TECHNISCHE UNIVERSITÄT DRESDEN

Cyber-Insurance Revisited

Workshop on the Economics of Information Security
Kennedy School of Government · Harvard University
03 June 2005

TECHNISCHE UNIVERSITÄT DRESDEN

Rainer Böhme
rainer.boehme@inf.tu-dresden.de

Department of Computer Science
Institute for System Architecture
01062 Dresden, Germany

Participation in this workshop was kindly supported by a stipend from the Institute for Information Infrastructure Protection.

Structure of the Talk

TECHNISCHE UNIVERSITÄT DRESDEN

1

Literature review
Why cyber-insurance is a good idea
to tackle IT security risks

Incentives · Market situation · Theories

2

Contribution of this paper
Explaining immature supply of cyber-insurance
with concentration in relevant equipment markets

Model · Results · Interpretation

Subjective rationality

Transfer of risk
Exchange of uncertain future costs to fixed expenses at present

Manageability
Constant liquidity prevents undue shortages and crises

Quantification
Premiums form a metric for the value (≠cost) of security strength

Substantial rationality

Incentives to innovate
More secure technologies pay off in lower premiums
Buzzword: Total cost of ownership

Incentives to implement
effective security measures in reasonable scope

Infosec R&D
Evaluation and code reviews, information sharing

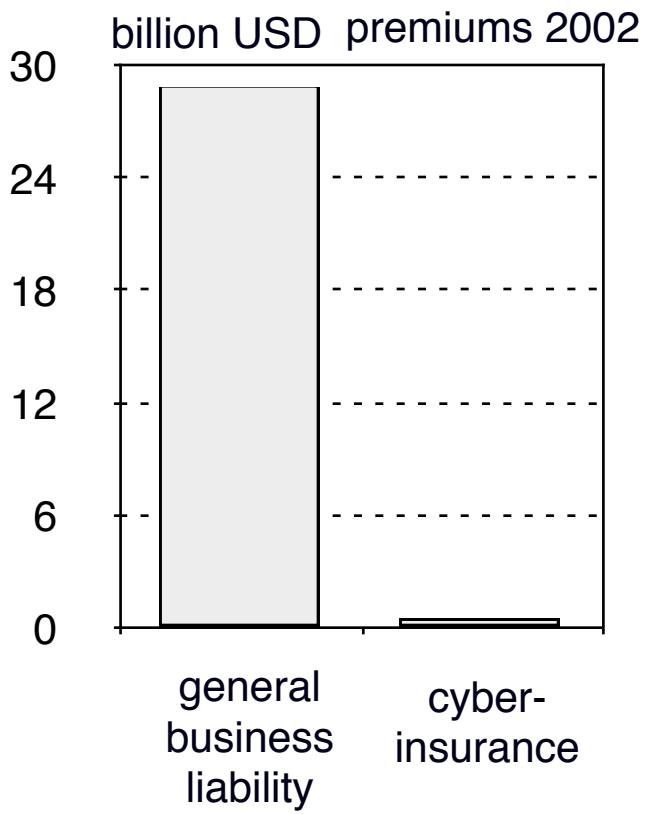
Ref.: Anderson 1994, Varian 2000, Kesan et al. 2004, Schneier 2004, a.o.

Immature Market for Cyber-Insurance

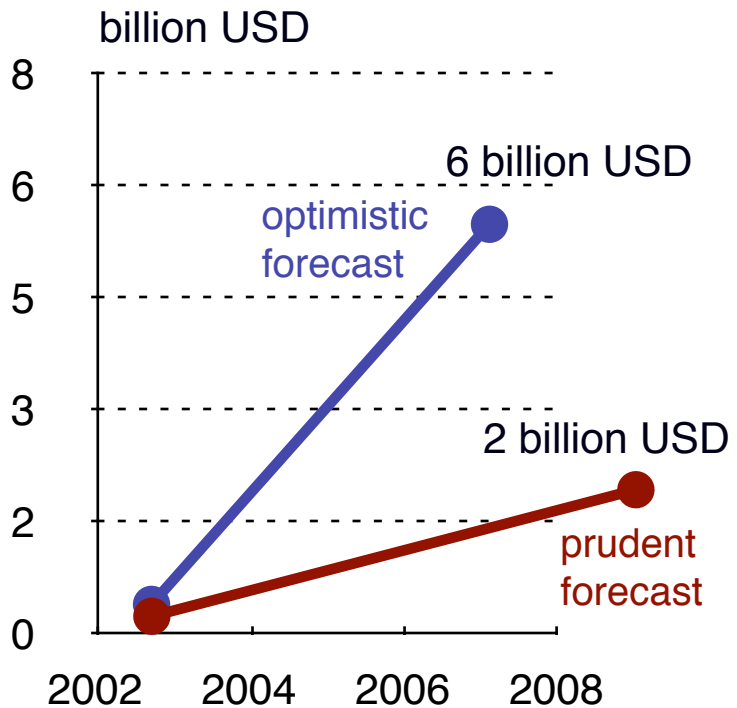
Share

Others: Chubb, Lloyds, St. Paul, Zurich, Hartford, Ace u.a.

Comparison



Forecast



Revenue 2002:
60–120 M USD

Worldwide losses 2003:
· about 13 billion USD (worms & viruses)
· about 226 billion USD (all attacks)

Sources: Cashell et al. (CRS) 2004, Panko 2003, Insurance Information Institute 2004, Conning & Co 2004

Thesis 1: **Liability unsolved**

- Losses occur nevertheless: instead of the originator, the aggrieved party could demand coverage

Thesis 2: **"New risks" lack actuarial data**

- Early satellite starts got coverage as well

Thesis 3: **High probability of loss**

- You can even insure warships at wartime

Thesis 4: **Difficulty to substantiate claims**

- Probably – can be interpreted as combination of residual juridical risk together with high transaction costs ...

Thesis 5: **Cyber-risks are accumulation risks**

- Market concentration causes correlation of claims

Ref.: Schneier 2004, Borch 1995, Knowledge@Wharton 2001 (via news.com), CSO Magazine 2002

Recall: Economic Causes for Monoculture

Network externalities

Utility of a system increases with its market share, i.e., with the number of users of compatible devices (Metcalfe's law)

Negligible marginal costs

Low costs for additional output (e.g., copy of a software CD) enables strategic pricing and fosters predatory competition

Dependencies in complementary markets

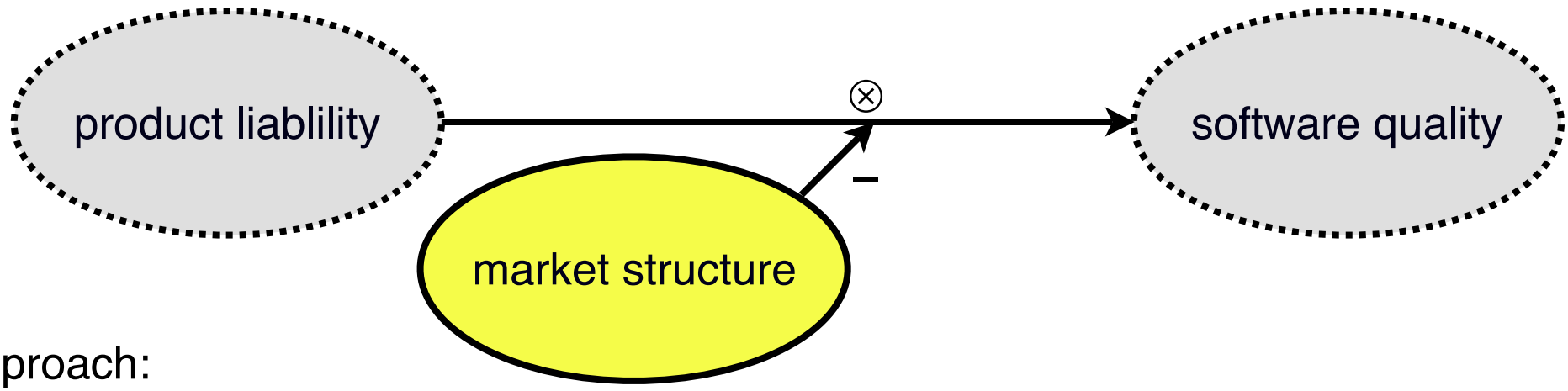
Third-party vendors of supplementary products first support the dominant platform and thus contribute to increase its attraction

Ref.: Shapiro & Varian 1999, Anderson 2001, a.o.

Links to relevant literature

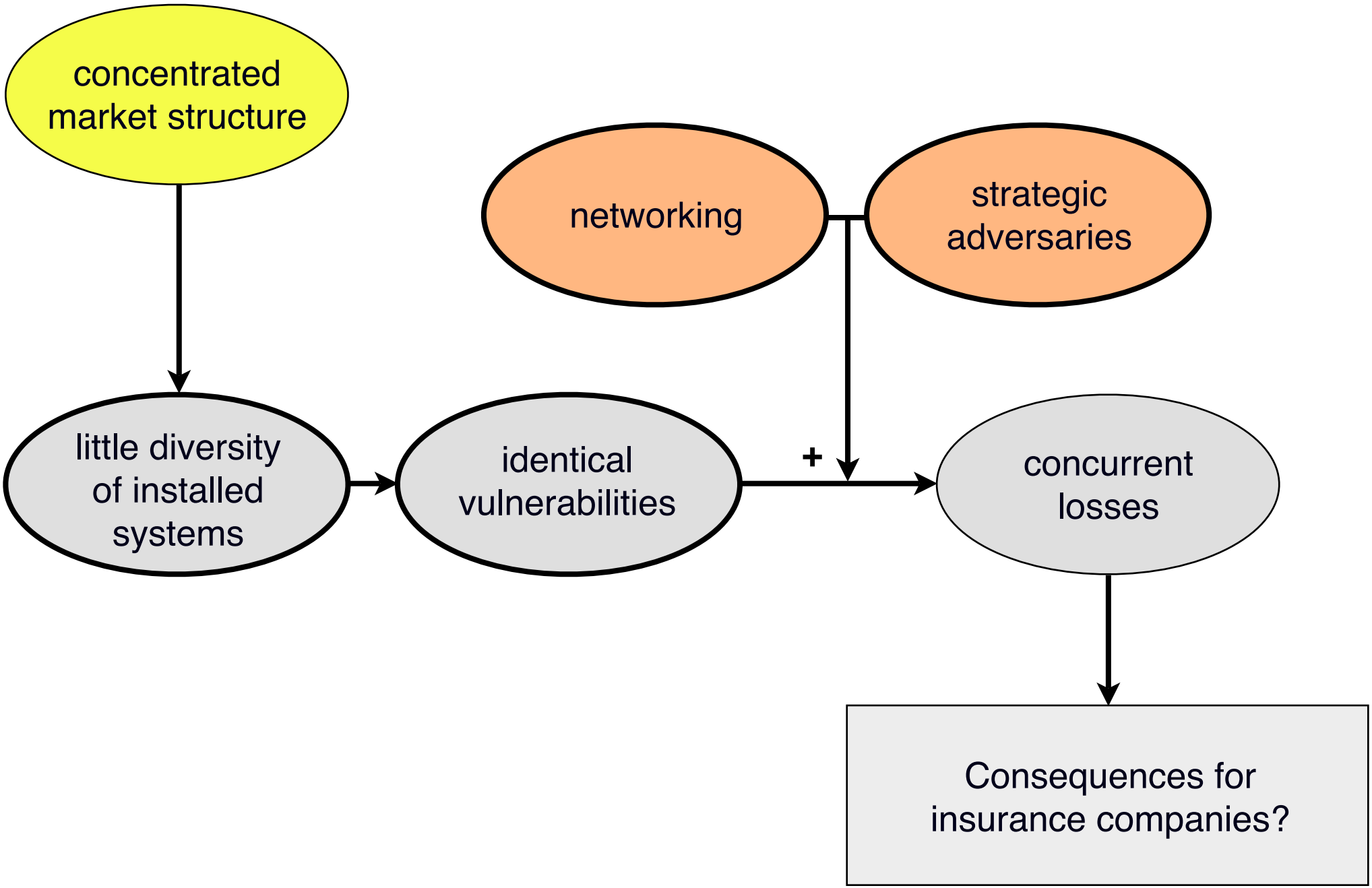
Varian 2000, Anderson 2001, and others

Kim, Chen & Mukhopadhyay, 2004 (WISE)



Our approach:

Implications of Market Structure

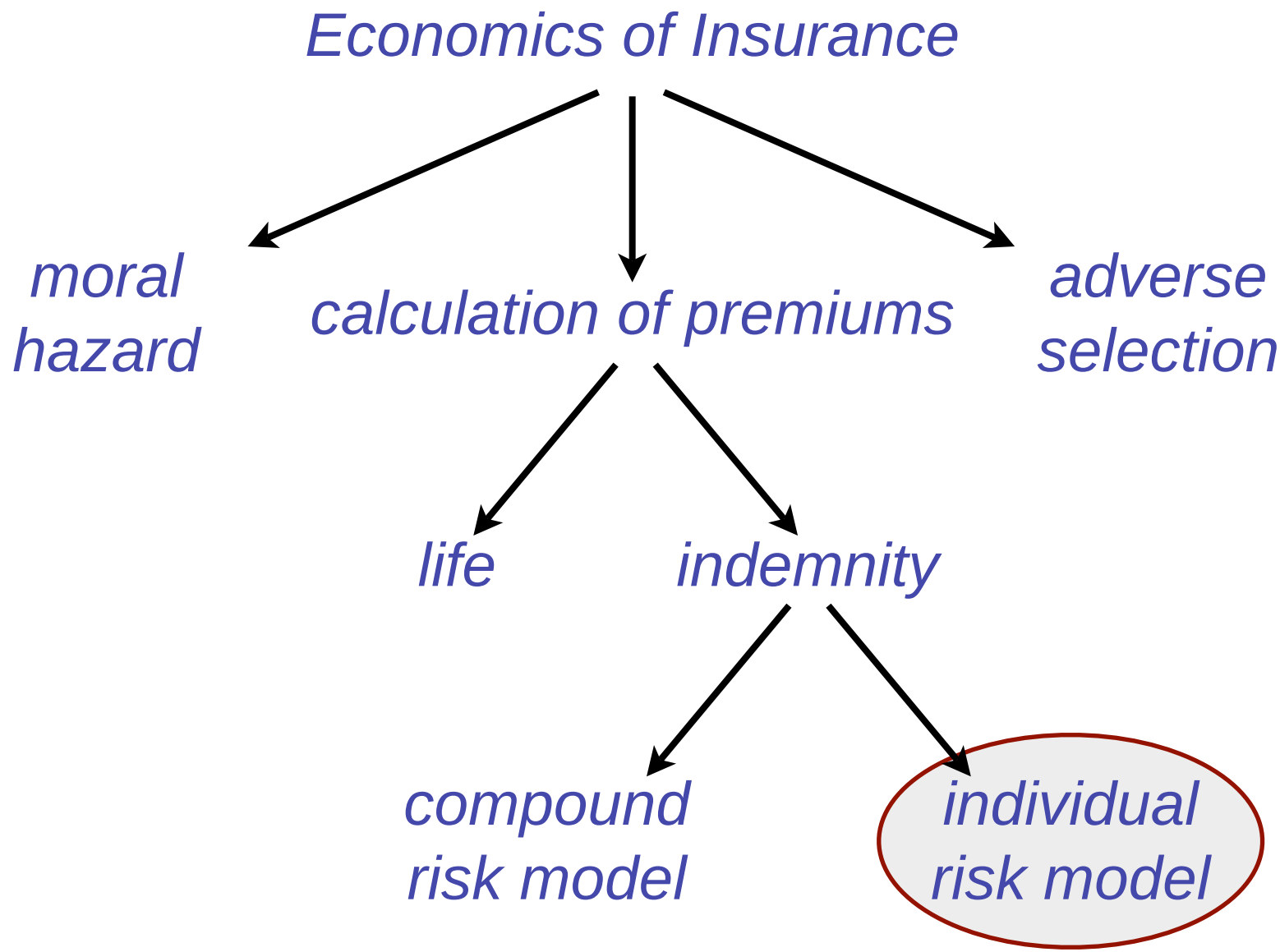


2

Explaining immature supply of cyber-insurance with concentration in equipment markets

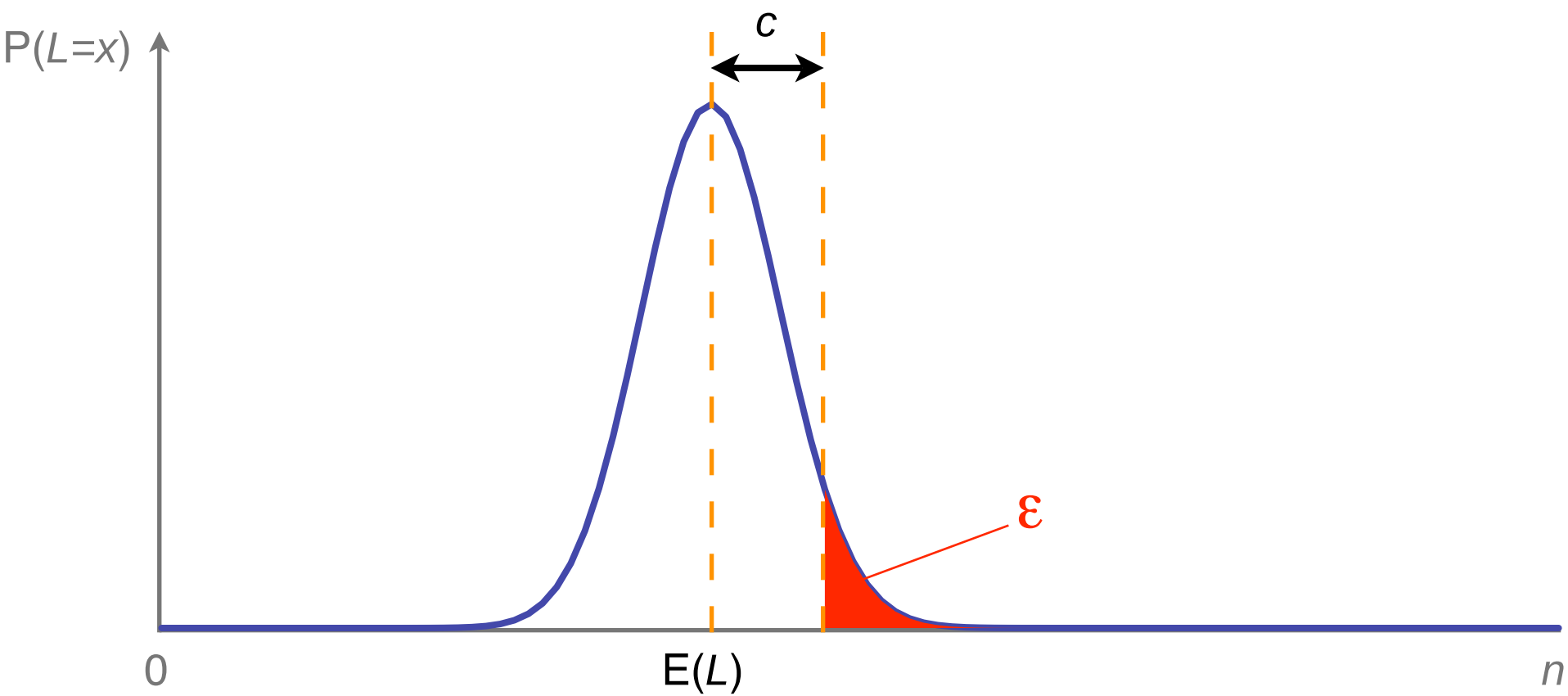
Model · Results · Interpretation

Structure of the Domain



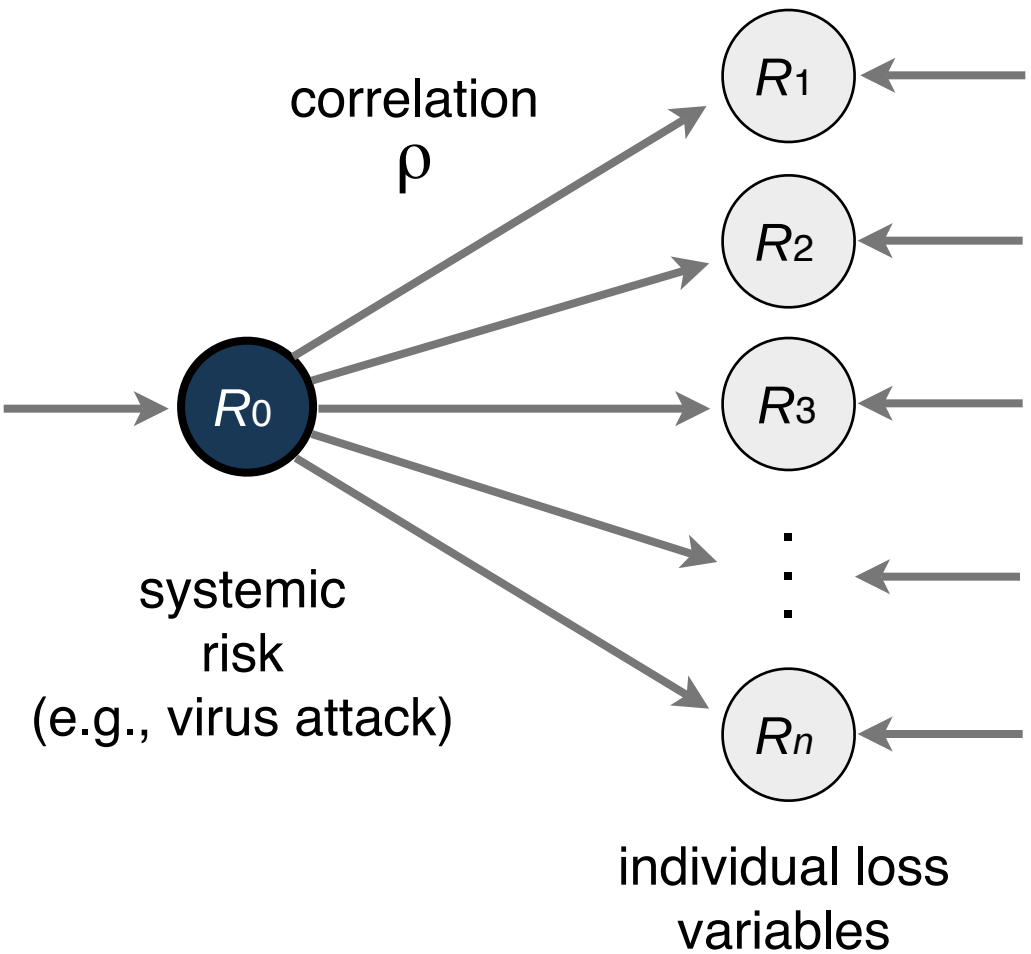
Supply-Side Model of General Indemnity Insurance

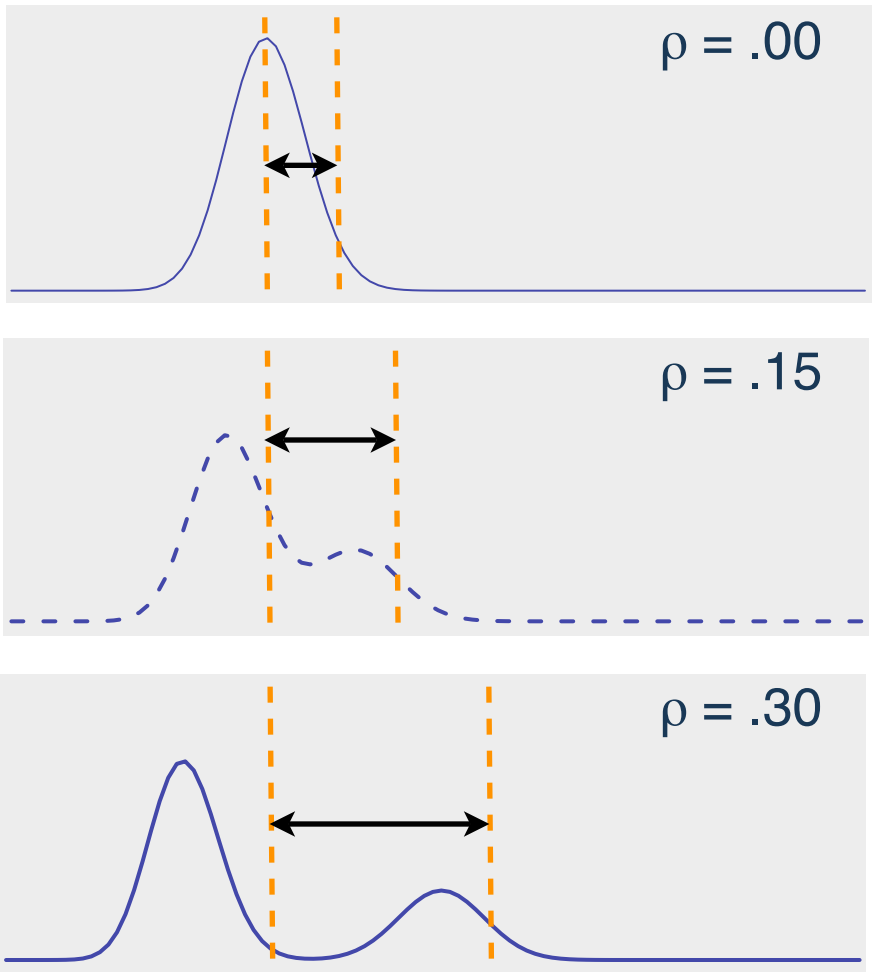
Portfolio of *n* independent Bernoulli-risks with probability of loss *p*.
Expected total claim amount E(*L*) follows a Binomial distribution **B**(*n*,*p*).



Premium must comprise additional safety loading to finance safety capital *c*, so that the probability of ruin of the insurance company keeps below a defined upper bound ε.

Single-Factor-Model





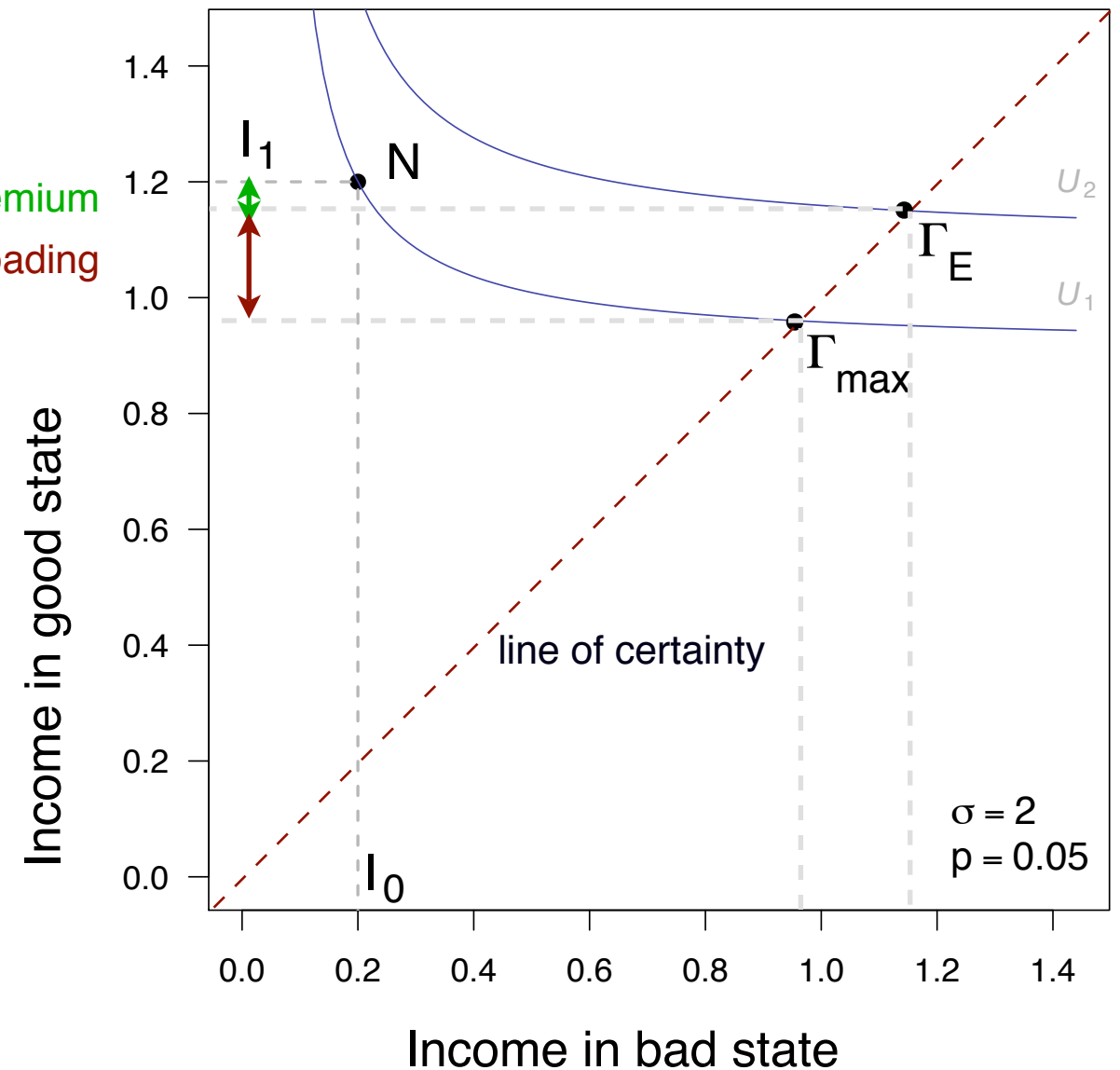
Total probability of loss $p = const$

Formulation as composition of two Binomial distributions depending on p, n, and ρ.

Two-State Model of Income

net premium

max. safety loading



Indifference curves according to CRRA utility function

Individuals prefer
· lower expected income
· under certainty
to
· higher expected income
· under uncertainty

Results 1: Insurability of "Monocultures"

TECHNISCHE UNIVERSITÄT DRESDEN

Upper bounds for correlation of claims ρ

		Risk aversion of insurance holder					
		moderate (σ=1)			strong (σ=3)		
Risk *p*	I_0 =	0.2	1.0	5.0	0.2	1.0	5.0
0.01		0.11	0.04	0.01	1.00	0.20	0.03
0.05		0.55	0.19	0.05	1.00	0.89	0.16
0.10		1.00	0.37	0.09	1.00	1.00	0.31
0.20		1.00	0.73	0.18	1.00	1.00	0.60

No problem
- Coverage for perils with high probability of loss
- High risk averse individuals

Problem
- "Small policies" against unlikely losses

These are the mass market products that could deliver liquidity and volume to form a mature market for cyber-insurance

Results 2: Advantage of Diversification

Comparison of two example platforms ...

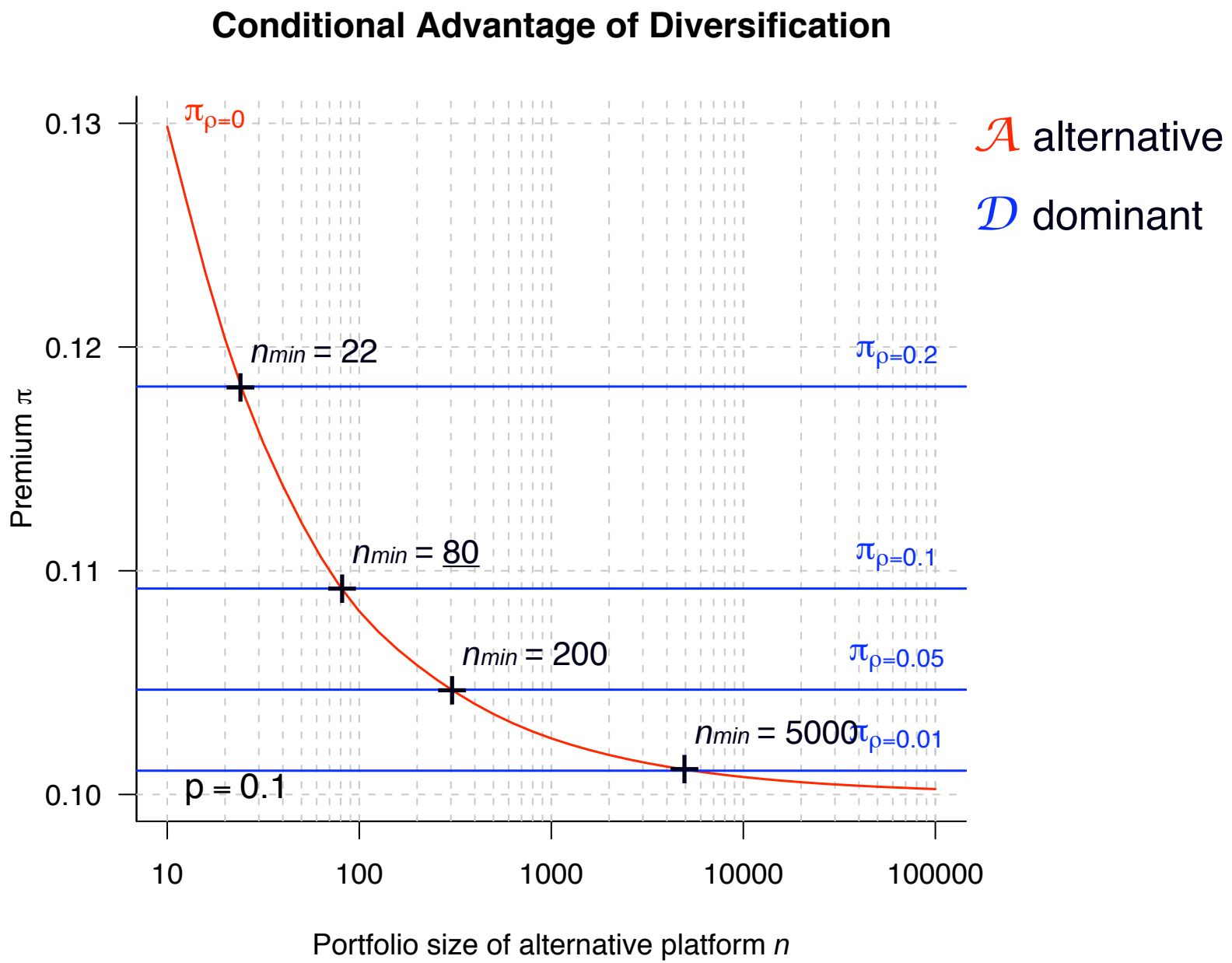
Dominant platform $\mathcal{D}$

- Total probability of loss p
- Large portfolio size $(n \to \infty)$
- Correlation of losses $\rho > 0$

Alternative platform $\mathcal{A}$

- Total probability of loss p
- Finite portfolio size n
- No correlation of losses (plausible for virus contagion)

Premiums for Dominant and Alternative Platform



Results 2: Advantage of Diversification

Comparison of two example platforms ...

Dominant platform $\mathcal{D}$

- Total probability of loss p
- Large portfolio size $(n \to \infty)$
- Correlation of losses $\rho > 0$

Alternative platform $\mathcal{A}$

- Total probability of loss p
- Finite portfolio size n
- No correlation of losses (plausible for virus contagion)

Result: A minimum portfolio size of $\mathcal{A}$ is required before insurance premiums fall below the level of $\mathcal{D}$.

Market entry barrier

Implications

Frame:

Favorable economic effects

Cyber-insurance moderates IT security investment, reduces residual risk, and creates incentives for R&D.

Thesis 1:

Shortage of supply due to market structure

Though demand for cyber-insurance exists, a monoculture of installed systems may thwart a market equilibrium.

Thesis 2:

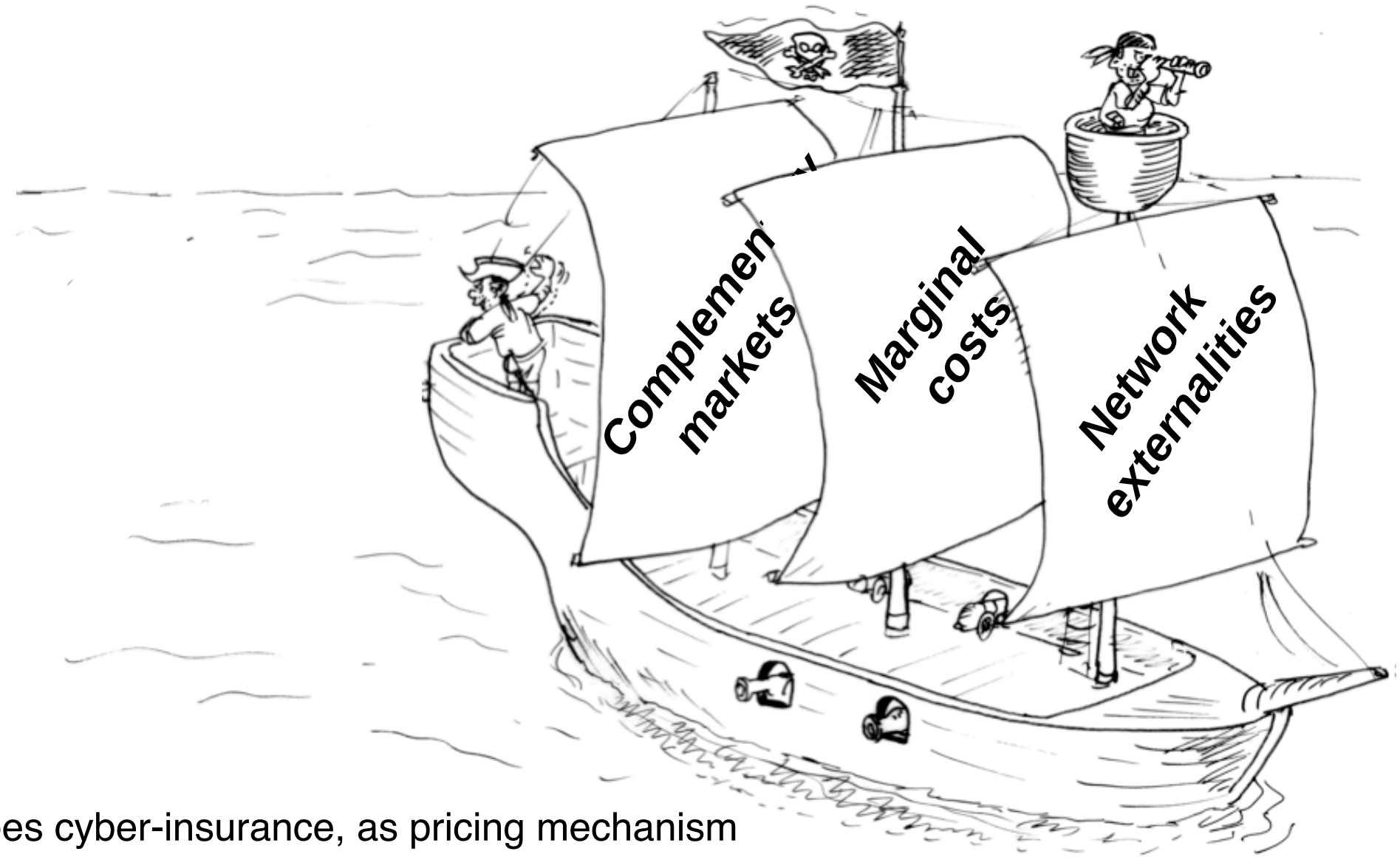
Reciprocity of interventions

Since market structure in the equipment market and conditions for cyber-insurance are linked, regulatory policies supporting cyber-insurance might cause a shift in market shares.

Can Premiums Steal the Thunder of Market Power?

CYBER-INSURANCE REVISITED

TECHNISCHE UNIVERSITÄT DRESDEN



Does cyber-insurance, as pricing mechanism for security properties, outweigh the strong drivers to market concentration?

Limitations

Supply-side model

- Naive selection of Bernoulli risks
- Measure of dependence (correlation) unrealistic
- Individual risk approach hinders empirical substantiation

Demand-side model

- Partial coverage not regarded
- Restricted to one class of utility functions (CRRA)
- Difficulty to quantify losses left out

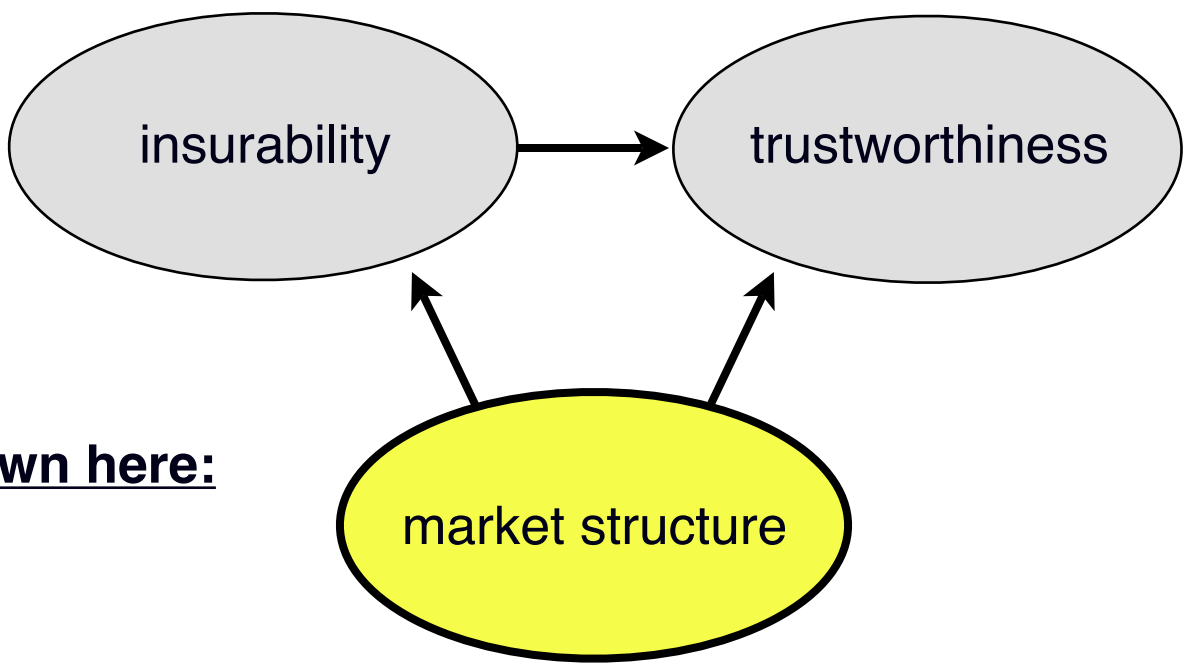
Comparison of platforms

- Market position is likely to influence total probability of loss
- Inclusion of transaction and monitoring costs might reveal advantages for the market leader (Metcalfe ... again!)

Further interdisciplinary research needed

"A trusted component or system is one which you can insure."

Ross Anderson, ESORICS 1994



Shown here:

Q&A

TECHNISCHE UNIVERSITÄT DRESDEN

Rainer Böhme
Institute for System Architecture
rainer.boehme@inf.tu-dresden.de

Thanks for your attention.