

# The Determinants of Operational Risk in Financial Institutions

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# Background: Definition

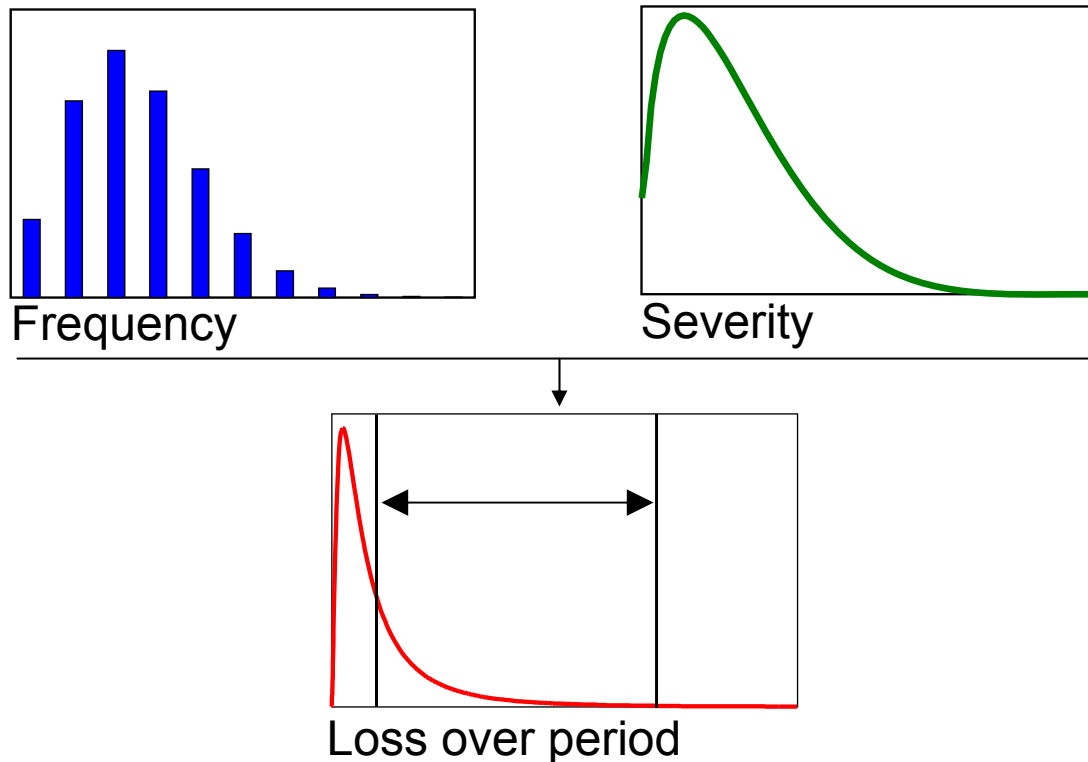
■ **Definition: Operational risk** is the risk of loss resulting from inadequate or failed *internal processes, people and systems*, or from *external events*.

■ **Categories include:**

- Internal fraud
- External fraud
- Employment practices and workplace safety
- Clients, products, and business practices
- Damages to physical assets
- Business disruption and system failures
- Execution, delivery, and process management

# Background: Drivers

- The distribution of operational losses over the next year is usually constructed from 2 risk drivers:
  - Frequency of loss: number of events over period
  - Severity of loss: size of loss when it occurs



# Background: Rationale

## ■ Focus: Financial industry

- ★ New capital adequacy framework (**Basel II**) includes a new regulatory capital charge for OpRisk
- ★ Allows **Advanced Measurement Approach** (AMA), based on economic capital at 99.9% over 1 year (e.g., VAR)

## ■ Bank compute their own economic capital

- ★ OpRisk accounts for significant fraction of total risk:

Operational Risk Capital	JPM Chase		Deutsche Bank	
	2006	2005	2006	2005
Billions (\$ or €)	\$5.7	\$5.5	€3.3	€2.4
Sum of EC	\$41.1	\$41.7	€13.6	€12.4
% of Total	13.9%	13.2%	24.4%	18.3%

# Motivation

## ■ Operational risk is a major stand-alone risk:

- Roger Ferguson, former Fed Vice Chairman (June 18, 2003): *Operational risks “have become an even larger share of total risk [and] at some banks they are the dominant risk.”*

## ■ Operational losses are NOT “one-off” events and may signal serious internal control flaws:

- GARP (Feb. 2, 2008): *“Some of the simple, unspoken rules at SocGen were “you never get punished for making money regardless of the rules broke” or “make as much money as possible.” ”*

- Financial Times (July 16, 2008): *“Organisations with weak data security are generally also weak in terms of wider risk management and governance. So a failure adequately to manage information security risks is often symptomatic of broader risk issues. [...] ”*

## ■ Macroeconomic environment can play a role:

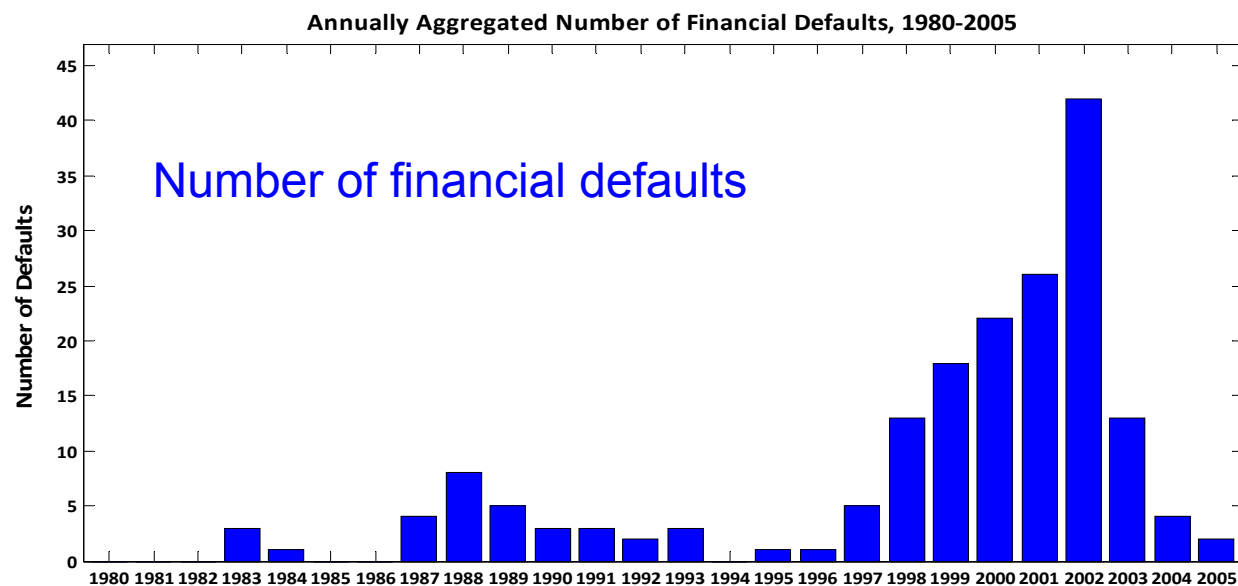
- BCBS (2006): *“Dependence structures [between operational losses] could occur as a result of business cycles (e.g., economic difficulties that cause an increase in rogue trading and fraud)”*

# Motivation

## Operational losses vs. financial defaults:

What drives OpRisk?

Is there a link?



# Literature

## ■ Size of operational losses

- ★ **de Fontnouvelle, DeJesus, Jordan, and Rosengren (2006 JMCB)**
  - Describe the severity distribution of OpRisk losses
  - Capital requirements could exceed those for market risk

## ■ Stock price impact of operational losses

- ★ **Cummins, Christopher, and Wei (2006 JBF)**
  - OpRisk events cause market value loss due to reputational loss
  - Especially banks with higher growth prospects
- ★ **Perry and de Fontnouvelle (2005)**
  - Market values fall 1-for-1 with losses due to external events
  - Market values fall by more with losses due to internal fraud
  - The effect is more significant for banks with strong shareholder rights

## ■ Exposure to macroeconomic factors

- ★ **Allen and Bali (2006 JBF)**
  - Use equity returns, not actual operational loss data
  - Find cyclical components

# Literature

## ■ Related to recent studies of corporate defaults

### ★ Duffie, Saita, & Wang (2007 JFE)

- Estimate time-varying intensity of corporate defaults using compound Poisson model
- Default intensity is a function of Merton's distance to default, stock return, S&P 500, interest rates

Link: Operational loss events are unevenly spaced in time

⇒ Poisson framework is relevant

## ■ Related to studies on earnings restatements

### ★ Burns & Kedia (2006 JFE), Efendi *et al.* (2007 JFE), etc.

- Sensitivity of CEO options to stock price is positively related to propensity to misreport
- Greater options holdings increase likelihood of misreporting

Link: Operational loss events of various types are directly linked to internal controls and CEO compensation structure

⇒ Executive compensation can help explain probability of OpRisk



# Data Description

## ■ Data source

Algorithmics' Financial Institutions Risk Scenarios Trends (FIRST) database

## ■ Data collection process

Public sources, mostly 3<sup>rd</sup> parties:

- SEC filings
- NYSE
- Court orders
- Customers, investors
- Media

*Issues and limitations:*

- Larger-scale events (upward bias)
- Discovery bias
- But no or little self-selection bias

## ■ Sample used in our study

- U.S. financial industry (SIC 6xxx)
- 1980 – 2005

Only firms with info in CRSP and Compustat

176 firms; 925 events

# Data Description

## ■ Event types (Basel II definitions)

ET1: Internal Fraud – unauthorized activity, theft & fraud involving at least 1 internal party

ET2: External Fraud – theft & fraud by a 3<sup>rd</sup> party, systems security

ET3: Employment Practices and Workplace Safety – discrimination, general liability, compensation

ET4: Clients, Products, and Business Practices – improper business & market practices, model errors

ET5: Damage to Physical Assets – natural and man-made disasters, vandalism

ET6: Business Disruption and Systems Failures – hardware & software failures, telecommunications

ET7: Execution, Delivery, and Process Management – data entry error, missed deadline, delivery failure

Other

## ■ Distribution

- ★ Majority of OpRisk events occur in ET1, ET2, ET4
- ★ Very few (but significant in \$) in ET5

# Data Description

## ■ Most frequently cited contributory factors

- Lack of control
  - Management action/inaction
  - Employee misdeeds
  - Organizational structure
  - Excessive concentration of power
  - Changes in market conditions
- } *Internal*
- } *External*

## ■ Classify events into 5 categories

Model 1	Internal Fraud
Model 2	External Fraud
Model 3	Clients, Products, and Business Practices
Model 4	All Other Events
Model 5	All Events

Exclude *Damage to Physical Assets*: too random

# Frequency Analysis: *Basic Framework*

## ■ Operational loss process (simplistic; used in practice)

$S_t = \sum_{i=1}^{N_t} X_i$	<ul style="list-style-type: none"><li>• <math>N_t</math> and <math>X</math> are independent</li><li>• <math>N_t = N(\lambda \cdot t)</math> homogeneous Poisson process</li><li>• <math>\lambda</math> constant arrival rate</li><li>• <math>X</math> <i>i.i.d.</i>, continuous distribution</li></ul>
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## RELAX KEY ASSUMPTIONS

## ■ Operational loss process (our model)

$S'_t = \sum_{i=1}^{N'_t} X_{t(i)}$	<ul style="list-style-type: none"><li>• <math>N'_t</math> and <math>X</math> are independent</li><li>• <math>N'_t = N(\Lambda(t))</math> Cox process (doubly-stochastic)</li><li>• <math>\hat{\lambda}(t) = \hat{\beta}_0 + \sum_{k=1}^K \hat{\beta}_k Y_{kt}</math></li><li>• <math>\hat{X}_t = \hat{\gamma}_0 + \sum_{m=1}^M \hat{\gamma}_m Z_{kt}</math></li></ul> <p>} <math>Y</math> and <math>Z</math> both are firm-specific and macroeconomic variables</p>
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# Frequency Analysis: *Methodology*

## ■ Frequency model

$$N_{it} = \text{function} (\text{firm-specific covariates}, \text{macroeconomic factors})$$

## ■ Econometric methodology

- MLE estimator (arrival of events is a Poisson process)
- Panel data (1 panel = 1 firm)
- Firm-month data: 195,888 firm-months
- Include all financial firms with and without losses
  
- Dependent variable: monthly aggregated loss count
- Independent variables: firm-specific and macro-level

# Frequency Analysis: *Results*

## Result 1:

**Larger firms experience more frequent losses**

**(MVE +\*\*\*)**

- ★ Larger banks have higher number of losses
- ★ Why? Larger volume and greater complexity of transactions
- ★ *Or:* Larger banks are more in the public eye ?

⌘ Other firm size measures (Total Assets, Net Income, Total Liabilities)

# Frequency Analysis: Results

	Expected Sign	Model 1		Model 2		Model 3		Model 4		Model 5	
		Internal Fraud		External Fraud		Clients, Prod., & Bus. Practices		Other Events		All Events	
		A	B	A	B	A	B	A	B	A	B
<i>Intercept</i>		-17.9687 (-21.48)***	-18.7459 (-18.34)***	-20.0537 (-22.00)***	-21.1711 (-22.25)***	-19.8943 (-21.97)***	-20.7708 (-34.19)***	-18.2834 (-17.26)***	-18.2140 (-27.01)***	-17.7176 (-36.38)***	-18.5113 (-38.10)***
Variables related to firm characteristics											
<i>LogMVE<sub>t</sub></i>	(?)	0.8320 (8.91)***	0.8412 (9.32)***	0.9156 (8.31)***	0.9012 (9.03)***	1.0481 (12.65)***	1.0263 (14.75)***	0.8756 (8.90)***	0.8794 (16.13)***	0.9457 (11.94)***	0.9378 (13.94)***
<i>Market-to-book<sub>t-3</sub></i>	(-)	-0.2527 (-1.64)	-0.1923 (-1.51)	-0.1966 (-1.21)	-0.1958 (-1.11)	-0.3527 (-2.23)**	-0.3358 (-2.40)**	-0.1792 (-1.47)	-0.1406 (-1.69)*	-0.2670 (-2.01)**	-0.2386 (-2.01)**
<i>CashTA<sub>t-3</sub></i>	(+)	0.0962 (3.00)***	0.0933 (3.10)***	1.9161 (2.81)***	0.0773 (2.32)**	0.1696 (4.66)***	0.1350 (4.05)***	0.1065 (3.68)***	0.1031 (5.46)***	0.1277 (4.41)***	0.1089 (3.96)***
<i>Tier1R<sub>t-3</sub></i>	(-)	-0.4787 (-1.33)	-0.4488 (-1.18)	-0.7412 (-2.95)***	-0.9805 (-3.92)***	0.0287 (0.06)	-0.0175 (-0.04)	-0.4199 (-1.59)	-0.4139 (-2.10)**	-0.3538 (-1.20)	-0.3640 (-1.19)
<i>ROE<sub>t-3</sub></i>	(?)	0.8357 (0.94)	0.7663 (0.86)	0.2470 (0.18)	0.3058 (0.22)	0.9818 (1.02)	1.1066 (1.16)	0.3163 (0.38)	0.3354 (0.72)	0.7110 (0.79)	0.7735 (0.87)
<i>Retsd<sub>t</sub></i>	(+)	3.6475 (4.09)***	4.0363 (5.09)***	3.4331 (3.09)***	2.6811 (2.02)**	5.0187 (7.23)***	4.6513 (6.40)***	3.7269 (5.93)***	4.0369 (7.80)***	4.2390 (7.99)***	4.1642 (7.50)***
<i>Dum_ExcessGr<sub>t</sub></i>	(+)	0.3497 (1.81)*	0.3805 (2.05)**	0.1516 (0.65)	0.1937 (0.84)	-0.0040 (-0.03)	0.0356 (0.26)	-0.2962 (-1.84)*	-0.3185 (-1.80)*	-0.0021 (-0.02)	0.0257 (0.27)
<i>Dum_HighDivr<sub>t-3</sub></i>	(-)	-0.4370 (-1.77)*	-0.4201 (-1.64)*	0.1614 (0.39)	0.0449 (0.11)	-0.3808 (-1.55)	-0.3602 (-1.50)	-0.5530 (-2.25)**	-0.5076 (-2.99)***	-0.3821 (-1.91)*	-0.3573 (-1.79)*
Variables related to the macroeconomic environment											
<i>Spread<sub>t</sub></i>	(?)		0.0807 (0.18)		-0.6522 (-0.87)		-0.0476 (-0.18)		0.0483 (0.15)		-0.0024 (-0.01)
<i>DispIncomeGr<sub>t</sub></i>	(?)		-6.2886 (-0.66)		8.0870 (0.66)		-12.5501 (-2.12)**		-10.3551 (-1.78)*		-8.7385 (-2.18)**
<i>S&amp;P500r<sub>t</sub></i>	(?)		0.7277 (0.30)		4.9133 (1.56)		0.9796 (0.89)		-5.2531 (-2.31)**		-0.3109 (-0.36)
<i>S&amp;P500rsd<sub>t</sub></i>	(?)		-0.1161 (-0.01)		24.7643 (1.49)		15.0602 (1.88)*		-7.8589 (-0.69)		8.4192 (1.48)
<i>GDPgr<sub>t</sub></i>	(?)		-0.1054 (-1.72)*		0.0494 (0.48)		0.0048 (0.08)		-0.1486 (-1.98)**		-0.0530 (-1.91)*
<i>SECbudgetGr<sub>t</sub></i>	(-)		-3.0583 (-1.51)		3.1294 (1.28)		1.1363 (1.34)		-0.1977 (-0.17)		0.1625 (0.33)
<i>Dum_Reg<sub>t</sub></i>	(-)		-0.4497 (-1.25)		-1.6584 (-3.08)***		-0.9197 (-4.47)***		-0.3814 (-1.68)*		-0.7632 (-3.38)***
<i>January Dummy</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Year Fixed Effects</i>	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	No
Num. Obs.		195,888	195,888	195,888	195,888	195,888	195,888	195,888	195,888	195,888	195,888
$\chi^2$ macro			20.10		43.03		95.15		26.80		89.61
[p-value]			[0.0053]***		[0.0000]***		[0.0000]***		[0.0004]***		[0.0000]***
Pseudo R <sup>2</sup>		0.2970	0.2847	0.3345	0.3091	0.4706	0.4543	0.3273	0.3127	0.4347	0.4227

# Frequency Analysis: *Results*

## Result 2:

**Operational loss events signal financial distress  
(low market-to-book +\*\*, high equity volatility +\*\*\*)**

- ★ Similar to default risk literature
- ★ Financially constrained firms can not devote sufficient resources to regulatory oversight and internal control  
⇒ OpRisk and financial distress
- ★ Especially true for **Internal Fraud** and all **Business Practices-**related events



# Frequency Analysis: Results

	Expected Sign	Model 1		Model 2		Model 3		Model 4		Model 5	
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<i>Market-to-book<sub>t-3</sub></i>	(-)	-0.2527 (-1.64)	-0.1923 (-1.51)	-0.1966 (-1.21)	-0.1958 (-1.11)	-0.3527 (-2.23)**	-0.3358 (-2.40)**	-0.1792 (-1.47)	-0.1406 (-1.69)*	-0.2670 (-2.01)**	-0.2386 (-2.01)**
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Pseudo R <sup>2</sup>		0.2970	0.2847	0.3345	0.3091	0.4706	0.4543	0.3273	0.3127	0.4347	0.4227

# Frequency Analysis: Results

## Result 3:

### Macroeconomic environment plays a smaller role

★ Results overall inconclusive: Coefficients often insignificant

★ GDP growth ( - ) } Economy slowdown  
Disposable Income growth ( - ) } ⇒ more frequent losses

⇒ Overall, OpRisk appears largely *idiosyncratic*

★ SEC budget growth ( - , mildly significant)  
but only for Internal Fraud

★ Basel II dummy ( - , significant) for most events

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<i>Dum_ ExcessGr<sub>t</sub></i>	(+)	0.3497 (1.81)*	0.3805 (2.05)**	0.1516 (0.65)	0.1937 (0.84)	-0.0040 (-0.03)	0.0356 (0.26)	-0.2962 (-1.84)*	-0.3185 (-1.80)*	-0.0021 (-0.02)	0.0257 (0.27)
<i>Dum_ HighDivr<sub>t-3</sub></i>	(-)	-0.4370 (-1.77)*	-0.4201 (-1.64)*	0.1614 (0.39)	0.0449 (0.11)	-0.3808 (-1.55)	-0.3602 (-1.50)	-0.5530 (-2.25)**	-0.5076 (-2.99)***	-0.3821 (-1.91)*	-0.3573 (-1.79)*
Variables related to the macroeconomic environment											
<i>Spread<sub>t</sub></i>	(?)		0.0807 (0.18)		-0.6522 (-0.87)		-0.0476 (-0.18)		0.0483 (0.15)		-0.0024 (-0.01)
<i>DisplIncomeGr<sub>t</sub></i>	(?)		-6.2886 (-0.66)		8.0870 (0.66)		-12.5501 (-2.12)**		-10.3551 (-1.78)*		-8.7385 (-2.18)**
<i>S&amp;P500r<sub>t</sub></i>	(?)		0.7277 (0.30)		4.9133 (1.56)		0.9796 (0.89)		-5.2531 (-2.31)**		-0.3109 (-0.36)
<i>S&amp;P500rsd<sub>t</sub></i>	(?)		-0.1161 (-0.01)		24.7643 (1.49)		15.0602 (1.88)*		-7.8589 (-0.69)		8.4192 (1.48)
<i>GDPgr<sub>t</sub></i>	(?)		-0.1054 (-1.72)*		0.0494 (0.48)		0.0048 (0.08)		-0.1486 (-1.98)**		-0.0530 (-1.91)*
<i>SECbudgetGr<sub>t</sub></i>	(-)		-3.0583 (-1.51)		3.1294 (1.28)		1.1363 (1.34)		-0.1977 (-0.17)		0.1625 (0.33)
<i>Dum_ Reg<sub>t</sub></i>	(-)		-0.4497 (-1.25)		-1.6584 (-3.08)***		-0.9197 (-4.47)***		-0.3814 (-1.68)*		-0.7632 (-3.38)***
<i>January Dummy</i>	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Year Fixed Effects</i>	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	No
Num. Obs.	195,888	195,888	195,888	195,888	195,888	195,888	195,888	195,888	195,888	195,888	195,888
$\chi^2$ macro		20.10		43.03		95.15		26.80		89.61	
[p-value]		[0.0053]***		[0.0000]***		[0.0000]***		[0.0004]***		[0.0000]***	
Pseudo R <sup>2</sup>	0.2970	0.2847	0.3345	0.3091	0.4706	0.4543	0.3273	0.3127	0.4347	0.4227	

# Frequency Analysis: *Results*

## Result 4:

More frequent losses with younger firms with more complex operations (# segments)

(firm age - \*\*\*, # segments + \*\*\*)

- ★ Less internal controls for young firms
- ★ Internal controls less effective for complex firms, with more operating and geographic segments
- ★ Even with **distance to default** variable, which is negative and significant, correlated with default risk

# Frequency Analysis: Results

## ■ All event types: Other specifications

	Expected Sign	(0)	(1)	(2)	(3)	(4)
<i>Intercept</i>		-18.5113 (-38.10)***	-19.7960 (-27.93)***	-18.2519 (-32.01)***	-18.6290 (-38.63)***	-17.9922 (-31.08)***
Variables related to firms characteristics						
<i>LogMVE<sub>t</sub></i>	(?)	0.9378 (13.94)***	0.9328 (13.94)***	0.8864 (18.13)***	0.9383 (16.29)***	0.8681 (17.46)***
<i>Market-to-book<sub>t-3</sub></i>	(-)	-0.2386 (-2.01)**	-0.2103 (-2.79)***	-0.1849 (-2.19)**	-0.2463 (-2.38)**	-0.1677 (-2.00)**
<i>CashTA<sub>t-3</sub></i>	(+)	0.1089 (3.96)***	0.1058 (3.49)***	2.6688 (5.49)***	2.0828 (9.44)***	2.8280 (5.47)***
<i>Tier1r<sub>t-3</sub></i>	(-)	-0.3640 (-1.19)	-0.4341 (-1.74)*	-0.3094 (-1.73)*	-0.3806 (-1.09)	-0.3509 (-1.37)
<i>ROE<sub>t-3</sub></i>	(?)	0.7735 (0.87)	-0.2798 (-0.34)	0.8015 (1.64)	0.6956 (0.88)	0.6573 (1.33)
<i>Retsd<sub>t</sub></i>	(+)	4.1642 (7.50)***	3.6695 (5.40)***	3.6002 (5.26)***	4.7671 (6.92)***	3.6514 (4.25)***
<i>Dum_ExcessGr<sub>t</sub></i>	(+)	0.0257 (0.27)	0.0595 (0.69)	-0.0927 (-0.78)	0.0193 (0.22)	-0.0995 (-0.82)
<i>Dum_HighDivr<sub>t-3</sub></i>	(-)	-0.3573 (-1.79)*	-0.1923 (-1.06)	-0.3634 (-1.66)*	-0.1667 (-0.91)	-0.2839 (-1.33)
<i>FirmAge<sub>t</sub></i>	(-)			-0.0043 (-3.11)***		-0.0040 (-2.86)***
<i>NumSegments<sub>t</sub></i>	(+)			0.0489 (3.11)***		0.0479 (2.93)***
<i>Distance-to-Default<sub>t</sub></i>	(-)				-0.0175 (-6.68)***	-0.0155 (-5.99)***
Variables related to the macroeconomic environment						
<i>Spread<sub>t</sub></i>	(?)	-0.0024 (-0.01)	0.0379 (0.18)	0.4504 (1.24)	-0.1224 (-0.48)	0.3999 (1.09)
<i>DisplIncomeGr<sub>t</sub></i>	(?)	-8.7385 (-2.18)**	-8.4921 (-2.21)**	-5.9698 (-0.99)	-9.2556 (-2.23)**	-7.2960 (-1.14)
<i>S&amp;P500r<sub>t</sub></i>	(?)	-0.3109 (-0.36)	-0.4245 (-0.52)	0.5021 (0.37)	-0.1891 (-0.22)	0.6551 (0.47)
<i>S&amp;P500rsd<sub>t</sub></i>	(?)	8.4192 (1.48)	7.1364 (1.25)	1.1841 (0.14)	6.7574 (1.22)	0.2551 (0.03)
<i>GDPgr<sub>t</sub></i>	(?)	-0.0530 (-1.91)*	-0.0545 (-2.03)**	-0.0014 (-0.03)	-0.0442 (-1.66)*	-0.0013 (-0.03)
<i>SECbudgetGr<sub>t</sub></i>	(-)	0.1625 (0.33)	0.2973 (0.58)	0.9139 (1.21)	0.1229 (0.24)	0.6622 (0.79)
<i>Dum_Reg<sub>t</sub></i>	(-)	-0.7632 (-3.38)***	-0.9027 (-3.92)***	-1.0393 (-4.28)***	-0.6846 (-2.97)***	-1.0296 (-4.32)***

# Predictability of OpRisk

- Our frequency models indicate OpRisk is linked to internal control environment
- **Conjecture:**  
OpRisk could be explained by governance & CEO incentives
- **Predictions:**
  - (a) Governance: Firms with**
    - Weak shareholder rights have loose internal controls ⇒ OpRisk
    - Auditors on board have strong internal controls ⇒ prevent losses
    - Board independence ⇒ prevent losses
  - (b) CEO Compensation**
    - Higher sensitivity to stock price (“ $\Delta$ ”), bonus/salary, options/salary  
⇒ incentive to loosen controls ⇒ higher OpRisk
    - Higher long-term incentive plan  
⇒ aligned with stockholders ⇒ prevent losses

# Predictability of OpRisk: Governance

## ■ Logit Model 1: Governance and OpRisk

*Prob (oprisk) = function (internal & external governance)*

### ★ Methodology:

- Single cross section
- I=0 Control sample: no-loss firms (1980-2005) N=242
- I=1 Treatment sample: loss-firms (1998-2005) N=23

### ★ Key variables:

- Gompers, Ishii, & Metrick's governance index (G-index)
- Ratio of auditors on board
- Board independence

## ■ Results:

- High G-index, weak shareholder rights (+ \*\*) for all event types ⇒ more risk
- High ratio of auditors on board (- \*\*) for fraud only ⇒ less risk
- Board independence not significant

# Predictability of OpRisk: Governance

	Expected Sign	Model 1 & 2 <sup>a</sup> Internal & External Fraud	Model 3 Clients, Prod., & Bus. Practices	Model 4 Other Events	Model 5 All Events
<i>Constant</i>		20.9277 (2.78)***	-12.2486 (-2.69)***	-5.0954 (-1.33)	-9.0528 (-2.25)**
Gompers, Ishii, and Metrick (2003) external governance index					
<i>G-index</i>	(+)	0.1751 (0.42)	0.1819 (1.93)*	0.1753 (1.06)	0.2273 (2.02)**
Internal governance variables					
<i>Auditr</i>	(-)	-22.9779 (-2.09)**	3.3857 (1.08)	-0.8083 (-0.24)	-0.5258 (-0.18)
<i>Dum_BoardIn depr_Q4</i>	(-)	0.0933 (0.06)	-1.2049 (-1.31)	0.4650 (0.34)	-1.3954 (-1.19)
<i>BoardSize</i>	(?)	-3.5787 (-2.52)**	0.3053 (0.92)	-0.2113 (-0.64)	0.2406 (0.66)
<i>BoardSize</i> <sup>2</sup>	(?)	0.1142 (2.50)**	-0.0065 (-0.58)	0.0088 (0.82)	-0.0076 (-0.58)
<i>NumMeetings</i>	(?)	0.4067 (0.70)	0.7403 (1.02)	-0.3859 (-0.39)	0.5374 (0.89)
<i>NumMeetings</i> <sup>2</sup>	(?)	-0.0115 (-0.40)	-0.0411 (-1.09)	0.0310 (0.67)	-0.0331 (-0.94)
Control variables					
<i>MVE</i>	(?)	0.1841 (2.62)***	0.0796 (1.98)**	0.0949 (2.96)***	0.1417 (4.84)***
<i>Market-to-Book</i>	(-)	-0.6280 (-1.89)*	0.0151 (0.11)	-0.8341 (-1.95)*	-0.2585 (-1.48)
<i>Cash_TA</i>	(+)	12.3522 (4.30)***	-1.1680 (-0.41)	7.2054 (2.02)**	2.5050 (1.11)
<i>Tier1r</i>	(-)	-20.1937 (-4.24)***	0.6180 (0.46)	-3.1797 (-1.55)	-0.3467 (-0.32)
<i>SIC fixed effects</i>		Yes	Yes	Yes	Yes
Num. Obs.		265	265	265	265
$\chi^2$ Governance		24.77	9.40	13.98	8.76
[ <i>p</i> -value]		[0.0008]***	[0.2252]	[0.0515]*	[0.2700]
P(Corr. Specified   Y=1)		87.50%	81.25%	87.50%	86.96%
[Baseline: P(Y=1) <sup>b</sup> ]		[3.02%]	[6.04%]	[3.02%]	[8.68%]
Pseudo R <sup>2</sup>		0.8140	0.3081	0.5772	0.4777



# Predictability of OpRisk: CEO Compensation

## ■ Logit Model 2: CEO compensation incentives and OpRisk

$$Prob(oprisk) = function(CEO\ compensation\ characteristics)$$

### ★ Methodology:

- Pooled time-series cross-section
- Control sample: no-loss firm-years (1993-2005) N=1,527 FirmYr
- Treatment sample: loss-firm firm-years (1993-2005) N= 533 FirmYr

### ★ Key variables:

- CEO option awards' stock price sensitivity ("Δ", Core & Guay 2002)
- CEO stock holding ratio
- CEO bonus-to-salary ratio; salary, bonus sensitivity to firm earnings
- CEO LTIP/total compensation ratio

## ■ Results:

- In-the-money options / salary (+\*\*), option awards / salary (+\*), bonus / salary (+\*\*\*) ⇒ more risk
- Long-term incentives not significant

# Predictability of OpRisk: CEO Compensation

	Expected Sign	Model 1 Internal Fraud	Model 2 External Fraud	Model 3 Clients, Products, & Bus. Practices	Model 4 Other Events	Model 5 All Events
<i>Intercept</i>		-8.7094 (-6.75)***	-7.9485 (-7.63)***	-6.4076 (-10.73)***	-7.4773 (-8.62)***	-5.7020 (-10.41)***
<i>LogTA<sub>t-12</sub></i>	(?)	0.8973 (5.00)***	0.6104 (3.18)***	0.6531 (5.07)***	0.7200 (5.48)***	0.6087 (5.71)***
CEO compensation structure at beginning of previous year						
<i>InMonOpt<sub>t-12</sub>/Salary<sub>t-12</sub></i>	(+)	0.0065 (1.40)	0.0133 (2.69)***	0.0040 (1.14)	0.0101 (2.76)***	0.0078 (2.46)**
<i>OptAwards<sub>t-12</sub>/Salary<sub>t-12</sub></i>	(+)	0.0177 (0.69)	0.0271 (1.51)	0.0211 (1.35)	0.0368 (1.81)*	0.0151 (0.91)
<i>Bonus<sub>t-12</sub>/Salary<sub>t-12</sub></i>	(+)	-0.0064 (-0.12)	0.0641 (1.41)	0.0737 (2.48)**	0.1044 (2.90)***	0.0891 (2.61)***
<i>RestrStGrnt<sub>t-12</sub>/Salary<sub>t-12</sub></i>	(+)	0.0575 (1.08)	-0.0749 (-1.61)	-0.0155 (-0.42)	-0.0364 (-0.94)	-0.0040 (-0.10)
<i>RestrStHold<sub>t-12</sub>/Salary<sub>t-12</sub></i>	(+)	-0.0019 (-0.16)	-0.0021 (-0.13)	0.0103 (1.18)	-0.0146 (-1.24)	0.0027 (0.27)
<i>StockHolding<sub>t-12</sub></i>	(-)	4.3865 (1.20)	-6.1489 (-0.69)	-2.2549 (-0.49)	-4.2776 (-1.22)	-3.2211 (-0.91)
<i>Salary<sub>t-12</sub></i>	(?)	0.0005 (0.84)	0.0007 (1.27)	0.0009 (1.98)**	0.0007 (1.54)	0.0006 (1.61)
<i>ΔSalary&gt;FirmPerformance<sub>t</sub></i>	(+)	-0.2174 (-0.36)	-0.8046 (-1.12)	-0.2744 (-0.78)	-0.1348 (-0.30)	-0.1831 (-0.67)
<i>LTIP<sub>t-12</sub>/Compens<sub>t-12</sub></i>	(-)	1.4662 (1.36)	-2.0203 (-0.89)	-0.8467 (-0.62)	-0.6674 (-0.56)	0.9598 (1.04)
<i>CEO is Chair<sub>t</sub></i>	(+)	0.2179 (0.45)	0.1827 (0.48)	0.3048 (0.94)	0.2695 (0.62)	0.2847 (1.04)
CEO compensation sensitivity measures at beginning of year with operational losses						
<i>OptionPPS<sub>t</sub></i>	(+)	-0.0001 (-0.34)	-0.0004 (-1.75)*	-0.0001 (-0.66)	-0.0001 (-0.79)	-0.0002 (-1.02)
<i>SalaryBonus_Sens<sub>t</sub></i>	(+)	-0.4477 (-0.77)	0.4854 (1.19)	-0.5684 (-1.09)	0.8873 (2.02)**	-0.2879 (-0.78)
<i>Year fixed effects</i>		Yes	Yes	Yes	Yes	Yes
<i>SIC fixed effects</i>		Yes	Yes	Yes	Yes	Yes
Num. Obs.		1,681	1,681	1,681	1,681	1,681
$\chi^2$ ExecuComp		21.07	30.41	21.65	47.13	33.07
[p-value]		[0.0493]**	[0.0024]***	[0.0417]**	[0.0000]***	[0.0009]***
P(Corr. Specified   Y=1)		81.13%	78.95%	76.69%	80.00%	75.48%
[P(Y=1) <sup>2</sup> ]		[3.15%]	[2.26%]	[7.91%]	[4.76%]	[12.37%]
Pseudo R <sup>2</sup>		0.2935	0.2412	0.2824	0.2920	0.2598

# Conclusions

## ■ Summary of main findings:

- ★ Operational risk events are largely *idiosyncratic*; macroeconomic environment has a limited role.
- ★ Operational risk events are not one-off events, but *are signals of internal control deficiencies*.
- ★ *Governance and executive compensation* help explain operational risk.

## ■ Extensions—Current research:

- ★ Links between firms' OpRisk events? Clustering?  
Preliminary findings: **yes!**
- ★ OpRisk and **default prediction** (work in progress)  
Preliminary findings: **yes!**

# QUESTIONS?

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