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SWISS CORPORATE BANKRUPTCY RATES, 1911–2000: BUILDING A TIME SERIES

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1. Introduction

1.1 The Need for a Long Historical Time Series of Swiss Corporate Default Rates

Portfolio credit risk models are being developed within Swiss banks since the mid-nineties. The hope is that, some time in the future, they shall be approved by financial regulators for computing regulatory capital for credit risk. In the meantime, they are used to

assess internally the optimal capital needed as buffer against credit risk (the “economic capital”) and to develop risk-adjusted performance measurement tools like the Risk-adjusted return on risk-adjusted capital (“RARORAC”) schemes. Credit portfolio models also are a prerequisite for pricing large credit derivatives like synthetic securitization structures and credit portfolio swaps.

These credit risk models, however refined, have to be calibrated with external parameters – typically mean yearly default rates, ideally per rating class and per industry sector, and volatilities of these rates, not to mention migration probabilities between rating classes.

To value these parameters, a possible approach is to choose “savvy” values, according to management experience. That might not lead to a very different picture than before the advent of portfolio credit risk models and may not get approval by regulators. Another approach is to measure historical values and possibly increase them by a margin for safety.

This second method has the advantage of being less twistable, but it has been criticized as being past-oriented. Indeed, it could lead to too optimistic a picture in case the future turns out to be nastier than the past, or too pessimistic a picture in case the future gets much better. However, the first, guesswork, approach is by no means better, since managers are not neces-

sarily able to correctly foresee events to come. Thus the use of historical values for the model parameters can be seen as a “least-worse” approach.

For mathematical and economic reasons, *long* series of data are needed to derive meaningful model parameters. First, any number like an average and a standard deviation must be extracted out of more than a few points if it is to make sense statistically. Second, a mean default rate has to be based on observations done on both bust and boom times if it is to realistically depict the behaviour of the economy. Last but not least, a large set of data has more chance to include extreme events, which are the focus of risk management. Thus, the longer the time series, the better.

These facts are known to the international financial regulators, who have made a condition for their acceptance of credit risk models that they be properly backtested, which requests long time series.

It is sometimes argued that a long time series of credit data would be of no practical use because it would go back several decades into the past. It would then contain economy-wide structural changes, making it irrelevant for the present time. We shall argue that the opposite is true. The structural changes contained in a century-long time series make it even more valuable. Indeed, the main task of risk management should be to fathom big, unexpected changes, i.e. structural changes. For the daily routine, front people do just as well as risk managers. Which better source of data, then, than a time series containing several structural changes?

1.2. Time Series Contents and Data Source

Swiss banks have stored detailed credit and default data from their loan portfolios for a few years at best, that is, they have time series with at most a few points. In North America,

rating agencies have compiled longer time series of default statistics. In particular, Moody's publishes a default statistics starting in 1920 (“Historical Default Rates of Corporate Bond Issuers, 1920–1999”).

To get out of the data bottleneck, we took the initiative to build a time series of corporate default rates in Switzerland across the whole XXth century. The now-completed series discloses estimations of the yearly failure rates of Swiss companies, continuously from 1911 to 2000. The rates are aggregated figures for the whole of Switzerland, that is, they do not distinguish between economic sectors, geographical regions and company types, ratings or sizes. The statistics concerns firms registered at the office of commerce.

The series was built by reprocessing data from three sources. The main source was the Annual Statistical Book of Switzerland (*Statistisches Jahrbuch der Schweiz / Annuaire statistique de la Suisse*), yearly editions from 1910 to 2000, archived at the Federal Office of Statistics (*Bundesamt für Statistik / Office fédéral de la statistique*) in Neuchâtel. The second source was the statistics of Creditreform, an independent institute in St.Gallen, which covers the years 1970 to 2000. The third source was “Cantons and Cities of Switzerland” (*Kantone und Städte der Schweiz / Cantons et Villes suisses*).

The input parameters required by portfolio credit risk models are typically default rates and rates of loss on liabilities given default – and this for each rating class, industry sector, geographical region, company type and size... So ideally we would have collected historical data for these variables. However, it was hardly possible to extract so much information from available statistics, for practical reasons. The largest source of data, the Statistical Book of Switzerland, is a true treasure trove of data. It supplies an amazing mass of information about the number of failures per canton, per economic sector, per size of liabilities, per

month, and even per cause of failure. It offers matricial reporting per canton and per sector, or per month and per canton. It sometimes supplies the losses creditors incurred in bankruptcies.

However, most of this data is highly patchy and irregular in content. Some statistics is available for only a short period, for example 1920–31, another is available only for one year... Definitions of what is reported change, so that sometimes no consistent series may be extracted. Formats, contents and places fluctuate wildly in the Statistical Book, making harsher to find what belongs together.

For these reasons, any sector and region analysis would be heavily time-consuming. We thus opted for a single statistics for Switzerland as a whole, aggregating across sectors, cantons and sizes. Evenso, the task was not straightforward. There were many hurdles on the way, due to the length of the bankruptcy procedures (procedure openings and closings have different timings and different statistics), varying levels of data aggregation (sometimes all Switzerland is reported, sometimes parts of it), holes in reported data during some time intervals and for some bankruptcy types, difficulties in separating private and corporate bankruptcies. The building of the time series is described in detail in the three following sections.

In summary, after some reprocessing, we extracted the total number of Swiss bankruptcies per year from 1911 to 2000, and the total number of registered companies at the beginning of each year. Combining the two figures led to the yearly failure rates from 1911 to 2000.

Since the Federal Bankruptcy Act of 11th April 1899, there was no substantial change in Swiss law as to whether a company is declared bust or not. Thus our data is coherent throughout time with this respect.

2. Collecting the Number of Bankruptcies

2.1 Procedure Openings vs. Procedure Closings

The Statistical Book of Switzerland delivers statistics at two stages of the bankruptcy procedure:

- Openings of procedure (*Konkurseröffnungen / ouvertures de faillites*)
- Closings of procedure (*Konkurserledigungen / liquidations de faillite*).

The first category, openings, was selected to build the time series, for two converging reasons.

First, procedure openings are more continuously reported. The Statistical Book delivers them for 1933–2000. Until 1932, it supplies substatistics for 22 cantons (1910–1919), for 23 cantons (1920–31) and for 20 cantons (1919–40), from which the total Swiss number can be estimated.

There are three types of bankruptcy procedures:

- Normal procedure (*ordentliches Verfahren / procédure ordinaire*)
- Short procedure (*summarisches Verfahren / procédure sommaire*)
- Suspended procedure for lack of assets (*Einstellung mangels Aktiven / suspension pour défaut d'actifs*).

For openings, the Statistical Book displays exhaustive figures, including normal, shortened and interrupted procedures.

The statistics for procedure closings is much more patchy. The total number of closings was reported only for the years 1936, 1960, 1965, 1970 and for the interval 1973–1998. They are as well various substatistics according to procedure type. For example, the total number of normal and short procedures (without suspended) over 1936–2000 and the total number of closings for registered firms over 1916–1940. All bankruptcies should be included to build a complete time series.

Second reason to prefer procedure openings, their timing matches more closely the economic situation, i.e. the time when the lenders have to react. The moment when a company files for bankruptcy (opening of procedure) is supposedly closer to the time when it underwent severe difficulties than the end of the liquidation procedure. A procedure might close much later, for a lot of reasons not connected to the economic situation, like disagreement between debt owners. A time series of closings would thus suffer from an uncontrollable smoothening effect blurring the real magnitude of the economic cycle.

2.2 Sorting out the Holes in the Reported Data

The Statistical Book reports the total number of bankruptcy openings (summed up over registered companies, non-registered companies and individuals) for each year between 1933 and 2000. The figures can be found in Appendix 5.

Up to 1933, we had to estimate the numbers, because they were not reported for the whole of Switzerland. Failures were reported for 22 cantons and half cantons from 1910 to 1919 (Uri, Zug, and Vaud missing), then from 1920 to 1931 for 23 cantons and half cantons (Zug and Vaud missing). In parallel, they were reported for 20 cantons and half-cantons (Luzern, Zug, Baselstadt, St-Gallen and Vaud missing) during 1919–40.

We merged the 22-canton and the 23-canton series, neglecting the absence of Uri in the 22-series. Uri typically represents about 0.1% – 0.2% of the total 23 canton number of failures. In 1920, there was 1 opening there out of 998. The resulting estimate very slightly underestimates the number of failures.

By nature, the 22/23-canton series should be closer to the total-Swiss picture than the

20-canton. So we relied on the 22/23-canton to estimate the total-Swiss figure.

However, the 22/23-canton series and the total-Swiss series never overlap, forbidding to find a direct relation between them. The 20-canton series has an eight-year overlap with the total-Swiss series (1933–40) and a 13-year overlap with the 22/23-canton (1919–1931). So we went through a two-steps rule of thumb to estimate the national default figure over 1918–31. We derived the mean ratio between the 20-canton and the 23-canton numbers (= first ratio ≈ 1.26) over 1919–31, and the mean ratio between the 20-canton and the total-Swiss (= second ratio ≈ 1.38) over 1933–40. The ratio between these two ratios is 1.09 (= second ratio/first ratio).

Assuming that these ratios remained roughly stable (neglecting possible regional diverging evolutions), we estimated the yearly total-Swiss figure in the interval 1910–31 by multiplying the 22/23-canton number each year with 1.09. For the year 1932, where only the 20-canton statistics was available, we multiplied the 20-canton figure with the 1.38 factor (Appendix 1).

2.3 Distinguishing between Corporate and Private Bankruptcies

We are interested in the total number of *corporate* defaults, in order to get a corporate default rate. Unfortunately, the Statistical Book mixes corporate and private bankruptcies for most years.

Direct statistics about the split private-corporate is very scarce. In the Statistical Book, a split between “private” and “non-private” bankruptcies was reported during the interval 1936–72 within the category of procedure closings (without suspended procedures). Although this series is non-exhaustive and too short for our purpose, it delivers an interesting insight: the share of firm bankruptcies is seen

to slightly decrease. It went down from an average of 73% over the first ten years (1936–45) to an average of 62% over the last ten years (1963–1972).

An approach feasible with the available data was to identify firms inscribed at the register of commerce (*im Handelsregister eingetragene Firmen / firmes incrites au registre du commerce*) as “companies” and non-registered entities as “private”. This is the approach we opted for.

In Switzerland, some small companies are not inscribed at the register of commerce, like some lawyers and doctors. Thus, considering only registered-firms as “firms” is not perfectly accurate. And non-registered firms are not necessarily negligible for banks, since they are part of the small and median enterprises category (SME) category, a heavy exposure class in domestic lending. Selecting only the registered firms as “companies” induces some distortion. The hope is, however, that non-registered firms display the same failure rate trends as registered firms.

For splitting bankruptcy openings between registered and non-registered, two sources are available: the Statistical Book of Switzerland for 1936–1972 and Creditreform for 1970–2000.

The Statistical Book supplies the total number of procedure openings of registered firms in Switzerland for the period 1936–72. Combined with the total number of procedure openings in Switzerland over the same time span, these figures allow to compute a yearly ratio of registered companies failures to the total number of failures (i.e. failures from registered companies, non-registered companies and individuals). The ratio fluctuates within a 27%–52% band, with an average of 38% (Appendix 2). In the first decade (1936–45), the share of registered in the total number of openings was 38%, in the second decade 46%, and in the third 32%.

Creditreform offers a statistics of the registered/non-registered split over the period 1970–2000. The series underwent a definition change in 1993, but the registered-firm side of the statistics should be untouched by this change. Until 1992, Creditreform built its statistics by gathering cantonal court announcements about bankruptcy procedure openings (*Gerichtsmeldungen von Konkursöffnungen*) and classified them according to whether registered in the office of commerce or not. From 1993 on, Creditreform has collected information published in the official cantonal commerce newspapers (*Kantonale Handelsblätter / Feuilles du commerce cantonales*) for the same classification. The total figure for bankruptcy openings agrees perfectly with that of the Statistical Book during the first phase (until 1992). During the second phase (since 1993), the total number of bankruptcies markedly differs from that of the Statistical Book, and, badly enough, not in a regular way: it is some years higher, some years lower, without any clear pattern. Creditreform estimates that the change in method affects only the non-registered side of the statistics, and is confident that registered firms should show the same figures as in the Statistical Book.

These figures show a relatively stable pattern. The share of registered firms in the total number of bankruptcies fluctuates within a 38%–52% band year after year, with a very stable mean from decade to decade. The average ratio during the 1970s is 45.5%, in the 1980s it is 44.3%, and in the 1990s it is 44.0%. The overall mean over 1970–2000 is 44.7% (Appendix 3).

Unfortunately, over the short time span when both the Statistical Book and Creditreform data overlap (1970, 71 and 72), their figures for the ratio differ markedly, as can be seen by comparing appendices 2 and 3. Creditreform displays a ratio of 42.1%, 43.8%, 42.0% over these three years, whereas the Statistical Book gives 33.5%, 34.8%, 34.2%. Clearly, there

must have been some methodological difference between both reportings. In the following we arbitrarily opted for the ratio from Creditreform (45%) to estimate the number of registered failures from the total number of bankruptcies, in order to compute the failure rates over the whole century.

To estimate the number of purely corporate failures over 1910–1969, we assumed that the ratio of 45% (observed over 1970–2000 in Creditreform data) was constant across the century. We multiplied the total numbers of failures (registered and non-registered) over 1910–1969 with 0.45 to get an estimation of the number of registered-firm failures.

Of course, we have no guarantee that the ratio of registered/total was effectively constant across the century, even when staying within a single reporting methodology. But because the mean was observed to be relatively stable over the observation interval of Creditreform (1970–2000), we think that the constant multiplying factor is an acceptable approximation.

As a note, we may add that the real ratio of registered vs. all failure openings from 1910 to 1969 need not remain out of reach for ever. The cantonal offices of commerce maintain archives. Any interested person might devote some time in the future to score the 26 offices of commerce successively and sort out the 260,000 openings observed between 1910 and 2000 one by one according to whether they are or not from companies registered in the office of commerce.

3. Collecting the Number of Companies

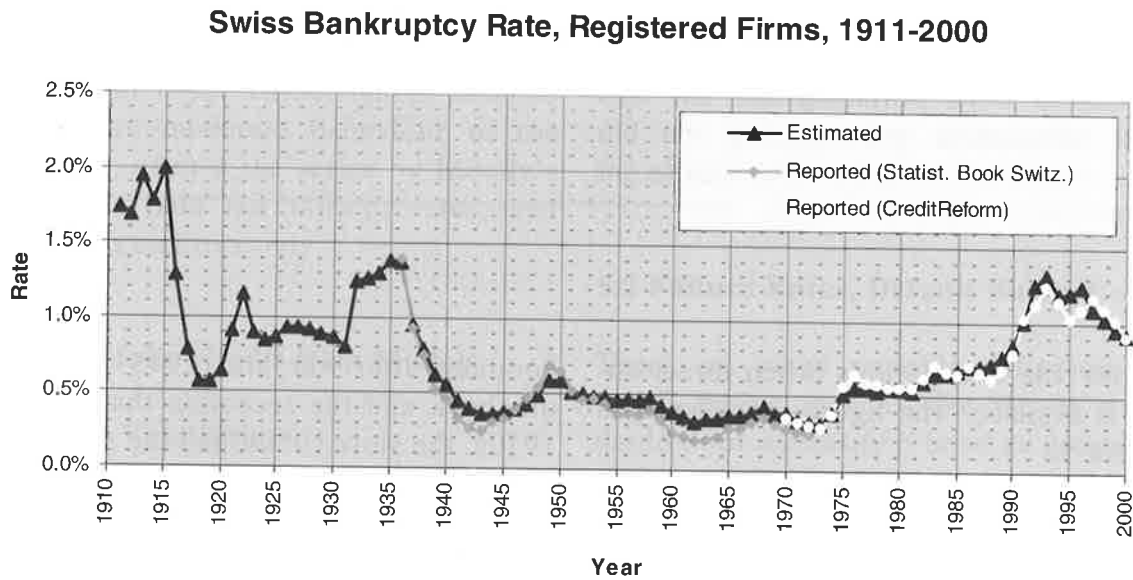
When it comes to counting the number of companies, the same definition issue comes up. We chose again to consider only entities inscribed at the register of commerce as “companies”, for consistency, and because this is the only statistics extractable from the Statistical Book and from Creditreform. Like before-

hand, we hope that the number of registered companies follows a similar trend as the total number of (registered and non-registered) enterprises.

The total number of registered companies in Switzerland is steadily reported in the Statistical Book for each year in the interval 1911–83 (with hints that it was done since 1885). The figure for 1910 is an average value over 1906 to 1910. Until 1949, the figures do not include public-law societies (*Institute und Körperschaften des öffentlichen Rechts / instituts et corporations de droit public*), but the difference is of a small order of magnitude – about 150 entities out of about 100,000. Figures are valid for each year as of December 31st.

Between 1980 and 1995, the number is reported for 1981, 1982, 1985, 1989, 1990, 1994 and then again yearly. To fill in the holes in the data (1983–84, 1986–88, 1991–93), we attempted to use the detailed sub-statistics provided by the Statistical Book. Between 1980 and 1995, the book reports the number of companies per legal form (there are 10 legal forms). A nice table extending over ten years gives the figures for the first 9 forms and the last legal form – public limited companies (*Aktiengesellschaften / sociétés anonymes*) – is reported on an annual basis in a separate table, except for the years 1991–1993. For these years 1991–93, another annual statistics was necessary for the public limited companies (*Kantone und Städte der Schweiz – statistische Übersichten / Cantons et Villes suisses – données statistiques*) annually published by the Federal office of statistics (Appendix 4).

Unfortunately, the two methods (total number directly reported or sum of the ten legal forms) lead to slightly different results in the years when they are both obtained. For the year 1990, for instance, the sum of the 10 legal forms give 344,120 firms, whereas the total number supplied from the Statistical Book is 342,697. Sometimes the first figure is above the second, sometimes it is below, suggesting

Figure 1: Estimated Swiss Corporate Failure Rates vs. two (non-agreeing) Sources of Reported Data

that the discrepancy originates deeper in methodology than, for example, simply overlooking a single subgroup.

Creditreform offers a time series of the total number of registered companies in Switzerland from 1970 to 2000. It is in very good agreement with the figures of the Statistical Book except during the “troubled period” between 1983–93 when the reporting at the Federal Office of Statistics seemingly underwent some jolts and difficulties. For this unclear period 1983–1993 we adopted the number of registered companies delivered by Creditreform (Appendix 4).

The complete adopted series for the number of Swiss companies from 1910 to 2000 is displayed in Appendix 5.

4. Deriving the Corporate Bankruptcy Rates

4.1 Computation

Having for each year of the interval 1910–2000 the total number of (registered) Swiss companies and the number of (registered-corporate) bankruptcy or procedure openings, we could compute the ratio: the failure rate. We associated the number of bankruptcies of year n with the number of companies of year $n - 1$, since the latter figure is valid as per end of year. The formula for this corporate bankruptcy rate (the “estimated rate”) is on top of the following page.

The “mixed rate” is defined as the total number of failures divided by the number of registered firms.

The resulting synthetic time series of the Swiss corporate failure rate from 1911 to 2000 is plotted in Figure 1, compared with the curves

$$\begin{aligned}
 & \text{Estimated corporate bankruptcy rate of year } n \\
 = & \frac{\text{Estimated number of registered-company bankruptcy openings in year } n}{\text{Estimated number of registered companies at end of year } n-1} \\
 = & 0.45 * \frac{\text{Estimated total number of bankruptcy openings in year } n}{\text{Estimated number of registered companies at end of year } n-1} \\
 = & 0.45 * \text{mixed failure rate}
 \end{aligned}$$

obtained for the two periods when direct observation is available. The figures are displayed in Appendix 5.

The synthetic time series is an approximation. It does probably not deliver the exact historical Swiss bankruptcy rate, but certainly gives a good insight into it. As can be seen, it matches fairly well the trends displayed by the two directly reported series, even if it relies solely on the Creditreform ratio of registered companies. It would be impossible to match both of them exactly since the two series are not in agreement with each other, as mentioned before.

It might be discussed whether the estimated, “synthetic”, failure rate, computed as $0.45 * \text{mixed rate}$ (the latter more directly extracted from reported data) should be applied to the whole interval 1910–2000 or only to the periods where no direct observation for the pure registered-firm rate is available, i.e. 1911–1936, or perhaps to the period 1911–1969. We chose to apply the synthetic rate to the whole century for consistency.

4.2 Historical Interpretation

The time series allows an interesting insight into the evolution of the Swiss economy over the century, in particular, it offers a measure of the relative impacts of World War I (1914–18), the crisis of the early 1930s following the krach of 1929, World War II (1939–45), the

booming after-war era (1945–73), the 1973-oil-shock and the recession that ensued in the 1970s, the slow 1980s, and the recession of the 1990s.

The crisis time of the 1930s appears clearly as a tough period. From 1932 on, the default rates are the highest ever, except for the pre-1916 years. The two world wars seem to have been good to the economy, presumably thanks to a rise in government military orders and to the fact that Switzerland could remain out of both conflicts. The best years of the century are the 1960s and early 1970s, with the intervals 1962–64 and 1971–73 boasting the lowest bankruptcy rates ever. This is in harmony with the intense economic growth that this period enjoyed.

Regarding the quite high failure rates obtained in the pre-1916 years, it is not sure if the data can be trusted, or if it is an artefact of an unsure reporting start at the Federal Office of Statistics. To check on this, we researched the Swiss GDP time series. We found clues of a recession in 1913 and 1914. Nominal and real growths were negative (in 1915, only the real figure is negative) – but it is hard to say if they justify such high default rates, all the more so since there was positive growth in the years 1910–12. For comparable later recessions, or worse ones, the Swiss failure rates is not observed to jump that much. So a certain level of uncertainty still shrouds the synthetic failure rates obtained for 1911–15.

On the whole, the Swiss failure rate is generally very moderated. It never falls below 0.3% and never exceeds 2%. The time series by Moody's shows the U.S. rate falling below 0.2% in 1928 and jumping above 9% in 1932 and above 4% in 1990. These figures seem to point to a more moderate behaviour of the Swiss economy, even if the series by Moody's displays default (and not failure) rates, and pertains to bond emitters only.

5. Link to Portfolio Credit Risk Models

5.1 Means and Volatilities

An interesting information that can be derived out of any time series is the mean and the volatility (standard deviation) for different periods. We computed these parameters for three different time intervals. They are displayed in the following table. The "relative" volatility is defined as the "absolute" volatility divided by the mean.

The key new information provided by the time series are the century mean failure rate of 0.76% and the century mean relative volatility of 53%. From the table, one notices that the mean failure rate was lower over the whole century than over the last 20 years (effect of the recession of the 1990s), but that the long-term volatility was significantly higher.

Surprisingly enough, the (estimated) synthetic series obtained by multiplying the mixed data with a constant 0.45 factor displays a higher volatility over 1970–2000 than the reported (exact) series of Creditreform. Thus it seems that the multiplication by a constant factor did not produce any undesirable smoothening effect.

5.2 Failure Rates, Default Rates, Loss Rates

There are many possible definitions of "default". Rating agencies like Moody's and Standard&Poor's classify a bond as defaulted when any payment due (interest or principal) by the emitter is not made on time, grace period included. A company with temporary liquidity difficulties and one filing for bankruptcy are included in the same slot.

At some banks, a loan is called "defaulted" as soon as it requires provisioning, i.e. as soon as it is seen as partly or totally endangered, even if the customer goes on paying premiums and reimbursements. With this definition, "performing" and "defaulted" are compatible.

We based our time series on bankruptcies, assuming that at the level of the macroeconomy, the three phenomena – default in the pure sense, as used by agencies, looser definition by banks, or bankruptcy in the proper

Table 1: Means and Volatilities of Swiss Registered-Firm Failure Rate, for Different Periods

Time Interval	Time Series of Bankruptcy Rate	Mean	Absolute Volatility	Relative Volatility
1910–2000	Century Series	0.76%	0.40%	53%
1970–2000	Century Series	0.75%	0.30%	40%
	Creditreform	0.73%	0.28%	38%
1980–2000	Century Series	0.89%	0.25%	28%
	Creditreform	0.86%	0.23%	26%

sense – are related and should display similar trends.

We compared the provisioning rates (banks' definition of default) to our synthetic bankruptcy rate over available years. By "provisioning rate", we mean the ratio of the number of firms needing a new provision during year n to the total number of corporate obligors at the end of year $n - 1$. We found that this provisioning rate is about 2.2 times higher than the mean of the bankruptcy rate. This is to be hoped, since the category "in need of provision" should include many more companies than "bankruptcy".

Comparing with the loss rate (for that matter, the volume of new provisions in year n vs. the total lending volume at the end of year $n - 1$), we found out that, over the period considered, the mean of the century time series was pretty much representative. However, the volatility was about three times too low.

The difference of behaviour of the failure rates and loss rates might come from the fact that bad things never come alone. When trouble occurs during good times, the bank has no difficulty to realize its exposure because the collateral can be sold at good price. In bad times, not only are default events more frequent, but when an obligor defaults, its assets are smaller and more difficult to sell given bad market conditions.

In other words, other variables than corporate default rates play a significant role in banks' loss rates. Real estate prices, for example, definitely have to be considered. When a mortgage-backed loan fails, there is a loss if and only if real estate prices are low. It is well-known that, in the early 1990s, when the economic crisis hit, real estate prices dropped in Switzerland. Moreover, a large part of the loan portfolio of most Swiss banks are mortgages or mortgage-backed.

There might be a size effect as well. Larger companies, having more impact through their larger borrowed amounts, might have a more

volatile failure rate. Their default rate might be much lower in good times, than average companies, and higher in bad times. Some internal bank empirical studies hint at such effects.

To summarize, the above numbers seem to imply that, to model the loss rate, it would be safe to assume a mean of 0.75% and a relative volatility of 150% (longer-term approach) for overall Swiss portfolio loss rates, or a mean of 0.9% and a volatility of 90% (shorter-term approach).

Finally, we gathered the figures available in the Statistical Book about the total amounts lost by creditors in Swiss bankruptcies from 1936 to 1972 as per procedure closing (Appendix 7). The overall average over the period amounts to 72.2%. Banks may compare these figures with their own loss-given-default rates.

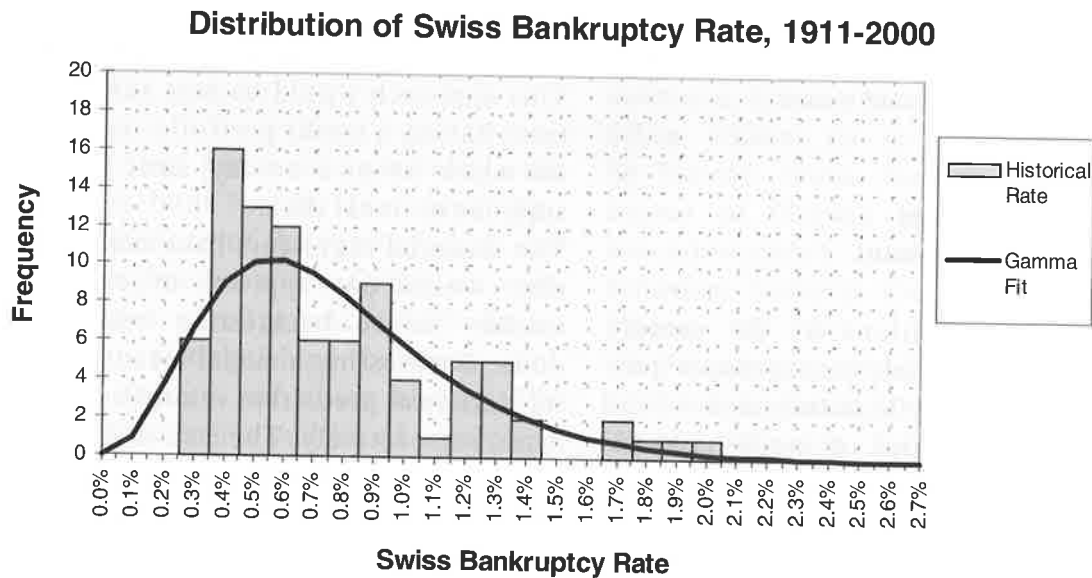
5.3 Shape of the Distribution Function

The synthetic time series allows another interesting insight, namely to investigate the profile of the failure rate distribution. Portfolio credit risk models must adopt, explicitly or implicitly, some convention for this distribution. Such hypotheses were previously difficult to check for Switzerland, due to the lack of historical credit data.

In Figure 2, we plotted the histogram of the estimated Swiss failure rate over 1911–2000 (90 points) compared with a gamma distribution. The horizontal axis displays the default rate bucket and the vertical axis displays the frequency. The frequency displayed for instance under rate = 0.4% is the number of years when the failure rate was between 0.35% and 0.45%. The gamma fit displayed in the graph has the same mean ($\approx 0.7611\%$) and standard deviation ($\approx 0.3946\%$) as that of the time series histogram. The figures are given in Appendix 6.

We are interested to check the gamma distribution because of its importance in the uni-

Figure 2: Historical Failure Rate Distribution vs. Gamma Distribution



verse of credit risk models. In particular, this function underlies the architecture of Credit Suisse First Boston's model *CreditRisk*⁺. This model, made freely available in 1997, is now widely implemented for credit risk management in middle-market lending departments of many European and American banks.

For large homogeneous loan portfolios, the loss distribution that *CreditRisk*⁺ produces, and from which it extracts its credit value-at-risk, reduces to a simple gamma distribution. As such, it is entirely determined by two parameters, the mean (or expected value) and the standard deviation of the total portfolio loss – and by the gamma distribution assumption. That is why it makes sense to check the suitability of this function.

As can be seen visually on the graph, the gamma distribution fits rather well the historical distribution. Further mathematical investigati-

on would be needed, however, to check if the gamma distribution, or another statistical distribution, fits the data best.

The chart plotted above allows one more insight in the nature of the true failure rate distribution, namely whether it is “fat-tailed” or not. A distribution function determines the probability of very large events. If the value of the distribution is significantly above zero farther than 5 standard deviations from the mean, it will typically be considered “fat-tailed”, because its “wings” go farther away than usual distributions, like the normal and the gamma. We notice on the histogram that the Swiss corporate failure rate does not seem to be fat-tailed. The most extreme event (2.00% in 1915) lies at 3.1 standard deviations away from the mean. What is more, if we exclude the span 1911–15 because we deem it dubious, and look at the worst point in the rest of the

series, we find 1.39% at year 1935, lying at 2.3 standard deviations of the mean (using the new values for mean and volatility of the series starting with year 1916). If the distribution was fat-tailed, one would expect one or two events much farther from the mean.

5.4 Possible Applications in Credit Risk Management

Several possible applications of the century time series for credit risk management purposes at Swiss banks may be mentioned.

One of the responsibilities of credit risk departments is to develop crisis scenarios, the so-called “stress tests”, with the aim to imagine in advance what impact very bad years could have on the credit portfolio. The new time series reveals the worst years of the XXth century, as far as corporate failure rates are concerned. These specific years could inspire stress scenarios for Switzerland. These worst years are not so extreme, since the failure rate distribution is not fat-tailed. The series thus leaves us with modest suggestions for stress-testing purposes. The worst year since 1916 (as explained, the rates between 1911 and 1915 seem unreliable) is 1.39%, observed in 1935. It is not so different from the worst year of the nineties, 1993, with 1.32%. From that, one could conclude that to devise an efficient stress-testing scheme, there is no need to look further than at the economic crisis of the nineties, at least at the aggregated level.

Another possible application of the time series could be to estimate the main parameters entering into portfolio credit risk models, in the one-sector case. In this case, where all companies are aggregated across all industry sectors, rating classes and regions, one only needs the mean default rate, the volatility of the default rate and the distribution function of the default rate, in order to parametrize the model – all of which are provided by the time series for the

bankruptcy rate. To obtain these parameters for the default rate, one could assume a constant factor linking the default rates and the bankruptcy rates. This would give a first approximation of a bank’s credit value-at-risk. This approach would be best suited for institutions having a credit portfolio representative of the whole Swiss economy, since the time series supplies national data.

The financial regulators have made it clear that they would not approve of credit portfolio models before backtesting can be properly done. Backtesting a model means checking that its statistical prediction is confirmed, by letting it run retroactively. The lack of data has been a major obstacle hindering the backtesting of credit risk models. The availability of a century-long time series of Swiss corporate failure rates should help developing sound backtesting of credit risk models, at least in the specific one-sector case.

Another interesting application of the new time series could be to derive the correlations of Switzerland’s failure rate with that of other countries, in particular with the U.S. default rate supplied by Moody’s. Determining the correlations of Switzerland to other countries should be of interest to investors purchasing Swiss credit risk exposure, like mortgage-backed securities or synthetic CLOs (like UBS’s Hat and ZKB’s SwissAct transactions). These investors might be aiming at achieving international diversification and measuring the correlations between Switzerland and other national credit markets could help to assess the diversification achieved.

Last, but not least, the century time series could also allow to better calibrate forecasting models for the Swiss bankruptcy rate. Long time series of macro-economic factors like GDP growth, inflation, yield curve and unemployment are already available for the whole XXth century. Having the failure rate available over as long a time span might allow to build more solid regression models to predict the

Swiss failure rates a few years in advance. This might be of interest for banks willing to accurately plan provision volumes.

6. Conclusions

A century-long time series of Swiss corporate failure rate was built for the first time. The figures are estimations of the yearly failure rate of companies registered at the Office of commerce, aggregated over the whole of Switzerland – without distinguishing between economic sectors, regions and rating classes. We hope that this time series will be of some help to parametrize and test the portfolio credit risk models being developed in Switzerland at banks' and insurances' credit risk departments.

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APPENDIX 1:

Estimation of the Total Number of Bankruptcy Openings in Switzerland from 1918 to 1932

Year	Number of bankruptcy openings in Switzerland. (reported: white, estimated: shaded)	Number of bankruptcy openings in 20 cantons (reported).	Number of bankruptcy openings (reported). 22 cantons (normal) 23 cantons (bold)	1st ratio	2nd ratio
	$n_{25} = n_{23} * r_2 / r_1$ $n_{25} = n_{20} * r_2$	n20	n23	$r_1 = n_{23} / n_{20}$	$r_2 = n_{25} / n_{20}$
1910	1'917	–	1'759	–	–
1911	2'204	–	2'022	–	–
1912	2'312	–	2'121	–	–
1913	2'730	–	2'505	–	–
1914	2'552	–	2'341	–	–
1915	2'907	–	2'667	–	–
1916	1'890	–	1'734	–	–
1917	1'190	–	1'092	–	–
1918	893	–	819	–	–
1919	929	678	852	1.257	–
1920	1'088	793	998	1.259	–
1921	1'569	1'158	1'439	1.243	–
1922	2'040	1'483	1'872	1.262	–
1923	1'601	1'135	1'469	1.294	–
1924	1'524	1'110	1'398	1.259	–
1925	1'601	1'060	1'469	1.386	–
1926	1'737	1'255	1'594	1.270	–
1927	1'767	1'288	1'621	1.259	–
1928	1'777	1'289	1'630	1.265	–
1929	1'749	1'271	1'605	1.263	–
1930	1'735	1'297	1'592	1.227	–
1931	1'649	1'282	1'513	1.180	–
1932	2'607	1'889	–	–	–
1933	2'749	1'990	–	–	1.381
1934	2'897	2'175	–	–	1.332
1935	3'019	2'260	–	–	1.336
1936	3'022	2'232	–	–	1.354
1937	2'137	1'593	–	–	1.341
1938	1'770	1'273	–	–	1.390
1939	1'383	921	–	–	1.502
1940	1'230	894	–	–	1.376
Mean:				1.2633	1.3766

Source: Statistical Book of Switzerland

Light grey = estimation from 22/23-canton figure

Dark grey = estimation from 20-canton figure

20 cantons: all 25 cantons except Luzern, Zug, Basel-Stadt, St. Gallen and Vaud

22 cantons: all 25 cantons except Uri, Zug and Vaud

23 cantons: all 25 cantons except Zug and Vaud

APPENDIX 2:

Proportion of Registered Firms in the Total Number of Bankruptcy Openings (Reported Data, 1936–72)

Year	Total number of Swiss bankruptcy openings	Number of registered-firm bankruptcy openings (reported)	Share of registered firms in total number of bankruptcies
	nb tot	nb reg	nb reg / nb tot
1936	3'022	1'374	45%
1937	2'137	938	44%
1938	1'770	758	43%
1939	1'383	529	38%
1940	1'230	464	38%
1941	993	331	33%
1942	881	270	31%
1943	823	249	30%
1944	847	321	38%
1945	887	350	39%
1946	966	443	46%
1947	1'091	544	50%
1948	1'312	657	50%
1949	1'621	851	52%
1950	1'648	828	50%
1951	1'496	679	45%
1952	1'480	617	42%
1953	1'454	637	44%
1954	1'485	606	41%
1955	1'446	508	35%
1956	1'489	542	36%
1957	1'473	526	36%
1958	1'582	580	37%
1959	1'403	488	35%
1960	1'305	374	29%
1961	1'208	343	28%
1962	1'149	311	27%
1963	1'262	340	27%
1964	1'292	393	30%
1965	1'409	487	35%
1966	1'483	503	34%
1967	1'594	594	37%
1968	1'783	663	37%
1969	1'640	603	37%
1970	1'700	569	33%
1971	1'533	534	35%
1972	1'548	530	34%
Mean			37.902%

Source: Statistical Book of Switzerland

APPENDIX 3:

Proportion of Registered Firms in the Total Number of Bankruptcy Openings (Reported Data, 1970–2000)

Year	Total Number of Swiss bankruptcy openings	Number of registered-firm bankruptcy openings	Share of registered firms in total number of bankruptcies
	nb tot	n b reg	nb reg / nb tot
1970	1'700	716	42%
1971	1'533	672	44%
1972	1'548	650	42%
1973	1'527	650	43%
1974	1'960	855	44%
1975	2'648	1'322	50%
1976	2'960	1'515	51%
1977	3'004	1'415	47%
1978	2'913	1'414	49%
1979	3'069	1'367	45%
1980	3'080	1'394	45%
1981	3'040	1'428	47%
1982	3'488	1'643	47%
1983	3'935	1'915	49%
1984	3'995	1'845	46%
1985	4'298	1'873	44%
1986	4'605	2'055	45%
1987	4'717	2'001	42%
1988	4'963	1'919	39%
1989	5'494	2'180	40%
1990	6'207	2'631	42%
1991	7'648	3'545	46%
1992	9'819	3'952	40%
1993	10'513	4'451	42%
1994	10'346	4'183	43%
1995	9'761	3'820	38%
1996	10'192	4'156	39%
1997	9'182	4'552	48%
1998	8'850	4'363	48%
1999	8'490	4'196	48%
2000	8'313	3'842	45%
Mean			44.670%

Source: CreditReform

APPENDIX 4:

Number of Swiss Companies, 1980–2000

	Reported number of registered firms (CreditReform)	Reported number of registered firms ("Statistical Book")	Addition of firms of 10 legal forms ("Cantons and Cities")
1970	206'436	206'436	---
1971	213'551	213'551	---
1972	220'338	220'338	---
1973	226'227	226'227	---
1974	232'186	232'186	---
1975	236'725	236'725	236'299
1976	241'364	241'364	242'283
1977	244'624	244'624	246'156
1978	246'900	246'900	247'685
1979	250'841	250'841	251'875
1980	256'611	256'612	257'803
1981	263'023	263'024	264'136
1982	269'255	269'255	269'824
1983	275'434	---	275'388
1984	285'234	---	283'069
1985	290'400	290'400	291'165
1986	298'920	---	300'018
1987	308'616	---	309'614
1988	319'472	---	320'181
1989	331'067	332'285	332'285
1990	342'696	342'697	344'120
1991	350'916	---	350'916
1992	359'086	---	359'086
1993	365'303	---	365'303
1994	372'471	372'471	---
1995	379'902	379'902	---
1996	388'472	388'472	---
1997	399'081	399'081	---
1998	411'740	411'740	411'740
1999	421'215	421'215	421'215
2000	430'750	430'750	430'750

The total number of Swiss office-of-commerce-registered firms from 1970 to 2000, according to CreditReform and the Statistical Book of Switzerland (total statistics) and the sum of partial statistics after company type, from the Statistical Book and "Cantons and Cities of Switzerland". The data which we retained are shown in bold.

APPENDIX 5:

The Century Time Series: Failure Rate of Swiss Registered Firms, 1911–2000

- a) Nb est = estimated number of registered-firm failures computed as 0.45 times the total number of failures (bankruptcy procedure openings) in Switzerland during a given year.
 b) Nb firms = number of companies registered in the office of commerce at the end of the given year.
 c) The estimated century registered-corporate bankruptcy rate is derived as:
 $rate1 = nb\ est\ (year\ n) / nb\ firms\ (year\ n - 1)$

It is the "century time series".

The failure rate reported for 1936–72 and 1970–2000 respectively were extracted from the Statistical Book and CreditReform series.

The moments of the century time series are:

mean $\mu = 0.756\%$ absolute volatility $\sigma = 0.397\%$ relative volatility $\sigma = 52.6\%$

Year	Total number of failure openings (white=reported shaded=estim.)	Number of registered firm failures (estimated)	Regist. failures (normal= Stat Book, bold= CreditReform)	Nb of registered firms (normal= StatBook, bold= CreditReform)	Registered-Firm Failure Rate (normal= StatBook bold= CreditReform)	FINAL REGISTERED- FIRM FAILURE RATE (ESTIMATED)
	nb tot	nb est= 0.45*nb tot	nb rep	nb firms	rate 2 = nb rep / nb firms	rate 1 = nb est / nb firms
1910	1'917	863	—	57'076	—	
1911	2'204	992	—	61'686	—	
1912	2'312	1'040	—	63'284	—	1.74%
1913	2'730	1'229	—	64'610	—	1.69%
1914	2'552	1'148	—	65'471	—	1.94%
1915	2'907	1'308	—	66'239	—	1.78%
1916	1'890	851	—	68'402	—	2.00%
1917	1'190	536	—	70'877	—	1.28%
1918	893	402	—	73'601	—	0.78%
1919	929	418	—	75'786	—	0.57%
1920	1'088	490	—	77'668	—	0.57%
1921	1'569	706	—	78'893	—	0.65%
1922	2'040	918	—	79'858	—	0.91%
1923	1'601	720	—	81'270	—	1.16%
1924	1'524	686	—	82'610	—	0.90%
1925	1'601	720	—	83'880	—	0.84%
1926	1'737	782	—	84'703	—	0.87%
1927	1'767	795	—	86'526	—	0.93%
1928	1'777	800	—	86'526	—	0.94%
1929	1'749	787	—	88'136	—	0.92%
1930	1'735	781	—	89'990	—	0.89%
1931	1'649	742	—	92'058	—	0.87%
1932	2'607	1'173	—	94'601	—	0.81%
1933	2'749	1'237	—	97'644	—	1.24%
1934	2'897	1'304	—	100'122	—	1.27%
1935	2'897	1'304	—	98'014	—	1.30%
1936	3'019	1'359	—	98'745	—	1.39%
1936	3'022	1'360	1'374	100'192	1.39%	1.38%
1937	2'137	962	938	100'979	0.94%	0.96%
1938	1'770	797	758	100'359	0.75%	0.79%
1939	1'383	622	529	99'556	0.53%	0.62%

Year	Total number of failure openings (white=reported shaded=estim.)	Number of registered firm failures (estimated)	Regist. failures (normal= Stat Book, bold= CreditReform)	Nb of registered firms (normal= StatBook, bold= CreditReform)	Registered-Firm Failure Rate (normal= StatBook bold= CreditReform)	FINAL REGISTERED-FIRM FAILURE RATE (ESTIMATED)
	nb tot	nb est= 0.45*nb tot	nb rep	nb firms	rate 2 = nb rep / nb firms	rate 1 = nb est / nb firms
1940	1'230	554	464	99'268	0.47%	0.56%
1941	993	447	331	99'586	0.33%	0.45%
1942	881	396	270	101'332	0.27%	0.40%
1943	823	370	249	103'652	0.25%	0.37%
1944	847	381	321	106'263	0.31%	0.37%
1945	887	399	350	110'268	0.33%	0.38%
1946	966	435	443	115'710	0.40%	0.39%
1947	1'091	491	544	119'713	0.47%	0.42%
1948	1'312	590	657	123'494	0.55%	0.49%
1949	1'621	729	851	126'449	0.69%	0.59%
1950	1'648	742	828	129'838	0.65%	0.59%
1951	1'496	673	679	132'254	0.52%	0.52%
1952	1'480	666	617	135'127	0.47%	0.50%
1953	1'454	654	637	137'912	0.47%	0.48%
1954	1'485	668	606	141'189	0.44%	0.48%
1955	1'446	651	508	143'186	0.36%	0.46%
1956	1'489	670	542	144'965	0.38%	0.47%
1957	1'473	663	526	146'811	0.36%	0.46%
1958	1'582	712	580	148'707	0.40%	0.48%
1959	1'403	631	488	151'464	0.33%	0.42%
1960	1'305	587	374	155'084	0.25%	0.39%
1961	1'208	544	343	159'372	0.22%	0.35%
1962	1'149	517	311	164'775	0.20%	0.32%
1963	1'262	568	340	170'636	0.21%	0.34%
1964	1'292	581	393	175'836	0.23%	0.34%
1965	1'409	634	487	180'590	0.28%	0.36%
1966	1'483	667	503	184'940	0.28%	0.37%
1967	1'594	717	594	189'224	0.32%	0.39%
1968	1'783	802	663	194'329	0.35%	0.42%
1969	1'640	738	603	200'134	0.31%	0.38%
1970	1'700	765	716	206'436	0.36%	0.38%
1971	1'533	690	672	213'551	0.33%	0.33%
1972	1'548	697	650	220'338	0.30%	0.33%
1973	1'527	687	650	226'227	0.30%	0.31%
1974	1'960	882	855	232'186	0.38%	0.39%
1975	2'648	1'192	1'322	236'725	0.57%	0.51%
1976	2'960	1'332	1'515	241'364	0.64%	0.56%
1977	3'004	1'352	1'415	244'624	0.59%	0.56%
1978	2'913	1'311	1'414	246'900	0.58%	0.54%
1979	3'069	1'381	1'367	250'841	0.55%	0.56%
1980	3'080	1'386	1'394	256'611	0.56%	0.55%
1981	3'040	1'368	1'428	263'024	0.56%	0.53%
1982	3'488	1'570	1'643	269'255	0.62%	0.60%
1983	3'935	1'771	1'915	275'434	0.71%	0.66%
1984	3'995	1'798	1'845	285'234	0.67%	0.65%

Year	Total number of failure openings (white=reported shaded=estim.)	Number of registered firm failures (estimated)	Regist. failures (normal= Stat Book, bold= CreditReform)	Nb of registered firms (normal= StatBook, bold= CreditReform)	Registered-Firm Failure Rate (normal= StatBook bold= CreditReform)	FINAL REGISTERED-FIRM FAILURE RATE (ESTIMATED)
	nb tot	nb est= 0.45*nb tot	nb rep	nb firms	rate 2 = nb rep / nb firms	rate 1 = nb est / nb firms
1985	4'298	1'934	1'873	290'400	0.66%	0.68%
1986	4'605	2'072	2'055	298'920	0.71%	0.71%
1987	4'717	2'123	2'001	308'616	0.67%	0.71%
1988	4'963	2'233	1'919	319'472	0.62%	0.72%
1989	5'494	2'472	2'180	331'067	0.68%	0.77%
1990	6'207	2'793	2'631	342'696	0.79%	0.84%
1991	7'648	3'442	3'545	350'916	1.03%	1.00%
1992	9'819	4'419	3'952	359'086	1.13%	1.26%
1993	10'495	4'723	4'451	365'303	1.24%	1.32%
1994	9'680	4'356	4'183	372'471	1.15%	1.19%
1995	9'974	4'488	3'820	379'902	1.03%	1.20%
1996	10'541	4'743	4'156	388'472	1.09%	1.25%
1997	9'432	4'244	4'552	399'081	1.17%	1.09%
1998	9'117	4'103	4'363	411'740	1.09%	1.03%
1999	8'755	3'940	4'196	421'215	1.02%	0.96%
2000	8'665	3'853	3'842	430'750	0.91%	0.91%

APPENDIX 6:**Histogram of Swiss Failure Rate**

The gamma curve was fitted with the same norm, with the same mean $\mu \approx 0.7611\%$ and the same standard deviation $\sigma \approx 3946\%$ as the histogram of the century time series (with 0.1%-wide buckets). The century time series has an exact mean $\mu \approx 0.7565\%$ and standard deviation $\sigma \approx 0.3975\%$. The "frequency" displayed in the table is understood as the number of years when the observed rate fell between given rate plus or minus 0.05%. For example, the frequency of 6 for 0.7% means that there was six years when the failure rate was between 0.65% and 0.75%.

<i>Failure rate (size class)</i>	<i>Frequency of failure rate (century time series)</i>	<i>Frequency of failure rate (gamma fit)</i>
0.00%	0	0.00
0.10%	0	0.90
0.20%	0	3.64
0.30%	6	6.73
0.40%	16	9.03
0.50%	13	10.17
0.60%	12	10.24
0.70%	6	9.55
0.80%	6	8.43
0.90%	9	7.12
1.00%	4	5.82
1.10%	1	4.62
1.20%	5	3.59
1.30%	5	2.74
1.40%	2	2.06
1.50%	0	1.52
1.60%	0	1.11
1.70%	2	0.80
1.80%	1	0.58
1.90%	1	0.41
2.00%	1	0.29
2.10%	0	0.20
2.20%	0	0.14
2.30%	0	0.10
2.40%	0	0.07
2.50%	0	0.00

APPENDIX 7:

Loss Rate by Bankruptcies

Year	Liabilities (thsd CHF)	Loss (thsd CHF)	Loss rate	Average loss rate of decade
	liab	loss	loss / liab	
1936	234'592	146'437	62.4%	
1937	232'853	139'241	59.8%	
1938	171'808	104'492	60.8%	
1939	102'347	61'504	60.1%	
1940	78'903	47'664	60.4%	
1941	61'405	38'729	63.1%	
1942	64'523	43'311	67.1%	
1943	40'190	25'676	63.9%	
1944	25'014	15'928	63.68%	
1945	35'190	21'935	62.33%	62.4%
1946	25'216	18'606	73.79%	
1947	31'915	23'280	72.94%	
1948	41'432	33'071	79.82%	
1949	64'422	48'170	74.77%	
1950	86'970	67'762	77.9%	
1951	113'925	90'345	79.3%	
1952	73'049	55'370	75.8%	
1953	99'250	75'210	75.8%	
1954	80'889	62'867	77.7%	
1955	75'673	53'894	71.2%	75.9%
1956	79'666	60'470	75.9%	
1957	100'920	72'142	71.5%	
1958	97'966	67'105	68.5%	
1959	120'876	81'851	67.7%	
1960	112'313	81'216	72.3%	
1961	116'125	86'316	74.3%	
1962	86'336	63'905	74.0%	
1963	85'130	65'774	77.3%	
1964	77'942	62'670	80.4%	
1965	122'030	96'585	79.1%	74.1%
1966	162'132	126'411	78.0%	
1967	215'445	154'056	71.5%	
1968	235'560	197'710	83.9%	
1969	199'734	154'232	77.2%	
1970	278'969	221'252	79.3%	
1971	310'454	253'643	81.7%	
1972	365'765	277'306	75.8%	(78.2%)

Source: the Statistical Book of Switzerland
 Aggregated Swiss loss rates over all failures (private and corporate) at procedure closing.
 The overall average loss rate is 72.2%.

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Dresdner Bank (Schweiz) AG

HSBC Guyerzeller Bank AG

Lombard Odier Darier Hentsch & Cie.

Pictet & Cie.

Privatbank von Graffenried

Rentenanstalt / Swiss Life

RMF Investment Group

SWX Swiss Exchange

Schweizerische Nationalbank

SwissRe

Swissca Holding AG

Trafina Privatbank AG

UBS AG

Wegelin & Co. Privatbankiers

Winterthur Versicherungsgesellschaft

Zürcher Kantonalbank

Zürich Versicherungen

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