Forecasting Data Breaches

ISACA®
Philadelphia Chapter

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Agenda

ThomasL@VivoSecurity.com

- What is probability
- Developing a model
- What is the model; what does it **teach**.
- What is the model-risk
- The most effective way to reduce data breach

What is Probability

How we sell security

What business wants to know

Risk = Impact x Probability

$1,000,000 x 0.5 = $500,000

After controls are deployed

Residual-risk = Impact x Residual-probability

$1,000,000 x 0.0001 = $100

Enterprise residual-risk = Impact x ∑ Residual-probability

$1,000,000 x (0.0001+0.0003) = $400

This talk

Another way the breach can happen, and a control has been deployed

What is Probability

4% (annual probability)

Also express as…

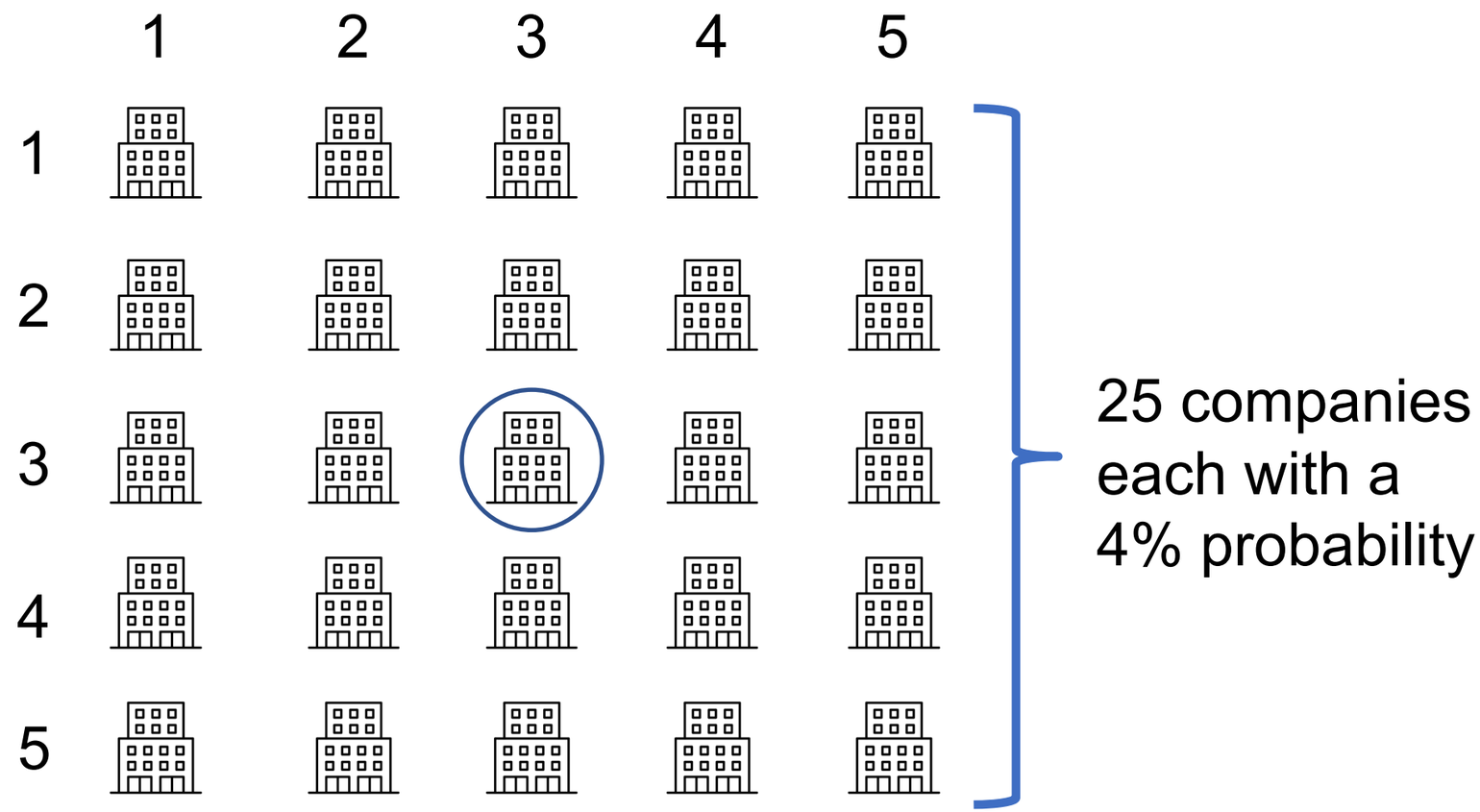
0.04

Also express as…

Once in 25-years (**1 ÷ 0.04**)

All indicate the same probability

What once in 25-years (4%) really means



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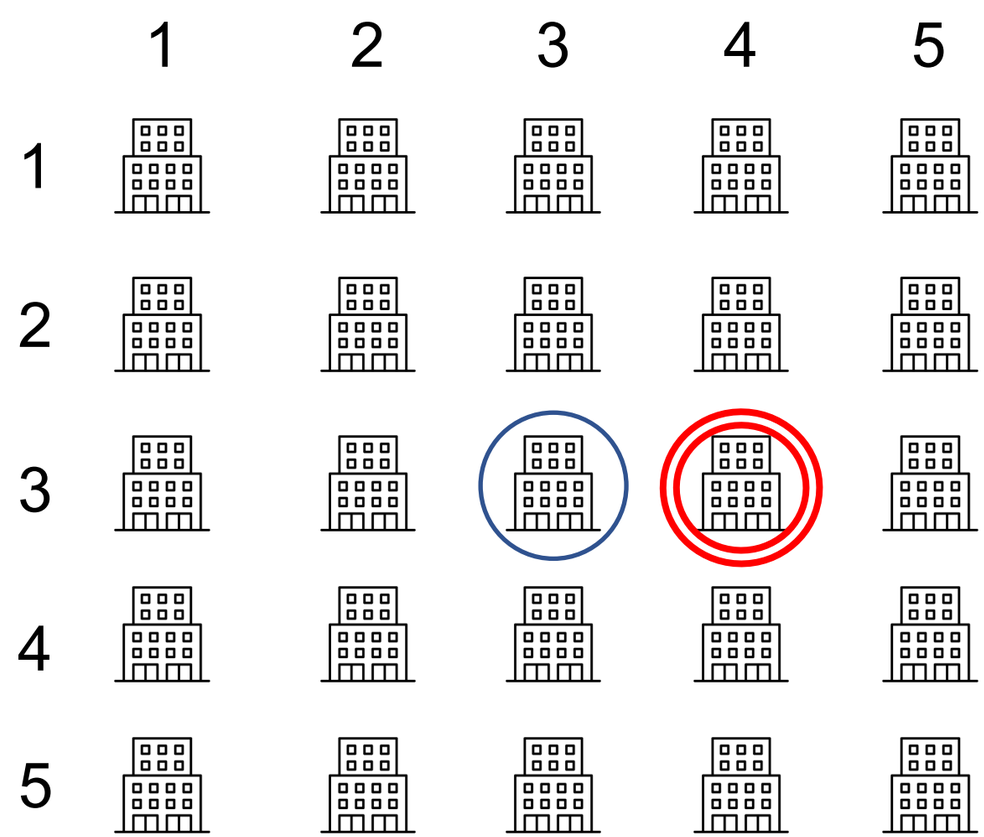
What once in 25-years (4%) really means



Over 1-year

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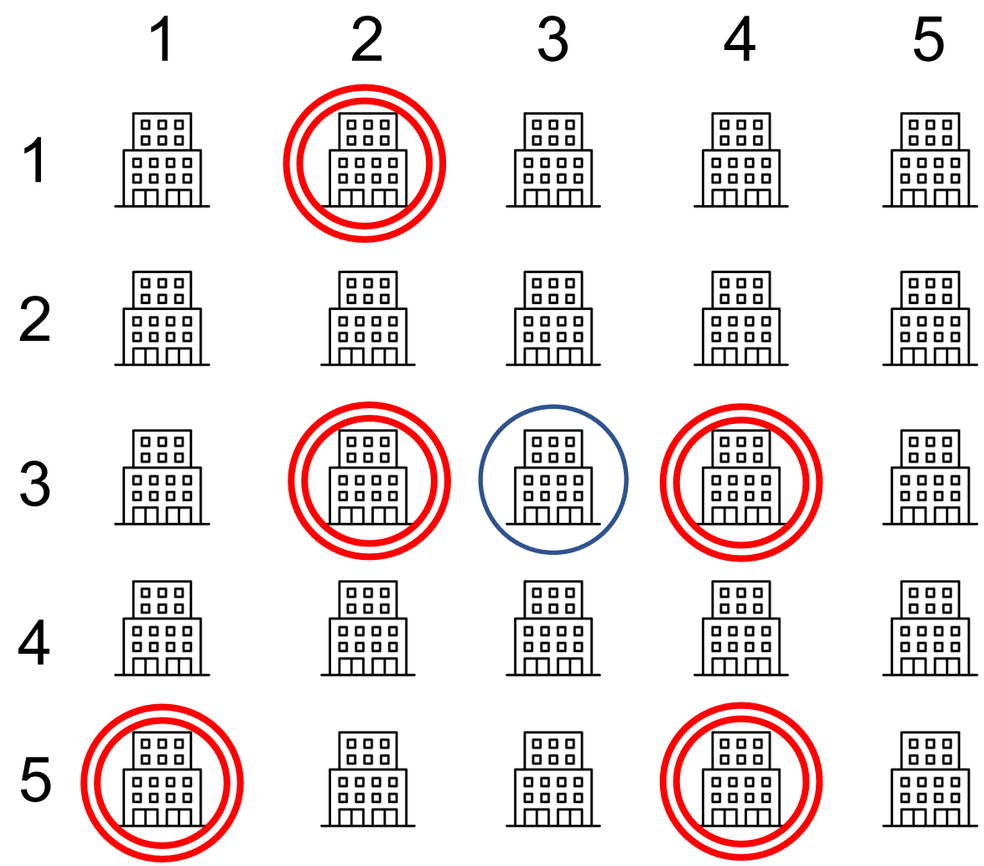
What once in 25-years (4%) really means



Over 5-year

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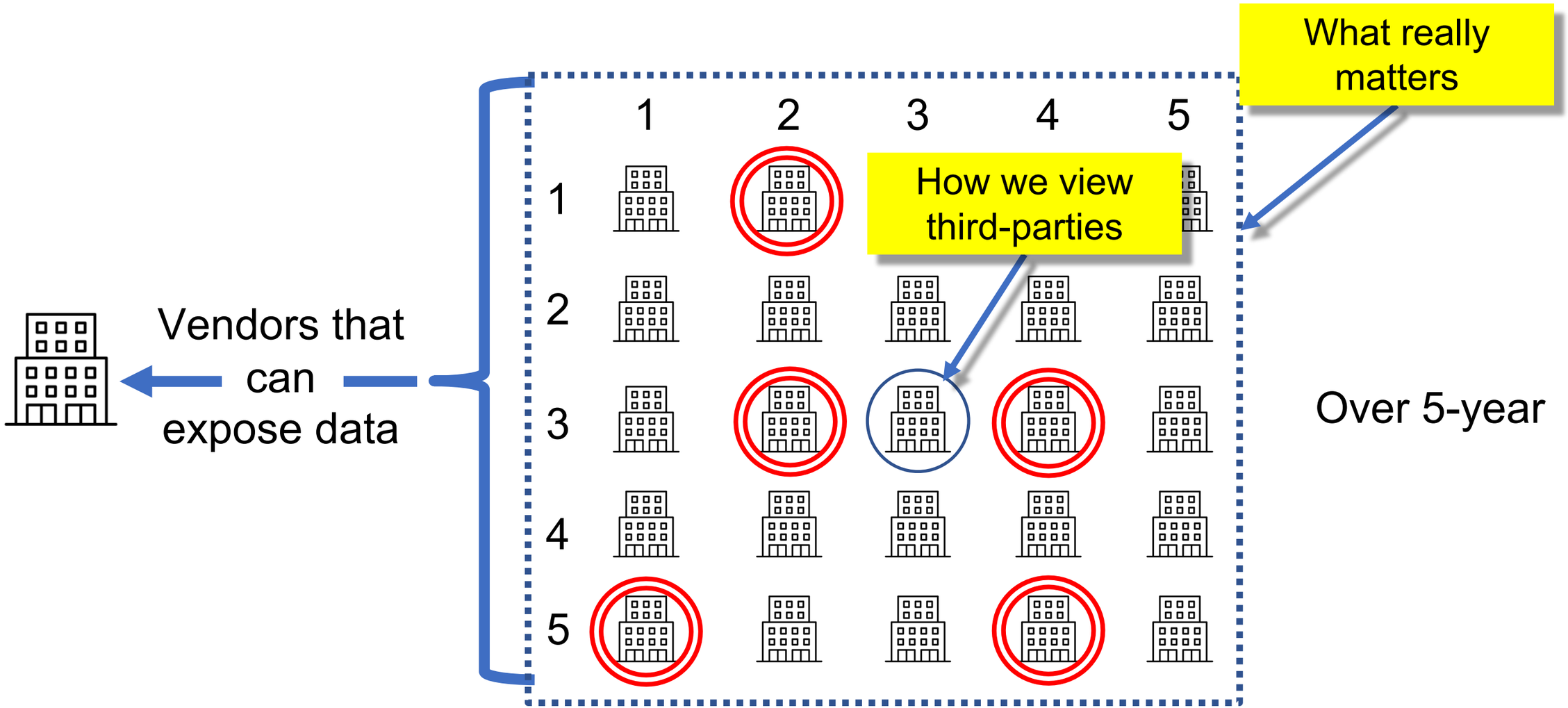
What once in 25-years (4%) really means



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How to Develop a Model

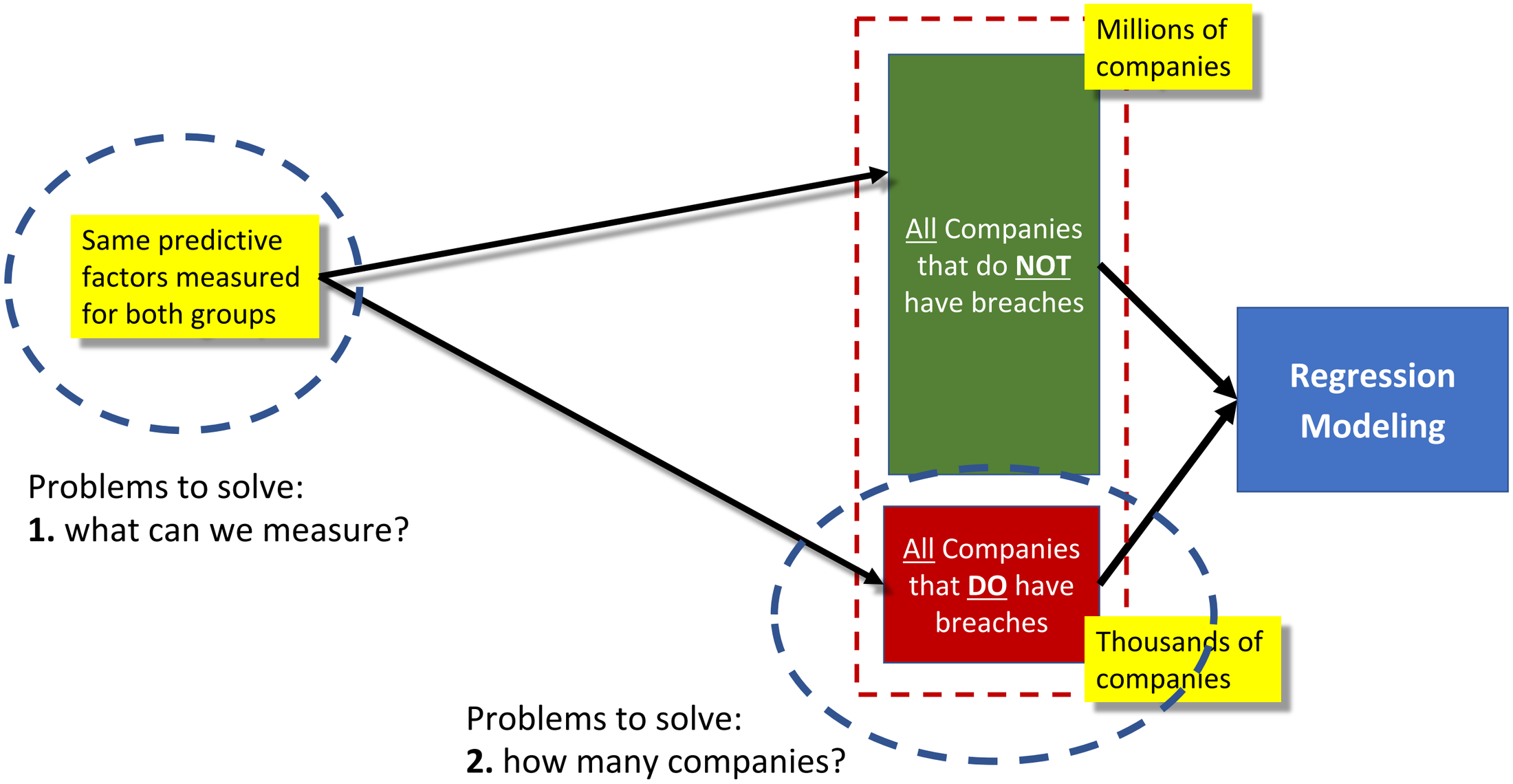
Finding the differences between all companies that did and did not experience data breach

Types of PII Data Breaches

Incident	Description	Examples
Malicious Outsider	Any attack by someone unknown to the company, that exposes PII data	• Phishing attack • Entry through an unpatched vulnerability in DMZ • Malware
Malicious Insider	Any PII theft by someone known to the company, including employees, ex-employees and vendors	• Unauthorized data access • PII theft by employee exiting company • PII theft from a call center
Accident	Any kind of accident within the company, or by company vendors, that exposes PII data	• Email/mail PII data to wrong person or company • Placing SSN on an envelope • Deploy new software that allows unauthorized access • Failing to erase the disk of a discarded computer
Lost or Stolen	Any kind of lost or stolen device that exposes PII data	• Laptop or thumb drive stolen from a car, house or offices • Magnetic tape that is lost in transit • Computer or backup drive lost track of in an office move • A misplaced thumb drive with PII data

How to predict data breach

Model all breach and all no-breach companies



Problems to solve:
1. what can we measure?

Problems to solve:
2. how many companies?

How we solved problem 2

How many data breaches are there?

Sources of Data Breaches

Company	State	Marylanc	Incident	Data	3rd Party
Ransom Memorial Hospital	KS	2	MO	PHI	No
HealthEquity, Inc. (attachec	UT	46	MO	PHI	Yes
Aflac	GA	78	MO	PHI	Yes
Jemison Internal Medicine,	AL	1	MO	PHI	No
Ohio Living	OH	1	MO	PHI	No
Flexible Benefit Service Co	IL	21	MO	PHI	No
Serene Sedation, LLC	MD	4327	MO	PHI	Yes
DecisionHR Holdings, Inc.	FL	2	MO	PHI	Yes
Michael Gruber, DMD, PA	NJ	14	MO	PHI	No
Arkansas Children's Hospit	AR				
Ebbs, Roberts, Head & Da	NM				
Cambridge Dental Consulti	NV				
Ruben U. Carvajal, MD	NY				
RISE Wisconsin, Inc	WI	2	MO	PHI	No
Dr. Robert Carpenter	TX	3	MO	PHI	No
SureFire, LLC	CA	39	MO	CHD	Yes
Capital Integration Systems	NY	181	MO	PFI	No
The Coca-Cola Company	GA	14	MO	PFI	No
Stein Eriksen Lodge Hotel	UT	5	MO	PII	No
Authentic Recovery, LLC	CA	3	MO	PHI	No
Securus Technologies, Inc.	TX	25	MO	PII	No
The Childrens Mercy Hospi	MO	6	MO	PHI	No

Companies with headquarters Across all 50 states

OSH

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ion Security Breach Not

ains consumer records is required by Maryland law to
on is compromised. The "security breach law" also re
age contains links to all notices sent to the OAG s
the notice, business name, how many people are

No of MD Residents	Information Breached	
3	name, ssn, dln, bank accour	
3	name, Social Security numb drivers license number and information	
675	name, ssn, dln, passport number, tax payer ID, payment card info, bank account info	unauthorized access to employee email accounts

MULLEN COUGHLIN LLC
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1275 Drummers Lane, Suite 302
Wayne, PA 19087

August 31, 2018

VIA E-MAIL & U.S. MAIL

Office of the Attorney General
Attn: Security Breach Notification
200 St. Paul Place
Baltimore, MD 21202
E-Mail: idtheft@oag.state.md.us

Re: Notice of Data Security Incident

Dear Attorney General Healey:

We represent Movement Mortgage LLC ("Movement"), 8024 Calvin Hall Road, Indian Land, SC 29707, and are writing to notify you of a recent incident that may affect the security of the personal information of six hundred and seventy-five (675) Maryland residents. Movement's response to this incident is ongoing, and this notice will be supplemented with any new significant facts learned subsequent to its submission. By providing this notice, Movement does not waive any rights or defenses regarding the applicability of Maryland law, the applicability of the Maryland data incident notification statute, or personal jurisdiction.

Nature of the Data Security Incident

Earlier this year Movement discovered that several employee email accounts were sending phishing emails. Movement quickly launched an investigation, with the assistance of a third party forensic investigator, to understand the nature and scope of the event and determine whether any sensitive data was at risk. The forensic investigator confirmed that numerous employee email accounts were subject to unauthorized access between October 9, 2017 and March 29, 2018. A

Maryland Data Breaches can be Accurately Predicted

State	Breaches Reported to Maryland		GDP	Maryland
	Observed	Predicted		
AK	5	-3	51,479	4,273
AL	10	8	211,196	780
AR	3	4	122,704	1,050
AZ	7	9	326,446	2,277
CA	99	97	2,797,601	2,625
CO	15	10	345,233	1,663
CT	8	13	264,510	253
DC	17	12	72,461	38
DE	4	13	135,768	74
FL	32	35	976,386	744
GA	23	21	563,608	664
IA	5	6	183,930	1,020
ID	4	-1	72,294	2,379
IL	45	30	822,540	702
IN	15	14	352,273	579
KS	9	4	159,108	1,254
KY	5	8	202,175	610
LA	2	8	235,960	1,126
MA	21	22	542,979	412
MD	67	65	399,538	0
MI	11	19	508,905	628
MN	13	12	350,179	1,109
MO	9	10	303,763	1,060

State	Breaches Reported to Maryland		GDP	Maryland
	Observed	Predicted		
MS	2	3	109,375	1,018
MT	3	-1	47,079	1,947
NC	22	21	540,497	437
NE	3	3	119,588	1,153
NJ	27	26	602,069	179
NM	1	1	94,211	1,861
NV	1	2	158,302	2,408
NY	58	62	1,606,601	188
OH	28	25	645,747	413
OK	3	5	188,632	1,319
OR	10	4	227,155	2,808
PA	40	34	756,269	101
RI	4	5	59,306	372
SC	7	9	221,690	570
TN	15	13	349,569	703
TX	55	57	1,645,136	1,416
UT	9	3	164,917	2,086
VA	30	24	510,586	147
VT	2	3	32,545	478
WA	7	15	524,323	2,764
WI	13	12	321,373	789
WV	2	5	74,047	365

Total US Data Breaches can now be Accurately Predicted

State	Breaches Reported to Maryland		GDP	Distance to Maryland
	Observed	Predicted		
AK	5	52	51,479	0
AL	10	58	211,196	0
AR	3	55	122,704	0
AZ	7	62	326,446	0
CA	99	151	2,797,601	0
CO	15	63	345,233	0
CT	8	60	264,510	0
DC	17	53	72,461	0
DE	4	55	135,768	0
FL	32	86	976,386	0
GA	23	71	563,608	0
IA	5	57	183,930	0
ID	4	53	72,294	0
IL	45	80	822,540	0
IN	15	63	352,273	0
KS	9	56	159,108	0
KY	5	58	202,175	0
LA	2	59	235,96	
MA	21	70	542,97	
MD	67	65	399,53	
MI	11	69	508,90	
MN	13	63	350,179	0
MO	9	61	303,763	0

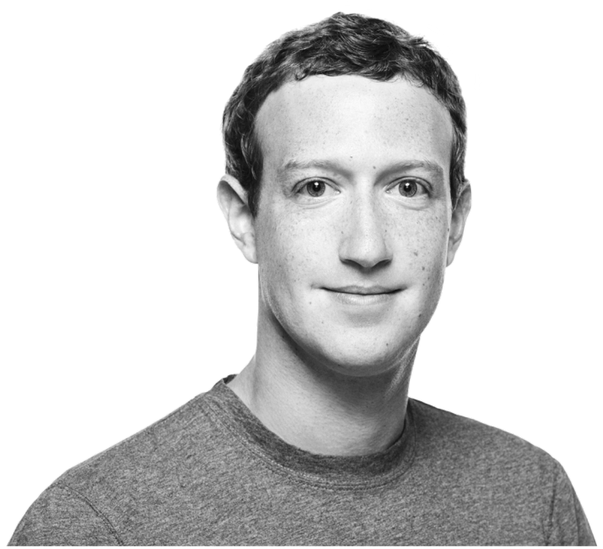
State	Breaches Reported to Maryland		GDP	Distance to Maryland
	Observed	Predicted		
MS	[illegible]	55	109,375	0
MT	[illegible]	[illegible]	47,079	0
NC	22	70	540,497	0
NE	3	55	119,588	0
NJ	27	72	602,069	0
NM	1	54	94,211	0
NV	1	56	158,302	0
NY	58	108	1,606,601	0
OH	28	74	645,747	0
OK	3	57	188,632	0
OR	10	59	227,155	0
PA	40	78	756,269	0
RI	4	53	59,306	0
SC	7	59	221,690	0
TN	15	63	349,569	0
TX	55	110	1,645,136	0
UT	9	57	164,917	0
			510,586	0
			32,545	0
			524,323	0
			321,373	0
WV	2	53	74,047	0

Set distance to zero

Forecast total breaches for state

Total breaches: 2957

Reported to Maryland: 771



Poll 1

If Russia required reporting of PII data breaches, would you expect:

A. A similar number of data breaches as California, because Russia develops a lot of high technology

B. A similar number of data breaches as Texas because both Russia and Texas have oil economies

C. A similar number of data breaches as Texas because Texas GDP is $1.6T and Russia GDP was $1.7T

The Answer is C: Russia and Texas have similar GDP

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	Observed	Predicted		
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Technology

Agriculture

State	Breaches Reported to Maryland		GDP	Distance to Maryland
	Observed	Predicted		
MS	2	3	109,375	1,018
MT	3	-1	47,079	1,947
NC	22	21	540,497	437
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WV	2	5	74,047	365

Oil

The Model

Headcounts can predict data breach

Predictors

Headcount	Description
CISA/IT	**Audit** (3rd-line) Certified Information Systems Auditor
CISSP/IT	**Technical** (2nd-line) Certified Information Systems Security Professional
MCSA/IT	**Vendor** (1st-line) Microsoft Certified Solutions Associate
Employees	Total employees

AUDITOR

People side of cybersecurity

Technical side of cybersecurity

Vendor side of cybersecurity
(consider also AWS, CISCO, etc.)

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Predictors

Headcount	Description		Effect	
			Small Breach	**Large Breach**
CISA/IT	**Audit** (3rd-line) Certified Information Systems Auditor	**Decrease** Probability (decreased risk)	Strong but Saturates	Very strong, does **NOT** saturate
CISSP/IT	**Technical** (2nd-line) Certified Information Systems Security Professional		Strong but Saturates	Very strong, does **NOT** saturate
MCSA/IT	**Vendor** (1st-line) Microsoft Certified Solutions Associate		Modest and saturates	
Employees	Total employees	**Increase** Probability (increased risk)	Moderate	Moderate

Predictors

Headcount	Description		Effect	
			Small Breach	**Large Breach**
CISA/IT	**Audit** (3rd-line) Certified Information Systems Auditor	**Decrease** Probability (decreased risk)	Strong but, diminishing return	Very strong, **no** diminishing return
CISSP/IT	**Technical** (2nd-line) Certified Information Systems Security Professional		Strong but, diminishing return	Very strong, **no** diminishing return
MCSA/IT	**Vendor** (1st-line) Microsoft Certified Solutions Associate		Modest and diminishing return	Weak
Employees	Total employees	**Increase** Probability (increased risk)	Moderate	Moderate

Equal Effectiveness

Predictors

Other observations

- RHCE (Red Hat Certified Engineer) a Linux certification increases probability for data breach and is also in the model.
- Many other certifications were tried and found to be predictive by themselves, but did not increase the accuracy when combined with CISSP.
- Counting employees with certifications was better than simply a count of people in cybersecurity.

An analogy: predicting family size

Family Size

We might find the amount of milk is a predictor

This is like the CISSP

Perhaps this is measuring older children

We might find cereal is also.

But adding cereal with milk does **not improve accuracy**

This is like other certs – important but don't improve accuracy

This is like CISA, measuring something different from CISSP

We might find diapers is also a good predictor.

Adding diapers with milk **is more accurate**

Perhaps this is capturing children **not yet drinking milk**

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An analogy: predicting family size

Best (most accurate) model

Note: there are lots of other things in the cart too! These other things are needed for a healthy family.

But all we need to measure is the milk and diapers.

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An analogy: predicting family size

Best (most accurate) model

Many other things in the cart too!
Cybersecurity controls, effective processes and many other certifications

But all we must measure is CISSP, CISA

Reduced Breach Probability

CISSP

CISA

AUDITOR

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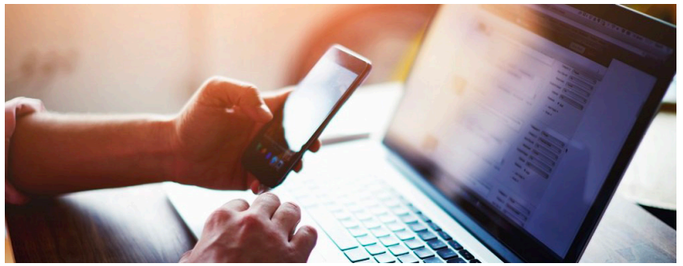
Certification-Handicapping

Predicting which company is best, without the direct use of the model

Take a picture of this with your phone



Measure	Decrease Probability (Decrease Risk)	
	Small Breach	Large Breach
CISA/IT	Strongly	Very Strongly
CISSP/IT	Strongly	Very Strongly
MCSA/IT	Moderate	Weak

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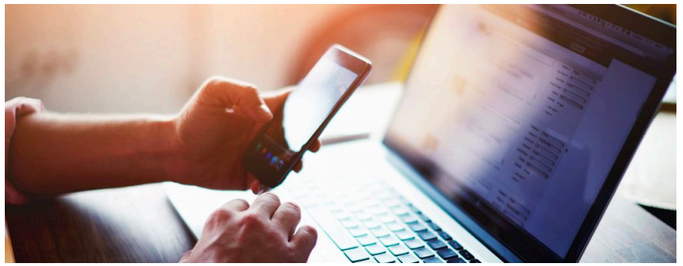
Take a picture of this with your phone



Measure	Increase Probability (Increase Risk)	
	Small Breach	Large Breach
Employees	Moderate	Moderate
RHCE/IT	Modest	Weak

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Poll 2: According to the model, which has the lowest probability for a data breach?

Note: all of these banks are very good!

A

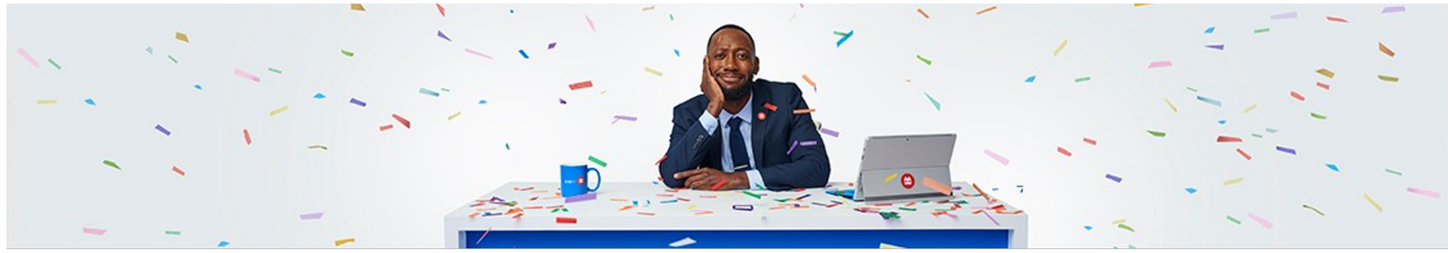
Headcount	Measure
82K	Employees
22	RHCE
204	CISSP
181	CISA
90	MCSA
7.5K	IT

B

Headcount	Measure
89K	Employees
20	RHCE
333	CISSP
275	CISA
95	MCSA
7.5K	IT

C

Headcount	Measure
49K	Employees
21	RHCE
181	CISSP
157	CISA
74	MCSA
4.5K	IT



The answer is: BMO (C)

Breach sizes

Annual probabilities

Years between breaches

A

Headcount	Measure
82K	Employees
22	RHCE
204	CISSP
181	CISA
90	MCSA
7.5K	IT

	1+	10+	100+	1K+	10K+				100M+
Probability	26%	26%	25%	20%	8.2%	3.0%	0.84%	0.075%	0.011%
Years	3.8	3.8	4.0	5.0	12	33	119	1333	9091

B

Headcount	Measure
89K	Employees
20	RHCE
333	CISSP
275	CISA
95	MCSA
7.5K	IT

	1+	10+	100+	1K+	10K+	100K+	1M+	10M+	100M+
Probability	22%	22%	20%	15%	4.5%	1.4%	0.30%	0.019%	0.0022%
Years	4.5	4.5	5.0	6.7	22	71	333	5263	45455

C

Headcount	Measure
49K	Employees
21	RHCE
181	CISSP
157	CISA
74	MCSA
4.5K	IT

	1+	10+	100+	1K+	10K+	100K+	1M+	10M+	100M+
Probability	12%	12%	12%	8.3%	2.7%	0.83%	0.19%	0.012%	0.0015%
Years	8.3	8.3	8.3	12	37	120	526	8333	66667

The answer is: BMO (C)

Large companies have small data breaches

A

Headcount	Measure
82K	Employees
22	RHCE
204	CISSP
181	CISA
90	MCSA
7.5K	IT

	1+	10+	100+	1K+	10K+	100K+	1M+	10M+	100M+
Probability	26%	26%	25%	20%	8.2%	3.0%	0.84%	0.075%	0.011%
Years	3.8	3.8	4.0	5.0	12	33	119	1333	9091

B

Headcount	Measure
89K	Employees
20	RHCE
333	CISSP
275	CISA
95	MCSA
7.5K	IT

	1+	10+	100+	1K+	10K+	100K+	1M+	10M+	100M+
Probability	22%	22%	20%	15%	4.5%	1.4%	0.30%	0.019%	0.0022%
Years	4.5	4.5	5.0	6.7	22	71	333	5263	45455

Smaller companies can more easily control small breaches

C

Headcount	Measure
49K	Employees
21	RHCE
181	CISSP
157	CISA
74	MCSA
4.5K	IT

	1+	10+	100+	1K+	10K+	100K+	1M+	10M+	100M+
Probability	12%	12%	12%	8.3%	2.7%	0.83%	0.19%	0.012%	0.0015%
Years	8.3	8.3	8.3	12	37	120	526	8333	66667

The answer is: BMO (C)

Probability for large data breach is very sensitive to CISSP and CISA and there is no diminishing return.

A

Headcount	Measure
82K	Employees
22	RHCE
204	CISSP
181	CISA
90	MCSA
7.5K	IT

	1+	10+	100+	1K+	10K+	100K+	1M+	10M+	100M+
						3.0%	0.84%	0.075%	0.011%
						33	119	1333	9091

B

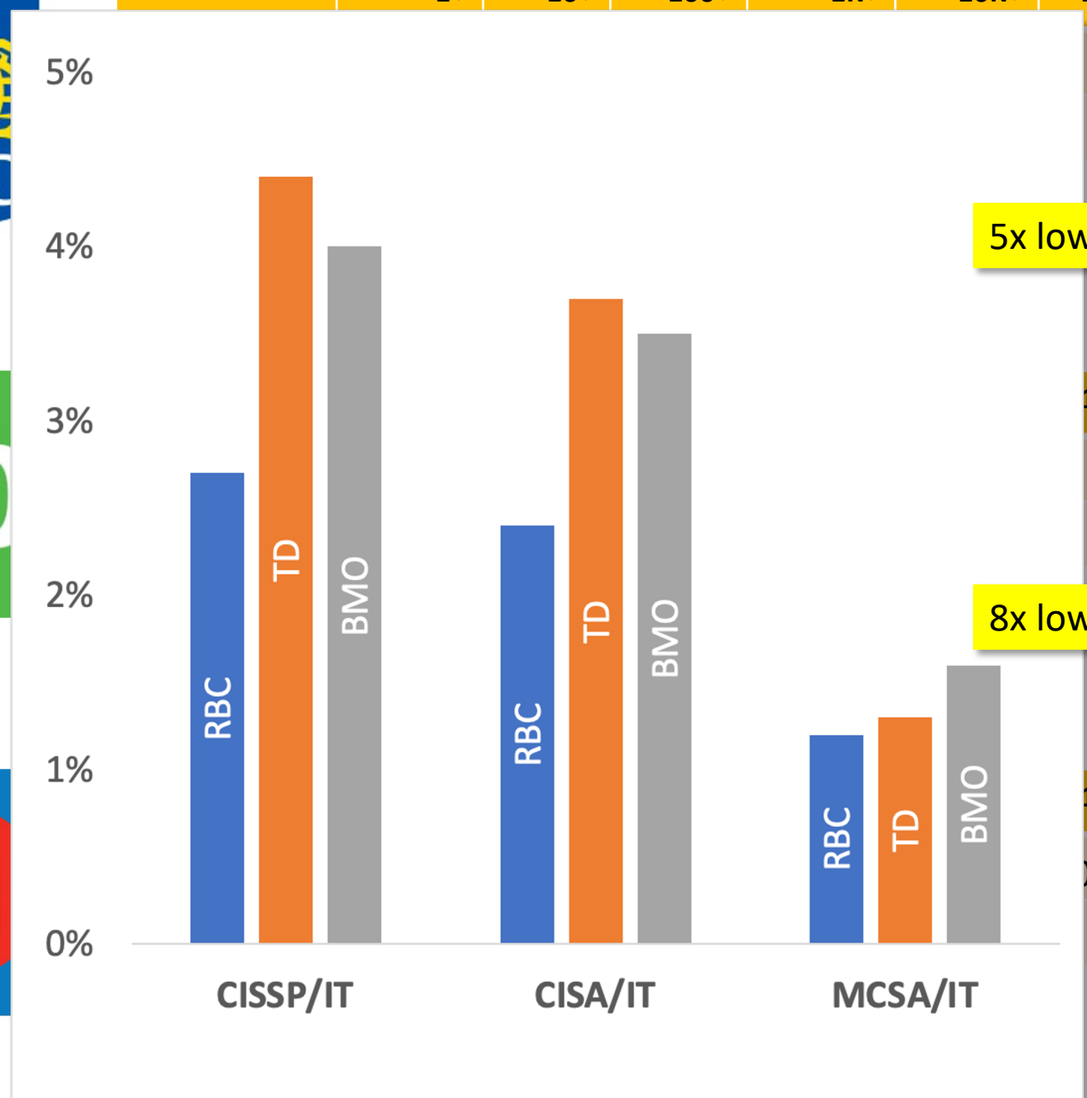
Headcount	Measure
89K	Employees
20	RHCE
333	CISSP
275	CISA
95	MCSA
7.5K	IT

100K+	1M+	10M+	100M+
1.4%	0.30%	0.019%	0.0022%
71	333	5263	45455

C

Headcount	Measure
49K	Employees
21	RHCE
181	CISSP
157	CISA
74	MCSA
4.5K	IT

100K+	1M+	10M+	100M+
.83%	0.19%	0.012%	0.0015%
120	526	8333	66667



5x lower probability

8x lower probability

Poll 3: According to the model, which has the lowest probability for a data breach?

A

Headcount	Measure
50,148	Employees
3	RHCE
17	CISSP
10	CISA
6	MCSA
817	IT

B

Headcount	Measure
34,701	Employees
0	RHCE
6	CISSP
1	CISA
3	MCSA
784	IT

The answer is: AutoZone (A)

Large companies have small data breaches.
There is diminishing return with CISSP & CISA

A

Headcount	Measure
50,148	Employees
3	RHCE
17	CISSP
10	CISA
6	MCSA
817	IT

AutoZone

	1+	10+	100+	1K+	10K+	100K+	1M+	10M+	100M+
Probability	23%	23%	23%	20%	9.3%	3.9%	1.2%	0.13%	0.023%
Years	4	4	4	5	11	26	81	742	4350

B

Headcount	Measure
34,701	Employees
0	RHCE
6	CISSP
1	CISA
3	MCSA
784	IT

O'Reilly AUTO PARTS
PROFESSIONAL PARTS PEOPLE

	1+	10+	100+	1K+	10K+	100K+	1M+	10M+	100M+
Probability	33%	33%	33%	30%	17%	8.2%	3.1%	0.44%	0.089%
Years	3	3	3	3	6	12	33	229	1127

The answer is: AutoZone (A)

Probability for large data breach is very sensitive to CISSP/IT and CISA/IT and there is no diminishing return.

A

Headcount	Measure
50,148	Employees
3	RHCE
17	CISSP
10	CISA
6	MCSA
817	IT

B

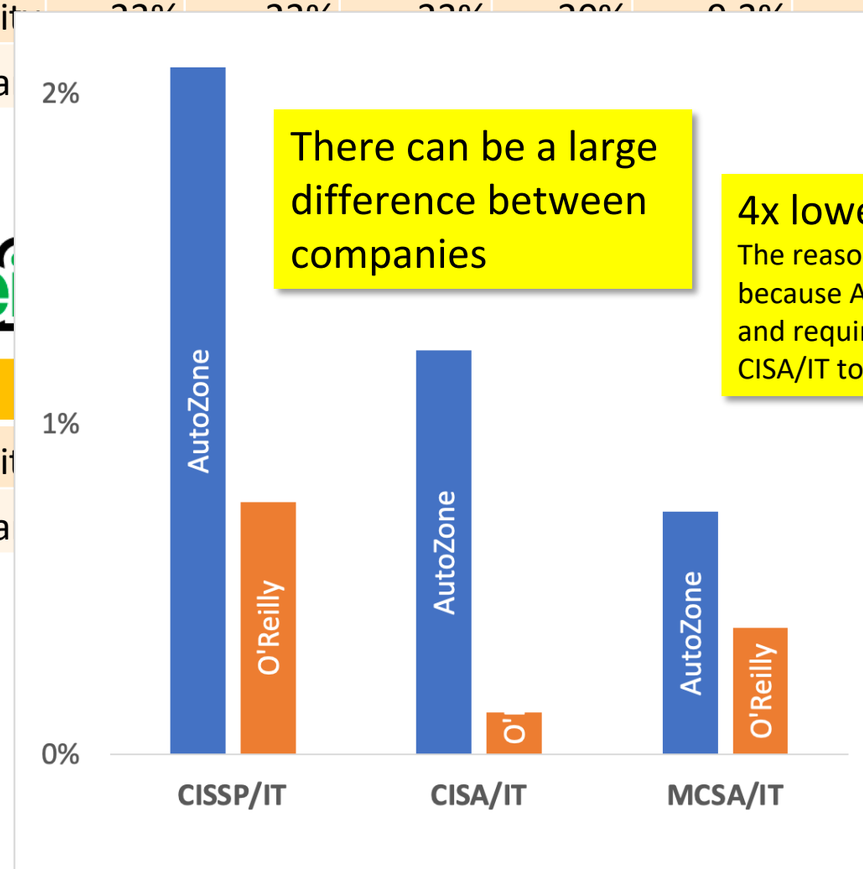
Headcount	Measure
34,701	Employees
0	RHCE
6	CISSP
1	CISA
3	MCSA
784	IT

AutoZone

	1+	10+	100+	1K+	10K+	100K+	1M+	10M+	100M+
Probabilit	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.9%	1.2%	0.13%	0.023%
Yea	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	26	81	742	4350

O'Rei

									10M+	100M+
Probabili	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8.2%	3.1%	0.44%	0.089%
Yea	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12	33	229	1127



There can be a large difference between companies

4x lower probability

The reason it is not more is because AutoZone is 1.5x bigger and requires a larger CISSP/IT & CISA/IT to offset its size.

MODEL RISK

The risk from using a model to make business decisions

There are standards

Office of the Superintendent of Financial Institutions Canada | Bureau du surintendant des institutions financières Canada

Guideline

Subject: **Enterprise-Wide Model Risk Management for Deposit-Taking Institutions**

Category: **Sound Business and Financial Practices**

No: **E-23** **Date: September 2017**

This Guideline outlines OSFI's expectations around institutions' establishment of sound policies and practices for an enterprise-wide model risk management framework. It applies to banks, bank holding companies, federally regulated trust and loan companies and cooperative retail associations, and collectively referred to as 'institutions'.

BOARD OF GOVERNORS

OF THE

FEDERAL RESERVE SYSTEM

WASHINGTON, D.C. 20551

DIVISION OF BANKING SUPERVISION AND REGULATION

SR 11-7

April 4, 2011

TO THE OFFICER IN CHARGE OF SUPERVISION AT EACH FEDERAL RESERVE BANK

SUBJECT: Guidance on Model Risk Management

The Federal Reserve and Office of the Comptroller of the Currency (OCC) are issuing the attached *Supervisory Guidance on Model Risk Management*, which is intended for use by banking organizations and supervisors as they assess organizations' management of model risk. This guidance should be applied as appropriate to all banking organizations supervised by the Federal Reserve, taking into account each organization's size, nature, and complexity, as well as the extent and sophistication of its use of models (as defined and discussed below).

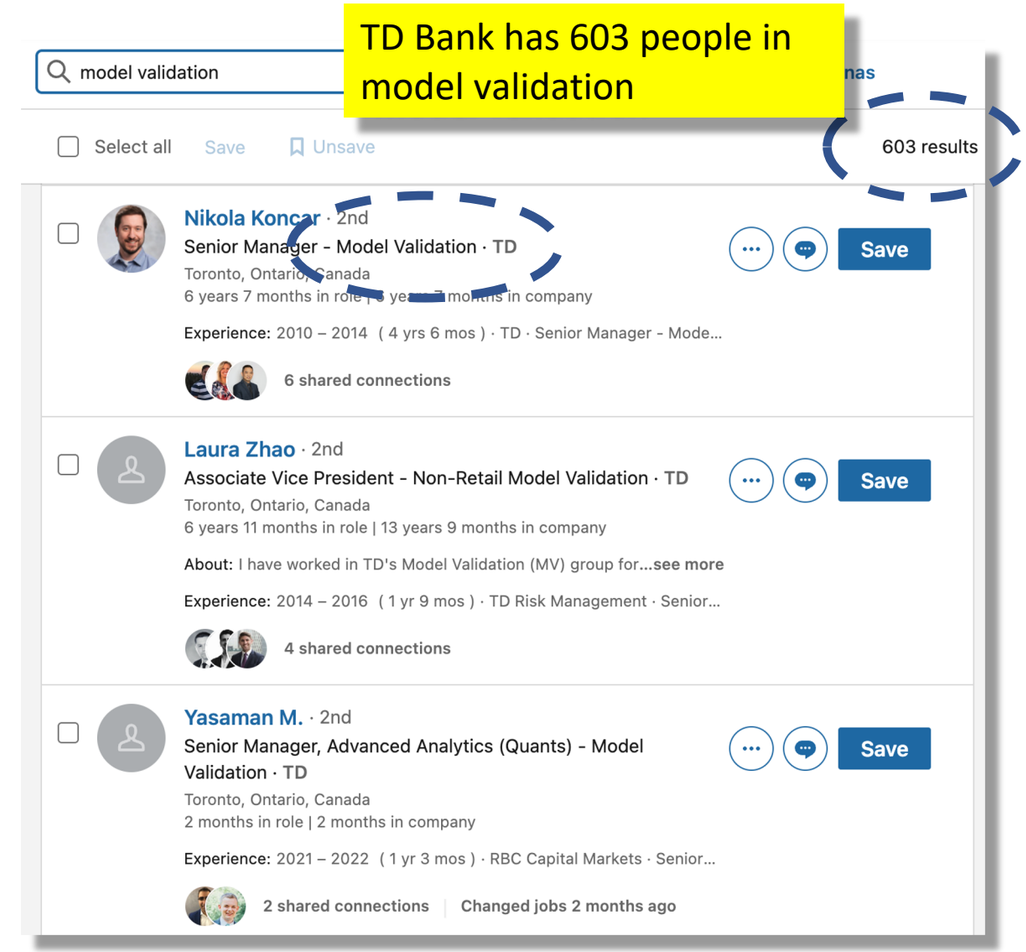
Two ways to test

During model development

- Jackknife
- Benchmarking
- lift chart

A larger bank will have a model validation team to evaluate this before a model can be used.

TD Bank has 603 people in model validation



After development

- Back testing: apply to vendors and compare forecast with data breach history

Note: that data breaches are rare events. A forecasting model cannot be test on a single company.

Back Testing

Cumulative forecast matches the past

About 20 data breaches in 10 years:
2 per year

~50 vendors

Company and Threats	Sum	Annual Probability by Breach Size									Breaches
Company		1	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000	Year(breaches)
Anthem Blue Cross and Blue Shield		14.032%	13.937%	12.955%	9.633%	5.205%	2.014%	0.52341%	0.09409%	0.01471%	2017(2) 2015(2) 2014(1) 2013(4)
Amazon Web Services		21.997%	21.563%	18.326%	10.872%	4.306%	1.178%	0.20601%	0.02392%	0.00257%	2019(1)
Microsoft		32.687%	32.364%	29.356%	20.404%	9.997%	3.457%	0.78969%	0.12313%	0.01702%	2015(1) 2014(1) 2013(1)
Linkedin Corporation		12.569%	12.481%	11.584%	8.575%	4.602%	1.767%	0.45509%	0.08100%	0.01255%	2016(1) 2013(1) 2012(1)
Best Buy		28.057%	27.911%	26.294%	20.349%	11.684%	4.856%	1.37165%	0.27023%	0.04573%	2018(1) 2011(1)
Comcast		42.554%	42.303%	39.607%	30.087%	16.788%	6.744%	1.83129%	0.34543%	0.05629%	2015(1) 2013(1) 2012(1) 2009(1)
		2	2	2	1.5	0.79	0.30	0.079	0.014	0.0023	

Forecasts **2 per year**

CISA is the low hanging fruit

Hiring more CISA is the most effective way to reduce data breaches

Predictors

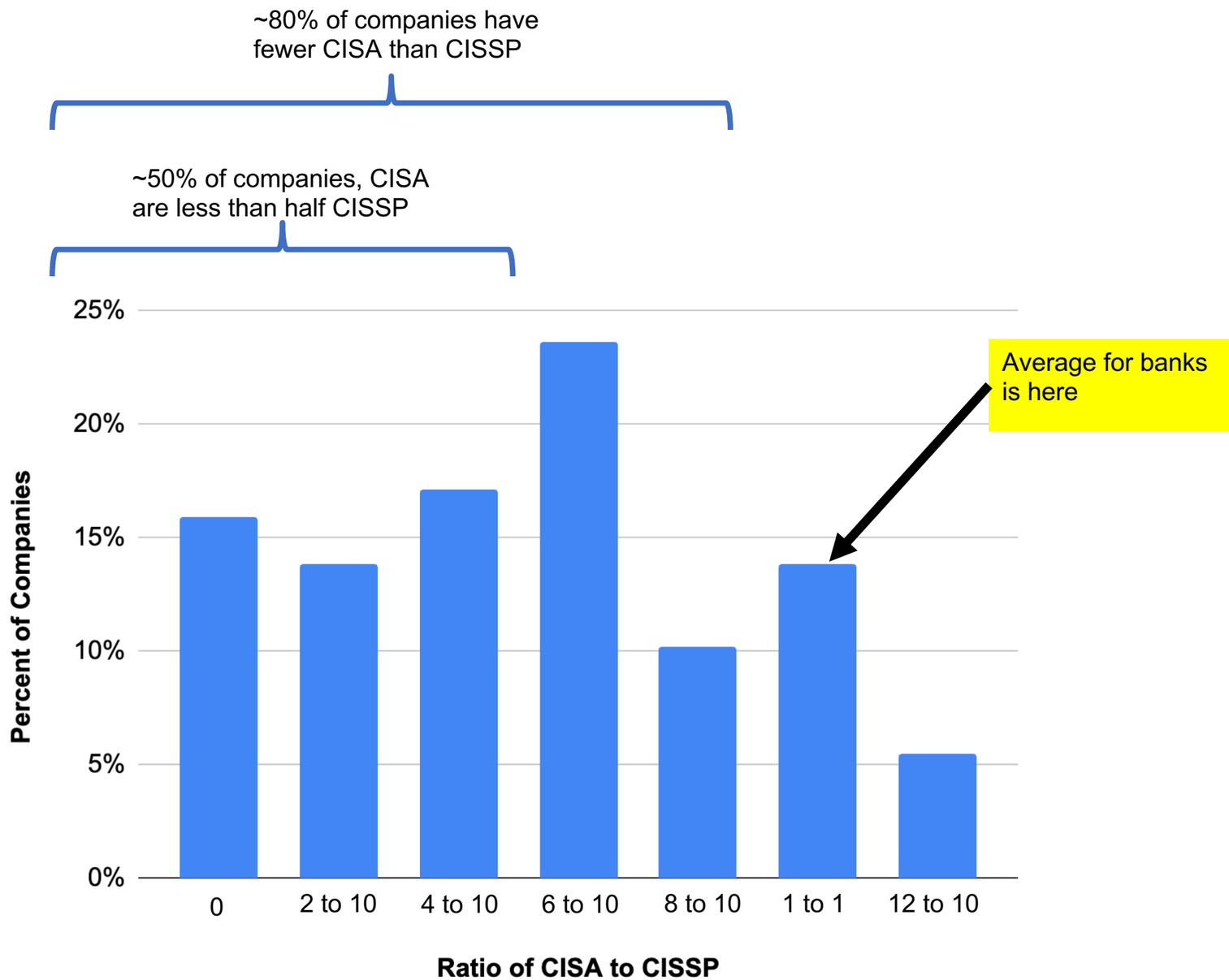
Headcount	Description		Effect	
			Small Breach	Large Breach
CISA/IT	**Audit** (3rd-line) Certified Information Systems Auditor	**Decrease** Probability (decreased risk)	Strong but, diminishing return	Very strong, **no** diminishing return
CISSP/IT	**Technical** (2nd-line) Certified Information Systems Security Professional		Strong but, diminishing return	Very strong, **no** diminishing return
MCSA/IT	**Vendor** (1st-line) Microsoft Certified Solutions Associate		Modest and diminishing return	Weak
Employees	Total employees	**Increase** Probability (increased risk)	Moderate	Moderate

2 Diminishing return

1 Equal Effectiveness

Ratio of 3rd-line of defense (CISA) to 2nd-line of defense (CISSP)

Analysis of 1,500 companies



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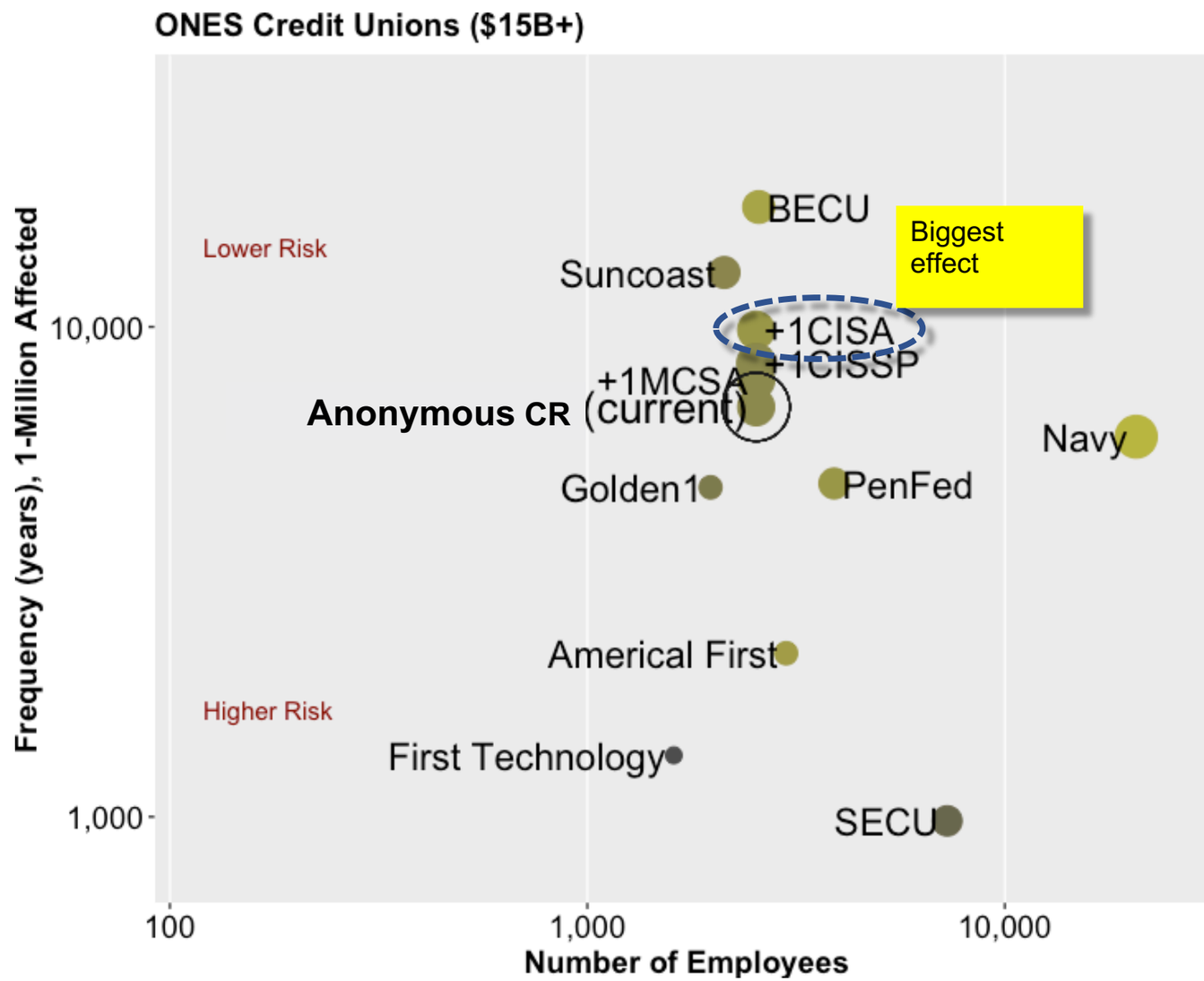
Sensitivity Analysis

Increasing CISA-headcount has the biggest effect

Anonymous CR Current headcount

Cert	Count
CISSP	8
CISA	2
MCSA	2

Diminishing returns reduces value of adding more CISSP compared with CISA



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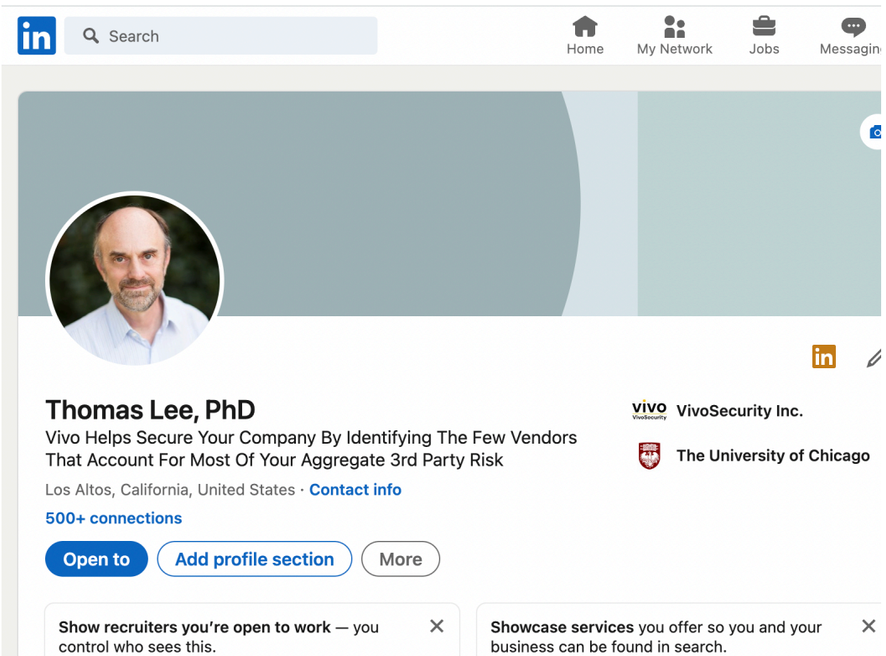
Linkup with me

Tell me how you interpret results from modeling



Send me an email

Tell me how you interpret results from modeling

ThomasL@VivoSecurity.com

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