Do Banks Price Firms' Data Breaches?

Henry He Huang [1]   Chong Wang [2]
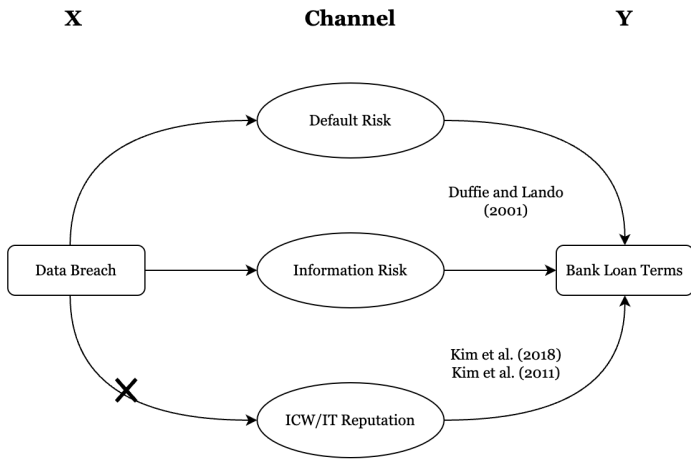
[1]Yeshiva University

[2]The Hong Kong Polytechnic University

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The story

Sample development

Step	Authors'	Mine
# data breaches from 2005 (2010) to 2014 (2020)	551	587
Less:		
# firms with a prior breach event	(16)	(9)
# events that are not the most significant	(70)	(195)
# event firms lacking the data for (PSM)	(252)	(155)
# event firms after PSM	213	228
event firms + control firms	426	456
Bank loan observations from 2003 (2008) to 2016 (2022)	1,428	2165
Less:		
financial services industries	(254)	(166)
bridge loans and non-fund-based facilities	(55)	(NA)
insufficient to calculate control variables	(37)	(26)
Final sample involving 139 (149) data breach event firms	1,081	1973

Probit Regression

$$\Phi^{-1}(\text{Data Breach Event}_t) = \alpha_0 + \alpha_1\text{Firm Size}_{t-1} + \alpha_2\text{Leverage}_{t-1} + \alpha_3\text{ROA}_{t-1}$$
$$+ \alpha_4\text{Operational Risk}_{t-1} + \alpha_5\text{Tangibility}_{t-1}$$
$$+ \alpha_6\text{Z-score}_{t-1} + \alpha_7\text{MB}_{t-1} + \alpha_8\text{IT Expertise}_{t-1}$$
$$+ \alpha_9\text{IT Reputation}_{t-1} + \alpha_{10}\text{Number of Segments}_{t-1}$$
$$+ \alpha_{11}\text{ICW}_{t-1} + \alpha\text{Industry} + \alpha\text{Year} + \varepsilon$$

```
reg_formula <- breach ~ firm_size + leverage + roa +
    operational_risk + tangibility + z_score + mb +
  it_expertise + fyear + industry

ps_model <- glm(reg_formula, data = psm_panel,
    family = binomial(link = "probit"))
```

Probit Regression (Cont.)

	Authors'	Mine
Firm Size$_{t-1}$	0.154***	0.182***
Leverage$_{t-1}$	-0.016	0.199*
ROA$_{t-1}$	0.089***	-0.164
Operational Risk$_{t-1}$	0.358*	0.761
Tangibility$_{t-1}$	-0.005	-0.331*
Z-score$_{t-1}$	-0.086	0.002
MB$_{t-1}$	-0.000**	0.010
IT Expertise$_{t-1}$	0.233***	-0.024
IT Reputation$_{t-1}$	0.222**	NA
Number of Segments$_{t-1}$	-0.009	NA
ICW$_{t-1}$	-0.134	NA
Intercept	-7.881***	-11.895
Industry/Year	Included	Included
Number of Observations	57,462	33,157
Pseudo R^2	0.166	0.243

Difference in Variables for firms Matched by PSM

Variable	Treated	Control	Diff.	p
Firm Size	8.308 (8.846)	8.190 (8.752)	0.118 (0.094)	0.591 (0.545)
Leverage	0.459 (0.653)	0.485 (0.679)	-0.026 (-0.026)	0.768 (0.397)
ROA	0.122 (0.134)	0.124 (0.130)	-0.002 (0.003)	0.859 (0.693)
Operational Risk	0.059 (0.039)	0.077 (0.036)	-0.018 (0.002)	0.137 (0.472)
Tangibility	0.431 (0.237)	0.449 (0.241)	-0.018 (-0.003)	0.643 (0.881)
Z-score	3.245 (4.965)	2.129 (4.770)	1.116 (0.196)	0.408 (0.809)
MB	2.330 (1.619)	2.455 (1.552)	-0.125 (0.067)	0.859 (0.683)
IT Expertise	0.364 (0.123)	0.341 (0.105)	0.023 (0.018)	0.616 (0.567)
IT Reputation	0.092	0.083	0.009	0.735
Number of Segments	2.055	1.853	0.203	0.252
ICW	0.028	0.009	0.018	0.154

Descriptive statistics

Variable	Authors' Mean	My Mean
Bank Loan Characteristics		
Loan Spread	210.500	173.673
Loan Amount	0.954	1.781
Maturity	55.310	47.196
Performance Pricing	0.423	0.298
Secured	0.485	0.276
Total Covenants	3.096	5.104
Data Breach Variables		
Breach	0.543	0.568
Post	0.475	0.375
Firm-Level Variables		
Firm Size	8.779	9.422
Leverage	0.503	0.650
ROA	0.144	0.136
Operational Risk	0.043	0.032
Tangibility	0.568	0.285
Z-Score	2.883	3.966
MB	2.372	1.329
IT Expertise	0.391	0.114

DiD

$$\text{Loan Contract Terms} = \beta_0 + \beta_1 \text{Data Breach} \times \text{Year}_{-1} + \beta_1 \text{Data Breach} \times \text{Year}_0$$
$$+ \beta_1 \text{Data Breach} \times \text{Year}_1 + \beta_1 \text{Data Breach} \times \text{Year}_2$$
$$+ \beta \text{Controls} + \varepsilon$$

```
rhs_formula <- ~ breach:year_pre_1 + breach:year_0 +
    breach:year_post_1 + breach:year_post_2 + log(
  loan_amount + 1) + log(loan_maturity + 1) +
  performance_pricing + firm_size + leverage + roa
  + operational_risk + tangibility + z_score + mb +
   it_expertise

model_loan_spread <- plm(update.formula(rhs_formula,
    log(loan_spread) ~ .), data = did_panel, index =
    c("Ticker", "loan_year"), model = "within",
  effect = "twoways")
```

Authors' DiD Result

TABLE 4

Relation between Data Breaches and Bank Loan Contracting: Main Test

Dependent Variable	(1) Ln(Loan Spread)	(2) Secured	(3) Number of Total Covenants
Data Breach * Year −1	−0.014	−0.008	−0.332
	(−0.17)	(−0.18)	(−0.96)
Data Breach * Year 0	0.052	0.067	−0.074
	(0.66)	(1.41)	(−0.21)
Data Breach * Year 1	0.221**	0.114**	0.783*
	(2.41)	(2.26)	(1.84)
Data Breach * Year 2+	0.037	0.097**	0.830**
	(0.49)	(2.14)	(2.13)
Ln(Loan Size)	−0.369***	−0.129***	0.196
	(−6.82)	(−3.95)	(0.82)
Ln(Loan Maturity)	0.197***	0.114***	−0.145
	(4.56)	(4.79)	(−0.91)
Performance Pricing	−0.193***	−0.029	2.135***
	(−5.25)	(−1.19)	(9.44)
Firm Size	−0.089	−0.024	−1.096*
	(−0.82)	(−0.43)	(−1.94)
Leverage	0.360*	−0.237*	−2.853**
	(1.93)	(−1.85)	(−2.46)
ROA	−3.625***	−0.848	−10.396**
	(−3.93)	(−1.57)	(−2.51)

Replication DiD Result

	Loan Spread	Total Covenants	Secured
Breach:Year -1	0.009	−0.163	−0.033
	(0.063)	(0.330)	(0.041)
Breach:Year 0	−0.010	0.022	−0.028
	(0.064)	(0.318)	(0.041)
Breach:Year 1	−0.031	−0.202	−0.025
	(0.066)	(0.415)	(0.045)
Breach:Year 2+	−0.033	−0.177	0.008
	(0.045)	(0.251)	(0.030)
Log(Loan Amount)	−0.018	−0.090	−0.018*
	(0.016)	(0.103)	(0.010)
Log(Loan Maturity)	−0.010	−0.031	0.066***
	(0.022)	(0.124)	(0.014)
Performance Pricing	0.082***	0.172	0.043**
	(0.027)	(0.136)	(0.018)

Replication DiD Result (Cont.)

	Loan Spread	Total Covenants	Secured
Firm Size	-0.200^{***}	-0.365^{*}	-0.037
	(0.037)	(0.211)	(0.024)
Leverage	0.844^{***}	1.012	0.203^{**}
	(0.128)	(0.922)	(0.085)
ROA	-1.075^{***}	-1.156	0.021
	(0.248)	(2.257)	(0.168)
Operational Risk	0.309	-3.580	0.170
	(0.638)	(3.449)	(0.418)
Tangibility	0.309	2.320	-0.398^{***}
	(0.237)	(1.417)	(0.154)
Z-Score	0.029^{*}	-0.103	-0.012
	(0.016)	(0.102)	(0.011)
MB	-0.079^{**}	0.094	-0.039^{*}
	(0.031)	(0.232)	(0.021)
IT Expertise	-0.161^{***}	0.120	0.009
	(0.054)	(0.288)	(0.034)
Observations	1,608	850	1,889

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Conclusion

Reasons for no results:

- Data breach sample
- Control variable
- Pattern not generalisable