Economics and the Underground Economy

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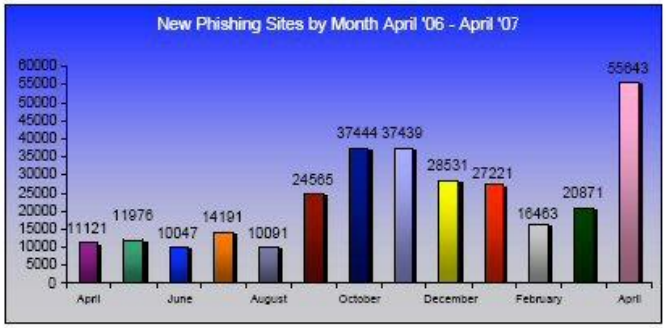
Everybody Knows Cybercrime is Big Money

``Everybody knows Phishers make lots of money ....."

- AntiPhish WG graphs
  - Growth in # sites
- Gartner Surveys:
  - 2005 "$929 mln"
  - 2006 "$2.1bn"
  - 2007 "$3.2 bn"



Everybody Knows:

Cybercrime (e.g. IRC) Markets are Big Money

How do we know this?

- Black Market In Credit Cards Thrives on Web
  - "Want drive fast cars?" asks an advertisement, in broken English, atop the Web site iaaca.com. "Want live in premium hotels? Want own beautiful girls? It's possible with dumps from Zoomer."
- The Underground Economy: priceless
  - "Even those without great skills can barter their way into large quantities of money they would never earn in the physical world."
- Symantec Underground Economy Survey
  - "Symantec has calculated that the potential worth of all credit cards advertised during the reporting period was US$5.3 billion."
- A Field Day for Financial Cyber-Scammers
  - "Total losses from cyber-related crime at financial institutions topped $20 billion last year, estimates security consultant Lance James"

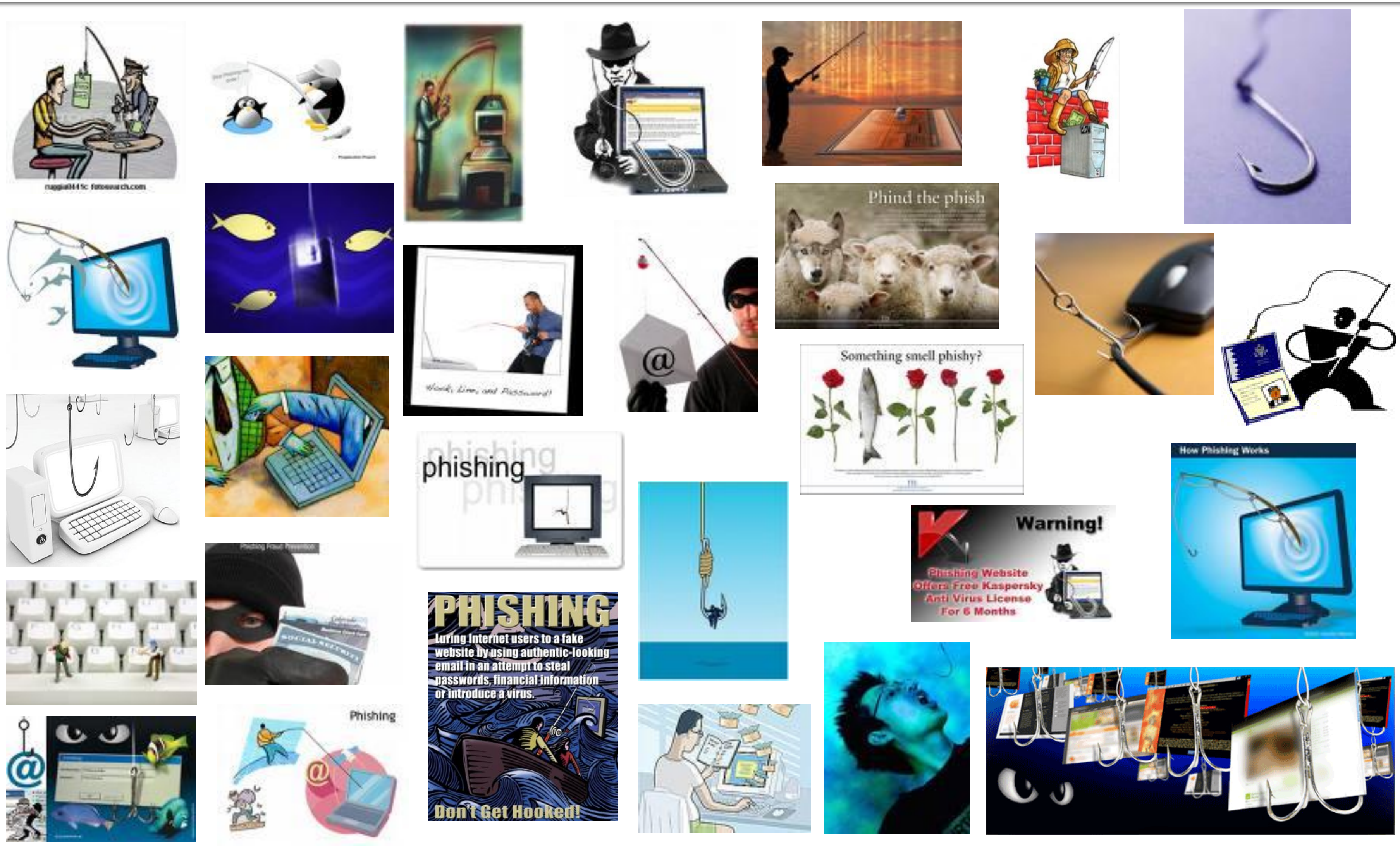
The New York Times

TEAM CYMRU

symantec.

BusinessWeek

Generates work for Graphic Designers



A Few Things That Make No Sense

Why do Credentials sell for pennies on dollar?

- Symantec: "CCN's sell for $0.5 to $12"
- Cymru: $500 for face value $10million creds
- Franklin etal.: 465 free CCNs/day on single channel

- Offered Explanations:
  - More supply drives price down [Symantec]:
    - But demand for free money is infinite?
  - Volume Sellers don't care [Cymru]:
- Nobody sells gold for the price of silver

How Can Market Function when Cheating is Common?

- Thomas & Martin:
  - "Each IRC network will normally have a channel, such as #help or #rippers, dedicated to the reporting of those who are known to conduct fraudulent deals."
- Symantec:
  - Many IRC servers have channels listing current rippers
- Franklin et al:
  - 22% of posted CCNs failed Luhn checksum
  - Utilities provided by channel admin designed to steal CCNs
- Dhanjani and Rios [Blackhato8]:
  - Backdoors common in for-sale phishing kits/tutorials
- Cova et al:
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- Countermeasures ought to be easy

Why is cheating common?

- Why does anyone bother putting backdoors in phishkits if easy money lies all around?
- Why steal $0.50 / CCN if you can do the real stuff?

Where are the bodies?

- Phish victims 2008: 5 million
  - [Gartner]
- US job losses July 08-June 09: 5.3 million
  - [Dept. of Labor]
- Named phish victims 2003-2007: 13
  - Online and paper journalists

Where's the loot?

- Gartner estimates: "$3.2 bn lost to phishing in 2007"
  - > TacoBell revenue $1.8bn
- FTC 2005 estimate: $47bn in ID theft
  - > earnings of top 5 US banks 2005
  - > $100k each for 0.5 million ID thieves
- When things are big they're visible
  - Even if they try to hide

Banks do little

- Negligible 2-factor deployment in US
- Cosmetic masures: e.g. SiteKey
- US banks entirely silent on losses
  - No published numbers
  - No demands for legislation (Remember DMCA?)
- Don't seem worried:
  - "We guarantee that you will be covered for 100% of funds removed from your Wells Fargo accounts in the unlikely event that someone you haven't authorized removes those funds through our Online Services."
  - "We will reimburse your Fidelity account for any losses due to unauthorized activity."

WELLS FARGO

Fidelity INVESTMENTS

Users do less

- Choose weakest passwords
- Anti-Virus installed? Current? Running?
- Ignore certificates
- Click on anything.
- Uptake on phishing protection low.
- Automatic updates?

Laws of Economics have not been suspended

- Competition decreases return
  - When it's raining money, there are always enough people with buckets
- Tragedy of the Commons
  - If anybody can do it, everybody does
- Market for Lemons
  - Cheating on IRC channels makes commerce impossible
- Firms are better than freelancers
  - Two Tier system
- W/o barrier to entry returns are bad

Phishing as Tragedy of the Commons

"And Simon answered, Master, we have fished all night, and caught nothing."

Luke 5:5

Looks like the perfect scam

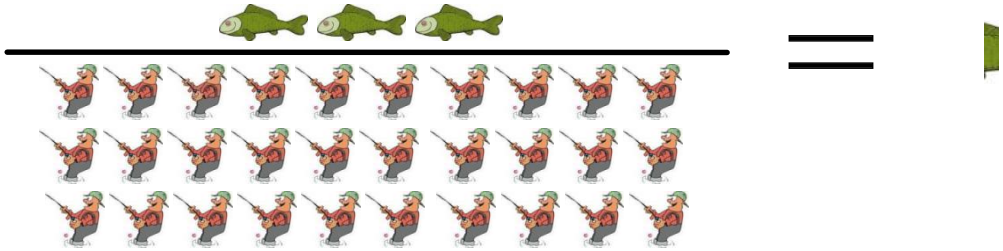
- Harvest free money
- Be 1000 miles from scene of crime
- Get everything you need online
- No capitol outlay, no training
  - Anybody can do it!!!!
- Except,
  - If anybody can do it, everybody does it
  - If everybody does it, nobody makes any money

Fishing and Phishing

- Both have predator-prey dynamics
  - Prey: fish or dollars
  - Predator: fishermen or phishers
- Fishermen are never rich
- Open access to the resource, i.e. no barrier
  - Anyone who wants to fish/phish can exploit
- Tragedy of the Commons
  - Fishing ground yields far less than it is capable of
  - Phishing yields far fewer dollars than possible

A Quick lesson in Competition

Return = Victims / Phishers



More Phishers

Less Phish?

The squeeze on phishing

- Return = Victims/Phishers

- Denominator increasing ("free money!!!!")
- Numerator decreasing
  - Technical measures: browser warnings etc
  - Fraud detection: banks get better
  - Users learn: nobody gets phished 10 times.

Conclusions

- Activity ≠> Dollars
  - Amount of phishing email/sites indicates denominator is increasing
  - Things are getting worse for phishers, not better
- The easier phishing gets the lower $R_{tot}(E)$
- Phishing is a low-skill low-rewards business
  - Avg phisher makes ~ lost opportunity costs
- Return = Victims/Phishers
  - Denominator increasing, numerator decreasing

What about all the estimates showing that Phishing is HUGE??

- Problems with Gartner surveys [2005,2006,2007,2008]
  - Selection Bias: how contact unbiased sample email users?
  - Refusal Rate: those who respond to Gartner spam more/less likely to respond to phishing spam?
  - Telescoping: users throw-in incidents outside interval

Surveys: Exaggeration of Losses

- Very Small number of victim respondents
  - E.g. Javelin (Gartner) 2005 found 3 (25) victims resp.
- Dollar numbers are averages over victims
- ***Victims who exaggerate hugely influence avg.***
- Speculation?
  - Gartner 2007: avg loss=$886, median=$200.

Our Estimate:
US phish victims: 0.4% of users per year

- Gartner
  - Users who say they were phished: 3.2%
  - Survey 4000
- Clayton&Moore
  - User credentials at hacked phish site: 0.34%
  - Hacked phishing site
- Florêncio&Herley
  - Toolbar users entering pwds at phish sites: 0.4%
  - Toolbar data, 500k users

Where are the bodies?

- Gartner "5 million lost money in 2008"
- Number of people in US who lost money
  - >\# babies born in the US (3.9 million)
  - > # deaths in the US (2.4 million)
  - > # HS grads (2.9 m)
  - > # Suckers (assuming one born every minute: 525k = 365x24x60)

Our Estimate: Victims x Loss
US annual phishing losses = $60 million

- Assume Gartner median loss: $200
- Assume 50% of fraud successful
  - $200 x 175e6 x 0.037 x 0.5 = $60 million

Inline with other Evidence

- APACS (UK payments assoc):
  - 2007 Online fraud = 22.6 GBP ~ $31.5 mln
  - Assume 50% of online fraud is phishing
  - Scale from UK pop to US:
  - $31.5 x 0.5 x 300 / 60 = $78.5 mln
- Paypal CSO: "phishing is not even in the top five fraud loss threats Paypal faces"
  - [darkreading 2007].

Do banks fear phishers or customers?

- Bank CEO is more afraid of :
  - ☐ Phishers
  - ☑ Own Customers

- Phishing loss: $60/175 = $0.34 per user/year
  - I.e. Avg. loss/customer < First Class Stamp
- Agent assisted phone call: $10/call
- 10% of customers making one call dwarves phishing all losses.
- "And you want me to roll out 2-factor to these people??"

Users are not irrational

- Banks cover the ***direct*** losses
- Regulation E limits user liability to $50
  - *even when the customer is negligent*
- Users are not irrational
  - Strong passwords, parsing URLs, understanding certificates is effort to save someone else money.
- Real cost for users is effort/hassle/headache
- If phishers steals $50, it'll take a lot more than $50 in time/effort to explain/figure out.

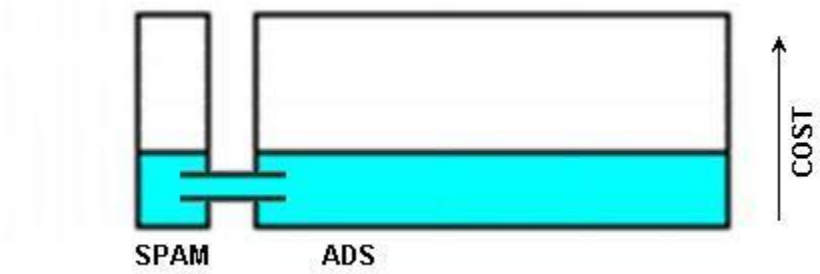
Spam is more expensive than AdWords/AdCenter

"spam may be free, but it's not cheap"

SPAM

- SPAM vs. ADS: which one is cheaper?

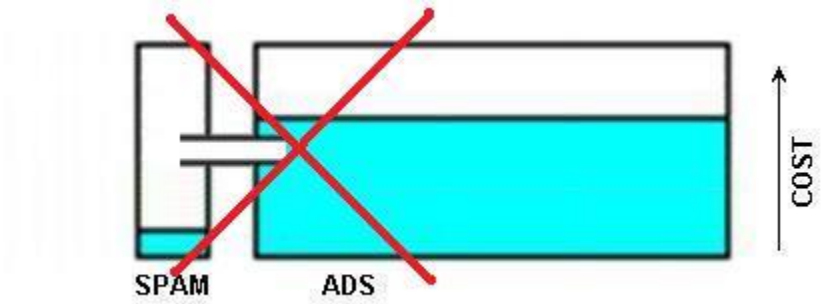
- Competitive equilibrium: if enough advertisers can choose between the two, they should reach similar pricing (ROI).



SPAM

- SPAM vs. ADS: which one is cheaper?

- Competitive equilibrium: if advertisers **cannot** choose, prices could be different. **But there are some constraints.**

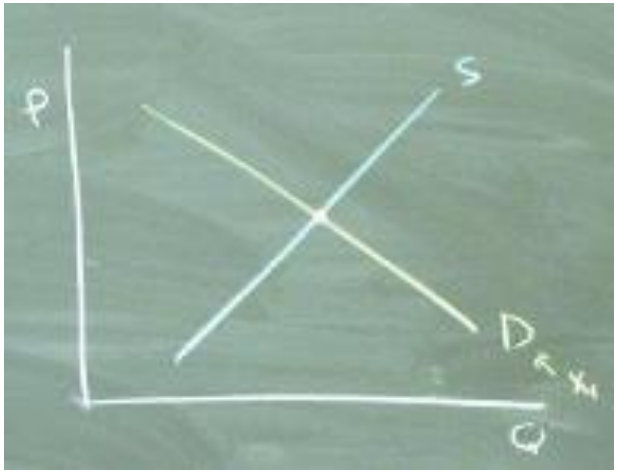


SPAM

- SPAM vs. ADS: which one is cheaper?
- Competitive equilibrium: if enough advertisers can choose between the two, they should reach similar pricing.
- "SPAM is cheaper" would require:
  - No business currently in AdWords/AdCenter could use spam instead
  - (are there enough legitimate ads outside the reach of US spam laws?)
- "SPAM is more expensive" would require:
  - No business currently in SPAM could use AdWords/AdCenter.
  - (are there any legitimate ads using SPAM?)
- SPAM is more expensive then legitimate ads or campaigns!

SPAM

- SPAM: Are spammers making any money?
  - Supply-and-demand equilibrium:
    - Buyers willing price&quantity = Sellers willing price&quantity



SPAM

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- Supply-and-demand equilibrium:
  - Buyers willing price&quantity = Sellers willing price&quantity
  - Marginal Demand: At this price, no buyers are wiling to buy more services
    - => "total" cost is not cheaper than alternatives.
  - Marginal Offer: At this price, no (current or prospective) sellers are willing to provide more merchandise
    - => profit is slim, Sellers cannot be making much money. (no *barrier to entry* markets)
- Spammers are not making much money.

SPAM

SPAM


MYTHBUSTERS
WEDNESDAYS AT 9PM
Spamming is
easy money
BUSTED

Underground Markets

"the underground economy has reached a very specialized division of labor"

Paradox 1: Creds sell for pennies on dollar

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Paradox 2:
How Can Market Function when Cheating is Common?

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These Paradoxes help explain each other:
Market for Lemons

Akerlof '70

- Seller knows quality better than buyer
  - Cars: is this a lemon or not?
  - CCNs/creds: am I a ripper or not?
- Buyers will pay only the average

What Causes a Lemon Market?

1. Asymmetry of Information
   - ✓ Are you a ripper or not?
2. No credible disclosure
   - ✓ Rippers are indistinguishable from real sellers
3. Low seller quality
   - ✓ Rippers abound
4. Lack of regulation/assurance
   - ✓ Anonymous irreversible transactions

IRC channels classic example of Lemon Market

The Ripper Tax

- Fraction q of transactions are with rippers
- Can we estimate tax rate q?
  - Recall none of [Cymru, Symantec, Franklin, …….] has observed a single transaction
- But Tragedy of Commons argues that it is high
  - IRC channel is Open Access resource pool for rippers
  - =>Resource overgrazed
- Three main factors reduce price of CCN
  - Banks detect fraud — e.g. 90%
  - Buyers demand premium — e.g. 5x
  - Rippers offer worthless CCNs — e.g. 90%
  - $2000 x 0.1 x 0.2 x 0.1 = $4

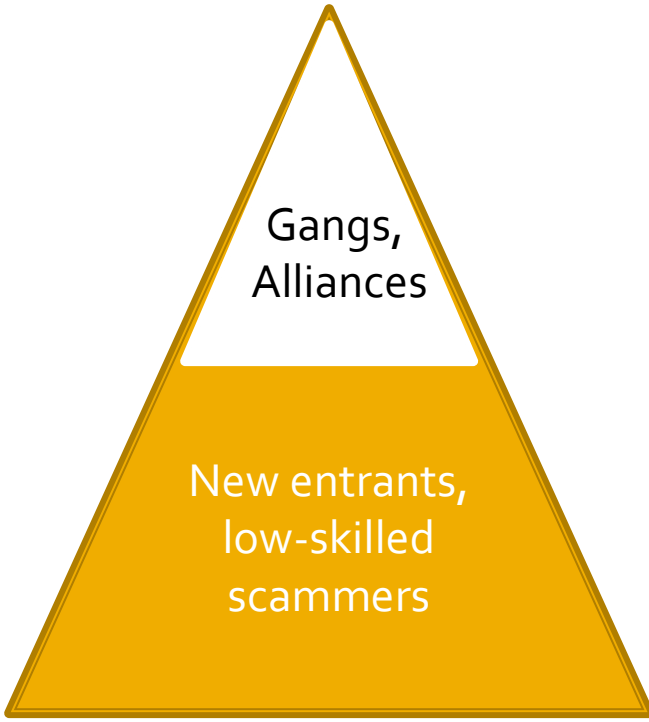
Avoiding the Ripper Tax: Formation of Gangs and Alliances

- Coase: "Nature of the Firm":
  - When transactions are taxed or uncertain it makes sense to form groups rather than buy/sell in a market.
- After a transaction with non-ripper makes more sense to deal with them again rather than pool of rippers/non-rippers

Two Tier Underground Economy

- Tier 1:
  - Avoid ripper tax
  - Extract all value from goods

- Tier 2:
  - Extract only part of value
  - No choice but to pay ripper tax



- Relying on markets for up/downstream services
  - Pay ripper tax on every transaction

What Can We Learn from this Market?

Why do these markets exist?

- Activity is real: e.g. 100k users/server

- Why does anyone trade in Lemon Market?
  - New entrants/need relationships
  - Sell resources that have no value to them
    - Cannot monetize
    - Sell kits/services with zero marginal cost
  - Intend to cheat others

Effort => Desperation

- Nobody sells in a Lemon Market if they have a choice
- Activity => there are a lot of people with no choice
- Goods are easy to acquire, hard to monetize
  - Creds, CCNs, SSNs etc

Symantec:
"Potential value of CCNs stolen $5.3bn"

- Total CCNs offered for sale: 46k CCNs
- Sum of asking prices: $163 million
- [Total offered for sale] x
  FTC Avg CCN fraud $5.3 billion
- So Symantec estimate = [Sum of asking prices] x 32
- This assumes:
  - 100% of goods offered on IRC channels sell (at asking price)
  - Banks detect 0% of attempted fraud
  - Rippers account for 0% of sales
  - Sellers give buyers 30x return

Here's a Simpler Explanation

- Buyers demand 5x return
- Final price 50% of ask
- Assume 10% of offered creds sell *and* are good

- Total CC fraud from channels:

  $$163 \times 5 \times .5 \div 10 = \$41 \text{ million}$$

- Factor difference with Symantec: 128x
  - Extrapolating from $0 to $5.3 bn is a big jump

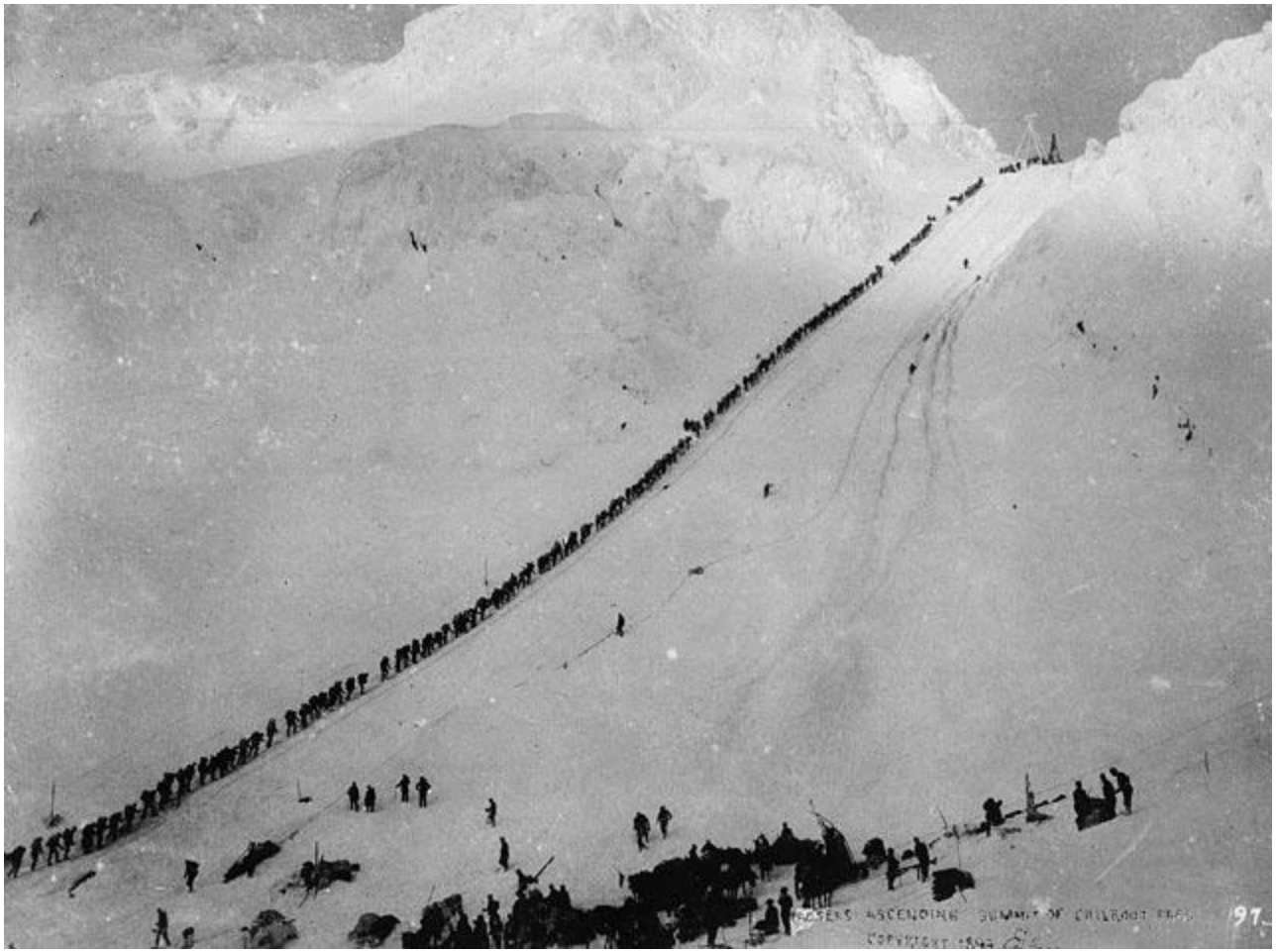
“But, they wouldn’t be doing this if they weren’t making money”

Effort ≠> Dollars

Phishing
- Denominator increasing
- Numerator decreasing

Spam

IRC channels:
- Newbies
- Rippers



Prospectors on the way to the Klondike 1897

Cannot estimate the gold in the mountains by activity at the shovel store

- News of Klondike gold strike July 1897
- Attempt to reach: 100000
- Reach Klondike: 20000
- Find any gold: 4000
- Get rich (> $5k): 300

- Gold extracted: $50 million
- Goods sold to prospectors: $100 million

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- No. They think they're going to make money
- Where would they get that idea?
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When we encourage overestimation of returns we make things worse.

Ironies

- Irony: Whitehats recruit their own opponents
  - Dubious reports of cybercrime riches
  - Recruits new entrants to Tier 2
  - Contribute to spam/phishing
- Irony II: realistic estimates benefits (almost) all
  - Who benefits: Banks, Users, InfoSec comm, Tier 1, Tier 2
  - Who suffers: Rippers

A few things that start to make sense

Credentials and Rippers

- Rippers abound on IRC channels
  - Cheating works because of newbies
- Creds sell for pennies on the dollar?
  - Most on IRC channels are junk
  - Creds easy to acquire, hard to monetize

Where are the bodies/loot

- Why so hard to find 5 million phishing victims
  - Off by 10x
- Who lost $3.2 billion
  - Off by 50x

Banks and Users

- Banks and Two-factor
  - Average loss/user/year $0.34
- Users have no liability for direct losses
  - Ignoring security advice rational

So you're saying Cybercrime is no big deal?

Single Spam Campaign

- Kanich et al. [Pharma campaign]
  - 350 million emails
  - 28 sales
  - $2731
- Indirect costs > 10 x direct costs
  - 1% got into inboxes, 2 seconds/recipient, 2xmin wage: $28k
  - Also, bandwidth, storage, provisioning

Direct and Indirect Costs

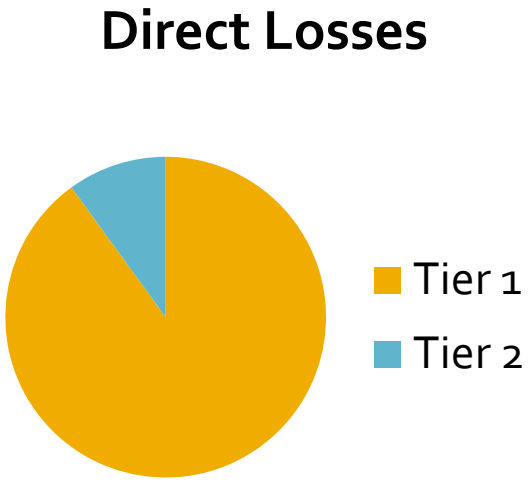
- Direct costs: zero-sum game
- Indirect costs: negative sum

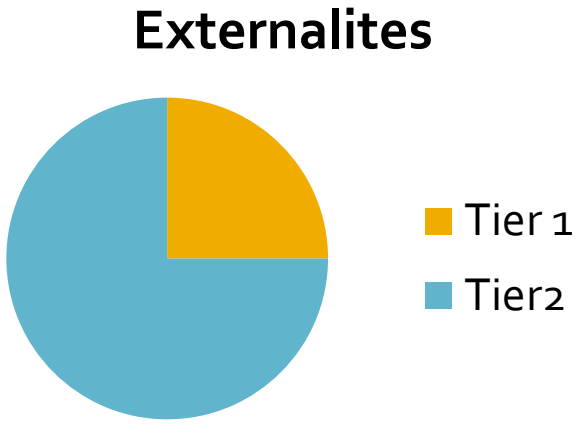
	Direct Costs	Indirect Costs
Phishers	+$60 million	Don't care
Banks	-$60 million	Customer support, new technology, Reputation, fraud detection.
Users	$0	Time, Effort, hassle

- Indirect costs >> direct costs

Direct Losses and Externalities

- Tier 1 prob gets the bulk of the direct gains
- Externalities are caused by all who spam/phish
  - (not just those who do it well)





Harder to apply economic incentives to Tier 2

Conclusions

Conclusions:

- Stuff on IRC channels
  - Easy to acquire, hard to monetize
- Effort ≠> dollars
  - Amount of spam, phishing etc not indicative of profit
- Cybercrime is a ruthlessly competitive predatory industry
  - Low-skill dead-end jobs
- Published cybercrime estimates hugely exaggerated
- Repeating claims makes matters worse.

Conclusions: Underground markets

- "Underground Markets are easy money"
  - Violates basic economics
  - Defies common sense
  - Contradicts experience from other crime
  - Unsupported by evidence
- Stories about "easy money" in cybercrime are so 2006

Supporting documents

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