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Does banks' size distort market prices? Evidence for too-big-to-fail in the CDS market

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Abstract

This paper examines the potential distortion of prices in the CDS market caused by too-big-to-fail. Overall, we find evidence for market discipline in the CDS market. However, CDS prices are distorted due to a size effect which arises when investors expect a public bail-out as a result of too-big-to-fail. A one percentage point increase in size reduces the CDS spread of a bank by about two basis points. We further find that some banks have already reached a size that makes them too-big-to-be-rescued. While the price distortion for these banks decreases the existence of banks that are considered to be too-big-to-rescue raises important new issues for banking supervisors.

Keywords: Market Discipline, Too Big To Fail, Too Big to Rescue CDS Spreads
JEL: G14, G21, G28

Non-technical summary

The information content of banks' security prices assumes an increasingly larger role in supervisory monitoring. The interest in this issue is twofold. Investors that share the business risk of banks have an incentive to discipline the business activities of a banks' management. They can exercise direct market discipline through an adjustment of refinancing conditions. If market prices reflect banks' riskiness supervisors can use this information to exert indirect market discipline.

The general consensus in the academic literature is that security prices adequately reflect risks of the underlying bank. However, an important concern is that banks' security prices may be distorted when a bank becomes large enough to threaten overall financial stability and a public bail-out becomes likely. These banks are called "too-big-to-fail" banks (TBTF). Consequently, investors are less concerned about the failure of a TBTF bank given that losses are limited which reduces their incentive to exercise market discipline.

This paper examines the information content of CDS spreads for a sample of 91 banks from 24 countries. CDSs have gained increasing prominence in the derivative market and have become a core instrument for the transfer of risk. Additionally, several papers show that CDS markets reflect new market information more rapidly than bond markets and that they are also leading indicators such as ratings. For these reasons, CDS spreads have become an important tool for supervisory risk assessment.

Overall, we find that CDS spreads reflect banks' risk. However, we further detect an important size effect that vindicates the existence of a distortion due to too-big-to-fail. A one percentage increase in the mean size of a bank relative to the home country's GDP reduces the CDS spread by about two basis-points. While this appears small, one has to keep in mind that mergers can involve substantially larger increases in size.

In addition, our results confirm that some banks may already have reached a size that makes them too-big-to-rescue. In other words, we find that the distortion of CDS spreads declines for banks beyond a threshold size of about 10 percent market capitalization relative to the home country's GDP.

Nichttechnische Zusammenfassung

Der Informationsgehalt von Wertpapierpreisen spielt eine immer größere Rolle im bankenaufsichtlichen Monitoring. Dies hat zwei Gründe. Anleger haben einen Anreiz, das Bankmanagement zu kontrollieren und gegebenenfalls durch Konditionsanpassungen direkt zu disziplinieren, wenn sie am Geschäftsrisiko der Bank partizipieren. Wenn Marktpreise das Risikoprofil der Banken widerspiegeln, kann die Bankenaufsicht diese Informationen verwenden und durch indirekte Marktdisziplin Einfluss auf das Verhalten der Banken nehmen.

In der akademischen Literatur besteht weitgehend die Ansicht, dass Preise von Wertpapieren das Risikoprofil von Banken adäquat widerspiegeln. Jedoch besteht auch die Möglichkeit, dass die Größe einer Bank einen Einfluß auf die Preisbildung haben kann. Besitzt eine Bank aufgrund ihrer Größe einen bedeutenden Einfluss auf die Stabilität des Finanzsystems, ist die Wahrscheinlichkeit einer staatlichen Rettungsaktion hoch. Derartige Banken werden als "too-big-to-fail" (TBTF) bezeichnet. Der Verlust im Falle einer Insolvenz von TBTF-Banken wäre für den Anleger begrenzt und somit auch sein Anreiz zum Ausüben von Marktdisziplin. Marktpreise von TBTF-Banken könnten hierdurch verzerrt sein und ein inadäquates Risikoprofil wiedergeben.

Das vorliegende Papier untersucht den Informationsgehalt von Credit Default Swaps (CDS) anhand einer Stichprobe von 91 Banken aus 24 Ländern. Der Schwerpunkt der Untersuchung liegt auf den CDS Markt, da dieser in den vergangenen Jahren im Bereich Risikotransfer beachtlich an Bedeutung gewonnen hat. Zudem zeigen Untersuchungen, dass die CDS Märkte durch die schnellere Verarbeitung neuer Marktinformationen gegenüber den Anleihemärkten und den Ratings einen deutlichen Vorlaufcharakter haben. Aus diesen Gründen ist die Beobachtung von CDS Spreads ein wichtiger Bestandteil bankenaufsichtlicher Risikoanalysen.

Unsere Untersuchung bestätigt, dass sich Geschäftsrisiken grundsätzlich in CDS Spreads von Banken widerspiegeln. Gleichzeitig zeigen unsere Ergebnisse jedoch, dass auch Bankengröße einen Einfluss auf die Höhe der CDS Spreads hat. Ausgehend von einer durchschnittlich großen Bank, gemessen an der Marktkapitalisierung relativ zum BIP ihres Heimatlandes, schlägt sich ein Größenzuwachs von einem Prozentpunkt in einem Abschlag von zwei Basispunkten im CDS Spread nieder. Dieses Ergebnis belegt vorhandene Preisverzerrungen aufgrund von TBTF und deutet auf einen Rückgang der Marktdisziplin für TBTF-Banken hin. Auch wenn dieser Effekt auf den ersten Blick gering erscheint, ist zu bedenken, dass es z.B. bei Fusionen größerer Banken zu deutlich höheren Größenzuwächsen kommen kann.

Unsere Untersuchung liefert zudem einen Nachweis dafür, dass dieser Preiseffekt nicht unbegrenzt gilt. Die Verzerrung der CDS Spreads durch die Größe einer Bank ist ab einem Schwellenwert, bezüglich Marktkapitalisierung über BIP, von etwa zehn Prozent rückläufig.

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1 Introduction

An important issue for banking supervisors is the information content of banks' security prices. The interest in this issue is twofold. First, investors may exert direct market discipline by identifying and controlling banks' risk taking activities. Second, when investors exert market discipline, supervisors can extract information on the risk profile of banks by monitoring security prices and use this information to exert indirect market discipline.

An amble literature has investigated the role of market discipline for controlling the risk-taking activities of banks. In a broad context, the term market discipline can be qualified in two distinct aspects. The first questions if investors accurately evaluate the risk profile of banks and incorporate their assessment promptly into the bank's security prices. The second issue deals with the ability of investors to subsequently influence managerial decisions (Flannery (2001) and Bliss and Flannery (2002)). The first aspect is a test on the link between a bank's security prices and measures of the bank's riskiness. Along this line Avery et al. (1988) and Gorton and Santomero (1990) found limited support for the incorporation of banks' riskiness in market prices. The bulk of the evidence, however, has shifted the overall balance towards the general belief in market monitoring (Hannan and Hanweck (1988), Flannery and Sorescu (1996), Morgan and Stiroh (2001), Jagtiani et al. (2002) and Sironi (2003)). With regard to the second aspect Bliss and Flannery (2002) find limited evidence for the ability of investors to influence managerial actions. They therefore conclude that supervisors should not rely on direct market discipline and retain the responsibility for disciplining banks.

This paper seeks to complement the existing literature on market discipline by

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examining the market for credit default swaps (CDS). We believe this market to be of particular importance for banking supervisors for two reasons. First, CDS spreads have become a widely used indicator of banks' health in early warning systems of banking supervisors. Secondly, participation in the CDS market is dominated by institutional investors which are better equipped to timely monitor the risk profile of banks. Consequently, CDS prices provide a potentially more accurate picture of a bank's riskiness (Flannery, 2001). The major purpose of this paper is to investigate whether expectations of too-big-to-fail (TBTF) affect CDS spreads and thus distort the information content on the risk profile of banks.

The TBTF problem emerges when bank creditors expect a public bailout of a large failing bank if overall financial stability is at stake. This expectation reduces the incentives to exert adequate market discipline on banks and thus enables managers to pursue riskier business strategies which may ultimately raise the overall risk in the financial system. The reason for a public bailout in the first place is that the collapse of a large bank can trigger further failures either through direct credit losses, contagion effects through affected markets or a general loss of confidence by investors.[2]

Stern and Feldman (2004) argue that the problem of TBTF has increased in recent years. First and foremost, the process of consolidation in the banking industry has led to more large banks posing a significant threat to financial stability in the event of their failure. Second, technology advances have allowed larger banks to play a more important role in payment systems and permitted large banks to increasingly rely on uninsured wholesale funding. Third, the activities of large banks have been growing in complexity and thus these banks have become "too complex to fail". Mishkin (2006) contends that efforts such as the Federal Deposit Insurance Improvement Act (FDICIA) have reduced the TBTF problem. However, these policies lack credibility due to the time-inconsistency problem (Kydland and Prescott, 1977). The literature on market discipline and TBTF has so far primarily focused on US banks. However, large and systemically important banks exist in national

[2]Large scale financial crisis can impose substantial cost on the real economy and thus make a public bailout appear inevitable. Honohan and Klingebiehl (2003) estimate that the cost for a sample of 40 banking crises in industrial countries was on average 12.8 percent of their national GDP. The considerable costs imposed by financial crisis were confirmed by evidence presented by Hoggarth et al. (2001) and IMF (1998) and Bini-Smaghi and Gros (2000).

financial systems around the world. As first departure from the literature this paper considers a sample of large banks from a number of different countries.

As a second departure, we examine if some banks have already become "too big to rescue" (TBTR). This aspect has so far received relatively limited attention. Hellwig (1998) points out that a TBTF policy sets incentives for further mergers. As a result it is conceivable that a country may be too small to bail out a large bank. A number of banks have already reached a size that can make an effective public intervention increasingly difficult given the costs associated. TBTR may thus provide market participants again with an incentive to act risk sensitive, because by reaching a certain size the investors may not believe in public coverage of potential losses.

Overall, these arguments warrant, in our view, an analysis to quantify the potential TBTF distortion of prices in the CDS market. The second section discusses the literature that has sparked the debate on TBTF. The third section describes the data and the empirical specification. Section four discusses the results of the empirical analysis. Section five summarizes the results.

2 Literature Review

During the banking crisis of 1931, TBTF was making the headlines for the first time in Germany. The crisis was primarily driven by the difficulties of the largest banks e.g. Deutsche Bank und Diskont Gesellschaft, Darmstädter und Nationalbank, Dresdner Bank and Commerz-und Privatbank (Schnabel, 2004). The government injected a substantial amount of new capital into these four banks to prevent their bankruptcy.

The debate on TBTF gained momentum during U.S. Savings- and Loans crisis, when in 1984 the U.S. bank Continental Illinois was near bankruptcy. As the 7th largest bank in US, Continental was holding large deposits of hundreds of smaller banks. A bank run was only prevented, because the Federal Deposit Insurance Company (FDIC) stepped in and gave an unlimited guarantee to all creditors on their deposits. In addition, the guarantee also included bondholders. The argument for the public intervention was based on the threat to financial stability when Continental Illinois as one of the ten largest banks in the U.S. would be allowed to fail. U.S. supervisors subsequently extended TBTF protection explicitly to the eleven largest banks (Carrington, 1984). O'Hara and Shaw (1990) investigate the equity prices before and after the announcement by the Comptroller of the Currency that some banks were TBTF and find a positive wealth effect for banks that were named TBTF. Their evidence highlights the relevance of TBTF for market prices.

In practice, the TBTF-policy appears to have been extended in varying degrees to banks outside the top eleven, which lead to excessive risk taking by large banks (Boyd and Gertler (1993)). In the light of the evidence of weaker market discipline the U.S. government implemented new conditions for dealing with failing banks under the Federal Deposit Insurance Corporation Improvement Act (FDICIA) in 1991 and the National Depositor Preference Law in 1993. The aim of the new rules was to re-establish the incentives for market discipline and to limit systemic risk in banking sector.[3] However, FDICIA includes a systemic risk exception, which can always be invoked when a failing bank is large enough and a financial crisis becomes likely. For this reason TBTF remains a prominent issue. Angbazo and Saunders (1996) examine equity prices and cost of deposits during the passage of FDICIA in 1991. Their findings point to negative wealth effects supporting the view that FDICIA reduced the problem of TBTF. Nevertheless, Morgan and Stiroh (2005) show that the spread-rating relationship remained flatter for TBTF banks after the passage of the FDICIA suggesting that the TBTF problem still persists.

A further aspect of the TBTF problem is the potential mis-allocation of resources. A bank seeking to gain the TBTF subsidy will dedicate resources to grow beyond its socially optimal size. Kane (2000) and Penas and Unal (2004) provide evidence supporting this claim. Penas and Unal (2004) focus on the effect of merger events on bond returns. They find a gain in bond returns and a decline in credit spreads after a merger which points to the existence of TBTF. The effect is especially pronounced for mid-sized banks which reach the threshold of TBTF after the

[3]While the FDICIA effectively limits the policy of protecting depositors above the official insurance amount of 100.000 US-Dollar, the National Depositor Preference Law altered the order of priority of claims on a failed bank. Depositors receive greater priority in repayment than non-deposit creditors such as unsecured creditors and subordinated bondholders (Angbazo and Saunders, 1996). Non-deposit creditors have to expect losing their investments.

merger.[4]

Another strand of the literature focuses on differences in ratings of banks in various size groups. By analyzing differences between stand alone ratings and so called support ratings of Fitch/IBCA, Soussa (2000) discovers a difference of three credit notches between small and TBTF banks which highlights a competitive advantage of banks with TBTF status. Similarly, Rime (2005) finds a rating advantage for banks with TBTF status using support ratings provided by Fitch/IBCA and Moody's.

A contribution by Flannery and Sorescu (1996) departs from the event study literature on TBTF. They explicitly include a measure for size to test for a TBTF effect in subordinated debenture yields. They find that smaller banks paid higher spreads in the period before 1991 confirming the existence of TBTF before FDICIA. Finally, Hughes and Mester (1993) directly measure funding costs for U.S. bank deposits in a cost function model. By analyzing prices of unsecured deposits, they find a significant negative relationship between funding costs and the size of the largest banks giving support to the existence of TBTF.

The possibility to exploit the advantages from the TBTF guarantee and to choose riskier portfolios does not necessarily imply that large banks have greater portfolio risk than small banks. Large banks, by virtue of their size, also benefit from factors that reduce the level of portfolio risk. The most obvious is the benefit of better diversification due to economies of scales. The empirical evidence on higher risk appetite by large banks is ambiguous. Boyd and Gertler (1993) and Ennis and Malek (2005) find that the regulatory environment in U.S. before FDICIA encouraged large banks to take excessive risks. Demsetz and Strahan (1997) and Soussa (2000) refute that large banks have higher portfolio risk. However, Demsetz and Strahan (1997) argue that large banks seem to exploit their diversification gains to operate with higher leverage and engage in more risky lending without increasing overall risk.

[4]Bailouts of large banks in financial distress have not been confined to the US.Banco di Napoli in Italy, the Long Term Credit Bank of Japan, Crédit Lyonnais in France and Nordbanken in Sweden are further examples.

3 Data and Empirical Specification

3.1 Data Description

We focus in this paper on spreads of single name 5-year senior CDS of international banks and bank holdings, which we simply refer to as *Spread*. We select all banks and holdings for which data on CDS spreads are available by Bloomberg and use only CDS contracts with a maturity of five years because trading liquidity is highest in this maturity (British Bankers' Association, 2006).[5] The CDS data provided by Bloomberg is based on daily price information contributed by some of the leading market participants (e.g. Credit Market Analysis Ltd.(CMA) or Credit Suisse).[6] Bloomberg constructs a composite quote referred to as Bloomberg Generic. The Bloomberg Generic reflect an arithmetic average of the CDS spread offered by market participants. When calculating the Generic time series Bloomberg excludes infrequent quotes but does not automatically exclude outliers. For this reason our historical observations are at-market, meaning that they are bids or offers of the default-swap rates at which a buyer or seller of protection is willing to enter into a new default swap contract. While these prices are daily averages of market quotations rather than transaction-based they have some clear advantages. First, the Bloomberg Generic time series cover a wider range of CDS price information e.g. for various market participants. Secondly, whereas some CDS are only rarely traded, the indicative quotes reflect a broader picture of market activity. Third, averages provide the advantage that prices are not distorted by the evaluation of a single market participant.

Another issue to bear in mind are recovery rates of CDS contracts. Empirical evidence shows that recovery rates vary across industries and time. For a given level of seniority, there is less heterogeneity in the recovery value if the default event is given by bankruptcy or failure to pay. To limit this heterogeneity we only collect

[5]Mergers and acquisition are an important part of the size effect we are investigating. The acquisition or merger of banks could lead to the creation of a bank that might be considered TBTF or TBTR and potentially affect their CDS spreads. Merger transactions in our case are thus not a nuisance. We therefore keep mergers and acquisition in our data and carefully checked that the data series of takeover targets end on the final day of the merger.

[6]We use CDS in different currencies. For each bank we choose the most actively traded CDS based on number of trading days. The majority of contracts in our sample are denominated in Euro. The remaining ones are in USD and Yen.

data of senior CDS contracts for which Bloomberg offered prices based on a fix recovery rate of 40 percent.[7]

Before 2002 trading activity in the CDS market was limited and pricing information incomplete. We therefore focus on the time period from January 2002 to December 2007 in our analysis. For each bank we use the monthly CDS spreads by averaging daily composite quotes. We choose monthly averages rather than end of period data due to infrequent trading activities for some CDS. Particulary in early sample period the data set is prone to this sparseness problem. Another reason for using monthly frequency is that most other control variables can only be observed monthly or even quarterly.

We also use CDS spreads provided by Datastream to cross check our results. Datastream also offers time series of CDS prices, but these are provided by only one contributor and are available only from January 2, 2003 onwards[8]

There are various alternatives to measure a bank's size. As a first measure we use market capitalization provided by Bloomberg. We use alternative measures of size to preempt the concern that our choice of a measure drives the results. The first alternative size measure is monthly asset value provided by Moody's KMV *SizeAVLM*. The asset value equals the sum of annually adjusted book liabilities and monthly market capitalization. Asset size varies with monthly market capitalization but also when book liabilities are updated once every year. The update of liabilities generally occurs in April of every year. To correct for this time lag we further collect balance sheet data from Bloomberg which for most banks is available annually but also quarterly for some of the larger banks. We use the sum of liabilities and market capitalization data *SizeASLB*. We also collect annual consolidate balance sheet data on total assets and total capital from Bankscope in Euro irrespective of the accounting standard.[9][10]

[7]Martin et al. (2006) find that that market prices of CDS are relatively insensitive to recovery rates.

[8]For days without trading activity Datastream uses the last traded CDS price for these days which lead to large distortions concerning the variation of CDS prices. Therefore we adjusted the Datastream time series by excluding all prices which show no price variation over two consecutive days.

[9]We included balance sheet data based on the accounting standard IFRS, US-GAAP and Local GAAP.

[10]Given the lack of agreements for burden sharing this option is left out of the analysis and only national GDP is used.

The setting of eleven banks as TBTF in 1984 was based on size of a bank's market share, which were based on a bank's asset size to the sum of assets of the whole banking system (Belke, 2001). A bank's asset size measured by book values primarily reflects historical values and is only available annually. In addition, book values are also influenced by national accounting standards. We therefore use asset value measured as the sum of market capitalization, which reflects the net present value of expected future cash flows and book liabilities. Instead of using the size of a bank relative to the banking sector, we focus on size relative to the home country's GDP. The banks in our sample are primarily large relatively to their respective banking system and thus likely to be systemically important. Furthermore, a banks market share does not capture the feasibility of a public bailout which should be rather reflected in a bank's relative size to the home country's GDP. We use GDP in Euro at current prices from Eurostat. For the non-European countries like e.g. Thailand or China we supplemented data provided by the International Monetary Fund.

We use a number of control variables for risk and liquidity which are important determinants of CDS spreads. Duffie (1999), Houweling and Vorst (2005), Longstaff (2004) and Blanco et al. (2005) show that CDS prices efficiently reflect credit risk. We thus need to include a measure for risk to control for banks' riskiness. In line with structural models we use the monthly 1-year cumulative Expected Default Frequency (*EDF*) provided by Moody's KMV.[11] The calculation of the *EDFs* is based on Black and Scholes (1973) and Merton (1974) which model the price of a firm's equity as the price of an (European) call option on assets with a strike price at the level of liabilities. It is a measure of the probability that a firm will default over a specified period of time. The default point is given when the market value of a firm falls below its liabilities. The EDF combines leverage as with asset volatility in a single number. Kealhofer (2003) and Kurbat and Korbalev (2002) found that Moody's KMV's EDF measures of default probability provide significantly more power to discriminate among default probabilities of firms than ratings. We thus prefer EDFs over alternative measures of risk such as ratings.

In addition to default risk, we control for liquidity which potentially influence

[11] We prefer EDFs over ratings as a measure of risk given that they reflect information about credit risk more efficiently. EDFs values change more frequently and potentially with a lower lag.

CDS prices (Chen et al. (2005), Tang and Yan (2006) and Fabozzi et al. (2007)). Liquidity has essentially three dimensions: 1. tightness, 2. depth i.e. volume of trades without affecting market prices and 3. resiliency i.e. the speed of price fluctuations due to demand and supply shocks (Bank of England, 2007). Tang and Yan (2006) show that systematic liquidity risk is particularly more important for actively traded CDS names due to demand pressure and adverse selection. Infrequently traded CDS names are more affected by individual liquidity characteristics such as search costs. We use the *BidAsk* spread as a proxy for the liquidity of a single name CDS (Fabozzi et al. (2007) and Houweling and Vorst (2005)). The *BidAsk* spread represents the cost a trader incurs to unwind a position. For the CDS market the effect of liquidity on spreads is theoretically not clear. Given that the CDS market is a zero net supply market, liquidity is likely to play a different role than in positive net-supply market, such as equity or fixed income markets, where higher liquidity risk leads to lower prices. In particular, asymmetries of buyers versus sellers in terms of restrictions and preferences may lead to buying or selling pressures and associated liquidity effects. Existing research on the relation between liquidity and spreads has been sofar ambiguous. While Fabozzi et al. (2007) and Chen et al. (2005) found a negative relationship between the Bid-Ask spread and the CDS spread, empirical findings by Deutsche Bundesbank (2004), Tang and Yan (2006) and Bongaerts et al. (2005) show a significant and positive relationship. We use the absolute difference of the bid-ask spread denominated in basis points on each trading day and average the differences over a given month. As a second liquidity measure, we use the number of trading days per month (TD). We expect that a frequently traded CDS indicate high liquidity and should therefore result in a lower CDS spreads.

Table A 1 provides a general overview on the variables used in this paper. Table 1 depicts the number of banks and observations across countries in our sample.[12] The sample contains 91 banks from 24 countries.

Table 2 provides summary statistics on our key variables. The average credit spread for the 5-year CDS contracts is 27 bp. The size of banks in our sample is on average 4% based on market capitalization (*Size*) and 54% based on asset value (*SizeAVL*) relative to national GDP. The average *BidAsk* spread is around 5 bp,

[12] Table A 2 in the appendix contains a list of the banks in our sample.

Table 1: **Banks and Observations per Country**

Country	No. of Banks	No. of Obs.	Percent	Country	No. of Banks	No. of Obs.	Percent
Australia	6	336	8.42	Korea	4	133	3.33
Austria	1	54	1.35	Malaysia	1	47	1.18
Belgium	2	108	2.71	Netherlands	3	140	3.51
China	1	14	0.35	Norway	1	46	1.15
Denmark	1	56	1.4	Portugal	2	128	3.21
France	5	206	5.16	Russia	1	2	0.05
Germany	4	172	4.31	Singapore	2	48	1.2
Iceland	3	27	0.68	Spain	4	207	5.19
India	4	107	2.68	Sweden	3	71	1.78
Ireland	3	122	3.06	Switzerland	2	128	3.21
Italy	10	409	10.25	UK	8	412	10.33
Japan	6	221	5.54	US	14	795	19.93
Total					91	3,989	100

which amounts to approximately 18 % of the average CDS spread. The creditworthiness measured by the EDF is 0.15 % which corresponds to a BBB rating.[13]

Table 2: **Summary Statistics of Key Variables**

Variable	Obs	Mean	Std. Dev.	Min	1st Perc.	99th Perc.	Max
Spread	3989	27.09	35.03	3.92	4.98	152.43	680.78
Size	3989	0.04	0.06	0.00	0.00	0.30	0.75
SizeAVL	3508	0.54	0.79	0.00	0.02	4.11	5.33
BidAsk	3989	4.97	3.53	0.06	1.95	18.80	50.47
EDF	3989	0.15	0.34	0.01	0.01	1.57	7.22
TD	3989	20.10	4.07	1.00	2.00	23.00	23.00

Table A 3 in the appendix summarizes the correlation between the variables. Remarkably, the correlation between *EDF* and *BidAsk* spread is relatively large (0.45), which may be due to the fact that CDS contracts of banks with low credit quality are traded less frequently. Moreover, the high and negative correlation between *BidAsk* and *TD* is as expected given that both variables control for liquidity.

3.2 Empirical Specification

In this section we outline the econometric specification. In a nutshell, we examine the relationship between banks' size and CDS spreads. The examination of cross-sectional and time variation for the impact of banks' size on CDS spreads is promising and may potentially offer new insights. Panel estimators permit the inclusion of bank specific effects μ_i, which can be modelled as fixed or as a random.[14] The

[13]The majority of observations is concentrated in the single A and triple B categories, reflecting the fact that CDs on investment grade banks dominate the market. The translation of EDF to rating groups is based on the Rating Mitigation Matrix provided by Standard&Poors (2007).

[14]A fixed effect implies a bank specific parameter needs to be estimated while under the random effect model it is assumed that the bank specific effect is randomly distributed with IID(0, σ^2_{μ}.) The

baseline specification is:

$$Spread_{i,t} = \mu_i + \beta_1 Size_{i,t} + \beta_2 Size^2_{it} + X_{i,t}\delta + u_{i,t} \tag{1}$$

The explanatory variable $Spread_{i,t}$ is given by the CDS spread of bank i in month t. We analyze CDS spreads in absolute terms denominated in basis point (bp). We include $Size_{i,t}$ linearly to test our hypothesis that TBTF is prevalent in the CDS market and also a quadratic term to test for TBTR. Evidence for a negative and significant β_1 would support the existence of TBTF, while a positive and significant coefficient β_2 for the quadratic term supports TBTF and TBTR.

4 Results

We start our analysis by running fixed effect estimation of equation 1 using market capitalization and report the results in column 1 of Table 3.

Table 3: **Testing Model Specification**

	Market Capitalization			Asset Value		
	FE Model	RE Model	Mundlak Model	FE Model	RE Model	Mundlak Model
$Size_{i,t}$	359.22***	280.91***	357.51***	43.65***	29.70***	43.89***
	[10.03]	[8.70]	[10.14]	[11.09]	[8.83]	[11.31]
$Size^2_{i,t}$	-665.96***	-456.10***	-649.41***	-4.68***	-2.98***	-4.69***
	[9.03]	[7.12]	[8.97]	[7.21]	[4.96]	[7.26]
BidAsk	6.95***	7.00***	6.98***	7.03***	7.03***	7.05***
	[66.16]	[67.82]	[67.35]	[61.66]	[62.23]	[62.79]
EDF	15.20***	14.92***	15.17***	28.38***	27.92***	28.18***
	[13.35]	[13.16]	[13.42]	[18.01]	[17.85]	[18.14]
TD	-0.14	-0.12	-0.14*	-0.25***	-0.23**	-0.25***
	[1.62]	[1.47]	[1.68]	[2.72]	[2.47]	[2.73]
$\overline{Size}_i$			-676.39***			-58.95***
			[6.14]			[5.32]
$\overline{Size^2}_i$			2,182.11***			8.73***
			[5.48]			[2.64]
Constant	-17.46***	-14.46***	-1.39	-25.17***	-18.26***	-3.06
	[8.10]	[4.53]	[0.36]	[9.95]	[5.14]	[0.71]
R^2	0.62	0.62	0.62	0.65	0.65	0.65
No. of Obs.	3989	3989	3989	3508	3508	3508
No. of Banks	91	91	91	82	82	82
Hausman [χ^2-value]		47.45***	4.08		48.33***	1.67
Hausman [p-value]		0.00	0.54		0.00	0.89
LM [p-value]		0.00	0.00		0.00	0.00

Absolute value of t-statistics in brackets.* significant at 10%; ** significant at 5%; *** significant at 1%

As we hypothesized there exist a strong relationship between the CDS spread and size. The coefficients of the linear and quadratic terms of size are significant at

random effect approach is only appropriate when μ_i is uncorrelated with the explanatory variables.

1%. However, contrary to our hypothesis $Size_{i,t}$ enters positively and $Size^2_{i,t}$ negatively. Liquidity measured by *BidAsk* shows a positive impact on CDS spreads. An increasing Bid-Ask spread reflects lower liquidity and thus leads to higher liquidity premiums. These findings are in line with Deutsche Bundesbank (2004), Tang and Yan (2006) and Bongaerts et al. (2005). The level of our liquidity premium is with around 7 bp similar to the result of Tang and Yan (2006) and (Houweling and Vorst, 2005). Regarding our control variable for risk, the EDF enters the model with a positive and significant effect on the CDS. This finding underlines that an increase in the probability of default due to portfolio risk leads protection sellers to require higher CDS spreads and provides strong evidence for an effective monitoring of banks' risk profiles. We obtain the expected negative coefficient for our second liquidity measure (TD). A more actively traded CDS receives a lower spread.

We additionally run our model using the random effects estimator. The results in column 2 of Table 3 reveal that signs and significance of the coefficients resemble the results for the fixed effects estimator. We tested for random versus fixed effects using the Hausman test which rejects the random effects model. This can be attributed to a non-zero correlation between the random effect and any of the explanatory variables (Wooldridge, 2003). The correlation of the random effects with the explanatory variables leads to inconsistent estimates of the coefficients. Mundlak (1978) argued that the rejection of the random effects model might be caused by a mis-specification due to omitting relevant variables. He recommends to use time averages of the explanatory variables, which would suggest itself as first candidates for the omitted variables.[15] The Mundlak specification allows the estimation of the within and the between coefficients. The former typically captures the short-run, while the latter reflects the long-run impact of the explanatory variables (Egger and Url, 2006). We thus proceeded with a Mundlak specification using averages over time for each bank's market capitalization ($\overline{Size}_i$ and $\overline{Size}^2_i$) in column 3.[16]

The time varying variables maintain their previous signs and significance. Both

[15] See also Egger and Pfaffermayr (2004), Egger and Url (2006) and Moser et al. (2008) for further applications of the Mundlak-random effects specification.

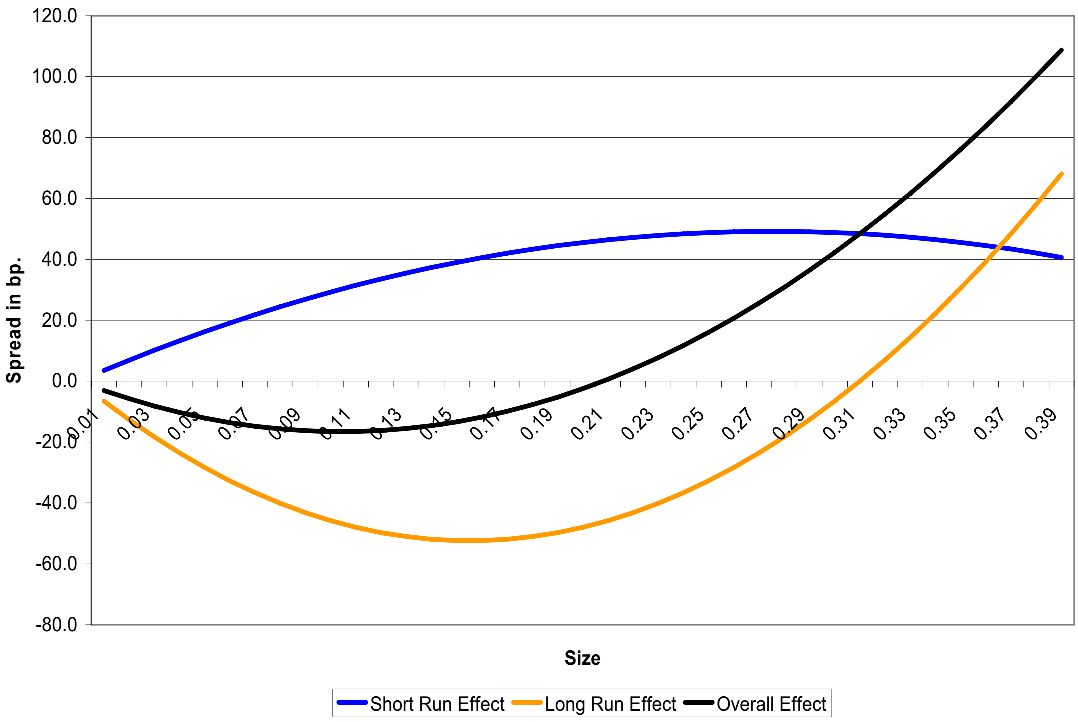
[16] The specification in Table 3 contain only time averages for size while Mundlak (1978) suggested to use all averages for all explanatory variables. We started off with a complete set of time averaged control variables but dropped them for *EDF*, *BidAsk* and *TD* due to insignificance and lack of impact on the remaining variables. The results using the full set of time averaged control variables is shown in column 6 of Table 5.

variables of size averaged over time ($\overline{Size_i}$ and $\overline{Size_i^2}$) are significant, which suggests that omitting these variables represents a mis-specification. Repeating the Hausman test for the fixed effect and Mundlak-type random effects specification yields an insignificant difference in the coefficients of the two specifications. In other words the time averages of *Size* remove the omitted variable bias present in the random effects specification. Using the Mundlak type random effect estimator therefore offers more efficient results and thus presents in our view the baseline for our further analysis. The positive sign on the coefficient of $\overline{Size_i^2}$ suggests a quadratic relation consistent with TBTF and TBTR.

To confront a first criticism, we clearly have to show that our key result holds when we use alternative measures of size. Market capitalization is a volatile measure especially during turbulent market periods. Total assets measured by book values may be a better proxy given that it reflect replacement costs. We therefore use this alternative proxy of bank size for testing the robustness of our results. We choose asset values based on Bloomberg data ($SizeASLB$). Columns (4)-(6) of Table 3 contains the fixed, random and Mundlak specification for asset values. The results mirror the quadratic effect found when using market capitalization. The random effect specification in column (5) is rejected by the Hausman test, while the Mundlak specification is not.

The important question raised by the results is whether the overall effect regarding size is a positive quadratic function that supports TBTF and TBTR. To answer this question we show the short, long and overall impact from the Mundlak specification in column (3) of Table 3 in Figure 1. The short run estimates yield a concave relation between *Size* and CDS spreads. The initial positive short run effect may be due to demand side effects which arise when an increase in a banks' size leads to higher demand for insurance. The summary statistics in Table 2 reveal that there are very few observations beyond the turning point at a market capitalization of around 28 percent of GDP and thus this part can be ignored (Wooldridge, 2003). The long run and overall impact both underline evidence for TBTF as well as TBTR. The critical size, beyond which a bail-out becomes less probable is given by a market capitalization relative to GDP of about 10 percent. A second question concerns the distortion of CDS spreads due to size. The overall effect evaluated at the mean implies that an increase by 1 percentage point in market capitalization relative to GDP reduces the spread by about 2 bp.[17] While this appears small, one has to bear in mind that a bank's size relative to the home country's GDP can quickly exceed 1 percentage point in cases of merger and acquisitions and lead to more substantial reductions in spreads.

Figure 1: Impact of Size on CDS Spreads based on Market Capitalization



4.1 Different Size Measures

In addition to asset values by Bloomberg, we also use alternative measures of size and data providers. First, we also used asset values provided by Moody's KMV *SizeAVLM*.[18] Secondly, we employ total assets taken from yearly balance sheet data published by Bankscope *AVLBOOK*. In addition, we use *TCSIZE* to proxy size with total capital. Finally, *SizeAVLMADJ* is an adjusted version of SizeAVLM. As already mentioned, the accounting data of liabilities are generally not processed

[17] The turning point using asset values is located at about 1.9 times the home country's GDP. A 1 percentage point increase in the asset value of a bank reduces the spread by 0.1 bp.

[18] Asset values by Bloomberg should measure asset values more accurately than *SizeAVLM* due to more frequently updated liability data.

before April each year. Consequently, *SizeAVLM* might be distorted for a minimum three month. We therefore adjust the data by shifting the liability data three months backward. We run Mundlak random effects specifications for each size measure and show the results in Table 4. All size measures offer similar results and are significant except *AVLBOOK*. The main difference resides in the magnitude of the size impact on spreads. Again, the short run impact exhibits the humpback shape observed previously, while the long run effects display a positive quadratic relation supporting TBTF and TBTR. Irrespective of the used proxies for size our control variables remain stable and significant.

Table 4: **Alternative Size Measures**

	SizeAVLM	SizeAVLMADJ	BOOK SIZE	TC SIZE
$Size_{i,t}$	34.20***	36.50***	13.14***	380.82***
	[8.47]	[9.19]	[2.85]	[3.06]
$Size^2_{i,t}$	-3.86***	-3.96***	-1.04	-3,316.56***
	[5.64]	[6.12]	[1.36]	[3.32]
$\overline{Size_i}$	-48.66***	-54.01***	-25.43**	-768.82***
	[4.31]	[4.03]	[2.38]	[3.55]
$\overline{Size_i^2}$	7.91**	8.61**	5.3	6,740.24***
	[2.21]	[2.08]	[1.64]	[4.29]
BidAsk	7.30***	7.25***	6.67***	6.67***
	[77.64]	[77.68]	[64.96]	[64.69]
EDF	1.53***	1.55***	0.97***	1.07***
	[6.88]	[7.07]	[5.02]	[5.40]
TD	-0.16*	-0.17**	-0.27***	-0.31***
	[1.92]	[2.04]	[3.29]	[3.65]
Constant	-2.72	-0.76	3.75	5.53
	[0.69]	[0.16]	[0.91]	[1.37]
No. of Obs.	4143	4054	3212	3208
No. of Banks	93	92	87	87
R^2	0.61	0.62	0.59	0.59

Absolute value of z-statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

4.2 Additional Control Variables

As a second robustness test, we us time and country specific effects. The presence of trends in the data may potentially bias the results. For this reason we include a linear trend and a set of monthly dummies. In column 1 of Table 5 we observe that the linear trend is significant and positive. Similarly, using time dummies in column 2 considerably improves the fit of specification. However, neither the inclusion of a trend nor time dummies changes the results regarding size. A further objection to our specification can be raised on the ground that country specific regulation and laws may drive the riskiness of banks and thus CDS spreads. We thus proceed to include country specific dummies in column 3. While changing the magnitude of the relevant size effects the overall conclusion remains. In column 4 we include country as well as time dummies confirming the effect of size.

An important issue that we need to address is the role of diversification. Large banks may simply have better diversified portfolios, more advanced risk management system and enjoy scale effects (Jones and Nguyen, 2005). Hence, our measure of size may simply capture these effects. In order to deal with this caveat, we include the monthly volatility of daily bank equity returns as a proxy for diversification (Penas and Unal (2004) and Demsetz and Strahan (1997)). High equity volatility is attributed to a less diversified portfolio and consequently higher risk. In column 5 of Table 5 we observe a significant and positive relation between CDS premium and equity return volatility, indicating that credit spreads are higher for those banks that are less diversified. Controlling for diversification, we continue to find a convex relationship between *Size* and the CDS spread.

We also test the influence of the general interest level and the yield curve.[19] In line with Houweling and Vorst (2005), Fabozzi et al. (2007) and Blanco et al. (2005) we use the *swap rate* as a benchmark for the risk free rate. We collect swap rates for exchanging 5-year fixed interest payment to 6-month European interbank offered rate (EURIBOR) to match the maturity of the CDS spreads.[20] In line with Ericsson et al. (2004), Deutsche Bundesbank (2004) and Blanco et al. (2005) we took the difference between 10 year and 2 year interest rates as a measure of the yield curve. The inclusion of both variables is shown in column 6 of Table 5. Market interest rates alone are not driving our results.

Similar to Collin-Dufresne et al. (2001) and Ericsson et al. (2004) we find a negative and significant relationship between the CDS spread and the slope of the yield curve. A flat interest curve can be an indication of an unfavorable economic environment characterized by high default probabilities and high expected losses which induces higher spreads. The *Swap Rate* enters the specification positively and may be linked to increasing refinancing costs. Banks as compared to other

[19] Houweling and Vorst (2005) find evidence that the CDS market seems to use swap rates rather than treasury rates as risk free measure.

[20] We prefer the Euribor swap rates, because the majority of our data set consist of European banks.

Table 5: **Further Control Variables**

	Trend	Time Dummies	Country Dummies	Country & Time	Diversific.	Swap Rate & Yield Curve	Mundlak Model
$Size_{i,t}$	52.37	203.16***	356.88***	172.84***	192.16***	187.85***	362.02***
	[1.31]	[5.32]	[10.00]	[4.28]	[4.90]	[4.59]	[10.23]
$Size^2_{i,t}$	-268.14***	-381.79***	-651.26***	-286.54***	-318.15***	-448.29***	-638.30***
	[3.57]	[5.42]	[8.92]	[4.10]	[4.73]	[5.89]	[8.88]
$\overline{Size}_{i,t}$	-308.05***	-432.96***	-430.35**	-118.37*	-114.76	-484.54***	-705.84***
	[2.85]	[6.38]	[2.56]	[1.72]	[1.53]	[4.41]	[7.82]
$\overline{Size}^2_{i,t}$	1,674.51***	1,521.25***	1,815.70***	746.32***	772.22***	1,969.43***	2,229.01***
	[4.38]	[6.08]	[3.98]	[3.27]	[3.38]	[5.06]	[6.64]
BidAsk	7.35***	6.74***	6.97***	6.82***	6.61***	7.01***	7.02***
	[70.66]	[53.64]	[66.84]	[53.18]	[49.45]	[65.35]	[66.43]
EDF	17.72***	18.31***	15.46***	19.54***	20.60***	16.60***	15.21***
	[15.90]	[16.87]	[13.67]	[17.99]	[18.91]	[14.63]	[13.28]
TD	-0.35***	-0.33***	-0.14*	-0.29***	-0.25***	-0.24***	-0.17*
	[4.22]	[3.87]	[1.67]	[3.27]	[3.00]	[2.79]	[1.95]
Trend	0.30***						
	[14.67]						
Diversification					181.61***		
					[3.57]		
Yield Curve						-3.65***	
						[5.33]	
Swap Rate						1.63**	
						[2.55]	
$\overline{BidAsk}_{i,t}$							-0.04
							[0.09]
$\overline{EDF}_{i,t}$							-7.39
							[1.09]
$\overline{TD}_{i,t}$							0.51
							[1.29]
Constant	-18.70***	3.13	-12.23	-14.08*	-19.93**	-3.55	-5.65
	[4.80]	[0.82]	[0.56]	[1.77]	[2.39]	[0.77]	[0.68]
No. of Obs.	3989	3989	3989	3989	3621	3989	3989
No. of Banks	91	91	91	91	80	91	91
R^2	0.64	0.69	0.62	0.69	0.7	0.63	0.62

Absolute value of z-statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%

industry sectors rely less on equity and more on debt. Investors may require higher risk premiums due to higher opportunity costs if the risk free rate increases. The increasing refinancing costs can boost the default probability of the bank. Finally, we also show the results for the full set of time invariant control variables in column 7. None of the time averages for the liquidity nor risk proxies are significant. We thus excluded time averaged control variables for liquidity and risk from all further specifications.

4.3 Sampling Issues

In this section, we examine if our results are driven by a subsample of our observations over time or countries. First, there are a few countries with relatively large banks such as Switzerland and Iceland, which may drive the overall evidence for TBTR. We thus estimated the baseline specification for the different sub-samples and show the results in Table 6. In the first sub-sample we excluded Swiss banks because they represent outliers.[21] In the second sub-sample we excluded Icelandic banks for the same reason. The exclusion of banks from either country impacts the results regarding magnitude of the *Size* effects, but does not change the coefficients otherwise. The third sub-sample drops U.S. banks, because they contain the largest banks in the world in absolute terms, but are comparably small relative to U.S. GDP. Sub-sample four only includes industrial countries. Banks from non-industrial countries are potentially more exposed to country risk and thus may present a special case. The exclusion of either U.S. banks or banks from non-industrial countries has only minor effects on the results. Finally, we exclude all banks which were dropped in the first subsamples in column 5. While the evidence for TBTF can still be verified the quadratic effect and thus evidence for TBTR disappears. The joint exclusion of Icelandic and Swiss banks causes the drop in significance of the coefficient of $\overline{Size}_i^2$.

Table 6: **Country Samples**

	Based on Market Capitalization				
	excl. Switzerl.	excl. Iceland	excl. US	Industrial Countries only	excl. All Cases
$Size_{i,t}$	375.45***	421.79***	175.48***	363.84***	127.32***
	[9.34]	[8.73]	[8.69]	[10.11]	[2.77]
$Size^2_{i,t}$	-665.97***	-896.99***	-517.68***	-654.81***	-557.98*
	[8.59]	[6.20]	[12.59]	[8.92]	[1.89]
$\overline{Size}_i$	-667.76***	-632.89***	-573.55***	-677.65***	-506.23**
	[5.69]	[4.26]	[7.21]	[5.73]	[2.24]
$\overline{Size}_i^2$	2,211.36***	1,691.39**	2,555.28***	2,167.38***	2,883.60
	[5.13]	[2.24]	[9.32]	[5.17]	[1.36]
BidAsk	6.99***	6.95***	5.17***	7.02***	4.76***
	[65.69]	[65.17]	[76.89]	[64.55]	[72.33]
EDF	15.18***	15.57***	2.44***	15.58***	3.28***
	[13.23]	[13.74]	[3.56]	[13.34]	[5.30]
TD	-0.14*	-0.15*	-0.13***	-0.09	-0.04
	[1.66]	[1.83]	[2.69]	[0.95]	[0.73]
Constant	-2.19	-2.53	10.83***	-2.91	8.61**
	[0.55]	[0.61]	[3.59]	[0.67]	[2.13]
No.of Obs.	3861	3962	3194	3688	2738
No.of Banks	89	88	77	81	62
R^2	0.62	0.61	0.7	0.62	0.7

Absolute value of t-statistics in brackets * significant at 10%; ** significant at 5%; *** significant at 1%

Secondly, given that our data contains the year 2007 our results may be affected by the subprime crises, which started in summer 2007. During this period CDS spreads increased and liquidity in the CDS market dropped markedly. According to market participants, there was a strong reluctancy to sell insurance in the CDS market at the time. We thus first consider the sub-period up to the year 2007. We

[21] The size of UBS measured by total assets is approximately five times the GDP and that of Credit Suisse 2.8 times the GDP of Switzerland.

continue to find a quadratic relationship between size and CDS spreads in column 1 of Table 7. The inclusion of the turbulent period in 2007 is not driving our results. The market seems to have already priced in expectations of TBTF and TBTR in CDS premia before 2007.

Given that some banks may have reached the TBTF or TBTR status only during our sample period, we secondly examine each year separately. Given that the time dimension consists of only the 12 months in a given year, we use the random effects estimator without the time-invariant variables. Remarkably, in columns 2-7 of Table 7 we find evidence for TBTF and TBTR from 2004 onwards. The lack of evidence in 2002 and 2003 may be due to fact that the CDS market was still in its infancy and only a few banks had CDS quotes at that time.[22]

Table 7: **Sample Results per Year**

	excl. 2007	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007
$Size_{i,t}$	378.38***	-1,163.64*	-263.54**	-202.48***	-153.65***	-161.70***	38.2
	[6.56]	[1.83]	[1.99]	[3.90]	[4.64]	[5.42]	[0.76]
$Size^2_{i,t}$	-814.37***	5,239.09	837.35	703.02***	376.71***	368.01***	-68.62
	[4.95]	[1.46]	[1.07]	[2.79]	[2.76]	[3.43]	[0.83]
$\overline{Size}_{i,t}$	-555.02***						
	[4.68]						
$\overline{Size}^2_{i,t}$	1,431.21**						
	[2.55]						
Liquidity	6.90***	8.10***	6.00***	3.06***	4.58***	3.23***	8.02***
	[60.82]	[10.66]	[22.92]	[17.29]	[24.75]	[17.65]	[34.83]
EDF	16.87***	7.83	11.89***	-1.52	0.03	6.02***	21.53***
	[15.43]	[0.57]	[8.22]	[1.27]	[0.01]	[4.12]	[2.69]
Trading Days	0.06	-0.45	-0.19	-0.02	-0.05	-0.04	-0.45**
	[0.68]	[0.45]	[1.06]	[0.29]	[0.75]	[0.87]	[2.34]
Constant	-8.00**	6.86	-1.01	15.07***	7.75***	8.58***	-1.84
	[2.27]	[0.27]	[0.19]	[6.81]	[3.79]	[4.79]	[0.36]
No. of Obs.	3145	159	626	760	804	796	844
No. of Banks	80	42	63	71	72	71	79
R^2	0.66	0.36	0.56	0.28	0.34	0.3	0.62

Absolute value of z-statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%

4.4 Alternative Specifications and Endogeneity

A further potential concern may be the presence of endogeneity in our specification, which would lead to biased and inconsistent coefficients. Potential endogenous variables are our control variables for liquidity and risk, which may be determined simultaneously with the CDS spread. In order to deal with endogeneity, we use

[22]The lack of significance for the coefficients of size in the 2007 sample may be due to the large dislocation of prices in the CDS market which manifest itself as well in the large volatility of spreads. The inclusion of data for 2008 will potentially be even more affected by the turmoil which intensified after the collapse of Lehman Brothers.

random effects instrumental variable estimators (RE-IV) and instruments for the bid-ask spread and the EDF using lagged values. Columns 1 and 2 in Table 8 report the results.[23] Clearly, endogeneity appears to be of limited importance and does not impact our results regarding size. We additionally use a First-Difference-Instrumental-Variable estimator (FD-IV) in column 3 and 4 to control for endogeneity and more importantly to deal with non-stationarity in the data. Our key results for size are robust to either IV estimation. Under the First-Difference-Estimator only the EDF is insignificant, when modelled as an endogenous variable.

We further considered the presence of heteroscedasticity and serial correlation in our specification. In column 5 of Table 8 we use the Huber-White sandwich estimator to obtain robust standard errors (Wooldridge, 2002). Clearly, the significance of our results remains and violations of the assumptions regarding the error term do not appear to be an issue.

Complementary, we use a dynamic specification to account for an autoregressive data generating process of CDS spreads. Typically, the inclusion of lagged dependent variable leads through its correlation with the individual effect to a bias (Nickell, 1981). This bias declines in the number of time periods. Given that we have about 80 months of data, we neglect this bias and present the results in column 6 of Table 8.[24] The dynamic specification further corroborates our results. The important takeaway from column 6 of Table 8 is that our hypothesis regarding the impact of size is still confirmed even when we specify a dynamic data-generating process. The coefficient of the lagged dependent variable (CDS spread) is positive and significant.

4.5 Results with Alternative Data Provider

Finally, we cross check the robustness of our results using CDS data provided by Datastream. The result are given in Table A 5. The evidence for TBTF and TBTR is clearly not driven by the data provider. Similar conclusions regarding the functional form between *Size* and the CDS spread can be drawn from columns 1-4 of Table A

[23] Table A 4 contains similar results for asset value as alternative measure of size.

[24] Alternatively, one could have used dynamic panel estimators suggested in the literature. We refrain from their use because of the considerable computational demand due to the time dimension of the data and the large number of potential instruments.

Table 8: **Alternative Specifications**

	Market Capitalization					
	RE-IV Liquidity	RE-IV Risk	FD-IV Liquidity	FD-IV Risk	Cluster	Dynamic
$CDS_{i,t-1}$						0.74***
						[91.62]
$Size_{i,t}$	289.77***	264.71***	-504.13***	-548.87***	357.51***	156.61***
	[8.79]	[9.15]	[8.62]	[10.22]	[2.86]	[8.10]
$Size^2_{i,t}$	-528.56***	-539.74***	280.28***	217.75***	-649.41***	-231.85***
	[6.99]	[9.28]	[3.70]	[3.89]	[4.84]	[6.12]
$\overline{Size}_{i,t}$	-555.10***	-575.21***			-676.39***	-255.23***
	[8.35]	[8.75]			[6.57]	[8.41]
$\overline{Size}^2_{i,t}$	2,015.90***	2,107.18***			2,182.11***	757.52***
	[7.78]	[8.48]			[7.66]	[6.38]
BidAsk	6.49***	6.35***	6.09***	3.82***	6.98***	2.10***
	[57.50]	[60.25]	[10.32]	[35.84]	[7.38]	[26.02]
EDF	12.23***	11.31***	5.37***	-0.72	15.17	-1.04
	[11.84]	[9.61]	[6.12]	[0.18]	[1.15]	[1.56]
TD	-0.24**	-0.22***	-0.03	-0.02	-0.14	0.18***
	[2.48]	[3.17]	[0.53]	[0.48]	[1.25]	[3.40]
Constant	0.27	3.28	0.60***	0.62***	-1.39	-5.24***
	[0.10]	[1.35]	[4.57]	[4.78]	[0.14]	[3.88]
No. of Obs.	3724	3818	3632	3702	3989	3912
No. of Banks	85	91	84	91	91	91
R^2	0.61	0.56	0.49	0.38	0.62	0.86

Absolute value of z-statistics in brackets. * significant at 10%, ** 5%, *** at 1%.

5 for market capitalization and asset values *(SizeAVLB)*. Only the significance of short run impact is somewhat weaker. We again observe for the long run evidence for TBTF and TBTR of a similar magnitude as when using Bloomberg data. These findings are also confirmed, when we control for diversification in column 2 and 4 as an additional control variable for CDS spreads. Table A 5 also confirms the presence of market monitoring given by the positive and significant effect of the EDF. Likewise liquidity captured by the *BidAsk* spread remains robust regarding the signs and magnitude. The variable trading days (TD), however, loses its explanatory power for the Datastream data.

5 Conclusion

This paper analyzes pricing effects due to banks' size for the CDS market. We hypothesized that CDS spreads decline in banks' size, because of an increase in the probability of a bail-out due to too-big-to-fail. We find that an increase in the mean size of 1 percentage point reduces the CDS spread by about 2 basis points. While this appears comparably small mergers of large banks can induce substantially larger changes in banks' size and subsequently in their CDS spreads. This raises two potential concerns. First, the reduction in CDS spreads may limit any potential influence of market discipline on bank management via refinancing costs providing a competitive advantage. Second, banks might pursue a socially suboptimal size to exploit better refinancing conditions. Third, supervisors may receive wrong market signals, when they monitor distorted market prices.

A further aspect raised by our analysis is the existence of banks that have already achieved a size that makes them too-big-to-be rescued. The existence of such banks leaves us with an ambiguous feeling. While a stronger market discipline for such banks is reassuring from a supervisory perspective it also demonstrates the limits of public bail-outs. As a consequence, the private sector will have to be bailed in bearing a larger part of the costs. Additionally, given that large banks typically pursue a substantial part of their business activities across borders may make the coordination of national supervisors necessary. An important step towards this direction represents the Memorandum of Understanding (MoU) on the cooperation between the financial supervisory authorities, Central banks and finance ministries of the European Union on cross border financial stability in June 2008. It aims to facilitate the management and resolution of cross-border systemic financial crises in order to minimize the economic and social costs, while promoting market discipline and limiting moral hazard.

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6 Appendix

Table A 1: **Background Information on Data**

Variable	**Type**	**Unit**	**Market/Book Value**	**Source**	**Calculation Method**
Size Measures					
Size	Market Capitalization	ratio	market value	Bloomberg	Monthly average of market Capitalization over GDP
SizeAVLB	Asset Value	ratio	mixture	Bloomberg	Monthly average market capitalization plus partly quarterly liability over GDP
SizeAVLM	Asset Value	ratio	mixture	Moody's KMV	End of month market capitalization plus annually adjusted liability over GDP
SizeAVLMADJ	Asset Value	ratio	mixture	Moody's KMV	End of month market capitalization plus annually adjusted liability [t-3] over GDP
AVLBOOK	Asset Value	ratio	book value	Bankscope	Annual Total Assets over GDP
TCSIZE	Capital Value	ratio	book value	Bankscope	Annual Total Capital over GDP
Main Control Variables					
EDF	1year default probability	in %	mixture	Moody's KMV	Model of Moody's KMV
BidAsk	Bid-Ask-Spread of CDS	in bp	market value	Bloomberg / Datastream	Monthly average of daily Bid-Ask-Spread
TD	Trading days	number		Bloomberg / Datastream	No. of traded prices per month
Further Control Variables					
Diversification	Volatility	number	market values	Datastream	Monthly Standard derivation of daily equity returns based on equity return indices
Swap rate	Interest rate	in %	market values	Bloomberg	Monthly average of daily swap rates (interest swap 5 year to 6 month Euribor)
Swap rate curve	Interest rate curve	in %	market values	Bloomberg	Monthly Difference between 10 year swap rate and 2 year swap rate

Table A 2: **List of Banks in the Sample**

1) ABN Amro	32) Commonwealth Bank of Australia	63) Mitsubishi UFJ Financial Group INC
2) ANZ Banking Group	33) Credit Lyonnais	64) Mizuho Financial Group Inc
3) Abbey National PLC	34) Credit Suisse Group	65) Morgan Stanley
4) Alliance & Leicester PLC	35) CreditAgricole	66) National Australia Bank
5) Allied Irish Bank	36) DNB Nor Bank	67) Natixis
6) Anglo Irish Bank Corp plc	37) Danske Bank	68) Nordea Bank
7) Banco Santander Ctl. Hisp	38) Deutsche Bank	69) Oversea Chinese Banking Corp
8) BBVA	39) Dexia SA	70) Resona Bank
9) BNP	40) Erste Bank	71) Royal Bank of Scotland
10) Banca Italesa	41) Fortis Bank SA	72) SEB
11) Banca Monte dei Paschi di Siena	42) Freddie Mac	73) SNS Bank
12) Banca Nazionale del Lavoro	43) Glitnir Banki HF	74) San Paolo Imi
13) Banca Popolare di Lodi	44) Goldman Sachs Group	75) Shinhan Financial Services Group
14) Banca Popolare di Milano	45) HBOS PLC	76) Shinsei Bank LTD.
15) Banco Commercial Portugues SA	46) HSBC Bank PLC	77) Societe Generale
16) Banco Espirito Santo	47) HSBC Finance Corp.	78) St. Georg Bank Ltd
17) Banco Popolare	48) Bayer. Hypo-und Vereinsbank AG	79) Standard Chartered PLC
18) Banco Sabadell International	49) ICIC Bank	80) State Bank of India/ London
19) Bank One	50) IKB	81) Sumitomo Mitsubishi Banking Corp (SMBC)
20) Bank of America	51) Industrial Bank of Korea	82) Svenska Handelsbanken
21) Bank of China Ltd	52) Industrial Development Bank India	83) UBS
22) Bank of India	53) Ing Bank	84) UFJ Bank
23) Bank of Ireland	54) Intesa Sanpaolo SpA	85) Unicredito
24) Bank of Moscow	55) JPM Chase & Co	86) United Overseas Bank
25) BankInter. Espanol	56) Kaupthing	87) Wachovia Corp
26) Barclays Bank Plc	57) Kookmin Bank	88) Washington Mutual INC
27) Bear Stearns Cos Inc	58) Landsbanki Islands	89) Wells Fargo
28) Capital One Bank	59) Lloyds Bank TSB	90) WestPac Banking Corp
29) Capitalia	60) Macquarie Bank LTD	91) Woori bank
30) Citigroup Inc	61) Malayan Banking BHD	
31) Commerzbank	62) Merill Lynch & Co Inc	

Table A 3: **Correlation of Key Variables**

	Spread	*Size*	$Size^2$	*SizeAVL*	$SizeAVL^2$	*BidAsk*	*EDF*	*TD*
Spread	1.00							
Size	-0.07	1.00						
$Size^2$	0.06	0.84	1.00					
SizeAVL	-0.12	0.86	0.57	1.00				
$SizeAVL^2$	-0.04	0.80	0.63	0.92	1.00			
BidAsk	0.79	-0.07	0.02	-0.12	-0.07	1.00		
EDF	0.44	-0.17	-0.07	-0.14	-0.09	0.45	1.00	
TD	-0.15	-0.05	-0.02	0.04	0.05	-0.23	-0.05	1.00

Table A 4: **Alternative Specifications**

	Asset Value					
	RE-IV Liquidity	RE-IV Risk	FD-IV Liquidity	FD-IV Risk	Cluster	Dynamic
$CDS_{i,t-1}$						0.74***
						[83.82]
$Size_{i,t}$	39.81***	36.36***	-10.85	-5.26	43.89***	20.47***
	[12.11]	[11.26]	[1.41]	[0.72]	[4.47]	[9.22]
$Size^2_{i,t}$	-4.19***	-3.75***	1.69	0.37	-4.69***	-2.00***
	[7.64]	[6.83]	[1.18]	[0.28]	[3.97]	[5.17]
$\overline{Size}_{i,t}$	-47.47***	-49.36***			-58.95***	-24.02***
	[7.47]	[7.62]			[5.27]	[8.08]
$\overline{Size}^2_{i,t}$	6.66***	7.23***			8.73***	2.87***
	[3.84]	[3.99]			[3.62]	[4.15]
BidAsk	6.47***	6.42***	7.50***	4.05***	7.05***	2.25***
	[51.82]	[57.25]	[11.64]	[35.34]	[9.70]	[25.60]
EDF	24.48***	19.61***	18.18***	15.95	28.18	-1
	[16.41]	[12.95]	[10.31]	[0.86]	[1.54]	[1.08]
TD	-0.35***	-0.27***	-0.04	-0.02	-0.25**	0.17***
	[3.36]	[3.67]	[0.64]	[0.47]	[2.16]	[2.83]
Constant	-1.07	1.23	0.68***	0.65***	-3.06	-6.17***
	[0.35]	[0.46]	[4.42]	[4.14]	[0.35]	[4.24]
R^2	0.63	0.58	0.57	0.51	0.65	0.87
No. Of Obs.	3286	3357	3204	3254	3508	3443
No. Of Banks	76	82	75	82	82	82

Absolute value of z-statistics in brackets. * significant at 10%, ** 5%, *** at 1%.

Table A 5: **Alternative Data Provider: Datastream**

	Market Capitalization		Asset Value	
$Size_{i,t}$	54.27*	101.44***	14.92***	12.13***
	[1.72]	[3.42]	[3.97]	[3.17]
$Size^2_{i,t}$	-81.05*	-134.42***	-1.07	-0.68
	[1.76]	[3.12]	[1.54]	[0.97]
$\overline{Size}_{i,t}$	-249.75***	-292.95***	-34.41***	-31.08***
	[3.16]	[3.82]	[4.27]	[3.72]
$\overline{Size}^2_{i,t}$	827.76***	831.21***	5.89**	5.36**
	[3.19]	[3.35]	[2.52]	[2.22]
BidAsk	6.42***	7.13***	7.22***	7.18***
	[79.15]	[82.89]	[87.94]	[80.21]
EDF	6.31***	4.98***	4.70***	4.38***
	[5.05]	[4.26]	[3.84]	[3.51]
TD	0.04	-0.05	-0.03	-0.07
	[0.64]	[0.86]	[0.49]	[1.18]
Diversification		383.12***		400.95***
		[10.45]		[10.14]
Constant	5.64**	-0.77	5.41**	1.03
	[2.16]	[0.28]	[2.10]	[0.36]
R^2	0.6	0.67	0.68	0.68
No. of Obs.	4312	3876	3898	3529
No. of Banks	105	92	96	85

Absolute value of z-statistics in brackets.
* significant at 10%; ** significant at 5%; *** significant at 1%

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