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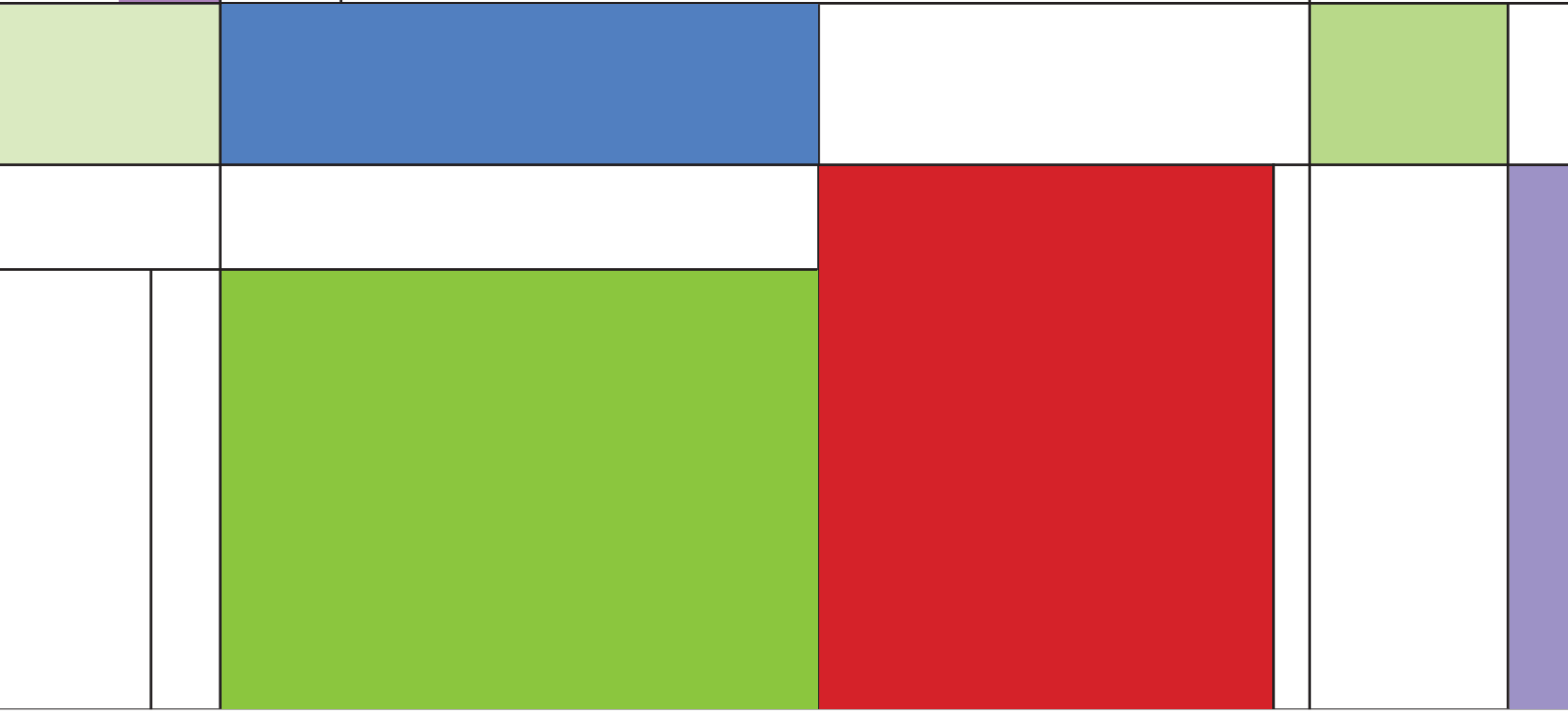

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Business models of banks, leverage and the distance-to-default

by
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This study models the distance-to-default (DTD) of a large sample of banks with the aim of shedding light on policy and regulatory issues. The determinants of the distance-to-default in a panel sample of 94 banks over the period 2004 to 2011, controlling for the market beta of each bank, included house prices, relative size, simple leverage, derivatives Gross Market Value of exposure, trading assets, wholesale funding and cross-border revenue. The Basel Tier 1 ratio found no support as a predictor of default risk. The un-weighted leverage ratio, on the other hand, found strong support. At the macro level house prices are a powerful predictor of the DTD. At the business model level, the results appear to be consistent with an approach to policy that focuses on the apparent importance of the "size-derivatives-leverage and wholesale funding' nexus in influencing the DTD of banks. While these results are preliminary, it was encouraging that the out-of-sample predictive power of the model improves systematically as each year of new observations is added. The results are also consistent with some central bank involvement in the supervision process, given the importance of the asset price cycle, identified in this study.

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I. Introduction

The OECD has maintained from the outset of the crisis that the main mechanisms causing banks to move towards the default point have been excess leverage and business models that permit the co-mingling of (highly-levered) derivatives and structured products that result in collateral and margin calls which are too large relative to bank capital. This would not cause immediate problems were banks able to fund these calls by borrowing from other banks, but inevitably uncertainty and fear enters the picture during a crisis, resulting in liquidity drying up – and setting in train mechanisms that shorten dramatically the move to default. While the mechanics of the default path can be understood, the evolution of the regulatory structures and business models of banks from the late 1990's remains highly disputed. Regulators cannot bring themselves to the conclusion that the Basel system is excessively complex and ineffective compared to a simple leverage ratio, while banks lobby very hard against rules that would alter their business models which evolved towards more vulnerable structures following the regulatory and product innovation trends (particularly) from the end of the 1990's.

To date much of the literature on bank regulation and safe versus less safe business structures has been either conceptual or descriptive in terms of events surrounding the global financial crisis. This study presents more rigorous evidence on the determinants of the distance-to-default based on a large sample of banks. Using an econometric approach, it tests hypotheses about the determinants of the distance-to-default as a function of: alternative leverage concepts; incentives for risk taking; the extent to which banking business models concentrate more on certain activities – what banks do; and bank diversification strategies. To test these micro-prudential arguments it is important also to control for macro-prudential risk factors, which have been an important focus of the literature on credit booms and busts. The study is based on panel data of 94 large global banks over the period 2004 to 2011, which encompasses the financial crisis.

Section II sets out some of the main hypotheses as to why banks get into trouble. Section III presents the data definitions, the model and the econometric results, taking care to distinguish between the full sample, the sub-sample for G-SIFI banks and that for other large banks. Section IV examines the results from the perspective of approaches to policy that aim to reduce the riskiness of banks, paying some attention to the role of business models – while controlling for macro-prudential factors. Finally, some concluding remarks are made in Section V.

II. Hypotheses about bank default and financial risks

OECD research has consistently argued that:

- The Basel system is excessively complex, rendering it ineffective, and that a simple leverage ratio should be the primary regulatory tool for bank capital; and
- there is an urgent need to influence the business models of systemically important banks by separating traditional banking from securities businesses.

These policy views have been developed as a consequence of research on the causes of the crisis, outcomes and on-going vulnerabilities, most often related to regulatory failure and the structure of bank business models. At the Reserve Bank of Australia's annual conference in July 2008 Blundell-Wignall and Atkinson (2008) argued that: *"Simple rules should be favoured over complex ones based on unrealistic models."*[1] Giving due credit to Gordy (2003), who sets out the structure of the Basel approach and its "simplifying' assumptions for risk weighting (the principle of portfolio invariance) and dependence on a single global risk factor, they point out that not only is Basel too complex, but it allows banks to optimise risk weights in a pro-cyclical manner.[2] The paper also pointed to the failure of Basel to penalise concentration in bank business models, and the authors favoured limiting these with benchmarks for the various activities of banks, deviations from which could be penalised. Blundell-Wignall, Wehinger and Slovik (2009) evolve this view further, arguing that both leverage and the business models of what banks actually are two different types of risk that need to be managed: the first with a group leverage ratio and the second with separation of traditional banking from securities subsidiaries in a ring-fenced non-operating holding company structure (NOHC) in order to reduce the risk of default through interconnectedness risk. This paper shows that a high leverage ratio was associated with less losses over the first two years of the crisis, whereas the Basel Tier 1 ratio actually showed a positive ratio (the higher the Basel ratio the greater the riskiness of the bank). Evidence on business models from this paper was presented to the working group in the research phase of the Vickers enquiry.[3]

OECD (2009) summarised views on the required responses to the crisis, including the need to streamline and simplify the complex regulatory structure (favouring a leverage ratio over the Basel concept), to improve transparency in reporting, to strengthen corporate governance, and to do so in the context of separating banking from various securities activities in the NOHC structure.[4] This book was presented to participants in the London G20 summit and to the OECD Ministerial of that year. Blundell-Wignall and Atkinson (2010) review the Basel III proposals and ask whether they will have a material positive influence on the flaws in the Basel II model that result in risk-weight optimisation for regulatory and tax arbitrage reasons.[5] The paper argues that Basel III does not address adequately the most basic regulatory issues: that financial promises should be treated in the same way wherever they are shifted with derivatives; that too big to fail (TBTF) incentive structures lead to unintended cross-subsidisation of high-risk activities and create moral hazard problems; that risk-weight optimisation combined with only a 3% leverage ratio "backstop' provides little incentive for banks to be adequately capitalised; and that the liquidity proposal causes a bias to government bonds and against lending, depending too heavily on modelling stable and unstable funding in crisis situations. With respect to the latter, the paper argues that solvent well regulated banks – including the penalisation of asset concentration – should be left to carry out maturity transformation and run their own funding strategies.

Blundell-Wignall and Atkinson (2011) emphasise the key role of interconnectedness in the financial crisis, focusing global systemically important banks (G-SIFI's).[6] The astounding growth of derivatives greatly raised interconnectedness risk and the path to default via margin calls. Derivatives and the use of excessively complex internal models are also associated with increased leverage (the paper shows the systematic reduction of RWA – to which the Tier 1 ratio applies – to total assets from the early 1990's to the onset of the crisis). The paper argues that the Basel III CVA charge to deal with derivatives

counterparty risk will serve mainly to further concentrate derivatives businesses in G-SIFI banks (via the netting pool mechanism), and that the desired move to central clearing risks serving to re-create even bigger TBTF problems in concentrated clearers controlled by G-SIFI banks. Blundell-Wignall, Atkinson and (2012) focus on good versus bad deleveraging, and argue for more banking capital, particularly in Europe.[7] The paper points to the role of derivatives in bank balance sheets, arguing that netting provides no protection from market risk and that collateral and margin calls played a key role as default mechanisms during the crisis. This paper again argues strongly for a simpler leverage ratio and the separation of traditional banking from securities-based business models. In this respect the paper argues that the Volcker rule may be too complex and difficult to apply, so that the simpler approach of the NOHC and Vickers models alongside a leverage ratio is to be preferred. Blundell-Wignall, Atkinson and Roulet (2012) focus on G-SIFI business models and the collateral and margin call paths to default.[8]

Ayadi et al (2011) looks at business models of EU banks using cluster analysis to group institutions into retail banks, wholesale banks, and investment banks.[9] This study uses a definition of the distance-to-default based on reported bank profits. Wholesale banks, often linked to the public sector in the sample are the worst performers, highly-levered investment banks bounced back after the crisis in response to policy, and retail banks were found to be the safest. Ironically, retail (safer) banks have the highest ratio of RWA to TA. In Ayadi et al (2012), and using the same definition of the distance-to-default, again finds that retail banks are safer, that RWA are a poor indicator of default risk for EU investment banks, and that other risk indicators fail to distinguish between business models perhaps due to TBTF incentives affecting all groups.[10] This non-econometric approach is based on a sample of European banks.

More recently Andrew Haldane (2012) of the Bank of England appears to support the earlier OECD views that regulation is too complex under Basel, that a leverage ratio is better, and bank separation is essential. He shows that in a single variable model a leverage ratio is a better predictor of actual default than any of the Basel ratios with data from 45 banks.[11] However, there has been no extensive modelling of the distance-to-default based on leverage as well as important aspects of bank business models.

While OECD research has focused mainly on the regulations and structure as causes of bank failure, it is clear that macro-prudential aspects may be equally important. Borio and White (2004), and White (2006), while making no prediction of a crisis or its timing, argued that the monetary policy framework in the context of liberalised financial markets could lead to excesses that risk being disorderly in their unwinding.[12] Rajan (2005) argued that it had become more difficult for financial firms to outperform their peers in terms of the return on equity (and hence stock market performance) as the competitive structure has evolved and innovations are available to move products onto the capital market.[13] To justify their higher salaries, managers have increasingly invested in high-risk but illiquid products that would cause problems in the event of a crisis. Blundell-Wignall (2007a, 2007b, and 2007c) argued that structured products were exploding in size and posed the greatest present risk to the financial system – particularly synthetic products based on derivatives of which sub-prime mortgages were only one part.[14] Gap events related to illiquidity would lead to knock-on effects through the financial system and take a long time to be worked out in bank balance sheets. Gramlich (2007) warned that that the boom in subprime mortgages in part due to low rates posed a huge risk to the financial system.[15] Reinhart and Rogoff (2009) show that crises through history always have the pattern where they are

preceded by easy credit, asset price increases that lead to excess leverage and further speculation, until reversal mechanism are triggered.[16]

III. Determinants of the distance-to-default

From the preceding discussion it is clear that there are both macro as well as micro influences on defaults in the banking system, so that any tests of leverage and business model channels needs to control for both.

III.1. The data

The dependent variable is the distance-to-default. The DTD is the number of standard deviations away from the default point based on a sophisticated measure described in Appendix 1. To derive the measure, it is assumed that a bank defaults (or is bankrupt) when the market value of assets equals (or is lower) than the book value of debt. This measure uses the Black-Scholes model for capitalising equity to calculate the former. A bank defaults (or is bankrupt) when the distance-to-default equals 0 (or is negative).

Explanatory variables of a macro-prudential control nature are:

- House prices in the country location of the bank, to capture monetary policy and credit cycles driving asset prices.

  HP_CHG: House price index (% change)

  It is expected that the DTD is positively related to house prices (falling house prices reduce the DTD).[17]

- The correlation of the banks share price with that of the overall market (BETA), which reflects its systemic importance with respect to the economy:

  CAPM Beta

  This is defined as the covariance of a firm's stock returns with the market divided by variance of market returns. It is assumed that the equity market conveys useful information for predicting financial deterioration. If the market is efficient, prices and returns should incorporate the risk exposure of banks and thus their overall default risk from multiple sources. The higher is beta, the more susceptible the bank is to the economy-wide macro-systemic risk and the smaller is its DTD (the DTD is expected to be negatively related to Beta).

In the above literature incentives to excessive risk taking focused on TBTF (the cross-subsidisation of high risk products for banks that carry the implicit size guarantee), and high remuneration levels that require greater risk taking to be justified in a lower return competitive market, are as follows. The explanatory variables chosen are:

- Total assets (IFRS) of banks i/total assets of the banking system in country j

  TA_BKST

  It is expected that the DTD is negatively related to size.

- Log of total expenses per employees

  LN_EXP_EMPL

  It is expected that the DTD is negatively related to compensation per employee.

Leverage is a key risk to all banks, and is the rationale for capital ratios under the Basel system. Much of the OECD analysis has provided theoretical analysis of why the Basel ratio is too complex and flawed, and illustrations of the effects or risk weight optimisation to

reduce capital holding have been provided in a number of the papers. For the role of leverage, a two-horse race is tested in the model (with macro and business model variables being controlled for):

- Total assets (IFRS)/(total equity – goodwill and other intangible assets)

  LEV

  It is expected that the DTD is negatively related to leverage.

- Tier1 capital/total risk weighted assets.

  T1_RWA

  If weighting assets by risk bucket is useful (as opposed to un-weighted asset in LEV above), then lower leverage of risk-weighted assets (RWA) should be a better predictor of default than a simple leverage ratio. It is expected that the DTD is positively related to the Tier 1 capital ratio.

Of prime interest with respect to the separation debate, are key variables that capture the business model of a bank with respect to interconnectedness. In the above OECD literature this has focused on derivatives counterparty risk and the availability of cash to make margin payments. However, other aspects may be important too, such as interbank assets and degree of funding from wholesale markets as opposed to deposits. The variables tested are:

- Gross market value of derivatives/total assets

  GMV_TA

  If banks have a high concentration of derivatives in their business model, they will be subject to margin calls in periods of market volatility. The larger the derivatives position, the larger the calls can relative to capital and or liquid assets. The DTD is expected to have a negative sign with respect to this variable.

- Trading assets/total assets

  TD_TA

  The availability of liquid trading assets that can be sold mitigates counterparty risk. The DTD is expected to have a positive sign with respect to this variable.

- Central bank total Repo with banks and securities held for monetary policy purposes/ central bank total assets

  CB_LIQBK

  These constitute assets held which are liabilities of the central bank. Such assets on hand mitigate counterparty risk. The DTD is expected to have a positive relationship with this variable.

- Interbank assets/total assets

  IB_TA

  Banks hold each others' liabilities in the interbank market, and such liquid assets can be used in the event of liquidity needs. The DTD is expected to have a positive relationship with this variable.

- Wholesale funding/total liabilities

  WFD_TL

It is widely accepted that deposits are a more stable funding source than dependence on wholesale funding, which is often short-term and may dry up in the event of a crisis. The DTD is expected to have a negative relationship with higher proportions of wholesale funding.

Finally, business diversification in terms of the number of subsidiaries and more diverse geographical sources of revenue may reduce the risks of dependence on any one subsidiary or revenue source. The two variables tested are:

- Number of recorded subsidiaries

  N_SUB

- Cross border revenue/total revenue

  XBORD_REV

The DTD is expected to have a positive relationship with both variables.

Table 1. **The banks covered in the study**

Mnemo	Name	Country	Market cap	Mnemo	Name	Country	Market cap
CITI	**Citigroup**	**United States**	**254**	RF	Regions Financial	United States	23
BAC	**Bank of America**	**United States**	**217**	RBI	Raiffeisen Bank	Austria	23
HSBC	**HSBC Holdings**	**United Kingdom**	**215**	SEB	SEB	Sweden	22
JPM	**JP Morgan & Chase**	**United States**	**166**	BBT	BB&T	United States	22
UBS	**UBS**	**Switzerland**	**127**	FITB	Fifith Third Bancorp	United States	22
RBS	**Royal Bank of Scotland**	**United Kingdom**	**120**	BMPS	Banca Monte Dei Pasci	Italy	21
WFC	**Wells Fargo**	**United States**	**118**	BCP	Banco comercial Portugal	Portugal	20
SAN	**Banco Santander**	**Spain**	**116**	BKIR	Bank of Ireland	Ireland	20
BNP	**BNP Paribas**	**France**	**112**	SWEDA	Swedbank	Sweden	19
WB	**Wachovia**	**United States**	**109**	MB	Mediobanca	Italy	19
ISP	**Intesa Sanpaolo**	**Italy**	**95**	VBPS	Oest Volkbanken	Austria	18
GS	**Goldman Sachs**	**United States**	**94**	SHBA	Svenska	Sweden	18
UCG	**Unicredit**	**Italy**	**94**	DNBNOR	DNBNOR	Norway	17
BARC	**Barclays**	**United Kingdom**	**91**	UBI	UBI Banca	Italy	16
MS	**Morgan Stanley**	**United States**	**88**	BTO	Banesto	Spain	16
BBVA	**BBVA**	**Spain**	**88**	EUROB	EFG Eurobank	Greece	15
CS	**Credit Suisse**	**Switzerland**	**87**	ANGL	Anglo Irisk Bank	Ireland	15
GLE	**Societe Generale**	**France**	**86**	DPB	Deutsche Postbank	Germany	14
HBOS	**HBOS**	**United Kingdom**	**83**	CC	CIC	France	14
MER	**Merrill Lynch**	**United States**	**82**	KEY	Keycorp	United States	13
DBK	**Deutsche Bank**	**Germany**	**76**	ALPHA	Alpha bank	Greece	13
ACA	**Credit Agricole**	**France**	**67**	MTB	M&T Bank	United States	12
LLOYDS	**Loyds Banking**	**United Kingdom**	**64**	BES	Banco Espirito	Portugal	11
WAMU	**Washington Mutual**	**United States**	**43**	SNV	Synovus Financial	United States	10
LEHM	**Lehman Brothers**	**United States**	**41**	TPEIR	Piraeus Bank	Greece	10
NDA	**Nordea**	**Sweden**	**41**	CPB	Cyprus Popular Bank	Cyprus	9
DEXB	**Dexia**	**Belgium**	**37**	BOCY	Bank of Cyprus	Cyprus	9
CBK	**Commerzbank**	**Germany**	**31**	CMA	Comerica	United States	9
BEARS	**Bear Stearns**	**United States**	**24**	NA	National Bank of Canada	Canada	9
POP	**Banco Popular**	**Spain**	**23**	KBCA	KBC Ancora	Belgium	9
SAB	**Banco Sabadell**	**Spain**	**14**	ZION	Zions Bancorp	United States	8
RY	Royal Bank of Canada	Canada	68	BEB2	Landesbank Berlin	Germany	8
USB	US Bancorp	United States	57	BKT	Bankinter	Spain	7
KBC	KBC Groep	Belgium	50	EFGN	EFG International	Switzerland	7
TD	Toronto Dominion Bank	Canada	49	BPI	Banco BPI	Portugal	7
FORB	Fortis	Belgium	49	HCBK	Hudson City Bancorp	United States	7
BNS	Bank of Nova Scotia	Canada	48	CRG	Banca Carige	Italy	7

Table 1. **The banks covered in the study** *(cont.)*

Mnemo	Name	Country	Market cap	Mnemo	Name	Country	Market cap
STAN	Standard Chartered	United Kingdom	46	PMI	Banco Popular Milano	Italy	6
BMO	Bank of Montreal	Canada	32	BPE	Banco Popular Emilia	Italy	6
STI	Suntrust	United States	31	BVA	Banco Valencia	Spain	6
CM	Canadian Imperial Bank	Canada	31	BPSO	Banco Popular Sondri	Italy	5
KN	Natixis	France	30	HBAN	Huntington Bancorp	United States	5
DANSKE	Danske	Denmark	29	NYB	NY Commercial Bancorp	United States	5
ETE	National Bank of Greece	Greece	27	PBCT	People's United	United States	5
PNC	PNC Financial	United States	25	FHN	First Horizon	United States	5
EBS	Erste Group Bank	Austria	25	ATE	Agricultural Bank	Greece	5
ALBK	Allied Irish Bank	Ireland	24	CSE	Capitalsource	United States	5

Source: Bloomberg and authors calculations.

The sample consists of 94 US and EU internationally active commercial banks and broker dealers with equity market capitalization in excess of $5 bn. Only publicly traded banks are included because market data are required for the model. These banks encompass all of the main counterparties for capital markets products (particularly bonds and derivatives). The sample also encompasses the G-SIFI banks, as defined by the Financial Stability Authority in November 2011. In addition, banks that failed in the crisis, but which can be considered as G-SIFIs, such as HBOS, Merrill Lynch, Lehman Brothers, Washington Mutual, Wachovia and Bear Stearns are included. Finally, a few banks with a system-wide importance in their related countries (such as Intesa San Paolo, Unicredit, Banco de Sabadell and Banco Popular Espanol) are also included. The sample consists of 31 G-SIFIs and 63 other large banks. The list of all banks in the sample is shown in Table 1, and G-SIFI banks are shown in bold.

Table 2 shows the descriptive statistics of the data for all 94 banks for the period 2004 to 2011. The data are broken into five risk buckets, arranged according to the distance-to-default. Five asterisks indicates being in the 10% of the most at-risk institutions with the smallest DTD (a group populated with many more specialist investment banks), 4 asterisks denotes the next 22.5%, 3 asterisks the next 35%, 2 asterisks the next 22.5%, and one asterisk denotes (safer) banks in the 10% with the greatest distance-to-default. Large universal banks that operate investment banks often frequent the second and third groups. Smaller regional banks are frequently found in the 4th and 5th two and one asterisk groups.

Table 2. **Descriptive statistics by default risk bucket, 94 largest banks**
2004 to 2011

	Distance-to-default	Size	Leverage	Tier1 capital ratio	Interbank assets	Trading assets	Wholesale funding	Derivatives	Beta
				* * * * *					
Mean	**2.00**	**7.49**	**25.53**	**10.11**	**8.00**	**16.50**	**36.96**	**14.30**	**1.33**
Median	2.22	3.70	20.39	10.39	5.89	12.70	38.57	4.22	1.32
Maximum	*4.43*	*34.27*	*73.72*	*17.90*	*30.78*	*85.15*	*92.89*	*74.70*	*2.42*
Minimum	*-0.41*	*0.01*	*9.56*	*2.15*	*0.00*	*0.23*	*2.73*	*0.09*	*0.32*
Std. Dev.	1.55	9.33	15.16	3.22	6.82	16.16	20.98	21.51	0.47

Table 2. **Descriptive statistics by default risk bucket, 94 largest banks** *(cont.)*

2004 to 2011

	Distance-to-default	Size	Leverage	Tier1 capital ratio	Interbank assets	Trading assets	Wholesale funding	Derivatives	Beta
				*****					
Mean	**2.77**	**14.85**	**27.91**	**9.60**	**9.88**	**23.25**	**40.80**	**13.43**	**1.38**
Median	2.95	13.04	24.78	9.42	8.29	19.62	39.11	6.61	1.37
Maximum	*5.59*	*55.02*	*77.58*	*16.60*	*46.15*	*84.90*	*85.85*	*77.56*	*2.40*
Minimum	*0.15*	*0.01*	*1.30*	*4.44*	*0.00*	*0.17*	*4.55*	*0.08*	*0.21*
Std. Dev.	1.68	12.73	14.94	2.40	7.94	16.74	18.01	16.44	0.43
				***					
Mean	**3.55**	**14.53**	**26.87**	**10.17**	**9.01**	**24.29**	**35.83**	**12.01**	**1.16**
Median	3.61	10.33	23.80	9.35	7.39	20.10	36.56	5.76	1.17
Maximum	*6.60*	*62.60*	*78.60*	*23.70*	*53.08*	*86.44*	*92.07*	*72.19*	*2.38*
Minimum	*1.00*	*0.01*	*1.30*	*5.71*	*0.00*	*0.17*	*3.99*	*0.00*	*0.17*
Std. Dev.	1.85	14.92	13.89	2.91	8.06	17.66	17.35	14.69	0.35
				**					
Mean	**4.52**	**7.70**	**22.05**	**10.40**	**7.49**	**20.33**	**30.89**	**8.34**	**0.92**
Median	4.46	3.13	20.60	9.44	6.80	18.50	26.73	2.40	0.92
Maximum	*7.98*	*51.90*	*80.33*	*24.86*	*43.89*	*83.98*	*82.34*	*72.28*	*1.53*
Minimum	*1.71*	*0.01*	*3.12*	*4.00*	*0.00*	*0.45*	*0.72*	*0.05*	*0.12*
Std. Dev.	2.09	10.49	10.30	3.62	7.44	12.54	17.43	14.12	0.29
				*					
Mean	**4.52**	**7.70**	**22.05**	**9.91**	**7.49**	**20.33**	**30.89**	**8.34**	**0.92**
Median	4.46	3.13	20.60	9.00	6.80	18.50	26.73	2.40	0.92
Maximum	*7.98*	*51.90*	*80.33*	*21.71*	*43.89*	*83.98*	*82.34*	*72.28*	*1.53*
Minimum	*1.71*	*0.01*	*3.12*	*6.54*	*0.00*	*0.45*	*0.72*	*0.05*	*0.12*
Std. Dev.	2.09	10.49	10.30	2.66	7.44	12.54	17.43	14.12	0.29

Source: Bloomberg, DataStream and SNL (2004-2011). This table shows the descriptive statistics for an unbalanced panel of US and European internationally active commercial banks and broker dealers with equity market capitalization in excess of 5 billion USD over the period. Our sample includes 94 banks. All variables are expressed in percentage, except distance-to-default, Leverage and Beta. Distance-to-default: number of standard deviations away from the default point.

Table 3 show the same breakdown for the 31 G-SIFI banks.

Table 3. **Descriptive statistics by default risk bucket, 31 G-SIFI's banks**

2004 to 2011

	Distance-to-default	Size	Leverage	Tier1 capital ratio	Interbank assets	Trading assets	Wholesale funding	Derivatives	Beta
				*****					
Mean	**1.96**	**16.37**	**39.49**	**10.16**	**10.10**	**36.57**	**51.20**	**34.31**	**1.71**
Median	2.46	17.11	37.57	9.10	9.60	31.31	54.49	27.06	1.72
Maximum	*4.40*	*34.27*	*73.72*	*17.90*	*30.78*	*85.15*	*84.05*	*74.70*	*2.31*
Minimum	*0.05*	*5.90*	*20.39*	*6.66*	*0.57*	*0.65*	*11.61*	*2.03*	*1.20*
Std. Dev.	1.57	8.53	15.18	3.25	9.45	27.15	19.94	27.12	0.36

Table 3. **Descriptive statistics by default risk bucket, 31 G-SIFI's banks** *(cont.)*

2004 to 2011

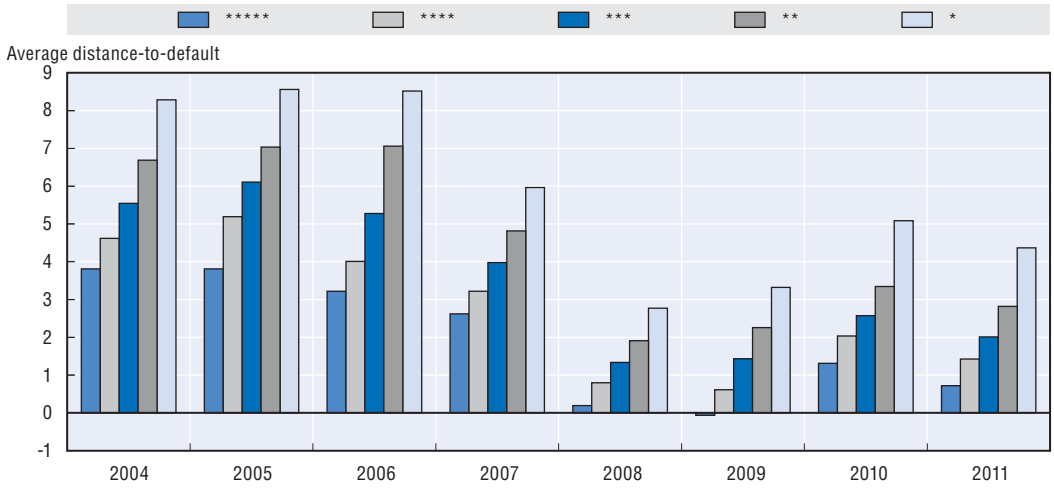
	Distance-to-default	Size	Leverage	Tier1 capital ratio	Interbank assets	Trading assets	Wholesale funding	Derivatives	Beta
				****					
Mean	**2.55**	**20.40**	**34.97**	**10.20**	**11.06**	**31.29**	**44.54**	**23.15**	**1.54**
Median	2.09	17.66	30.63	10.29	7.83	25.14	42.87	16.38	1.51
Maximum	*5.51*	*55.02*	*77.58*	*16.60*	*46.15*	*84.90*	*85.85*	*77.56*	*2.34*
Minimum	*0.15*	*1.81*	*4.77*	*6.03*	*1.15*	*1.64*	*14.68*	*1.71*	*0.97*
Std. Dev.	1.63	13.18	16.23	2.44	9.88	21.36	18.91	19.09	0.34
				***					
Mean	**3.74**	**22.30**	**34.38**	**9.83**	**11.10**	**35.82**	**39.97**	**19.36**	**1.26**
Median	4.18	20.66	31.41	8.80	9.66	28.58	38.81	13.99	1.23
Maximum	*6.46*	*62.60*	*77.67*	*18.07*	*53.08*	*86.44*	*76.93*	*72.19*	*2.38*
Minimum	*1.00*	*1.79*	*6.98*	*5.77*	*0.03*	*3.79*	*8.42*	*0.21*	*0.56*
Std. Dev.	1.88	14.64	14.47	2.65	9.88	21.89	16.83	16.99	0.29
				**					
Mean	**4.71**	**17.74**	**25.91**	**10.27**	**10.80**	**27.55**	**37.73**	**16.42**	**1.08**
Median	4.63	16.63	25.47	9.13	7.84	23.42	39.03	6.47	1.06
Maximum	*7.59*	*43.78*	*51.42*	*17.76*	*43.89*	*83.98*	*68.41*	*72.28*	*1.48*
Minimum	*1.71*	*2.77*	*12.96*	*6.87*	*1.08*	*2.41*	*11.49*	*0.14*	*0.79*
Std. Dev.	2.01	10.66	8.01	3.06	10.20	20.03	14.91	20.09	0.21
				*					
Mean	**7.02**	**14.44**	**25.88**	**8.33**	**7.69**	**21.07**	**35.33**	**15.76**	**0.78**
Median	8.18	14.15	22.33	8.47	8.82	20.58	39.99	4.30	0.80
Maximum	*9.41*	*29.57*	*47.17*	*9.36*	*15.69*	*48.56*	*53.20*	*52.10*	*0.94*
Minimum	*2.61*	*2.53*	*13.22*	*6.54*	*1.10*	*5.49*	*18.23*	*0.26*	*0.58*
Std. Dev.	2.28	10.77	12.07	0.75	4.66	10.58	11.96	21.23	0.10

Source: Bloomberg, DataStream and SNL (2004–2011). This table shows the descriptive statistics for an unbalanced panel of US and European internationally active commercial banks and broker dealers with equity market capitalization in excess of 5 billion USD over the period. Our sample includes 94 banks. All variables are expressed in percentage, except distance-to-default, Leverage and Beta. Distance-to-default: number of standard deviations away from the default point.

In both cases a number of interesting features stand out. Riskier banks in the first 2 rows tend to have more leverage, more derivatives and more wholesale funding than banks lower down in the table. This is not the case for the other variables, where a mixed picture emerges. Tier 1 capital ratios in particular show no consistent patterns. It is also of interest that the G-SIFI banks (Table 3) in the higher risk categories are larger, have more leverage, more wholesale funding, more trading assets and more derivatives exposure than do banks in general (Table 2). Tier 1 ratios are broadly comparable for G-SIFI's and banks in general.

The evolution of the average DTD for the banks within each of the five risk buckets over time is shown in Figure 1. The worst year is 2008. There was a sharp improvement in 2009 which continued into 2010. However, illustrating that the banking issues have not be dealt with adequately, and particularly due to the European members of the sample, the distance-to-default began to fall again in 2011, across all risk buckets.

Figure 1. **The evolution of the distance-to-default before and after the crisis**



Source: Bloomberg and authors calculations.

It is not possible to conclude very much from looking at the data in these tables and graphs, as it is not possible to control for all of the macro, business model, leverage and diversification arguments without using econometric techniques.

III.2. The econometric results

A panel regression approach is used to explain the differences in DTD's across banks over the period 2004-2011. The following equation uses the variables discussed earlier, for macro-prudential influences, incentives for risk taking, leverage, business model aspects and diversification. The equation is estimated with two alternatives for leverage: the leverage ratio or the regulatory capital approach in the Tier 1 ratio. The empirical model is specified in equation (1); where the subscripts *i* and *t* denote the bank and the period, respectively:

$$\begin{aligned} DTD_{i,t} &= \alpha_{i,t} + \beta_1 * TA\_BKST_{i,t} + \beta_2 * K\_R_{i,t} + \beta_3 * IB\_TA_{i,t} + \beta_4 * TD\_TA_{i,t} + \beta_5 * WFD\_TL_{i,t} \\ &+ \beta_6 * GMV\_TA_{i,t} + \beta_7 * N\_SUB_{i,t} + \beta_8 * XBORD\_REV_{i,t} + \beta_9 * LN\_EXP\_EMPL_{i,t} + \beta_{10} * BET \\ &+ \beta_{11} * HP\_CHG_{i,t} + \beta_{12} * CB\_LIQBK_{i,t} + \varepsilon_{i,t} \end{aligned} \quad \ldots\ldots (1)$$

$K\_R_{i,t}$ corresponds to $LEV_{i,t}$ or $T1\_RWA_{i,t}$ as the equation is estimated twice, once with the simple leverage ratio, excluding the Basel capital concept, and once with leverage excluded and the Basel Tier 1 capital ratio included. These two equations are estimated using ordinary least squares (OLS). After testing for cross-section versus time-fixed versus random effects, and for the heteroskedasticity of error, cross-section and time-fixed effects are introduced into the regression. The regression results are first shown in the form of the arguments tested separately in univariate models, in Table 4.

All of the variables have the expected signs. However, the Tier 1 ratio is statistically insignificant, in contrast to strong significance at the 1% level for the leverage ratio. This finding is quite extraordinary, given the amount of effort that has gone into the Tier 1 ratio over the past 2 decades and the general support it has in regulatory and banking circles. Size, trading assets, the gross market value (GMV) of derivatives, cross-border revenue and beta also all appear to be well determined in the univariate regressions. It was somewhat surprising on the other hand that interbank assets, wholesale funding, the number of

Table 4. **The determinants of banks' distance-to-default: Univariate regression results**

Constant	TA_BKST	LEV	T1_RWA	IB_TA	TD_TA	WFD_TL	GMV_TA	N_SUB	XBORD_ REV	LN_EXP_ EMPL	BETA	HP_CHG	CB_ LIQBK
6.87 ***	-7.83 ***												
(27.15)	(-3.83)	–	–	–	–	–	–	–	–	–	–	–	–
6.51 ***		-0.02 ***											
(26.66)	–	(-2.33)	–	–	–	–	–	–	–	–	–	–	–
5.79 ***			2.97										
(19.68)	–	–	(0.87)	–	–	–	–	–	–	–	–	–	–
5.83 ***				1.30									
(31.49)	–	–	–	(0.80)	–	–	–	–	–	–	–	–	–
5.40 ***					2.56 **								
(19.98)	–	–	–	–	(2.28)	–	–	–	–	–	–	–	–
6.34 ***						-1.08							
(17.75)	–	–	–	–	–	(-1.16)	–	–	–	–	–	–	–
-4.16 ***							-4.16 ***						
(-3.24)	–	–	–	–	–	–	(-3.24)	–	–	–	–	–	–
4.84 ***								0.01					
(2.47)	–	–	–	–	–	–	–	(0.58)	–	–	–	–	–
5.58 ***									1.53 **				
(25.93)	–	–	–	–	–	–	–	–	(2.00)	–	–	–	–
7.32 ***										-0.32			
(4.14)	–	–	–	–	–	–	–	–	–	(-0.79)	–	–	–
8.47 ***											-3.08 ***		
(48.11)	–	–	–	–	–	–	–	–	–	–	(-15.99)	–	–
5.16 ***												11.23 ***	
(45.27)	–	–	–	–	–	–	–	–	–	–	–	(11.34)	–
4.00 ***													-0.79
(14.76)	–	–	–	–	–	–	–	–	–	–	–	–	(-1.39)

Note: This table shows the results of estimating single regressions for an unbalanced panel of 94 US and European internationally active commercial banks and broker dealers with equity market capitalization in excess of $5 bn over the 2004-2011period. See Section III.1 for the definition of the explanatory variables. The list of G-SIFIs is detailed in Table 1. Cross-section and time fixed effects are used in the regressions as is the White cross-section covariance method. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

subsidiaries and compensation levels were not significant, even at the 10% level. However, as noted earlier, individual arguments in the equation may have very different levels of significance in the multivariate regression, once the influence of other variables is controlled for.

The multivariate regression result is shown in Table 5. The regression is run for the two equations in three separate steps: *i)* for all of the banks in the sample; *ii)* for the 31 G-SIFI banks; and *iii)* for the other large banks not considered to be G-SIFI's.

Table 5. **The determinants of banks' DTD: Multivariate regression results**

	All banks		GSIFIs		Other large banks	
TA_BKST	-4.02 **	-4.90 ***	-3.97 **	-5.06 ***	-4.94	-3.59
	(-1.91)	(-2.60)	(-2.14)	(-4.51)	(-0.94)	(-0.63)
LEV	-0.03 ***		-0.02 ***		-0.04 **	
	(-3.01)	–	(-3.34)	–	(-2.06)	–
T1_RWA		0.95		4.97 *		-2.05
	–	(0.31)	–	(1.76)	–	(-0.55)
IB_TA	0.53	0.16	-0.36	-0.56	1.66	0.89
	(0.40)	(0.11)	(-0.24)	(-0.36)	(0.79)	(0.35)

Table 5. **The determinants of banks' DTD: Multivariate regression results** *(cont.)*

	All banks		GSIFIs		Other large banks	
TD_TA	2.24 **	1.39	3.79 ***	2.56 **	0.17	0.01
	(2.24)	(1.27)	(3.38)	(2.32)	(0.11)	(0.00)
WFD_TL	-2.67 ***	-3.51 ***	-2.36	-3.56 **	-1.70	-2.47
	(-2.67)	(-3.15)	(-1.59)	(-2.13)	(-1.16)	(-1.50)
GMV_TA	-2.87 ***	-4.03 ***	-1.67 ***	-2.16 ***	-2.76	-3.30
	(-2.62)	(-3.68)	(-3.07)	(-7.06)	(-1.20)	(-1.44)
N_SUB	0.01	0.01	0.01	0.01	0.14	0.07
	(0.43)	(0.43)	(0.59)	(1.41)	(1.40)	(0.65)
XBORD_REV	0.61	0.82	3.24 ***	2.76 ***	-1.69 *	-1.59
	(0.92)	(1.20)	(4.77)	(3.84)	(-1.75)	(-1.46)
LN_EXP_EMPL	0.10	-0.33	0.04	-0.30	0.46	0.07
	(0.26)	(-0.82)	(0.07)	(-0.66)	(0.83)	(0.11)
BETA	-2.40 ***	-2.42 ***	-2.50 ***	-2.54 ***	-2.28 ***	-2.32 ***
	(-16.31)	(-16.37)	(-15.14)	(-14.79)	(-11.86)	(-11.73)
HP_CHG	8.89 ***	10.14 ***	9.44 ***	10.78 ***	10.34 ***	11.61 ***
	(9.59)	(10.45)	(3.06)	(3.46)	(7.74)	(7.91)
CB_LIQBK	-1.03	-0.83	-0.92	-0.75	-0.72	-1.06
	(-1.53)	(-1.22)	(-1.20)	(-1.14)	(-0.65)	(-0.85)
C	8.19 ***	10.17 ***	6.53 ***	7.85 ***	1.32	5.86
	(3.36)	(4.05)	(2.81)	(3.62)	(0.25)	(1.01)
R^2	0.84	0.85	0.88	0.89	0.83	0.84
Fisher Stat	27.85	26.49	28.29	29.28	23.00	20.18
P-Value F	0.00	0.00	0.00	0.00	0.00	0.00
Total Obs.	467	418	196	180	271	238

Note: This table shows the results of estimating single regressions for an unbalanced panel of 94 US and European internationally active commercial banks and broker dealers with equity market capitalization in excess of $5 bn over the 2004-2011 period. See Section III.1 for the definition of the explanatory variables. The list of G-SIFIs is detailed in Table 1. Cross-section and time fixed effects are used in the regressions as is the White cross-section covariance method. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Step 1: All banks

The leverage ratio argument in the first regression is well determined at the 1% level, but the Basel Tier 1 ratio appears to find no support as a determinant of the distance-to-default in the second. Both of these variables were also included together in the model. While the results are not reported in the table, the leverage ratio only was supported by the data. These multivariate results support the earlier finding in the univariate regressions that the Tier 1 ratio does not seem to matter for understanding the DTD. Focusing on the first equation the macro control variables in house prices and the market beta are correctly signed and significant at the 1% level. With respect to influences on risk taking, the results show that the size of a bank in its own market (TBTF) is significant at the 5% level, but firm employee compensation levels find no support in the data. In terms or arguments relating to the business model, the GMV of derivatives and wholesale funding have the expected signs and are significant at the 1% level. Trading assets find support at the 5% level. None of the other variables (central bank assets and interbank assets) appear to be supported by the data. This is also the case for diversification arguments (subsidiaries and cross-border revenue), though this is perhaps not surprising in the case of cross-border revenue, given the large number of national commercial banks in the sample that have little income from this source.

Step 2: G-SIFI banks

For the G-SIFI sample, the leverage ratio is correctly signed and significant at the 1% level in the first equation, while the Basel Tier 1 ratio is significant only at the 10% in the second. This latter equation has a less observations, and the first is preferred. The control macro control variables (house prices and beta) are strongly supported at the 1% level. With respect to influences on risk taking, the result are comparable to the sample of all banks, in that size matters, but compensation finds no support at statistically significant levels. The business model arguments for G-SIFI's once again show strong evidence that the GMV of derivatives is a key driver of the DTD (at the 1% level), high levels being associated with much greater vulnerability. A high level of liquid trading assets (also of the correct sign and significant at the 1%level) appears, on the other hand, to have the reverse implication: higher ratios reduce the risk of default.[18] In contrast to the full sample results, wholesale funding slips in significance to just below the 10% level. The diversification variables provide a contrast to the preceding results for all banks (*i.e.* where nationally focused banks are included). For G-SIFI banks cross-border revenue is supported by the data as a diversification benefit, and at the 1% level – so higher levels are associated with lower risk. The number of subsidiaries, on the other hand, remains statistically insignificant.

Step 3: Other large banks

The results for the subset of banks considered not to be G-SIFI's, provides a perhaps not too surprising contrast. In the first equation the leverage ratio is correctly signed and significant at the 5% level, whereas in the second equation the Tier 1 ratio is actually incorrectly signed, though not significant. Focusing on the first equation, it appears that only the leverage ratio, house prices and beta find strong support in the data for banks that are not G-SIFIs. There is weak support at the 10% level for diversification through cross border revenue. The size variable appears not to matter for these other banks, suggesting that G-SIFI's only are associated with the TBTF risk taking argument. None of the other variables (including derivatives) find support in the data.

III.3. Out of sample forecasting properties

It is important to consider whether tools such as that developed above might be useful guides to policy. This would require that as more observations come to hand the DTD model would have improving and not unreasonable out-of-sample forecasting properties. To do this the model is estimated first for the sample of 2004 to 2007 (240 observations), before the crisis, and using the random walk extrapolation of the independent variables the DTD's are projected for the banks in 2008. Subsequently the model is estimated to 2008, and 2009 is extrapolated, and so on. The mean square errors for the results of this exercise are shown in the top panel of Table 6. This exercise is then repeated for the G-SIFI model and the other (non G-SIFI) banks. In all cases the mean square error (MSE) reduces as new observations are added. The model with 413 observations to 2010, has a MSE of 0.9 for all banks, 1.12 for the G-SIFI banks and 0.62 for the case of the other large banks.

Table 6. **Multivariate regressions: Mean square error of out-of-sample tests**

	2008	2009	2010	2011
		All banks		
Multivariate regression	5.25	3.34	2.19	0.90
Total obs.	240	296	354	413
		G-SIFIs		
Multivariate regression	4.04	2.04	1.55	1.12
Total obs.	104	127	150	174
		Other large banks		
Multivariate regression	6.00	3.73	2.64	0.62
Total obs.	136	169	204	239

Note: This table shows the MSE of regressions calculated by subtracting actual DTD to the fitted DTD of models based on an unbalanced panel of 94 US and European internationally active commercial banks with equity market capitalization in excess of 5 billion USD over the 2004-2011 period.

IV. Possible policy implications of the results

When discussing these results from a policy perspective it is important to bear in mind that there have been many financial crises over the centuries, each with their own characteristics. This study is focused only on data from 2004-2011, which encompasses the recent (albeit huge) crisis. Even within this period, the reasons for bank failures and/or the need to save banks with government intervention varies widely. In general terms history teaches that the main elements of risk for banks have been:

- Macro-prudential risk: Essentially national business cycle risk most often related to too easy monetary policy and debt-associated asset bubbles that subsequently reverse.
- Diversification risk: Too great a concentration of bank lending or securities acquisition related to regional or national economic cycles – oil, agriculture, technology, and housing.
- Leverage risk: Banks having too little capital to deal with balance sheet losses.
- Liquidity risk: That banks may depend on short-term unstable wholesale funding that can dry up during a crisis.
- Counterparty risk: Related to derivatives businesses, which exploded in size from the end of the 1990's.

Policy makers have sought to deal with these issues at various levels:

- Macro: Via better monetary and macro-prudential policies.
- At the regulatory level the policy approach has been mainly via: *i)* asset risk-weighted and/or un-weighted capital rules to influence leverage; *ii)* supplementary capital rules for market risk and for counterparty risk; *iii)* supplementary liquidity ratio rules; and *iv)* business model interventions via policies that separate high-risk activities (Vickers and the Volcker rule).
- Finally, bank supervision in the second pillar of Basel is seen to be important and, most recently, rules within Europe have been agreed for EU-wide supervision of euro area banks, with the ECB having overall responsibility.

The results in this paper provide some tentative evidence that might be helpful when discussing the relative importance of these policy ideas.

IV.1. Macro-prudential risk

It is very clear that the potential role for monetary policy and perhaps also macro prudential policy is supported by the data in this study, given the strong panel regression results for the influence of house prices and beta. An unexpected fall in house prices of 10%, for example, might be expected to reduce the distance-to-default by 0.89 standard deviations. Asset price mechanisms of that order of magnitude can push a vulnerable bank with a low DTD past the zero point. The results here are entirely consistent with the literature relating to macro policies to lean against cycles in asset prices.

IV.2. Diversification risk

Unfortunately, the data available for the 94 banks are not rich enough to cover own-country geographical concentration issues. Within the sample of banks considered the anecdotal evidence that such effects are important seems *a priori* to suggest that further research is worth undertaking. For example, Wachovia's purchase of the Californian S&L Golden West is almost certainly the reason that it ran into problems. US Bancor, on the other hand, was a geographically-diversified commercial bank that has performed well during the crisis. Cross-border revenue was, however, available for the study, and such international diversification is undertaken by G-SIFI banks, but not by most of the smaller national banks that were included in the full sample. Perhaps not surprisingly, the econometric results support the hypothesis that cross-border revenue is important for risk diversification in the G-SIFI banks. A 10 percentage point rise in the share of cross-border revenue could result in a 0.32 standard deviation rise in the DTD.

Product concentration was also a clear factor in the crisis. Banks that had excessive concentration on sub-prime mortgages and their securitisation clearly faced substantial problems. The problem with the Basel rule in this area, as noted earlier, is that it does not deal with concentration risk in pillar 1. This is because of the principle of portfolio invariance used to make the model analytically tractable. Blundell-Wignall and Atkinson (2008) suggest that benchmarks should be set for commercial bank portfolios and that deviation should be penalised via a quadratic rule. This recommendation for commercial banks remains valid independently of whether the policy of bank separation (discussed below) should be applied to G-SIFI banks.

IV.3. Leverage risk and basel

The results from this study are very clear-cut when it comes to leverage. A simple leverage ratio finds clear support in the data as a predictor of the DTD. The Basel Tier 1 ratio, in the univariate model, and when controlling for other variables in a multivariate approach, finds no support as an explanation of the DTD. This result is entirely consistent with reasoning noted earlier, that there is no effective control on leverage as the Basel system allows large banks to run their own models to determine risk weights and this, together with the use of CDS and swaps to transform the risk characteristics of securities, allows banks to optimise their risk weights to reduce the amount of capital they are required to hold (calculated as a percentage of RWA).

The OECD has recommended a leverage ratio of 20 (equity less intangibles should be 5% of un-weighted assets), which is close to the median of banks in all of the categories of Table 2.[19] It is always outlying banks with much higher leverage that pose risks from this source. To obtain some idea of the broad orders of magnitude of policy changes with

respect to the leverage ratio, consider the banks in the 3rd and largest (3 asterisk) category of Table 2. It is in this group that many of the G-SIFI's are found. A cut in the leverage ratio from the maximum ratio of 78.6 times equity to 20 times, using the equation coefficient of -0.03, would increase the DTD by 1.75 standard deviations (the median DTD for this group from 2004 to 2011 was 4.2 standard deviations and the minimum was 1.0). That would be a very powerful improvement in prudential safety.

It does not seem to be in the proper interests of financial stability to relegate the leverage ratio to a backstop ratio of 0.03, implying leverage of 33 times equity, as is currently proposed under Basel III.

Such a policy step with respect to capital and leverage would need to be implemented with the concept of "*good deleveraging* " in mind, as in Blundell-Wignall and Atkinson (2012). That is, it is important to raise equity and not to collapse balance sheets, which has negative impacts on the economy. Equity is best raised on the stock market, resulting in a diluting of existing shareholders. Where it is difficult to issue new shares in illiquid markets, warrants can be issued and special purpose vehicles (SPVs) with public and private participation can be used to buy them. In the limit, funding can be provided for the SPV via the central bank, provided the SPV has a banking licence.[20]

IV.4. Liquidity risk

One aspect of the results that proved to be a surprise, and contradicted earlier commentary in Blundell-Wignall and Atkinson (2010), concerns the net stable funding ratio, which was argued to depend too heavily on defining and modelling stable versus unstable funding sources. The results from this study suggest that when macro and business model risks are controlled for, wholesale funding remains a highly significant determinant of the DTD. The bank with the largest percentage of wholesale funding in the large 3 asterisk group of Table 2 sits at 92% of liabilities. A cut in this percentage to the median value of 36.6% would increase the DTD by 1.5 standard deviations. This effect seems to be material, and commercial banks with less wholesale funding would appear to be safer institutions.

IV.5. Counterparty risk, size, and leverage in the derivatives business

Bank business models focusing on derivatives are associated with elevated counterparty risk, but appear also to be relatively highly correlated with other business risk factors.

Table 7 shows the "cut-down' correlation matrix for the 5 features of the business model of banks that are statistically significant for the sample of 94 banks used in this study: size, leverage, derivatives, trading assets, and wholesale funding:

- The highest correlation of 0.67 is that found between the proportion of derivatives in the bank portfolio and the proportion of trading assets. The high correlation may be indicative of a general focus on securities combining derivatives, including synthetics, such as structured products, and re-hypothecations involving the repo market. As the signs of these variables are opposite in the DTD model, it is possible that liquid securities might be held for risk control reasons in banks with a strong derivatives focus – because of the ability to sell in liquid markets to meet margin calls. Based on the model results, the bank with the smallest 0.2% of trading assets in the 3-asterisk group in Table 2 would increase the DTD by 0.44 standard deviations if this were increased to the median of

Table 7. **Correlation matrix for key business features**

	Size	Leverage	Derivatives	Trading assets	Wholesale funding
Size	1				
Leverage	0.48	1			
	0.00				
Derivatives	0.32	0.41	1		
	0.00	*0.00*			
Trading	0.21	0.39	0.67	1	
assets	*0.00*	*0.00*	*0.00*		
Wholesale	0.24	0.24	0.24	0.32	1
Funding	*0.00*	*0.00*	*0.00*	*0.00*	

20.1%. Presumably this would provide some offset to business risks associated with derivatives.

- A derivatives focus also appears to be positively well correlated with leverage, with a coefficient of 0.41. This should not be surprising, as all derivatives are highly-levered instruments, operating on small collateral margins that permit much higher exposures. Consider again the largest group of banks in the 3-asterisk group of Table 2. The bank with the maximum exposure to derivatives has 72.2% of its portfolio in the GMV of derivatives. If this exposure was cut to the median value 5.8%, the DTD could be expected to rise by a very substantial 1.9 standard deviations.
- Derivatives also have a 0.32 correlation with size. The bank with the maximum relative size in table 2 has 62.6% of the domestic market for bank assets. If this exposure was cut to the median value 10.3%, the DTD could be expected to rise by a very substantial 2.1 standard deviations. This is perhaps not so surprising, given that regulatory rules and market practices encourage concentration in the derivatives business. Furthermore, TBTF guarantees lend comfort to derivative counterparties if it is reasonable to assume that the governments will honour failed counterparty business contracts, as proved to be so reliable during the crisis.
- Wholesale funding also has a reasonable correlation with bank business models that have high trading assets and a substantial correlation with derivatives, size and leverage.

Derivatives have a powerful direct effect on the DTD. It should be apparent from this discussion that the effect of high derivatives exposure on risk is much more if it is considered also to be correlated with size, leverage risk and wholesale funding risks. Cutting the exposure to derivatives would presumably be associated not only with less counterparty risk, but also with reductions in the size, leverage and wholesale funding risk factors – a very much safer bank would be the result.

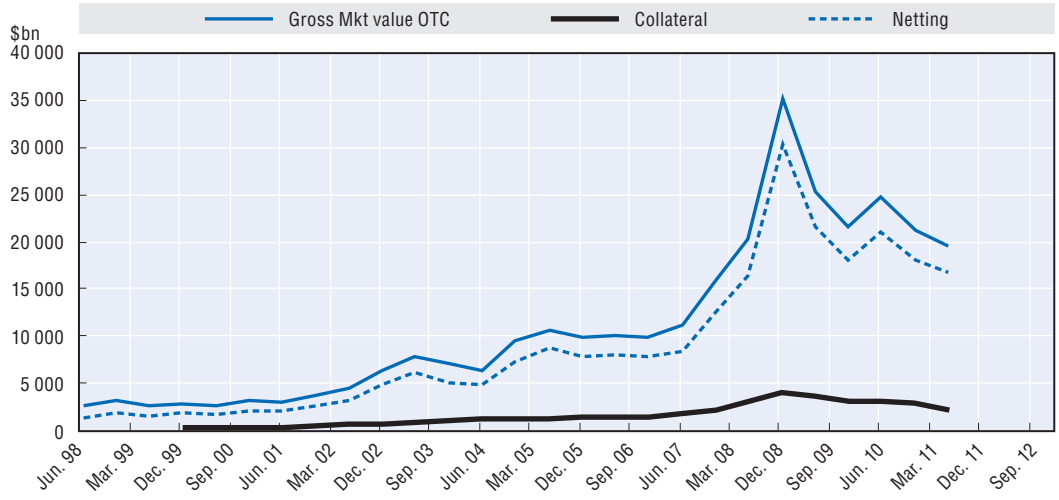
Counterparty risk during the crisis

The global GMV of derivatives is shown in Figure 2. While the notional value was around $586 tn on the eve of the crisis (December 2007), the GMV at the same time was only $16 tn – not unlike the net settlement amount on which the trades are based (at about 2.7% of the notional). Financial firms have offsetting positions that can be netted and banks expressly hedge most of their positions. Figure 2 also shows these netting amounts – if all

positions were to be closed at a point in time, then only the net amounts would be settled. The GMV less netting is the Gross Credit Exposure (GCE).

It is against the GCE that collateral is held. Figure 3 shows the global value of GCE and estimated collateral. On the eve of the crisis the GCE was only $3.3 tn and, against this, $2.1tn collateral was held.

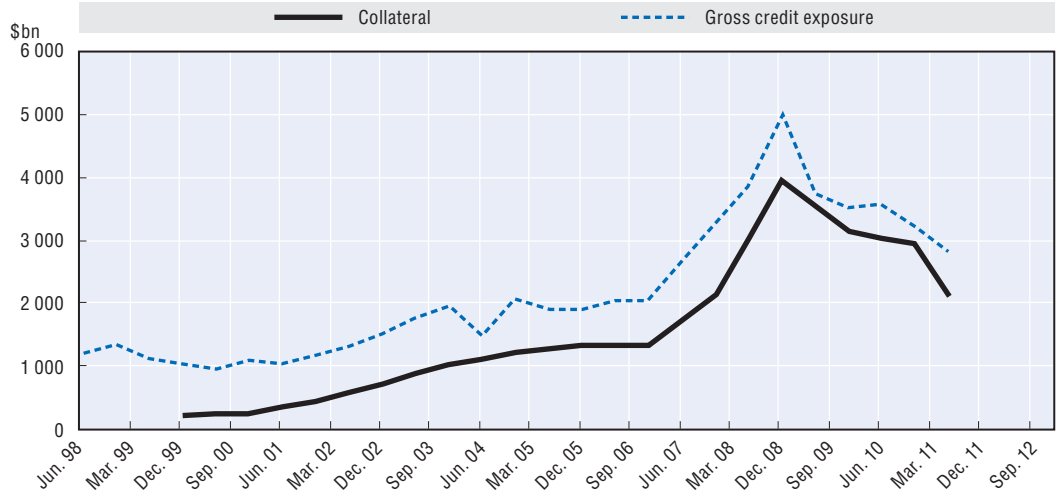
Figure 2. **Gross market value, netting and gross credit exposure**



Source: BIS, ISDA, OECD.

The net global open exposure of only $1.2 tn in December 2007 seems barely measurable versus the notional – yet a massive global crisis involving derivatives was about to ensue.

Figure 3. **Gross credit exposure versus collateral**



Source: BIS, ISDA, OECD.

Derivatives do not fund new investment and growth. Instead, they serve to shift exposures from one party to another and work through margins (collateral). However,

derivatives still carry all the bankruptcy characteristics of debt. A sudden move in volatility can shift the GMV quickly, and netting provides no protection for this. Netting does not protect any financial firm from market risk. On the eve of the crisis, the GCE net of collateral was around $1.2 tn. The G-SIFI banks considered in this paper dominate the derivatives business.[21] As the crisis hit in 2008, the GMV rose by around $19.5 tn (from $15.8 to $35.3), the GCE rose $1.7 tn (from $3.3 tn to $5 tn), and estimated collateral (margin calls) rose by $1.9 tn (from $2.1 tn to $4.0 tn). Counterparties had to make these margin calls in the face of illiquidity in the interbank market.

To put this amount in context, Table 8 shows the amount of equity less intangibles held by the G-SIFI banks included in this study. In 2007 this amounted to $1.2 tn, significantly less than the $1.9 tn rise in financial system collateral needs that was about to follow. The size of these moves illustrates why central banks had to take drastic action to become the main lender in the interbank market. Collateral calls can be huge for individual banks where the concentration of derivatives is very high.

Table 8. **G-SIFI equity**

	31 G-SIFIs Equity – Goodwill Mln USD
2004	779 913
2005	873 436
2006	1 103 342
2007	1 208 648
2008	1 280 824
2009	1 686 454
2010	1 775 374
2011	1 816 371

Source: Bank reports, Bloomberg.

Bank separation versus Basel III on counterparty risk

The above model results and observations on correlations suggest that size, leverage, derivatives, trading portfolios and wholesale funding risk factors are linked. Most large banks carry out all of those business activities alongside traditional banking, but from the point of view of risk, it is a question of proportions with which they do so; *i.e.* the degree of concentration on these activities.

Basel III has tried to address the issue of risk associated with OTC derivatives and counterparty risk by further modifying Basel II methodology where banks run their own risk models:

- *Counterparty credit risk (CCR)*: A capital buffer is derived by asking banks to run a stressed value at risk, which would have the effect of raising RWA.
- *A credit valuation adjustment (CVA)*: An up-front charge for counterparty risk measured in bond equivalents for each derivative netting pool, to which the market risk regulatory charge for bond equivalents is applied.
- *Collateral standards*: Strengthening collateral margin management practices.
- *Interconnectedness*: Raise the correlation coefficients for positions between large financial entities in bank models (by 25%).

- Encourage central counterparties (CCP): Collateralised positions with CCP's attract only a modest risk weight compared to un-cleared OTC derivatives.

But such policies may not be very effective in influencing business-model risk related to an excessive focus on capital market products that are unlike the activities undertaken by commercial banks. The problems with Basel III in this area, set out in more detail in Blundell-Wignall and Atkinson (2011), include:

- CCR and CVA exposures are model based and rely on judgement and the "good faith" of banks. There has yet to be a bank that self reported ex-ante damaging exposure risk. *Ex-post* outcomes during the crisis were always another order of magnitude compared to public reporting before the event.
- There is a cause and effect issue, in that models use credit spreads which are not independent of the size TBTF issue, the implicit guarantees from which subsidise risk taking (reduce spreads compared to what they would otherwise be).
- Illiquid OTC derivatives are virtually impossible to handle in a model context. For example, products like credit default swaps (CDS) have binary outcomes that may or may not be triggered by a default event.
- Correlations play a key role in models of bank portfolios, yet in a crisis period they become endogenous and often move towards unity across products regardless of historical characteristics.
- The CVA charge applies across netting pools, and the problematic Basel portfolio invariance principle continues to play a role here – the CVA charge is additive across netting pools. Netting is a settlement concept and does not protect a financial institution from ex-ante market risk. Furthermore, the charge directly encourages concentration trends to continue in an already heavily concentrated market (larger netting pools provide more scope for netting to avoid capital charges).
- The CCP role transfers some of the TBTF problem to the CCP, it does not eliminate it. Furthermore, banks are likely to resist pressure on margins from this source via their role in defining what a standardised product that can be subject to clearing and trading on exchanges in a transparent manner might be. Under Dodd-Frank swap execution facilities (SEF's) will play a large role in clearing process, and the concentrated G-SIFI banks that control the flow will in any case likely succeed in controlling an oligopolistic SEF market.

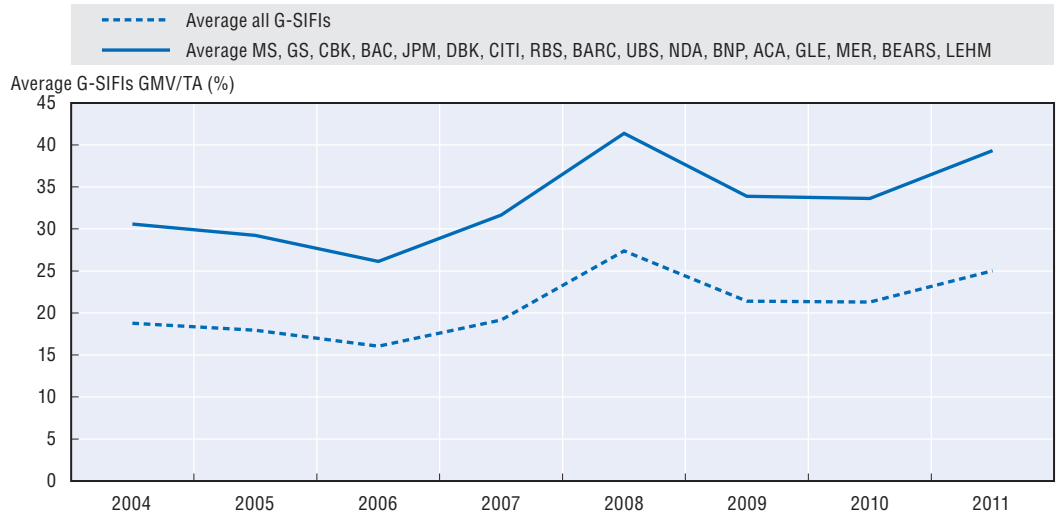
The announcement of such measures has had no effect on the extent to which G-SIFI banks concentrate on derivatives (and hence the derivatives-size-leverage-wholesale-funding nexus). Figure 4 shows the percentage of the GMV of derivatives in the sample of G-SIFI banks considered in this study and a subset of these banks that mainly control the derivatives market. The post-crisis derivatives activity in these banks is actually rising. Furthermore, in 2011 and 2012, well after the lessons of AIG were supposed to have been learned, significant incidents involving derivatives and structured products have if anything become more frequent: *e.g.* MUFG, UBS, JPM, and Dexia.

Subsequent OECD papers, however have focused on the problem of complexity…

Separation alternative

The OECD, as outlined earlier, has long favoured separation to deal with business model risk, via an NOHC structure (which has some similarities to Vickers in the UK). This

Figure 4. **% derivatives GMV in bank portfolios**



Source: Bloomberg, SNL, author's calculations.

would break the derivatives-size-leverage and wholesale funding nexus identified in this study as an important determinant of the DTD. At minimum, the NOHC structure would entail a non-operating parent with ring-fenced subsidiaries that separate commercial banking from securities businesses which concentrate on derivatives for proprietary trading, regulatory arbitrage and the structuring of products. With the ring-fenced structure, the creditors of one subsidiary would not be able to pursue those of another, either directly or through the parent. This would directly address the TBTF size problem and serve to reduce the volume of derivatives not serving end-user clients.

The reason for this is that when a financial firm is setting up a counterparty relationship, it is very important to have access both to as much capital of the counterparty group as possible, in the event or a problem, and/or the strong likelihood that the group will be saved via the lender-of-last-resort or other forms of aid in the midst of a crisis. Under the NOHC structure, the commercial bank would be well capitalised, supervised and subject to deposit insurance and lender-of-last-resort. No such backstops would apply to the securities trading subsidiaries. This removal of implicit guarantees will cause the cost of capital for the securities firm to rise. With less capital to chase in the event of failure, and the absence of official support, credit ratings would be lower and clients would more likely demand physically segregated margin accounts with third parties, greater independent amounts/initial margins and 100% cleared variation margins. Re-hypothecation pyramids that accelerate leverage in these businesses would be diminished, greatly increasing the cost of capital. The securities businesses would become smaller and less levered, and the bar would be raised for dealing in high-risk products (not unlike hedge funds that caused so few problems during the crisis). Securities businesses with separation would be less likely to fail because the derivatives-size-leverage nexus business model would be addressed in a more direct manner. If these (smaller) subsidiaries did fail, they could be more easily resolved (with appropriate resolution authorities) without the disruptions seen in 2008/2009, 2010 and 2011 (such as Lehman and AIG).

The type of banks to which separation might apply

Table 9 shows the DTD alongside the business model risk factors for the sample of banks for the year 2011. While banks can move quickly between the risk categories, so that these ranking may not currently apply now in late 2012, a few general observations can be made:

- Government guarantees of bank liabilities and partial ownership of smaller banks does affect the DTD and can result in distorted leverage and wholesale funding (*e.g.* as certainly applies to some of the smaller European banks that sit in the highest DTD in Table 2).
- Amongst the G-SIFI banks JP Morgan has a DTD well above 2.0 standard deviations. Here it is worth noting that the balance sheet of Bear Stearns, which was taken over by JPM, received a guarantee for $29 bn of the $30 bn less-liquid MBS issued by BEARS, helping to ameliorate some of the negative DTD attributes. The vulnerability of structures such as JPM was, however, illustrated in 2012 in the "London whale" incident: derivatives were the key factor in the very sizeable losses, which were (surprisingly) reported to be straightforward hedging activities.

Table 9. **DTD and some key business model distinguishing features for a selection banks**

Mnemo	Stars	Distance-to-default	Size	Leverage	Trading assets	Wholesale funding	Derivatives	Beta
DPB	*	4.60	2.3	37.8	27.8	20.5	11.4	0.4
PBCT	*	3.80	0.2	9.0	10.5	4.5	0.2	1.0
MTB	**	3.38	0.6	14.0	8.7	10.9	0.8	1.1
HSBC	****	**3.35**	**20.2**	**18.6**	**15.0**	**11.5**	**13.7**	**0.9**
CC	**	3.25	2.8	25.2	18.1	51.8	1.1	0.7
PNC	**	3.02	2.2	10.0	24.4	15.7	3.5	1.3
STAN	**	2.88	4.7	17.5	17.5	17.8	11.7	1.0
BBT	**	2.88	1.4	15.9	15.2	16.1	0.9	1.3
WFC	****	**2.73**	**11.4**	**13.0**	**26.6**	**14.9**	**7.8**	**1.4**
GS	****	**2.70**	**13.5**	**25.0**	**83.4**	**61.3**	**59.5**	**1.3**
SAB	****	**2.70**	**2.8**	**20.4**	**15.5**	**33.5**	**1.7**	**0.9**
CMA	**	2.59	0.5	9.8	16.6	9.3	0.5	1.4
BTO	**	2.58	3.0	20.3	8.4	36.3	6.9	0.9
SHBA	**	2.55	24.1	28.1	10.0	58.4	5.8	1.2
JPM	****	**2.55**	**33.1**	**30.7**	**37.9**	**32.5**	**46.4**	**1.5**
BEB2	**	2.39	1.6	80.3	13.9	44.8	10.4	0.4
KEY	**	2.38	0.7	10.1	19.6	14.7	2.7	1.5
FITB	***	2.37	1.0	10.8	15.8	12.8	2.0	1.6
POP	*****	**2.34**	**3.6**	**15.8**	**9.2**	**40.4**	**1.7**	**1.2**
HBAN	***	2.30	0.4	11.4	17.9	9.3	0.9	1.6
ZION	***	2.28	0.4	9.0	6.5	6.0	0.2	1.6
UBS	*****	**2.28**	**21.8**	**29.5**	**23.0**	**19.7**	**34.3**	**1.2**
SAN	*****	**2.18**	**34.5**	**22.8**	**19.9**	**30.4**	**5.6**	**1.4**
CS	*****	**2.17**	**16.1**	**32.6**	**30.3**	**22.7**	**86.4**	**1.3**
MB	***	2.16	2.1	11.3	36.0	75.8	7.3	1.2
STI	***	2.11	1.4	13.9	20.8	15.4	1.1	1.7
NDA	*****	**2.11**	**62.6**	**31.4**	**39.7**	**35.0**	**23.6**	**1.4**
DNBNOR	***	2.07	24.0	19.2	19.8	46.8	4.5	1.4
DANSKE	***	2.02	40.1	33.0	29.4	42.0	25.9	1.2

Table 9. **DTD and some key business model distinguishing features for a selection banks** *(cont.)*

Mnemo	Stars	Distance-to-default	Size	Leverage	Trading assets	Wholesale funding	Derivatives	Beta
BBVA	***	**1.97**	**16.5**	**19.0**	**14.6**	**35.5**	**8.7**	**1.5**
SEB	***	1.96	23.2	25.9	22.9	36.2	7.1	1.6
SWEDA	***	1.92	18.2	22.0	13.1	53.5	4.8	1.6
CITI	***	**1.86**	**22.8**	**18.9**	**54.3**	**39.1**	**35.2**	**1.9**
DBK	***	**1.76**	**25.7**	**55.7**	**61.3**	**11.4**	**40.1**	**1.6**
BPE	***	1.74	1.5	14.4	8.2	41.3	0.5	1.2
BES	***	1.73	14.0	13.3	21.0	48.2	3.3	1.1
BCP	***	1.70	16.3	21.6	7.4	39.4	1.9	1.1
EBS	***	1.70	20.7	18.0	13.3	28.0	5.2	1.4
RBS	***	**1.69**	**18.5**	**24.6**	**14.4**	**18.0**	**35.1**	**1.5**
RF	***	1.67	1.0	11.4	21.2	10.1	2.2	2.1
BAC	***	**1.67**	**32.2**	**26.0**	**21.6**	**36.0**	**48.1**	**1.9**
BMPS	****	1.65	5.9	30.1	23.1	47.5	5.8	1.4
LLOYDS	****	**1.64**	**11.9**	**23.5**	**14.6**	**28.1**	**6.8**	**1.5**
MS	****	**1.61**	**12.6**	**26.2**	**77.1**	**63.6**	**77.6**	**2.0**
BARC	****	**1.59**	**19.2**	**27.3**	**12.4**	**16.4**	**34.5**	**1.7**
RBI	****	1.59	14.5	14.9	7.2	41.5	1.0	1.5
UBI	****	1.57	3.2	18.9	8.5	48.5	1.3	1.5
KN	****	1.54	6.0	28.8	55.3	76.6	24.7	1.7
BNP	****	**1.37**	**23.3**	**27.4**	**51.5**	**58.0**	**23.5**	**1.9**
ACA	****	**1.36**	**20.5**	**57.7**	**41.6**	**47.5**	**22.2**	**1.9**
CBK	****	**1.36**	**7.9**	**30.4**	**25.1**	**34.5**	**48.7**	**1.8**
UCG	****	**1.29**	**22.7**	**23.7**	**23.5**	**33.9**	**9.8**	**1.8**
KBC	****	1.25	23.7	19.2	28.2	30.5	6.1	1.9
ISP	****	**1.24**	**15.7**	**19.5**	**25.5**	**44.2**	**7.6**	**2.0**
GLE	****	**1.16**	**14.0**	**27.8**	**46.3**	**55.4**	**21.5**	**2.2**
DEXB	*****	**0.96**	**34.3**	**74.4**	**0.7**	**52.9**	**6.9**	**1.7**
ETE	*****	0.88	0.0	16.1	16.0	35.1	3.5	1.3
BKIR	*****	0.80	11.8	15.7	5.8	36.0	4.1	1.3
EUROB	*****	0.75	0.01	18.4	3.0	50.8	2.4	1.3
ALBK	*****	0.32	10.4	9.6	11.3	44.0	2.2	1.5

Source: Bloomberg, SNL, author's calculations.

- Some US banks and a number of European banks had a DTD below 2 standard deviations in 2011, in some case markedly so. The model results here would suggest that this high-risk profile for these banks is related to their derivatives activities, size, leverage and/or wholesale funding.
- Stand-alone investment banks vary greatly in the table, with Goldman Sachs looking strong and Morgan Stanley weak in 2011 (not now). At this time, GS appears to have a stronger trading asset portfolio that raises the DTD in the model. Nevertheless, such banks are always vulnerable to counterparty risks. In 2008, GS and most of the other US and European G-SIFI banks that maintain a high level of derivatives received cheques from the government that were very large in relation to their equity to settle the counterparty contracts of AIG – in many cases this involved amounts of around 1/3 of their equity. With so few banks controlling the global derivatives market, cross-hedging exposures to AIG with other G-SIFI banks would have been meaningless had the US government not decided to trigger close-out netting and to honour the AIG contracts.

- HSBC and Wells Fargo have very different business models to banks that focus heavily on derivatives: *i.e.* low leverage, a low concentration of derivatives and low proportions of trading assets. The DTD of both banks is high, and both rode out the crisis without major problems. The separation proposal would not apply to such banks, whose modest involvement in derivatives related to client and hedging needs would not have a material impact on the DTD.

IV.6. The Liikanen Report

As with Volcker in the USA and Vickers in the UK, the Liikanen Group has concluded that it is necessary to require legal separation of certain particularly risky financial activities from deposit taking banks within banking groups in Europe.[22] The activities to be separated include proprietary trading of securities and derivatives, and other activities closely linked with securities and derivatives markets, such as market making. The Group suggests that the decision to require mandatory separation should proceed in two stages. In the first stage, if a bank's assets held for trading and available-for-sale exceed a relative examination threshold of 15-25% of the bank's total assets (or an absolute examination threshold of EUR100bn) the banks would advance to the second stage examination, where the Commission would determine assets of a material size to be separated.[23] Only "Deposit banks' would provide retail payment services, and they would be allowed to use some derivatives to manage "own" assets, liabilities and liquidity, as well as providing some hedging for end-user clients. While the conclusion is to be supported, a question that need further exploration – on the basis of this study – concerns why trading and available-for-sale securities are the basis of the stage 1 process. The results in this paper suggest that considered on their own, higher levels of such assets raise (not reduce) the DTD. A better criterion for stage 1 would be the GMV of derivatives share where there is no ambiguity.

IV.7. Supervision

The econometric results suggest that the asset price cycle is important, and hence central banks should have some role as a macro-prudential supervisor. The study also suggested that the task of supervision is very different for banks that are smaller and have a national focus, as opposed to those that are large and might be identified as G-SIFI banks. This may have some implications for issues such as the Single Supervisory Mechanism in Europe, with the ECB having ultimate authority on issues for euro-area countries. There are 6 000 EU banks, and the ECB cannot be expected to supervise many of them. It will rely on coordination with national supervisors. The model results here suggest that a natural split might be between the G-SIFI banks and the rest. G-SIFI banks have quite different DTD mechanisms related to the derivatives, leverage and size nexus. It is also the G-SIFI banks where the issues of cross-border revenue factors and cross-border counterparty issues are most likely to be found. This suggests a macro-prudential role for the ECB with a supervisory focus specialising mainly on the G-SIFI banks.

V. Concluding remarks

This study is the first to attempt to model the DTD of a large sample of banks with the aim of shedding light on policy and regulatory issues. The determinants of the DTD in a panel sample of 94 banks over the period 2004 to 2011, controlling for the market beta of each bank, consisted of house prices at the macro level, and relative size, simple leverage, the GMV of derivatives exposure, trading assets, and wholesale funding. The G-SIFI

subsample found these same variables were very important and, in addition, cross-border revenue was found to be a positive diversifying factor. For the subsample of nationally-focused non-GSIFI banks, beta, the simple leverage ratio and house prices were the only variables that found support in the data. The Basel Tier 1 ratio found no support as a predictor of the DTD whatever sample was considered.

While these results are preliminary, it was encouraging that the out-of-sample predictive power of the model improves systematically as each year of new observations is added.

As decisions continue to be made in an uncertain environment where the mechanisms that influence the DTD are not well understood, the paper also attempts to provide some preliminary comments on some of the policy decisions and propositions that have been made to date. The results appear to be consistent with an approach to policy that focuses on the un-weighted leverage ratio for all banks, and on policies that address directly the apparent size-derivatives-leverage and wholesale funding nexus for some very large G-SIFI banks. The results are also consistent with central bank involvement in the supervision process, given their likely comparative advantage in macro-prudential policy and their lender-of-last-resort role that was called upon in unprecedented ways as counterparty risk unfolded in the crisis. This latter function may suggest a particular focus on the large G-SIFI banks in these respects.

Notes

1. Blundell-Wignall, A. and P.E. Atkinson (2008), "The Subprime Crisis: Causal Distortions and Regulatory Reform", in *Lessons From the Financial Turmoil of 2007 and 2008*, Kent and Bloxham (eds.), Reserve Bank of Australia, July.
2. Gordy, M.B. (2003), "A Risk-Factor Model Foundation for Ratings-Based bank Capital Rules", *Journal of Financial Intermediation*, 12 (3).
3. Blundell-Wignall, A., G. Wehinger, and P. Slovik (2009), "The Elephant in the Room: The Need to Focus on What Banks Do", *OECD Journal, Financial Market Trends*, 2009 Issue 2. See Independent Commission on Banking, Interim Report: Consultation on Reform Options, April 2011.
4. OECD (2009), *The Financial Crisis: Reform and Exit Strategies*, Paris.
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6. Blundell-Wignall, A. and P.E. Atkinson (2011), "Global SIFI's, Derivatives and Financial Stability", *OECD Journal, Financial Market Trends*, 2011 issue 1.
7. Blundell-Wignall, A and P.E. Atkinson (2012), "Deleveraging, Traditional versus Capital Markets Banking and the Urgent Need to Separate GSIFI Banks", *OECD Journal, Financial Market Trends*, 2012 Issue 1.
8. Blundell-Wignall, A., P.E. Atkinson and C. Roulet (2012), The Business Models of Large Interconnected Banks and the Lessons of the Financial Crisis, *National Institute Economic Review*, No. 221, July.
9. Ayadi, R., E. Arbak and W.P. de Groen (2011), *Business Models in European Banking: A Pre and Post-crisis Screening*, Centre for European Policy Studies, Brussels.
10. Ayadi, R., E. Arbak, and W.P. de Groen (2012), *Regulation of European banks and Business Models: Towards a New Paradigm?* Centre for European Policy Studies, Brussels.
11. Haldane, A. (2012), "The Dog and the Frisby", *Jackson Hole*, Wyoming. This paper is welcome support. It uses a take from Milton Friedman's 1953 essay on methodology: the analogy of the billiard player and the complexity of writing out the maths and friction coefficients of a successful billiards shot – the complexity of which would be unknown to the champion billiards player, (just as it would to Haldane's dog catching the frisby but not to the writers of Basel rules). The champion

billiards player just lines it up and takes a shot without all the complexity. Fortunately, Bank of England and other officials have benefitted from prior OECD work on Basel and its complexity and the arguments for a leverage ratio and bank separation which finds its way into this paper.

12. Borio, C.E., and W. White (2004), "Whither Monetary Policy and Financial Stability", *BIS Working Papers*, No. 147, March.

    White, W. (2006), "Is Price Stability Enough?", *BIS Working Papers*, No. 205, April.

13. Rajan, R.G. (2005), "Has Financial Development Made the World Riskier?", *Proceedings, Federal Reserve Bank of Kansas City*", August.

14. Blundell-Wignall, A. (2007a), "Innovation, Growth and Equity", Speech at the OECD Forum, May 2007; Blundell-Wignall, A. (2007b), "An Overview of Hedge Funds and Structured Products: Issues in Leverage and Risk", *OECD Journal, Financial Market Trends*, 2007 Issue 1.

    Blundell-Wignall, A. (2007c), "Structured Products: Implications for Financial Markets", *OECD Journal, Financial Market Trends*, 2007 Issue 2.

15. Gramlich, E.M. (2007), "Booms and Busts: The Case of Subprime Mortgages", *Economic Review, Federal Reserve Bank of Kansas City*, Q4.

16. Reinhart, C. and K.S. Rogoff (2009), *This Time is Different: Eight Centuries of Financial Folly*, Princeton University Press, Princeton, NJ.

17. Monetary aggregates were also explored in relation to macro effects, but the asset price cycle was the dominant variable supported by the data. Asset price growth in conjunction with monetary aggregates performed slightly worse for out-of-sample forecasting the DTD. Asset prices are more forward looking.

18. Trading assets can be sold on liquid markets in order to raise cash to meet margin calls if required.

19. See Blundell-Wignall and Atkinson (2012), *op. cit.*, It is also the FDIC definition of a well capitalised bank.

20. This has been recommended for Europe in several OECD publications – for example an SPV linked to the European Investment Bank, or providing the new ESM with a banking licence.

21. Herfindhal indexes suggest for interest rate derivatives (easily the bulk of the total OTC derivatives business) that around the equivalent of 11 or 12 equal-sized banks dominate the global derivatives market. See Blundell-Wignall and Atkinson (2011), *op. cit.*

22. Liikanen, E. (2012), "High-Level Expert Group on Reforming the Structure of the EU Banking Sector – Final Report", Brussels, October.

23. An examination threshold of greater than zero is useful, as it enables authorities to exempt banks which have limited trading activities as part of their business model.

APPENDIX 1

Distance-to-default

The distance-to-default indicator DD_t is the number of standard deviations away from the default point. To derive the measure, it is assumed that a bank defaults (or is bankrupt) when the market value of assets equals (or is lower) than the book value of debt ($V_t = D_t$). The formula to calculate the distance-to-default is derived from the option pricing model of Black and Scholes (1973) and is as follows:

$$DD_t = \frac{\log\left(\frac{V_t}{D_t}\right) + \left(r_f - \frac{\sigma_t^2}{2}\right).T}{\sigma_t\sqrt{T}}$$

where:

V_t : Market value of bank's asset at time t,

r_f : Risk-free interest rate,

D_t : Book value of the debt at time t,

σ_t : Volatility of bank's asset at time t,

T : Maturity of the debt.

However, the market value of assets (V_t) and its volatility (σ_t) have to be estimated. Equity-holders have the residual claim on a firm's assets and have limited liability. As first realised by Merton (1977), equity can be modelled as a call option on the underlying assets of the bank, with a strike price equal to the total book value of the bank's debt. Thus, option-pricing theory can be used to derive the market value and volatility of bank's underlying assets from equity's market value (VE) and volatility (σ_E), by solving:

$$V_t = \frac{VE_t + D_t e^{-r_f T} N(d2)}{N(d1)}$$

$$\sigma_t = \frac{VE_t}{V_t}\frac{\sigma_{E,t}}{N(d1)}$$

where:

VE : Value of bank's equity,

N : The cumulative normal distribution,

σ_E : Equity's volatility.

A bank defaults (or is bankrupt) when DD_t equals to 0 (or is negative). All data are extracted from Bloomberg. The total annual debt liabilities (*i.e.*, the difference of the annual total assets and annual total equity) is interpolated using a cubic spline to yield daily observations (D_t). The volatility of equity (σ_E) is the standard deviation of daily return multiplied by $\sqrt{252}$ (*i.e.*, 252 trading days by year). The expiry date of the option (T) equals the maturity of the debt. A common assumption is to set it to 1. The risk free interest rate (r_f) is the 12 months interbank rate.

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