ONLINE APPENDIX (SUPPLEMENTAL)

APPENDIX 1: STATISTICAL TESTS

If we treat the observed first digits as a set of unordered categories, the Pearson chi-squared test is appropriate. However, this test neglects the fact that the categories are ordered. The Kolmogorov-Smirnov test is well-known and often employed in Benford studies. It accounts for the ordering of the Benford distribution and tests the equality of an empirical distribution with a specified continuous distribution. The test is nonparametric when applied to continuous distributions. However, because the null (Benford) distribution is discrete, Kolmogorov-Smirnov p-values are conservative and depend on the parameters of the null distribution (Conover, 1972). We therefore use the modified Kolmogorov-Smirnov test (Joenssen, 2015). To avoid numerical instability issues, we use empirically simulated standard errors. The modified Kolmogorov-Smirnov test is powerful when there is a large violation of Benford's Law over a small portion of the support (range of possible values) of the statistical distribution and less powerful for small deviations spread throughout the support. This is because the test statistic is based on whichever digit has the largest deviation between empirical and null distributions, rather than combining the deviations of all digits.

Although the modified Kolmogorov-Smirnov test accounts for the ordering of the digits, it does not account for the circularity of this ordering. If we increase the value of a number with first digit 9, the result is a number with one more digit and a leading digit of 1. The digit 2 is to the right of the digit 1, the digit 3 is to the right of 2, …, and the digit 1 is to the right of 9. The Freedman-Watson U^2 test is specifically designed for distributions with a circular support. The U^2 statistic does not depend on labeling the minimum of a support, because there is no minimum on a circle. This is unlike the Kolmogorov-Smirnov test, which relies on cumulative distributions that would be different if we started with a 2 or a 3. In addition, the U^2 test incorporates all the

deviations in frequencies of digits, not just the largest deviation. The continuous Watson U^2 test is known to be more powerful than the continuous Kolmogorov-Smirnov test when the deviations from Benford's frequencies are spread throughout the support. Analytic results are not available for the discrete versions, but Monte Carlo simulations by Lesperance et al. (2016) find that the Freedman-Watson U^2 test is more powerful than Pearson chi-square and Kolmogorov-Smirnov tests (except when deviations are expected to be concentrated on larger values of the first significant digit and then Pearson's chi-square statistic is superior). Because we have no prior beliefs on the distribution of deviations, we prefer the U^2 test whenever the results of the three tests differ.

In light of the false-positive problem discussed in the text, statistical power may seem undesirable. But the false-positive problem is not due to tests being too powerful, it is due to the fact that the ideal null hypothesis would incorporate finite sample divergence from the Benford distribution.

ONLINE APPENDIX (SUPPLEMENTAL)

APPENDIX 2: CALCULATION OF EXCESS MAD

Barney and Schulzke (2016) report the formula for calculating the expected value of MAD as a function of the number of records N for the first-two-digits case. Making the appropriate adjustments for the first-digit case, this becomes:

$$E(MAD) = \sum_{k=1}^{9} \sum_{j=0}^{N} \binom{N}{j} (p_k)^j (1 - p_k)^{N-j} \frac{|(j/N) - p_k|}{9}$$

where: $p_k = \log_{10}(1 + 1/k)$

We calculated E(MAD) for N = 100, 105, 110, …, 175, 200, 250, 300, 350, 400, 450, and 500, then, following Barney and Schulzke, interpolated all other values by estimating the following regression line:

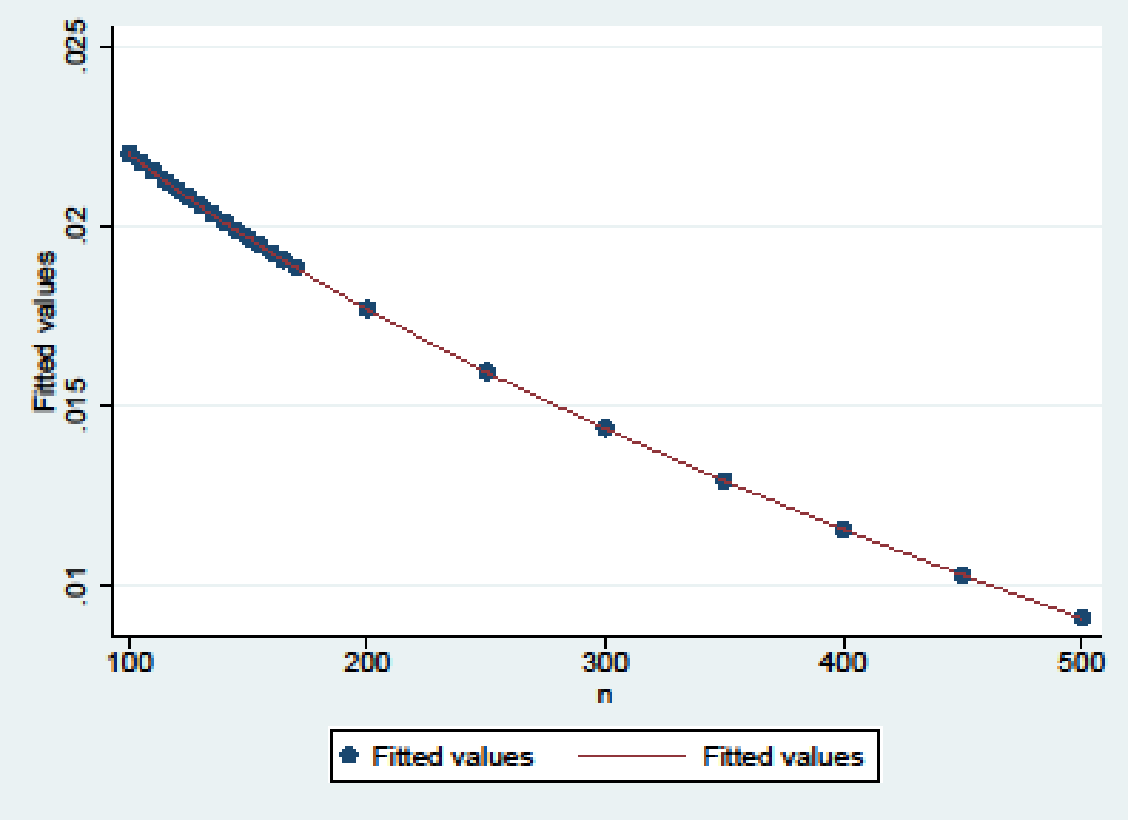
$$E(MAD) = 0.0590815 - 0.0079092 \ln(N)$$

Plots of fitted values for E(MAD) and residuals against N appear as Figure A2.1 and A2.2, respectively, indicating an excellent fit to the calculated values ($\bar{R}^2 = 0.9898$). Then, EXMAD was generated for each organization as:

$$EXMAD_j = Max\{(MAD_j - E(\widehat{MAD}|N_j), 0\}.$$

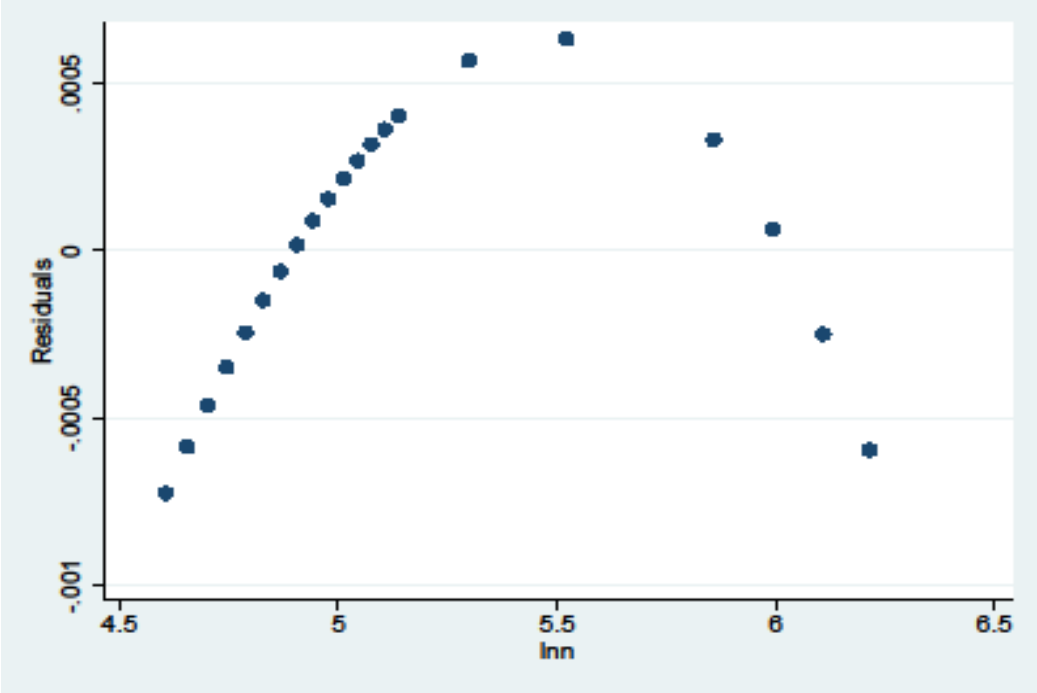
ONLINE APPENDIX (SUPPLEMENTAL)

Figure A2.1: Fitted Values of EXMAD



ONLINE APPENDIX (SUPPLEMENTAL)

Figure A2.2: Fitted minus Actual E(MAD)



ONLINE APPENDIX (SUPPLEMENTAL)

APPENDIX 3: TOBIT RESULTS

	Coefficients	Marginal Effects
Accrual accounting	0.0000141	0.0000
	(0.05)	(0.05)
Accounting fees	-0.000514**	-0.0004**
	(-1.93)	(-1.93)
Paid officers	-0.00157****	-0.0013****
	(-7.17)	(-7.18)
Reported 0 fundraising	-0.000106	-0.0001
	(-0.51)	(-0.51)
Reported 0 management	0.000164	0.0001
	(0.57)	(0.57)
Received government grants	-0.000787****	-0.0007****
	(-3.86)	(-3.86)
Received indirect public support	-0.000599***	-0.0005***
	(-2.88)	(-2.88)
Reported donor restricted funds	-0.000413**	-0.0004**
	(-1.86)	(-1.86)
Age	0.0000624****	0.0001****
	(9.52)	(9.54)
Average total assets (log)	0.000753****	0.0006****
	(11.47)	(11.51)
Number of observations	-0.0000443****	-0.00004****
	(-16.74)	(-16.85)
Number of annual reports	0.00224****	0.0019****
	(12.59)	(12.66)
Constant	-0.00348***	
	(-2.72)	
sigma _cons	0.00944****	
	(109.49)	

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Dependent variable is EXMAD, left-censored at zero. N=10889 of which 1,213 observations are left-censored. Coefficients for 27 NTEE subsectors not displayed. Significance levels account for hypotheses: we test the one-sided hypothesis that the coefficient is positive for reported zero fundraising and management costs and the one-sided hypothesis that the coefficient is negative for grants, indirect costs, and donor-restricted funds. All other tests are two-sided. *t* statistics in parentheses. Average marginal effects are for the observable dependent variable conditional on the latent variable being positive

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$

ONLINE APPENDIX (SUPPLEMENTAL)

APPENDIX 4: FORM 990 VARIABLES INCLUDED IN BENFORD ANALYSIS

Line on Form 990	**Variables included in Benford analysis**	Note
Part I Revenue		
1a	Direct public support	
1b	Indirect public support	
1c	Government contributions	
1d	*Total contributions (add lines 1a through 1c)*	*Included only when 1a-1c were 0 and 1d was positive*
2	Program service revenue	
3	Membership dues and assessments	
4	Interest on savings and temporary cash investments	
5	Dividends and interest from securities	
6a	Gross rents	
6b	Less: rental expenses	
6c	*Net rental income or (loss) (subtract line 6b from line 6a)*	*Included only when 6a-6b were 0 and 6c was positive*
7	Other investment income	
8a (A)	Gross amount from sales of assets other than inventory; securities	
8b (A)	Less: cost or other basis and sales expenses; securities	
8c (A)	*Gain or (loss); securities*	*Included only when 8a(A)-8b(A) were 0 and 8c(A) was positive*
8a (B)	Gross amount from sales of assets other than inventory, other	
8b (B)	Less: cost or other basis and sales expenses; other	
8c(B)	*Gain or (loss); other*	*Included only when 8a(B)-8b(B) were 0 and 8c(B) was positive*
9a	Special events and activities: Gross revenue	
9b	Less: direct expenses other than fundraising expenses	
9c	*Net income or (loss) from special events (subtract line 9b from line 9a)*	*Included only when 9a-9b were 0 and 9c was positive*
10a	Gross sales of inventory, less returns and allowances	
10b	Less: cost of goods sold	

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10c	*Gross profit or (loss) from sales of inventory (subtract line 10b from line 10a)*	*Included only when 10a-10b were 0 and 10c was positive*
11	Other revenue	
Part II Functional Expenses (Column B Program services only)		
22	Grants and allocations	
23	Specific assistance to individuals	
24	Benefits paid to or for members	
25	Compensation of officers, directors, etc.	
26	Other salaries and wages	
27	Pension plan contributions	
28	Other employee benefits	
29	Payroll taxes	
30	Professional fundraising fees	
31	Accounting fees	
32	Legal fees	
33	Supplies	
34	Telephone	
35	Postage and shipping	
36	Occupancy	
37	Equipment rental and maintenance	
38	Printing and publications	
39	Travel	
40	Conferences, conventions, and meetings	
41	Interest	
42	Depreciation, depletion, etc. (attach schedule)	
43	Other expenses (itemize)	
44	*Total functional expenses*	*Included only when 22-43 were 0 and 44 were positive*
Part IV Balance Sheets: Column (A) Beginning of year, Column (B) End of year		
45	Cash—non-interest-bearing	
46	Savings and temporary cash investments	
47	Accounts receivable	
48	Pledges receivable	
49	Grants receivable	
50	Receivables from officers, directors, trustees, and key employees	
51	Other notes and loans receivable	
52	Inventories for sale or use	

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53	Prepaid expenses and deferred charges	
54	Investments—securities	
55	Investments—Land, buildings, and equipment	
56	Investments—other	
57	Land, buildings, and equipment	
58	Other assets	
60	Accounts payable and accrued expenses	
61	Grants payable	
62	Deferred revenue	
63	Loans from officers, directors, trustees, and key employees	
64	Tax-exempt bond liabilities	
65	Other liabilities	
67	Unrestricted	
68	Temporarily restricted	
69	Permanently restricted	
70	Capital stock, trust principal, or current funds	
71	Paid-in or capital surplus, or land, building, and equipment fund	
72	Retained earnings, endowment, accumulated income, or other funds	

Excluded line items that involve adding or subtracting other line items, such as total revenue, total expenses, excess or (deficit) for the year, net assets or fund balances of beginning of year, other changes in net assets or fund balances, net assets or fund balances at end of year, total functional expenses on program services, management and general, and fundraising, and total assets and total liabilities beginning of year and end of year. Excluded detailed functional expenses on management and fundraising and kept only those on program expenses.