The Ghosts of Banking Past

Empirical Analysis of Closed Bank Websites

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Motivation

- The US has thousands of banks, and each year hundreds close through collapse or by acquisition
- While the FDIC has established an orderly process for winding down many bank assets after closure, the websites are often forgotten
- Customers may still try to visit websites after banks have closed, which could lead to confusion
- We set out to measure how prevalent ‘ghost’ banking domains are in practice

Outline

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Outline

FDIC data collection

- The FDIC provides an online database of all institutions it has supervised, including those which no longer exist due to merger or collapse
- We focused on 3 181 banks merged or closed between 1 July 2003 and 6 June 2013
- We obtained 2 302 URLs matching 2 393 banks
- For each URL, we fetched WHOIS details and a screenshot of the rendered website

Categorizing bank domain usage

- We manually inspected each of the screenshots and grouped them into one of the following categories
  1. Operable bank-held website (old bank, redirect, or interstitial)
  2. Domain parking pages with syndicated advertisements
  3. Websites used to distribute malware
  4. Other forms of reuse (e.g., blog spam, black-hat SEO)
  5. Inoperable websites (e.g., blank pages, misconfigured websites)
  6. Inactive domains (unregistered, or not resolving)

Identifying whether a bank still controls a domain

- We used the following heuristics to confirm that a bank controls a domain
  1. Any website whose screenshot is categorized as a bank *and* the domain has been continuously registered since before the bank closed
  2. Any website that redirects to a currently open bank website URL that appears in the FDIC list
  3. Any domain with WHOIS information indicating ownership by a bank

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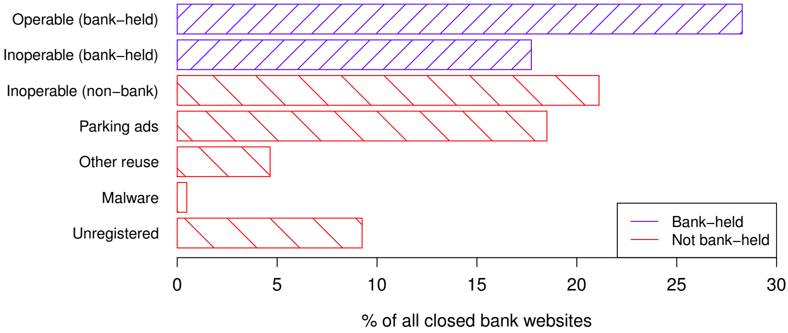
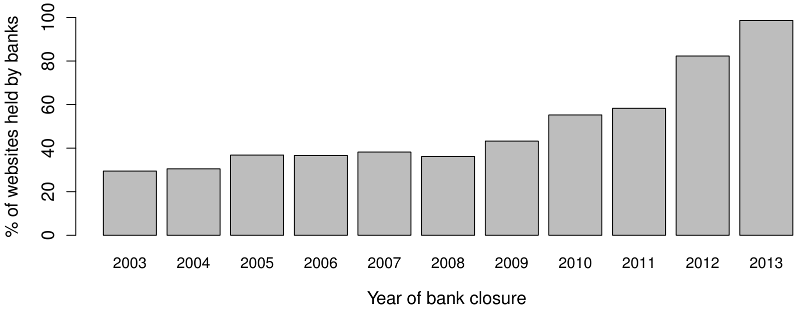
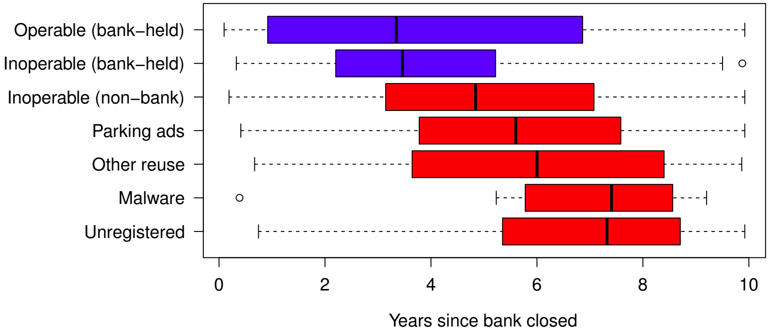
How closed banks are used



Fraction of closed banks whose domains are still owned by a bank, by year of bank closure



Lifecycle of domain reuse



What factors affect the chances a bank domain will be abandoned?

1. **Bank size**
   - Hypothesis: Smaller banks more likely to be abandoned than larger banks
   - Indicator: $\log(\text{Deposits})$
2. **Troubled circumstances at closure**
   - Hypothesis: Troubled banks *more likely* to be abandoned
   - Indicator: Boolean variable set to True if the bank collapsed or was merged with FDIC assistance
3. **Time since closure**
   - Hypothesis: The longer time since a bank has closed, the *more likely* the domain is to be abandoned
   - Indicator: Years since the bank has closed

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Logistic regression 1: Factors affecting abandonment

$$\log \frac{p_{abandoned}}{1-p_{abandoned}} = c_0 + c_1 \log(\text{Deposits}) + c_2 \text{ Troubled} + c_3 \text{ Years closed} + $$

Regression 1			Response variable: *Abandoned*	
	coef.	Odds Ratio	95% conf. int.	Significance
(Intercept)	0.58	1.79	(0.90,3.63)	-
log(Deposits)	-0.17	**0.84**	(0.80,0.89)	$p \ll 0.0001$
Troubled	0.87	**2.38**	(1.90,2.98)	$p \ll 0.0001$
Years closed	0.29	**1.33**	(1.29,1.39)	$p \ll 0.0001$
Model fit:	$\chi^2 = 322.8, p \ll 0.0001$			

The resurrection of abandoned bank domains

- 535 bank domains have been allowed to expire at some time after the bank closed
- 326 of these have subsequently been resurrected, that is, re-registered and a new creation date has been recorded in the WHOIS
- We next examine why some domains are resurrected while others aren't

What factors affect the chances an abandoned bank domain will be re-registered?

1. **Bank size**
   - Hypothesis: Larger banks *more likely* to be re-registered
   - Indicator: $\log(\text{Deposits})$
2. **Troubled circumstances at closure**
   - Indicator: Boolean variable set to True if the bank collapsed or was merged with FDIC assistance
3. **Time since closure**
   - Hypothesis: The longer time since a bank has closed, the *less likely* the domain is to be re-registered
   - Indicator: Years since the bank has closed

Logistic regression 2: Factors affecting re-registration

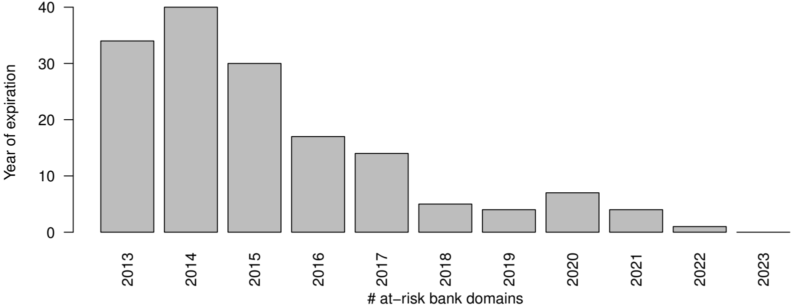
$$\log \frac{p_{registered}}{1 - p_{registered}} = c_0 + c_1 \log(\text{Deposits}) + c_2 \text{ Troubled} + c_3 \text{ Years closed} +$$

Regression 2			Response variable: *Registered*	
	coef.	Odds Ratio	95% conf. int.	Significance
(Intercept)	-0.84	0.43	(0.13,1.38)	-
log(Deposits)	0.33	**1.39**	(1.27,1.53)	$p \ll 0.0001$
Troubled	0.73	**2.08**	(1.18,3.86)	$p = 0.0151$
Years closed	0.24	**0.79**	(0.73,0.85)	$p \ll 0.0001$
Model fit:	$\chi^2 = 120.7, p \ll 0.0001$			

Identifying at-risk bank websites

- We consider a bank-controlled website to be *at-risk* if, according to the WHOIS record, the domain has not been updated since before the bank closed but has yet to expire
- In this circumstance, the bank has not yet had to make a decision whether or not to renew the domain (if they even know there's a decision to be made!)
- 157 of 1 127 bank-controlled websites are at-risk of falling out of bank control

At-risk banks by year of domain expiration



Outline

What is the harm imposed by ghost domains in general?

- Ghost domains are a problem not only for banks
  - At one end, businesses regularly close and domainers are often quick to buy their associated domain names to exploit residual traffic or resell
  - Cybercrime domains (e.g., botnet C&C) are registered to do harm, so their permanent removal seems desirable
  - Banks fall somewhere between, since trust in banking is so crucial to the sector's fiscal health
- We now review a range of mechanisms to reassert control over domains where restrictions over re-registration can be justified

Mechanisms to protect ghost domains

1. **Permanent cancellation**
   - + Avoids any possible harm
   - - Overkill; impractical (and often unwise) to enforce permanence
2. **Prepaid escrow:** certain classes of domains (e.g., banks) must prepay registration fees for many years in the future
   - + Avoids all harm
   - - Only practical in highly-regulated industries
3. **Trusted repository:** neutral body holds domains in trust and decides when and if to reopen a domain to registration
   - - Selecting criteria to release is difficult
   - - Funding could be problematic
4. **Warning lock:** automatic tracking of high-value domains with notification before expiry and volunteers choose whether to defensively register
   - - Selecting criteria to release is difficult
   - - Impact likely extremely patchy

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Conclusions

- When banks close, their domains are often forgotten: 53% of domains for US banks closed in the past decade are no longer controlled by banks
- This can create confusion for consumers and opportunities for cybercriminals
- Regression analysis has shown that smaller or troubled banks are more likely to abandon domains, while larger and more recently closed banks are more likely to be re-registered
- We recommend that bank regulators help coordinate the defensive registration of at-risk domains
- For more: `http://lyle.smu.edu/~tylerm/`

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