



**Comptroller of the Currency
Administrator of National Banks**

Exposure at Default: Estimation for Wholesale Exposures

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Outline

- Introduction – State of Research and Estimation Methodology
- The Citibank and Chase Studies
- Recent Research – Jacobs (2006) and others
- Practitioner Initiatives
- Summary and Directions for Future Research

Introduction: EAD Research

- There exists limited empirical research
- Many banks rely on two publicly available studies (and consultants)
- The “Citi study”
 - Asarnow and Marker (1995) analyze the performance of large corporate loans at Citibank from 1988-93
 - Calculation of *Loan Equivalency Factors* (LEQs) was ancillary to the study
 - LEQs appear in Exhibit 9 of the technical appendix
- The “Chase study”
 - Araten and Jacobs (2001) directly estimate LEQs for revolving credits and advised lines
 - Application of the “fixed-horizon” method to 1-5 years to default

EAD Estimation Methodology: LEQ Factor

- Banks must estimate possible additional drawdowns and most use the *loan equivalent exposure* (LEQ)
 - Typically expressed as a percentage of unutilized commitments, applied to the line's unused portion
 - Dollar EAD is represented as the current outstanding plus the expected additional drawdown to horizon
- Alternative methods
 - *credit conversion factor* (CCF): proportional change in the drawn amount at default
 - *exposure at default factor* (EADF): proportional change in the total commitment to default

The Citi Study: Summary of Results

- *General result:* LEQ decreases with increasing risk
- Why an inverse relationship?
 - Higher quality borrowers may have higher LEQs because of fewer restrictions/covenants and less strict monitoring
 - When they get into trouble they will draw down available credit without interference from the bank

▪ Issues

- Old data (1988 – 93)
- Small sample (50 observations)
- Limited sample (BB/B or worse; results extrapolated)
- Questions about estimation techniques

Debt Rating	Average Revolver Usage	"LEQ"
AAA	0.1%	69%
AA	1.6%	73%
A	4.6%	71%
BBB	20.0%	65%
BB	46.8%	52%
B	63.7%	48%
CCC	75.0%	44%

The Chase Study: Introduction

- This exercise highlighted various issues in measurement and data that many banks face
- Disconnect between credit exposure and non-accrual systems (e.g., need to add back chargeoffs at default)
- Use of “pseudo-defaults” (sub-standard or worse) to augment data
- Legacy EL grades mapped to two-dimensional rating system
- Outlier problems: LEQs $> 100\%$ ($< 0\%$) due to additional extensions of credit (paydowns)
- Other data problems: Spurious changes in commitment or usage
- Analyzed horizons to default greater than 1 year – portfolio management and economic capital purposes

The Chase Study: LEQ decreases with risk

AVERAGE LEQ BY FACILITY RISK GRADE AND TIME-TO-DEFAULT: REVOLVING CREDITS									
	Facility Risk Grades								
	1	2	3	4	5	6	7	8	Total
Time to Default	AAA/AA-	A+/A-	BBB+/BBB	BBB-/B+	BB	BB-/B+	B/B-	CCC	
1year		78.7%	93.9%	54.8%	32.0%	39.6%	26.5%	24.5%	32.9%
(number of obs)		(3)	(1)	(18)	(81)	(129)	(86)	(110)	(418)
1 to 6 years	12.1%	77.2%	55.5%	52.2%	46.4%	50.1%	30.7%	24.6%	43.4%
(number of obs)	(1)	(10)	(15)	(52)	(231)	(295)	(115)	(115)	(834)

- Much larger data sample than Citi Study (1000+ obs on 408 facilities covering the period 1995 – 2000)
- *Key Result:* LEQs generally decrease with increasing risk and time-to-default
- But robustness of results questionable

The Chase Study: Outliers

Summary Statistics for LEQ		
<i>Statistics</i>		<i>Values</i>
Average LEQ Coll.		43.40%
std dev		41.40%
Average LEQ Raw.		21,017.2%
std dev		534,400.5%
Median LEQ		35.20%
% Non-truncated		58.50%
Average LEQ		50.60%
std dev		35.10%
% Truncated		
from above		13.80%
from below		27.70%
Obs		834
Obligors		309
Facilities		317

- Outliers are a problem:
 - 14% of the LEQs are less than zero
 - 28% of the LEQs are greater than one

- Collar Method:
 - If $LEQ < 0$ then $LEQ = 0$
 - if $LEQ > 1$ then $LEQ = 1$

- Correcting for outliers results in much more reasonable distribution of LEQ

The Chase Study: LEQ Sample Distribution

Summary Statistics for LEQ				
	<i>All Data</i>		<i>1 Year TTD</i>	
<i>LEQ Group</i>	<i>Count</i>	<i>% Total</i>	<i>Count</i>	<i>% Total</i>
[0%, 10%)	323	38.8%	214	51.2%
[10%, 20%)	34	4.1%	16	3.8%
[20%, 30%)	40	4.8%	10	2.4%
[30%, 40%)	42	5.0%	24	5.7%
[40%, 50%)	44	5.3%	20	4.8%
[50%, 60%)	34	4.1%	11	2.6%
[60%, 70%)	31	3.7%	15	3.6%
[70%, 80%)	30	3.5%	14	3.3%
[80%, 90%)	40	4.8%	16	3.8%
[90%, 100%)	48	6.0%	22	5.3%
100%	168	19.9%	56	13.4%
Total	834	100%	418	100%

- High volatility and bimodal distribution: clustered around 0% and 100%
- Counter-intuitively there are a greater proportion of 0 or negative LEQs for only the 1 year TTD
- Similar characteristics to distributions of realized LGDs

Chase Study: Summary of Findings

- Size of Commitment
 - LEQ appeared to increase (albeit non-monotonically) with commitment size
 - E.g., average LEQ of 56% for commitments >\$25M in Large Corporate & Middle Market, but only 35% for <1M
 - However, results sensitive to business unit (e.g., Other C&I this does not hold)
- Region (Domestic vs. International)
 - LEQ for domestic loans was significantly higher (43.4%) than for international loans (29.0%), all else equal; however, there were far fewer international loans
- Industry
 - Some differences across broad industry groups observed (e.g., avg. LEQ 52.2% in Business Services vs. 32.6% in Consumer Products), but no apparent pattern in line with expectations

Recent Contributions: Jacobs (2007)

Estimated LEQ by Rating : S&P and Moody's Rated Defaulted Borrowers: Revolving Lines of Credit, 1987-2002*							
		<i>Risk Rating</i>					
		<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>Total</i>
<i>Time to Default</i>		<i>BBB</i>	<i>BB</i>	<i>B</i>	<i>CC/CCC</i>	<i>D</i>	
<i>1 year</i>		68.2%	44.6%	38.0%	21.0%	17.6%	32.9%
<i>(number of obs)</i>		(7)	(27)	(152)	(57)	(43)	(286)
<i>1 to 5 years</i>		76.0%	47.3%	41.3%	24.8%	22.3%	38.7%
<i>(number of obs)</i>		(9)	(77)	(314)	(69)	(52)	(521)

* Source: Jacobs, "An Empirical Study of Exposure at Default", Manuscript, 2007.

- LEQ vs. obligor rating generally consistent with Citi and Chase studies
- But inverse u-shaped in time-to-default (peaks at 3 years)
- Outliers Problem: Use "collared" method to correct data

Large Corporate Credits: Summary of Results

▪ LEQ* for Revolving Credit Exposures:

– Negatively correlated** with

- ratings -- $\rho_{(LEQ,r)} = -22.3\%$
- utilization -- $\rho_{(LEQ,u)} = -30.4\%$
- drawdown rate -- $\rho_{(LEQ,dd)} = -5.07\%$

– Positively correlated with

- undrawn -- $\rho_{(LEQ,ud)} = 19.4\%$
- commitment -- $\rho_{(LEQ,c)} = 9.77\%$
- time-to-default -- $\rho_{(LEQ,t)} = 20.3\%$

*Note: LEQ has been corrected for outliers using the “collar” method: i.e., if $LEQ < 0$, then corrected $LEQ = 0$; and, if $LEQ > 1$, then corrected $LEQ = 1$

** Measured by the Spearman rank correlation measure

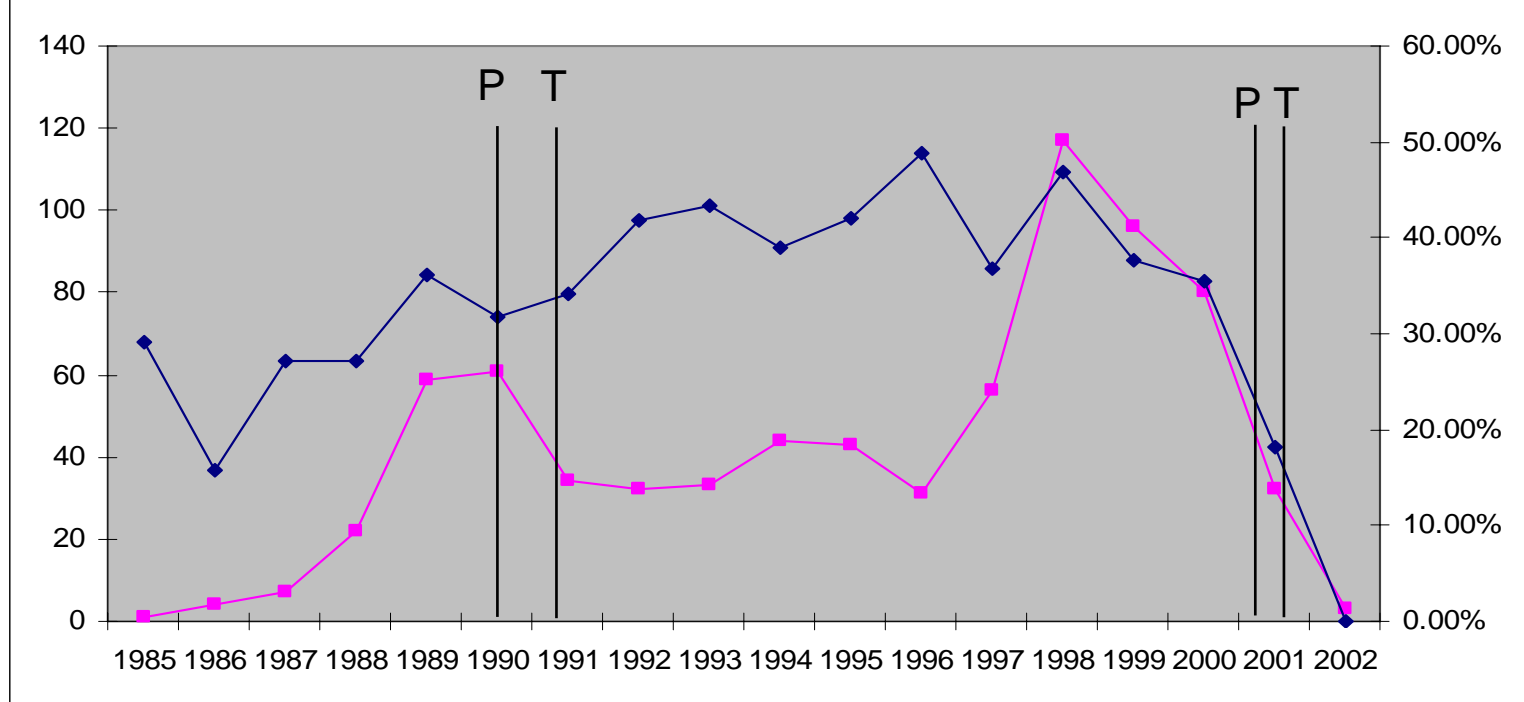
Summary of Results: Macro and Capital Structure Level Variables

- Countercyclical (?)
 - a *weak inverse* relationship with
 - default rates: $\rho_{(\text{LEQ},\text{dr})} = -7.55\%$
 - equity returns: $\rho_{(\text{LEQ},\text{er})} = -1.16\%$

- Direct relationship with the percentage of
 - secured debt: $\rho_{(\text{LEQ},\text{dr})} = 5.25\%$
 - bank debt: $\rho_{(\text{LEQ},\text{br})} = 18.35\%$

Jacobs (2006): Evidence of Downturn* EAD

Figure 1: Average LEQ and Number of Observations by Cohort Year
(Agency Rated Large-Corporate Defaults)



- Little evidence of a cyclical effect – in fact LEQ seems to *decrease* in last recession
- A secular upward trend is more apparent

* P and T denotes NBER peaks and troughs, respectively

Additional Comments

- There is an increase in dollar limit, utilization rate, and worse rating during downturns
- There is little apparent difference in conclusions when we segregate by industry
- Weak or inconclusive evidence that EAD risk measures increase with lower collateral quality

Multivariate Regression Analysis

- The correlation-based analysis outlined above focused on the univariate relationship between LEQ and a set of commonly used risk factors
- Implicit in that analysis is the assumption that all other factors are held constant: a very strong assumption
- It is important that we look at the relationship between those factors and LEQ within a multivariate framework
- For that reason, we are currently analyzing the results using a regression-based approach
- We experimented various econometric techniques and settled on a model suited to the distributional properties of LEQ

* Generalized Linear Model (GLM) with the beta distribution as the link function, a version of logistic regression* adapted for continuous variables in a closed $[0,1]$ interval

Regression Analysis: Preliminary Results

LEQ Regression Model: EAD Risk Measures

<i>Variables</i>	<i>Partial Effect</i>	<i>p-value</i>
Utilization	-0.3494	0.0001
Commitment	0.0000361	0.0746
Undrawn	0.0000362	0.0001
Time-to-Default	0.067	0.0001
Rating 1	-0.01442	0.0426
Rating 2	-0.0681	0.0001
Rating 3	-0.0735	0.0001
Rating 4	-0.0527	0.0002
Rating 5	-0.1182	0.1003
Leverage	-0.0527	0.0755
Size	0.1182	0.0001
Liquidity	-0.0411	0.0216
Profitability	-0.000672	0.0251
Collateral Rank	0.0277	0.0001
Debt Cushion	-0.2747	0.0001
Spec Default Rate	-0.9321	0.0637
Percent Bank Debt	0.2863	0.0001
Likelihood Ratio (p-value)	7.11E-12	
Pseudo R-Squared	0.2029	
Spearman Rank Correlation	0.4706	
MSE of EAD	2.62E+15	
Observations	388	

- Results *generally* statistically significant, in line with univariate analysis, but some anomalies
- Overall good fit (r-squared) and rank ordering ability (Spearman correlation), and superior \$ EAD forecasting compared to alternatives
- EAD risk reduced for greater utilization, worse rating, greater leverage or liquidity, more debt cushion or higher default rate
- EAD risk increased for longer time-to-default, greater size, higher collateral rank or more bank debt in the mix

Other Recent Contributions

- Sufi (2005): studies usage of bank lines of credit from SEC 10K Form filings of large public companies
 - Not a study of EAD or LEQ per se, but is of relevance
 - Finds that banks tend to extend lines of credit to historically profitable firms
 - The “race to default” intensifies (firm draws, bank cuts) as firms approach distress or trip covenants
 - The flexibility of bank revolvers relative to other funding makes them more susceptible to abuse
- Moral (2006): analyzes competing methods for estimating EAD implemented by banks
 - Looks at optimality of different techniques from a regulatory vs. internal risk management point of view
 - Proposes a more general approach that is potentially better suited for IRB calculations
 - Addresses various data issues: structure and scope, cleansing, treatment of outliers

LEQ Research: Issues in Recent Bank Research

- Attempt to estimate more robust LEQs
- Address questions about significance the effect of obligor grade on LEQ
- Quest for a default definition closer to the IRB concept
- Evidence of differential LEQs across business lines
- Evidence of cyclicity? – not definitive
- Attempts to measure covenants historically - difficult
- Application of non-parametric and robust statistics to accommodate outliers and non-normality
- Multiple regression modeling
- Some evidence that obligor financial condition matters
 - Consistent with new research (Sufi 2005, Jacobs 2006)

Summary and Directions for Future Research

- Analysis of LEQs for large corporate defaulted revolving credits is generally in line with well-known bank studies
- However, some new findings have arisen (e.g., potential counter cyclical, effect of obligor capital structure and financial ratios)
- New explanatory variables (e.g., equity volatility or Merton distance-to-default)?
- Alternative econometric methodologies (e.g., robust regression, alternative objective functions)?
- Theoretical models (e.g., Bank influence in the EAD-LGD tradeoff and timing of default)?