BA870: Topics in Financial & Accounting Analytics

Lecture #4 (Thursday, March 31, 2022)

Professor Peter Wysocki

Topics: Detecting Accounting Manipulations

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Why Managers “Cook the Books”

- Central Theme: Companies and managers are often motivated to misstate sales, earnings and balance sheet items
  - Contracting Incentives:
    - Avoid violating lending agreements based on financial ratios
    - Maximize bonus based on accounting performance
    - Avoid government/regulatory/union intervention
    - Maximize stock price (sale of shares to investors or by managers)
  - Stock market incentives:
    - Meet analysts’ earnings forecast targets
    - Maximize stock price (sale of shares to investors or by managers)

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Red Flags - Accounting Manipulations

- Warning signs to watch out for:
    - Net Income grows faster than Cash flow from Operations.

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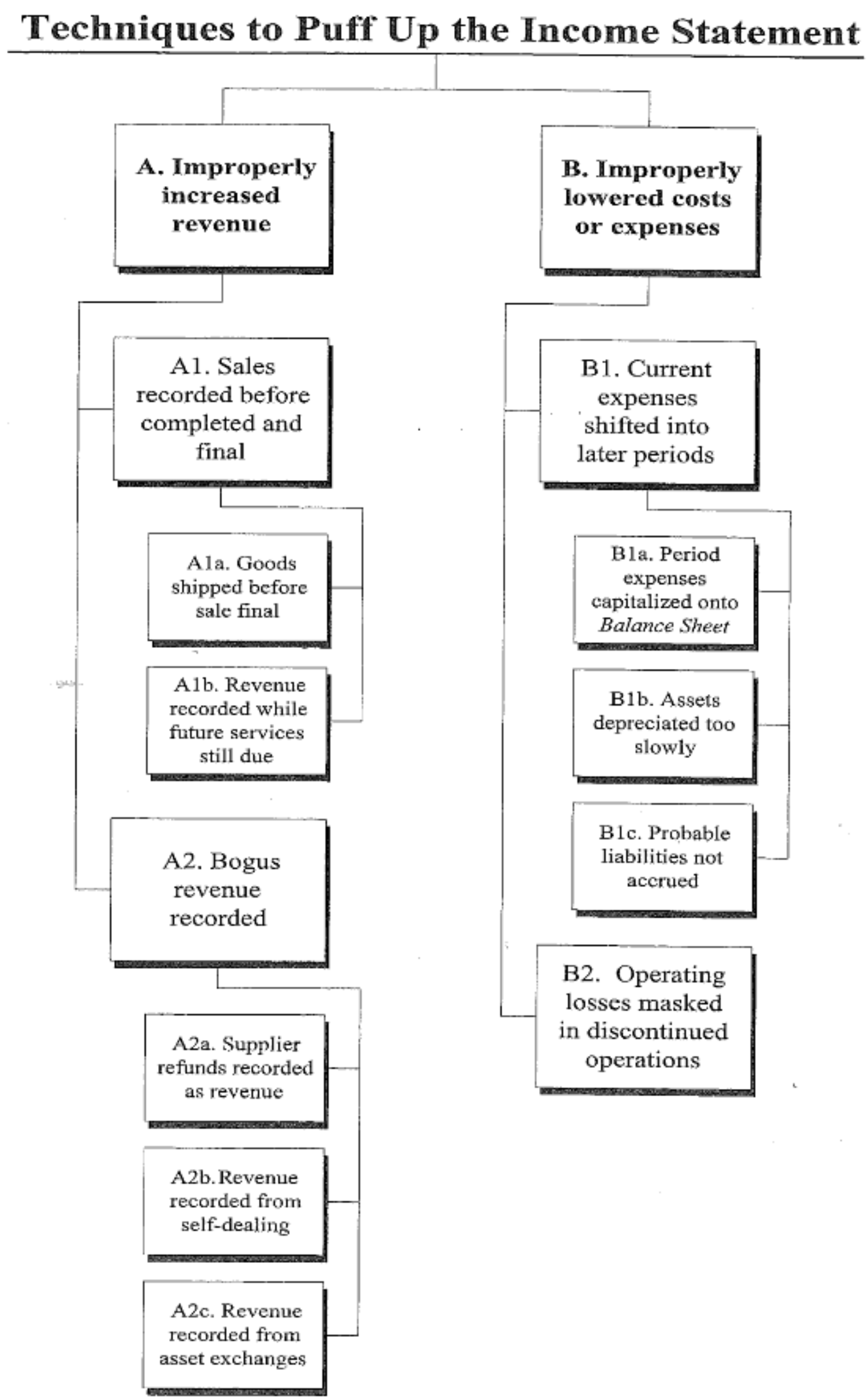
  - Accounts Receivable grows faster than Sales.
  - Sales slow while inventories pile up.
  - Allowance for Doubtful Accounts are cut sharply.
  - Methods for calculating revenue, expenses, depreciation are changed.
  - Sales are booked before payments received.
  - Dramatic increase or decrease in gross margin.
  - Turnover of auditor, key executives, general counsel.

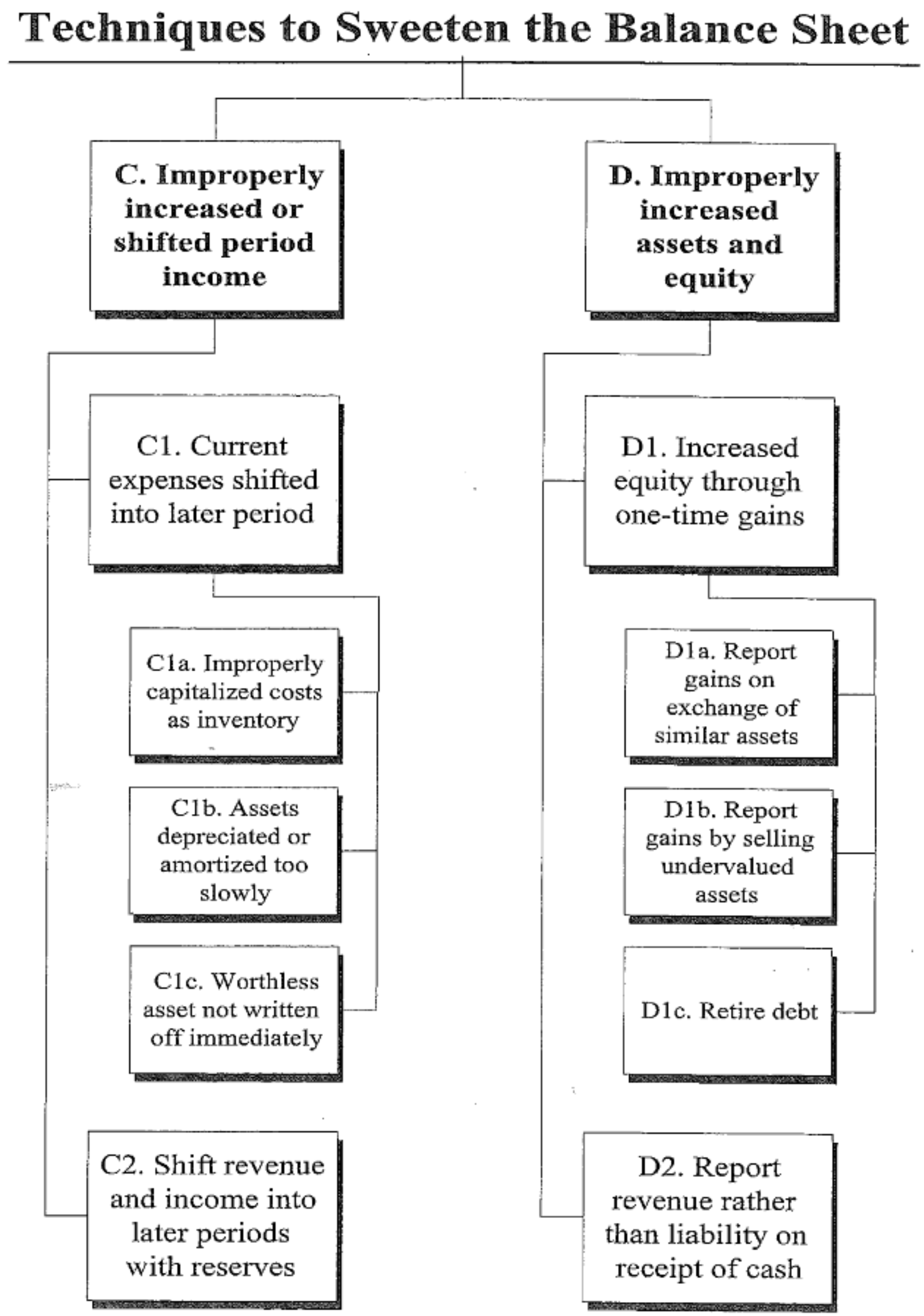
"Tricks of the Trade" for Accounting Manipulations

- Channel Stuffing:
  - What is it?
  - When does it usually occur in the year?
  - How to Detect? Compare 4th quarter changes in sales, accounts receivable, inventory compared to previous 3 quarters.
- "Hockey Stock" Phenomenon in High Tech Sector:
  - A large fraction of the sales by high tech companies appear to be made in the last few days of the fiscal quarter.
  - Why?

"Cooking Books"



"Cooking Books"



Simon Newcomb and the Origins of Benford’s Law

1835-1909

‘Note on the Frequency of Use of the Different Digits in Natural Numbers’, 1881

x	0	1	2	3	4	5	6	7	8	9	Δm	1	2	3	4	5	6	7	8	9
											+	ADD								
10	·0000	0043	0086	0128	0170	0212					42	4	8	13	17	21	25	29	34	38
						0212	0253	0294	0334	0374	40	4	8	12	16	20	24	28	32	36
11	·0414	0453	0492	0531	0569	0607					39	4	8	12	16	19	23	27	31	35
						0607	0645	0682	0719	0755	37	4	7	11	15	19	22	26	30	33
12	·0792	0828	0864	0899	0934	0969					35	4	7	11	14	18	21	25	28	32
						0969	1004	1038	1072	1106	34	3	7	10	14	17	20	24	27	31
13	·1139	1173	1206	1239	1271	1303					33	3	7	10	13	16	20	23	26	30
						1303	1335	1367	1399	1430	32	3	6	10	13	16	19	22	26	29
14	·1461	1492	1523	1553	1584	1614	1644	1673	1703	1732	30	3	6	9	12	15	18	21	24	27
15	·1761	1790	1818	1847	1875	1903	1931	1959	1987	2014	28	3	6	8	11	14	17	20	22	25
16	·2041	2068	2095	2122	2148	2175	2201	2227	2253	2279	26	3	5	8	10	13	16	18	21	23
17	·2304	2330	2355	2380	2405	2430	2455	2480	2504	2529	25	2	5	7	10	12	15	17	20	22
18	·2553	2577	2601	2625	2648	2672	2695	2718	2742	2765	24	2	5	7	10	12	14	17	19	22
19	·2788	2810	2833	2856	2878	2900	2923	2945	2967	2989	22	2	4	7	9	11	13	15	18	20
20	·3010	3032	3054	3075	3096	3118	3139	3160	3181	3201	21	2	4	6	8	11	13	15	17	19
21	·3222	3243	3263	3284	3304	3324	3345	3365	3385	3404	20	2	4	6	8	10	12	14	16	18
22	·3424	3444	3464	3483	3502	3522	3541	3560	3579	3598	19	2	4	6	8	10	11	13	15	17
23	·3617	3636	3655	3674	3692	3711	3729	3747	3766	3784	18	2	4	5	7	9	11	13	14	16
24	·3802	3820	3838	3856	3874	3892	3909	3927	3945	3962	18	2	4	5	7	9	11	13	14	16
25	·3979	3997	4014	4031	4048	4065	4082	4099	4116	4133	17	2	3	5	7	9	10	12	14	15
26	·4150	4166	4183	4200	4216	4232	4249	4265	4281	4298	16	2	3	5	6	8	10	11	13	14
27	·4314	4330	4346	4362	4378	4393	4409	4425	4440	4456	16	2	3	5	6	8	10	11	13	14
28	·4472	4487	4502	4518	4533	4548	4564	4579	4594	4609	15	2	3	5	6	8	9	11	12	14
29	·4624	4639	4654	4669	4683	4698	4713	4728	4742	4757	15	1	3	4	6	7	9	10	12	13
30	·4771	4786	4800	4814	4829	4843	4857	4871	4886	4900	14	1	3	4	6	7	8	10	11	13
31	·4914	4928	4942	4955	4969	4983	4997	5011	5024	5038	14	1	3	4	6	7	8	10	11	13
32	·5051	5065	5079	5092	5105	5119	5132	5145	5159	5172	13	1	3	4	5	7	8	9	10	12
33	·5185	5198	5211	5224	5237	5250	5263	5276	5289	5302	13	1	3	4	5	6	8	9	10	12
34	·5315	5328	5340	5353	5366	5378	5391	5403	5416	5428	13	1	3	4	5	6	8	9	10	12
35	·5441	5453	5465	5478	5490	5502	5514	5527	5539	5551	12	1	2	4	5	6	7	8	10	11
36	·5563	5575	5587	5599	5611	5623	5635	5647	5658	5670	12	1	2	4	5	6	7	8	10	11
37	·5682	5694	5705	5717	5729	5740	5752	5763	5775	5786	12	1	2	4	5	6	7	8	10	11
38	·5798	5809	5821	5832	5843	5855	5866	5877	5888	5899	11	1	2	3	4	6	7	8	9	10
39	·5911	5922	5933	5944	5955	5966	5977	5988	5999	6010	11	1	2	3	4	6	7	8	9	10
40	·6021	6031	6042	6053	6064	6075	6085	6096	6107	6117	11	1	2	3	4	5	7	8	9	10
41	·6128	6138	6149	6160	6170	6180	6191	6201	6212	6222	10	1	2	3	4	5	6	7	8	9
42	·6232	6243	6253	6263	6274	6284	6294	6304	6314	6325	10	1	2	3	4	5	6	7	8	9
43	·6335	6345	6355	6365	6375	6385	6395	6405	6415	6425	10	1	2	3	4	5	6	7	8	9
44	·6435	6444	6454	6464	6474	6484	6493	6503	6513	6522	10	1	2	3	4	5	6	7	8	9
45	·6532	6542	6551	6561	6571	6580	6590	6599	6609	6618	10	1	2	3	4	5	6	7	8	9
46	·6628	6637	6646	6656	6665	6675	6684	6693	6702	6712	9	1	2	3	4	5	5	6	7	8
47	·6721	6730	6739	6749	6758	6767	6776	6785	6794	6803	9	1	2	3	4	5	5	6	7	8
48	·6812	6821	6830	6839	6848	6857	6866	6875	6884	6893	9	1	2	3	4	4	5	6	7	8
49	·6902	6911	6920	6928	6937	6946	6955	6964	6972	6981	9	1	2	3	4	4	5	6	7	8

	No.	log			No.	log
π =	3·14159	0·49715	$\ln x = \log_e x = (1/M) \log_{10} x$	$(1/M)$ =	2·30259	0·36222
e =	2·71828	0·43429	$\log x = \log_{10} x = M \log_e x$	M =	0·43429	$\bar{1}$·63778

p	1	2	3	4	5	6	7	8	9	10
$\log e^{p}$	0·4343	0·8686	1·3029	1·7372	2·1715	2·6058	3·0401	3·4744	3·9087	4·3429
$\log e^{-p}$	$\bar{1}$·5657	$\bar{1}$·1314	$\bar{2}$·6971	$\bar{2}$·2628	$\bar{3}$·8285	$\bar{3}$·3942	$\bar{4}$·9599	$\bar{4}$·5256	$\bar{4}$·0913	$\bar{5}$·6571

x	0	1	2	3	4	5	6	7	8	9	Δm	1	2	3	4	5	6	7	8	9
											+	ADD								
50	·6990	6998	7007	7016	7024	7033	7042	7050	7059	7067	9	1	2	3	4	4	5	6	7	8
51	·7076	7084	7093	7101	7110	7118	7126	7135	7143	7152	8	1	2	2	3	4	5	6	6	7
52	·7160	7168	7177	7185	7193	7202	7210	7218	7226	7235	8	1	2	2	3	4	5	6	6	7
53	·7243	7251	7259	7267	7275	7284	7292	7300	7308	7316	8	1	2	2	3	4	5	6	6	7
54	·7324	7332	7340	7348	7356	7364	7372	7380	7388	7396	8	1	2	2	3	4	5	6	6	7
55	·7404	7412	7419	7427	7435	7443	7451	7459	7466	7474	8	1	2	2	3	4	5	6	6	7
56	·7482	7490	7497	7505	7513	7520	7528	7536	7543	7551	8	1	2	2	3	4	5	6	6	7
57	·7559	7566	7574	7582	7589	7597	7604	7612	7619	7627	8	1	2	2	3	4	5	6	6	7
58	·7634	7642	7649	7657	7664	7672	7679	7686	7694	7701	8	1	2	2	3	4	5	6	6	7
59	·7709	7716	7723	7731	7738	7745	7752	7760	7767	7774	7	1	1	2	3	4	4	5	6	6
60	·7782	7789	7796	7803	7810	7818	7825	7832	7839	7846	7	1	1	2	3	4	4	5	6	6
61	·7853	7860	7868	7875	7882	7889	7896	7903	7910	7917	7	1	1	2	3	4	4	5	6	6
62	·7924	7931	7938	7945	7952	7959	7966	7973	7980	7987	7	1	1	2	3	3	4	5	6	6
63	·7993	8000	8007	8014	8021	8028	8035	8041	8048	8055	7	1	1	2	3	3	4	5	6	6
64	·8062	8069	8075	8082	8089	8096	8102	8109	8116	8122	7	1	1	2	3	3	4	5	6	6
65	·8129	8136	8142	8149	8156	8162	8169	8176	8182	8189	7	1	1	2	3	3	4	5	6	6
66	·8195	8202	8209	8215	8222	8228	8235	8241	8248	8254	7	1	1	2	3	3	4	5	6	6
67	·8261	8267	8274	8280	8287	8293	8299	8306	8312	8319	6	1	1	2	2	3	4	4	5	5
68	·8325	8331	8338	8344	8351	8357	8363	8370	8376	8382	6	1	1	2	2	3	4	4	5	5
69	·8388	8395	8401	8407	8414	8420	8426	8432	8439	8445	6	1	1	2	2	3	4	4	5	5
70	·8451	8457	8463	8470	8476	8482	8488	8494	8500	8506	6	1	1	2	2	3	4	4	5	5
71	·8513	8519	8525	8531	8537	8543	8549	8555	8561	8567	6	1	1	2	2	3	4	4	5	5
72	·8573	8579	8585	8591	8597	8603	8609	8615	8621	8627	6	1	1	2	2	3	4	4	5	5
73	·8633	8639	8645	8651	8657	8663	8669	8675	8681	8686	6	1	1	2	2	3	4	4	5	5
74	·8692	8698	8704	8710	8716	8722	8727	8733	8739	8745	6	1	1	2	2	3	4	4	5	5
75	·8751	8756	8762	8768	8774	8779	8785	8791	8797	8802	6	1	1	2	2	3	4	4	5	5
76	·8808	8814	8820	8825	8831	8837	8842	8848	8854	8859	6	1	1	2	2	3	4	4	5	5
77	·8865	8871	8876	8882	8887	8893	8899	8904	8910	8915	6	1	1	2	2	3	4	4	5	5
78	·8921	8927	8932	8938	8943	8949	8954	8960	8965	8971	6	1	1	2	2	3	4	4	5	5
79	·8976	8982	8987	8993	8998	9004	9009	9015	9020	9025	6	1	1	2	2	3	4	4	5	5
80	·9031	9036	9042	9047	9053	9058	9063	9069	9074	9079	5	1	1	2	2	3	3	4	4	5
81	·9085	9090	9096	9101	9106	9112	9117	9122	9128	9133	5	1	1	2	2	3	3	4	4	5
82	·9138	9143	9149	9154	9159	9165	9170	9175	9180	9186	5	1	1	2	2	3	3	4	4	5
83	·9191	9196	9201	9206	9212	9217	9222	9227	9232	9238	5	1	1	2	2	3	3	4	4	5
84	·9243	9248	9253	9258	9263	9269	9274	9279	9284	9289	5	1	1	2	2	3	3	4	4	5
85	·9294	9299	9304	9309	9315	9320	9325	9330	9335	9340	5	1	1	2	2	3	3	4	4	5
86	·9345	9350	9355	9360	9365	9370	9375	9380	9385	9390	5	1	1	2	2	3	3	4	4	5
87	·9395	9400	9405	9410	9415	9420	9425	9430	9435	9440	5	0	1	1	2	2	3	3	4	4
88	·9445	9450	9455	9460	9465	9469	9474	9479	9484	9489	5	0	1	1	2	2	3	3	4	4
89	·9494	9499	9504	9509	9513	9518	9523	9528	9533	9538	5	0	1	1	2	2	3	3	4	4
90	·9542	9547	9552	9557	9562	9566	9571	9576	9581	9586	5	0	1	1	2	2	3	3	4	4
91	·9590	9595	9600	9605	9609	9614	9619	9624	9628	9633	5	0	1	1	2	2	3	3	4	4
92	·9638	9643	9647	9652	9657	9661	9666	9671	9675	9680	5	0	1	1	2	2	3	3	4	4
93	·9685	9689	9694	9699	9703	9708	9713	9717	9722	9727	5	0	1	1	2	2	3	3	4	4
94	·9731	9736	9741	9745	9750	9754	9759	9763	9768	9773	5	0	1	1	2	2	3	3	4	4
95	·9777	9782	9786	9791	9795	9800	9805	9809	9814	9818	5	0	1	1	2	2	3	3	4	4
96	·9823	9827	9832	9836	9841	9845	9850	9854	9859	9863	4	0	1	1	2	2	2	3	3	4
97	·9868	9872	9877	9881	9886	9890	9894	9899	9903	9908	4	0	1	1	2	2	2	3	3	4
98	·9912	9917	9921	9926	9930	9934	9939	9943	9948	9952	4	0	1	1	2	2	2	3	3	4
99	·9956	9961	9965	9969	9974	9978	9983	9987	9991	9996	4	0	1	1	2	2	2	3	3	4

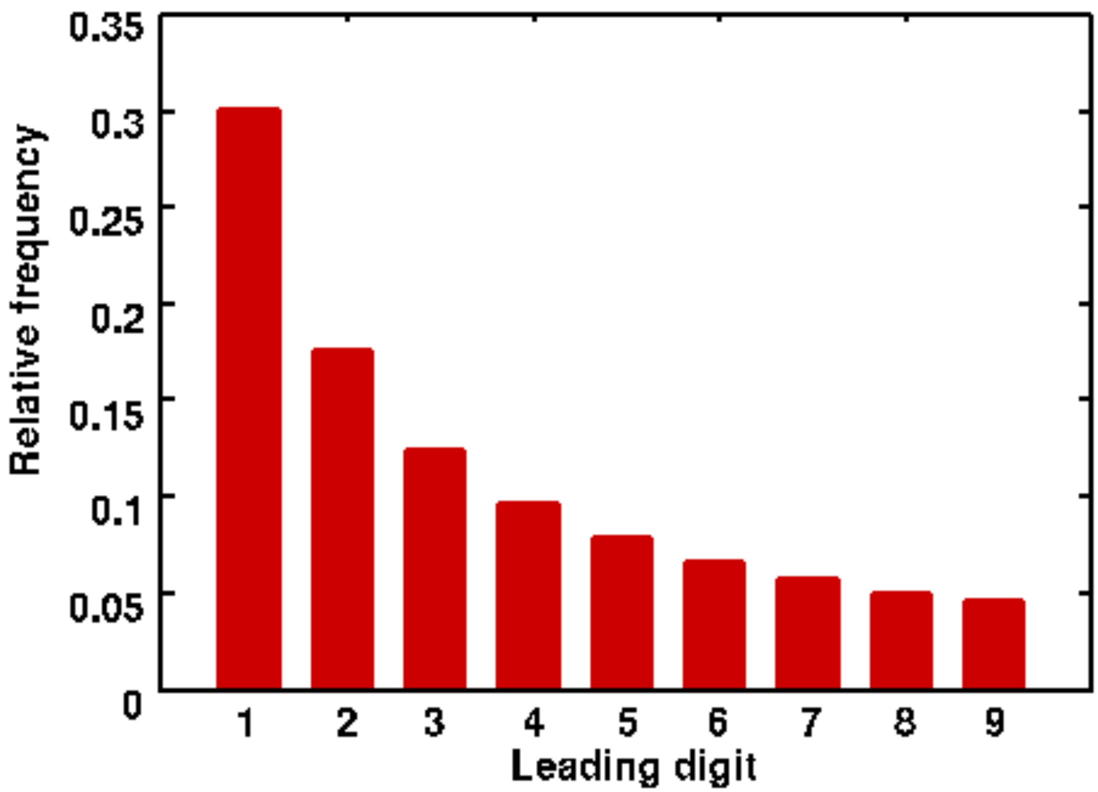
Newcomb's 'Law'

"That the ten digits do not occur with equal frequency must be evident to anyone making much use of logarithmic tables, and noticing how much faster the first pages wear out than the last ones.

The first significant figure is oftener 1 than any other digit, and the frequency diminishes up to 9."

Probability of the First Digit Being Equal to d

$$P(d) = \log_{10}[1 + 1/d],\ d = 1, 2, ..$$



Ignore signs and take first digit after decimal point eg for -3.1526 it is 1

A Big Surprise

You might have thought P(1) = P(2) = P(3) = ….P(9) = 0.11..
But…

P(1) = 0.30
P(2) = 0.18
P(3) = 0.12
P(4) = 0.10
P(5) = 0.08
P(6) = 0.07
P(7) = 0.06
P(8) = 0.05
P(9) = 0.05

Rediscovered by Frank Benford at GEC in 1938

1883-1948

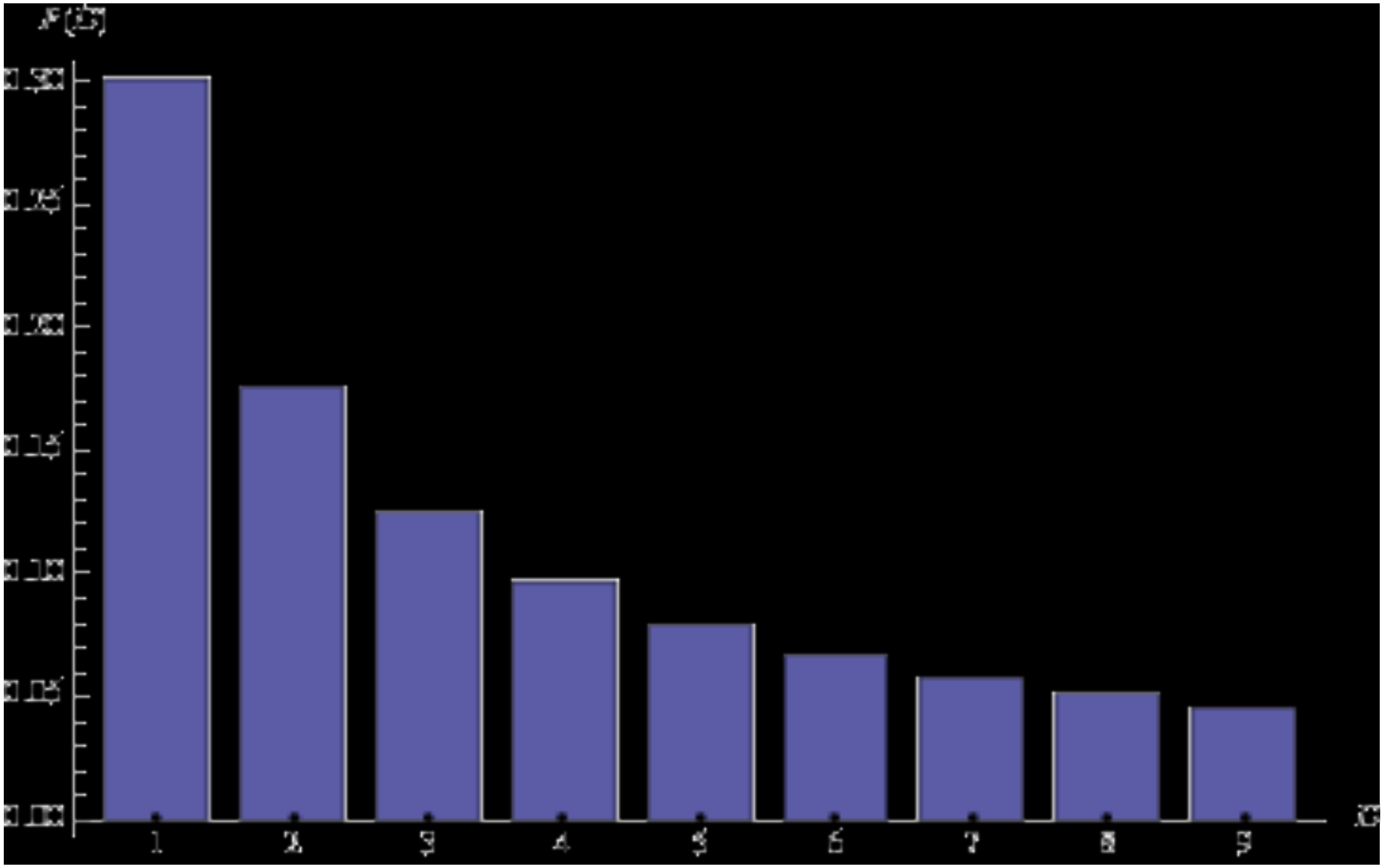
$P(d) = \log_{10}[1 + 1/d]$ first-digit distribution then becomes known as

“Benford’s Law”

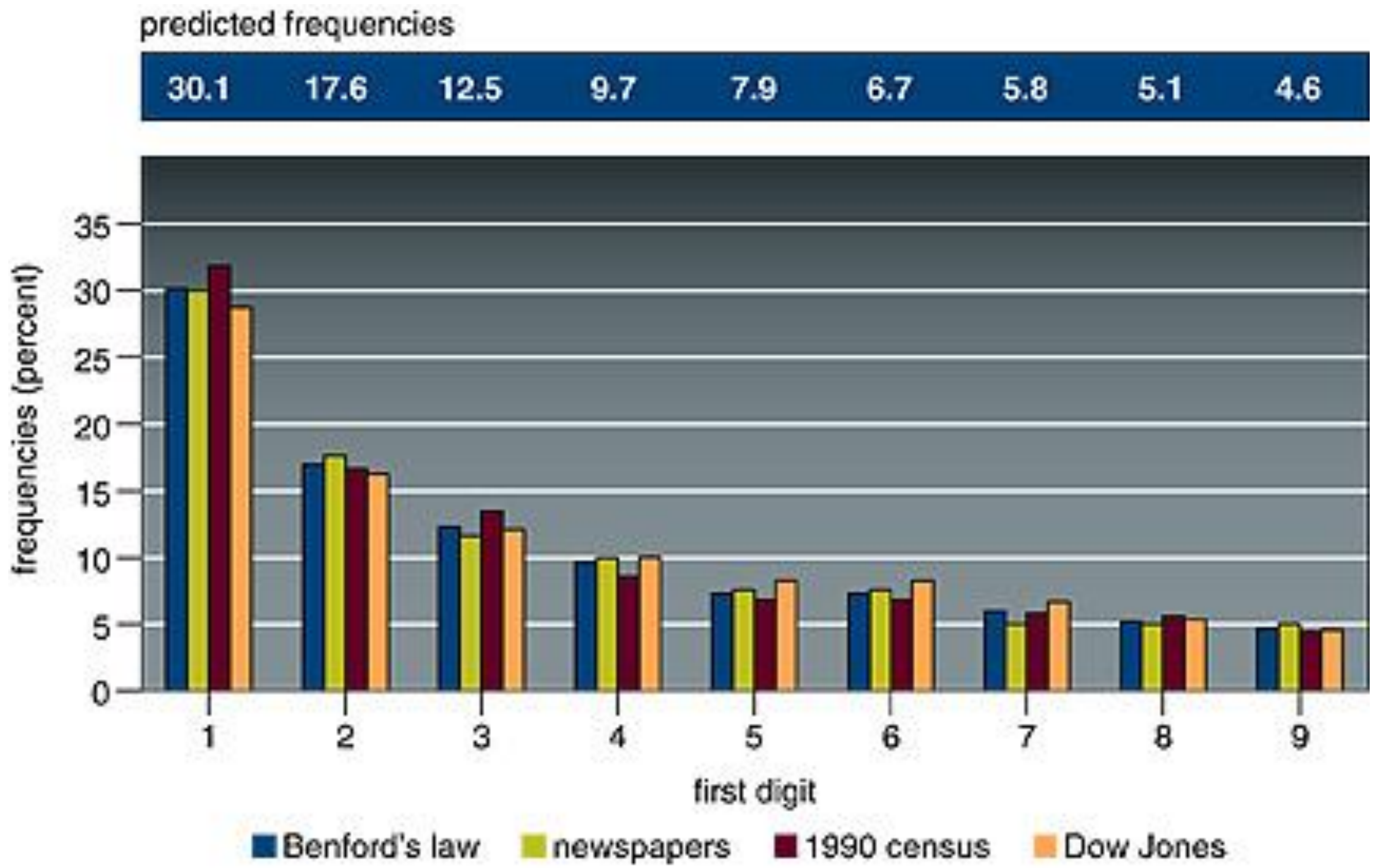
‘The Law of Anomalous Numbers’ (1938)

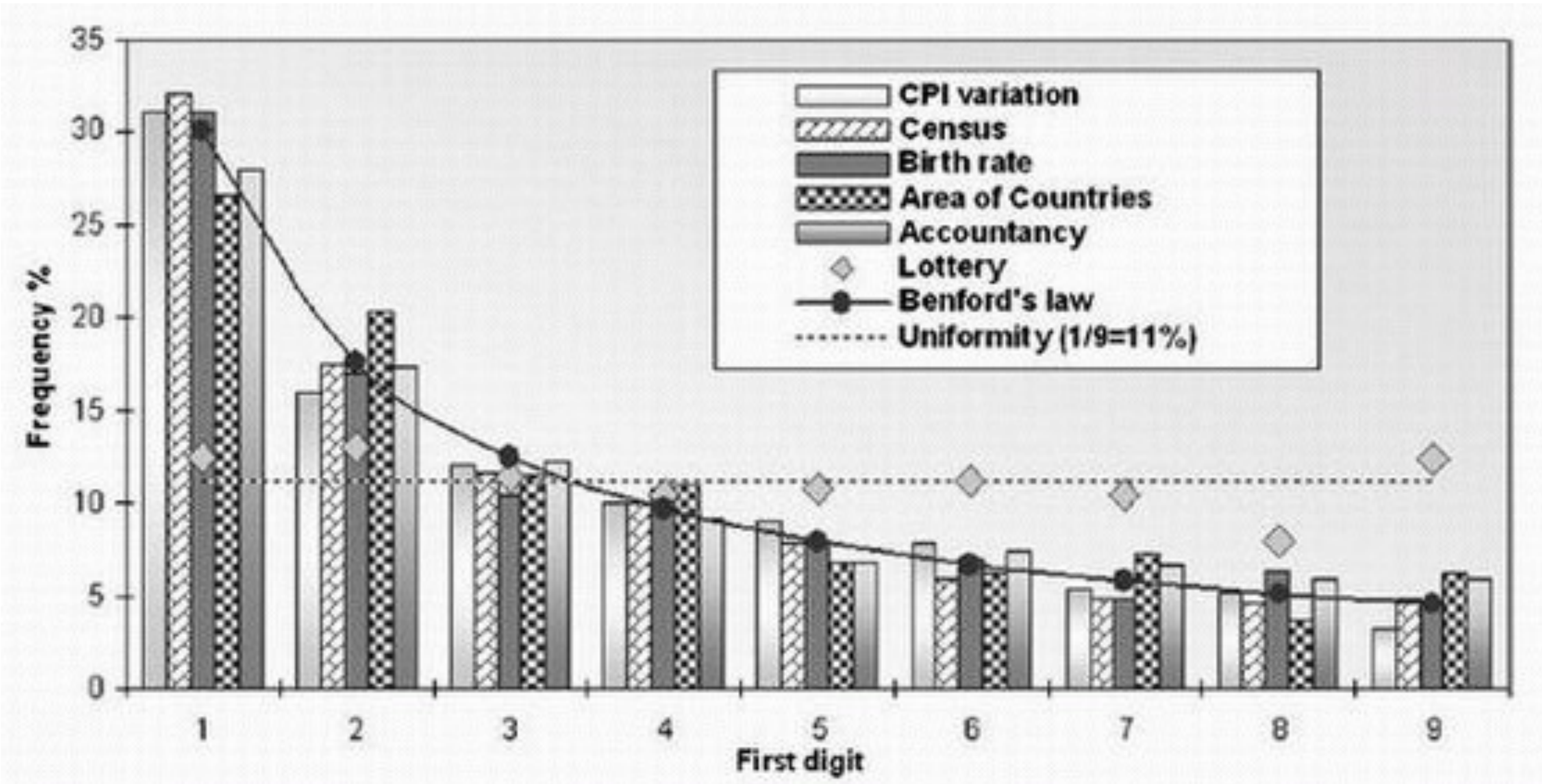
Benford gathered 20,000 pieces of data and studied First-digit frequencies

Data	1	2	3	4	5	6	7	8	9
River areas	31.0%	16.4	10.7	11.3	7.2	8.6	5.5	4.2	5.1
Base ball	32.7	17.6	12.6	9.8	7,4	6.4	4.9	5.6	3.0
magazi nes	33.4	18.5	12.4	7.51	7.1	6.5	5.5	4.9	4.2
Powers of 2	30	17	13	10	7	7	6	6	5
20 tables	30.6	18.5	12.4	9.4	8.0	6.4	5.1	4.9	4.7
α half - lives	29.6	17.8	1.7	10.5	9,9	4.8	5.2	5.2	5.2
Benford Law	30.1	17.6	12.5	9.7	7.9	6.7	5.8	5.1	4.6

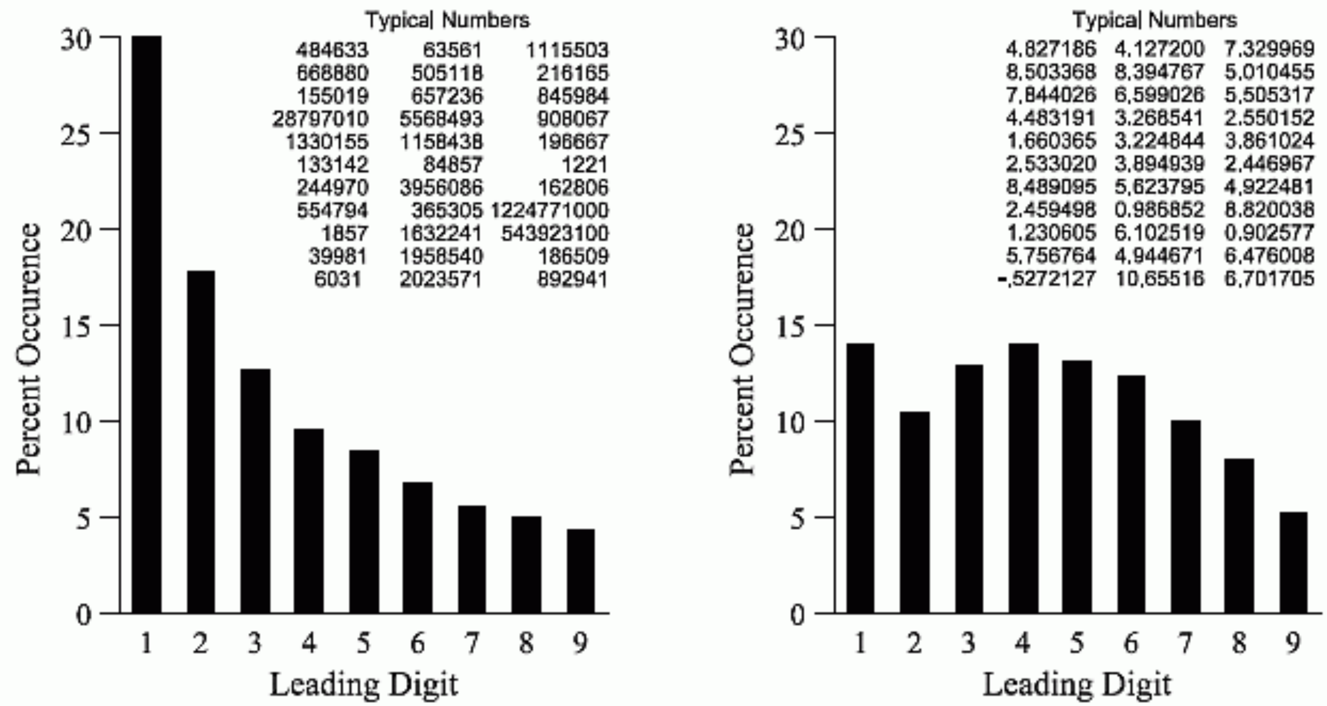


Random street addresses


predicted frequencies
30.1
17.6
12.5
9.7
7.9
6.7
5.8
5.1
4.6
frequencies (percent)
35
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
first digit
Benford's law
newspapers
1990 census
Dow Jones



CPI variation
Census
Birth rate
Area of Countries
Accountancy
Lottery
Benford's law
Uniformity (1/9=11%)
Frequency %
First digit
0
5
10
15
20
25
30
35
1
2
3
4
5
6
7
8
9



a. Tax return numbers, *Benford's law*

b. RNG numbers, *not Benford's law*

US tax return data

Random number generator

Winning Lotteries

- The Massachusetts Numbers Game – State Lottery

  1. Bet on a 4-digit number
  2. A 4-digit number is generated randomly
  3. All winners share the jackpot

- A Possible Strategy

  To avoid sharing the prize. Assume entrants pick numbers from their experience (ie not at random) and obey Benford's law. So pick numbers that are least probable by the Benford-Newcomb law. So start with 9's and 8's

- Evidence (Hill 1988) that numbers 'randomly' chosen by people tend to start with low digits

Detecting Financial Fraud

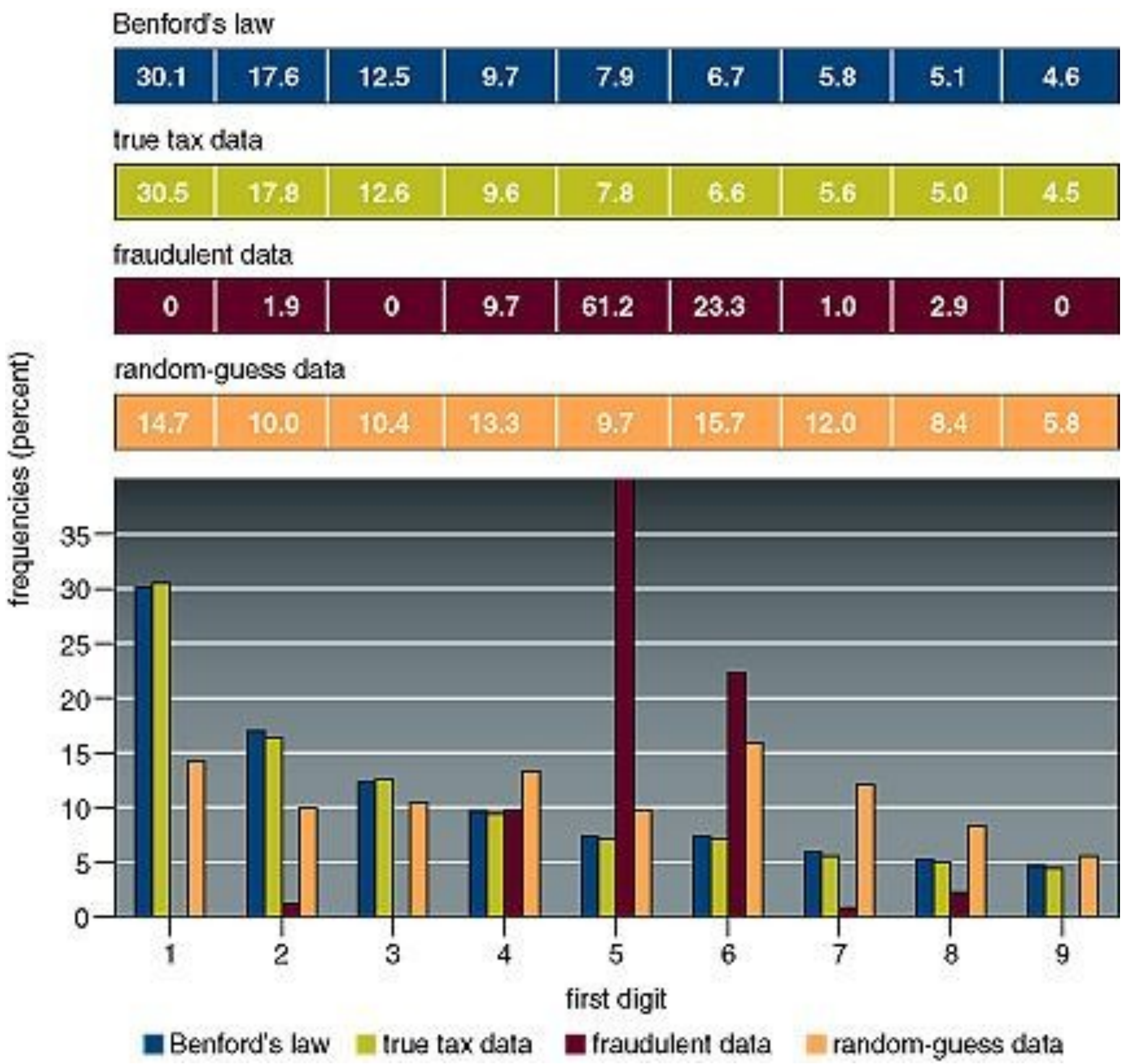
'Natural' distributions and their combinations should follow Benford
Maybe 'Doctored' or 'artificial' constructions do not ???

Mark Nigrini Univ. Cincinnati PhD thesis (1992)
'The detection of income evasion through an analysis of digital distributions'

Data from the lines of 169,662 IRS model files follow Benford's law closely.

Fraudulent data taken from a 1995 King's County, New York, District Attorney's Office study of cash disbursement and payroll in business don't follow Benford's law.

The fraudulent or concocted data appear to have far fewer numbers starting with 1 and many more starting with 5 or 6 than do true data.


Benford's law
30.1 17.6 12.5 9.7 7.9 6.7 5.8 5.1 4.6
true tax data
30.5 17.8 12.6 9.6 7.8 6.6 5.6 5.0 4.5
fraudulent data
0 1.9 0 9.7 61.2 23.3 1.0 2.9 0
random-guess data
14.7 10.0 10.4 13.3 9.7 15.7 12.0 8.4 5.8
frequencies (percent)
35
30
25
20
15
10
5
0
1 2 3 4 5 6 7 8 9
first digit
Benford's law
true tax data
fraudulent data
random-guess data

Forensic Accounting with Benford's Law: The Bernie Madoff Scandal

- Here is the expected distribution of leading digits under Benford's law:

Leading digit	1	2	3	4	5	6	7	8	9
Frequency	30.1%	17.6%	12.5%	9.7%	7.9%	6.7%	5.8%	5.1%	4.6%

- Here is the distribution of leading digits from 215 months of returns for the Fairfield Sentry Fund, a fund that invested only with Bernie Madoff:

Leading digit	1	2	3	4	5	6	7	8	9
Frequency	39.6%	14.2%	10.4%	7.1%	7.5%	6.6%	6.1%	6.6%	1.9%

Forensic Accounting with Benford's Law: Link with Other Methods?

- Amiram, Bozanic, and Rouen (2014) studied Benford's Law in financial statements
- Aggregating all financial statements by industries or by years for 2000-2011, the leading digits follow Benford's distribution
  - 83.7% of firm's annual financial statements conform with the distribution
- Larger discrepancy versus Benford's distribution is associated with
  - Larger Modified Jones Model discretionary accruals
  - Higher Beneish M-Score

When to Apply Benford Method?

When Benford Analysis is likely useful	**Examples**
Set of numbers that result from mathematical combinations of numbers - Results come from two distributions	Accounts receivables (number sold * price) Accounts payables (Number bought * price)
Transaction level data - No need to sample	Sales, expenses, disbursements
On larger data sets - The more observations, the better	Full year's transaction
Accounts that appear to conform - When the mean of a set of numbers is greater than its median and the skewness is positive	Most sets of accounting numbers
When Benford Analysis is not likely useful	**Examples**
Data set is comprised of assigned numbers	Check numbers, invoice numbers, zip code
Numbers that are influenced by human thought	ATM withdrawals, price set at psychological thresholds (1,99 $)
Accounts with a large amounts of firm - specific numbers	An account specifically set to record $100 refunds
Accounts with a built in minimum or maximum	Set of assets that must meet a threshold to be recorded
Accounts where no transactions are recorded	Thefts, kickbacks

Detecting Fraud & Earning Manipulations Using Ratios: Beneish Model

- Identifying earnings management is important for financial statement users to assess current economic performance, to predict future profitability, and to determine firm value.
- The M-score Model was created by Professor Daniel Beneish, who gives the name to the tool. The Beneish Model is a mathematical model that exploits some financial metrics and ratios to identify the occurrence of financial fraud or the tendency of a firm to engage in earnings manipulation.

Beneish Model

- Financial statement ratios are fed into a model to create the M-score, an indicator that shows the degree to which earnings have been manipulated.
- Beneish used data from 1982 to 1992 from COMPUSTAT database to develop the model
  - Sample consists of 74 firms that manipulated earnings and 2332 non-manipulators.
  - Tests correctly identified 76 percent of frauds, while generating 17.5 percent of false alarms.

Beneish Model

- The M-Score is composed of eight ratios that capture either financial statement distortions that can result from earnings manipulation or indicate a predisposition to engage in earnings manipulation.
- The analysis of the financial statement required at least two period of financial reporting to detect unusual fact and event.

Beneish Model

<u>The model includes eight variables:</u>

<u>Days Sales in Receivables Index (DSRI):</u>

DSRI is the ratio of days sales in receivable measures the ratio of days that sales are in accounts receivable in a year compared to that of the prior year. This variable gauges whether receivables and revenues are in or out-of-balance in two consecutive years. An index higher than 1 describes the increased percentage of non-cash sales compared to the prior year. A disproportionate increase of accounts receivable may be indicative of an inflation of revenues.

#1. Days' Sales in Receivables Index (DSRI)

It is the ratio of days sales in receivables in a year with respect to the previous year. The large increase in the value of DSR is an indicator of revenue inflation.

DSRI = (Net Receivables$_t$ / Sales$_t$) / Net Receivables $_{t-1}$ / Sales $_{t-1}$)

Beneish Model

Variables continued:

Gross Margin Index (GMI):

GMI is the ratio between gross operating margins from two following years. It identifies the variation of gross margin and if it is higher than 1 shows that the profits has decreased in the period analyzed with the consequence that the firm is likely to manipulated its revenues and expenditures.

#2. Gross Margin Index (GMI)

It is the ratio of gross margin of a year with respect to the previous year.

$$GMI = [(Sales_{t-1} - COGS_{t-1}) / Sales_{t-1}] / [(Sales_t - COGS_t) / Sales_t]$$

Beneish Model

Variables continued:

Asset Quality Index (AQI):

AQI is the ratio of current and non-current asset (PPE + Securities) to total assets in one year to the prior year. An increase in the index may mean more expenses that are being capitalized to improve or maintain the same level of profitability. From the other side, a value of index higher than 1 indicates that the firm has potentially increased its intangible assets or its cost deferral, generating a potential earnings manipulation.

#3. Asset Quality Index (AQI)

It is the ratio of non-current assets (other than the plant, property and the equipment) to total assets of a year versus the prior year.

AQI = [1 – (Current Assets$_t$ + PP&E$_t$ + Securities$_t$) / Total Assets$_t$] / [1 – ((Current Assets $_{t-1}$ + PP&E $_{t-1}$ + Securities $_{t-1}$) / Total Assets $_{t-1}$)]

Beneish Model

Variables continued:

4. Sales Growth Index (SGI):

SGI measures the growth in revenue and if it is greater than 1, it will indicate a positive growth in the year under review.

$$SGI = Sales_t / Sales_{t-1}$$

Beneish Model

Variables continued:

Depreciation Index (DEPI):

DPI is the ratio of depreciation expense and gross value of property, plants and equipment (PPE) in one year over a prior year. An index that is higher than 1 could reflect an upward adjustment of the useful life of PPE.

#5. Depreciation Index (DEPI)

It is the ratio of the rate of depreciation of a year with respect to the previous year.

> DEPI = (Depreciation $_{t-1}$/ (PP&E $_{t-1}$ + Depreciation $_{t-1}$)) / (Depreciation $_{t}$ / (PP&E $_{t}$ + Depreciation $_{t}$))

Beneish Model

Variables continued:

Sales General and Administrative Expenses Index (SGAI):

SGAI is calculated as the ratio of SGA to sales in a year to the corresponding measure in prior year. The variable is taken into account in the Beneish Model following Lev and Thiagarajan's [20] suggestion that analysts would interpret a disproportionate increase in sales as a bad signal about firms' future prospects. This may increase the possibility of earnings manipulation.

#6. Sales, General, and Administrative expenses Index (SGAI)

It is the ratio of SG&A expenses of a year with respect to the previous year.

> SGAI = (SG&A Expense $_t$ / Sales $_t$) / (SG&A Expense $_{t-1}$/ Sales $_{t-1}$)

Beneish Model

Variables continued:

Leverage Index (LVGI):

LVGI measures the ratio of total debt to total assets, giving a representation of the long term risks of a company. A LVGI that is higher than 1 indicates an increase in leverage. The variable is included to capture debt covenants incentives for earnings manipulation.

#7. Leverage Index (LVGI)

It is the ratio of total debt to total assets of a year with respect to the previous year.

> LVGI = [(Current Liabilities $_t$ + Total Long Term Debt $_t$) / Total Assets $_t$] / [(Current Liabilities $_{t-1}$ + Total Long Term Debt $_{t-1}$) / Total Assets $_{t-1}$]

Beneish Model

<u>Variables continued:</u>

Total Accruals to Total Assets Index (TATA):

TATA measure the quality of cash flows of the firms. Total accruals are determined as the change in working capital accounts other than cash less depreciation. An increasing level of accruals as part of total assets may indicate a higher chance of manipulation.

#8. Total Accruals to Total Assets (TATA)

It is calculated as the change in the accounts of working capital other than the cashless depreciation

TATA = (Income from the Continuing Operations $_t$ – Cash Flows from the Operations $_t$) / Total Assets $_t$

Beneish Model

M-Score:

To define the M-score, the index is included in the following formula:

M-score = -4.84 + 0.92 DSRI + 0.528 GMI + 0.404 AQI + 0.892 SGI + 0.115 DEPI – 0.172 SGAI + 4.679 TATA – 0.327 LVGI

Eight different types of indices are weighted together as per the following formula to derive at the M-score:

Beneish M Score Formula = -4.84 + 0.92 * DSRI + 0.528 * GMI + 0.404 * AQI + 0.892 * SGI + 0.115 * DEPI – 0.172 * SGAI + 4.679 * TATA – 0.327 * LVGI

Beneish Model

M-Score:

The Beneish M Score helps to uncover companies who are likely to be manipulating their reported earnings. Companies with a higher score are more likely to be manipulators. This is a probabilistic model, so it will not detect manipulators with 100% accuracy.

Often used cutoff: An M-Score of greater than -1.78 signals that the company is likely to be a manipulator.

But, the best cut-off point depends on the costs mistakenly classifying in one of two ways:

1) Classifying firm that is manipulating earnings as a non-manipulator (Type I error), and

2) Classifying a firm as a manipulator when it actually was not manipulating (Type II Error).

Beneish Model

Here are optimal cut-offs according to Beneish, presented as the score followed by the cost of Type I error relative to cost of Type II error):

M Score Cutoffs

Score	Relative Error Costs (Type I:Type II)
M Score > -1.49	(10:1)
M Score > -1.78	**(20:1)**
M Score > -1.89	(40+:1)

Also, Beneish excluded financial institutions from his sample when calculating the M-Score. Thus, do not use M-Scores for financial firms - their business models are different from the manufacturing and other service firms that Beneish used in his study.

M-Score Example

1. DSRI : 0.814
2. GMI : 1.556
3. AQI : 0.608
4. SGI : 0.755
5. DEPI : 0.801
6. SGAI : 1.110
7. LVGI : 0.878
8. TATA : 0.044

M-Score Example

Calculation of M-Score

M-score= -4.84 + 0.92 * DSRI + 0.528 * GMI + 0.404 * AQI + 0.892 * SGI + 0.115 * DEPI – 0.172 * SGAI + 4.679 * TATA – 0.327 * LVGI

D2 =B2*C2

	A	B	C	D
1	Ratio	Ratio value	Weights in M-score	Value in M- Score
2	DSRI	0.814	0.92	0.749
3	GMI	1.556	0.528	0.822
4	AQI	0.608	0.404	0.246
5	SGI	0.755	0.892	0.673
6	DEPI	0.801	0.115	0.092
7	SGAI	1.11	0.172	0.191
8	TATA	0.044	4.679	0.206
9	LVGI	0.878	0.327	0.287
10				

M-score= -4.84 + 0.749 + 0.822 + 0.246 + 0.673 + 0.092 – 0.191 + 0.206 – 0.287

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M-Score Example

M-score= -4.84 + 0.749 + 0.822 + 0.246 + 0.673 + 0.092 – 0.191 + 0.206 – 0.287

B11 | =-4.84 +D2+D3+D4+D5+D6-D7+D8-D9

	A	B	C	D
1	Ratio	Ratio value	Weights in M-score	Value in M- Score
2	DSRI	0.814	0.92	0.749
3	GMI	1.556	0.528	0.822
4	AQI	0.608	0.404	0.246
5	SGI	0.755	0.892	0.673
6	DEPI	0.801	0.115	0.092
7	SGAI	1.11	0.172	0.191
8	TATA	0.044	4.679	0.206
9	LVGI	0.878	0.327	0.287
10				
11	M- Score	-2.530		
12				

M-score= **-2.530**

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Applications of the Beneish M-Score

Many researchers have applied the Beneish model to some of the biggest corporate scandals in order to identify financial statement manipulations. John Maccarthy noted that if the Beneish model had been applied to Enron Corporation, the scandal could have been discovered in a proactive manner as early as 1997, significantly before it petitioned for insolvency in 2001.

Comparison of Beneish & Benford Methods

	Beneish Model	Benford's Law
Definition	Mathematical tool that uses eight financial ratios to detect whether a corporate has manipulated its earnings	Advanced digital analysis technique based on the examination of the actual frequency of the digits in the data
Application	Used to detect earnings manipulation in organizations as long two years financial data is available	It's usually used to identify fraud in insurance claims, corporate income tax, accounts receivable, accounts payable, fixed assets records
Pros	• It considers variables related to both the detection and incentives for fraud • It allows users to assess the different aspects of a firm's performance simultaneously instead of in isolation • Exploratory power for fraud	• Powerful tool to detect anomalies in data • Most accounting-related data can be expected to conform to Benford, distribution • Computers can easily be programmed to include a Benford's Law component to test sets of data
Cons	• Based on out-dated data • Data from financial statement can be estimated without committing a manipulation • There is a large rate of classification errors	• Caution must be used when using Benford's law as not all distributions that do not conform to expected distribution are fraudulent • Not all types of fraud can be detected with this digital tool