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Are Banks in Switzerland Too-Big-To-Fail?

Master Thesis in Economics

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Abstract

Too-big-to-fail has been a subject of controversy and has gained much attention in the course of the sub-prime financial crisis 2007-2009. Subjects related under this topic for instance are usually about the excessive risk taken by the government, and moral hazard. In this paper, we perform an analysis to examine the existence of too-big-to-fail impact on the banking sector in Switzerland during the financial crisis. By implementing a structural model to value the CDS contracts, and thus compare the model estimates with market observation. Deviation between model estimates and market data indicates the asymmetric expectations between shareholders and creditors. Since government bailout tends to favor creditors, thus the stock-implied model estimates will be less affected. As we expected, overestimation of model predicted CDS spreads are found for banks in Switzerland, where the magnitude differs by government intervention. Our results comply with the theory that under government bailout, the expected default probability diverges between shareholders and creditors, which is a sign of having too-big-to-fail impact.

Key words: Too-big-to-fail, Credit Default Swaps, CreditGrades model, Structural model

Contents

1 Introduction

"A too-big-to-fail firm is one whose size, complexity, interconnectedness, and critical functions are such that, should the firm go unexpectedly into liquidation, the rest of the financial system and the economy would face severe adverse consequences"

- Bernanke B.S (2010).

Banks have for centuries failed, many unnoticed and others capture attention of the public and policymakers. The banks that get noticed are the ones that are large in size and play a significant part in the financial system. A bankruptcy can affect not only the financial system but also other financial institutions and the economic order. The term "too-big-to-fail" describes insolvent banks that are supported by government interventions even though they are not automatically entitled to receive the funding. A significant reason is to protect the uninsured creditors from losing part or the whole sum that has been invested into the bank. When creditors of too-big-to-fail banks expect government supports, their monitoring of the banks activities reduces which can create a platform for the banks to take on excessive risk by increasing the loans and unnecessary costs. This application is more known as the Moral Hazard problem and can lead to billions of dollars lost in income for countries because of the increased risk taken by too-big-to-fail banks. Stern and Feldman (2004) emphasized a couple of years before the crisis the importance of decreasing the expectations creditors have on too-big-to-fail protection in order to minimize the future damage on the financial stability. They also argued that the too-big-to-fail problem has only increased during the last years due to consolidation in the banking industry and the advances in the technology. Technology has allowed larger banks to take on a more significant payment system and has given the incitements to rely on uninsured wholesale funding. They also emphasize that some banks have increased in complexity and thus have become "too-complex-to-fail".

The last financial crisis during 2007-2009 raised the concern of the too big to fail issue, especially when the collapse of Lehman Brothers in September 2008 transpired. Governments and central banks joined in force to save the financial system and tried to stop the spread of financial contagion. When a larger financial institution is in distress the government´s main priority is to avoid default. Schweikhard and Tsesmelidakis (2011) illuminate that creditors are prioritized and honoured while shareholders are uncertain of their outcome. Simply put, government interventions are mainly focused on creditors and do not favour shareholders. A clear example occurred when JP Morgan Chase acquired the investment bank Bear Stearns during May in 2008, where the Federal Reserve granted a USD 30 billion loan to JP Morgan. The reason for this was to ensure that JP Morgan was able to cover the Bear Stearns´s risky assets. Since this was considered by the market as a rescue plan for the creditors of Bear Stearns, it resulted into a mismatch between the credit market and stock market of the market price of default risk, the default risk on the stock market increased and exceeded the risk on the credit market (Schweikhard & Tsesmelidakis, 2011). Kaufman (2002) argued in an early stage that disagreements about the definitions of the term and thus the calculations of the costs and profits make this issue hard to solve. In line with Völz & Wedow (2011), Barth & Davis (2008) and Demirgüç-Kunt & Huizinga (2010) investigated what impact a bank´s size and government in despair has on the stock price and the CDS spreads. Yu (2005) tried to conduct a research by looking at different volatilities and their impact on the CDS Spread. Schweikhard and Tsesmelidakis (2011) use calibration on the data before the crisis and underline the misfit between the credit market and equity market during the crisis, which is indicated by the higher stock-implied default risk.

The term too-big-to-fail is used to explain the fact that when large financial institutions are trapped in distress, government bailout tends to occur in order to prevent a chain effect of catastrophes due to the large interconnectedness (Schubert, 2011). The aim of this study is to examine the existence of the too-big-to-fail impact on the Swiss banking sector during the recent subprime crisis. Switzerland, as many other countries was deeply affected by the financial crises. Especially, the two largest financial institutions in Switzerland, UBS and Credit Suisse, had difficulties during the crisis but in different ways.

The analysis is performed by comparing the CDS spreads estimated using a structural model with the actual market spreads. Credit valuation is based upon the structural approach for modeling CDS spreads, and estimated from the Merton (1974) model, which values equity and debt as contingent claims with the firm value. Based on the Merton framework, the CreditGrades model utilizes firm fundamentals with only balance sheet and stock market data to calculate theoretical CDS spreads. According to Byström (2006) the model is because of that more straightforward. The observed deviations in this setting indicate different expectations on default probabilities between shareholders and creditors, and thus is an evidence of the existence of too-big-to-fail impact.

The uniqueness of this paper is that the method used makes it possible to detect the impact of too-big-to-fail, by observing the deviations between modelled and market observed CDS spreads. In addition, very few studies were done using the CreditGrades model and thus make this paper more interesting to write about.

In *section 2*, we start with a review on the previous literature that has been done on the too-big-to-fail issue and the structural model. Followed by the next section with an overview of too-big-to-fail and its impact on banking sectors. *Section 4* gives a general picture about the Swiss banking system with a focus on the two largest banks, UBS and Credit Suisse. *Sections 5* and *Section 6* provide the methodology of this paper, starting with explaining the CreditGrades model, as well as the data collection and model implementation method. At last, the results are presented in *Section 7* while conclusion and further research in *Section 8*.

2 Literature Review

This section of the paper reviews previous literature on topics about the too-big-to-fail issue and the structure model. That provides some background knowledge on the two most important concepts of this paper.

2.1 Too-Big-To-Fail

At the beginning of the 21st century, the too-big-to-fail problem intensified and the interest to find a resolution for insolvent large financial institutions increased. Kaufman (2002) argued that too-big-to-fail impact is hard to resolve because there are disagreements about the definitions of the term and thus the calculations of the costs and profits.

Prior to the financial crisis of 2007-2009, Stern and Feldman (2004) wrote a book on the issue of too-big-to-fail. The following quote summarizes the attention of the book: *"Despite some progress, out central warning is that not enough has been done to reduce creditors´ expectations of* too-big-to-fail *protection."* The reason for this warning lies behind the fact that when creditors believe that they will be bailed out by the government there is less incentive for them to monitor the banks and their activities. Furthermore, when this kind of market discipline is relaxed, banks may engage in excessive risk taking actions. The authors also alert that the too-big-to-fail impact has been growing and has become more severe because of the growth in size of banks, more complex operations, more concentrated assets in the industry and certain policy trends that can contribute to the severity. Later on, Mishkin (2005) wrote a review on the book where he argued that Stern and Feldman (2004) overestimated the issue with too-big-to-fail because the legislation that was implemented during the 1990s made it less likely to occur.

When it comes to credit derivatives, Yu (2006) conducted a research on which volatility measure is more informative, historical or option-implied volatility, once the CDS contracts have to be priced. They noticed that option-implied volatility offers more significant results than historical volatility for time-series regressions. The CreditGrades model, as one of the structural models, was used in order to illustrate the non-linear relationship between CDS spreads and volatility. The results showed that implied volatility is beneficial when it comes to companies with lower credit rating, greater option volume and companies with a significant increase in CDS due to a credit event. Another paper that tried to stipulate the structural model of Merton (1974) was Schweikhard and Tsesmelidakis (2011). They applied the calibration method on the data before the crisis and indicated that there was a misfit between the credit market and equity market during the crisis, which can be seen in higher stock-implied default risk. Shareholders are exposed to higher risk since the government puts its focus on saving the debt of the bank, and this entails that creditors have a lower risk. This creates a gap between the effects of default on the two markets, but when the calibration lowers the default boundary as a sign of support from the government, the two markets can be connected.

In Völz and Wedow (2011) paper they emphasized that under too-big-to-fail impact, the CDS spreads decrease as the bank size increases, as a consequence of an inflated probability of bailout. The CDS spreads can decrease up to two basis points when a growth in mean of one percentage occurs. Even though, this can be seen as a trivial reduction, the problem occurs when two superior banks merge, and the size increases extensively. Another aspect of the paper touches upon the issue of banks that are already too-big-to-rescue. Even though this can be seen as something positive for the managers it can have a huge impact on the fiscal budget and the overall financial stability. Solutions need to be created in order to reduce the probability of default or manage the failure without colossal costs on the society. A more recent paper that positions its focus on size is the editorial of Barth and Schnabel (2012), which argued that bank size is not a good indicator of systematic risk, the reason for that is since it does not take into account interconnectedness, correlation and the economic situation. With the help of Adrian and Brunnermeier (2011) they were able to control systematic risk using the CoVaR measurement. Their theory on too-systematic-to-fail is supported by their results, which specify that when a bank influences systematic risk it provides negative effects on the CDS spreads. They also found that size does not have an effect on the CDS spreads. The terms "too-systematic-to-fail" and "too-big-to-save" became an important factor in their contribution.

In line with Völz and Wedow (2011) as well as Barth and Schnabel (2012), Demirgüç-Kunt and Huizinga (2010) discussed in their paper what impact the size of the bank and a government distress can have on the stock prices and the CDS spreads. The financial crisis of 2008 had large negative impacts on the countries and governments, which raises the question if governments that are in despair are able to rescue future failing banks and their creditors. Their first outcome specifies that a bank´s market-to-book ratio is negatively connected to the size and the systematic risk, which suggests that some banks have grown too big to be rescued. The second outcome provides that CDS spreads are negatively linked to countries fiscal balance, so if a country does not have strong public finances it will be harder to rescue a bank on the verge of bankruptcy.

2.2 Structural Model

There are three different models that have been used to value the credit derivatives. First in line is the model provided by (Alman, 1968), where he conducted a research based upon companies that have defaulted and companies that survived. The analysis is made on companies' right before the default in order to identify characteristics of the company. The other model is called the reduced model where the information is extracted from real credit prices in order to receive their default probabilities. This model gives information on how the market looks like at individual credit level but does not explain the reason behind the probability of default. Nevertheless, it compares different structures of credit risk but cannot provide information on the price if the market does not exist. The third model, central in this paper, is the *structured model* that was originally derived from Black and Scholes (1973) and Merton (1974). The Merton model describes that the default is present when the firm´s asset drops below a barrier, which indicates that the structure of the individual firm and the asset volatility defines the default. To be able to evaluate the model one must estimate the volatility and the market value of the firm´s asset. The parameters used in the model can only be estimated for companies with publicly traded equity, which is not always available (Smithson, 2003).

Within the group of structural models, RiskMetrics Group created the CreditGrades Model in 2002 (Finger et al., 2002), which is the model that will be implemented in this paper. The model is set apart from the other models described due to two reasons. First, other models aim to separate default companies from healthy companies and measure the precise probability of default. Second, the time reference is more present in the CreditGrades model since the estimates are done when a firm´s credit is getting reduced.

3 Too-Big-To-Fail

The purpose of this paper is to address the too-big-to-fail impact on Swiss banking sector; therefore it is important to have some insights on the concept of too-big-to-fail, this section starts with a historical review followed with an European perspective and eventually its application on banking system.

3.1 Historical Review

Too-big-to-fail is a term that has repeatedly been used in order to describe in which way bank regulators deal with banks that are in despair. In 1984, the bank Continental Illinois National in Chicago was the first major bank that received the term "too-big-to-fail." Continental Illinois National in Chicago was the seventh largest bank in the US at that time and had interconnectedness with more than 2,200 other banks via interbank deposits and Fed funds. During that period, regulators in the US applied what was before used on smaller banks to prevent the banks from collapse: selling its assets, insuring deposits by allowing another bank to take over at par and by protecting all uninsured depositors and creditors against losses, and as a result, banks survived from bankruptcy. Since the bank was large in size and had an extensive interconnectedness with other banks, the regulators thought that allowing the bank to fail would cause a chain reaction and affect other banks and furthermore the financial market and the macro-economy. In addition, the regulators provided funds to the parent company of the Continental via equity capital without any concern on the consequences it entailed. As a result, the banks operated as normal but under Federal Deposit Insurance Corporation (FDIC) control and a new senior management (Kaufman, 2002).

A couple of years later the hedge fund Long-Term Capital Management (LTCM) experienced significant losses and liquidity issues because of the consequences of the Asian and Russian financial crisis in 1997-1998. The hedge fund had to be rescued by larger banks under the support of the Federal Reserve of New York in September 1998. The failure of LTCM indicated an important factor that had to be considered; even though the hedge fund was not considered to be large (assets amounted up to USD100 billion), many researchers thought it would have had catastrophic consequences if they filed for bankruptcy because of the chain reaction it would have caused (Goldstein & Véron, 2011).

3.2 The Perspective of Europe

The historical and political foundation of the too-big-to-fail impact looks a bit different within the European Union. The continent consists of independent centralized-nation states with substantial financial integration where the national government encourages a strong autonomous financial sector that can be strong enough to be compared with the largest financial sectors in the world. Their aim is to protect and foster banks in order to prevent the disappearance or foreign takeover, which is done by consolidation or nationalization. A clear example took place during 1870s when the Deutsche Bank in Berlin was created to encounter the large British banks that headed the international transactions. During the World War II and in the aftermath of the Great Depression, the government such as Italy in 1933 and France in 1946 nationalized many financial institutions in the banking sector (Goldstein & Véron, 2011). There is a significant difference between US and European Union when it comes to attitudes towards bank failures. In the US, the tolerance for corporate insolvency is bigger than in the European countries, and they are more protective on corporate executives and employees. However, in Europe banking failure triggers many negative memories, for instance in Europe, the last wave of bank default occurred in 1931 during the Second World War. Therefore, if a bank is in despair among European countries, it is supported at all costs even if the bank is small. The US also consists of many non-bank financial institutions, which provide financial services such as asset management or broker dealing. While within the European Union banks accommodate for most of the financial services.

In order to grasp the term too-big-to-fail more correctly one has to be able to define what is meant by "too-big." There is no particular measure or bank attribute that provides a straightforward answer, but the level of systematic risk possessed by the bank has given better guidelines. A couple of years ago the European Central Bank (ECB) identified in their framework what it considers as large and complex banking groups (LCBGs). The aim of their framework was to prove that the traditional analysis of asset size in the balance sheet was not enough to explain the term of too-big-to-fail and the interconnections in the financial sector. ECB argued that it was also important to include activities that banks were engaged in, especially the ones not included in the balance sheet. (Goldstein & Véron, 2011) states that the ECB proposed 19 different key factors that had to be taken into consideration when defining the size of the bank. Although, many more factors were in fact involved, the asset size alone was discovered to be a sufficient measure for LCBGs. With R^2 of 0.93 between total assets and the compound index it was proven that size of the assets provided enough information to define the scale of “too-big”.

Through out the years many European banks increased their size via international funding, well enough to be compared to the respective country’s GDP. A small country like Iceland was able to have a banking system that was nine times greater than the country’s GDP in 2007. Switzerland and United Kingdom had during 2008 reached a size that was 6.3 and 5.5 times their countries’ GDP. Banks in Belgium, Denmark, France, Ireland and Netherlands had reached the amount of liabilities that was two times their GDP. Thereby if assets are compared to the home country´s GDP, the European banks are more likely to be considered too-big-to-fail. This indicates that the too-big-to-fail impact is more present in the European Union than in the US. Even though there is much integration between the European Union countries and the aim is to create one single financial market, in most cases when a bank defaults the government in the home country will have to intervene, not the European Union. (Goldstein & Véron, 2011).

Iceland, a small country in Europe that did not want to participate in the European Union suffered a great deal during the crisis. The three of the largest banks in Iceland filed for bankruptcy, and the consequences were catastrophic. The damage after the financial crisis was estimated to be 800% of the 2006 (GDP) in financial assets. It was clear that the three banks possessed a large enough portfolio of (toxic) assets to be declared too-big-to-fail. The results generated after this bankruptcy created a chain of events that worsened the economy further. Different countries that did not want to get affected froze Icelandic assets, the Icelandic Kronor fell fast from a value of 60iKr/USD to approximately 140iKr/USD; the Icelandic stock market dropped by 90% and the GDP dropped fast. The country had fallen into a recession (Schubert, 2011).

3.3 The Banking System

The definition of the term states that failure is when a financial institution does not succeed in meeting its contractual obligations to a third party. Failure has a different implication in banking compared to the corporate world. In the world of corporates, the default process is seen as an isolated bankruptcy while in finance there can be more consequences than just an individual institution that fails due to the systematic risk connected with banks. In the case that the financial institution reaches a point beyond insolvency there are three options that can be carried out. First, is the "resolution regime" which involves transferring the bank's assets and economic rights to the public entity which in return decides what obligations will be honored or not. The other option is more well-known as "bailout" where the government steps in and repays the creditors, which in times can lead to nationalization (transfer of ownership to the state) of the institution without closing down the business continuity. The last option to consider is "regulatory forbearance" where the authorities are in denial of the institutions insolvency. This leads to wishful thinking that the crisis will disappear or become less severe with time (Goldstein & Véron, 2011).

One might ask why too-big-to-fail is considered to be a problem and where the issues lie from the economic point of view. An issue that rises from larger banks is the fact that they can distort competition. Banks in the US that have assets that are worth more than USD 100 billion can reduce their funding costs more than 70 basis points compared to the smaller banks. Another problem that occurs is the fact that the public lowers trust in the fairness of the system and undermine responsibility and accountability in the capitalist economies. Larger institutions also worsen systematic risk by not managing their risk properly and create a liability for the government that is providing the support (Goldstein & Véron, 2011). A different term closely related to too-big-to-fail is moral hazard. Moral hazard occurs when creditors of larger financial institutions expect the government to provide support to their loans, so that they will pay less attention to the behavior of the financial institutions or select institutions that are cautious. Financial institutions on the other hand realize that their creditors monitor their behavior less and are more willing to take on riskier projects and act more irresponsibly than if they did not have the support from the government. This type of behavior can lead to wasted resources and a high chance of failure. Another dimension of moral hazard is underlined in the implication that bigger banks maintain lower capital ratios than smaller banks (Moosa, 2010).

4 The Banking Sector in Switzerland

Switzerland, a small country in Europe with a strong banking sector and their determination to not join the EU, however, was massively suffered from the financial crisis started in the US. In this section, we describe some general introduction about their banking sector and the two largest banks in Switzerland: UBS and Credit Suisse.

The Swiss have always taken pride in their country being independent, having a sustainable banking sector and the desire to not be part of the European Union (EU). They chose to be neutral during several wars but held strong defensive army at all times. Attracting foreign investors has always been important in order to maintain both a political and economic level of strength. Even though the country was able to stand on its own feet, the impact of the global financial crisis between 2007 and 2009 had undesirable effects on the largest bank in the country, UBS.

Events that occur in the US can have a big impact on other countries due to the globalization today. Switzerland, even though neutral, was not able to avoid the consequences of the financial crises that affected the whole world.

As in most countries, the Swiss banking system is built upon a private banking sector and the central bank, Swiss National Bank (SNB). SNB can be compared to the US Federal Reserve bank (FED) where both are in charge of the monetary policy. The Central bank acts as a "bank for banks," which means that other banks can among other things hold accounts and takeout loans from the Central bank.

Regional banks and the two larger institutions UBS and Credit Suisse together create the Swiss private banking sector. UBS is the largest bank and following right after is the Credit Suisse bank. When Union Bank of Switzerland and Swiss Bank merged during 1998, they created what is today known as UBS. The bank grew and developed during the years and needed to invest abroad. They increased their investments further when they acquired the US brokerage firm PaineWebber during 2000. Not long after the acquirement risk managers at UBS headquarters in Zurich studied the impact of the large amount of trades invested in the US mortgage securities. By the year 2002, USD24 billion had been invested into the US mortgage market. This was considered to be risky in the sense that the US mortgage market was very illiquid, which meant that it would be problematic to sell the securities in difficult times. The subprime mortgage market in the US experienced difficulties already during 2006 when the house prices began to dive (Schubert, 2011). At that point, the exposure that UBS had to the subprime mortgages was unknown and the bank even hoped to benefit from the fall. Due to their triple-A rating that they possessed by international agencies made it harder for the risk management to acknowledge the exposure they had. On the 9th of August 2007, the uncertainty of the magnitude of losses and write-offs had reached a different point. The liquidity had dried up on the interbank market, and the warning signals were official. SNB started to monitor the larger banks and their activities on the market. The crash of the global financial system, triggered by the bankruptcy of Lehman Brothers in September 2008, added to the already severely distressed situation. The support from the SNB was inevitable in order to maintain the stability of the financial system and the Swiss national economy. By the 14th of October, UBS had officially requested protection from the Swiss National Bank (The Swiss Parliament , 2010).

Since the largest institutions in the economy are so interconnected with other banks, the government did not allow UBS to file for bankruptcy because the whole economy would have been greatly hurt. UBS was considered to be too-big-to-fail during the financial crisis. On the 16th of October 2008, The Swiss National Bank created the Swiss National Bank Stability Fund (SNB-StabFund). This was an agreement with UBS where the SNB supplied UBS with money. In order to decrease the financial risk, UBS had to transfer USD 38.7 billion of toxic assets to a legal entity that was initiated by the SNB. UBS and Credit Suisse reduced the size of the trading portfolio and balance sheets and decreased the amount of risky positions. Credit Suisse managed to raise capital on their own, while UBS was forced to consider financial support from the public sector (Schubert, 2011). Credit Suisse managed to raise USD8.8 billion from major global investors including Qatar authorities (Cowell, 2008). During the financial crisis between 2007 and 2009 banks that did not have the same exposure to the US mortgage securities managed to regain their financial stability in a much better way. The financial crisis raised the question whether a small country like Switzerland, was able to maintain stability on its own while being exposed to a large financial industry.

Whether or not the Swiss economy would have experienced the same consequences as Iceland is hard to know but the concept of too-big-to-fail was more realistic for the regulators in Switzerland than in other European countries.

The consequences of the financial crisis made world leaders think about how to prevent this so that it does not repeat itself. The main question is; if a bank is too big to fail, is it too big to exist? The lesson learned from the aftermath is that the country should try to apply diversification and to not depend too much on a single bank. UBS and Credit Suisse are quite large in proportion compared to the Swiss economy. The Swiss GDP was estimated to a value of USD 488 billion during 2008, which can be compared to the USD 1.84 trillion that UBS held in worldwide assets (Schubert, 2011).

Bailing out a bank in order to preserve a stable economy is not easily attained since public money is used. Taxpayers in Switzerland are affected, and so are other banks that have not obtained the support from the government since they had a different risk-adverse approach. The message sent out to the public and financial institutions was that risk is not that problematic because the government will provide support. Many regulators have expressed that “if they are too-big-to-fail, they are too-big” but restricting a banks size is not the solution either. If a country tries to prevent a bank from becoming too big, the ability to grow will be limited. This in return will create an unfair advantage on the international level between banks (Schubert, 2011).

As soon as 2013 UBS had managed to repay the bailout loan since the toxic assets that were removed from the bank during the financial crisis became profitable. The bank was able to buy back the assets and define it in the News Business as “important step, which closes this chapter in the firm´s history with a positive outcome” (BBC News, 2013).

5 Linking the Credit and Equity Market

This section first introduces the concept of CDS and its importance on the credit market as a measure of the credit risk. Then we introduce how a CDS contract is valued under an arbitrage-free condition, followed by some background knowledge and the advantages on using the CreditGrades model.

5.1 Credit Default Swaps

When counterparties or borrowers have difficulties in fulfilling their obligations, it creates a credit risk for commercial banks. The credit risk can be seen in most financial activities and is therefore important to get managed accurately. Through the introduction of Credit Derivatives, these issues are more manageable since it creates financial contracts where the risk and the return of the underlying are transferred from one counterparty to another without actually owning the underlying asset. The credit derivatives market has grown virtually during the last years since the global market is much more sensitive to the credit risk than interest rate or currency risk. During the beginning of the 21st century the credit derivatives market had a notional amount of USD 0.7 trillion and after only three years that amount increased to USD 4.5 trillion.

'Credit Guarantees' and 'Credit Letters' have been used in centuries, but they were contrary to credit derivatives between an issuer of the underlying and the guarantor. This can include more costs when the underlying is about to be sold. The credit derivative on the other hand minimizes the exposure towards counterparty without any funding changing place until a credit event occurs. When a credit event occurs, the buyer of the credit risk will transfer the fund to the seller. Hedge funds also use credit derivatives to hedge their trades, and non-financial companies can use them for protection against suppliers and customers as well as traders in investment banks seek for arbitrage openings between the credit derivatives and the underlying bond and stock market.

As the traditional credit market had many issues so that the Credit Default Swaps (CDS) as a credit linked instrument was able to get around. The CDS separates the credit risk component from other risks such as foreign exchange risk and interest rate risk. Through the standardized contracts with different maturities and ability to take short positions, the liquidity becomes more present. Investors are also able to buy or sell large arbitrary positions for the purpose of speculation or hedging.

CDS market is nowadays the largest credit derivative market, a CDS contract, is in terms of providing the protection buyer an insurance against the certain type of credit events by the protection seller. In other words, CDS is a 'bilateral credit derivative contract where two counterparties exchange credit risk' (Hull, 2009). When the credit event occurs during the contract period, the protection buyer has the right to sell their bonds for the face value, the CDS's notional principal, is hence compensated for the losses the buyer would otherwise suffer. The protection seller meanwhile receives periodic coupon in return, and the annual coupon received as a percentage of the notional principal is quoted in basis points (bps, a basis point is 0.01% percentage point), which is usually called the CDS spreads, which gives a value on the CDS contracts (Schweikhard & Tsesmelidakis, 2011). The contract terminates as soon as the credit event takes place, and thus no further payments will be induced.

Instead of using bond yield spreads to measure credit risk, CDS spreads are guaranteed with distinctive advantages: CDS spreads provides more direct and 'pure' measure on the default risk. Since unlike bond spreads, CDS contract is less affected by short sale restrictions, liquidity and interest rate risk, which are commonly related with bond spreads ((Ericsson, Reneby, & Wang, 2007); (Blanco, Brennan, & Marsh, 2005)). In addition, CDS are traded on standardized terms while flexibilities are applied to bond market to a larger extend. Last but the most important is that CDS market reacts to new information more rapidly when there are changes in the credit rating of the underlying company (Zhu, 2006). Therefore, our study chooses to use CDS spreads as a measure of the credit risk.

5.2 CDS Valuation

The valuation of a CDS contract under arbitrage-free condition is estimated as: the present value of the periodic payment made by the protection buyer equals the present value of the notional principal, or the protection. Under this setting, the initial value of a CDS contract must equal to zero. The total cash flow can be summarized as below in terms of Net Present Value (NPV):

$$NPV = \sum_{N}^{i=1}(1 - R) * (p_{i-1} - p_i) * d_i - \sum_{N}^{i=1} s * p_{i-1} * d_i = 0$$

s Indicates the spreads paid.

The NPV calculation for the cash flow includes both fee and contingent, which are weighted according to the survival probability and default probability respectively, and are discounted under the risk-free rate regime (Goldman Sachs FICC Credit Strategies, 2009).

5.3 CDS Models

Besides the advantages of using CDS spreads, it also addresses the differences from stock and credit market on estimating default risk. Therefore by comparing model estimates on CDS contract with market data, indicates to what extent, the government intervention has impacts on the credit market, and thus address the too-big-to-fail impact. The model of our choice is the CreditGrades model, developed by RiskMetrics and Deutsche Bank AG, Goldman Sachs Group Inc. and JPMorgan Chase & Co, which provides a stock-market-implied price on CDS spreads. The model was first introduced in Finger et al. (2002) and explored further in Finger and Stamicar (2006). It belongs to the structural approach, and emanated from the Merton (1974) model, which values equity and debt as contingent claims with the firm value. By using only firm fundamental and equity market data, the estimation of CreditGrades model is more straightforward to implement (Byström, 2006).

Another reason to choose CreditGrades model is that under the Merton (1974) model, the short-term spreads produced are too low comparing to real spreads. To correct this problem, the CreditGrades model introduces randomness in the default barrier, which allows the firm to get closer to the barrier than otherwise estimated (Finger et al. 2002). In fact, one could also incorporate jumps into the asset to capture randomness, as in the study from Zhou (2001). Another minor issue with Merton (1974) model is that, it only allows the event of default to occur at maturity, while under the CreditGrades model, default can occur at any time during the contract period (Löeffler & Posch, 2011), which reflects the reality better.

6 Methodology and Data Implication

The CreditGrades model was chosen for this study is because that it was proposed by some large financial institutions and was efficient for measuring the credit risk. Therefore, this section is contributed to describe the model as well as its parameters and data that are needed to implement the model.

6.1 CreditGrades Model

The CreditGrades model is considered as one of the most commonly used commercial credit models for pricing CDS spreads, and as pointed out by the CreditGrades Technical Document (Finger et al., 2002), the purpose of the model is to '*establish a robust but simple framework linking the credit and equity market*' by exploiting equity values and firm's balance sheet information together under a set of standard assumptions (Byström, 2006).

Intuitively, the model assumes V as the firm's asset value process on a per share basis follows a stochastic process:

$$\frac{dV_t}{V_t} = \sigma dW_t + \mu_D dt$$

where W is a standard Brownian motion, σ is the asset volatility, and μ_D is the asset drift.

Initially the model sets $\mu_D = 0$, because it assumes that the firm will try to remain at a steady level of leverage by varying the amount of debt issued in line with the variations in stock drift. In other words, the drift term is set to be zero in order to avoid arbitrage.

The model defines the event of default as the first time firm's asset V crosses the default barrier, whereas the default barrier is the amount of assets remains at the firm in case of default. The term $L \cdot D$, measures the default barrier numerically, where L is the recovery rate on debt, and D, the firm's specific debt-per-share value. The most important is that randomness is introduced to the recovery rate in order to produce more realistic short-term CDS spreads, and is one of the prominent corrections of the CreditGrades model over the Merton model (Finger et al., 2002).

The randomness is modeled by introducing the term global recovery rate, which follows lognormal distribution with mean $\bar{L}$ and standard deviation of λ:

$$\bar{L} = \mathrm{E}L$$

$$\lambda^2 = Var log(L)$$

and thus

$$LD = \bar{L}De^{\lambda Z - \lambda^2/2}$$

where Z is a standard normal random variable, and is independent of the Brownian motion W. Additionally, Z is initially unknown but reveals at the time of default. Most importantly, the random variable Z captures the uncertainty in the firm's actual debt-per-share level, which makes the true level of L not vary over time, and the default barrier can be hit unexpectedly.

Accordingly, the assumptions of CreditGrades model can be illustrated by the figure below:

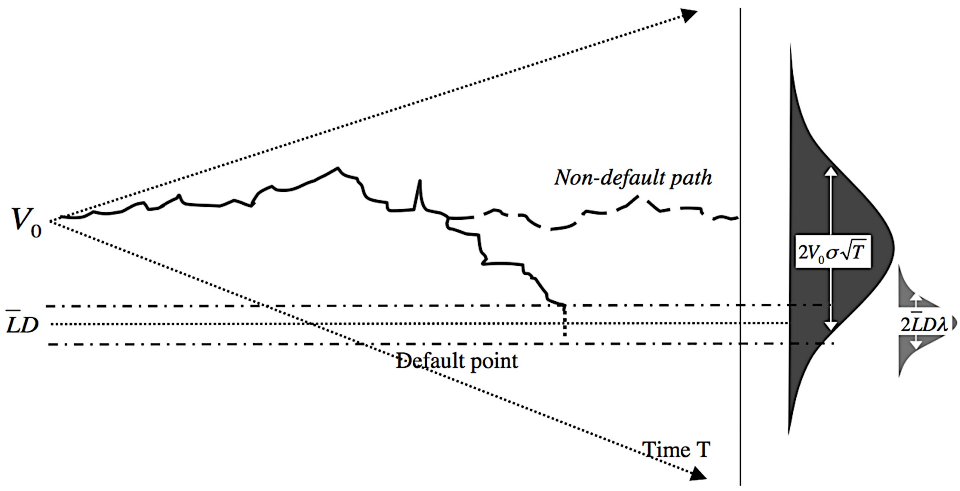

Figure 1: Asset Valuation for the CreditGrades Model

Source: reprinted form CreditGrades Technical Documents (Finger et al., 2002)

As pointed out in the figure above, V_0 is the initial asset value and the model assumes that default does not occur as long as

$$V_0 e^{\sigma W_t - \sigma^2 t/2} > \bar{L} D e^{\lambda Z - \lambda^2/2}$$

The probability of survival for the firm at time t is measured by the probability that the asset value of the firm not hitting the barrier up to time t. To estimate the probability, a process is introduced:

$$X_t = \sigma W_t - \lambda Z - \frac{\sigma^2 t}{2} - \frac{\lambda^2}{2}$$

note that X_t is normally distributed for $t \geq 0$, with

$$\mathrm{E}X_t = -\frac{\sigma^2}{2}(t + \lambda^2/\sigma^2)$$

$$Var\, X_t = \sigma^2(t + \lambda^2/\sigma^2)$$

By following the process X, which gives a closed form solution for the survival probability before time t:

$$P(t) = \phi\left(-\frac{A_t}{2} + \frac{\log(d)}{A_t}\right) - d\phi\left(-\frac{A_t}{2} + \frac{\log(d)}{A_t}\right)$$

where

$$d = \frac{V_0 e^{\lambda^2}}{\bar{L}D}$$

$$A_t^2 = \sigma^2 t + \lambda^2$$

and ϕ is the cumulative normal distribution.

As can be seen, the closed form solution of survival probability does not have variable Z included, producing the results of having non-zero probability of default at $t = 0$, and thus an alternative method is to integrate the random variable Z. However, the CreditGrades Technical Document (Finger et al., 2002) claims that the differences by using the two methods are minor.

Kiesel and Veraart (2008) on the contrary shows that when the debt-per-share level of a firm is considerably high, the difference between two methods are perceptable. And in this case, the survival probability should be derived by using the exact formula containing the cumulative bivariate normal distribution:

$$P(t) = \phi_2\left(-\frac{\lambda}{2} + \frac{\log(d)}{\lambda}, -\frac{A_t}{2} + \frac{\log(d)}{\lambda}; \frac{\lambda}{A_t}\right) - \phi_2\left(-\frac{\lambda}{2} + \frac{\log(d)}{\lambda}, -\frac{A_t}{2} + \frac{\log(d)}{\lambda}; -\frac{\lambda}{A_t}\right)$$

where in this case ϕ_2 is the cumulative bivariate normal distribution.

The unique of using CreditGrades model is that it converts the survival probability into credit price, by using additional two parameters: the risk-free rate r , and the recovery rate R. To be notice that R differs from L to the extend that R is the expected recovery rate on specific debt, while L is the global recovery rate applies to the overall debt classes. Finger et al. (2002) sets R to a fixed parameter with value of 0.5 based on historical data, with the reason further explained in the CreditGrades Technical Document.

Eventually, the price of a CDS is valued by solving the continuously compounded spread c^* under the no-arbitrage condition, which means that the present value of expected premium payments on a CDS must equal to the present value of expected loss payouts, when default occurs.

$$c^* = r(1-R)\frac{1 - P(0) + e^{r\xi}\big(G(t+\xi) - G(\xi)\big)}{P(0) - P(t)e^{-rt} - e^{r\xi}(G((t+\xi) - G(\xi))}$$

where $\xi = \lambda^2/\sigma^2$ and the function G is given by

$$G(u) = d^{z+\frac{1}{2}}\phi\left(-\frac{\log(d)}{\sigma\sqrt{u}} - z\sigma\sqrt{u}\right) + d^{-z+\frac{1}{2}}\phi\left(-\frac{\log(d)}{\sigma\sqrt{u}} + z\sigma\sqrt{u}\right)$$

with $z = \sqrt{1/4 + 2r/\sigma^2}$.

In order to implement the survival probability $P(t)$, it is necessary to link the model to market observations by calibrating the model parameters. The asset value at $t = 0$ is

$$V_0 = S_0 + LD$$

with S_0 as the stock price at $t = 0$. This also gives the total asset volatility:

$$\sigma = \sigma_E \frac{S}{S + LD}$$

by connecting the asset volatility to the equity volatility σ_E, which is observable and can be calculated using historical or implied volatility estimation methods.

6.2 Data Description

Our study is designed to analyze the too-big-to-fail impact on the Swiss banking sector, but due to the limited availability of data, which in our case, CDS contracts are only available to the two largest banks in Switzerland: UBS and Credit Suisse. In addition, various data are collected from the banks within a time span of 2, Jul 2007 to 31, Mar 2010. This specific period was chosen to cover the recent sub-prime financial crisis and its aftermath.

In order to make comparison between market CDS spreads and model estimates, observed CDS spreads are downloaded from Thomson Datastream, which are quoted in EUR, but to make a better comparison, EUR quoted spreads are converted into CHF using historical exchange rates, which is also obtained from Datastream.

Being an over-the-counter derivative, CDS data are usually not available from most of the online database; we therefore rely on CDS data from Thomson Datastream. However, strictly speaking, a small but relevant problem with Datastream is that it does not provide the reader with reference from where it has gathered the spreads. However, since Datastream is a sufficient and well-known provider for financial data, it seems little reason to doubt its reliability.

To implement the CreditGrades model, data on following variables are required:

- ***Risk free rate*** (r): our analysis uses five-year US Treasury rate as the risk free interest rate, which are obtained from the Federal Reserves online database. However, several authors have argued that the Treasury rate is too low as measure of risk free rate (Collin-Dufresne & Goldstein 2001, Longstaff 2004). For robustness test in the later section, we will carry out an analysis using SWAP as the risk free rate.

- ***Debt-per-share*** (D): debt-per-share is calculated as the total liabilities divided by the number of common shares outstanding, with data collected from the latest annual financial reports available to the banks. The common shares adjusted for stock splits and other measures. However, we use long-term instead of total liabilities for banks because according to Löeffler & Posch (2011), for financial institutions, the debt calculation should be adjusted by excluding their financial subsidiaris. And for banks, the authors suggests that the total liabilities used for calculatig debt-per-share ratio should eliminat the short-term borrowings, in order to not overweight the value. But the total liability is used for calculation with non-financial companies.

- ***Stock prices*** (S^*): historical stock price is an important input determining the CDS spreads, the equity prices are collected on a daily basis, which are close prices adjusted for dividends and splits downloaded from Thomson Datastream.

In addition to the variables listed above, few more model specific parameters also need to be defined:

- ***Maturity*** (T): CDS spreads with five-year maturity are used, because five-year CDS contracts are considered to be the most liquid, and therefore are expected to provide the most accurate market spreads. (Rodrigues & Agarwal, 2011)

- ***Equity volatility*** (σ_E): the historical stock volatility estimation method is used to implement the model, with standard one-year window length of estimation, assuming 250 trading days a year.

- ***Total asset volatility*** (σ): as clarified in the previous section, the total asset volatility is estimated following the CreditGrades Technical Document (Finger et al., 2002).

- ***Debt specific recovery*** (R): is set to be 0.5 as motivated in Finger et al. (2002).

- ***Global recovery*** (L): is recovery rate averaged over all debts and therefore is firm specific variable and thus obtained by calibrating parameters for each bank.

- ***Percentage standard deviation of default barrier*** (λ): is the standard deviation of global recovery L, is also firm specific and calibrated together with L.

Finger et al. (2002) finds that a 1000-day estimation provides good results for five-year CDS contracts using implied volatility. However, the choice made for this study is using standard one-year estimation window with historical equity volatility, which is the same as the study from Byström (2006). Furthermore, our calculation of debt-per-share ratio is simplified comparing to the more complex definition mentioned in Finger et al. (2002), but the validity of our method is confirmed by some other studies, for instance Schweikhard and Tsesmelidakis (2011), and Yu (2006).

The Merton (1974) model defines the event of default as when the value of the firm's asset falls below its debt, or in terms of accounting ratios, default occurs when the financial leverage ratio of a firm approaches one. In other words, all else being equal, '*the default probability and the credit spread increase monotonically in the leverage ratio*' (Schweikhard & Tsesmelidakis, 2011). As pointed out in other studies, financial leverage ratio plays an important role in determining the goodness of model prediction on credit spreads. However, bias may arise that affects the prediction, since the asset and equity volatility is usually unobservable, but covariate with the degree of leverage (Eom & Huang, 2004).

For financial institutions, the leverage ratio is rather difficult to assess, because their stock market data only gives information on the equity part while debt is usually estimated by its book value. And thus financial leverage expressed as dividing the value of the debt by the firm's asset is imprecise, since the majority of debt for financial institutions are insured and thus should not be counted when valuing the notion of leverage. To address this issue, our study allows justification on the leverage ratio by calibrating the parameters using market data on CDS spreads, which is differed from Finger et al. (2002) but used in studies like Schweikhard and Tsesmelidakis (2012), Yu (2006) and Byström (2006).

In the CreditGrades model, the total asset volatility is expressed as a linear relation with the default barrier LD. Instead of using only the book value of debt D, we accommodate the model to fit the market data by allowing global recovery, L and its standard deviation λ to vary while minimizing the sum of squared errors between the model ($\overline{CDS}$) and market spreads (CDS). Specifically, the calibration is performed using data one-month prior to the sample period, which is before the crisis has launched.

$$\min_{L_i,\lambda_i} \sum_{n=1}^{N} (\overline{CDS}_{i,n}(L_i, \lambda_i) - CDS_{i,n})^2$$

To be mentioned, instead of adjusting the leverage ratio and default barrier endogenously as in Yu (2006) and Byström (2006), the CreditGrades Technical Document sets L exogenously to 0.5 and λ to 0.3 (Finger et al., 2002)

7 Empirical Results

In this section the results of our model estimates are presented and compared with the market observed CDS spreads. Starting off with descriptive statistics of CDS spreads before and during the crisis 2007-2009, then the empirical results for Swiss banks will be presented and discussed in relation with the too-big-to-fail impact, followed by remarks from equal-weighted indices for financial and non-financial sectors. Eventually, at the end of the section, we test for the robustness of the CreditGrades model.

7.1 Descriptive Statistics

In Switzerland, the banking system consists of Swiss National Bank (SNB), as well as a private banking sector. Among the regional banks of the private banking sector, UBS and Credit Suisse are the two largest, and also are the only banks with available CDS contracts. In order to give an intuitive understanding on how the recent crisis has impacts on the credit market, the descriptive statistics on *Table 1* below shows the CDS data of these two, which covers both the pre- and crisis period.

Table 1: Descriptive Statistics for Banks

		Observations	Mean	Std. Dev	Max	Min
Pre-Crisis (Jan 2005-Jun 2007)	UBS	650	12,05	3,89	22,41	6,36
	Credit Suisse	650	23,41	5,61	39,34	14,68
Crisis period (Jul 2007-Mar 2010)	UBS	720	181,49	107,12	546,61	17,43
	Credit Suisse	720	146,29	71,37	394,42	29,05

As can be seen from the table, during the pre-crisis period, the CDS spreads are rather moderate in comparison with the crisis period, where the spreads increase dramatically with significantly higher standard deviations for both banks. As well as the mean value of the spreads, for UBS, the CDS spreads before crisis was 12.05 bps, which increases to 181.49 bps for more than ten times growth. Whereas for Credit Suisse, the CDS spreads increase significantly from 23.41 bps to 146.29 bps; higher spreads reflect greater risk perceived by the investors about the market. For graphic descriptions, the comparison of market CDS spreads for two banks during the crisis is presented in *Figure 2*; evidently, they both grow considerably even with record peaks, but rather move in tandem during the same period.

When looking at the levels, UBS trades CDS contracts relatively higher than Credit Suisse with much higher peaks during and after the crisis.

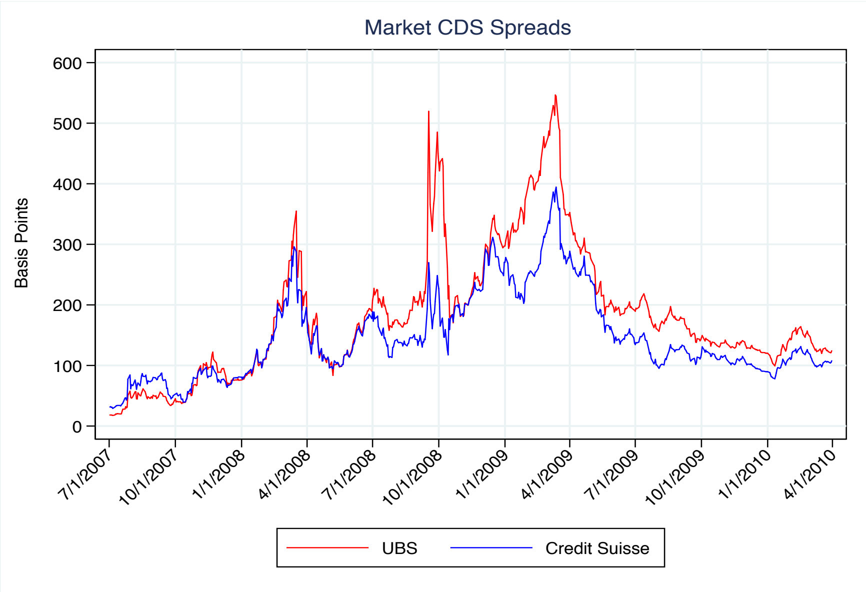

Figure 2: Market CDS Spreads for UBS and Credit Suisse

Besides these two largest banks, an equal-weighted (investing equal amounts in each stock) non-financial index consists of large Swiss firms was created to compare with the banks on their CDS contracts. The equal-weighted methodology for composing the index was used as in Byström (2006) who examines the predictability of CreditGrades model on CDS spreads. The choice of companies were made by following the criteria that they have to be publicly traded with CDS contracts signed. Companies included in the index are: Nestlé S.A., Novartis International AG, Roche Holding AG, ABB Ltd., Adecco S.A., Holcim Ltd., Swisscom AG. With the companies included, the index covers industries of agriculture and food, chemical and pharmaceutical, engineering, construction materials as well as telecommunications. The data collection are the same as for the banks but only covers the crisis period, and the pre-crisis period was excluded due to the unavailability of data.

In order to highlight the differences between financial and non-financial companies of their performance on the credit markets, another equal-weighted financial index containing the two largest Swiss banks (UBS and Credit Suisse) is constructed. See *table 2* below for descriptive statistics, and the *figure 3* shows a time series plot of the two indices.

Table 2: Descriptive Statistics for Indices

		Observations	Mean	Std. Dev	Max	Min
Crisis period (Jul 2007-Mar 2010)	Financial Index	720	163,89	87,75	469,43	23,24
	Non-Financial Index	720	149,04	89,92	435,86	28,02

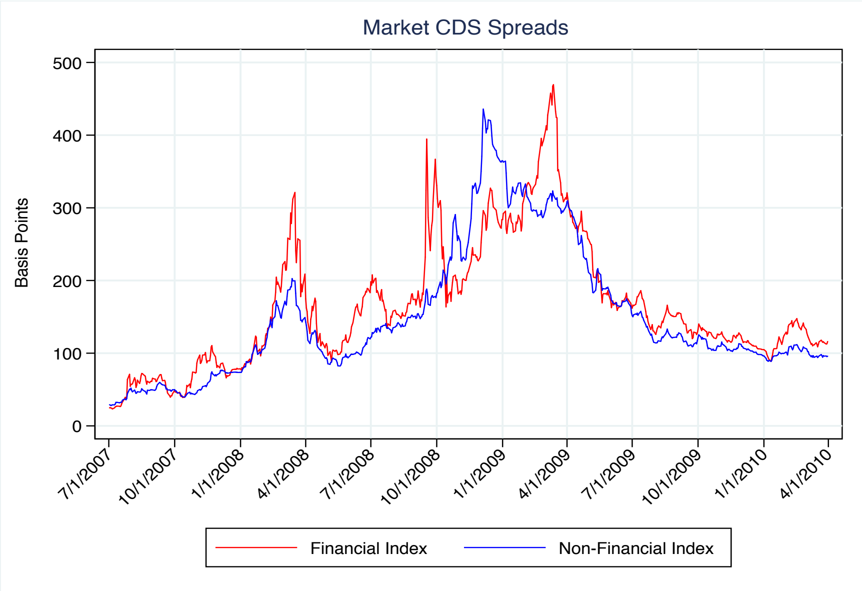

Figure 3: Market CDS Spreads for Financial and Non-Financial Indices

Both financial and non-financial index give comparable CDS spreads with almost same standard deviations and mean values. However, the spreads for financial index have more intensive reactions to the financial events as indicated by sudden increases on the spreads.

7.2 Calibration Results

Finger et al. (2006) sets model parameters L and λ exogenously to 0.5 and 0.3. However, the calibration process from our study gields different results:

Table 3: Calibration Results for Indices

	L	λ
Financial Index	0.21	0.29
Non-Financial Index	0.79	0.72

Our calibration results are lower for financial index but substantially higher for non-financial index in comparison with Finger et al. (2002). The lower values for financial sectors are expected due to distinctive liability structures and specific government regulations imposed on banks, which intends to reduce their asset volatilities (Schweikhard & Tsesmelidakis, 2011). The higher calibration results for non-financial sector are though unexpected but are in line with findings in Byström (2006). Furthermore, Schweikhard and Tsesmelidakis (2012) and Yu (2005) have calibration results close to one for the model parameter L, which is also consistent in our results.

In addition to the calibration results, the relative deviation between model estimates and market spreads is introduced as a relative measure to address the too-big-to-fail impact. The relative deviations are named 'residuals' and is defined as:

$$Residual_i = \frac{\overline{CDS_i} - CDS_i}{CDS_i}$$

Where $\overline{CDS_i}$ is the CreditGrades model estimation, and CDS_i represents observed market spreads. The residuals for banks are included in *Appendix A*.

7.3 Swiss Banks

The repercussion of government intervention can be captured by the relative deviations, i.e. residuals. The effect of intervention arose due to the asymmetric treatment between debt and equity. In other words, when government bailout banks, the default expectations will be differed between shareholders and creditors, since the rescue action tends to favor creditors, therefore would have less impact on the stock-market implied model estimates, which in our case is the CreditGrades model. As a result, we would expect the market price of default risk denoted by the CDS spreads, to differ across debt and equity market; in the way that the model estimates exceed its counterpart market observed CDS spreads (Schweikhard & Tsesmelidakis, 2011), and thus signal for the too-big-to-fail impact.

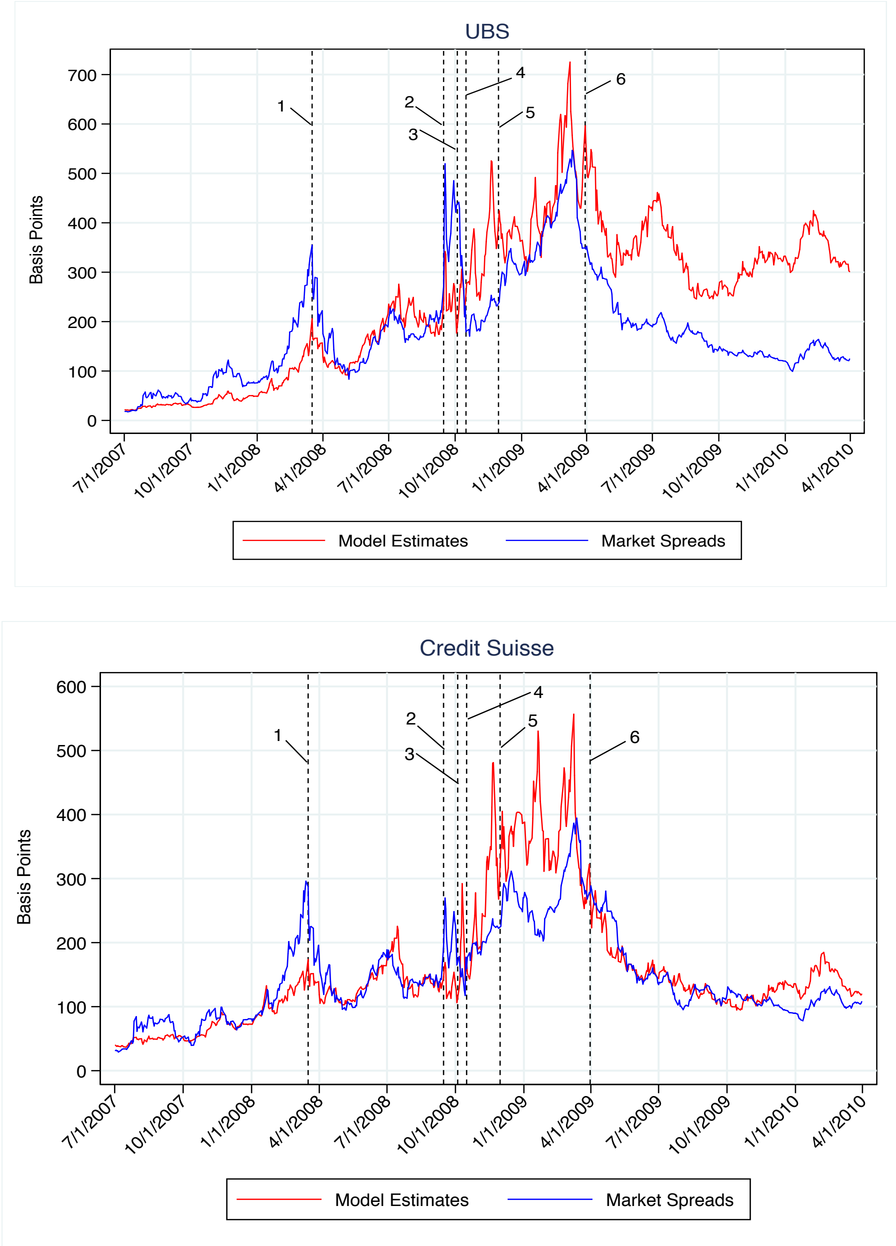

Figure 4: Model Estimation

NOTE: For each of the graph, following events are marked:
1. Taken over of Bear Steams; 2. Lehman Brother Bankruptcy; 3. Revised TARP Announcement;
4. The SNB-StabFund; 5. Swiss Central Bank cuts rate; 6. Aftermath of the Crisis

In general, our results indicate that the CreditGrades model tends to overestimate the CDS spreads during the most acute phase of the financial crisis, which in turn comply with the theory of diversified default expectations between debt and equity markets. However, the degree of overestimation differs for the two Swiss banks as indicated in *Figure 4* above.

The bailout for Bear Stems as illustrated by the first line shifts the market spreads and the model estimates upward to a new peak. However, after the bailout, the CDS spreads start to decrease and returned to the same basis points, even though the peak for market spreads was higher. Since the model estimate and market spread increase simultaneously, which indicates no immediate market respond and government intervenes discovered, and thus no clear evidence for too-big-to-fail. Moreover, in fact, during that period, the banks in Switzerland were not yet in trouble until the Lehman Brother filed for bankruptcy on the 15th of September, which gives another shock to the credit market as illustrated in the second line.

Surprisingly, the immediate effect on the failure of Lehman Brother is not significant; the market shows higher spreads than the model estimates. But it all changes at the third line, which demonstrate the government intervention in the US through the revision of TARP, and the setup of SNB StabFund in Switzerland as indicated in the fourth line. Starting with the revised TARP, the model estimate starts to overestimate the CDS spreads with increasing residuals. Considering the TARP and SNB StabFund as government bailout schemes, the subsequent overestimation on CDS spreads is worth discussing. When the US government announced the revised TARP plan, the expected further collapses on banks in the US were probably to decrease. And since the US financial market are very much interconnected with the market in Switzerland, the lower market risk results downward movement on the CDS spreads for both banks. But the reduction was more significant for UBS that the market spreads drops from 400bps to somewhere below 200bps. The greater impact on UBS was because its growing trades in the US mortgage securities, and the bank's illiquid stake on the US mortgage market, which makes the bank less easily to sold off as the times got tough in the US..

As a result, due to its sub-prime related investments, UBS was the first top-flight banks announce losses, USD 3.4 billion by the beginning of October in 2008. Thus on the 14th of October, the bank requested government support to overcome the distress. After much discussion, the SNB announced the agreement of SNB-StabFund by the time of October 16, 2008, which injects USD 5.2 billion worth capital into the bank meanwhile transfer up to USD 38.7 billion 'toxic' assets to another legal entity created to isolate the bank's financial risk (Stability Report, 2009). Immediate after the government intervention, the market spreads for CDS contracts continuous to increase but at a slower pace in comparison with the model estimates, which generates large relative deviation captured by the positive residuals, whereas the probability of default continuous to increase, but not as much as the model predicts.

For Credit Suisse, the second largest bank in Switzerland, our results show that the overestimation is also found between model estimates and market spreads on CDS contracts, but with smaller residuals than for UBS. The SNB Financial Stability Reports (2009) pointed out that even though both UBS and Credit Suisse took measures to strengthen their resilience, but unlike UBS, Credit Suisse is less tied to the US mortgage problems, and thus less affected by the crisis. “In addition to reducing risky positions and overall size of their trading portfolios and balance sheet, they raise sizeable amounts of capital” and most importantly, “Credit Suisse managed to overcome the distress without financial support from the public sector.” (Stability Report 2009) In fact it also explains that Credit Suisse represents much larger residuals when the SNB cuts rates to 0.5%, which is indicated by the fifth line. Because lower interest rate tends to encourage larger investment, so that to bring itself together, Credit Suisse Group AG raises USD 8.8 billion capital from “a small group of major global investors” including the Qatar Investment Authority. (Logutenkova & Giles, 2008)

During the peak session of the recent sub-prime financial crisis, for both banks the larger overestimation between modeled and market CDS spreads, approves the too-big-to-fail impact which can be explained as: to prevent the largest banks in Switzerland from going bankruptcy was crucial for the country’s national insistence on independence (Schubert, 2011). The interconnected roles of these two largest banks in Switzerland are in great importance for the economy; the Swiss government had to take measurements and help the banks meet tighter capital rules, because letting them fail would hurt the small mountainous country so badly.

The aftermath of the 2008 financial crisis is also worth mentioning since the impacts of government intervention are still in presence. As indicated in *Figure 5*, the mispricing of model estimates differs considerably between UBS and Credit Suisse. Less issue arose for Credit Suisse where the model and market spreads for CDS move simultaneously with little residuals. One possible explanation could be that instead of getting direct capital injections from the government, Credit Suisse survived from the crisis through raising capital from the investors. Whereas with injections from SNB, the probability of default for UBS decreases as indicated by much lower market CDS spreads, the large deviation between market and model spreads, which results significant positive residuals as can be seen in *Appendix A*.

7.4 Financial and non-financial indices

Two indices are constructed to highlight the differences between banks and non-financial companies as illustrated in *Figure 5*. During the most acute phase of the financial crisis, the model consistently underestimates the CDS spreads for the non-financial sector. The outcome is not surprising but happens to be the standard results by using structural models, as the model used in our study; the CreditGrades model (Rodrigues & Agarwal, 2011). The liquidity premium in the CDS market explains the observed underestimation (Schweikhard & Tsesmelidakis, 2011). And in addition, Rodrigues and Agarwal (2011) mentioned that there are additional counterparty credit risks not captured by the structural models so that the model under-performs for non-financial firms. Although the model estimates increase less than the market data, but the simultaneous movements in between still indicate a certain degree of pricing efficiency (Byström, 2006). Which also gives evidence of a strong link between the stock market and the risk market, as measured by CDS spreads. In addition, it also indicates the existence of consistency between market and model pricing on CDS contracts for both financial and non-financial companies.

The overestimation of CDS spreads for financial index is somewhat more interesting to discuss, as well as the difference in residuals between indices. Our results in *Figure 5* suggest that the actions undertaken by the Swiss government to bailout the banks had a significant impact on their default probability, and as expected creates asymmetric default expectations between shareholders and creditors, is also comply with the too-big-to-fail impact.

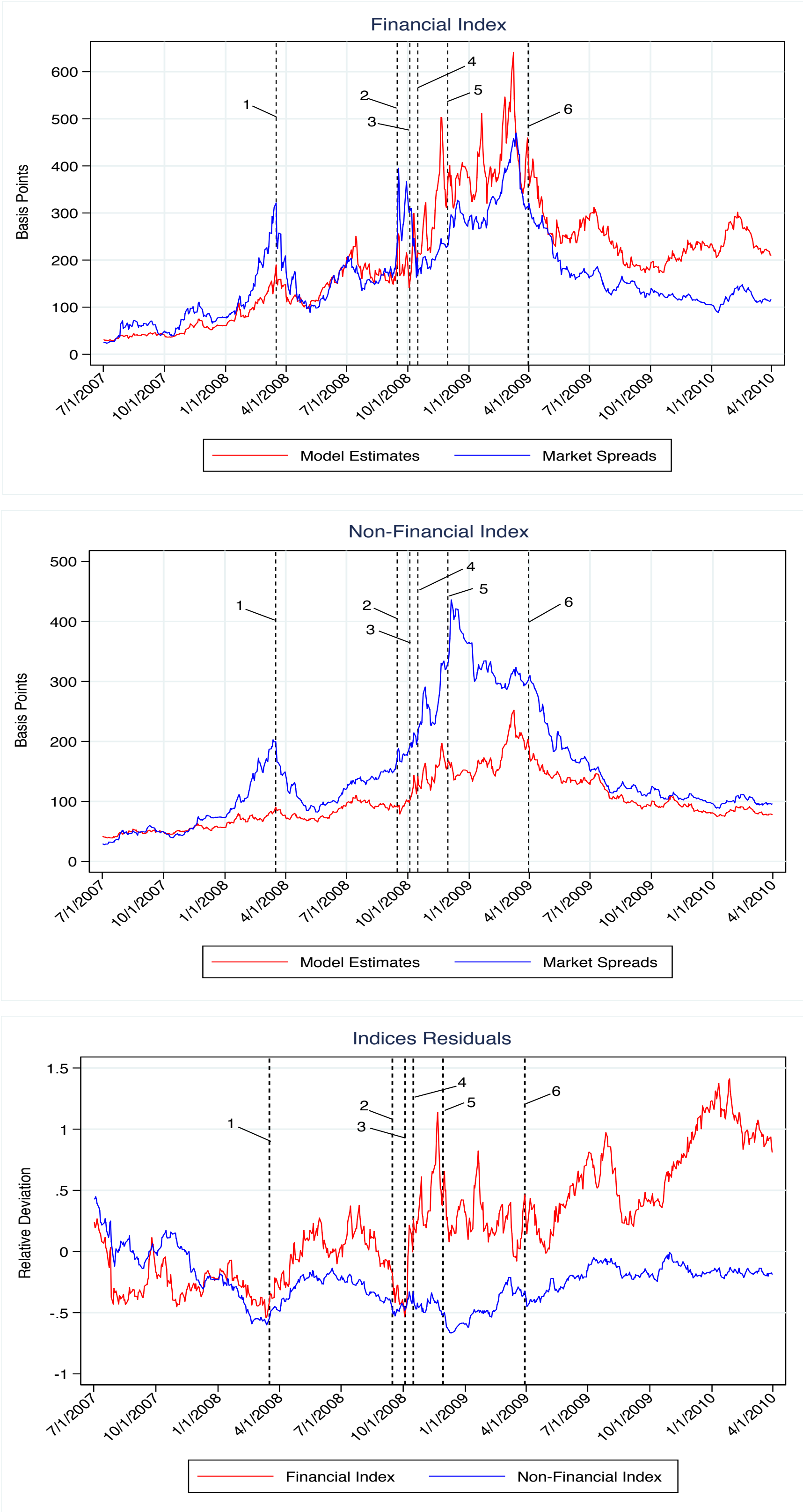

Figure 5: Model Estimates and Market Spreads for Indices

NOTE: For each of the graph, following events are marked:
1. Taken over of Bear Steams; 2. Lehman Brother Bankruptcy; 3. Revised TARP Announcement; 4. The SNB-StabFund; 5. Swiss Central Bank cuts rate; 6. Aftermath of the Crisis

7.5 Test for Robustness

The model predicted CDS spreads depend on how the CreditGrades model is implemented. For instance, the equity volatility can be estimated using historical volatility as we did in this study with standard one-year estimation window. However, some study has advocated using longer estimation period, therefore, in order to address this issue, we will test the model using historical 1000-day equity volatility. The one-year estimation window was chosen as in the study carried out by Byström (2006). Nevertheless, longer estimation window may capture more information. As the model estimated results attached in *Appendix B*, longer estimation horizon would incorporate less volatile CDS spreads estimated, since the volatility is higher the longer estimation window is. Furthermore, another method to estimate is using the implied volatility, which is not used in this study, but can be done for further research to provide more forward looking volatility.

Another issue related to the model estimation is the risk-free rate; our study uses the US five-year Treasury rate the same as the original model from the CreditGrade Technical Document (Finger et al., 2002). However, Schweikhard and Tsesmelidakis (2012) argues that this rate may imply a too low interest rate compare to the true value, due to the existence of the forward liquidity and tax related issues. To get more accurate estimation, we test the model again with the five-year SWAP rate, with data also acquired from Datastream. The estimated results are reported in *Appendix C*. Changing in the risk-free rate improves the model prediction, but the effect is negligible. However, using SWAP rate can be doubtful due to the counter-party risk, so we may conclude that using five-year Treasury rate as in this study nevertheless provides reasonably good model estimation.

8 Conclusion

The sub-prime financial crisis 2007-2009 impelled government intervention in the market, through capital injection, provide guarantees for debts, or backup the toxic assets in order to help large interconnected financial institutions overcome the distress. Thus, the purpose of this paper is to examine the existence of the too-big-to-fail impact on the Swiss banking sector during the recent crisis as a result of government intervention. The examination is carried out by comparing the market observed CDS spreads and the stock market implied CreditGrades model spreads, for both the largest Swiss banks and two equal weighted indices. With one index consisting of two largest Swiss banks and the other with non-financial companies in Switzerland.

For the two banks, UBS and Credit Suisse, overestimation of modelled CDS spreads is discovered during the most acute period of the crisis, which indicates the presence of too-big-to-fail impact and thus positive residuals in times of government bailout. While for UBS, the largest bank in Switzerland, there is a tendency for the bank to be affected to a greater extent, as indicated by rather small overestimation of model estimates during the crisis, but followed by much larger positive residuals during the crisis aftermath period. As for Credit Suisse, overestimation is only observed during the most acute phase of the crisis, whereas no significant deviations between model and market observed spreads were found during the subsequent period. One possible explanation is that, Credit Suisse is not closely tied to US mortgage problems, unlike UBS, who was severely affected by the financial crisis due to its large investment in the US mortgage securities. As for the two indices, overestimation was found for the financial index as the same for the two individual banks, whereas underestimated model spreads was observed for non-financial index, this is because some of the additional credit risks are linked to the non-financial companies, however the structural model might fail to capture these risks.

As a result, we conclude that the government intervention does change the default expectations between shareholders and creditors, which are captured by deviations between the market observed spreads and stock market implied CreditGrades spreads. In addition, our conclusion is in line with the study carried out by Schweikhard and Tsesmelidakis (2011), which illustrates that government bailout or rescue actions create model deviations which indicate the existence of too-big-to-fail impact. However, too-big-to-fail is a subject with controversy, for instance the topics of too-big-to-save and moral hazard, which may indicate higher risk for the financial institutions, and negative externalities for the government and the public, and thus ought to attract great attentions from the regulators.

For the study carried our in this paper, there is one limitation that is the reliability of the CreditGrades model, since the predicted results are highly depend on the performance of the model. Although the model is considered to be well-established and efficient to estimate CDS spreads, strictly speaking, this issue can still be considered as a weakness. Another limitation has to be mentioned is that there are only two banks included in the study, because CDS contracts are only available for the two largest Swiss banks. The results would be strengthened and easier to identify the too-big-to-fail impact if smaller banks are involved to make a comparison with large banks.

The results of this study are build upon the CreditGrades model as one of the structural models, however, for further research, including model estimates from more structural models would reduce the dependency on the model prediction and produce more reliable results. On the other hand, to capture the degree of too-big-to-fail impact, further research could devote to calculate the price of a too-big-to-fail premium, and how it contributes to minimizing the issues with negative externalities and moral hazard.

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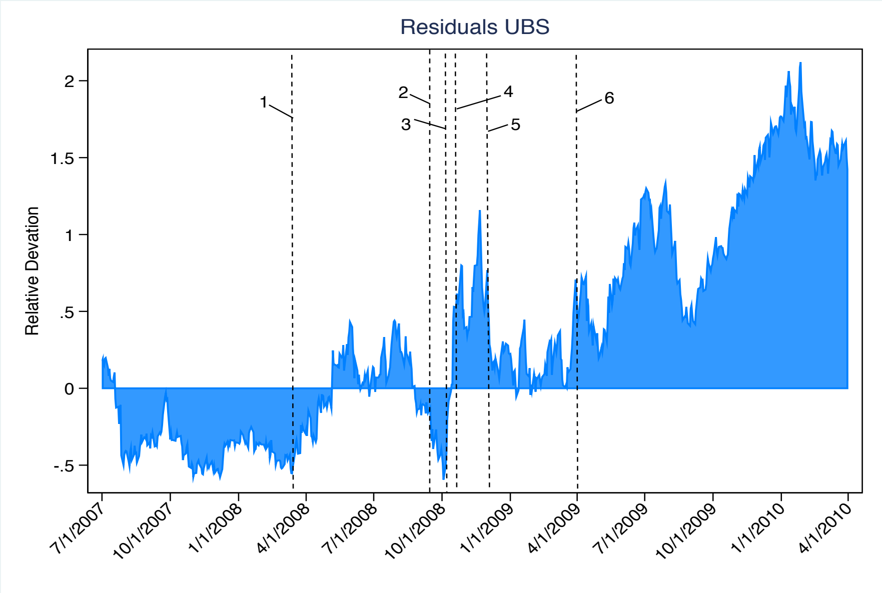
Appendix A



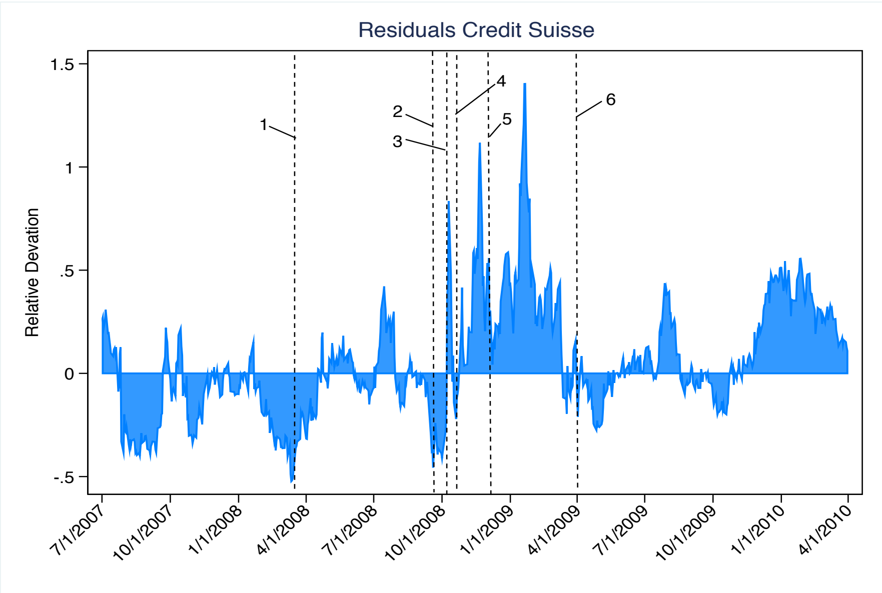
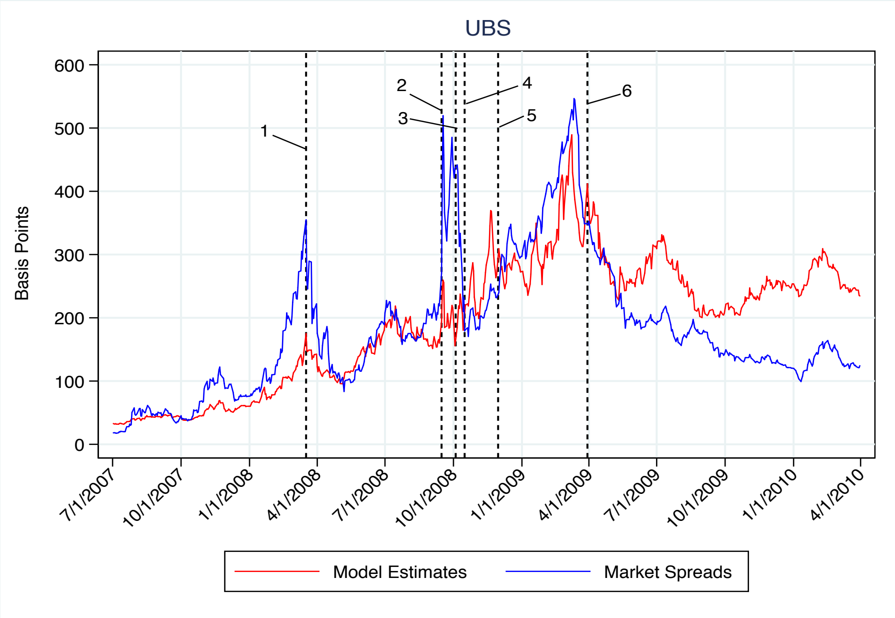


Figure 6: Deviations of Model Estimates from the Market Spreads

Appendix B



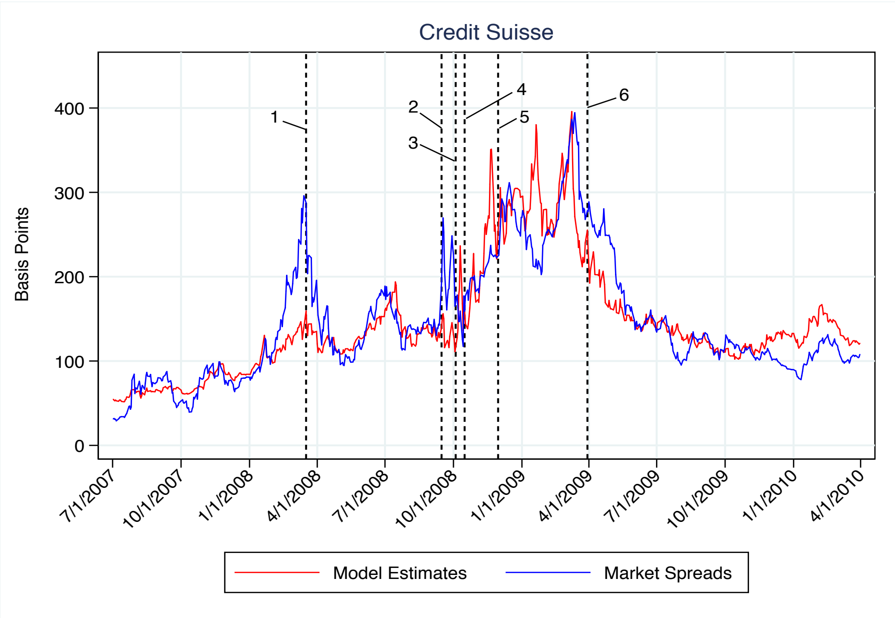


Figure 7: 1000-Day Volatility Estimation Window

Appendix C

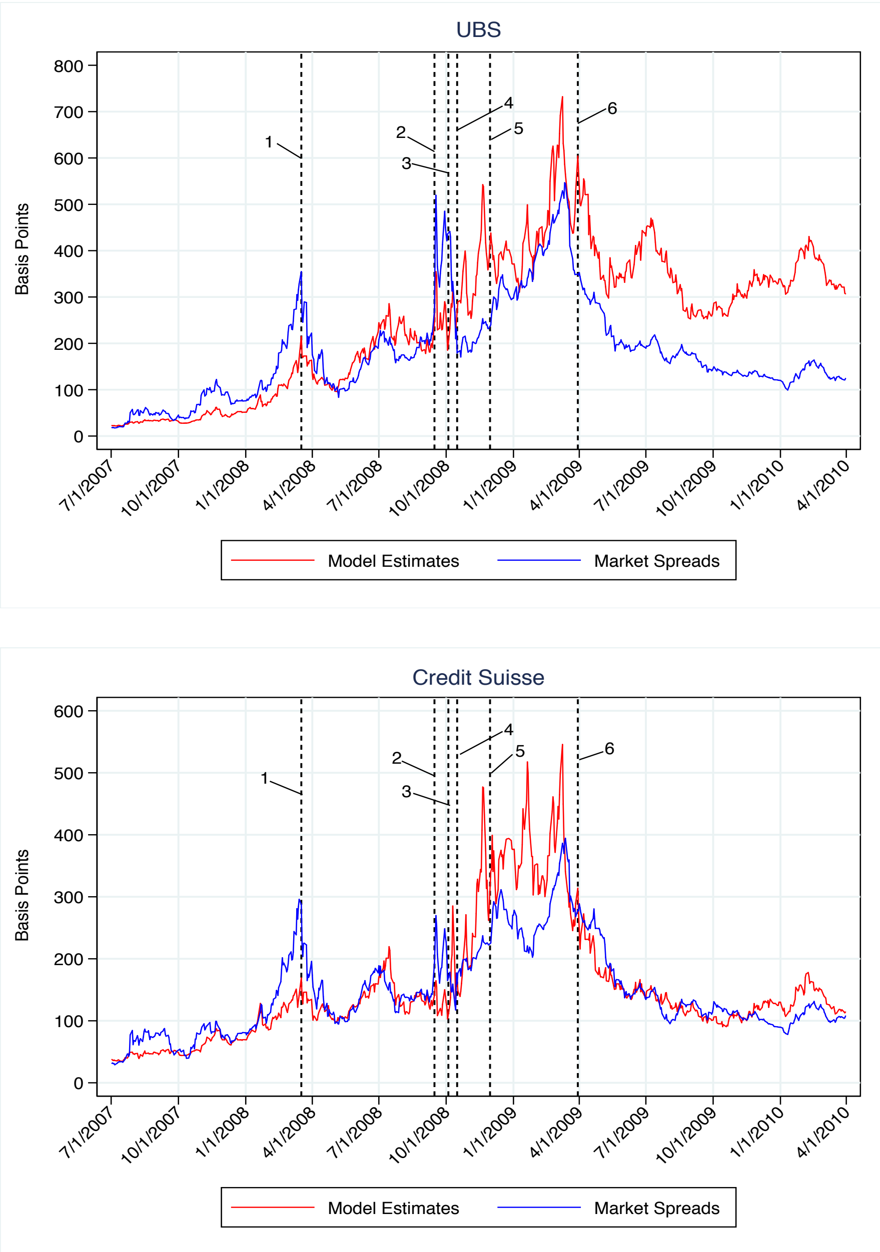


Figure 8: Five-year SWAP Rate as the Risk-free Interest Rate