Micro- and macroeconomic modelling of intangible cyber-costs

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Enterprises intangible Risk Management
via Economic models based on
simulatioN of modErn cyber-aTtacks

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Micro- and macroeconomic modelling of intangible cyber-costs

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1- Context and objectives

Current approaches to IT security and risk management tend to underestimate, or even ignore, the following key aspects:

- The **human factor** (covering subjective, organisational, societal and economic aspects) and how it contributes to vulnerabilities to cyber-attacks
- The **strategy of the attacker** in the identification of vulnerabilities and assets at risk: modern attacks follow the same business logic as that followed by big companies that involve multidisciplinary competences in the definition process of their strategies and business plans
- The **role of intangible assets** in the quantification of the consequences of cyber-attacks

2. On relevance of intangibles for cybersecurity

- Sharp rise of R&D investments and intangibles at the corporate level
- Intellectual capital and innovation are fundamental drivers of value creation on the long run
- More than 50% of investment in commercial markets are intangibles and more than 80% of value of listed firms are intangibles

3. The main WP3 deliverables

- WP 3: Micro and Macro Economics Models of Intangible Cyber-Costs

  - Deliverables:
    - *Generic microeconomic model of intangibles costs/impacts of cyber-attacks*
    - *Macroeconomic estimates of intangibles costs of cyber-attacks*
    - *Microeconomic (sectoral) estimates of intangibles costs of cyber-attacks Business models of cyber-attacks*

4. The fast growing interest of the literature in the topic … as well as of Executives and policy makers

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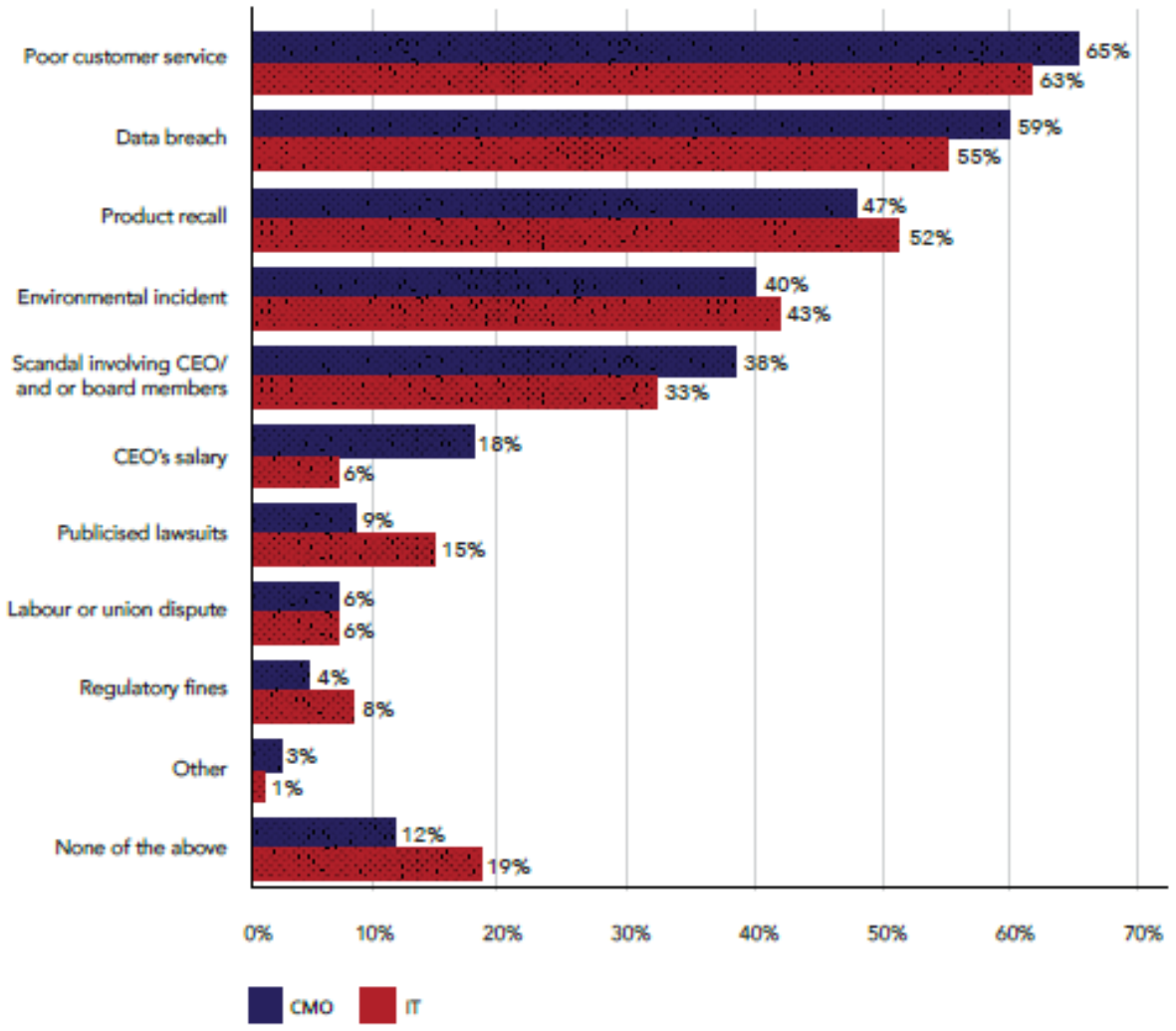
Data breach and market price

- Generally limited, but highliy significant impact market reaction to the breach involving unauthorised access to confidential data (Campbell et al. 2003)
- A significant impact of privacy breach (Acquisti et al. (2006)
- Value stock of 113 companies declined by average 5% immediately following the disclosure of a breach involving customer data : with recover of 7 days for those strong IT security and more than 90 days for the lowest (Ponemon, 2017) . Average loss of revenue between 2 .08 M£ and 3.07 £

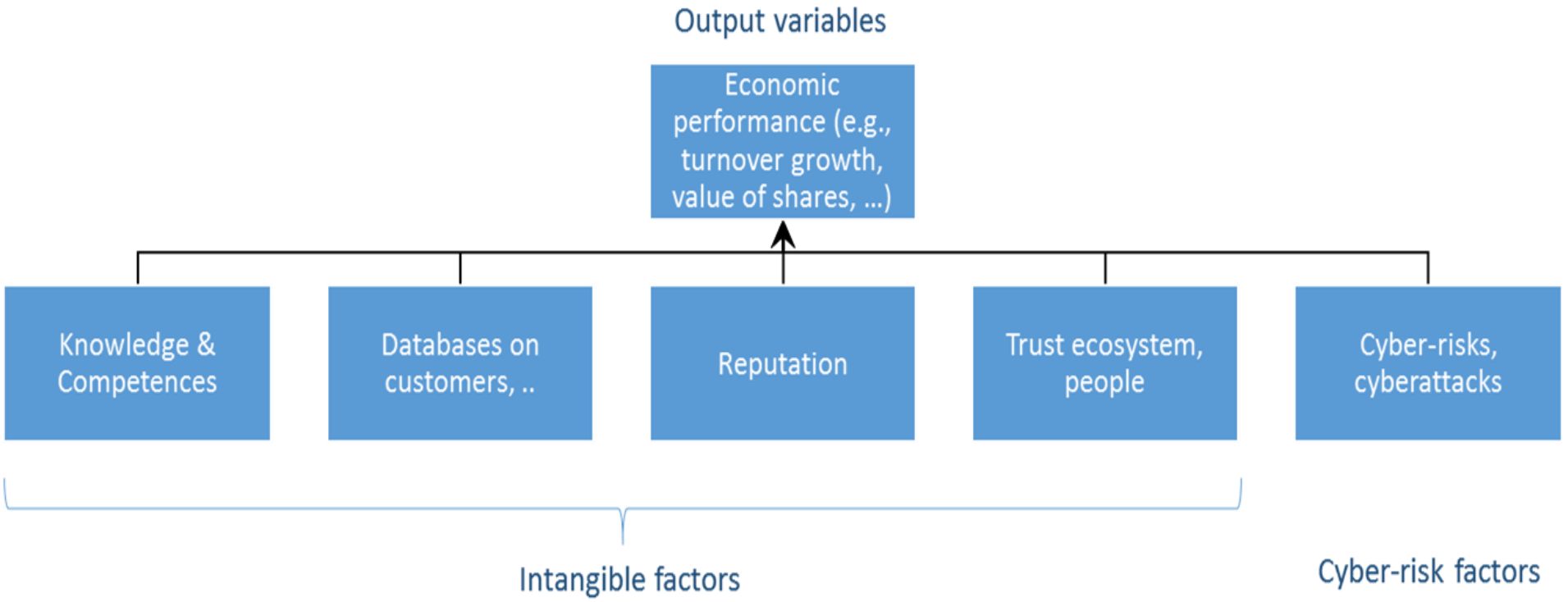
The impact on brands

Figure 6. Which of the following issues would most likely have a negative impact on your organisation's reputation? Please select the top three choices



Source: Penomian 2017

5. General modelling WP3 – Economics of intangibles /cybersecurity



5. General modelling
Economics of intangibles /cybersecurity

Examples of intangibles costs related to cyber risks:

- Sovereignty impacts (knowledge and information taken over by competitors, criminal organisations or foreign intelligence agencies (industrial espionage)
- Loss of reputation
- Loss of trust of stakeholders and relevant ecosystems
- Business/services interruption and related recovery costs (including contingency management at organisational level)
- Loss of competitiveness deriving from the possession of critical knowledge (such as designs and blueprints, best practices and process guidelines, licence contracts, consumer databases, confidential documents, etc.)
- Negative impact on employees (scepticism, distrust, stress, change in tasks, etc.);
- Loss of value in financial markets (for listed companies)
- Cost of cases in court

5. General modelling
Task 1: The Impact of Cyber-Attacks on Intangibles - Microeconomics

- Step 1: Estimate the Economic Value of Intangibles
  - Accounting standards represent a static report of intangibles (Lev and Gu, 2016)
  - Balance sheets do not mirror all innovation aspects

Proposition 1: Residual Approach, (Lev and Gu, 2011)

1. Economic Performance= $f(\alpha$ x Physical Assets, β x Financial Assets, Υ x Intangible Assets)
2. Intangible-Driven Earnings (*IDE*): The contribution of intangibles to firm performance
3. Discounted (IDE) to measure *K* the value of intangibles

$$K_{it} = \sum \frac{IDE_{it}}{(1+r)^t}$$

Proposition 2: Valuing data as digital assets , productivity approaches

5. General modelling
Task 1: The Impact of Cyber-Attacks on Intangibles - Microeconomics

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Variable	Description
Turnover	Dependent Variable -Performance of company *i* at time *t*
Independent Variables	
L	Number of Employees- Human Capital
PPE	Property Plants and Equipment- Physical Capital
T, S, RND	Training Expenditures, Software, R&D expenses
Control Variables	Industry, Country Effects
Cyber-Attacks	Exogenous Variable

5. General modelling
Task 1: The Impact of Cyber-Attacks on Intangibles - Microeconomics

- Step 2: The impact of Cyber-Attacks on Intangibles
- $K_{it} = f(RND_{it}, Patents_{it}, Brand\ Value_{it}, Reputation_{it}, Organizational\ Capital_{it} \dots) + CyberAttacks_{it}$

5. General modelling
Task 1: The Impact of Cyber-Attacks on Intangibles - Microeconomics

- Step 2 – Event approach

***Event study analysis*. Cumulative Abnormal Returns**, (Campbell et al., 2003; Acquisti et al., 2006) : Data breach & impact on company's stock

5. General modelling
Task 2: The Impact of Cyber-Attacks on Intangibles – Macro/MESOECONOMICS

- The CHS model as a starting point
- The productivity of data practices
- Introduction of cyberattacks variables
- Three key sectors of activities :
  - Knowledge IP intensive
  - Financial services
  - Health sector

6. Sources of information

Available public information as a starting point:

- Rand Corporation /Advisen
- IBM /Ponimon Institute
- Verizon (UK)
- Deloitte
- McKinsey report

- Data On vulnerabilities, costs …. But no individual data

- Plus industry (IP intensive sectors, financial services, key infrastructures)

7. Conclusion

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- Modeling and measuring intangible impact of cyber events present important stakes

For research on intangibles:

- How to address the issue, especially in the absence of individual reliable and usable data

For Policy makers :

- High stakes in terms of protecting strategic & operational assets
- Societal stakes are also very high (privacy, social cohesion and trust)

For Executives

- Protecting and Valorising critical assets
- Digital governance
- Pricing for digital risks

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