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Credit risk versus capital requirements under Basel II: are SME loans and retail credit really different?

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Abstract

The new Basel II regulation contains a number of new regulatory features. Most importantly, internal ratings will be given a central role in the evaluation of the riskiness of bank loans. Another novelty is that retail credit and loans to small and medium-sized enterprises will receive a special treatment in recognition of the fact that the riskiness of such exposure derives to a greater extent from idiosyncratic risk and much less from common factor risk. Much of the work done on the differences between the risk properties of retail, SME and corporate credit has been based on parameterized models of credit risk. In this paper we present new quantitative evidence on the implied credit loss distributions for two Swedish banks using a non-parametric Monte Carlo re-sampling method following Carey [1998]. Our results are based on a panel data set containing both loan and internal rating data from the banks' complete business loan portfolios over the period 1997-2000. We compute the credit loss distributions that each rating system implies and compare the required economic capital implied by these loss distributions with the regulatory capital under Basel II. By exploiting the fact that a subset of all businesses in the sample is rated by both banks, we can generate loss distributions for SME, retail and corporate credit portfolios with a constant risk profile. Our findings suggest that a special treatment for retail credit and SME loans may not be justified. We also investigate if any alternative definition of SME's and retail credit would warrant different risk weight functions for these types of exposure. Our results indicate that it may be difficult to find a simple risk weight function that can account for the differences in portfolio risk properties between banks and asset types.

Key words: Internal ratings, credit risk, Value-at-Risk, banks, Basel II, retail credit, SME, risk weights.

JEL codes: C14, C15, G21, G28, G33.

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1 Introduction

Although non-financial corporate debt (bond issues and privately issued debt) has become more common in the past 10-20 years, bank loans are still the prime source of business finance, especially for small and medium-sized enterprises (SMEs). As a consequence, banks' ex-ante assessment of the riskiness of loan applicants and the resulting decision to grant credit (or not) at some risk-adjusted interest rate, is of great importance for businesses. Bank regulators increasingly lean on the risk assessments made by banks: in the Basel Committee's proposal for new capital adequacy rules, the so called Basel II Accord [5], internal risk ratings produced by banks have been given a prominent role.[1] Unlike previous regulation, the rules of Basel II will make the size of the required buffer capital contingent on a bank's appraisal of ex-ante *individual* counterpart risk. It will be up to each bank to characterize the riskiness of the counterparts and loans in its portfolio by means of a relatively small number of risk categories or "rating classes". A special feature of the new regulation is that retail credit and loans to SMEs will receive a different treatment than corporate loans and will require less regulatory capital for given default probabilities. The main reason for this differential treatment is the supposedly low correlation between small business loans. Their risk is generally thought to be largely of an idiosyncratic nature.

The Basel proposal has been criticized extensively because of its implications. Altman and Saunders [4] found that relying on traditional agency ratings may produce cyclically lagging rather than leading capital requirements and that the risk based bucketing proposal lacks a sufficient degree of granularity. Among other things, they advise to use a risk weighting system that more closely resembles the actual loss experience on loans. Criticism like this has spurred subsequent research by authors like Carling, Jacobson, Lindé and Roszbach [11], Dietsch and Petey [14], Estrella [16], Calem and LaCour-Little [7], and Hamerle, Liebig, and Rösch [19]. Their work employs credit risk models for the ultimate goal of calculating capital requirements under a variety of alternative systems. It makes clear how the proposed internal ratings based (IRB) approach relates to general Value-at-Risk (VaR) models of credit risk and state-of-the-art risk rating and how the technical specification of the final IRB design will affect banks' policies.

To what extent a different treatment of retail credit and SME loans is justified will depend on at least two factors: the ability of banks' internal risk rating systems to adequately capture the differences between different loans and different types of assets, and the methods used to calculate the relevant risk measure. Several authors have studied the ability of internal ratings (IR) systems to handle differences between (portfolios of) assets and the implications for credit risk measurement and the eventual functioning of Basel II. Gordy [18] shows that IRB bucket models of credit can be reconciled with the general class of credit Value-at-Risk (VaR) models. Carey [9] concludes that the success of the IRB approach will depend on the extent to which it will take into account differences in assets and portfolio characteristics, such as granularity, risk properties and remaining maturities. Jacobson, Lindé and Roszbach [22] find that IRB parameters such as the target forecasting horizon, the method to estimate average probabilities of default (PDs) and banks´ business cycle sensitivity will also affect the way in which the IRB system can function. Carey and Hrycay [10] study the effect of internal risk rating systems on estimated portfolio credit risk and find that some of the commonly used methods to estimate average probabilities of default (PDs) by

[1] Basel II is organized around three so-called pillars, with the first pillar describing the rules for determination of the required buffer capital for banks [5]. The 1988 Accord and its impact on bank behaviour is reviewed in Jackson et al.[20].

rating class are potentially subject to bias, instability and gaming. Jacobson, Lindé and Roszbach [23] investigate the consistency of internal ratings at two major Swedish banks. They find that loan size and portfolio size are very important determinants of the shape of credit loss distributions and that the banks differ significantly in their perception of an identical loan portfolio's riskiness.

Differences between corporate loans and both SME and retail credit have been the subject of range of studies. A large part of the literature has focused on the special character of small business lending and the importance of relationship banking for solving information asymmetries. Cole [12], for example, finds empirical support for the theory that banking relationships generate valuable private information about borrower quality. Degryse and Ongena [13] report evidence that confirms the importance of geographical distance for monitoring (costs). In more recent work, Petersen and Rajan [26] find that firms with long distances to their lenders, typically SMEs, no longer need to be the highest quality counterparts, indicating that they have obtained greater access to credit. In response to the work of the Basel Committee, a number of authors has looked more explicitly into the differences in risk properties between credit types. A range of currently available methods to measure retail credit risk is surveyed by Allen, DeLong and Saunders [1]. Schmit [27] studies retail lease portfolios by means of a Monte Carlo resampling method and finds that the Basel II framework insufficiently recognizes collateral. Perli and Nayda [25] model future margin income and show that the capital ratios generated by the Basel formula are matched best by the ratios that their model implies for low risk portfolio segments. Their results suggest some inadequacies in the Basel framework. Capital ratios for high risk segments can, for example, sometimes be lower than for low risk segments. They also indicate that the Basel II assumptions about the interaction between asset correlations and the probability of default may be inaccurate, especially at the extreme ends of the risk spectrum. With respect to SME loan portfolios, Dietsch and Petey [14] propose two parametric methods for estimating credit risk. They establish, when applying these methods, that actual capital requirements are significantly lower than those derived under Basel II. They [15] also find that SMEs are riskier than large businesses and that PDs and asset correlations are not negatively, as assumed by Basel II, but positively related to each other. Glennon and Nigro [17] analyze small business repayment behavior on SBA loans and determine that default characteristics can vary widely within the SME segment, depending on the original maturity of the loan.

This paper joins the literature investigating the assumed differences between SME, retail and corporate credit, but takes a different avenue. Using data from two major Swedish banks´ complete business loan portfolios over the period 1997Q1 - 2000Q1, we explore not only if the retail and SME definitions employed in the Basel documents justifies the use of more favorable risk weights for these types of credit, but also if any other definition would do so. For this purpose, we present empirical evidence on the credit loss distributions and the implied IRB capital requirements for both SME, retail and corporate loan portfolios, using different thresholds for total sales and total credit exposure to define the SME and retail segments. The very large number of loan spells in each loan portfolio allows us to apply a non-parametric Monte Carlo resampling method as in Carey [8], thereby guaranteeing robust results.[2]

The organization of the remainder of this paper is as follows. First, in Section 2, we begin with a characterization of the two banks' business loan portfolios and their internal rating systems. Section 3 outlines how retail and SME credit will be treated under the new Basel Accord. Section 4 contains the

[2]The loan portfolios contain 180,000 and 300,000 loan spells respectively. During the sample period, the two banks represent approximately 40% of the Swedish market for business loans.

implied credit loss distributions of corporate, SME and retail credit portfolios. Here we also display both banks´ IRB capital requirements. Section 5 concludes the paper.

2 Data

This section provides a detailed description of the data that we use in Sections 3 and 4. The primary sources of our data are two of the four major Swedish commercial banks and the leading credit bureau in Sweden, Upplysningscentralen AB (UC). For bank A, the data set is a panel consisting of 338,118 observations on bank counterparts, covering 13 quarters of data on all 39,521 Swedish *aktiebolag* companies that had one or several loans outstanding at the bank on the last day of at least one quarter between January 1, 1997, and March 31, 2000. For bank B we have 183,392 observations on 20,966 *aktiebolag* between January 1, 1997, and June 30, 2000. *Aktiebolag* are by approximation the Swedish equivalent of US corporations and UK limited businesses. Swedish law requires every *aktiebolag* to have at least SEK 100.000 (approximately US $ 10,000) of equity, to be eligible for registration at the Swedish Patent and Registration Office (PRV). Although we have annual report data on small firms such as general partnerships, limited partnerships and sole proprietors, these will be disregarded because we could not dispose of the relevant credit histories. Observe, however, that a large part of the sample still consists of relatively small enterprises: respectively 65% and 53% of the banks' observations concern businesses with 5 or fewer employees. During the overlapping sample period, from January 1, 1997 until March 31, 2000, 2,880 of these businesses simultaneously have one or more loans in both banks for at least one quarter. This results in 17,476 "overlapping" spells, making the average overlap duration just over six quarters.

Both banks have supplied a full history of internal credit related data for all debtors, including the unique, government provided, company identification number. By means of the latter, we have been able to match the banks' data with UC's database, that contains quarterly updated official annual report data and payment remarks information on all Swedish companies. The annual accounting data is collected by UC from PRV, to which firms are required to submit their annual report, and includes all typical balance sheet and income statement data, such as turnover, inventories, short and long term debt, total assets and a range of earnings related variables. Payment remarks data are reported by banks and other businesses and stored by UC and comprise information on the events related to the remarks and payment behavior for both the company and its principals. The data provided by UC has different frequencies, varying from daily for payment remarks to annually for accounting data. We will discuss the specifics of both data sources in greater detail below.[3]

Both banks are general commercial banks, with a nationwide branch network serving both private and business customers; neither of them is known to have any widely known specialization profile within these groups. To verify this, we converted the various types of credit into three broader groups, also used by the banks for certain analytical purposes: short term, medium term and long term lending. Of all counterparts at bank A (B) 69 (71) percent have short term loans and 72 (68) percent have a long term or some other type of loan.[4] Having multiple loans is quite common too: about 30 percent of A's and

[3] A complete list with all available variables is provided in the appendices of Jacobson, Lindé and Roszbach [23].

[4] Due to different granularities in the banks' classification systems, it is difficult to make detailed comparisons beyond short term loans.

Table 1: Profile of companies in bank loan portfolios: average credit line per industry and their relative importance in terms of counterparts and total credit outstanding, N_A=323,671, N_B=176,985.

Industry	C´parts (%)		Total credit (%)		Av. credit line (SEK mn.)	
	A	B	A	B	A	B
Agriculture & fishing	3.08	3.06	0.6	0.6	1.427	2.188
Forestry & paper	1.20	2.34	2.6	4.3	14.900	20.800
Electro	1.16	1.10	2.3	0.6	13.400	6.368
Chemical	0.54	0.48	2.6	0.7	32.800	17.400
Energy & water	0.34	0.78	3.6	5.0	71.000	73.000
Construction	9.80	8.21	3.5	3.6	2.423	4.956
Other manufacturing	13.55	15.54	20.2	8.8	10.079	6.473
Wholesale trade	17.73	19.61	10.1	9.9	3.848	5.717
Retail trade	9.64	9.23	3.1	2.4	2.143	2.903
Hotel & restaurant	2.51	2.49	0.8	0.8	2.229	3.870
Transport	6.95	7.52	4.8	4.4	4.653	6.591
Telecom	0.11	0.12	0.2	1.1	14.600	105.000
Finance	1.48	1.20	10.8	8.6	49.200	81.600
Real estate	6.62	13.79	26.33	33.1	26.900	27.300
Other services	22.35	13.18	7.94	15.8	2.401	13.623
Government & health	2.94	1.34	0.4	0.3	1.019	2.288

B's counterparts have both a short term loan and at least one other loan. The average censored duration of a firm's presence in the bank portfolio is 8.6 (8.7) quarters. On average, bank A's and B's portfolio have a size of SEK 168.4 bn. and 143.7 bn. and contain 24,895 and 12,642 counterparts respectively. A thus typically grants its counterparts 40% smaller loans than B: 6.76 mn. kronor on average compared with 11.37 mn. for B. Still, despite this apparent difference, Table 1 shows that the banks are quite similar in many respects. Agriculture, forestry, electrochemical industries, energy and water, construction, wholesale, retail, hotel and restaurants, and transport, for example, have very similar shares in the banks' portfolios, both in terms of counterparts and most of them also in terms of total exposure. In terms of client numbers, other services, wholesale trade and other manufacturing are the three greatest customer groups in bank A: in bank B it is real estate, wholesale trade and other manufacturing.[5,6] Together, they account for about 50 percent of all customers. Other industries with large groups of counterparts are other services (13,2% of all counterparts in B), construction (9.8 and 8.2% respectively), retail trade (9.6 and 9.2%) and transport (7.0% for A). For each bank, approximately three out of four counterparts come from one of these six industries. Despite the apparent similarities between bank A and B, there are also a number of differences to speak of, mainly related to the variation in the size of average credit lines between industries, both within each bank and between banks. The most significant differences between the banks occur in telecom, finance, the chemical industry and other services. In telecom, bank A grants on average a little less than SEK 15 mn. while bank B has an average exposure of SEK 105 mn. To financial and other services companies, bank A furnishes on average SEK 49.2 and

[5] Real estate business includes, among other things, the exploitation of land, trade in real estate, intermediation, rental and management of both commercial and private real estate and tenant-owners associations.

[6] Broadly, other services is composed of three main groups: business, publicly and personally oriented service companies. The first consists mainly of computer and software consultancy, R&D and all other remaining business service companies, including law firms, accountants and (non-computer) consultants. The second comprises cleaning, waste management and special interest organizations. The last group includes, apart from any other services that most people regularly purchase, artistic professions, radio, tv, museums and leisure activities.

Table 2: Profile of companies in bank loan portfolios: debtors split up according to employee number, credit line size and total sales (in percentage shares), N_A=323,671, N_B=176,985.

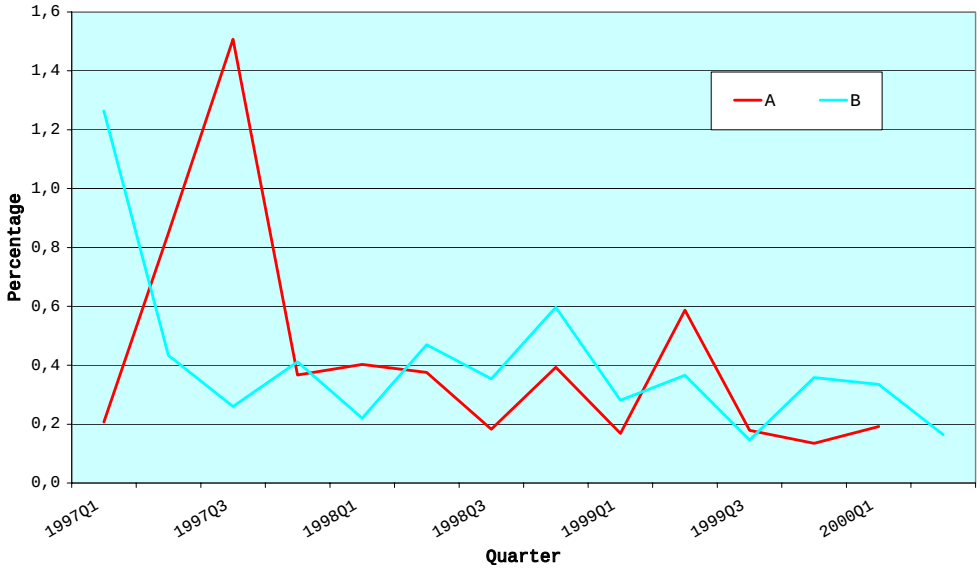
No. employees	A	B	Granted credit (SEK)	A	B	Total sales (SEK mn.)	A	B
0	11.07	14.32	0-50k	13.65	2.37	<.5	12.36	8.10
1	16.72	9.38	50k-100k	13.27	2.24	.5-1	11.00	6.67
2-5	37.67	29.79	100k-250k	19.85	6.53	1-2	15.67	10.56
6-25	24.42	32.46	250k-500k	15.71	12.17	2-3	9.52	8.10
26-50	4.27	6.65	0.5mn-1mn	11.20	20.52	3-4	6.36	6.63
51-100	2.54	3.86	1mn-2,5mn	10.76	23.80	4-5	4.74	5.43
101-250	1.83	2.26	2,5mn-5mn	5.75	12.68	5-7.5	8.08	9.80
250-1000	1.07	0.90	5mn-10mn	3.82	7.97	7.5-10	4.83	6.40
>1000	0.41	0.38	10mn-1bn	5.91	11.59	10-25	12.04	17.17
	100.00	100.00	1bn-	0.08	0.13	25-50	5.63	8.12
				100.00	100.00	50-100	3.76	5.57
						100-250	2.97	4.44
						250-1000	2.07	2.12
						>1000	0.97	0.89
							100.00	100.00

2.4 mn respectively, compared with 81.6 and 13.6 mn. by B. In the chemical industry, A is a provider of larger loans, with on average SEK 32,8 mn. (17,4 mn. at B). Industries that have big loans in both banks are energy & water businesses and real estate services. The former category of debtors receives on average SEK 71 mn. at bank A (SEK 73 mn. at B) to while the latter gets SEK 27 mn. at both banks. The banks have in common that the least significant debtors come from agriculture & fishing, government & health, retail trade and hotel and restaurants, with average loans ranging between SEK 1.0 and 3.9 mn. Because other industries with comparable or larger average loan sizes contain relatively few counterparts, both banks have on average the biggest exposure in real estate, with portfolio shares of 26 and 33 percent. Otherwise bank A is relatively overrepresented in manufacturing, with a 20.2 percent share (8.8 percent for B). Wholesale trade, finance and 'other services' are other important debtor groups for both banks, with loan portfolio shares of close to 10 percent. B has a somewhat bigger involvement in 'other services': 15,8 percent.

Table 2 offers some more perspective on the composition of the banks' portfolios in terms of counterpart size. Both grant an important part of their loans to small and medium sized enterprises: of all counterparts, 65 percent at A and 55 percent at B have 5 or fewer employees; A is somewhat better represented among businesses with 1-5 employees.[7] Only 6-7 percent of all counterparts at both A and B have more than 25 employees. The third column of Table 2 supports our first impression of A being slightly more specialized in small businesses: approximately 40 percent of all its counterparts have sales under SEK 2 mn. and 25 percent even stay below SEK 1 mn., compared to 25 and 15 percent at B. Obviously, B has a larger presence among firms with higher sales; close to 40 percent have revenues over SEK 10 mn. whereas only 25 percent at A do so. Only two percent of each bank's counterparts does not

[7] Companies without any employees are either owner-run businesses or holding/finance units within a larger concern. Although we believe the number of holding/finance units to be small, we are not able to verify this in our data. For the purpose of our analysis, this distinction is not of importance, however, because we select businesses by means of their total turnover or total credit facility.

Figure 1: Quarterly default rates for counterparts in complete portfolios of banks A and B.



classify as an SME according to the Basel definition.[8] In terms of total credit exposure, the non-SMEs are significant enough, though, due to the size of their credit lines: at bank A they represent about 35 percent of total credit, while they stand for just over 20 percent at bank B.

Table 2 also reveals that not only the average but also the median size of credit lines varies between banks, implying that differences not only occur at the tails of the distribution. In bank A the median credit line has a size between SEK 250k and SEK 500k, quite a bit below its average of SEK 6.76 mn., while bank B has a median credit facility between SEK 1 mn. and SEK 2.5 mn., somewhat closer to its average of SEK 11.37 mn. Although it is difficult to identify a single explanation, one can point out some differences. Bank A is strongly represented in the loan size segment up to SEK 1mn., while more than 50 percent of the counterparts in bank B has a total exposure over SEK 1 mn.; only about 10 percent of its loans stays under than SEK 250,000. Overall, bank B has a greater share of its counterparts in industries with larger credit lines, such as real estate, energy & water, and forestry & paper, and in addition lends more to some businesses than A does, for example in telecom and other services. If we employ the Basel definition of "other retail exposure", approximately 94 percent of all counterparts in bank A and about 88 percent in bank B could potentially qualify as retail exposure. The "corporate" exposure, however, represents the bulk of each bank's loan portfolio: 88 percent in A and 86 percent in B.

Figures 1 and 2 provide us with some further insight into the counterparts of both banks. Figure 1 summarizes the available information on default behavior among counterparts in each bank's business loan portfolio. Although the sample period covers only thirteen quarters, the default rates display quite some fluctuation over time. In Bank A defaults reach their maximum rate in the third quarter of 1997 at a level of 1.51%. In bank B the sample peak is reached two quarters earlier, at 1.26%. It should be noted though that a likely cause of the severity of both peaks, beside the general slump in business that occurred in 1997, can be found in the aftermath of the Swedish real estate crisis in the early 1990's.

[8] Total sales below EUR 50 mn, which corresponds to approximately SEK 450 mn.

The ensuing recession struck the Swedish economy during the first half and middle of the 1990's, but its overall peak came off in 1991-92 and was accompanied by a full banking crisis. In 1992 the Swedish government granted a non-bankruptcy guarantee to all banks and founded a national banking emergency authority. Bad loan portfolios of banks that were in risk of collapse were taken over and managed by this authority. It is not unlikely that the short 1997 recession lead to the default of a number of businesses that had been in trouble since the early 1990's but not at immediate risk of collapse. From 1998 onwards the quarterly default rates of both banks move up and down more or less synchronously, at levels between 0.6 and 0.1 percent, but differentials of about 0.2% occur in about half of the remaining quarters.

The data set from the credit bureau contains all typical balance sheet and income statement information.[9] In addition to the annual report data collected by PRV, we have information on the firms' track records regarding credit and tax related payment behavior. Broadly, remarks belong to one of two categories: non-payment remarks or bank remarks.[10] In practice, with a record of non-payment remarks individuals will not be granted any new loans and small businesses will find it very difficult to open new lines of credit. The second type of remarks provide information on firms' payment behavior at banks. All Swedish banks participate in this scheme and report any abuse of a bank account or a credit card and slow loans (repayment is considered questionable) to the credit bureau, that maintains these records. Whereas a bank remark may have the same consequences as having a non-payment remark, this is not the case in general. Their effect on individual applications for credit presumably works mainly through the accumulation of negative indicators.[11]

Both institutions maintain an internal credit rating scheme. Bank A requires each business customer to be assigned to one of 15 credit rating classes, while B uses 7 classes. At A, rating class 1 represents the highest credit quality and class 15 stands for the lowest credit quality (factual default) with the intermediate grades intended to imply a monotonically increasing risk profile. Bank B has the most creditworthy counterparts in rating class 1 and the least creditworthy ones in class 7.[12] Two conditions must be satisfied for a counterpart to be assigned to the default category. First, payments on the principal or interest must be at least 60 days overdue. Second, a bank official needs to make a judgement and conclude that any such payment is unlikely to occur in the future. A comparison with data from the credit bureau (not shown here) shows that ratings A15 and B7 are both highly correlated with (the officially registered) bankruptcy. Generally the rating class leads the latter by one or more quarters, most likely due to the length of legal procedures that have to be completed before bankruptcy is officially invoked. In the remainder of this paper, when talking about a default, we will refer to the above definition by the banks: a loan that is assigned to rating class 15 in bank A or class 7 in B.

The assignment of an internal rating to a new loan, or the re-evaluation of a counterparty rating is performed according to a set of quantitative and qualitative criteria. There are two quantitative measures. First, the credit bureau UC provides an external rating that reflects the assessment of counterparty

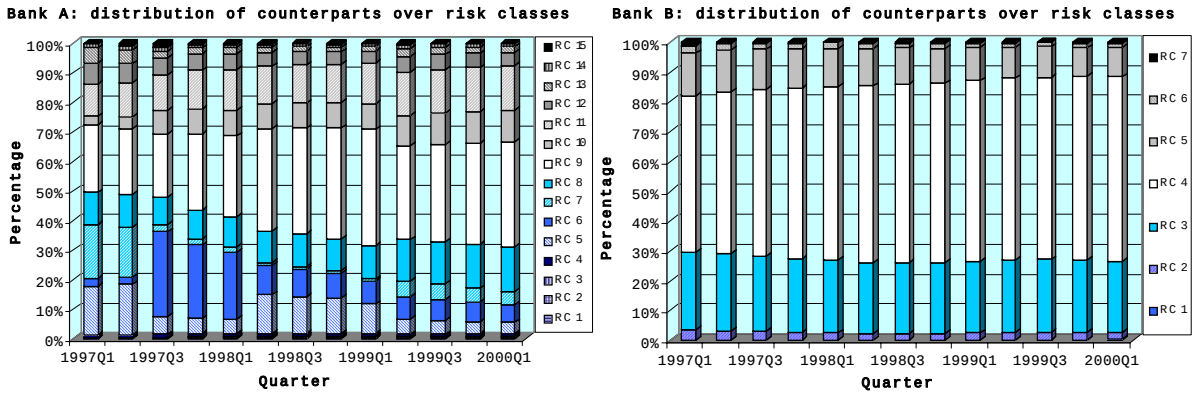
[9] Here too, we refer to Jacobson et al. [23] for a complete list with all variables available from the credit bureau.

[10] Storage and usage of the first group are regulated by the Credit Information Act, the Personal Data Act and overseen by the Swedish Data Inspection Board. Examples of events that are registered are: delays in tax payments, the repossession of delivered goods, seizure of property, resettlement of loans and actual bankruptcy. Storage and usage of Bank remarks is regulated merely by the Personal Data Act.

[11] Appendix C in Jacobson et al. [23] contains a complete list of the non-payment and bank remarks.

[12] The original system of bank B had the best counterparts in class 7 and the worst in 1. For the sake of consistency and simplicity, we transformed these ratings so that both banks have the best loans in grade 1, with creditworthiness falling as the rating class increases.

Figure 2: Distribution of debtors over risk classes in the complete portfolios of banks A and B.



bankruptcy risk over the next 8 quarters. This rating is calculated using information available from the tax authorities, PRV and credit remark data.[13] Second, the banks estimate the probability of default by means of models that use both the information available from UC internal information as inputs. Our understanding is that these models have been inspired by the Z-score model of Altman [2], the Zeta model of Altman, Haldeman and Narayanan [3] and the KMV model [24]. Bank A maps these probabilities of default into a rating class scheme such that the classes should mimic the ratings of Moody's and Standard & Poor's. The qualitative criteria are summarized in counterparty rating classification handbooks.[14] Credit ratings are updated at least once every 12 months.

Figure 3 shows how the counterparts in the complete portfolios were distributed over all rating grades. A number of characteristics are worth mentioning. First, both banks appear to allocate a large share of debtors to one risk class. Over the sample period, A has between 20 and 40 percent of all counterparts in class 9, while B has 50-60 percent in rating class 4. To a large extent, this phenomenon reflects the fact that new loans generally enter the system in these two classes. Given the inertia in risk ratings, this automatically creates a concentration in the "entrance" class. More generally, counterparts tend to be confined to a subset of the available grades: between 95 and 99 percent is located in 9 (3) classes in bank A (B). In both banks the relative importance of each class varies quite a bit over time, although the pattern is simpler and clearer in bank B due to the smaller number of grades. The aggregated effect of these composition changes on the riskiness of the portfolios is difficult to determine, however, without a weighting scheme for the loans in each rating class.[15,16] For more details about the complete data set, we refer to Jacobson, Lindé and Roszbach [23].

[13] For details and an evaluation of their model based approach, see Jacobson and Lindé [21].

[14] The handbook provides so called verbal definitions (descriptions) of the properties of firms in a given rating class along a number of dimensions. The criteria are not weighted according to some *formal* scoring procedure in the rating decision. Ultimately, a so called credit committee aggregates all information and decides to what class a counterpart is assigned. Jacobson et al. [22] contains a description of the essentials of bank A's handbook characterization of the rating classes.

[15] Carling et al. [11] do evaluate the effect of counterpart migrations on aggregate risk, by calculating VaR with a credit risk model.

[16] These changes will not affect our results here as long as we can rely on stable transition patterns into the default class. In our Monte Carlo draws, we only use the probability that a counterpart in risk class i defaults within time horizon s.

3 The Basel II treatment of retail and SME credit

In the new Basel regulatory framework, each counterpart will be assigned an internal risk rating by its bank. Each risk grade will be associated with a specific risk weight such that the product of the relative risk weight, the exposure and the eight percent absolute capital requirement, summed over all asset types and all loans will yield the bank's minimum regulatory buffer capital. Risk weights can be determined along two routes under the new rules. One way is to follow a "standardized approach", designed to be implementable for all banks. Under this approach, a portfolio of bank loans is characterized by (a relatively small number of) risk categories and the risk weight associated with each category is based on an external rating institution's evaluation of counterpart risk. The other route is to adopt the, more elaborate, IRB approach, that makes further use of the information collected and processed in the bank's internal counterpart risk rating operations. The current proposal allows banks to apply the IRB-approach at two different levels of sophistication. The "foundation" only requires the bank to provide estimates of PD for each rating grade, while the "advanced" approach also requires internally generated inputs on loss given default (LGD) rates and exposure at default (EAD).

Under the IRB approach, banks must categorize banking-book exposures into five broad classes of assets with different underlying risk characteristics: corporate, sovereign, bank, retail and equity. Within the corporate and retail classes, five and three subclasses, respectively, are separately identified.[17] Corporate exposure and retail exposure thus receive a different treatment, and within the corporate category loans to SMEs get a favorable treatment. For each asset type, the IRB methodology contains three key elements: the estimated risk factors, the mapping of risk factors into risk weights, and a set of minimum requirements that must be met in order for a bank to use the IRB method. For corporate, sovereign and banks exposures both a foundation and an advanced approach exists. Under the former approach, banks provide their own estimates of PD and rely on supervisory estimates for other risk components, while under the latter the banks supply internal estimates for all risk components. For retail exposure there is no distinction between the foundation and the advanced approach.

For all corporate exposure i, the relevant risk weight is:

$$\begin{aligned} RW_i = \quad & LGD_i \times N\left[(1-\rho_i)^{-.5}.N^{inv}\left[PD_i\right] + \sqrt{\left(\tfrac{\rho_i}{1-\rho_i}\right)}.N^{inv}\left[.999\right]\right] \times \\ & \times \left(1-1.5\mu_i\right)^{-1} \times \left(1+\mu_i\left(M_i-2.5\right)\right) \end{aligned} \tag{1}$$

where $N\left[.\right]$ is the standard Normal distribution PD_i is the probability of default, LGD the loss-given-default rate (both measured as decimals), M the effective maturity, and ρ_i the "correlation" coefficient, an adjustment factor defined as

$$\rho_i = \quad .12 \times \left(\tfrac{1-e^{-50\times PD_i}}{1-e^{-50}}\right) + .24 \times \left(1 - \left(\tfrac{1-e^{-50\times PD_i}}{1-e^{-50}}\right)\right) \tag{2}$$

The "maturity" adjustment factor μ_i is defined as

$$\mu_i = \left(.08451 - .05898\ln\left(PD_i\right)\right)^2 \tag{3}$$

In calculating the capital ratio (CR), the denominator (total risk weighted assets, RWA) will be determined by multiplying the risk weight for market and operational risk by 12.5 (=1/.08). The definition

[17] For corporate exposure the categories are: income-producing real estate IPRE), high-volatility commercial real estate (HVCRE), project (PF), object (OF) and commodity finance (CF). For retail exposure, they are residential property-backed loans, revolving loans and "other" retail loans.

of eligible regulatory capital (the numerator) is unchanged from the 1998 Accord. The risk-weighted assets that result then become

$$RWA_i = 12.5 \times RW_i \times E_i \tag{4}$$

where E_i is the size of exposure type i.

In addition to the earlier mentioned special treatment of retail exposures, loans to small and medium-sized corporate borrowers (SMEs) will also undergo a more favorable regimen.[18] To take into account that such counterparts carry more idiosyncratic risk, a size-adjustment factor is added to the correlation coefficient for SMEs with annual sales below EUR 50 mn.:

$$\rho_i^{SME} = \rho_i - .04 \times \left(1 - \frac{S_i - 5}{45}\right) \tag{5}$$

where $S_i = \max[5, S_i^*]$ and S_i^* represents total annual sales in millions of euros.

Banks that have chosen the IRB methodology will be using internal data to estimate the risk parameters. Nevertheless, they are obliged to use a minimum probability of default of 0.03 percent if the one-year PD associated with the borrower's internal risk grade falls below this lower bound, so that

$$PD_i = \max\left\{0.0003, PD_i^{internal,\ 1\ year}\right\} \tag{6}$$

where $PD_i^{internal,\ 1\ year}$ is the average one-year historical cumulative default frequency obtained from the bank's internal rating data. Unlike the way in which the probability of default is calculated, the method a bank should use to calculate the loss-given-default depends on whether it has chosen the "foundation" or the "advanced" IRB approach. Under the foundation approach senior claims not secured by recognized collateral carry a 45% LGD compared with 75% for subordinated loans.[19]

Within the category retail credit, three different types of exposures exist in the current proposal, each with its own risk weight functions: one for residential mortgage exposures, one for qualifying revolving retail exposures and a third for other retail exposures. Typical for the retail formulas is that they automatically impose a maximum capital requirement equal to the LGD value, and that none of them contains an explicit maturity adjustment.

Exposure is defined as retail if it meets all of the following criteria:

1. Exposure to natural persons is typically eligible for retail treatment irrespective of the size of the credit. Typical examples are revolving credits, leases, car loans, study loans, in principle regardless of the size of the exposure. For definitional purposes, regulators may set a formal threshold, in order to have an objective boundary between retail and corporate.

2. Residential mortgage loans to owner-occupiers and small condominium - or cooperative residential housing units in a single building or complex.

[18] Defined as businesses that have consolidated group sales of less than EUR 50 mn. If sales are not considered a meaningful measure of firm size, then supervisors may allow banks to replace total sales by total assets.

[19] It is at national discretion to set a 35% LGD rate for mortgages on office and/or multi-purpose/tenant premises or to employ a broader definition of subordination. Collateral is taken into account in a way that closely follows the comprehensive method under the standardized approach. To be allowed to apply the advanced approach a bank must satisfy a number of minimum requirements, mostly concerning the quality of their internal loss rate data. The most important ones are that: (i) the estimate should be a long-term (also called default weighted) average, not an average of mean annual loss rates and (ii) the minimum data observation period should be at least seven years (five years for retail exposure). Exposure types for which the LGD fluctuates over the business cycle should be assigned a LGD that is typical for economic downturns.

3. Loans to small businesses that are managed in its internal risk management systems as retail, provided the total banking group's exposure (or on a consolidated basis where applicable) does not exceed EUR 1 mn. Small business loans extended through or guaranteed by an individual are subject to the same exposure threshold. Such loans must have originated in a similar manner as other retail exposures and should not be managed in a way comparable to corporate exposures. Rather, it should be managed as part of a portfolio segment or pool of exposures with similar risk characteristics. However, this does not preclude retail exposures from being treated individually at some stages of the risk management process!

4. The exposure must be one of a large pool of exposures that are managed by the bank on a pooled basis. Supervisors may determine a minimum number of exposures for a pool to be recognized as such.

Supervisors are expected to be flexible in the practical application of these thresholds, so that banks are not forced to develop extensive new information systems, simply for the purpose of ensuring perfect compliance. For a subportfolio to be treated as a *qualifying revolving retail exposure*, it must in addition satisfy all of the following criteria:

5 The exposures are revolving, unsecured, and uncommitted (both practically and contractually). That is: exposures fluctuate based on clients' decision to borrow and repay up to a contractual limit.

6 The borrower is an individual.

7 The maximum credit to a single individual is EUR 100,000.

8 The bank can demonstrate that the subportfolio exhibits a high ratio of future margin income (FMI) to expected losses. In general $FMI \geq \mu_{loss} + 2\sigma_{loss}$, where μ_{loss} and σ_{loss} are the mean and standard deviation of the credit loss distribution, should be satisfied approximately for an annual horizon.[20]

9 Data on loss rates and margin income must be retained for the subportfolio to allow for an evaluation.

10 The supervisor must agree that the treatment as a qualifying revolving retail exposure is consistent with the underlying risk characteristics of the subportfolio.

Because we only work with business loans in this paper, we restrict our discussion to "other retail exposure". For all "other retail exposure" risk weights will be assigned on the basis of equation (1), assuming yet another correlation, namely

$$\rho_i = .02 \times \left(\frac{1-e^{-35\times PD_i}}{1-e^{-35}}\right) + .17 \times \left(1 - \left(\frac{1-e^{-35\times PD_i}}{1-e^{-35}}\right)\right) \tag{7}$$

[20] FMI is defined as the amount of income, anticipated to be generated by the relevant exposures over the next 12 months, that can reasonably be assumed to be available to cover for potential credit losses, after covering for normal business expenses. It does not include income anticipated from new accounts. Assumptions regarding changes in the expected balances must be in line with historical experience, even taking into account the effect of anticipated business conditions.

The requirements for calculation of the various risk components for retail exposure are broadly the same as for non-retail exposure. Among other things, PD_i has a minimum level of .03 percent for each rating class:

$$PD_i = \max\left\{0.0003, PD_i^{internal,\ 1\ year}\right\} \tag{8}$$

4 Results

In this section, we investigate the properties of both banks' credit loss distributions, as calculated with a Monte Carlo resampling method. Our main interest is to investigate if the differential treatment of "other retail" credit and SME loans under the new Basel rules is justified by the actual loss distributions in our data. For this purpose we look at the loss distributions of SME loans, retail credit and corporate loans when we apply the Basel definitions and verify if our findings would change if one alters the definitions of what constitutes an SME loan or a retail credit. The insights from these experiments can help us to understand if the "simple" risk mapping functions, that large banking corporations should apply under the Basel Committee's new rules, will be able to adequately capture the actual (differences in the) riskiness of loan portfolios and thus provide regulators with a correct and consistent picture of banks' loan portfolio credit risk.

4.1 Methodology

The sampling method that we use to estimate the portfolio loss distributions is a non-parametric Monte Carlo method that closely follows the approach of Carey [8]. By using this method we avoid the parametric assumptions about the form that many frequently used portfolio credit risk models use.[21] The most frequently made assumption is to postulate a common factor structure for the correlations between assets. Due to a lack of data, many assumptions about the correlation structure, that are incorporated in portfolio credit risk models - but also in the Basel II framework - remain untested. The approach used here keeps clear of such conjectures.

The selection of the data is done as follows. First, we set the definition of SME (or retail) exposure. In the experiments with SME loans, we use nine different threshold values for a counterpart's (average) total sales to split up the data set. For each threshold value, businesses with sales below the critical sales will be defined as SME exposure and those with sales above the critical value are treated as corporate exposure. In the retail case, we employ six different thresholds for the bank's (average) total exposure to a counterpart to split up the data set into retail (firms with total exposure below the threshold) and corporate credit (firms with exposure above the threshold).

Next, for one of the two subsamples that we have created, we store, for each counterpart in each bank, the company number, the date (quarter t) of the observation, the loan size at t and the risk rating at t.

Then, we determine for each observation present at date t if it is still present in the portfolio at quarter t+h, where h is the forecast horizon that we want to apply. If it is still present and has not defaulted, we store the rating class at t+h. If the company is still present but has defaulted, we store the actual exposure and a default indicator. If the company is missing at t+h, we verify if it defaulted at any of the dates between t and t+h. If it defaulted, we store the actual exposure at the date of default

[21] A notable exception is Schmit [27].

and a default indicator. For companies that were present at t+h, we also verify if they did not exit from the portfolio or defaulted at any intermediate quarter. Loans that defaulted at an intermediate date but returned before or at date t+h are registered as a default - not with the rating with which they re-enter or have at t+h. We assume that the banks are likely to incur at least some losses on such defaulting counterparts and then continue the relationship, most likely at renegotiated terms.[22] Firms that exited at an intermediate date but returned before or at t+h, are considered not to have transited and therefore disregarded. For our experiments, this implies that we ignore any possible effect that exiting behavior may have on credit risk. However, since we are unable to determine the causes of the exit (voluntary exit by a healthy company or, for example, a forced exit of a potentially bad loan), we prefer to abstract from this effect.

After repeating this for all quarters that are at least h quarters away from the last quarter of the sample period, T, we obtain T-h data matrices, one for each quarter 1, 2, ... T-h. Each such data matrix contains four variables for each counterpart: the credit exposure and the corresponding risk rating, if any, at time t and, if any, at t+h. Counterparts that were absent at one of these two points in time, or any intermediate quarter, have zero entries.

Although our prime goal is to evaluate the treatment of SME and retail credit under the Basel II regulation, our experiments will implicitly include an evaluation of the banks' rating systems' ability to correctly classify counterparts. To avoid comparing portfolios with different levels of risk, one would prefer to have a benchmark loan portfolio that should be considered equally risky by both banks. Because our data includes 17,476 overlapping loan spells, we can construct such a benchmark portfolio by calculating, for each possible risk grade, the percentage share of total exposure that the loans (in the overlapping portfolio) in a grade represent. We will call this the "standard" portfolio profile. We use the average size of the banks' loan portfolio as the standard portfolio size.

Once we have determined the number of portfolios that we need to generate to obtain a loss distribution that has converged, we can start drawing observations from the dataset. For our purpose, 10,000 portfolios turned out to be adequate.[23] Resampling then occurs according to the following steps. Before anything else, we impose two conditions when sampling. First, to avoid that portfolio loss rates display "abnormal" outliers, we restrict any loan to make up at a maximum of three percent of the total portfolio. Second, we do not to sample any observations from a rating class if it contains fewer than 15 observations at that specific date to make sure that no single loans ends up making up a big part of a portfolio because it is repeatedly drawn "to fill the class" with enough loans. Next we randomly draw a date. This determines from which quarter we will be sampling. By separating quarters, we avoid that drawing outcomes from both good and bad times for one portfolio evens out the calculated credit losses. Although our 13 quarters of data do not cover a full business cycle, Figure 1 shows that there is quite some variation in the default rate within this period. Still, our results should not be seen as representative for a full business cycle. Then we draw loans from the rating classes in the respective bank's full (not only the overlapping) credit portfolio according to the proportions of the "standard" portfolio, until the desired portfolio size is attained. Losses are then calculated as the sum of all exposures at *the date of default* to counterparts

[22] Had we disposed of data on actual losses, then this effect would have been captured by the loss given default (LGD) rate.

[23] By converging, we mean here that the estimated percentiles do not change more than marginally when increasing the number of portfolios generated.

that defaulted between t and t+h.[24] The full loss distribution is obtained by sorting the percentage loss rates according to size. A percentile is obtained by picking out the $(nrpf * percentile/100)th$ observation from the loss distribution, where $nrpf$ is the number of simulated portfolios. For further details, we refer to Carey [8] and Jacobson et al. [23].

4.2 Loss distributions, economic capital and required IRB capital

If the proposed treatment of SME and retail credit in the Basel II regulation is justified, then we should observe that the loss rates for some specified percentile of the loss distribution is smaller for these asset types than for corporate exposure. The underlying idea is that defaults among SMEs are more weakly correlated than among corporates. In general, defaults among bigger companies are thought to be primarily caused by systematic risk factors, while defaults by smaller businesses are considered to be driven by idiosyncratic risk factors (see for example Carey [8]).

The currently available text of the new Basel Accord still considers regulatory capital to be a buffer against total credit losses. In November 2003, however, it was proposed that the Accord be modified such that regulatory capital only protects banks against unexpected loan losses. Expected losses may well be higher for SME and retail credit than for corporate loans, but it is thought that lenders will be compensated for higher expected risk by means of a higher price (interest rate) and provision for expected losses by means of loan-loss reserves. However, even unexpected losses, due to the supposedly lower default correlation, are expected to be smaller for SME and retail credit portfolios than for corporate loan portfolios.[25] This in its turn would justify smaller regulatory risk weights. Because no adjusted risk weight functions have been published yet, the discussion in this paper will focus on the regulatory capital's ability to match the percentiles of the loss distributions. If the Accord is indeed revised, then the focus should instead shift to the match between regulatory capital and unexpected losses.

Our approach here is twofold. First, we generate the credit loss distributions for retail, SME and corporate credit portfolios, and calculate the required economic capital implied by these distributions. Significant differences between the percentiles of the loss distributions and the regulatory Basel II capital should be indicative of an inability of the Basel risk weight function to represent (a relevant percentile of) banks' loss distributions. Second, we verify for what, if any, definitions of SMEs and retail credit the supposed presence of a lower correlation and concomitant smaller tail losses for SME and retail credit is supported by our data.

4.2.1 SME loans

Tables 3 and 4 show the mean loss rate and a range of percentiles of the credit loss distributions, for bank A and bank B respectively, when the borrowers are split up into SMEs and corporates using nine different threshold values of total sales. The last two columns contain (i) the mean regulatory capital

[24] We thus assume a zero recovery rate in the computation of Value-at-Risk. When calculating the required regulatory capital, we adopt the 45 percent LGD rate that Basel II prescribes for unsecured senior claims.

[25] The estimated amount of capital needed by a bank to support its risk taking activities is generally termed required or allocated economic capital. The economic capital is thought to be chosen such that the probability of unexpected credit losses exceeding the economic capital (the probability of insolvency) stays below some preferred level. The probability of insolvency is typically selected in a way that gives a bank the credit rating it desires. Expected losses should be provided for by a bank's loan loss reserves, not by economic capital.

Table 3: A comparison of simulated portfolio loss rates and IRB capital requirement ratios for corporate and SME loan portfolios in bank A for varying definitions of SME's .
Table shows the mean and various percentiles of the loss distribution and the capital ratio required under Basel II for bank A when the total sales threshold, by which SME's are defined, is varied from the SEK .5 mn up to SEK 450 mn. Risk profiles are maintained constant. The Basel SME definition requires total sales below EUR 50 mn., approx. SEK 450 mn. The forecast horizon is 4 quarters.

Portfolio characteristics												
Total sales threshold (mn SEK)	Business type	Simulated portfolio loss rates at loss distribution percentiles									IRB capital requirement	
		mean	90	95	97.5	99	99.5	99.75	99.9	99.99	mean	90
.5	SME	1.81	5.02	5.39	5.65	5.95	6.16	6.31	6.46	6.69	6.19	10.94
.5	*Corporate*	*0.29*	*0.38*	*0.41*	*0.44*	*0.47*	*0.49*	*0.51*	*0.54*	*0.58*	*4.51*	*5.21*
1.0	SME	1.57	4.05	4.41	4.67	4.96	5.13	5.26	5.42	5.61	6.07	9.85
1.0	*Corporate*	*0.29*	*0.38*	*0.40*	*0.43*	*0.46*	*0.48*	*0.49*	*0.51*	*0.52*	*4.43*	*4.95*
2.5	SME	1.09	2.78	3.15	3.37	3.56	3.71	3.82	4.02	4.22	5.22	8.31
2.5	*Corporate*	*0.27*	*0.35*	*0.38*	*0.40*	*0.43*	*0.46*	*0.48*	*0.51*	*0.58*	*4.49*	*4.99*
5.0	SME	0.92	2.08	2.3	2.46	2.62	2.72	2.84	2.95	3.19	5.13	8.09
5.0	*Corporate*	*0.25*	*0.34*	*0.37*	*0.4*	*0.44*	*0.47*	*0.48*	*0.52*	*0.58*	*4.29*	*4.55*
10	SME	0.60	1.02	1.15	1.24	1.35	1.40	1.48	1.55	1.65	4.48	6.36
10	*Corporate*	*0.22*	*0.30*	*0.34*	*0.37*	*0.41*	*0.43*	*0.46*	*0.48*	*0.53*	*4.23*	*4.44*
25	SME	0.53	0.82	0.91	0.97	1.05	1.10	1.14	1.18	1.21	4.37	6.06
25	*Corporate*	*0.18*	*0.29*	*0.33*	*0.36*	*0.41*	*0.44*	*0.48*	*0.52*	*0.61*	*3.80*	*4.25*
50	SME	0.48	0.63	0.68	0.73	0.78	0.82	0.85	0.9	0.97	4.13	5.36
50	*Corporate*	*0.12*	*0.21*	*0.26*	*0.31*	*0.37*	*0.41*	*0.46*	*0.49*	*0.53*	*3.22*	*3.59*
100	SME	0.42	0.54	0.59	0.62	0.67	0.70	0.73	0.76	0.81	4.10	5.16
100	*Corporate*	*0.09*	*0.21*	*0.26*	*0.29*	*0.34*	*0.38*	*0.44*	*0.51*	*0.55*	*2.41*	*3.38*
450	SME	0.35	0.43	0.46	0.48	0.52	0.54	0.56	0.59	0.64	4.23	5.30
450	*Corporate*	*0.03*	*0.06*	*0.08*	*0.09*	*0.11*	*0.12*	*0.13*	*0.14*	*0.16*	*2.06*	*3.32*

requirement as a share of the loan portfolio and (ii) the 90th percentile of the capital requirement distribution corresponding to the loan portfolios that were generated to compute the credit loss distributions. In most empirical work investigating the impact of the new Basel Accord on capital requirements, one has sufficed with calculating the mean capital ratio. Calculating the full distribution of capital requirements gives us a better estimator of the regulatory capital requirement and, in addition, a measure of the uncertainty in a point estimate of regulatory capital, due to stochastic variation in the default rate. For reasons of tractability and because the shape of the risk weight mapping causes the higher percentiles to close track the 90th percentile, we do not show higher percentiles.

If we start with the loss distributions that result if we employ Basel II's actual SME definition, total sales below than SEK 450 mn. (approximately EUR 50 mn.), Table 3 shows that, despite the construction of a constant risk profile (in terms of rating classes), the SME portfolio is actually riskier than the corporate portfolio in both expected and unexpected terms. Expected losses are more than ten times greater for SMEs than they are for corporates. If one would consider 0.05 an acceptable probability of insolvency for the bank, then "unexpected" credit losses and thus the required economic capital are 0.19 (=0.54-0.35) for SME loans and 0.09 (=0.12-0.03) for corporates. But the SME portfolio generates bigger expected and unexpected losses than the corporate portfolio, even if we define SMEs by means of a threshold for total sales between SEK .5 and 100 mn.. The general impression that Table 3 conveys is that the smaller the average firm in the SME portfolio is, the larger do both the expected and the

Table 4: A comparison of simulated portfolio loss rates and IRB capital requirement ratios for corporate and SME loan portfolios in bank B for varying definitions of SME's .

Table shows the mean and various percentiles of the loss distribution and the capital ratio required under Basel II for bank B when the total sales threshold, by which SME's are defined, is varied from the SEK .5 mn up to SEK 450 mn. Risk profiles are maintained constant. The Basel SME definition requires total sales below EUR 50 mn., approx. SEK 450 mn. The forecast horizon is 4 quarters.

Portfolio characteristics												
Total sales threshold	Business	Simulated portfolio loss rates at loss distribution percentiles									IRB capital requirement	
(mn SEK)	type	mean	90	95	97.5	99	99.5	99.75	99.9	99.99	mean	90
.5	SME	1.20	1.61	1.76	1.84	1.89	1.93	1.96	2.01	2.06	5.99	8.72
.5	*Corporate*	*0.27*	*0.41*	*0.47*	*0.51*	*0.56*	*0.59*	*0.62*	*0.67*	*0.72*	*4.00*	*4.61*
1.0	SME	0.75	1.03	1.12	1.16	1.21	1.24	1.28	1.30	1.34	5.03	7.20
1.0	*Corporate*	*0.28*	*0.43*	*0.48*	*0.52*	*0.58*	*0.60*	*0.64*	*0.67*	*0.69*	*4.06*	*4.71*
2.5	SME	0.51	0.80	0.83	0.86	0.88	0.89	0.91	0.93	0.96	4.12	6.23
2.5	*Corporate*	*0.27*	*0.43*	*0.49*	*0.53*	*0.58*	*0.62*	*0.66*	*0.67*	*0.71*	*3.95*	*4.63*
5.0	SME	0.36	0.43	0.45	0.47	0.49	0.50	0.51	0.53	0.54	3.72	4.21
5.0	*Corporate*	*0.29*	*0.46*	*0.52*	*0.56*	*0.61*	*0.65*	*0.69*	*0.73*	*0.77*	*3.84*	*4.59*
10	SME	0.32	0.39	0.41	0.43	0.45	0.47	0.48	0.49	0.52	3.53	3.95
10	*Corporate*	*0.29*	*0.49*	*0.55*	*0.61*	*0.67*	*0.71*	*0.74*	*0.79*	*0.86*	*3.90*	*4.45*
25	SME	0.30	0.36	0.38	0.40	0.41	0.43	0.44	0.45	0.47	3.56	4.00
25	*Corporate*	*0.30*	*0.54*	*0.61*	*0.67*	*0.75*	*0.80*	*0.85*	*0.89*	*0.95*	*3.53*	*4.05*
50	SME	0.32	0.40	0.42	0.45	0.48	0.49	0.51	0.53	0.57	3.51	4.04
50	*Corporate*	*0.28*	*0.53*	*0.59*	*0.65*	*0.70*	*0.74*	*0.77*	*0.82*	*0.93*	*3.04*	*4.68*
100	SME	0.32	0.41	0.45	0.48	0.52	0.54	0.57	0.60	0.64	3.58	4.12
100	*Corporate*	*0.14*	*0.52*	*0.62*	*0.69*	*0.77*	*0.82*	*0.86*	*0.90*	*0.99*	*2.87*	*5.70*
450	SME	0.32	0.48	0.54	0.59	0.64	0.68	0.70	0.75	0.79	3.72	4.22
450	*Corporate*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*	*1.18*	*1.18*

unexpected SME portfolio loss rates become.[26] Table 4, with the results for bank B, offers a somewhat different picture. As before, SME loans always produce bigger expected losses. However, for thresholds within the 5 - 100 mn. kronor interval, SME loans do generate smaller loss rates and unexpected losses than corporate loans, and thus require less economic capital. If one excludes all businesses with total sales over SEK 2.5 mn. from the SME category, then the inequality reverses again and SME loans lead to higher loss rates and greater unexpected losses than corporates.

A comparison of implied loss rates with the corresponding regulatory capital points out a number of properties of the risk weight mappings.[27] First, both the SME and the corporate risk weight mappings capture the broad movements in portfolio credit risk. Generally, higher loss rates (and a higher required economic capital) are accompanied by higher regulatory capital requirements. However, equal levels of credit risk can well be associated with significantly different levels of regulatory capital. For example, in Table 3 the corporate portfolios generated with thresholds of SEK 25 mn. and SEK 50 mn. have very similar loss rates at most percentiles, but their Basel capital requirement differs by 0.58 percent points.

[26] Due to the fact that smaller firms are underrepresented in the best rating grades, the SME portfolios generated with thresholds between SEK 0.5 mn. and SEK 5.0 mn. have a greater share of counterparts with higher risk grades. Although the size of expected and unexpected loss are still correct in this range, one cannot ascribe the increase in portfolio loss rates, that occurs when we reduce the total sales threshold, exclusively to the "SME" factor. Tables A1-A4 in the appendix contain the exact portfoliocompositions.

[27] Regulatory capital is calculated using one-year cumulative PD´s. The LGD rate is set at 45 percent, Basel II's rate for unsecured senior claims.

Table 5: A comparison of simulated portfolio loss rates and IRB capital requirement ratios for corporate and "other retail" loan portfolios in bank A for varying definitions of retail credit.
Table shows the mean and various percentiles of the loss distribution and the capital ratio required under Basel II for bank A when the total credit threshold, by which retail credit is defined, is varied from SEK .25 mn to SEK 10 mn. Risk profiles are kept constant. The Basel definition of "other retail" credit requires an exposure below EUR 1 mn., approx. SEK 9 mn. Forecast horizon is 4 quarters.

Portfolio characteristics												
Total sales threshold	Business	Simulated portfolio loss rates at loss distribution percentiles									IRB capital requirement	
(mn SEK)	type	mean	90	95	97.5	99	99.5	99.75	99.9	99.99	mean	90
.25	Retail	1.22	2.47	2.50	2.51	2.52	2.53	2.53	2.54	2.55	3.44	5.70
.25	*Corporate*	*0.31*	*0.41*	*0.45*	*0.47*	*0.51*	*0.53*	*0.56*	*0.58*	*0.60*	*4.48*	*4.74*
.5	Retail	1.03	1.99	2.02	2.04	2.05	2.06	2.07	2.07	2.09	2.99	5.39
.5	*Corporate*	*0.30*	*0.41*	*0.44*	*0.47*	*0.51*	*0.53*	*0.55*	*0.58*	*0.63*	*4.42*	*4.58*
1	Retail	0.98	1.64	1.69	1.71	1.72	1.74	1.74	1.75	1.77	2.79	4.21
1	*Corporate*	*0.29*	*0.39*	*0.42*	*0.45*	*0.48*	*0.51*	*0.54*	*0.57*	*0.62*	*4.30*	*4.48*
2.5	Retail	0.84	1.38	1.42	1.45	1.47	1.48	1.50	1.51	1.53	2.58	3.56
2.5	*Corporate*	*0.26*	*0.35*	*0.38*	*0.41*	*0.44*	*0.47*	*0.50*	*0.53*	*0.58*	*4.13*	*4.37*
5	Retail	0.80	1.22	1.27	1.30	1.32	1.34	1.35	1.37	1.39	2.54	3.45
5	*Corporate*	*0.22*	*0.32*	*0.36*	*0.38*	*0.43*	*0.45*	*0.47*	*0.50*	*0.52*	*3.94*	*4.45*
10	Retail	0.72	0.96	1.03	1.06	1.08	1.10	1.11	1.12	1.14	2.45	3.20
10	*Corporate*	*0.15*	*0.24*	*0.27*	*0.30*	*0.34*	*0.36*	*0.39*	*0.42*	*0.46*	*3.18*	*3.91*

Second, if the SME risk weight function is at all able to capture actual credit losses, then it appears to be best at doing so for the very smallest enterprises. Especially in the range close to the definition used by the Basel document, the risk weight function seems to require much larger capital ratios than what is indicated by the loss distributions. Third, our results indicate that the probability of a match between the regulatory and the economic capital requirement will be highly dependent on bank specific portfolio properties and the choice of other parameters, such as the definition of an SME.

4.2.2 Retail credit

In Section 3, it was mentioned that, under certain conditions, loans to business with a total exposure of less than EUR 1 mn. can be treated as "other retail" credit. In the experiments in this section, we abstract from the other conditions, such as the internal risk system by which the loans are managed, and focus exclusively on the size of the exposure.

Tables 5 and 6 contain summary statistics of the credit loss distributions for bank A and bank B derived when the loans are split up into retail and corporate credit by means of six different threshold values for total counterparty exposure. As in the preceding tables, the last two columns contain (i) the mean regulatory capital requirement as a share of the loan portfolio and (ii) the 90th percentile of the capital requirement distribution corresponding to the generated loan portfolios. Table 5 makes clear that, independent of the way in which it is defined, retail credit is characterized by higher loss rates and both bigger expected and unexpected losses than corporate loans, independent of the relevant level of insolvency risk that one considers. In bank B, however, the retail loans do, to some extent, exhibit the expected behavior: they experience higher expected losses but smaller unexpected losses than the corporate portfolio, due to the slimmer tails of the retail loss distributions. These characteristics are invariant to the chosen definition. For bank A, the capital requirements implied by the Basel risk weight

Table 6: A comparison of simulated portfolio loss rates and IRB capital requirement ratios for corporate and "other retail" loan portfolios in bank B for varying definitions of retail credit.
Table shows the mean and various percentiles of the loss distribution and the capital ratio required under Basel II for bank B when the total credit threshold, by which retail credit is defined, is varied from SEK .25 mn to SEK 10 mn. Risk profiles are kept constant. The Basel definition of "other retail" credit requires an exposure below EUR 1 mn., approx. SEK 9 mn. Forecast horizon is 4 quarters.

Portfolio characteristics												
Total sales threshold	Business	Simulated portfolio loss rates at loss distribution percentiles									IRB capital requirement	
(mn SEK)	type	mean	90	95	97.5	99	99.5	99.75	99.9	99.99	mean	90
.25	Retail	0,63	0.91	0.92	0.93	0.93	0.94	0.94	0.95	0.96	1,65	2.19
.25	*Corporate*	*0,29*	*0.44*	*0.48*	*0.53*	*0.58*	*0.61*	*0.64*	*0.67*	*0.72*	*4,19*	*4.69*
.5	Retail	0.78	1.09	1.11	1.12	1.13	1.13	1.14	1.15	1.16	2.24	2.90
.5	*Corporate*	*0.29*	*0.43*	*0.48*	*0.52*	*0.56*	*0.59*	*0.62*	*0.66*	*0.71*	*4.09*	*4.66*
1	Retail	0.65	0.73	0.75	0.76	0.77	0.77	0.78	0.79	0.79	2.08	2.38
1	*Corporate*	*0.28*	*0.43*	*0.48*	*0.52*	*0.57*	*0.60*	*0.64*	*0.68*	*0.72*	*3.97*	*4.56*
2.5	Retail	0.57	0.66	0.68	0.69	0.70	0.71	0.71	0.72	0.73	2.06	2.39
2.5	*Corporate*	*0.27*	*0.44*	*0.50*	*0.54*	*0.59*	*0.63*	*0.67*	*0.70*	*0.73*	*3.77*	*4.87*
5	Retail	0.54	0.66	0.69	0.71	0.73	0.74	0.75	0.76	0.78	2.14	2.61
5	*Corporate*	*0.25*	*0.44*	*0.49*	*0.54*	*0.59*	*0.63*	*0.65*	*0.69*	*0.76*	*3.42*	*4.24*
10	Retail	0.52	0.59	0.61	0.63	0.65	0.67	0.68	0.69	0.71	2.17	2.56
10	*Corporate*	*0.22*	*0.43*	*0.50*	*0.55*	*0.61*	*0.65*	*0.69*	*0.75*	*0.79*	*2.82*	*4,00*

mapping for "other retail" exposure track the movements in the loss rates and unexpected losses reasonably well. For example, if we consider the 99.5th percentile of the loss distribution (or the corresponding unexpected losses) as we move from SEK 10 mn. towards the SEK 0.25 mn. threshold, the retail loss rate increases by 1.40 percent to 2.53 percent, while the corresponding average regulatory capital ratio rises by 1.00 percent to 3.44 percent. However, despite being less risky than the retail credit, the corporate portfolio requires a higher capital ratio. For bank B nearly the same holds and the corporate loan portfolios require more capital despite being equally or even less risky than the retail portfolios.

5 Summary and conclusions

This work is one of the few pieces of a small literature that takes the hypotheses about properties of SME and retail credit to the data. We employ data from two Swedish banks' on business loan portfolios to investigate the assumption in the Basel II regulation that SME and retail loan portfolios display smaller (unexpected) loss rates than corporate loan portfolios due to a lesser dependence on systematic risk factors. The results presented here indicate that there is no evidence that SME loan portfolios are consistently less risky, or require less economic capital, than corporate loan portfolios. We do find that changes in the definition of SMEs, in terms of total sales, sometimes lead to the finding that SME loan portfolios are associated with smaller (unexpected) loss rates. However, this finding is highly dependent on the SME definition chosen, bank specific, and likely to be sensitive to the size of the portfolio. Moreover, the Basel II risk weight function appears to be only modestly successful in matching the actual loss rates derived from our calculations. Similar results were found for retail credit.

Our findings thus grant little support to the idea of using a "simple" risk weight mapping, as in the Basel II framework, to approximate the actual credit risk exposure or economic capital requirement for

a large variety of differentiated banks. Related work by Jacobson et al. [23] has already shown that banks can have different perceptions of the riskiness of a portfolio with identical counterparts and how important portfolio size is for credit risk and economic capital requirements. Our results show that using "simple" risk weight mappings may create large inequalities between banks, due to (i) differences in the shape of loss distributions between banks, and (ii) between asset types. However, since a relatively simple mapping of probabilities of default (together with maturity and loss-given-default) into credit losses, can only match one percentile or moment of a loss distribution, our results should not be surprising.

Our conclusions require a number of reservations. Firstly, the experiments in this paper implicitly also mean a test of the banks' counterparty risk rating abilities. If, for example, the banks' loan officers do explicitly take firm size into account in their ratings, then this would affect our results because businesses with a certain size would be overrepresented in some rating classes. Secondly, we were not always able to perfectly match the "standard" portfolio risk profile, thereby somewhat limiting the generality of our findings. Thirdly, our data does not include a full business cycle, thereby limiting the variation in our default variable and our ability to calculate through-the-cycle PDs. The Basel Accord requires PDs to be calculated with at least 5 years of data. Through the curvature of the risk weight function, calculating risk weights based on average PDs over the business cycle could affect the size of the regulatory capital ratio. However, we believe it is unlikely that our results would have changed qualitatively, had we added the years 2001-2003, with relatively low default and loss rates.

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A Appendix

In this appendix we provide exact information on the risk profiles of the simulated portfolios. Because counterparts of certain sizes, in terms of total sales or total exposure, may be over - or under represented in certain rating classes, simulated portfolios that impose a specific risk profile can fail to satisfy the exact profile of the "standard" portfolio. In the simulations for bank B this occurs only in the SME calculations with thresholds of SEK .5 mn. and SEK 1.0 mn. For bank A the problem occurs more frequently, due to the finer grid of the ratings system. For the SME calculations, all portfolios generated with total sales thresholds up to SEK 5 mn. generate substantial deviations from the "standard" risk profile. The retail portfolio risk profiles generally match the standard profile reasonably well, possibly with some reservation for those generated with thresholds of SEK .25 mn. and SEK .50 mn.

Table A1: True rating class distributions and simulated rating class distributions for bank A.
Table shows what share of a portfolio is composed of counterparts from a specific rating class when the total sales threshold, by which SMEs are defined, is varied from the SEK .5 mn up to SEK 450 mn. The rating class shares shown here correspond to the portfolios shown in Table 3 in the paper.

Portfolio characteristics															
Total sales threshold (mn SEK)	Business type	Portfolio share of each rating class													
		RC1	RC2	RC3	RC4	RC5	RC6	RC7	RC8	RC9	RC10	RC11	RC12	RC13	RC14
Complete portfolio		0.01	0.07	0.11	0.16	0.06	0.14	0.06	0.05	0.17	0.07	0.05	0.03	0.01	0.01
.5	SME	0.00	0.00	0.00	0.08	0.09	0.21	0.05	0.07	0.25	0.10	0.07	0.04	0.02	0.01
.5	*Corporate*	*0.01*	*0.07*	*0.12*	*0.16*	*0.06*	*0.14*	*0.06*	*0.05*	*0.17*	*0.07*	*0.05*	*0.03*	*0.02*	*0.01*
1.0	SME	0.00	0.00	0.00	0.08	0.09	0.21	0.05	0.07	0.25	0.10	0.07	0.04	0.02	0.01
1.0	*Corporate*	*0.01*	*0.07*	*0.12*	*0.16*	*0.06*	*0.14*	*0.06*	*0.05*	*0.17*	*0.07*	*0.05*	*0.03*	*0.02*	*0.01*
2.5	SME	0.00	0.00	0.00	0.12	0.08	0.19	0.08	0.07	0.23	0.10	0.06	0.04	0.02	0.01
2.5	*Corporate*	*0.01*	*0.07*	*0.12*	*0.16*	*0.06*	*0.14*	*0.06*	*0.05*	*0.17*	*0.07*	*0.05*	*0.03*	*0.02*	*0.01*
5.0	SME	0.00	0.00	0.00	0.14	0.08	0.19	0.08	0.07	0.23	0.09	0.06	0.04	0.02	0.01
5.0	*Corporate*	*0.01*	*0.07*	*0.12*	*0.16*	*0.06*	*0.14*	*0.06*	*0.05*	*0.17*	*0.07*	*0.05*	*0.03*	*0.02*	*0.01*
10	SME	0.00	0.00	0.05	0.19	0.07	0.17	0.07	0.06	0.20	0.08	0.06	0.03	0.02	0.01
10	*Corporate*	*0.01*	*0.07*	*0.12*	*0.16*	*0.06*	*0.14*	*0.06*	*0.05*	*0.17*	*0.07*	*0.05*	*0.03*	*0.02*	*0.01*
25	SME	0.00	0.00	0.09	0.19	0.07	0.16	0.07	0.06	0.19	0.08	0.05	0.03	0.02	0.01
25	*Corporate*	*0.01*	*0.07*	*0.12*	*0.17*	*0.06*	*0.14*	*0.06*	*0.05*	*0.17*	*0.07*	*0.05*	*0.03*	*0.01*	*0.00*
50	SME	0.00	0.01	0.12	0.18	0.06	0.15	0.06	0.05	0.18	0.07	0.05	0.03	0.02	0.01
50	*Corporate*	*0.01*	*0.07*	*0.12*	*0.17*	*0.06*	*0.14*	*0.06*	*0.05*	*0.17*	*0.07*	*0.05*	*0.03*	*0.00*	*0.00*
100	SME	0.00	0.07	0.12	0.16	0.06	0.14	0.06	0.05	0.17	0.07	0.05	0.03	0.02	0.01
100	*Corporate*	*0.01*	*0.07*	*0.12*	*0.17*	*0.06*	*0.14*	*0.06*	*0.05*	*0.17*	*0.07*	*0.05*	*0.02*	*0.00*	*0.00*
450	SME	0.00	0.07	0.12	0.16	0.06	0.14	0.06	0.05	0.17	0.07	0.05	0.03	0.02	0.01
450	*Corporate*	*0.00*	*0.08*	*0.14*	*0.19*	*0.07*	*0.16*	*0.07*	*0.03*	*0.19*	*0.08*	*0.00*	*0.00*	*0.00*	*0.00*

Table A2: True rating class distributions and simulated rating class distributions for bank B.
Table shows what share of a portfolio is composed of counterparts from a specific rating class when the total sales threshold, by which SME's are defined, is varied from the SEK .5 mn up to SEK 450 mn. The rating class shares shown here correspond to the portfolios shown in Table 4.

Portfolio characteristics

Total sales threshold (mn SEK)	Business type	Portfolio share of each rating class RC1	RC2	RC3	RC4	RC5	RC6
Complete portfolio		0.00	0.25	0.44	0.26	0.04	0.01
.5	SME	0.00	0.00	0.60	0.34	0.05	0.01
.5	*Corporate*	*0.00*	*0.26*	*0.44*	*0.25*	*0.04*	*0.01*
1.0	SME	0.00	0.00	0.60	0.34	0.05	0.01
1.0	*Corporate*	*0.00*	*0.26*	*0.44*	*0.25*	*0.04*	*0.01*
2.5	SME	0.00	0.21	0.47	0.27	0.04	0.01
2.5	*Corporate*	*0.00*	*0.26*	*0.44*	*0.25*	*0.04*	*0.01*
5.0	SME	0.00	0.26	0.44	0.25	0.04	0.01
5.0	*Corporate*	*0.00*	*0.26*	*0.44*	*0.25*	*0.04*	*0.01*
10	SME	0.00	0.26	0.44	0.26	0.04	0.01
10	*Corporate*	*0.00*	*0.26*	*0.44*	*0.25*	*0.04*	*0.01*
25	SME	0.00	0.25	0.44	0.26	0.04	0.01
25	*Corporate*	*0.00*	*0.26*	*0.45*	*0.26*	*0.04*	*0.00*
50	SME	0.00	0.26	0.44	0.26	0.04	0.01
50	*Corporate*	*0.00*	*0.26*	*0.45*	*0.26*	*0.04*	*0.00*
100	SME	0.00	0.26	0.44	0.26	0.04	0.01
100	*Corporate*	*0.00*	*0.27*	*0.46*	*0.26*	*0.01*	*0.00*
450	SME	0.00	0.26	0.44	0.25	0.04	0.01
450	*Corporate*	*0.00*	*0.27*	*0.46*	*0.27*	*0.00*	*0.00*

Table A3: True rating class distributions and simulated rating class distributions for bank A.
Table shows what share of a portfolio is composed of counterparts from a specific rating class when the total credit threshold, by which retail credit is defined, is varied from the SEK .1 mn up to SEK 10 mn. The rating class shares shown here correspond to the portfolios shown in Table 5 in the paper.

Portfolio characteristics

Total sales threshold (mn SEK)	Business type	Portfolio share of each rating class													
		RC1	RC2	RC3	RC4	RC5	RC6	RC7	RC8	RC9	RC10	RC11	RC12	RC13	RC14
Complete portfolio		0.01	0.07	0.11	0.16	0.06	0.14	0.06	0.05	0.17	0.07	0.05	0.03	0.01	0.01
.25	Retail	0.00	0.00	0.04	0.05	0.09	0.20	0.09	0.07	0.24	0.10	0.07	0.04	0.02	0.01
.25	*Corporate*	*0.01*	*0.07*	*0.12*	*0.16*	*0.06*	*0.14*	*0.06*	*0.05*	*0.17*	*0.07*	*0.05*	*0.03*	*0.02*	*0.01*
.5	Retail	0.00	0.00	0.05	0.18	0.07	0.17	0.07	0.06	0.21	0.08	0.06	0.03	0.02	0.01
.5	*Corporate*	*0.01*	*0.07*	*0.12*	*0.16*	*0.06*	*0.14*	*0.06*	*0.05*	*0.17*	*0.07*	*0.05*	*0.03*	*0.02*	*0.01*
1	Retail	0.00	0.00	0.07	0.19	0.07	0.16	0.07	0.06	0.19	0.08	0.05	0.03	0.02	0.01
1	*Corporate*	*0.00*	*0.07*	*0.12*	*0.17*	*0.06*	*0.14*	*0.06*	*0.05*	*0.17*	*0.07*	*0.05*	*0.03*	*0.02*	*0.01*
2.5	Retail	0.00	0.02	0.12	0.17	0.06	0.15	0.06	0.05	0.18	0.07	0.05	0.03	0.02	0.01
2.5	*Corporate*	*0.00*	*0.07*	*0.12*	*0.17*	*0.06*	*0.14*	*0.06*	*0.05*	*0.17*	*0.07*	*0.05*	*0.03*	*0.02*	*0.01*
5	Retail	0.00	0.02	0.12	0.18	0.06	0.15	0.06	0.05	0.18	0.07	0.05	0.03	0.02	0.01
5	*Corporate*	*0.00*	*0.07*	*0.12*	*0.17*	*0.06*	*0.14*	*0.06*	*0.05*	*0.17*	*0.07*	*0.05*	*0.03*	*0.02*	*0.01*
10	Retail	0.00	0.05	0.12	0.17	0.06	0.14	0.06	0.05	0.17	0.07	0.05	0.03	0.02	0.01
10	*Corporate*	*0.00*	*0.07*	*0.12*	*0.17*	*0.06*	*0.14*	*0.06*	*0.05*	*0.17*	*0.07*	*0.05*	*0.03*	*0.02*	*0.00*

Table A4: True rating class distributions and simulated rating class distributions for bank B.
Table shows what share of a portfolio is composed of counterparts from a specific rating class when the total credit threshold, by which retail credit is defined, is varied from the SEK .25 mn up to SEK 10 mn. The rating class shares shown here correspond to the portfolios shown in Table 6.

Portfolio characteristics

Total credit threshold (mn SEK)	Business type	Portfolio share of each rating class					
		RC1	RC2	RC3	RC4	RC5	RC6
Complete portfolio		0.00	0.25	0.44	0.26	0.04	0.01
.25	Retail	0.00	0.25	0.45	0.26	0.04	0.00
.25	*Corporate*	*0.00*	*0.26*	*0.44*	*0.25*	*0.04*	*0.01*
.5	Retail	0.00	0.25	0.44	0.26	0.04	0.01
.5	*Corporate*	*0.00*	*0.26*	*0.44*	*0.25*	*0.04*	*0.01*
1	Retail	0.00	0.26	0.44	0.25	0.04	0.01
1	*Corporate*	*0.00*	*0.25*	*0.44*	*0.26*	*0.04*	*0.01*
2.5	Retail	0.00	0.25	0.44	0.26	0.04	0.01
2.5	*Corporate*	*0.00*	*0.26*	*0.44*	*0.25*	*0.04*	*0.01*
5	Retail	0.00	0.25	0.44	0.26	0.04	0.01
5	*Corporate*	*0.00*	*0.26*	*0.44*	*0.26*	*0.04*	*0.01*
10	Retail	0.00	0.25	0.44	0.26	0.04	0.01
10	*Corporate*	*0.00*	*0.26*	*0.45*	*0.26*	*0.04*	*0.00*

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