Property Appraisal Manipulation and Mortgage Loan Performance

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Lax Mortgage Underwriting v. Failure to Follow Underwriting Guidelines

The housing bubble formed partly because of "looser loan underwriting practices," and partly because of "poor underwriting practices." Testimony of John C. Dugan, Comptroller of the Currency before the Financial Crisis Inquiry Commission (2010).

- "[L]ooser loan underwriting practices" (i.e., lax underwriting guidelines) were disclosed
- "[P]oor underwriting practices" (i.e., failure to follow guidelines) were not
    - Sloppy work
    - Fraud

Laxity was too small to have caused a crisis...

"Low house price appreciation was quantitatively too small to explain the poor performance of 2006 and 2007 vintage loans. . . . [The authors] uncover a downward trend in loan quality, determined as loan performance adjusted for differences in [reported] loan and borrower characteristics and macroeconomic circumstances." Demyanyk and van Hemert (2011)

Failure to follow guidelines has been more difficult to discern

Sloppy work

Economies of production particularly important during boom times

- Employment verification
- Stated income verification
- Drive-by appraisals

Failure to follow guidelines has been more difficult to discern

Fraud

Fraud is important both during boom and bust periods

"During boom periods, high mortgage loan volume impacts expedited quality control efforts which often focus on production. Therefore, perpetrators may submit loans based on fraudulent information anticipating that the bogus information will be overlooked. [During busts], loan officers, brokers, and others in the industry are paid by commission and may be tempted to approve questionable loans when the housing market is down to maintain current levels of income." U.S. Federal Bureau of Investigation (2007)

Types of fraud

- Occupancy Fraud (Mayer, et al. 2009; Piskorski, et al. 2015; Elul and Tilson 2015)
- Employment and Income Fraud (Jiang, et al. 2014; Hayre, et al. 2008; Mian and Sufi 2017; Garmaise 2015)
- Property Valuation (Appraisal) Fraud (Agarwal, et al. 2015; Ben-David 2011; Griffin and Maturana, 2016; Carrillo 2013; Mian and Sufi 2017; Piskorski, et al. 2015; Demiroglu and James 2016)
  - Appraisal fraud accounted for up to 40% of fraud reported to the MIDEX from 2000-2004

Manipulation v. Fraud

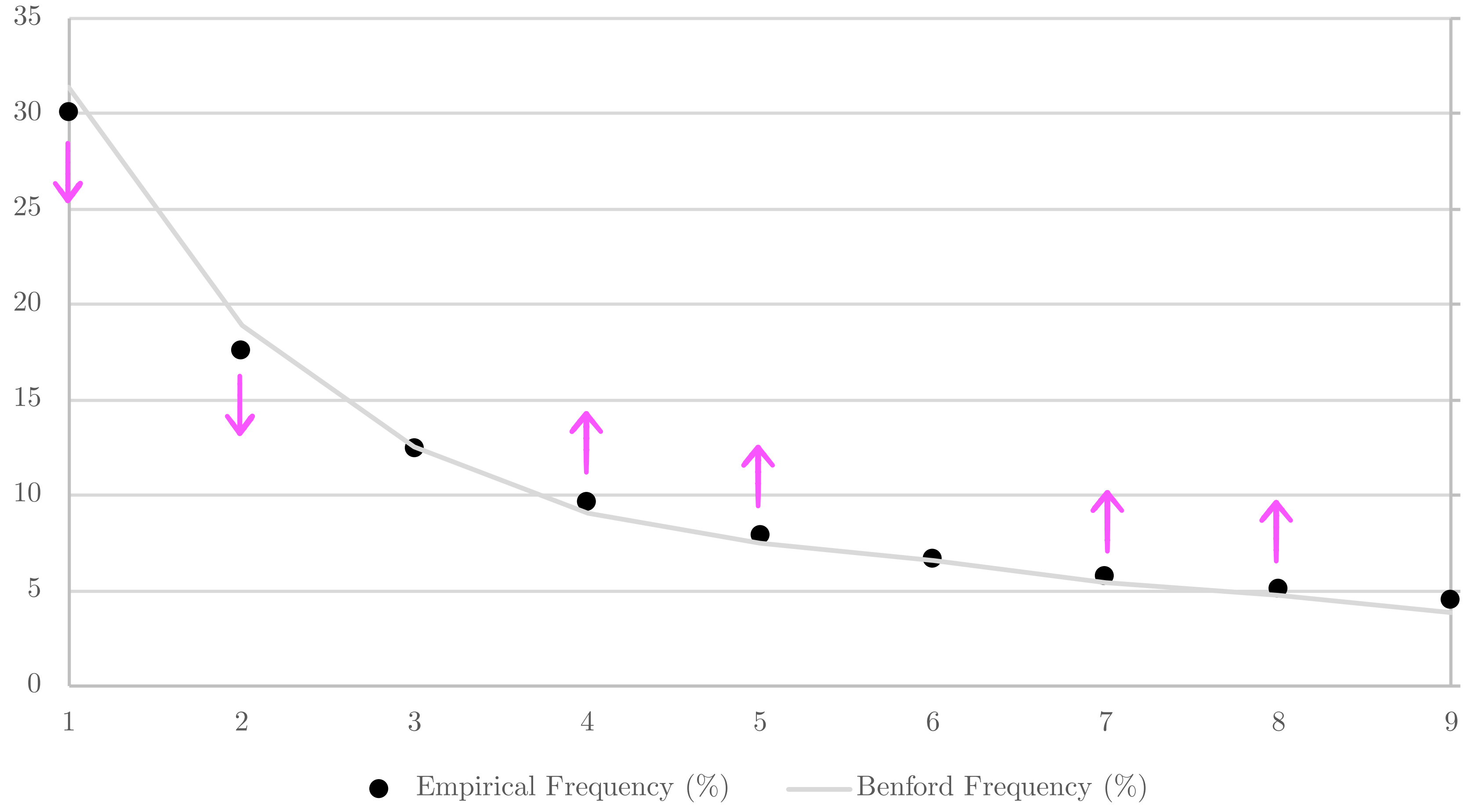
Manipulations result in a distributional shift from natural patterns

- Whether arising from sloppiness or fraud, numbers have been manipulated

Fraud is hypothesized to result in a shift toward *riskier* loans

- Random sloppiness is hypothesized to result in a more random shift
- While association with risk is *consistent* with fraud, it is not evidence of such fraud in and of itself

Figure 0.4: Benford and Empirical Frequencies of the Leftmost Single Digit of Appraisals



Differences small... ...but statistically significant.

Table 2. Benford Compliance in the First Digit: Entire Sample

	N	MAD	r	m	d^*	a^*	χ^2	V_N^*	m_N^*	d_N^*
All mortgages	20,785,187	0.0058	0.9992	0.0131	0.0206	0.1263	76,428.1147	118.54	59.2680	94.1023

Notes. The table examines the goodness-of-fit to Benford's distribution of the first digit of appraised value for the whole data. Distance measures include the mean absolute deviation (MAD= $\sum_{i=1}^{9}\frac{|e_i-b_i|}{9}$), Pearson correlation coefficient (r), Leemis et al.'s (2000) measure ($m = \max_{i\in\{1,\ldots 9\}} |e_i - b_i|$), the modified Cho and Gaines' (2007) measure ($d^* = \frac{[\sum_{i=1}^{9}(e_i-b_i)^2]^{0.5}}{[\sum_{i=1}^{8} b_i^2+(1-e_9)^2]^{0.5}}$), and Judge and Schechter's (2009) measure ($a^* = |\mu_e - \mu_b| / \left[\sum_{i=1}^{8} b_i^2 + (1-e_9)^2\right]^{0.5}$). For goodness-of-fit tests, we use four statistics including $\chi^2 = \sum_{i=1}^{9}[(e_i - b_i)^2/b_i]$, the modified Kuiper's statistic ($V_N^* = V_N(N^{0.5} + 0.155 + 0.24N^{-0.5})$, where $V_N = \max_i[F_e(i) - F_b(i)] - \max_i[F_b(i) - F_e(i)]$) and Morrow's two asymptotic test statistics ($m_N^* = \sqrt{N}m$ and $d_N^* = \sqrt{N}d$). MAD from 0% to 0.4% indicates close conformity; 0.4% to 0.8% indicates acceptable conformity; 0.8% to 1.2% implies marginally acceptable conformity; greater than 1.2% means no conformity (Drake and Nigiri 2000). With eight degrees of freedom, critical values for χ^2 are 13.36, 15.51, and 20.09 respectively at the 90%, 95%, and 99% significance level. Benford-specific critical values are 1.191, 1.321, and 1.579 respectively at the 10%, 5%, and 99% significance levels for V_N^*. Critical values for m_N^* are 0.851, 0.967, and 1.212 respectively at the 10%, 5%, and 1% significance levels. Critical values for d_N^* are 1.212, 1.330, and 1.569 (Morrow 2014).

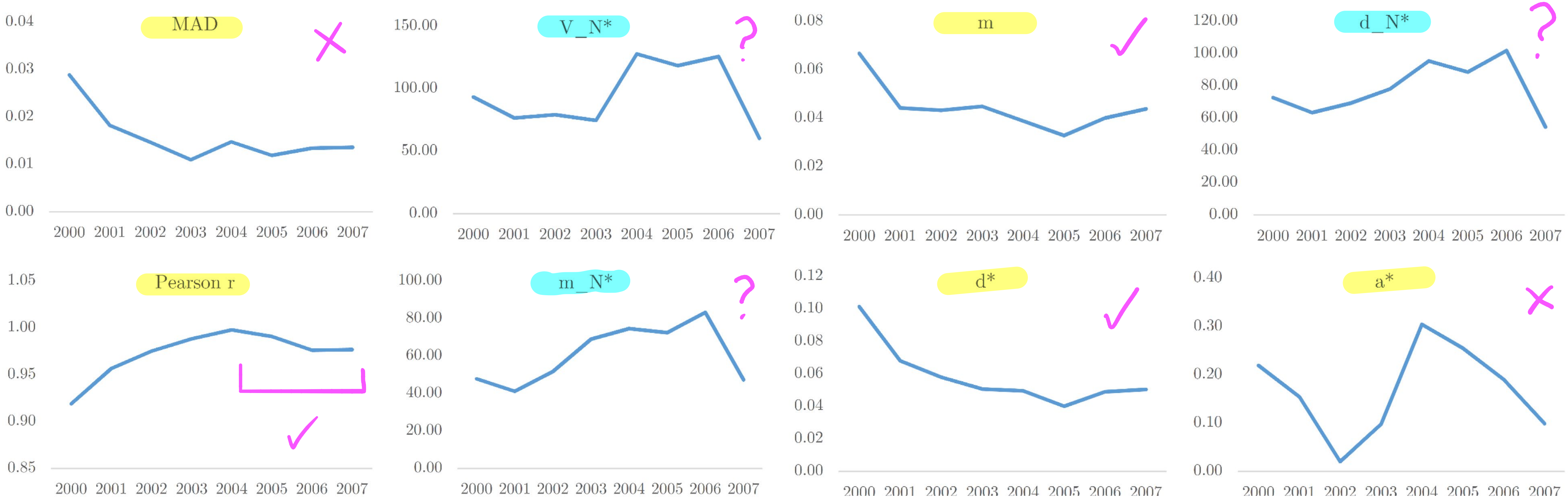
Table 3. Comparison of the First Digit Deviations from Benford Distribution between Risky and Less Risky Mortgage Loans

	N	MAD	R	M	d^*	a^*	χ^2	V_N^*	m_N^*	d_N^*
FICO $<$ 620	6,846,690	0.0166 ✗	0.9910	0.0605	0.0693	0.2451	196,263.19	194.95	158.31	181.30
FICO $\geq$ 680	8,183,130	0.0097 ✓	0.9910	0.0312	0.0387	0.1077	107,060.19	125.23	89.81	111.53
Δ distance		71.99%	0.00%	93.91%	78.83%	127.51%	83.32%	55.68%	76.26%	62.56%
LTV $\geq$ 100%	1,034,631	0.0151 ✗	0.9856	0.0583	0.0660	0.1364	25,590.18	69.38	59.30	67.16
LTV $<$ 80%	9,786,677	0.0029 ✓	0.9989	0.0066	0.0104	0.0110	12,643.08	29.72	20.65	32.55
Δ distance		422.22%	-1.33%	783.33%	534.51%	1137.20%	102.40%	133.44%	187.21%	106.31%
CLTV $\geq$ 100%	2,500,784	0.0235 ✗	0.9962	0.0708	0.0866	0.4828	131,145.55	167.01	111.96	137.00
CLTV $<$ 80%	9,409,618	0.0035 ✓	0.9991	0.0098	0.0127	0.0363	15,047.54	42.33	30.06	38.90
Δ distance		576.60%	-0.29%	622.45%	583.12%	1230.84%	771.54%	294.51%	272.44%	252.17%
DTI $>$ 44.74%	856,050	0.0177 ✗	0.9940	0.0399	0.0575	0.3770	26,949.27	73.75	36.92	53.25
DTI $<$ 31%	848,868	0.0087 ✓	0.9967	0.0232	0.0318	0.1635	6,869.65	36.12	21.38	29.26
Δ distance		103.31%	-0.28%	71.98%	81.19%	130.55%	292.29%	104.17%	72.71%	81.95%
Junior-lien	2,863,633	0.0277 ✗	0.9930	0.0605	0.0916	0.5644	205,089.96	210.87	102.38	155.00
First-lien	16,328,330	0.0034 ✓	0.9992	0.0074	0.0121	0.0548	27,583.38	49.70	29.90	48.90
Δ distance		706.80%	-0.62%	717.57%	656.84%	930.74%	643.53%	324.25%	242.38%	216.95%

Table 3. Comparison of the First Digit Deviations from Benford Distribution between Risky and Less Risky Mortgage Loans (continued)

	N	MAD	R	M	d^*	a^*	χ^2	V_N^*	m_N^*	d_N^*
IO	3,337,244	0.0257 ✗	0.9103	0.0733	0.0915	0.0329	193,823.94	211.38	133.91	167.13
No IO	16,952,903	0.0084 ✓	0.9980	0.0294	0.0335	0.1420	109,894.08	155.64	121.05	137.73
Δ distance		205.68%	-8.79%	149.32%	173.51%	-76.81%	76.37%	35.81%	10.62%	21.35%
NegAm	1,167,583	0.0392 ✗	0.6802	0.1440	0.1621	0.3058	192,117.95	190.85	155.60	175.15
No NegAm	19,402,323	0.0080 ✓	0.9988	0.0224	0.0291	0.1536	114,136.75	159.02	98.67	128.33
Δ distance		387.85%	-31.90%	542.86%	456.36%	99.04%	68.32%	20.02%	57.70%	36.48%
Balloon	1,889,233	0.0254 ✗	0.9498	0.0663	0.0866	0.4204	144,600.26	157.12	91.13	119.01
No Balloon	18,895,954	0.0052 ✓	0.9992	0.0156	0.0197	0.0965	51,899.24	100.85	67.81	85.44
Δ distance		385.35%	-4.95%	325.00%	340.52%	335.75%	178.62%	55.79%	34.38%	39.29%
Pur (1)	8,597,915	0.0075 ✓	0.9990	0.0158	0.0252	0.1743	54,493.39	98.23	46.33	73.96
REFI (2)	2,849,445	0.0117 ✗	0.9848	0.0225	0.0393	0.1586	47,079.57	88.97	37.98	66.32
COREFI (3)	7,386,478	0.0086 ✓	0.9945	0.0260	0.0308	3.2950	65,251.76	104.64	70.66	83.57
Δ distance (1 vs 2)		56.00%	-1.42%	42.41%	55.95%	-9.01%	-13.60%	-9.43%	-18.02%	-10.33%
Δ distance (1 vs 3)		14.75%	-0.45%	64.56%	21.92%	1790.83%	19.74%	6.52%	52.52%	13.00%

Figure 3. Benford Conformity Measure and Test Statistic Dynamics for the First Digit in Appraisals



Notes: These figures present annual variations of the distance between observed and Benford distributions of the leading digit in mortgage property appraisals from 2000 to 2007. The distance is measured with the mean absolute deviation (MAD), Pearson correlation coefficient (r), Leemis et al.'s (2000) measure (m), the modified Cho and Gaines' (2007) measure (d^*), and Judge and Schechter's (2009) measure (a^*). Test The statistics for goodness-of-fit tests are calculated with the modified Kuiper's statistic (V_N^*) and Morrow's two asymptotic test statistics (m_N^* and d_N^*).

Figure 0.5: Benford and Empirical Frequencies of the Leftmost Two Digits of Appraisals

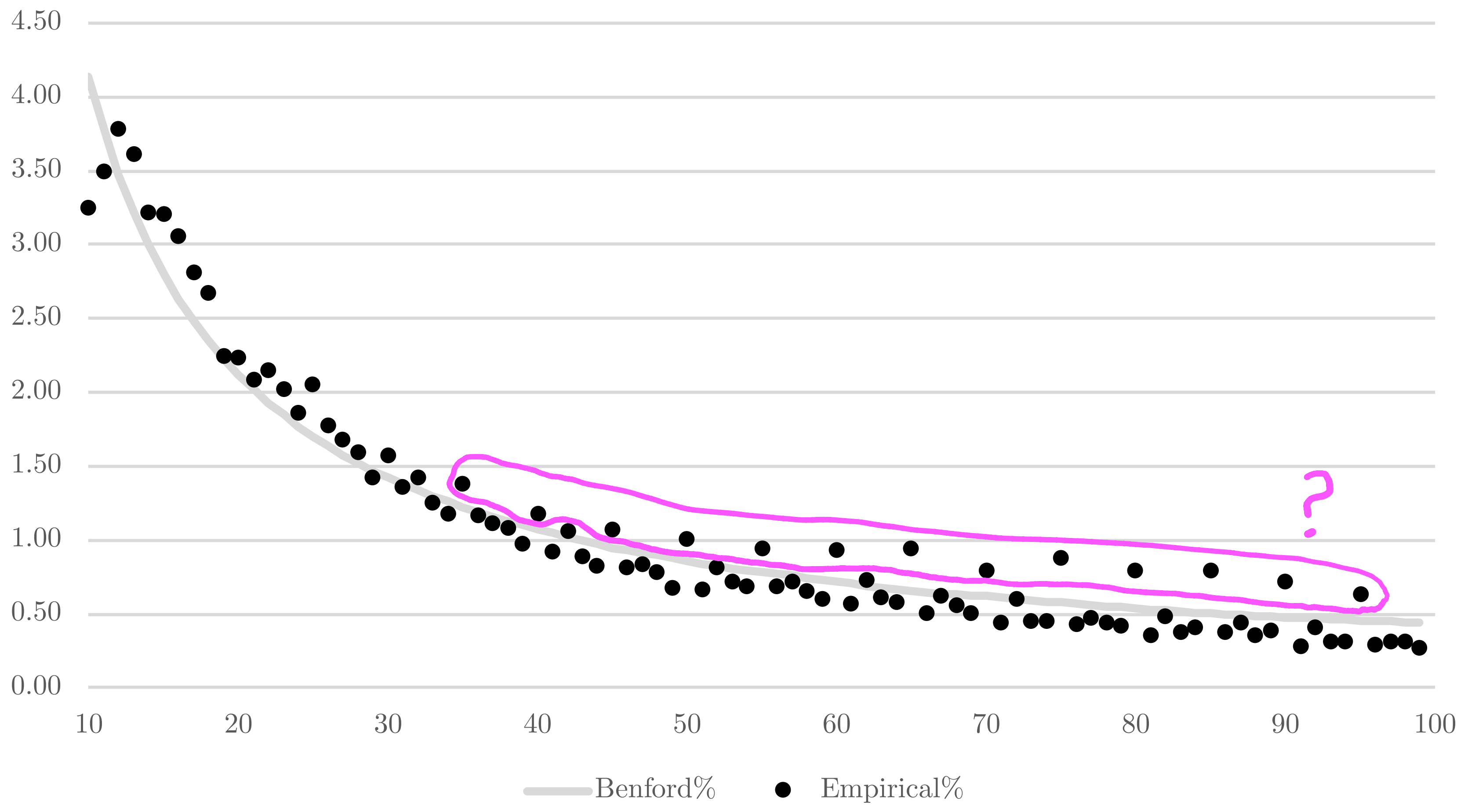


Figure 1: Benford and Empirical Frequencies of the Leftmost Three Digits of Appraisals

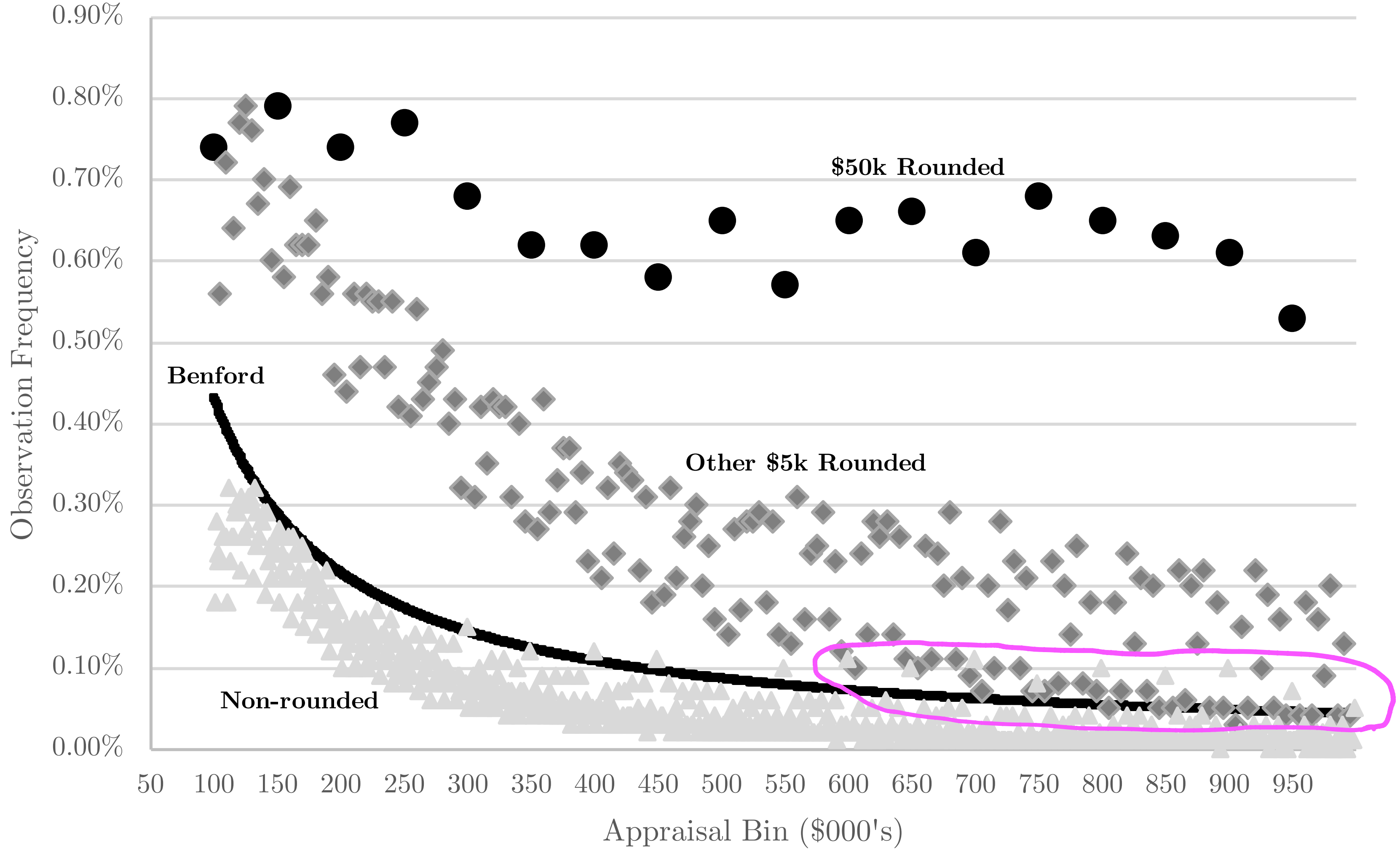
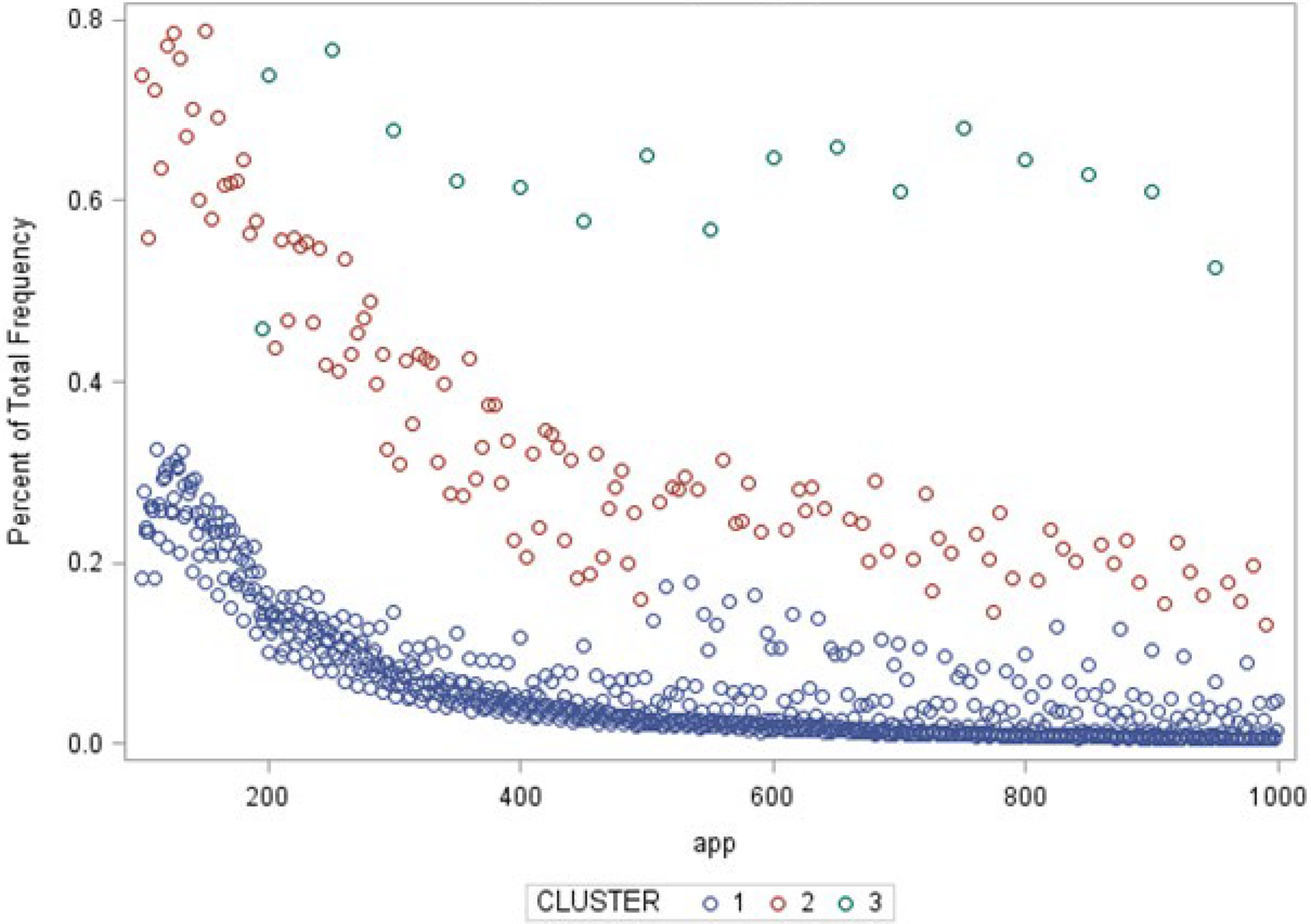


Figure 4. Empirical Frequency of the Leftmost Three Digits of Appraisals by Cluster

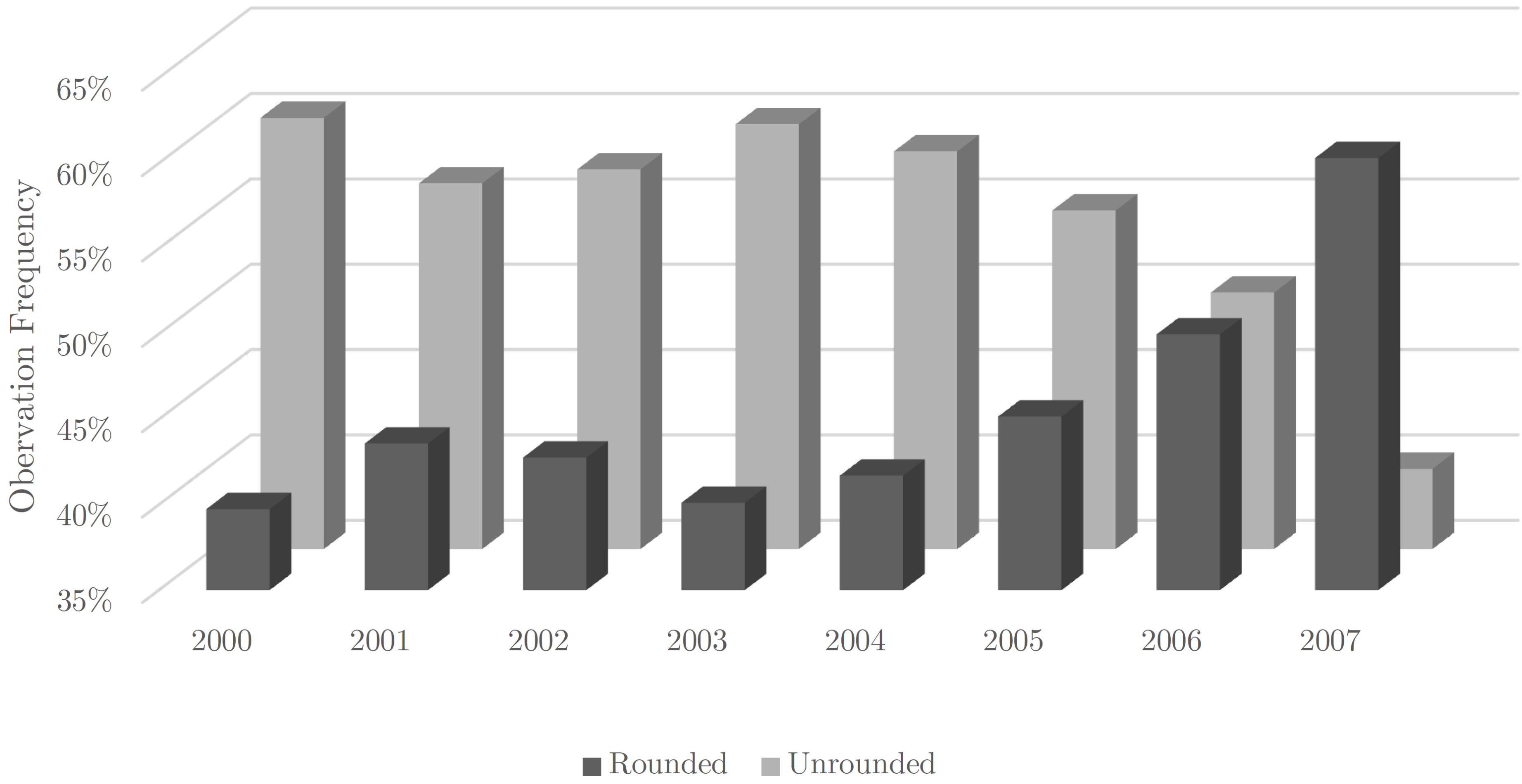


Notes: The figure presents untrained empirical frequencies of the leftmost three digits (100 to 999) in mortgage property appraisals. SAS procedures such as proc aceclus, proc cluster, and proc tree identify visually indistinguishable differences when used to identify the different clusters.

Three Cohorts

- Below Rounded, Above Rounded, and Rounded
  - Individuals without information are likely to report a round number
  - When self-interest is at stake, however, it is even more appealing for individuals to report *above* round numbers (See, e.g., Garmaise 2015 at p. 450 and related literature)
- Non-rounded, Rounded $5k, Rounded $50k
- Cluster 1 (~Non-rounded), Cluster 2 (~$5k), Cluster 3 (~$50k)

Figure 2. The Dynamics of Appraisal Rounding over Time



Notes: Figure 2 illustrates the time dynamics embedded in Figure 1.

Table 4. Appraisals At, Above and Below Rounding and Serious Delinquency ***(three months past due within the first 24 months)***

Panel A (Model 1)

Dependent variable:	Serious delinquency indicator							
	2000	2001	2002	2003	2004	2005	2006	2007
Rounded to $5k	0.0050***	0.0053***	0.0003	-0.0021***	-0.0017***	0.0030***	0.0191***	0.0171***
	(3.496)	(5.510)	(0.498)	(-5.289)	(-4.817)	(8.400)	(37.467)	(16.180)
Above $5k	0.0018	0.0003	-0.0000	-0.0010**	-0.0005	-0.0019***	-0.0028***	-0.0001
	(1.141)	(0.249)	(-0.042)	(-2.325)	(-1.188)	(-4.566)	(-4.768)	(-0.108)
adj. R-sq	0.0714	0.0776	0.0711	0.0670	0.0757	0.0748	0.1194	0.1432
N	267,475	491,409	957,814	1,660,602	2,627,839	3,717,785	3,638,907	1,031,483
Panel B (Model 2)								
Rounded to $5k	0.0047***	0.0047***	0.0000	-0.0021***	-0.0016***	0.0041***	0.0212***	0.0182***
	(3.649)	(5.480)	(0.043)	(-5.901)	(-5.093)	(12.530)	(46.888)	(20.173)
Rounded to $50k	0.0008	0.0074***	0.0017*	0.0002	-0.0008	0.0031***	0.0169***	0.0131***
	(0.316)	(4.661)	(1.853)	(0.354)	(-1.405)	(5.495)	(21.949)	(9.671)
adj. R-sq	0.0714	0.0777	0.0711	0.0671	0.0757	0.0748	0.1194	0.1432
N	267467	491248	957186	1657845	2627181	3717192	3637289	1031479
Panel C (Model 3)								
Rounded to Cluster 2	0.0206***	0.0153***	0.0099***	0.0077***	0.0111***	0.0088***	0.0151***	0.0130***
	(11.180)	(12.265)	(12.271)	(14.129)	(21.700)	(16.899)	(20.769)	(9.658)
Rounded to Cluster 3	0.0102***	0.0089***	0.0027***	0.0008**	0.0023***	0.0043***	0.0137***	0.0148***
	(7.747)	(10.549)	(5.178)	(2.430)	(7.446)	(13.627)	(30.967)	(17.123)
adj. R-sq	0.0718	0.0780	0.0712	0.0672	0.0758	0.0748	0.1191	0.1432
N	267467	491248	957186	1657845	2627181	3717192	3637289	1031479

Appraisal manipulation and interest-only, negative amortization, and balloon loans

- Panel A: Rounded loans increased the risk of SDQ in 2001, 2005, 2006, and 2007, regardless of exotic features.
  - Exotic loans moved over time from up to 5% less risky than Non-exotic loans in 2004 to almost 4% more risky than Non-exotic loans in 2007.
- Panel B: Rounded loans increased the risk of SDQ in 2000, 2001, 2005, 2006, and 2007, regardless of exotic features.
  - Exotic loans move over time from up to 5% less risky than Non-exotic loans in 2004 to almost 4% more risky than Non-exotic loans in 2007.
- Panel C: For all years, Cluster 2 was riskier than Cluster 1. No statistically significant difference between the effects of Cluster 2 and Cluster 3 in 2000 (for Non-exotic loans), 2006, and 2007.
  - Exotic loans moved over time from up to 6% less risky than Non-exotic loans in 2004 to around 3% more risky than Non-exotic loans in 2007.

Table 7. Appraisals At, Above and Below Rounding and Early Payment Defaults ***(three months past due within the first 12 months)***

Panel A (Model 1)

Dependent variable:	Early payment default indicator							
	2000	2001	2002	2003	2004	2005	2006	2007
Rounded to $5k	0.0053***	0.0064***	0.0027***	0.0014***	0.0023***	0.0032***	0.0137***	0.0133***
	(5.856)	(10.515)	(6.811)	(5.476)	(10.444)	(14.751)	(43.336)	(19.181)
Above $5k	0.0014	-0.0002	-0.0001	-0.0002	-0.0001	-0.0009***	-0.0006	-0.0005
	(1.438)	(-0.349)	(-0.331)	(-0.675)	(-0.567)	(-3.556)	(-1.639)	(-0.638)
adj. R-sq	0.0372	0.0428	0.0302	0.0287	0.0323	0.0366	0.0471	0.0715
N	292,516	534,880	1,046,773	1,802,553	2,859,604	3,979,340	3,765,139	1,044,429

Panel B (Model 2)

	2000	2001	2002	2003	2004	2005	2006	2007
Rounded to $5k	0.0046***	0.0063***	0.0025***	0.0012***	0.0023***	0.0035***	0.0139***	0.0137***
	(5.617)	(11.499)	(6.807)	(5.231)	(11.550)	(17.654)	(49.690)	(23.081)
Rounded to $50k	0.0051***	0.0076***	0.0040***	0.0020***	0.0025***	0.0044***	0.0141***	0.0134***
	(3.054)	(7.625)	(6.428)	(4.909)	(6.821)	(12.684)	(29.459)	(15.035)
adj. R-sq	0.0372	0.0428	0.0303	0.0288	0.0323	0.0366	0.0471	0.0715
N	292510	534714	1045820	1797461	2858669	3978645	3763292	1044425

Panel C (Model 3)

	2000	2001	2002	2003	2004	2005	2006	2007
Rounded to Cluster 2	0.0102***	0.0103***	0.0060***	0.0039***	0.0062***	0.0064***	0.0127***	0.0100***
	(8.684)	(12.762)	(11.159)	(11.008)	(19.313)	(20.196)	(28.164)	(11.246)
Rounded to Cluster 3	0.0063***	0.0071***	0.0028***	0.0015***	0.0024***	0.0031***	0.0091***	0.0102***
	(7.608)	(13.138)	(7.986)	(6.778)	(12.338)	(16.108)	(33.022)	(17.899)
adj. R-sq	0.0374	0.0430	0.0303	0.0289	0.0323	0.0366	0.0468	0.0713
N	292510	534714	1045820	1797461	2858669	3978645	3763292	1044425

Appraisal manipulation and interest-only, negative amortization, and balloon loans

- Panel A: Rounded appraisals are the riskiest for EPD in all years.
  - Exotic loans move over time from up to 2% less risky than Non-exotic loans in 2004 to around 1% more risky than Non-exotic loans in 2007.
- Panel B: Rounding is always associated with increased risk of EPD. $50k Rounding on Non-exotic loans was associated with increased risk of EPD over $5k rounding in all years except 2007.
  - Exotic loans move over time from up to 2% less risky than Non-exotic loans in 2004 to around 1% more risky than Non-exotic loans in 2007.
- Panel C: Clusters 2 and 3 are always associated with higher risk of EPD.
  - Exotic loans moved over time from up to 2% less risky than Non-exotic loans in 2004 to around 1% more risky than Non-exotic loans in 2007.

Conclusions

- Important to drill down to multiple digits
- Multiple cohorts in multiple digits may further obscure relationships

- Appraisal misrepresentation often associated with riskier loans
    - Rounded loans riskier than below or above
    - Not all rounding created equal: for SDQ, loans rounded to $5k/Cluster 2 riskier than $50k/Cluster 3
- Misrepresentations interact
    - Accounting for appraisal manipulation, other aspects such as "exotic" loan features are only important in later years, primarily 2007