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Credit Risk and Real Capital: An Examination of Swiss Banking Sector Default Risk Using CVaR

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ABSTRACT

The global financial crisis (GFC) has placed the creditworthiness of banks under intense scrutiny. In particular, capital adequacy has been called into question. Current capital requirements make no allowance for capital erosion caused by movements in the market value of assets. This paper examines default probabilities of Swiss banks under extreme conditions using structural modeling techniques. Conditional Value at Risk (CVaR) and conditional probability of default (CPD) techniques are used to measure capital erosion. Significant increase in probability of default (PD) is found during the GFC period. The market asset value based approach indicates a much higher PD than external ratings indicate. Capital adequacy recommendations are formulated which distinguish between real and nominal capital based on asset fluctuations.

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Keywords: Real capital; Financial crisis; Conditional value at risk; Credit risk; Banks; Probability of default; Capital adequacy

1. Introduction

Switzerland is one of the world's most important banking centres, with an enviable reputation for prudency and discreetness. Besides the United States, it is the only country to have two cities, Geneva and Zurich, achieve a top 10 ranking by the Global Financial Centres Index (ZYen and the City of London, 2009). The banking industry is of crucial importance to Switzerland. The Central Bank, the Swiss National Bank (SNB), note in their Financial Stability Report (2009) that the banking sector's total assets amount to 8 times GDP, the largest ratio of all the G10 countries. In comparison, the United States has a ratio of approximately 1x GDP and the UK 4x.

The Swiss banking sector, as reported by the SNB (2009), has 4 main categories of banks. Firstly, the sector is dominated by two big banks, UBS and Credit Suisse, which make up 76% of total banking sector asset values but only 34% domestic lending share due to their large international presence. Then there are 24 Cantonal banks with a domestic lending market share of 34%. 367 independent bank members of the Raiffeisen group and 75 regional banks make up the balance of the sector.

In line with the global banking industry, Switzerland banks have been severely affected by the financial crisis, with large losses incurred by the major banks. Globally, governments have introduced measures to support troubled banks. Examples include the 2008 US $700bn Troubled Asset Relief (TARP) programme and the 2008 UK £500bn financial support package. In Switzerland, rescue has primarily surrounded the largest bank, UBS. In 2008 a package was put together to allow a SFr6bn capital injection into UBS and the transfer of USD $60bn of troubled assets to a special purpose vehicle of the SNB.

Regulators in Switzerland have moved to shore up capital adequacy requirements. The Swiss Financial Market Supervisory Authority (FINMA) has introduced capital adequacy requirements for the big banks above the minimum required by Basel, as well as a minimum leverage ratio of 3%, measured as Tier 1 capital to total assets (this ratio was 2.9% for Credit Suisse at end 2008, and 1.6% for UBS). These new requirements are to be implemented by 2013. It is expected that in good times the ratios will be well above these minimum levels.

Leverage in European banks is typically high compared to US banks. The aggregated equity of Swiss banks in this study is 3.5% of total assets, compared to 4.2% for a pool of the world's 20 largest non-Swiss banks. US banks in the pool have an equity ratio of 7.1%, Asian banks 3.6%, UK banks 4.4%, and other European banks 3.2%. The big two Swiss banks have a smaller combined equity ratio (2.8%) than the remaining Swiss banks (6.5%). Tier 1 Capital ratio to risk weighted assets is 11.5% for the combined big Swiss banks and total capital to risk weighted assets is 15.6%. These ratios are higher than for either US or UK banks, indicating a lower risk weighting is being applied by Swiss banks.

Concerns over high leverage and major differences between risk weighted and absolute ratios have led to concerns over the Basel approach. The SNB has been at the forefront of calls for a leverage ratio to be introduced by Basel. Blum (2007) argued, that despite a leverage ratio being a blunt instrument which does not differentiate between risk profiles of banks, it has the advantage of inducing truthful risk reporting where supervisors have a limited ability to identify or sanction dishonest banks. Hildebrand (2008) views excessive leverage as a main cause of financial fragility. He views a simple leverage ratio as a safety valve against shortcomings of risk weighted adjustments, and ensuring a minimal capital buffer is maintained against unexpected losses and underestimation of risk.

Others have expressed concerns that reducing asset values in times of crisis reduce equity levels. The Bank of England (2008) is concerned that not only do asset values reduce in times of uncertainty, but rising default probabilities make it more likely that assets have to be liquidated at market values, providing a need for increased capital.

The linkage between asset values, economic cycles and default probabilities is discussed by several authors. Examples include the structural models of Merton (1974) and KMV (Crosbie & Bohn, 2003) which incorporate asset value fluctuations and which are dealt with in depth in this paper. Jarrow (2001) incorporates equity prices into the estimation of default probabilities, where recovery rates and default probabilities are correlated and depend on the state of the macroeconomy. Using structural analysis which incorporates market fluctuations based on CVaR, Allen and Powell (2009) find that there is no significant correlation between industry default probabilities from year to year, and the authors (Powell & Allen, 2009) find no significant correlation between those industries which had high default probabilities prior to the financial crisis and those which have high default probabilities subsequent to the onset of the crisis.

This study focuses on the impact of fluctuating asset values on default probabilities and capital adequacy of Swiss banks. This is compared to a 'pool' of Global banks. In particular, the study uses CVaR to measure the most extreme of asset value fluctuations.

Section 2 outlines the benefits and contributions of the study, followed by a discussion on VaR and CVaR in Section 3. PD is discussed in Section 4, giving consideration to Basel measurements for banks, and the structural models of Merton and KMV. Data and Methodology are discussed in Section 5. Results are presented in Section 6, which also includes an examination of whether current bank credit ratings are consistent with PD values. Conclusions are provided in Section 7, which also includes recommendations for a revised capital adequacy framework based on our findings.

The study does not make any representations about default probabilities of any individual banks. It is also noted that default probabilities calculated using structural methodology are based on available balance sheet and equity price information, and do not take into account external options available to banks for reducing default probability such as additional capital raising or government intervention.

2. Contribution and Benefits of the Study

Firstly, the study can benefit regulators and banks by providing new credit risk and capital adequacy methodologies which measure extreme risk. Not only is risk being measured during the extreme conditions of the global financial crisis, but asset values are being measured at their utmost fluctuation levels using CVaR. It is during adverse conditions when default is most likely to occur.

Secondly, the techniques are not only applicable to banks themselves, but can also be applied to corporate borrowers in assessing default probabilities.

Thirdly, CVaR is incorporated into PD calculations using the unique CPD methodology of the authors. A novel concept introduced in this study is the use of VaR and CVaR techniques to distinguish between real and nominal capital, and to formulate capital adequacy recommendations based on real equity levels.

Finally, the study provides insight into how the Swiss banking industry has been affected by extreme asset fluctuations.

3. VaR and CVaR

VaR is well understood and widely applied by the banking industry for measuring market risk and determining capital adequacy. VaR measures potential losses at a given level of confidence for a specific time period. There is extensive literature coverage on VaR. Examples include Jorion (1996), RiskMetricsTM (1996), as well as comprehensive discussion of VaR by more than seventy recognised authors in the VaR Modeling Handbook and the VaR Implementation Handbook (2009a, 2009b).

VaR has received widespread criticism since the onset of the global financial crisis. The banking industry is perceived to have placed overreliance on VaR models which focus on historical losses and which do not incorporate a measure of tail risk. Well before the financial crisis, VaR was found to have shortcomings. Artzner, Delbaen, Eber, & Heath (1999; 1997) found VaR to have certain undesirable mathematical properties; such as lack of sub-additivity, convexity and monotonicity. Analysts at Standard & Poor's (Samanta, Azarchs, & Hill, 2005) found VaR to have severe limitations which they believe could lull a company into a false sense of security. They report that VaR does not provide consistent measures of risk appetite across institutions due to varying assumptions used in its calculation. In addition VaR ignores tail risk, which is especially important under abnormal market conditions, and the S&P analysts report that VaR should ideally be used in conjunction with other measures.

One such other measure which does measure tail risk is CVaR. CVaR measures losses beyond VaR. If VaR is measured at the 95% confidence level, then CVaR measures the tail 5% returns. In addition to measuring losses beyond VaR, CVaR has been proved to be a coherent risk measure (Pflug, 2000), which does not demonstrate the undesirable mathematical properties of VaR. A number of papers apply CVaR to portfolio optimization problems; see for example Rockafeller and Uryasev (2002; 2000), Andersson et.al (2000), Alexander, Coleman & Li (2003), Alexander and Baptista (2003), Rockafellar et al (2006) and Menoncin (2009).

4. Probability of Default

We commence this section with a discussion on Basel requirements for bank counterparties as per the Bank for International Settlements (2004). We then discuss the background to the structural methodology used in this study.

4.1. Basel and Bank Exposures

Basel requires banks to calculate Tier 1 and Total Capital, and apply these as a percentage of risk weighted assets. For bank counterparties, risk weightings can be calculated using either the Standardised or Internal Ratings Based (IRB) approach. The standardised approach relies on external ratings for corporates and banks, with lower weightings applied to some bank categories as compared to corporates. This is shown in Table 1.

Table 1 to be placed about here

A range of adjustments are applied according to circumstances. For example, lending fully secured by residential property is weighted at 35%, and secured by commercial property 100%. Past due loans are weighted at 100 - 150% depending on specific provisions.

Banks using an IRB approach must use it across the entire banking group. For corporate, sovereign, and bank exposures, data under the advanced approach must cover one business cycle but must in any case be at least 7 years. The capital requirement (K) is calculated as a function of:

P Probability of default (also often referred to as PD)

LGD Loss given default

EA Exposure at default

M Effective maturity (in some cases)

This approach has two levels – the foundation approach and the advanced approach. Under the foundation approach, banks generally provide their own P and rely on supervisory estimates for other components. Under the advanced approach, banks generally provide more of their own estimates of P, LGD, EA, M, subject to meeting certain standards.

4.2. Structural Models and PD

Using the option pricing methodology of Black & Scholes (1973), the Merton (1974) structural model assumes that the firm has one single debt issue and one single equity issue. The debt (D) is consistent with a zero coupon bond that matures at time (T). The initial position (asset value) of the firm is:

$$A_0 = E_0 + D_0 \tag{1}$$

The value of the firm $V_0 = A_0$. At T, the firm pays off the bond and the remaining equity is paid to the shareholders. The firm defaults if the debt obligation exceeds the asset value of the firm at T. In this case the bondholders take ownership of the firm and the shareholders get nothing (due to limited liability of shareholders the amount will not be negative). The amount paid to bondholders = b. Equity at T (remaining value payable to the shareholders) is as follows:

$$ET = VT - b \tag{2}$$

Where the debt value is greater than the asset value, then ET = 0. Thus the value of a firm's stock at debt maturity:

$$ET = max(AT - b, 0) \tag{3}$$

This is the same as the payoff of a call option on the firm's value with strike price b. A call option is an option contract that gives the holder the right to buy a certain quantity (usually 100 shares) of an underlying security from the writer of the option, at a specified price (the strike price) up to a specified date (the expiration date).

If, at T, assets exceed loans, the owners will exercise the option to repay the loans and keep the residual as profit. If loans exceed assets, then the option will expire unexercised and the owners (who have limited liability) default. The call option is in the money where AT – b > 0, and out the money where AT – b < 0.

Under the KMV model, Probability of Default PD is a function of the distance to default DD (number of standard deviations between the value of the firm and the debt) determined by using the market value of assets (A), less the amount of debt (b) divided by the volatility of assets σ.

$$\frac{A-b}{\sigma A} \tag{4}$$

PD can be determined using the normal distribution. For example, if DD = 2 standard deviations, we know there is a 95% probability that assets will vary between 1 and two standard deviations. There is a 2.5% probability that they will fall by more than 2 standard deviations.

KMV find that the normal distribution approach followed by Merton results in PD values much smaller than defaults observed in practice. KMV has a large worldwide database from which to provide empirically based Estimated Default Frequencies (EDF). For example, KMV finds that historical data shows that firms with a DD of 4 have an average default rate of approximately 1% and therefore assign an EDF of 1% to firms with this DD. By comparison, the normal distribution approach yields a PD of almost 0 for this DD. (Crosbie & Bohn, 2003).

In KMV, b is taken as the value of all short-term liabilities (one year and under) plus half the book value of all long term debt outstanding. T is usually set as 1 year.

Thus the KMV model consists of 3 steps. Firstly, estimate market value and volatility of firm's assets. Secondly, calculate distance to default. Thirdly, match distance to default to an empirically obtained EDF.

Merton assumes that asset values are log normally distributed. Distance to default and probability of default are calculated as:

$$DD = \frac{\ln(V / F) + (\quad - 0.5\sigma_V^2)T}{\sigma_V \sqrt{T}} \tag{5}$$

$$PD = N(-DD) \tag{6}$$

where

V = market value of firms debt

F = face value of firm's debt

μ = an estimate of the annual return (drift) of the firm's assets

N = cumulative standard normal distribution function.

Different aspects of credit risk using structural methodology have been examined by several authors, such as extreme risk (Allen & Powell, 2007a, 2007b), asset correlation (Cespedes, 2002; Kealhofer & Bohn, 1993; Lopez, 2004; Vasicek, 1987; Zeng & Zhang, 2001), predictive value and validation (Bharath & Shumway, 2004; Stein, 2002), fixed income modeling (D'Vari, Yalamanchili, & Bai, 2003), default probabilities and capital (Bischel & Blum, 2004) and the effect of default risk on equity returns (Chan, Faff, & Koffman, 2008; Gharghori, Chan, & Faff, 2007; Vassalou & Xing, 2002).

5. Data and Methodology

5.1. Data

The study compares Swiss banks to a 'pool' of global banks. 15 years of equity data is obtained from Datastream, together with current balance sheet data on equity and debt. Swiss banks include listed banks for which equity prices and Worldscope balance sheet data are available in Datastream. This involves 24 Swiss banks with total assets of CHF 4.5 trillion. The "pool" comprises the 20 largest banks in the world (aside from Swiss banks and also excluding Chinese banks for which an insufficient length of data is available). The "pool" is summarised in Table 2.

Table 2 to be placed about here

5.2 VaR and CVaR Methodology

We use the parametric method of RiskMetrics (J.P. Morgan & Reuters, 1996) who introduced and popularised VaR. We calculate the logarithm of price relatives every day for each bank for the past 15 years. Based on a normal distribution, the standard deviation is multiplied by 1.645 to obtain VaR at 95% confidence level. As we are not calculating VaR for investment purposes, we do not need to show the effect of portfolio diversification. We therefore use an undiversified approach, whereby total VaR is the weighted average of the individual bank VaRs. CVaR is calculated as the average of the worst 5% of returns, i.e., returns beyond VaR.

5.3. Structural Methodology

We apply the Merton methodology discussed in Section 4.2. An initial estimation for asset returns is made using the equity volatility obtained in section 5.2 and multiplying it by equity as a percentage of asset value. The daily log return is calculated and new asset values estimated. This is applied for every day. Following KMV, this process is repeated until asset returns converge.

In order to measure DD at the most extreme of the asset value fluctuations, we also incorporate CVaR methodology into the structural model. Prior applications of this methodology have been applied to Australian sectoral analysis and US and UK banks (Allen & Powell, 2009a, 2009b; Powell & Allen, 2009a, 2009b). We substitute the standard deviation of all returns with the standard deviation applying to the most extreme 5% of returns (CStdev) to calculate a conditional DD (CDD) and conditional PD (CPD) as follows:

$$CDD = \frac{\ln(V/F) + (\quad - 0.5\sigma_V^2)T}{CStdev_V \sqrt{T}} \tag{7}$$

$$CPD = N(-DD) \tag{8}$$

6. Results

Table 3 to be placed about here

VaR and CVaR results are summarised in Table 3 which shows how both VaR and CVaR reduce over the boom times in the mid 2000's and then spike during the Global Financial Crisis (GFC) period, dramatically so in 2008. It is also interesting to note that volatility is noticeably lower for Swiss banks during the GFC period. CVaR is much higher than VaR, especially during the GFC period. Figure 1 illustrates these trends with 3 point polynomial trend lines.

Figure 1 to be placed about here

Up to this point, we have only focused on fluctuations in equity values, which are an important component of default probability. We now analyse the results of our structural modeling. This is summarised in Table 4.

Table 4 to be placed about here

Both the Pool and Swiss banks show a dramatic jump in default probabilities in 2008, with DD falling below one standard deviation, although the PD is slightly lower for Swiss banks. CPD values exceed 40% for Swiss and Pool banks. Swiss DD and CPD trends are shown in Figure 2 and compared to the Pool in Figure 3.

Figures 2 and 3 to be placed about here

Swiss banks show a fairly similar default trend to the pool (for DD and CPD), with DD increasing during the mid-2000's and decreasing dramatically during the GFC. Whilst in earlier years, default distance was further than the pool, this has narrowed during the mid to late 2000's. However, if we analyse the components of distance to default, then we see this similarity in default distances between Swiss and Pool banks is caused by different factors. DD is a function of two key components: leverage and asset volatility. For example, in a bank with equity of 10%, if market value of assets reduces by 10% then the default line is breached.

Figure 4 to be placed about here

Figure 4 shows the relationship between equity, market value of assets and DD. In 2008 DD levels for Pool and Swiss banks are very similar. Pool market equity is approximately 10% with Swiss market equity approximately 8%. Therefore Swiss banks have a shorter distance to travel to default. However, Swiss Asset VaR is lower. Asset VaR peaks in 2008 at approximately 6% for the pool, and 4% for Swiss banks. The combination of lower market equity, lower VaR for Swiss banks results in a similar DD to the higher capital, higher VaR combination of Pool banks.

Standard & Poor's (2008), provide transition default probabilities associated with credit ratings. Almost all the banks in our sample of Swiss and Pool banks carry a credit rating above BBB, equating to transition to default probabilities of less than 0.5% for 2008. This is significantly lower than the default calculated in Table 4 based on fluctuating asset values.

We now examine impacts of market movements on capital adequacy. If market asset values reduce by 10% (VaR is 10%), then in real terms capital also reduces by 10%. Current capital requirements for banks are based on book values (nominal values) as opposed to market values (real values). Therefore real capital (Kr) can be measured as nominal capital requirement (K) less market asset VaR. Alternatively, Asset CVaR (CStdev) can be used, giving a more conservative measure, shown for Company x as follows:

$$Kr_x = K_x - CStdev_x \tag{9}$$

Current nominal capital requirements are designed to cover credit risk and market risk associated with operations, not asset value fluctuations. Therefore to cover these asset value movements, required capital (K*) should be increased by the fluctuating asset value. For Company *x*, this is depicted as follows:

$$K^*_x = K_x + CStdev_x \tag{10}$$

The relationship between real and nominal capital is shown in figures 5.

Figure 5 to be placed about here

7. Summary and Conclusions

Four key observations are made from the results. Firstly VaR, CVaR, DD and CPD all follow a similar trend. Risk is moderately high during the early 2000's reducing substantially during the mid 2000's and increasing dramatically during the GFC.

Second, Swiss banks show similar default levels to the Pool. However this is brought about through a combination of lower equity and lower asset value fluctuations as compared to the pools higher equity and higher asset value fluctuations.

Third, default probabilities based on fluctuating asset values are much higher than default probabilities shown by external credit ratings.

Fourth, asset value fluctuations have severely eroded bank equity during the GFC. In real terms capital adequacy is poor, and nominal capital needs a significant boost.

The results of this study provide a strong case for capital adequacy reform. Leverage ratios are certainly a step in the right direction, however, the setting of a leverage level needs to factor in moving asset values. It is of course not practical to have continuously fluctuating capital requirements. However, it is strongly recommended that the required capital adequacy level is based on an assessment over time of real, as opposed to nominal capital. CStdev is recommended as a good method for assessing real capital requirements (as per figure 5), given that it measures tail risk, and extreme circumstances are when banks are most likely to fail.

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Tables

Table 1. Basel II Risk Weights

Credit assessment	AAA to AA-	A+ to A-	BBB+ to BB-	BB+ to B-	Below BB-	Unrated
Corporate Risk Weight	20%	50%	100%	100%	150%	100%
Bank Risk Weight	20%	50%	50%	100%	150%	50%

Basel Capital requirements are based on capital (Tier 1 and Total capital) as a percentage of risk weighted assets. The percentages show the risk weightings that must be applied to the assets for the purpose of calculating capital allocation. The Corporate risk weightings do not include exposures to small business. The bank risk weightings are those that must be applied to Bank counterparties.

(Compiled from Bank for International Settlements, 2004)

Table 2. "Pool" of Banks Used in This Study

Region	Number of Banks	Assets USD $tr
U.S.	4	6.04
U.K.	4	4.66
Other European	9	16.86
Asian	3	4.91

There are 20 Banks included in our Banking Pool. This consists of the world's largest non-Swiss Banks. Chinese banks are also excluded, due to insufficient length of equity information. A full listing of Swiss and Pool banks is contained in Appendix 1.

Table 3. VaR and CVaR - Results Summary

	Swiss Banks		Pool	
	Daily VaR	Daily CVaR	Daily VaR	Daily CVaR
2008	0.0791	0.1117	0.1127	0.1584
2007	0.0418	0.0609	0.0444	0.0597
2006	0.0195	0.0272	0.0176	0.0249
2005	0.0213	0.0301	0.0192	0.0266
2004	0.0143	0.0190	0.0154	0.0215
2003	0.0194	0.0261	0.0206	0.0283
2002	0.0364	0.0515	0.0352	0.0481
2001	0.0402	0.0569	0.0437	0.0621
2000	0.0369	0.0544	0.0412	0.0573
1999	0.0278	0.0398	0.0396	0.0534
1998	0.0293	0.0386	0.0393	0.0524
1997	0.0474	0.0716	0.0494	0.0706
1996	0.0276	0.0386	0.0361	0.0504
1995	0.0174	0.0270	0.0242	0.0336
1994	0.0175	0.0236	0.0256	0.0353

The table shows Daily VaR and CVaR. VaR is calculated on a parametric basis, whereby the standard deviation of daily returns is multiplied by 1.645 (being 95% confidence level based on a normal distribution). Annual VaR can be obtained by multiplying Daily VaR by the square root of 250. Figures are undiversified and represent the weighted average of the individual Bank VaRs. CVaR is calculated as the average of the worst 5% of actual returns (those beyond the 95% VaR).

Table 4. Distance to Default - Results Summary

	Swiss Banks				Pool			
	DD	PD	CDD	CPD	DD	PD	CDD	CPD
2008	0.94	0.1729	0.24	0.4037	0.68	0.2486	0.16	0.4359
2007	1.86	0.0315	0.46	0.3215	1.87	0.0305	0.48	0.3172
2006	4.06	0.0000	1.04	0.1491	4.66	0.0000	1.14	0.1262
2005	3.72	0.0001	0.96	0.1691	4.12	0.0000	1.03	0.1513
2004	5.46	0.0000	1.46	0.0723	5.28	0.0000	1.31	0.0958
2003	4.04	0.0000	1.08	0.1406	3.60	0.0002	0.89	0.1864
2002	2.25	0.0123	0.58	0.2820	2.15	0.0160	0.54	0.2958
2001	1.99	0.0231	0.51	0.3054	1.84	0.0332	0.45	0.3269
2000	2.35	0.0094	0.58	0.2817	1.88	0.0302	0.45	0.3269
1999	2.68	0.0036	0.68	0.2471	1.93	0.0266	0.48	0.3161
1998	2.54	0.0055	0.71	0.2400	1.95	0.0257	0.49	0.3127
1997	1.58	0.0576	0.38	0.3518	1.55	0.0606	0.36	0.3588
1996	2.70	0.0034	0.71	0.2403	2.12	0.0170	0.51	0.3060
1995	4.29	0.0000	1.01	0.1570	3.16	0.0008	0.76	0.2234
1994	4.27	0.0000	1.15	0.1246	2.99	0.0014	0.72	0.2348

Calculations are described in Sections 4.2 and 5.3. DD shows the number of standard deviations to default of the market value of assets. Default occurs when the firm's debt exceeds asset values. Debt is measured as current debt plus 50% of long term debt. Prior year figures calculate the distance to default of current balance sheet values based on historical fluctuations in asset values. CDD and CPD are calculated as for DD and PD, but based on the worst 5% of asset returns.

Figures

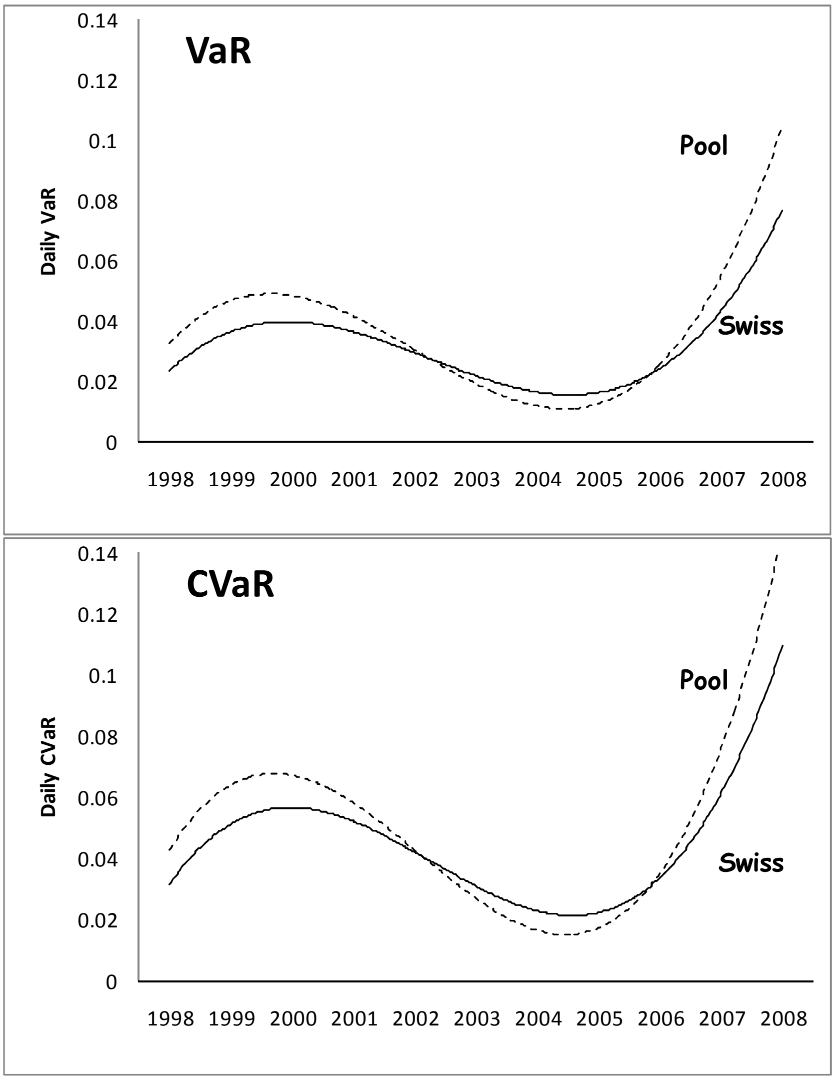


Figure 1. The figure compares Daily VaR and CVaR between the Swiss Banks and the pool of European Banks using an order 3 polynomial trend line. VaR is calculated on a parametric basis, whereby the standard deviation of daily returns is multiplied by 1.645 (being 95% confidence level based on a normal distribution). Annual VaR can be obtained by multiplying Daily VaR by the square root of 250. Figures are undiversified and represent the weighted average of the individual Bank VaRs. CVaR is calculated as the average of the worst 5% of actual returns (those beyond the 95% VaR).

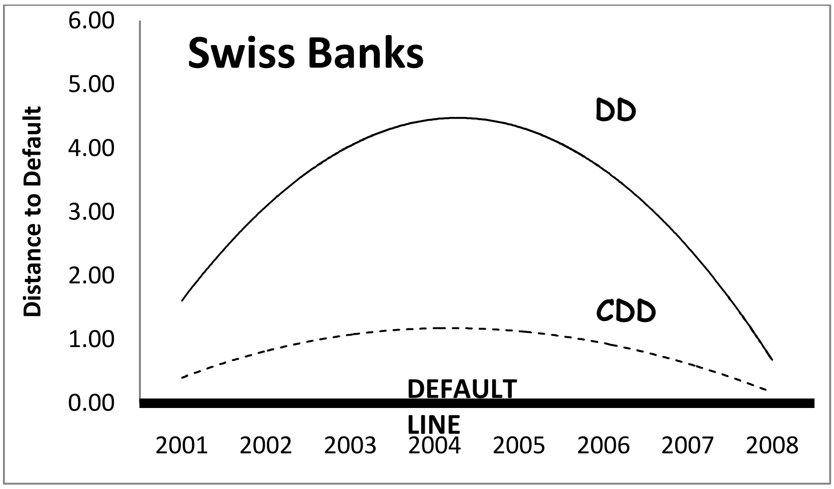


Figure 2. The figure compares Distance to Default (DD) and Conditional Distance to Default CDD of Swiss Banks. DD is calculated using Metrton structural methodology, and shows the number of standard deviations to default of the market asset of assets, with default occurring when the firm's debt exceeds asset values. CDD is calculated as for DD but based on the worst 5% of asset returns. The order 3 polynomial trendline shows how distance to default increased over the mid-2000s and reduced during the GFC.

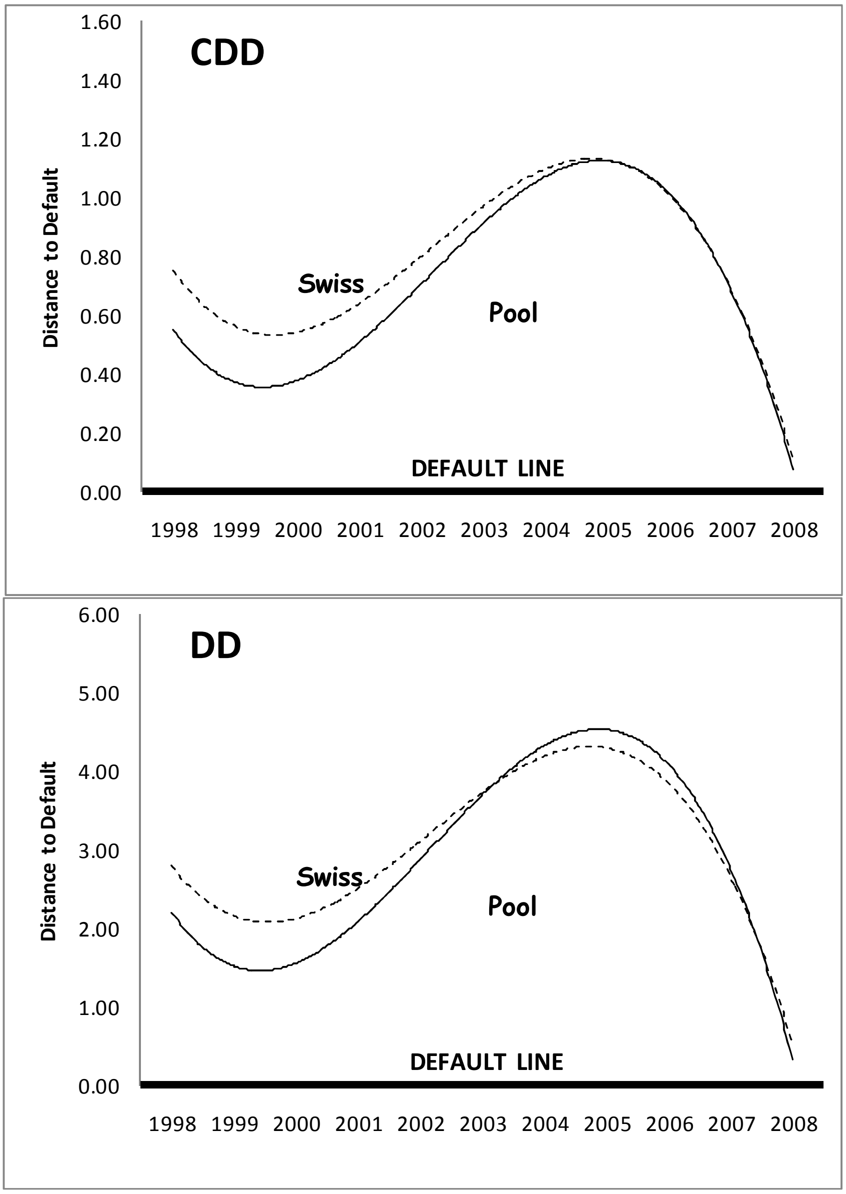


Figure 3. The figure compares Distance to Default (DD) and Conditional Distance to Default CDD between Swiss Banks and the pool of European Banks. DD is calculated using Merton structural methodology, and shows the number of standard deviations to default of the market asset of assets, with default occurring when the firm's debt exceeds asset values. CDD is calculated as for DD but based on the worst 5% of asset returns. The order 3 polynomial trendline shows how distance to default increased over the mid-2000s and reduced during the GFC. A similar trend is noted for Swiss Banks and Pool Banks, with pool banks showing a somewhat higher probability of default than Swiss Banks during downturn periods of the early 2000's.

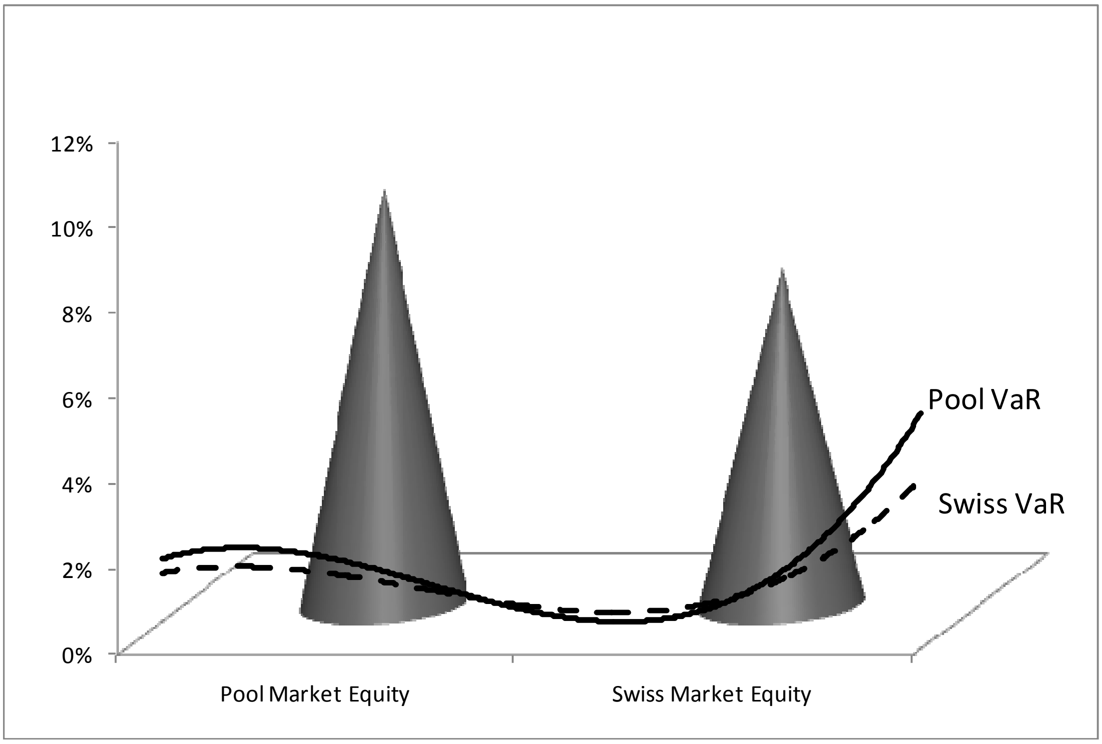
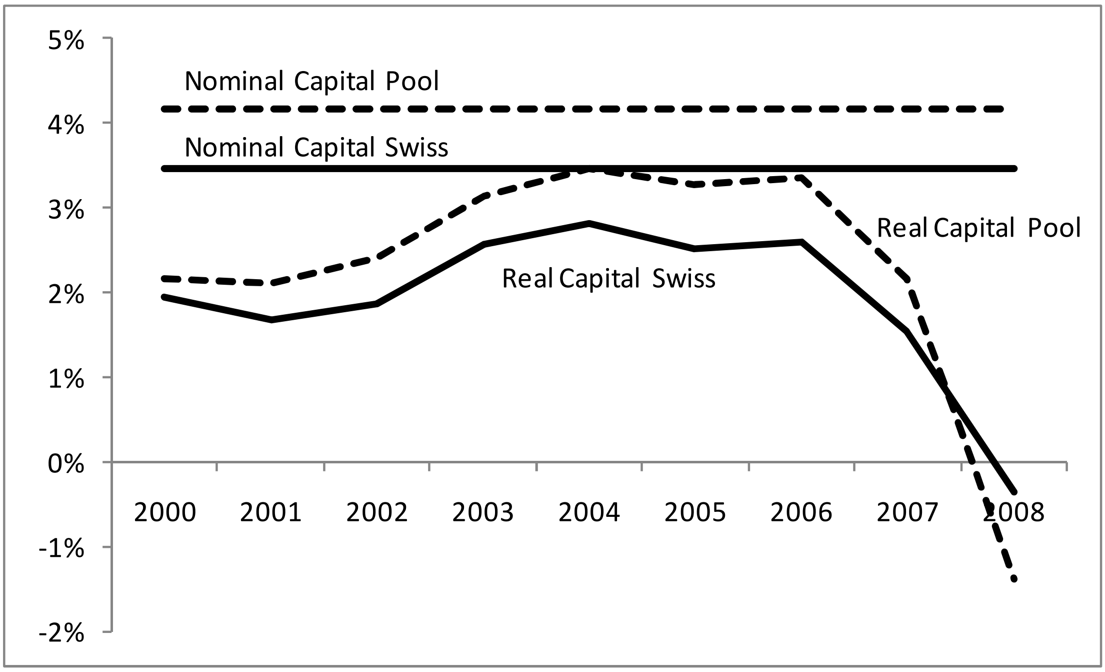


Figure 4. The figure shows market asset VaR (99% level) for years 2000 - 2008 (represented by the 'waves') superimposed on bank market equity levels (represented by the 'cones'). In this diagram we define market equity per KMV as the distance between market asset values and debt (debt being current debt plus half of long term debt). Default occurs when the wave level rises above the cone level. Using VaR, this comes closest to happening in 2008. If CVaR were used, the waves are at higher levels.



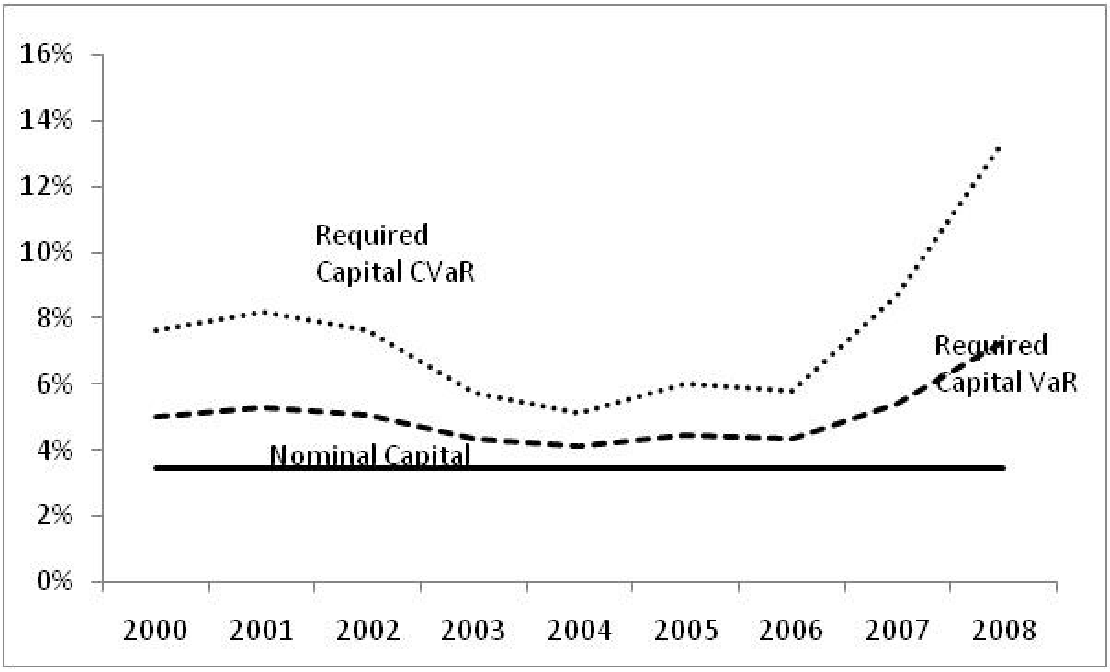


Figure 5. The top graph compares nominal capital to real capital, where real capital in this graph is Nominal capital (K) – Asset VaR (at 95% confidence level). Figure 6 shows the required capital to cover asset value fluctuations for Swiss banks. The lower graph shows required capital to cover fluctuations in asset values. Required capital as measured by VaR is nominal capital + VaR, and to cover extreme asset fluctuations is nominal capital + CVaR.

Appendix 1. List of Banks Used in This Study

Swiss Banks	Pool Banks	
Bank CA St. Gallen	Banco Santander	Spain
Bank Linth	Bank of America	U.S.
Bank LLB	Barclays Bank	U.K.
Bank Sarasin	BNP Paribas	France
Banque Cantonale de Genève	Citigroup	U.S.
Banque Cantonale du Jura	Commerzbank	Germany
Banque Cantonale Vaudoise	Credit Agricole	France
Basellandschaftliche Kantonalbank	Deutsche Bank	Germany
Basler Kantonalbank	Dexia	Belgium
BEKB/BCBE	HSBC Holdings	U.K.
Coop Bank	ING Bank	Netherlands
Credit Suisse Group	JP Morgan	U.S.
EFG International	Lloyds TSB	U.K.
Graubündner Kantonalbank	Mitsubishi UFJ	Japan
Hypothekarbank Lenzburg	Mizuho Financial Group	Japan
Luzerner Kantonalbank	Royal Bank of Scotland	U.K.
Neue Aargauer bank	Societe Generale	France
Schwyzer Kantonalbank	Sumitomo Mitsui	Japan
St.Galler Kantonalbank	UniCredit	Italy
UBS AG	Wells Fargo	U.S.
Valiant Bank		
VP Bank		
Walliser Kantonalbank		
Zuger Kantonalbank		

Swiss Banks include all listed banks for which Equity and WorldScope balance sheet data is available on Datastream. Pool banks include the 20 largest Global non-Swiss banks by total asset values for which equity and balance sheet data is also available on Datastream. Inclusions are similar to lists of the largest world banks provided by other sources (BankersAlmanac, 2009; The Banker, 2009), but Chinese banks are excluded due to insufficient historical equity data.