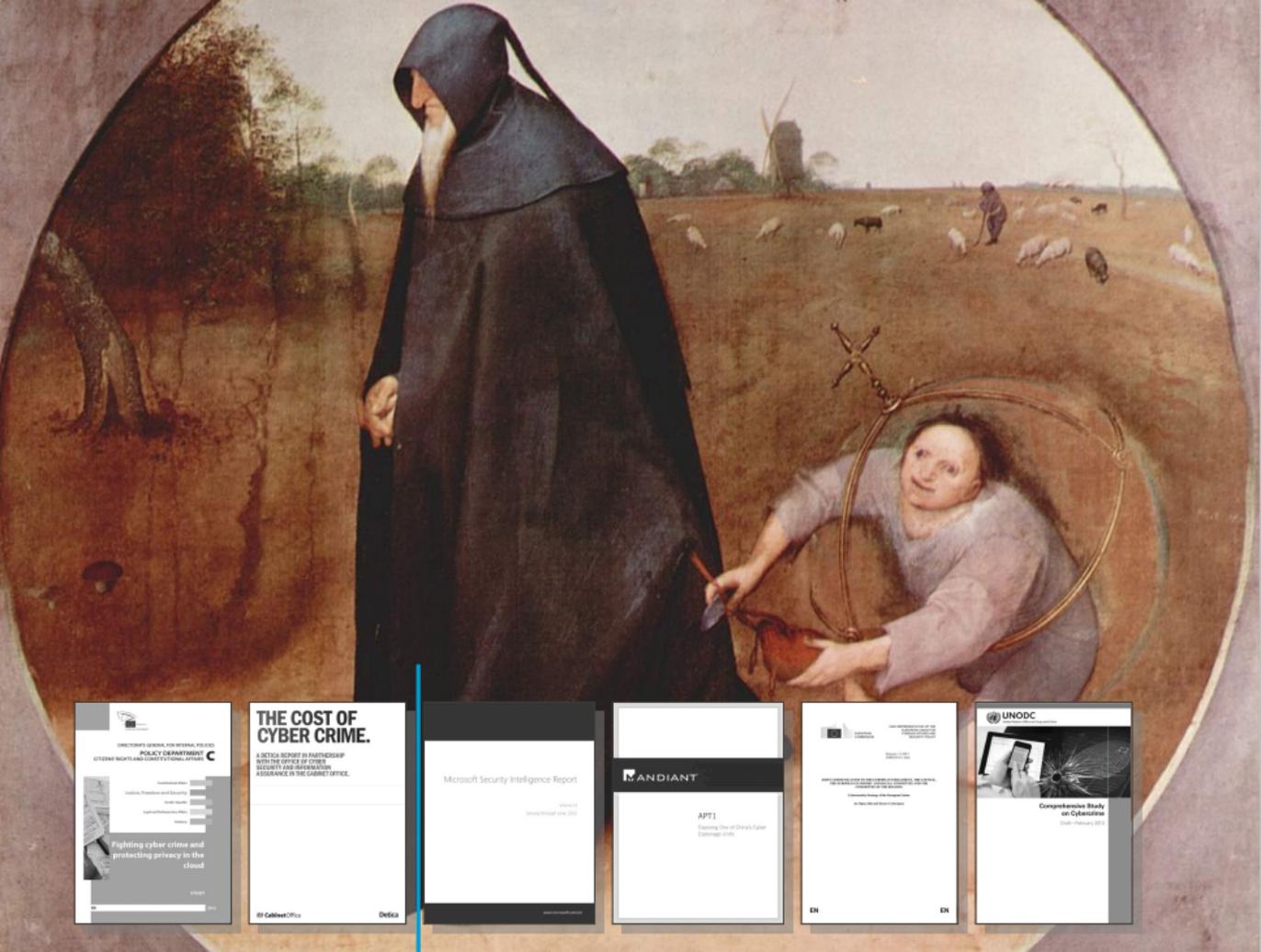




WESTFÄLISCHE
WILHELMS-UNIVERSITÄT
MÜNSTER

Measuring the Cost of Cybercrime

IMF 2013 Keynote, Nürnberg



UNITED STATES OF AMERICA
POLICY DEPARTMENT
CYBER SECURITY AND DIGITAL AFFAIRS

Executive Summary

Justice, Freedom and Security

Introduction

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

26

27

28

29

30

31

32

33

34

35

36

37

38

39

40

41

42

43

44

45

46

47

48

49

50

51

52

53

54

55

56

57

58

59

60

61

62

63

64

65

66

67

68

69

70

71

72

73

74

75

76

77

78

79

80

81

82

83

84

85

86

87

88

89

90

91

92

93

94

95

96

97

98

99

100

101

102

103

104

105

106

107

108

109

110

111

112

113

114

115

116

117

118

119

120

121

122

123

124

125

126

127

128

129

130

131

132

133

134

135

136

137

138

139

140

141

142

143

144

145

146

147

148

149

150

151

152

153

154

155

156

157

158

159

160

161

162

163

164

165

166

167

168

169

170

171

172

173

174

175

176

177

178

179

180

181

182

183

184

185

186

187

188

189

190

191

192

193

194

195

196

197

198

199

200

201

202

203

204

205

206

207

208

209

210

211

212

213

214

215

216

217

218

219

220

221

222

223

224

225

226

227

228

229

230

231

232

233

234

235

236

237

238

239

240

241

242

243

244

245

246

247

248

249

250

251

252

253

254

255

256

257

258

259

260

261

262

263

264

265

266

267

268

269

270

271

272

273

274

275

276

277

278

279

280

281

282

283

284

285

286

287

288

289

290

291

292

293

294

295

296

297

298

299

300

301

302

303

304

305

306

307

308

309

310

311

312

313

314

315

316

317

318

319

320

321

322

323

324

325

326

327

328

329

330

331

332

333

334

335

336

337

338

339

340

341

342

343

344

345

346

347

348

349

350

351

352

353

354

355

356

357

358

359

360

361

362

363

364

365

366

367

368

369

370

371

372

373

374

375

376

377

378

379

380

381

382

383

384

385

386

387

388

389

390

391

392

393

394

395

396

397

398

399

400

401

402

403

404

405

406

407

408

409

410

411

412

413

414

415

416

417

418

419

420

421

422

423

424

425

426

427

428

429

430

431

432

433

434

435

436

437

438

439

440

441

442

443

444

445

446

447

448

449

450

451

452

453

454

455

456

457

458

459

460

461

462

463

464

465

466

467

468

469

470

471

472

473

474

475

476

477

478

479

480

481

482

483

484

485

486

487

488

489

490

491

492

493

494

495

496

497

498

499

500

501

502

503

504

505

506

507

508

509

510

511

512

513

514

515

516

517

518

519

520

521

522

523

524

525

526

527

528

529

530

531

532

533

534

535

536

537

538

539

540

541

542

543

544

545

546

547

548

549

550

551

552

553

554

555

556

557

558

559

560

561

562

563

564

565

566

567

568

569

570

571

572

573

574

575

576

577

578

579

580

581

582

583

584

585

586

587

588

589

590

591

592

593

594

595

596

597

598

599

600

601

602

603

604

605

606

607

608

609

610

611

612

613

614

615

616

617

618

619

620

621

622

623

624

625

626

627

628

629

630

631

632

633

634

635

636

637

638

639

640

641

642

643

644

645

646

647

648

649

650

651

652

653

654

655

656

657

658

659

660

661

662

663

664

665

666

667

668

669

670

671

672

673

674

675

676

677

678

679

680

681

682

683

684

685

686

687

688

689

690

691

692

693

694

695

696

697

698

699

700

701

702

703

704

705

706

707

708

709

710

711

712

713

714

715

716

717

718

719

720

721

722

723

724

725

726

727

728

729

730

731

732

733

734

735

736

737

738

739

740

741

742

743

744

745

746

747

748

749

750

751

752

753

754

755

756

757

758

759

760

761

762

763

764

765

766

767

768

769

770

771

772

773

774

775

776

777

778

779

780

781

782

783

784

785

786

787

788

789

790

791

792

793

794

795

796

797

798

799

800

801

802

803

804

805

806

807

808

809

810

811

812

813

814

815

816

817

818

819

820

821

822

823

824

825

826

827

828

829

830

831

832

833

834

835

836

837

838

839

840

841

842

843

844

845

846

847

848

849

850

851

852

853

854

855

856

857

858

859

860

861

862

863

864

865

866

867

868

869

870

871

872

873

874

875

876

877

878

879

880

881

882

883

884

885

886

887

888

889

890

891

892

893

894

895

896

897

898

899

900

901

902

903

904

905

906

907

908

909

910

911

912

913

914

915

916

917

918

919

920

921

922

923

924

925

926

927

928

929

930

931

932

933

934

935

936

937

938

939

940

941

942

943

944

945

946

947

948

949

950

951

952

953

954

955

956

957

958

959

960

961

962

963

964

965

966

967

968

969

970

971

972

973

974

975

976

977

978

979

980

981

982

983

984

985

986

987

988

989

990

991

992

993

994

995

996

997

998

999

1000

1001

1002

1003

1004

1005

1006

1007

1008

1009

1010

1011

1012

1013

1014

1015

1016

1017

1018

1019

1020

1021

1022

1023

1024

1025

1026

1027

1028

1029

1030

1031

1032

1033

1034

1035

1036

1037

1038

1039

1040

1041

1042

1043

1044

1045

1046

1047

1048

1049

1050

1051

1052

1053

1054

1055

1056

1057

1058

1059

1060

1061

1062

1063

1064

1065

1066

1067

1068

1069

1070

1071

1072

1073

1074

1075

1076

1077

1078

1079

1080

1081

1082

1083

1084

1085

1086

1087

1088

1089

1090

1091

1092

1093

1094

1095

1096

1097

1098

1099

1100

1101

1102

1103

1104

1105

1106

1107

1108

1109

1110

1111

1112

1113

1114

1115

1116

1117

1118

1119

1120

1121

1122

1123

1124

1125

1126

1127

1128

1129

1130

1131

1132

1133

1134

1135

1136

1137

1138

1139

1140

1141

1142

1143

1144

1145

1146

1147

1148

1149

1150

1151

1152

1153

1154

1155

1156

1157

1158

1159

1160

1161

1162

1163

1164

1165

1166

1167

1168

1169

1170

1171

1172

1173

1174

1175

1176

1177

1178

1179

1180

1181

1182

1183

1184

1185

1186

1187

1188

1189

1190

1191

1192

1193

1194

1195

1196

1197

1198

1199

1200

1201

1202

1203

1204

1205

1206

1207

1208

1209

1210

1211

1212

1213

1214

1215

1216

1217

1218

1219

1220

1221

1222

1223

1224

1225

1226

1227

1228

1229

1230

1231

1232

1233

1234

1235

1236

1237

1238

1239

1240

1241

1242

1243

1244

1245

1246

1247

1248

1249

1250

1251

1252

1253

1254

1255

1256

1257

1258

1259

1260

1261

1262

1263

1264

1265

1266

1267

1268

1269

1270

1271

1272

1273

1274

1275

1276

1277

1278

1279

1280

1281

1282

1283

1284

1285

1286

1287

1288

1289

1290

1291

1292

1293

1294

1295

1296

1297

1298

1299

1300

1301

1302

1303

1304

1305

1306

1307

1308

1309

1310

1311

1312

1313

1314

1315

1316

1317

1318

1319

1320

1321

1322

1323

1324

1325

1326

1327

1328

1329

1330

1331

1332

1333

1334

1335

1336

1337

1338

1339

1340

1341

1342

1343

1344

1345

1346

1347

1348

1349

1350

1351

1352

1353

1354

1355

1356

1357

1358

1359

1360

1361

1362

1363

1364

1365

1366

1367

1368

1369

1370

1371

1372

1373

1374

1375

1376

1377

1378

1379

1380

1381

1382

1383

1384

1385

1386

1387

1388

1389

1390

1391

1392

1393

1394

1395

1396

1397

1398

1399

1400

1401

1402

1403

1404

1405

1406

1407

1408

1409

1410

1411

1412

1413

1414

1415

1416

1417

1418

1419

1420

1421

1422

1423

1424

1425

1426

1427

1428

1429

1430

1431

1432

1433

1434

1435

1436

1437

1438

1439

1440

1441

1442

1443

1444

1445

1446

1447

1448

1449

1450

1451

1452

1453

1454

1455

1456

1457

1458

1459

1460

1461

1462

1463

1464

1465

1466

1467

1468

1469

1470

1471

1472

1473

1474

1475

1476

1477

1478

147

We decided to write one, too:

Measuring the Cost of Cybercrime

Ross Anderson ¹ Chris Barton ² Rainer Böhme ³ Richard Clayton ⁴
Michel J.G. van Eeten ⁵ Michael Levi ⁶ Tyler Moore ⁷ Stefan Savage ⁸

Abstract

In this paper we present what we believe to be the first systematic study of the costs of cybercrime. It was prepared in response to a request from the UK Ministry of Defence following scepticism that previous studies had hyped the problem. For each of the main categories of cybercrime we set out what is and is not known of the direct costs, indirect costs and defence costs – both to the UK and to the world as a whole. We distinguish carefully between traditional crimes that are now ‘cyber’ because they are conducted online (such as tax and welfare fraud); transitional crimes whose modus operandi has changed substantially as a result of the move online (such as credit card fraud); new crimes that owe their existence to the Internet; and what we might call platform crimes such as the provision of botnets which facilitate other crimes rather than being used to extract money from victims directly. As far as direct costs are concerned, we find that traditional offences such as tax and welfare fraud cost the typical citizen in the low hundreds of pounds/Euros/dollars a year.

Workshop on the Economics of Information Security (WEIS) 2012

Quantifying cybercrime

Triangulation approach



Police-recorded crime statistics



Victimization surveys



Technology-based cybersecurity indicators

Translating incidents to costs

- ▶ Prioritize policy initiatives
- ▶ Evaluate efficiency of countermeasures

The figures in our heads

- ▶ In 2009 AT&T's Ed Amoroso testified before the US Congress that global cybercrime profits topped \$ 1 trillion.
- ▶ That is 1.6 % of world GDP.
- ▶ In 2011 Detica's figure (£27 Bn) is 2 % of UK GDP.
- ▶ Not only are the figures eye-poppingly large, it is often unclear what is being measured.
- ▶ Amoroso spoke of cybercrime "profits", while Detica describes "losses".



Quote from a widely cited industry source

“Methodology

[...] A team of researchers combined manual search methods with advanced search tools including [vendor's own product], which specialises in turning large amounts of structured and unstructured data into intelligence.

The research team compiled a comprehensive evidence review of over 7,000 documentary sources, including public, private and ‘grey’ documentation.”

Truth by repetition

Poorly-sourced estimates get “laundered” by derivative reports that use the estimates without critically examining the methodology.



The screenshot shows a news article on the TNO website. The article title is "COST OF CYBER CRIME LARGELY MET BY BUSINESSES" dated April 10, 2012. The text states that exploratory research by TNO shows cyber crime costs Dutch society at least 10 billion euros per annum, or 1.5 to 2 percent of GDP. It notes that this is equal to economic growth in the Netherlands in 2010. The article mentions that further research is needed to identify precisely where impact is greatest and how the cost can be reduced. It also references TNO's findings based on research carried out in the United Kingdom for the Home Office by consulting firm Delica, and a study by Ernst & Young.

- ▶ In spring 2012 TNO scaled the 2 % GDP figure to the Netherlands.
- ▶ Surprise, surprise! German intelligence sources estimated the cost of cybercrime to €50 billion p. a. in late summer 2012.

Games people play



Consumers

Are concerned; pay the bill



Government

Spends public money; wants to stay in power



Security industry

Needs customers; smells defense budgets



Other industry

“Keep out of my way!”



Academia

Wants research grants

But can we do better?

- ▶ It is one thing to point out flaws, but it is quite another to produce a more reliable estimate of cybercrime losses.
- ▶ The UK Ministry of Defence challenged us to produce a more accurate estimate.
- ▶ We documented our attempt to measure cybercrime losses using publicly available data.
- ▶ Our methodology is bottom-up: we count what we know, knowing that we undercount what we cannot measure.



The Blind Leading the Blind

Cybercrimes we considered

- ▶ Online banking fraud
 - ▶ Fake antivirus
 - ▶ ‘Stranded traveler’ scams
 - ▶ ‘Fake escrow’ scams
 - ▶ Advance-fee fraud
 - ▶ Infringing pharmaceuticals
 - ▶ Copyright-infringing software
 - ▶ Copyright-infringing music and video
 - ▶ Online payment card fraud
 - ▶ In-person payment card fraud
 - ▶ PABX fraud
 - ▶ Industrial cyber-espionage and extortion
 - ▶ Welfare fraud
 - ▶ Tax and tax filing fraud
- “Genuine” cybercrime
- Transitional cybercrime
- Traditional crime becoming “cyber”

A working definition of cybercrime

We adopt the European Commission's proposed definition:



Traditional forms of crime

such as fraud or forgery, though committed over electronic communication networks and information systems;



Publication of illegal content

over electronic media (e.g., child sexual abuse material or incitement to racial hatred);



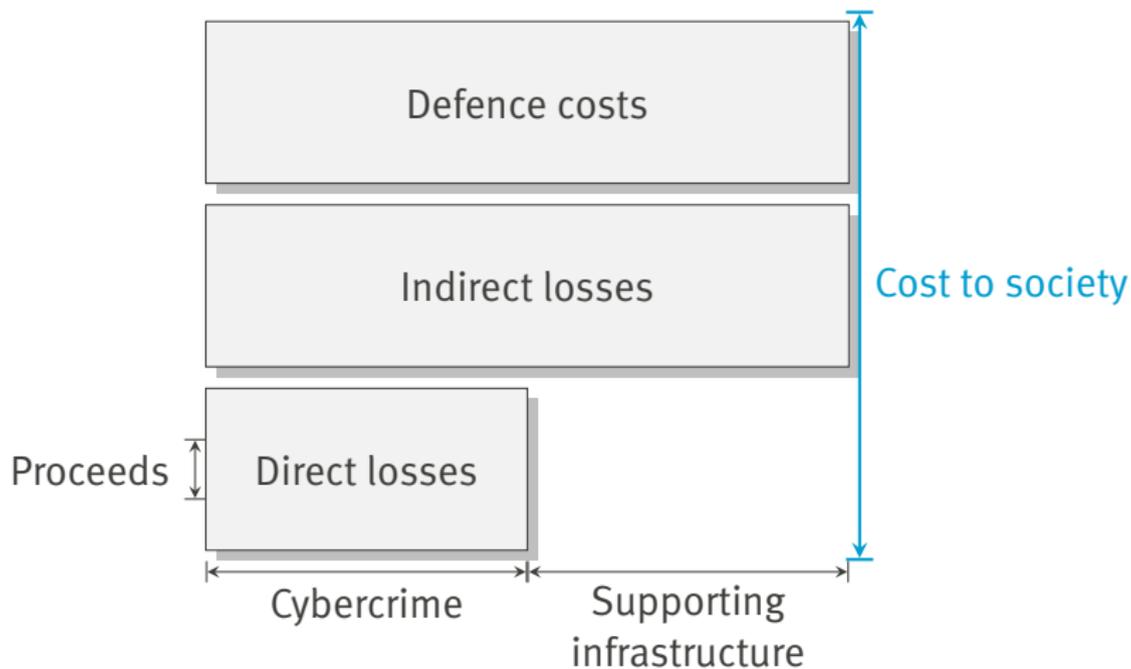
Crimes unique to electronic networks

e.g., attacks against information systems, denial of service and hacking.

COM (2007) 267

- ▶ The boundary between traditional and cybercrimes is fluid.

Framework for analysing the cost of cybercrime



Indirect and defense costs outweigh direct losses

Cybercrime cost category	Estimate
Direct losses	
– genuine cybercrime (e.g., phishing, advanced-fee fraud)	\$ 2–3 Bn
– online payment card fraud	\$ 4 Bn
Indirect costs	
– cybercriminal infrastructure (e.g., malware cleanup)	\$ 10 Bn
– loss of confidence in online transactions	\$ 30 Bn
Defense costs	
– cybercriminal infrastructure (e.g., antivirus)	\$ 15 Bn
– payment card and online banking security measures	\$ 4 Bn

Global estimates for 2010. Source: Measuring the Cost of Cybercrime, WEIS 2012.

- ▶ See our report for details and limitations.

Cost per citizen



Traditional crime becoming “cyber”

such as tax and welfare fraud

... a few **hundred** €/\$/£ per year



Transitional cybercrime

such as payment card fraud

... a few **tens** €/\$/£ per year



“Genuine” cybercrime

such as fake antivirus

... a few **tens** €/\$/£ per year

(but the vast bulk are indirect and defense costs)

Our report's conclusions

- ▶ Today's cybercriminals are best compared to metal thieves: relatively small proceeds cause tremendous social costs.
- ▶ Every €/\$/£ spent on better law enforcement seems to be more efficient than one spent on protection technology.
- ▶ As social interactions move online, there will soon be hardly any crime not involving a cyber component.

So the real question is how a networked society can protect its institutions and values despite a base rate of criminal activity.

Drivers of indirect costs

- ▶ The European Commission's speechwriting unit conducts regular surveys of EU citizens on a range of topics.
- ▶ In Spring 2012 they ran a survey asking about citizens' concerns about and reactions to cybercrime using face-to-face interviews: 26,593 EU residents (18K Internet users) age 15+.
- ▶ The report provides descriptive statistics on how experiences with cybercrime varied across 27 EU Member States.
- ▶ We were granted access to micro-data on responses in order to conduct a secondary analysis.
- ▶ We focus on the relationship between **experiences and concerns** over cybercrime and the resulting **actions taken** by consumers.

Analytical approach



Intent

to bank or shop less
because of cybercrime



Experience with cybercrime

e.g., falling victim to identity theft, receiving phishing emails



Concern over cybercrime

e.g., concern over security of online payments



Exposure to news about cybercrime

e.g., read newspaper articles



Proficiency

e.g., educational attainment, online expertise, running antivirus

- ▶ Method: logistic regression model with country fixed effects

Dependent variables

“Has concern about security issues made you change the way you use the Internet in any of the following ways ?”



Indicator	EU27	DE
Less likely to buy goods online	17.5	13.4
Less likely to bank online	14.4	9.0
Less likely to participate online (summary of:)	63.0	74.3
– Less likely to give personal information on websites	36.3	50.8
– Only visit websites you know and trust	33.5	33.1
– Do not open emails from people you don't know	42.8	56.5

N = 18, 133 EU residents, Internet users, age 15+

Explanatory variables (1)



Indicator	EU27	DE
Experience with cybercrime		
Personal experience (at least “occasionally”) with ...		
– Identity theft	8.0	6.1
– Phishing/advance-fee fraud spam	37.4	40.0
– E-commerce fraud	12.2	13.5

N = 18, 133 EU residents, Internet users, age 15+

Explanatory variables (2)

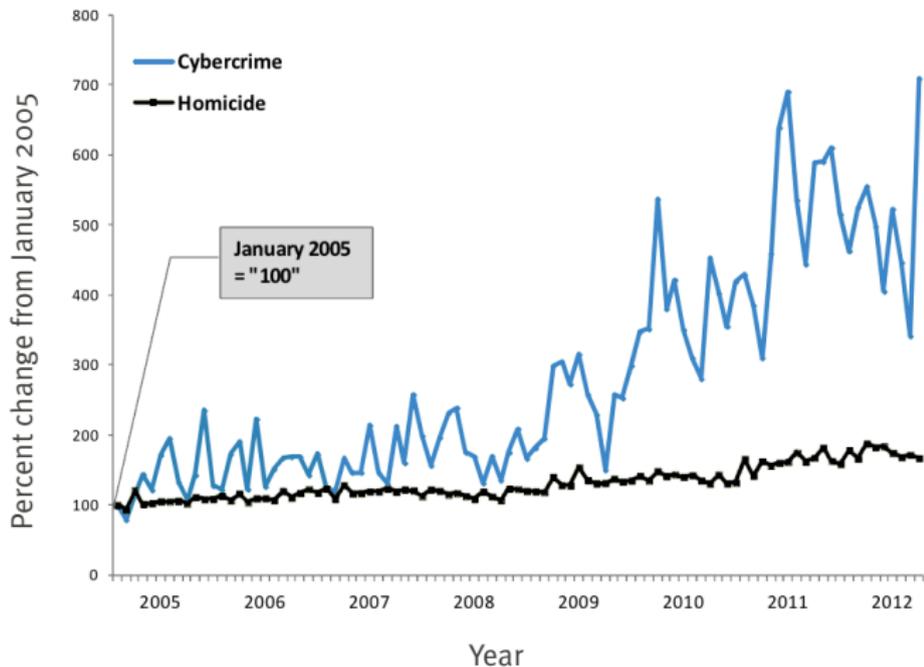


Indicator	EU27	DE
Concerns about cybercrime		
Personally (at least “fairly”) concerned about ...		
– Identity theft	63.3	53.4
– Phishing/advance-fee fraud spam	50.2	47.9
– E-commerce fraud	51.7	41.7
Generally concerned about ...		
– Security of online payments	37.1	32.6
– Misuse of personal data	39.7	58.3

N = 18, 133 EU residents, Internet users, age 15+

Cybercrime makes the news

Relative frequency of global news reports 2005–2012



Explanatory variables (3)



Indicator	EU27	DE
Exposure to news about cybercrime		
On television	66.5	72.2
On radio	22.9	28.5
In the newspapers	33.3	48.8
On the Internet	33.9	36.5
From friends, family or colleagues	25.5	30.8
Not heard anything about cybercrime (spontaneous)	14.8	8.5

N = 18, 133 EU residents, Internet users, age 15+

Control variables



Indicator	EU27	DE
Proficiency indicators		
Internet access more than once a day	54.2	49.0
Bank online	47.8	48.4
Buy goods or services online	52.0	68.5
Feel confident about Internet skills	67.7	72.7
Feel informed about the risks of cybercrime	51.1	48.4
Changed at least one password in the past 12 months	48.4	44.2
Use different passwords for different sites	24.8	36.6
Antivirus installed	50.7	71.9
Higher education	46.5	41.8
Perceived social status above median	51.3	52.5

N = 18, 133 EU residents, Internet users, age 15+

Hypotheses



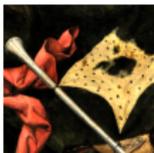
H1 – Supported with evidence

Falling victim to cybercrime reduces online participation, in particular online banking and shopping.



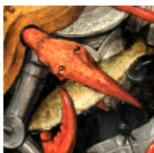
H2 – Supported with strong evidence

Expressing concern over cybercrime reduces online participation, in particular online banking and shopping.



H3 – Supported only for online banking

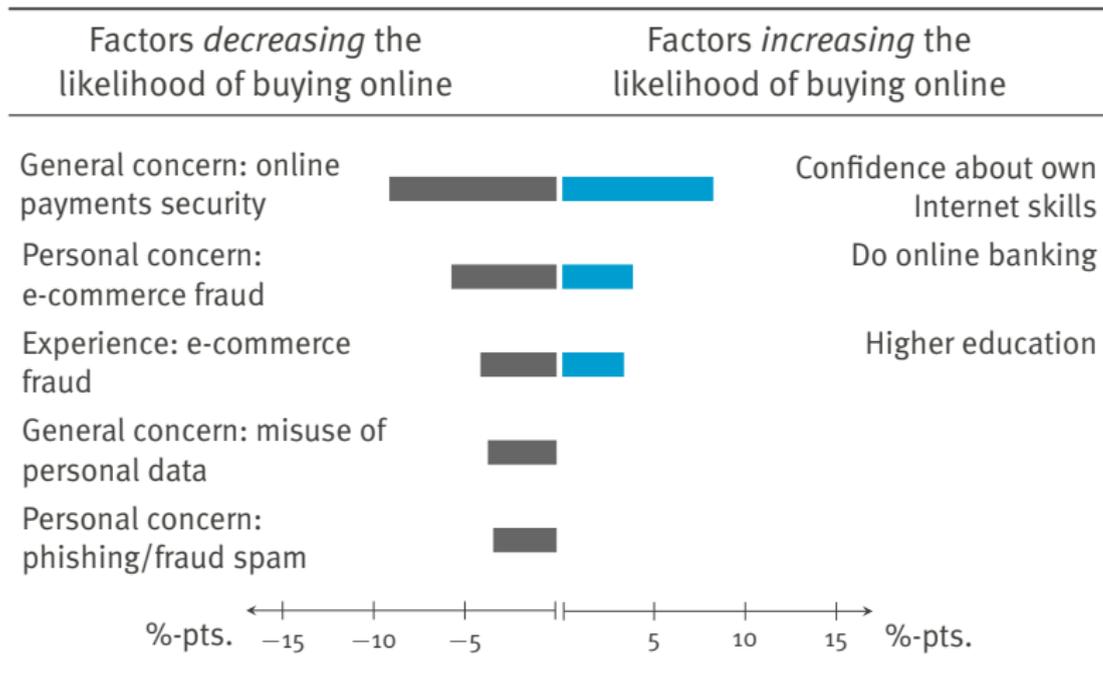
Exposure to cybercrime in the news media reduces online participation, in particular online banking and shopping.



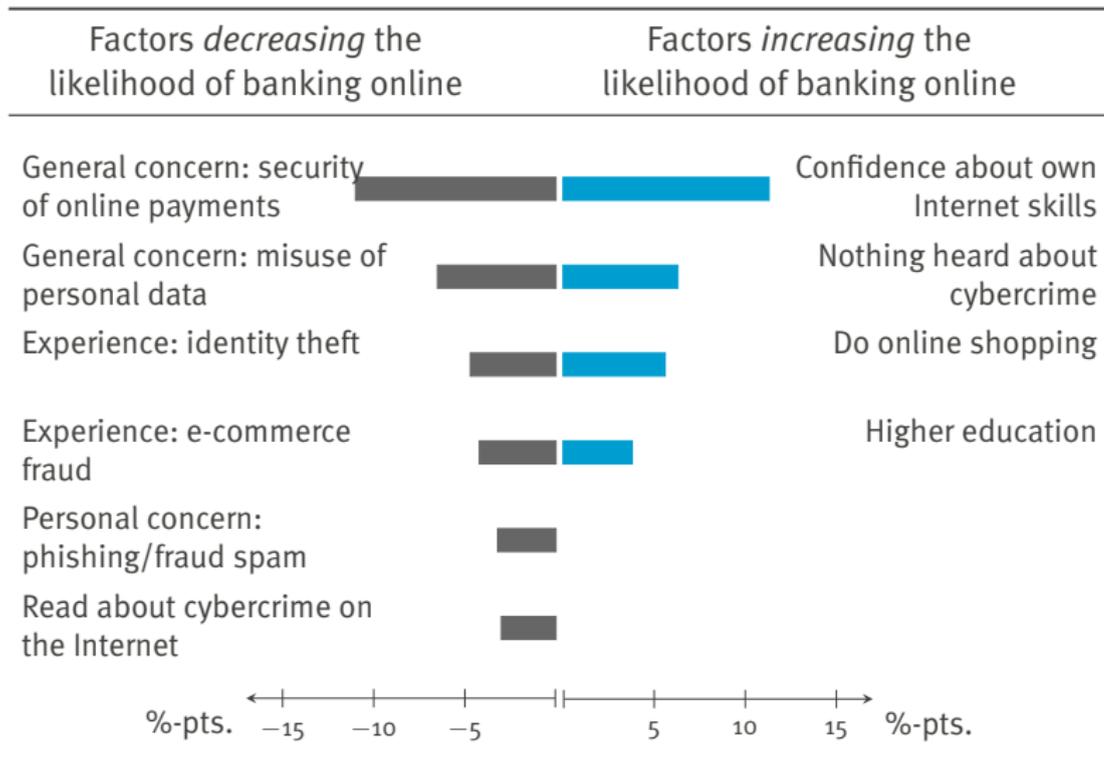
H4 – Some support for e-commerce fraud

Falling victim to one form of cybercrime reduces participation in unrelated forms of online activity.

Likelihood of shopping online



Likelihood of banking online



Drivers of indirect costs

One important and unexpected result

Concern about cybercrime inhibits online participation more than direct **experience** with cybercrime does.

- ▶ People may find the experience of cybercrime to be less painful than their worst fears.
- ▶ Regardless of what is driving the result, its implications are clear: assuaging society's concerns over cybercrime could make a greater impact than allocating further resources on assisting victims.
- ▶ Since experiencing cybercrime is relatively rare, this calls into question the use of frightening narratives for the purpose of awareness raising.

State-sponsored cyber-espionage



“We spy because you bribe.”

Allegations of espionage have always accompanied international trade talks, often as cover for protectionist behavior.

The myths conflate different threats. But it remains very hard to map the incidents we observe to tangible losses.

The “shareconomy” needs a Kerckhoffs’ principle for business models.

Importantly, tensions about cyber-espionage must not

- ▶ thwart cooperation in the prosecution of (other) cybercrime,
- ▶ militarize the cyberspace further.

Militarization of cyberspace

Traditional Indicator	Online Parallel
1) Extortion techniques	- Threats to close down systems by malware attacks - Use of compromising browser records for blackmail obtained by key logging software
6) Sex & prostitution	- Creation of online pornography empires - Links between escort sites, trafficking and organised groups
7) Violence	- Attacks on carding forums to take over rival operations - Willingness to use violence to acquire identification or other digital currencies

BAE/Detica 2012

Worrisome narratives:

- ▶ linking violence to objectively less serious (intangible) offenses,
- ▶ branding cybercrime as “organized crime”; there is a difference between gangs and a mafia.

After all, there is no violence in “cyber” alone.

Responsibility lasts on engineers who connect “cyber” to physical force.

A slippery slope

Article 15

Implementation and enforcement

1. Member States shall ensure that the competent authorities have all the powers necessary to investigate cases of non-compliance of public administrations or market operators with their obligations under Article 14 and the effects thereof on the security of networks and information systems.
2. Member States shall ensure that the competent authorities have the power to require market operators and public administrations to:
 - (a) provide information needed to assess the security of their networks and information systems, including documented security policies;
 - (b) undergo a security audit carried out by a qualified independent body or national authority and make the results thereof available to the competent authority.

COM (2013) 48 final (7 Feb 2013)

After recent German and EC policy initiatives on cybersecurity, it seems that the European version of breach disclosure laws ...

1. is ten years late,
2. blurs the boundary between police and intelligence,
3. is designed as a oneway street, and
4. empowers the wrong actors.

Recommendations to cybersecurity professionals



Question common narratives.

Be careful not to propagate “truth” by repetition.



Gather facts.

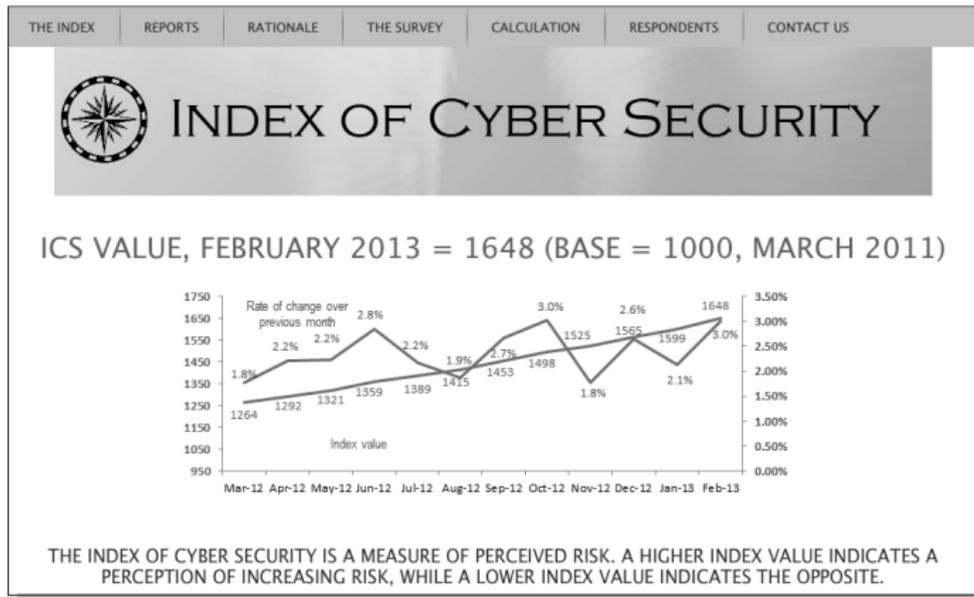
Refine measurements and make them transparent.



The world needs cyber-pacifists.

- ▶ Yes, we have to deal with cybercrime, but let us take it with professional distance and responsibility for society at large.

Cybersecurity professionals' sentiment indicators



Dan Geer & Mukul Pareek

- ▶ Help us to bring this index to the German-speaking community.

[Advertisement]

Survey-based sentiment indicators exist for:

- ▶ purchase managers (PMI),
- ▶ financial analysts (ZEW),
- ▶ professional economic forecasters (SPF), etc.



Why not regularly ask a panel of information security professionals to construct a **forward-looking** sentiment indicator?

We use a **short questionnaire**, asking for general observations of **changes in perceived attack intensity**. No breach disclosure!

Respondents will be privately recruited industry practitioners with operational responsibilities for managing information security risks.

**Take a flyer and contact us if you think you are eligible.
Forward them to suitable colleagues.**

Thank you.

Resources

- ▶ Ross Anderson, Chris Barton, Rainer Böhme, Richard Clayton, Michel J. G. van Eeten, Michael Levi, Tyler Moore, Stefan Savage (2012): **Measuring the Cost of Cybercrime**. *Workshop on the Economics of Information Security (WEIS)*, Berlin, June 25–26.

http://weis2012.econinfosec.org/papers/Anderson_WEIS2012.pdf

- ▶ Rainer Böhme, Tyler Moore (2012): **How Do Consumers React to Cybercrime?** *APWG eCrime Researchers Summit*, Puerto Rico, October 22–25.

<http://lyle.smu.edu/~tylerm/ecrime12eurobar.pdf>

- ▶ Comments and questions: **rainer.boehme@uni-muenster.de**

Epilogue



- ▶ Color on the slides is reserved to Pieter Bruegel the Elder (1525–1559)
- ▶ Detail squares form a bigger picture: The Fall of the Rebel Angels