank has to consider if this development would have been possible to foresee. The final challenge the Riksbank mention is the communication issue when institutions, the Riksbank and the banks, use different proxies for PD and other measures. This makes communication and comparisons between the stress-test outcomes and methods more difficult.

Appendix B: CLL calculation

A.4 Calculations of the banks' CLL underlying the graphical illustrations

Figure 5: The first forecasting period 2nd quarter 2007 to 1st quarter 2010

Time series:

Macro variables						CLLs							
						SHB		SEB		SWB		Nordea	
	gdpgap	cpi	tbill	realexr	oilprice	Actual	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast
jun-06	*2,48*	*1,53*	*2,1*	*127,15*	*69,4*	*-0,000051*		*0,000176*		*-0,000132*		*-0,000454*	
sep-06	*3,35*	*1,60*	*2,4*	*125,91*	*69,7*	*0,000021*		*0,000147*		*-0,000073*		*-0,000275*	
dec-06	*3,06*	*1,53*	*2,8*	*124,22*	*59,7*	*0,000051*		*0,000237*		*-0,000076*		*-0,000107*	
mar-07	*3,61*	*1,94*	*3,2*	*124,88*	*57,8*	*-0,000062*		*0,000238*		*0,000050*		*-0,000060*	
jun-07	3,87	1,81	3,4	125,30	68,7	-0,000055	-0,000054	0,000271	0,000635	0,000100	-0,000031	-0,000123	-0,000778
sep-07	4,13	1,94	3,5	125,34	75,0	-0,000003	-0,000345	0,000183	-0,000372	0,000217	-0,000007	-0,000056	-0,000631
dec-07	4,92	3,14	3,9	124,28	88,7	0,000131	0,000260	0,000300	-0,001248	0,000214	0,000043	-0,000025	-0,000096
mar-08	3,42	3,24	4,1	125,03	97,0	0,000082	0,000110	0,000336	0,000636	0,000250	0,000141	0,000086	0,001008
jun-08	3,13	3,80	4,1	122,8	121,9	0,000425	0,000384	0,000402	0,000814	0,000356	0,000144	0,000140	0,000717
sep-08	2,79	4,28	4,3	125,1	115,1	0,000165	0,000331	0,000613	-0,001698	0,000660	0,000116	0,000327	0,000839
dec-08	-1,66	2,45	2,8	137,3	55,0	0,000478	0,001069	0,001362	0,000947	0,001285	0,000306	0,001105	0,001187
mar-09	-5,03	0,79	0,9	144,6	44,5	0,000597	0,000556	0,001826	-0,001420	0,005328	0,000464	0,001281	0,001321
jun-09	-4,70	-0,37	0,4	141,1	58,9	0,000622	-0,000235	0,002721	-0,008656	0,005216	0,002099	0,001497	-0,002609
sep-09	-4,74	-1,09	0,2	135,1	68,3	0,000582	-0,000402	0,002656	-0,006760	0,004856	0,002311	0,001285	-0,002333
dec-09	-4,71	-0,41	0,2	133,5	74,7	0,000468	0,000369	0,002639	0,000099	0,003946	0,001955	0,001272	0,000551
mar-10	-3,70	1,01	0,2	130,3	76,3	0,000374	0,000625	0,001611	0,003830	0,001765	0,001759	0,000878	0,001245

2007											
SHB	Coefficient	T-stat	SEB	Coefficient	T-stat	SWB	Coefficient	T-stat	Nordea	Coefficient	T-stat
q1	-0,00029	-3,29	q1	-0,00055	-0,64	q1	0,00016	1,81	q1	0,00052	1,71
q2	-0,00017	-1,93	q2	-0,00030	-0,35	q2	0,00007	0,82	q2	0,00039	1,25
q3	0,00031	-1,53	q3	0,00034	-0,39	q3	0,00007	0,78	q3	0,00058	1,86
con	-0,00282	-3,07	con	0,01841	1,61	con	-0,00035	-3,39	con	-0,00518	-2,02
cll_1	0,31842	4,49	cll_1	-0,02454	-0,19	cll_1	0,42105	9,33	cll_1	-0,08691	-1,01
tbill_1	0,00032	2,87	cpi_1	0,00135	2,71	cpi_1	-0,00011	-1,80	realexr_1	0,00004	1,94
realexr1	0,00002	2,07	tbill_2	0,00219	2,70	tbill_1	0,00033	2,82	oilprice_2	0,00005	1,67
tbill_2	-0,00033	-1,69	realexr_2	-0,00015	-1,65	cpi_2	0,00014	2,57	cpi_4	0,00053	5,41
oilprice_2	0,00001	3,57	cpi_3	-0,00227	-3,28	tbill_2	-0,00044	-2,19	oilprice_4	-0,00007	-2,05
realexr2	-0,00004	-2,32	tbill_3	-0,00221	-2,70	tbill_3	0,00024	2,16	R2	0,1987	
tbill_3	0,00028	2,40	gdpgap_4	-0,00093	-3,18	gdpgap_4	-0,00006	-2,09			
realexr3	0,00003	2,42	cpi_4	0,00233	4,17	R2	0,9490				
gdpgap_4	-0,00013	-3,92	R2	0,6049							
R2	0,9501										

Panel data:

Macro variables						CLLs							
						SHB		SEB		SWB		Nordea	
	gdpgap	cpi	tbill	realexr	oilprice	Actual	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast
jun-06	*2,48*	*1,53*	*2,1*	*127,15*	*69,4*	*-0,00005*		*0,00018*		*-0,00013*		*-0,00045*	
sep-06	*3,35*	*1,60*	*2,4*	*125,91*	*69,7*	*0,00002*		*0,00015*		*-0,00007*		*-0,00028*	
dec-06	*3,06*	*1,53*	*2,8*	*124,22*	*59,7*	*0,00005*		*0,00024*		*-0,00008*		*-0,00011*	
mar-07	*3,61*	*1,94*	*3,2*	*124,88*	*57,8*	*-0,00006*		*0,00024*		*0,00005*		*-0,00006*	
jun-07	3,87	1,81	3,4	125,30	68,7	-0,00005	0,00379	0,00027	0,00461	0,00010	0,00407	-0,00012	0,00363
sep-07	4,13	1,94	3,5	125,34	75,0	0,00000	0,00238	0,00019	0,00320	0,00022	0,00266	-0,00005	0,00219
dec-07	4,92	3,14	3,9	124,28	88,7	0,00013	0,00027	0,00029	0,00106	0,00022	0,00057	-0,00002	0,00009
mar-08	3,42	3,24	4,1	125,03	97,0	0,00008	0,00016	0,00033	0,00095	0,00025	0,00043	0,00008	-0,00005
jun-08	3,13	3,80	4,1	122,8	121,9	0,00042	-0,00093	0,00040	-0,00012	0,00036	-0,00064	0,00014	-0,00109
sep-08	2,79	4,28	4,3	125,1	115,1	0,00016	-0,00219	0,00059	-0,00145	0,00067	-0,00196	0,00032	-0,00243
dec-08	-1,66	2,45	2,8	137,3	55,0	0,00047	0,00096	0,00131	0,00181	0,00130	0,00133	0,00106	0,00083
mar-09	-5,03	0,79	0,9	144,6	44,5	0,00059	0,00302	0,00181	0,00397	0,00532	0,00347	0,00126	0,00300
jun-09	-4,70	-0,37	0,4	141,1	58,9	0,00063	0,00611	0,00273	0,00716	0,00520	0,00754	0,00149	0,00611
sep-09	-4,74	-1,09	0,2	135,1	68,3	0,00059	0,00599	0,00276	0,00726	0,00480	0,00738	0,00131	0,00604
dec-09	-4,71	-0,41	0,2	133,5	74,7	0,00047	-0,00186	0,00266	-0,00057	0,00402	-0,00056	0,00127	-0,00185
mar-10	-3,70	1,01	0,2	130,3	76,3	0,00038	-0,00189	0,00160	-0,00060	0,00171	-0,00076	0,00089	-0,00186

2007	Coefficient	Std dev	Impact	T-stat
cllevel_1	0,25100	0,002679	0,0007	3,92
gdpgap_1	0,00073	1,794857	0,0013	5,22
gdpgap_2	-0,00073	1,785394	-0,0013	-5,55
cpi_1	0,00034	1,31883	0,0004	1,70
cpi_3	-0,00063	1,32466	-0,0008	-2,94
cpi_4	0,00067	1,327617	0,0009	3,66
tbill_1	0,00056	2,235591	0,0012	2,93
tbill_2	-0,00041	2,23787	-0,0009	-2,41
oilprice_1	-0,00009	15,36319	-0,0014	-5,11
oilprice_4	0,00012	14,79345	0,0018	7,28
realexr_3	-0,00019	5,568748	-0,0011	-4,41
realexr_4	0,00016	5,577207	0,0009	3,66
R2	0,6109			

SHB	Coefficient	Std dev	Impact	T-stat
i1	0,00017	0,43397	0,00007	0,54
q1	-0,00004	0,44132	-0,00002	-0,11
q2	0,00014	0,43140	0,00006	0,43
q3	-0,00025	0,43140	-0,00011	-0,80
cons	0,00263			0,60

SEB	Coefficient	Std dev	Impact	T-stat
i3	0,00091	0,43397	0,00040	2,91
q1	-0,00004	0,44132	-0,00002	-0,11
q2	0,00014	0,43140	0,00006	0,43
q3	-0,00025	0,43140	-0,00011	-0,80
cons	0,00263			0,60

SWB	Coefficient	Std dev	Impact	T-stat
i2	0,00041	0,43397	0,00018	1,35
q1	-0,00004	0,44132	-0,00002	-0,11
q2	0,00014	0,43140	0,00006	0,43
q3	-0,00025	0,43140	-0,00011	-0,80
cons	0,00263			0,60

Nordea	Coefficient	Std dev	Impact	T-stat
q1	-0,00004	0,44132	-0,00002	-0,11
q2	0,00014	0,43140	0,00006	0,43
q3	-0,00025	0,43140	-0,00011	-0,80
cons	0,00263			0,60

Time series AR(1):

CLLs								
	SHB		SEB		SWB		Nordea	
	Actual	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast
jun-06	*-0,00005*		*0,00018*		*-0,00013*		*-0,00045*	
sep-06	*0,00002*		*0,00015*		*-0,00007*		*-0,00028*	
dec-06	*0,00005*		*0,00024*		*-0,00008*		*-0,00011*	
mar-07	*-0,00006*		*0,00024*		*0,00005*		*-0,00006*	
jun-07	-0,00006	0,00004	0,00027	0,00087	0,00010	0,00011	-0,00012	0,00090
sep-07	0,00000	0,00001	0,00018	-0,00029	0,00022	0,00013	-0,00006	0,00006
dec-07	0,00013	0,00021	0,00030	0,00165	0,00021	0,00019	-0,00002	0,00033
mar-08	0,00008	-0,00025	0,00034	-0,00027	0,00025	0,00013	0,00009	0,00020
jun-08	0,00043	0,00017	0,00040	0,00093	0,00036	0,00029	0,00014	0,00096
sep-08	0,00017	0,00044	0,00061	0,00111	0,00066	0,00036	0,00033	0,00015
dec-08	0,00048	0,00036	0,00136	0,00190	0,00128	0,00058	0,00110	0,00047
mar-09	0,00060	0,00005	0,00183	0,00034	0,00533	0,00107	0,00128	0,00061
jun-09	0,00062	0,00062	0,00272	0,00179	0,00522	0,00476	0,00150	0,00139
sep-09	0,00058	0,00061	0,00266	0,00245	0,00486	0,00464	0,00128	0,00065
dec-09	0,00047	0,00072	0,00264	0,00308	0,00395	0,00428	0,00127	0,00082
mar-10	0,00037	0,00004	0,00161	0,00108	0,00176	0,00342	0,00088	0,00067

2007															
SHB		Coefficient	T-stat	**SEB**		Coefficient	T-stat	**SWB**		Coefficient	T-stat	**Nordea**		Coefficient	T-stat
	q1	-0,000578	-3,80		q1	-0,001991	-1,73		q1	-0,000062	-0,30		q1	-0,000147	-0,18
	q2	-0,000119	-0,78		q2	-0,000816	-0,71		q2	0,000065	0,31		q2	0,000572	0,69
	q3	-0,000148	-0,97		q3	-0,000666	-0,58		q3	0,000040	0,19		q3	-0,000252	-0,30
	con	0,000212	1,91		con	0,001546	1,84		con	0,000002	0,02		con	0,000353	0,60
	cll_1	0,877821	29,34		cll_1	0,578182	5,38		cll_1	0,880737	26,51		cll_1	0,365505	2,90
	R2	**0,9405**			**R2**	**0,3272**			**R2**	**0,9275**			**R2**	**0,0916**	

Panel data AR(1):

CLLs								
	SHB		**SEB**		**SWB**		**Nordea**	
	Actual	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast
jun-06	*-0,00005*		*0,00018*		*-0,00013*		*-0,00045*	
sep-06	*0,00002*		*0,00015*		*-0,00007*		*-0,00028*	
dec-06	*0,00005*		*0,00024*		*-0,00008*		*-0,00011*	
mar-07	*-0,00006*		*0,00024*		*0,00005*		*-0,00006*	
jun-07	-0,00005	0,00034	0,00018	0,00103	0,00010	0,00066	-0,00012	0,00037
sep-07	0,00000	0,00013	0,00015	0,00084	0,00022	0,00047	-0,00005	0,00011
dec-07	0,00013	0,00044	0,00023	0,00107	0,00022	0,00083	-0,00002	0,00044
mar-08	0,00008	0,00019	0,00023	0,00081	0,00025	0,00049	0,00008	0,00012
jun-08	0,00042	0,00043	0,00027	0,00109	0,00036	0,00078	0,00014	0,00046
sep-08	0,00016	0,00041	0,00019	0,00091	0,00067	0,00063	0,00032	0,00027
dec-08	0,00047	0,00054	0,00029	0,00132	0,00130	0,00110	0,00106	0,00066
mar-09	0,00059	0,00039	0,00033	0,00142	0,00532	0,00114	0,00126	0,00077
jun-09	0,00063	0,00073	0,00040	0,00198	0,00520	0,00381	0,00149	0,00116
sep-09	0,00059	0,00053	0,00059	0,00232	0,00480	0,00353	0,00131	0,00108
dec-09	0,00047	0,00079	0,00131	0,00262	0,00402	0,00357	0,00127	0,00126
mar-10	0,00038	0,00039	0,00181	0,00222	0,00171	0,00277	0,00089	0,00090

2007														
	Coefficient	T-stat	**SHB**	Coefficient	T-stat	**SEB**	Coefficient	T-stat	**SWB**	Coefficient	T-stat	**Nordea**	Coefficient	T-stat
cllevel_1	0,599	11,25	i1	-0,00003	-0,07	i3	0,00049	1,23	i2	0,00022	0,57			
			q1	-0,00033	-0,84	q1	-0,00033	-0,84	q1	-0,00033	-0,84	q1	-0,00033	-0,84
			q2	-0,00006	-0,16	q2	-0,00006	-0,16	q2	-0,00006	-0,16	q2	-0,00006	-0,16
			q3	-0,00028	-0,71	q3	-0,00028	-0,71	q3	-0,00028	-0,71	q3	-0,00028	-0,71
			cons	0,00047	1,25	cons	0,00047	1,25	cons	0,00047	1,25	cons	0,00047	1,25
R2	0.3684													

A.5 Calculations of the banks' CLL underlying the graphical illustrations

Figure 6: The second forecasting period 2nd quarter 2008 to 1st quarter 2010

Time series:

Macro variables						CLLs							
						SHB		SEB		SWB		Nordea	
	gdpgap	cpi	tbill	realexr	oilprice	Actual	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast
Jun-07	*3,87*	*1,81*	*3,4*	*125,30*	*68,7*	*-0,000054*		*0,000267*		*0,000100*		*-0,000123*	
Sep-07	*4,13*	*1,94*	*3,5*	*125,34*	*75,0*	*-0,000003*		*0,000185*		*0,000217*		*-0,000056*	
Dec-07	*4,92*	*3,14*	*3,9*	*124,28*	*88,7*	*0,000128*		*0,000293*		*0,000214*		*-0,000025*	
Mar-08	*3,42*	*3,24*	*4,1*	*125,03*	*97,0*	*0,000081*		*0,000331*		*0,000250*		*0,000086*	
Jun-08	3,13	3,80	4,1	122,8	121,9	0,000417	0,000365	0,000396	0,000990	0,000356	0,000228	0,000140	0,000288
Sep-08	2,79	4,28	4,3	125,1	115,1	0,000162	0,000500	0,000594	-0,001418	0,000660	0,000206	0,000327	0,000354
Dec-08	-1,66	2,45	2,8	137,3	55,0	0,000470	0,001028	0,001313	0,001339	0,001285	0,000417	0,001105	0,000312
Mar-09	-5,03	0,79	0,9	144,6	44,5	0,000590	0,000523	0,001811	-0,001173	0,005328	0,000540	0,001281	0,000706
Jun-09	-4,70	-0,37	0,4	141,1	58,9	0,000627	-0,000256	0,002734	-0,008455	0,005216	0,002212	0,001497	-0,001436
Sep-09	-4,74	-1,09	0,2	135,1	68,3	0,000587	-0,000228	0,002763	-0,006635	0,004856	0,002439	0,001285	-0,001281
Dec-09	-4,71	-0,41	0,2	133,5	74,7	0,000468	0,000346	0,002660	0,000082	0,003946	0,002005	0,001272	0,000137
Mar-10	-3,70	1,01	0,2	130,3	76,3	0,000375	0,000592	0,001600	0,003522	0,001765	0,001716	0,000878	0,000724

2008											
SHB	Coefficient	T-stat	SEB	Coefficient	T-stat	SWB	Coefficient	T-stat	Nordea	Coefficient	T-stat
q1	-0,00029	-3,53	q1	-0,00067	-0,85	q1	0,00015	1,81	q1	0,00049	1,69
q2	-0,00016	-2,00	q2	-0,00042	-0,53	q2	0,00007	0,80	q2	0,00040	1,35
q3	-0,00011	-1,42	q3	-0,00041	-0,52	q3	0,00007	0,85	q3	0,00055	1,84
con	-0,00276	-3,18	con	0,01915	1,99	con	-0,00034	-3,44	con	-0,00466	-1,90
cll_1	0,32697	4,95	cll_1	-0,01524	-0,13	cll_1	0,43572	10,35	cll_1	-0,07879	-0,95
tbill_1	0,00032	3,06	cpi_1	0,00134	3,00	cpi_1	-0,00011	-2,03	realexr_1	0,00004	1,80
realexr1	0,00002	2,15	tbill_2	0,00220	2,86	tbill_1	0,00034	3,08	oilprice_2	0,00002	1,23
tbill_2	-0,00032	-1,74	realexr_2	-0,00016	-2,03	cpi_2	0,00015	2,84	cpi_4	0,00029	3,13
oilprice_2	0,00001	3,93	cpi_3	-0,00221	-3,96	tbill_2	-0,00045	-2,32	oilprice_4	-0,00004	-1,73
realexr2	-0,00004	-2,44	tbill_3	-0,00223	-2,95	tbill_3	0,00023	2,18	R2	0,1841	
tbill_3	0,00026	2,46	gdpgap_4	-0,00089	-4,00	gdpgap_4	-0,00005	-1,83			
realexr3	0,00003	2,54	cpi_4	0,00232	4,61	R2	0,9494				
gdpgap_4	-0,00013	-4,38	R2	0,6117							
R2	0,9512										

Panel data:

Macro variables						CLLs							
						SHB		SEB		SWB		Nordea	
	gdpgap	cpi	tbill	realexr	oilprice	Actual	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast
jun-07	*3,87*	*1,81*	*3,4*	*125,30*	*68,7*	*-0,00005*		*0,00027*		*0,00010*		*-0,00012*	
sep-07	*4,13*	*1,94*	*3,5*	*125,34*	*75,0*	*0,00000*		*0,00019*		*0,00022*		*-0,00005*	
dec-07	*4,92*	*3,14*	*3,9*	*124,28*	*88,7*	*0,00013*		*0,00029*		*0,00022*		*-0,00002*	
mar-08	*3,42*	*3,24*	*4,1*	*125,03*	*97,0*	*0,00008*		*0,00033*		*0,00025*		*0,00008*	
jun-08	3,13	3,80	4,1	122,8	121,9	0,00042	0,00122	0,00040	0,00210	0,00036	0,00156	0,00014	0,00111
sep-08	2,79	4,28	4,3	125,1	115,1	0,00016	0,00130	0,00059	0,00213	0,00067	0,00160	0,00032	0,00114
dec-08	-1,66	2,45	2,8	137,3	55,0	0,00047	0,00284	0,00131	0,00374	0,00130	0,00323	0,00106	0,00275
mar-09	-5,03	0,79	0,9	144,6	44,5	0,00059	0,00137	0,00181	0,00235	0,00532	0,00182	0,00126	0,00136
jun-09	-4,70	-0,37	0,4	141,1	58,9	0,00063	0,00154	0,00273	0,00258	0,00520	0,00262	0,00149	0,00154
sep-09	-4,74	-1,09	0,2	135,1	68,3	0,00059	0,00197	0,00276	0,00315	0,00480	0,00303	0,00131	0,00200
dec-09	-4,71	-0,41	0,2	133,5	74,7	0,00047	-0,00036	0,00266	0,00083	0,00402	0,00063	0,00127	-0,00036
mar-10	-3,70	1,01	0,2	130,3	76,3	0,00038	0,00052	0,00160	0,00172	0,00171	0,00141	0,00089	0,00054

2008	Coefficient	Std dev	Impact	T-stat
cllevel_1	0,163000	0,0026045	0,0004	2,39
gdpgap_1	0,000008	2,031333	0,0000	0,05
gdpgap_2	-0,000262	2,011159	-0,0005	-1,83
cpi_1	0,000353	1,308848	0,0005	1,78
cpi_3	-0,000423	1,309821	-0,0006	-1,83
cpi_4	0,000460	1,312418	0,0006	2,24
tbill_1	0,000972	2,171396	0,0021	4,62
tbill_2	-0,000690	2,175644	-0,0015	-3,58
oilprice_1	-0,000003	19,92249	-0,0001	-0,25
oilprice_4	0,000037	19,33776	0,0007	3,30
realexr_3	-0,000135	5,387296	-0,0007	-2,90
realexr_4	0,000089	5,397959	0,0005	1,96
R2	0,5309			

SHB	Coefficient	Std dev	Impact	T-stat
i1	0,00011	0,43390	0,00005	0,35
q1	0,00004	0,44079	0,00002	0,11
q2	0,00002	0,43151	0,00001	0,07
q3	-0,00020	0,43151	-0,00009	-0,62
cons	0,00354			0,82

SEB	Coefficient	Std dev	Impact	T-stat
i3	0,00095	0,43390	0,00041	2,93
q1	0,00004	0,44079	0,00002	0,11
q2	0,00002	0,43151	0,00001	0,07
q3	-0,00020	0,43151	-0,00009	-0,62
cons	0,00354			0,82

SWB	Coefficient	Std dev	Impact	T-stat
i2	0,00042	0,43390	0,00018	1,34
q1	0,00004	0,44079	0,00002	0,11
q2	0,00002	0,43151	0,00001	0,07
q3	-0,00020	0,43151	-0,00009	-0,62
cons	0,00354			0,82

Nordea	Coefficient	Std dev	Impact	T-stat
q1	0,00004	0,44079	0,00002	0,11
q2	0,00002	0,43151	0,00001	0,07
q3	-0,00020	0,43151	-0,00009	-0,62
cons	0,00354			0,82

Time series AR(1):

CLLs	SHB		SEB		SWB		Nordea	
	Actual	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast
jun-07	*-0,00006*		*0,0002713*		*0,00010*		*-0,0001*	
sep-07	*0,00000*		*0,0001827*		*0,000217*		*-0,0001*	
dec-07	*0,00013*		*0,0002997*		*0,000214*		*0,0000*	
mar-08	*0,00008*		*0,0003361*		*0,00025*		*0,0001*	
jun-08	0,00043	0,00017	0,000402	0,0009	0,0004	0,0003	0,0001	0,000956
sep-08	0,00017	0,00044	0,000613	0,0011	0,0007	0,0004	0,0003	0,000152
dec-08	0,00048	0,00036	0,001362	0,0019	0,0013	0,0006	0,0011	0,000473
mar-09	0,00060	0,00005	0,001826	0,0003	0,0053	0,0011	0,0013	0,000610
jun-09	0,00062	0,00062	0,002721	0,0018	0,0052	0,0048	0,0015	0,001393
sep-09	0,00058	0,00061	0,002656	0,0025	0,0049	0,0046	0,0013	0,000648
dec-09	0,00047	0,00072	0,002639	0,0031	0,0039	0,0043	0,0013	0,000823
mar-10	0,00037	0,00004	0,001611	0,0011	0,0018	0,0034	0,0009	0,000671

2008											
SHB	Coefficient	T-stat	**SEB**	Coefficient	T-stat	**SWB**	Coefficient	T-stat	**Nordea**	Coefficient	T-stat
q1	-0,000551	-3,86	q1	-0,001863	-1,73	q1	-0,000055	-0,29	q1	-0,000130	-0,17
q2	-0,000119	-0,84	q2	-0,000764	-0,71	q2	0,000063	0,33	q2	0,000526	0,69
q3	-0,000144	-1,01	q3	-0,000631	-0,59	q3	0,000045	0,23	q3	-0,000238	-0,31
con	0,000207	1,99	con	0,001450	1,86	con	0,000005	0,03	con	0,000328	0,6
cll_1	0,877295	30,52	cll_1	0,581645	5,64	cll_1	0,879975	27,74	cll_1	0,369392	3,05
R2	**0,9410**		**R2**	**0,3344**		**R2**	**0,9289**		**R2**	**0,1593**	

Panel data AR(1):

CLLs	SHB		SEB		SWB		Nordea	
	Actual	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast
jun-07	*-0,00005*		*0,00027*		*0,00010*		*-0,00012*	
sep-07	*0,00000*		*0,00019*		*0,00022*		*-0,00005*	
dec-07	*0,00013*		*0,00029*		*0,00022*		*-0,00002*	
mar-08	*0,00008*		*0,00033*		*0,00025*		*0,00008*	
jun-08	0,000417	0,000396	0,000267	0,001029	0,000362	0,000736	0,000135	0,000421
sep-08	0,000162	0,000397	0,000185	0,000866	0,000674	0,000599	0,000321	0,00025
dec-08	0,00047	0,000509	0,000293	0,001253	0,001301	0,001055	0,00106	0,000629
mar-09	0,00059	0,000384	0,000331	0,001377	0,005317	0,001124	0,001259	0,000765
jun-09	0,000627	0,000704	0,000396	0,001926	0,005203	0,003804	0,001492	0,001133
sep-09	0,000587	0,000524	0,000594	0,002283	0,004797	0,003533	0,001314	0,001072
dec-09	0,000468	0,000767	0,001313	0,002568	0,004019	0,003554	0,001269	0,001231
mar-10	0,000375	0,000383	0,001811	0,002193	0,001712	0,002771	0,000887	0,000892

2008	Coefficient	T-stat	SHB	Coefficient	T-stat	SEB	Coefficient	T-stat	SWB	Coefficient	T-stat	Nordea	Coefficient	T-stat
cllevel_1	0,606	11,88	i1	-0,00002	-0,06	i3	0,00046	1,23	i2	0,00021	0,57			
			q1	-0,00031	-0,85	q1	-0,00031	-0,85	q1	-0,00031	-0,85	q1	-0,00031	-0,85
			q2	-0,00007	-0,18	q2	-0,00007	-0,18	q2	-0,00007	-0,18	q2	-0,00007	-0,18
			q3	-0,00027	-0,72	q3	-0,00027	-0,72	q3	-0,00027	-0,72	q3	-0,00027	-0,72
			cons	0,00044	-1,25	cons	0,00044	-1,25	cons	0,00044	-1,25	cons	0,00044	-1,25
R2	0,3774													

A.6 Calculations of the banks' CLL underlying the graphical illustrations

Figure 7: The third forecasting period 2nd quarter 2009 to 1st quarter 2010

Time series:

Macro variables						CLLs							
						SHB		SEB		SWB		Nordea	
	gdpgap	cpi	tbill	realexr	oilprice	Actual	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast
jun-08	*3,13*	*3,80*	*4,1*	*122,80*	*121,9*	*-0,00005*		*0,00027*		*0,00010*		*-0,00012*	
sep-08	*2,79*	*4,3*	*4,3*	*125,1*	*115,1*	*0,00017*		*0,00061*		*0,00066*		*0,00033*	
dec-08	*-1,66*	*2,5*	*2,8*	*137,3*	*55,0*	*0,00048*		*0,00136*		*0,00128*		*0,00110*	
mar-09	*-5,03*	*0,8*	*0,9*	*144,6*	*44,5*	*0,00060*		*0,00183*		*0,00533*		*0,00128*	
jun-09	-4,70	-0,4	0,4	141,1	58,9	0,00062	-0,06283	0,00272	-0,00786	0,00522	0,00085	0,00150	-0,00155
sep-09	-4,74	-1,1	0,2	135,1	68,3	0,00058	-0,06546	0,00266	2,54543	0,00486	0,00115	0,00128	-0,00141
dec-09	-4,71	-0,4	0,2	133,5	74,7	0,00047	-0,06304	0,00264	-0,00575	0,00395	-0,00056	0,00127	0,00025
mar-10	-3,70	1,0	0,2	130,3	76,3	0,00037	-0,06037	0,00161	0,00122	0,00176	-0,00084	0,00088	0,00086

2009

SHB	Coefficient	T-stat
q1	-0,00026	-3,22
q2	-0,00013	-1,66
q3	-0,00011	-1,40
con	-0,00275	-3,27
cll_1	0,34601	5,43
tbill_1	0,00026	2,96
realexr1	-0,00003	2,85
tbill_2	-0,00021	-1,31
oilprice_2	0,00001	4,45
realexr2	-0,00042	-2,72
tbill_3	0,00019	1,89
realexr3	0,00003	2,61
gdpgap_4	-0,00013	-4,63
R2	0,9464	

SEB	Coefficient	T-stat
q1	-0,00051	-0,68
q2	-0,00047	-0,62
q3	-0,00031	-0,41
con	0,02059	2,39
cll_1	-0,00482	-0,04
cpi_1	0,00127	3,17
tbill_2	0,00222	2,97
realexr_2	-0,00017	-2,45
cpi_3	-0,00199	-3,75
tbill_3	-0,00229	-3,10
gdpgap_4	-0,00081	-4,18
cpi_4	0,00228	4,68
R2	0,5980	

SWB	Coefficient	T-stat
q1	0,00043	1,48
q2	0,00020	0,67
q3	0,00041	1,40
con	-0,00065	-1,89
cll_1	-0,01861	-0,21
cpi_1	-0,00022	-1,05
tbill_1	0,00029	0,80
cpi_2	0,00039	2,09
tbill_2	-0,00069	-1,12
tbill_3	0,00049	1,40
gdpgap_4	0,00007	0,96
R2	0,0772	

Nordea	Coefficient	T-stat
q1	0,00047	1,74
q2	0,00035	1,29
q3	0,00051	1,84
con	-0,00484	-2,09
cll_1	-0,08061	-1,00
realexr_1	0,00004	1,95
oilprice_2	0,00003	1,92
cpi_4	0,00031	3,66
oilprice_4	-0,00004	-2,14
R2	0,2116	

Panel data:

Macro variables						CLLs							
						SHB		SEB		SWB		Nordea	
	gdpgap	cpi	tbill	realexr	oilprice	Actual	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast
jun-08	*3,13*	*3,80*	*4,1*	*122,80*	*121,9*	*-0,00005*		*0,00027*		*0,00010*		*-0,00012*	
sep-08	*2,79*	*4,3*	*4,3*	*125,1*	*115,1*	*0,00017*		*0,00061*		*0,00066*		*0,00033*	
dec-08	*-1,66*	*2,5*	*2,8*	*137,3*	*55,0*	*0,00048*		*0,00136*		*0,00128*		*0,00110*	
mar-09	*-5,03*	*0,8*	*0,9*	*144,6*	*44,5*	*0,00060*		*0,00183*		*0,00533*		*0,00128*	
jun-09	-4,70	-0,4	0,4	141,1	58,9	0,00063	0,00310	0,00272	0,00403	0,00522	0,00426	0,00150	0,00306
sep-09	-4,74	-1,1	0,2	135,1	68,3	0,00059	0,00462	0,00266	0,00571	0,00486	0,00576	0,00128	0,00462
dec-09	-4,71	-0,4	0,2	133,5	74,7	0,00047	0,00278	0,00264	0,00388	0,00395	0,00385	0,00127	0,00276
mar-10	-3,70	1,0	0,2	130,3	76,3	0,00038	0,00277	0,00161	0,00400	0,00176	0,00384	0,00088	0,00288

2009

	Coefficient	Std dev	Impact	T-stat
cllevel_1	0,18500	0,003	0,0005	3,07
gdpgap_1	0,00008	2,126652	0,0002	0,62
gdpgap_2	-0,00049	2,128046	-0,0010	-3,65
cpi_1	-0,00013	1,351978	-0,0002	-0,81
cpi_3	-0,00022	1,345864	-0,0003	-1,22
cpi_4	0,00034	1,34144	0,0005	2,13
tbill_1	0,00042	2,146661	0,0009	2,56
tbill_2	-0,00013	2,148705	-0,0003	-0,97
oilprice_1	0,00001	29,9372	0,0002	0,60
oilprice_4	0,00003	28,43707	0,0010	4,71
realexr_3	-0,00006	5,839717	-0,0004	-2,01
realexr_4	0,00007	5,85023	0,0004	2,09
R2	0,5984			

SHB	Coefficient	Std dev	Impact	T-stat
i1	0,00016	0,43385	0,00007	0,56
q1	0,00007	0,44032	0,00003	0,24
q2	-0,00005	0,43160	-0,00002	-0,16
q3	-0,00019	0,43160	-0,00008	-0,69
cons	-0,00273			-0,77

SEB	Coefficient	Std dev	Impact	T-stat
i3	0,00086	0,43385	0,00037	3,05
q1	0,00007	0,44032	0,00003	0,24
q2	-0,00005	0,43160	-0,00002	-0,16
q3	-0,00019	0,43160	-0,00008	-0,69
cons	-0,00273			-0,77

SWB	Coefficient	Std dev	Impact	T-stat
i2	0,00045	0,43385	0,00019	1,63
q1	0,00007	0,44032	0,00003	0,24
q2	-0,00005	0,43160	-0,00002	-0,16
q3	-0,00019	0,43160	-0,00008	-0,69
cons	-0,00273			-0,77

Nordea	Coefficient	Std dev	Impact	T-stat
q1	0,00007	0,44032	0,00003	0,24
q2	-0,00005	0,43160	-0,00002	-0,16
q3	-0,00019	0,43160	-0,00008	-0,69
cons	-0,00273			-0,77

Time series AR(1):

	CLLs							
	SHB		SEB		SWB		Nordea	
	Actual	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast
jun-08	*0,00043*		*0,0004016*		*0,0004*		*0,0001*	
sep-08	*0,00017*		*0,0006127*		*0,0007*		*0,0003*	
dec-08	*0,00048*		*0,0013616*		*0,0013*		*0,0011*	
mar-09	*0,00060*		*0,0018256*		*0,0053*		*0,0013*	
jun-09	0,00062	0,000618	0,002721	0,0018	0,0052	0,0048	0,0015	0,001393
sep-09	0,00058	0,000610	0,0026558	0,0025	0,0049	0,0046	0,0013	0,000648
dec-09	0,00047	0,000723	0,0026392	0,0031	0,0039	0,0043	0,0013	0,000823
mar-10	0,00037	0,000044	0,0016106	0,0011	0,0018	0,0034	0,0009	0,000671

2009																
SHB		Coefficient	T-stat	**SEB**		Coefficient	T-stat	**SWB**		Coefficient	T-stat	**Nordea**		Coefficient	T-stat
	q1	-0,00053	-3,85		q1	-0,00174	-1,73		q1	-0,00013	-0,18		q1	-0,00013	-0,18
	q2	-0,00011	-0,81		q2	-0,00076	-0,76		q2	0,00044	0,61		q2	0,00044	0,61
	q3	-0,00017	-1,23		q3	-0,00063	-0,63		q3	-0,00027	-0,37		q3	-0,00027	-0,37
	con	0,00022	2,18		con	0,00142	1,94		con	0,00037	0,71		con	0,00037	0,71
	cll_1	0,87514	30,95		cll_1	0,58170	5,85		cll_1	0,37106	3,18		cll_1	0,37106	3,18
	R2	**0,9387**			**R2**	**0,3365**			**R2**	**0,1002**			**R2**	**0,1002**	

Panel data AR(1):

CLLs	**SHB**		**SEB**		**SWB**		**Nordea**	
	Actual	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast
jun-08	*-0,00005*		*0,00027*		*0,00010*		*-0,00012*	
sep-08	*0,00017*		*0,00061*		*0,00066*		*0,00033*	
dec-08	*0,00048*		*0,00136*		*0,00128*		*0,00110*	
mar-09	*0,00060*		*0,00183*		*0,00533*		*0,00128*	
jun-09	0,00063	0,00068	0,000396	0,001189	0,005203	0,003955	0,001492	0,001126
sep-09	0,00059	0,00051	0,000594	0,001584	0,004797	0,003694	0,001314	0,001084
dec-09	0,00047	0,00077	0,001313	0,001889	0,004019	0,003724	0,001269	0,001259
mar-10	0,00038	0,00038	0,001811	0,00151	0,001712	0,002917	0,000887	0,000917

2009																		
	Coefficient	T-stat	**SHB**		Coefficient	T-stat	**SEB**		Coefficient	T-stat	**SWB**		Coefficient	T-stat	**Nordea**		Coefficient	T-stat
cllevel_1	0,633	13,16		i1	-0,00003	-0,08		i3	0,00049	1,23		i2	0,00026	-0,77				
				q1	-0,00031	-0,93		q1	-0,00033	-0,93		q1	-0,00033	-0,93		q1	-0,00033	-0,93
				q2	-0,00010	-0,29		q2	-0,00006	-0,29		q2	-0,00006	-0,29		q2	-0,00006	-0,29
				q3	-0,00029	-0,84		q3	-0,00028	-0,84		q3	-0,00028	-0,84		q3	-0,00028	-0,84
				cons	0,00043	1,33		cons	0,00047	1,33		cons	0,00047	1,33		cons	0,00047	1,33
R2	0,4110																	

A.6 RMSE formula

$$RMSE = \sqrt{\frac{1}{t}\sum_{t=12}^{Q2\ 2007}\left(CLL_t^{forecast} - CLL_t^{actual}\right)^2}$$