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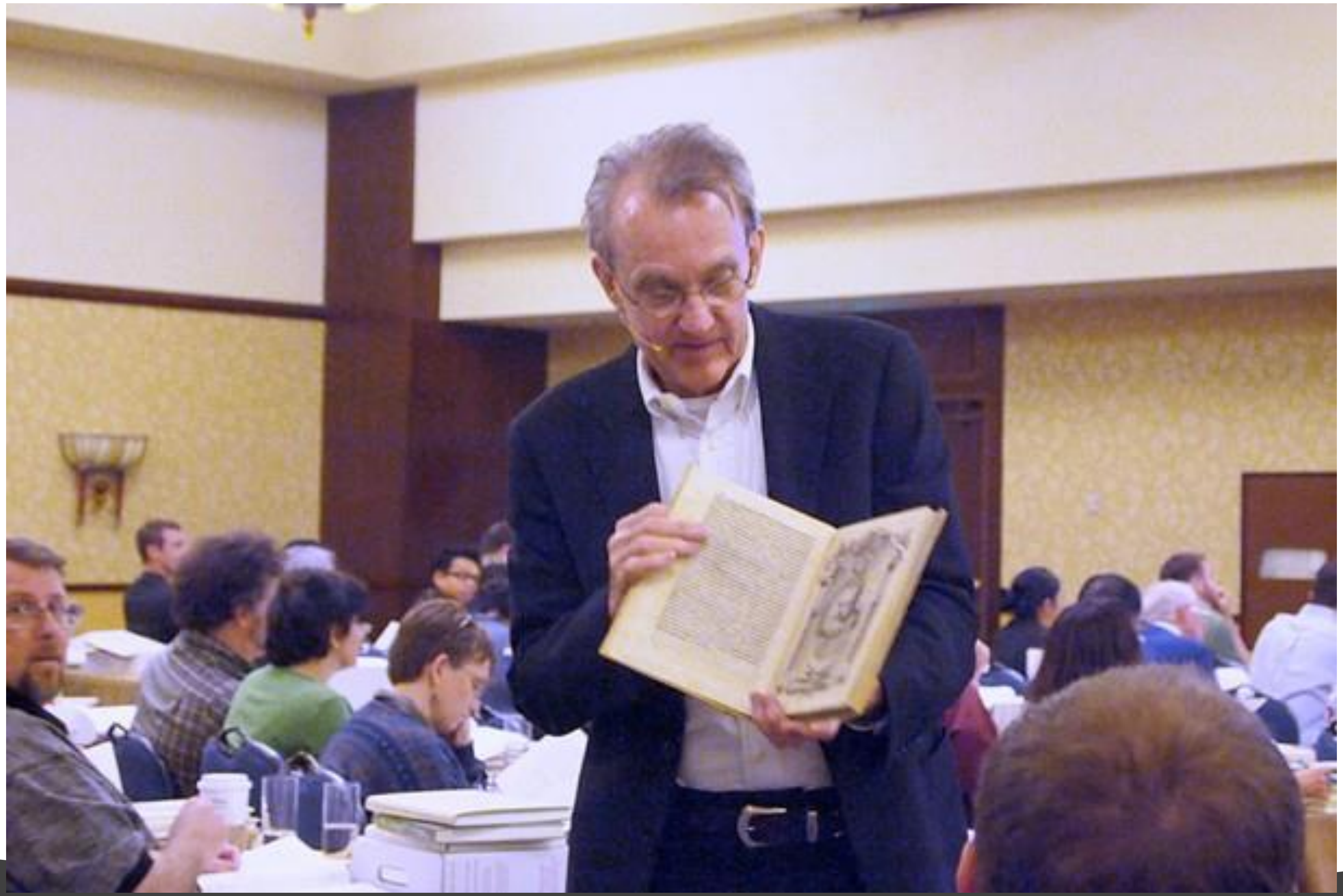
Visualization for Data Science
DS-4630 / CS-5630 / CS-6630

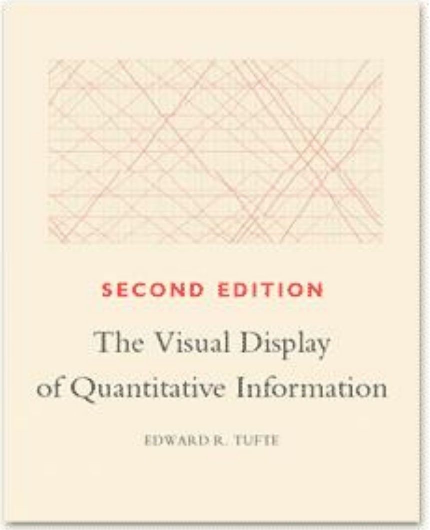
Visual Design and Dark Patterns

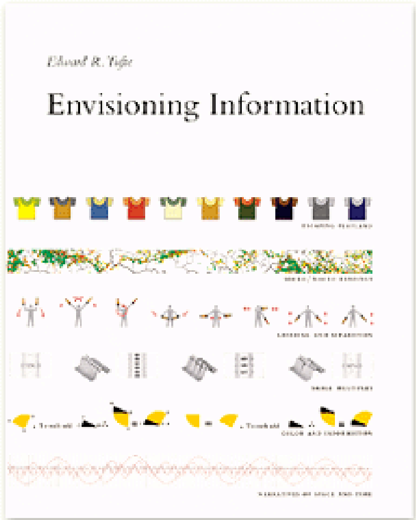
TUFTE
Design excellence

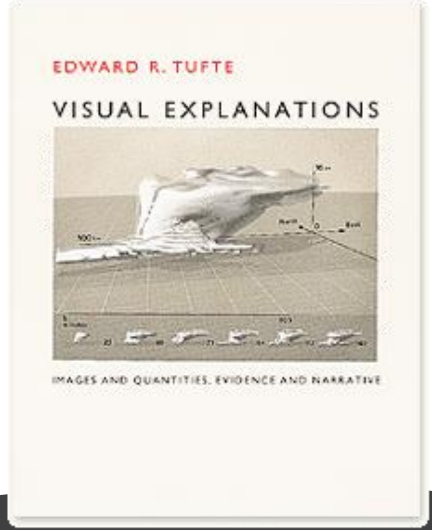
TUFTE'S LESSONS

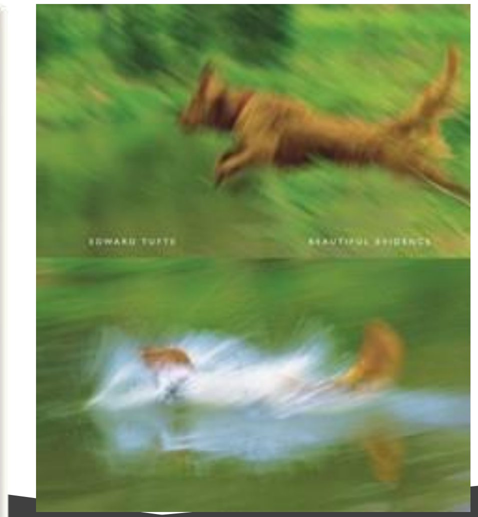
- practice—graphical integrity and excellence
- theory—design principles for data graphics











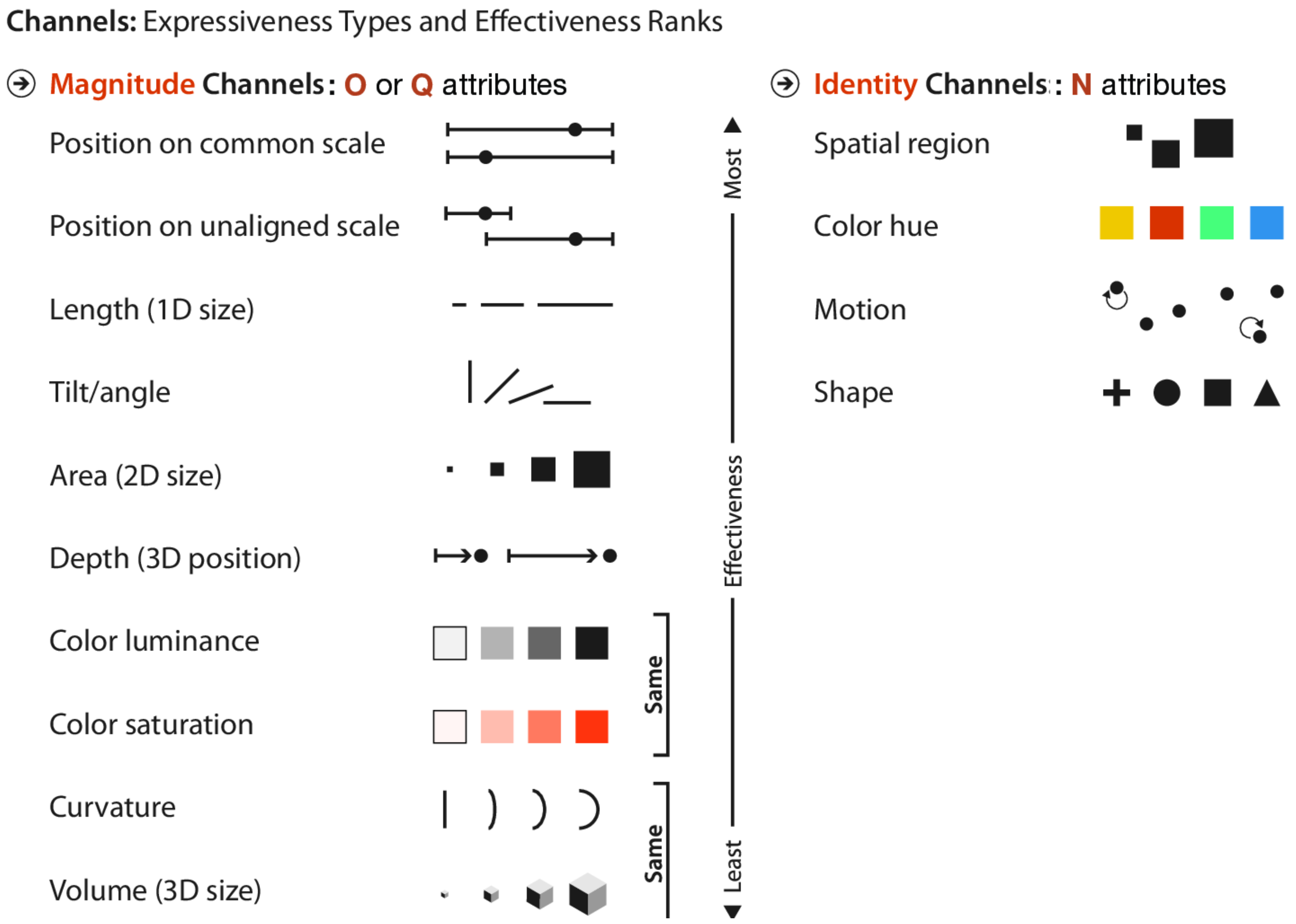
GRAPHICAL INTEGRITY
clear, detailed, and thorough labeling should be used to defeat graphical distortion and ambiguity

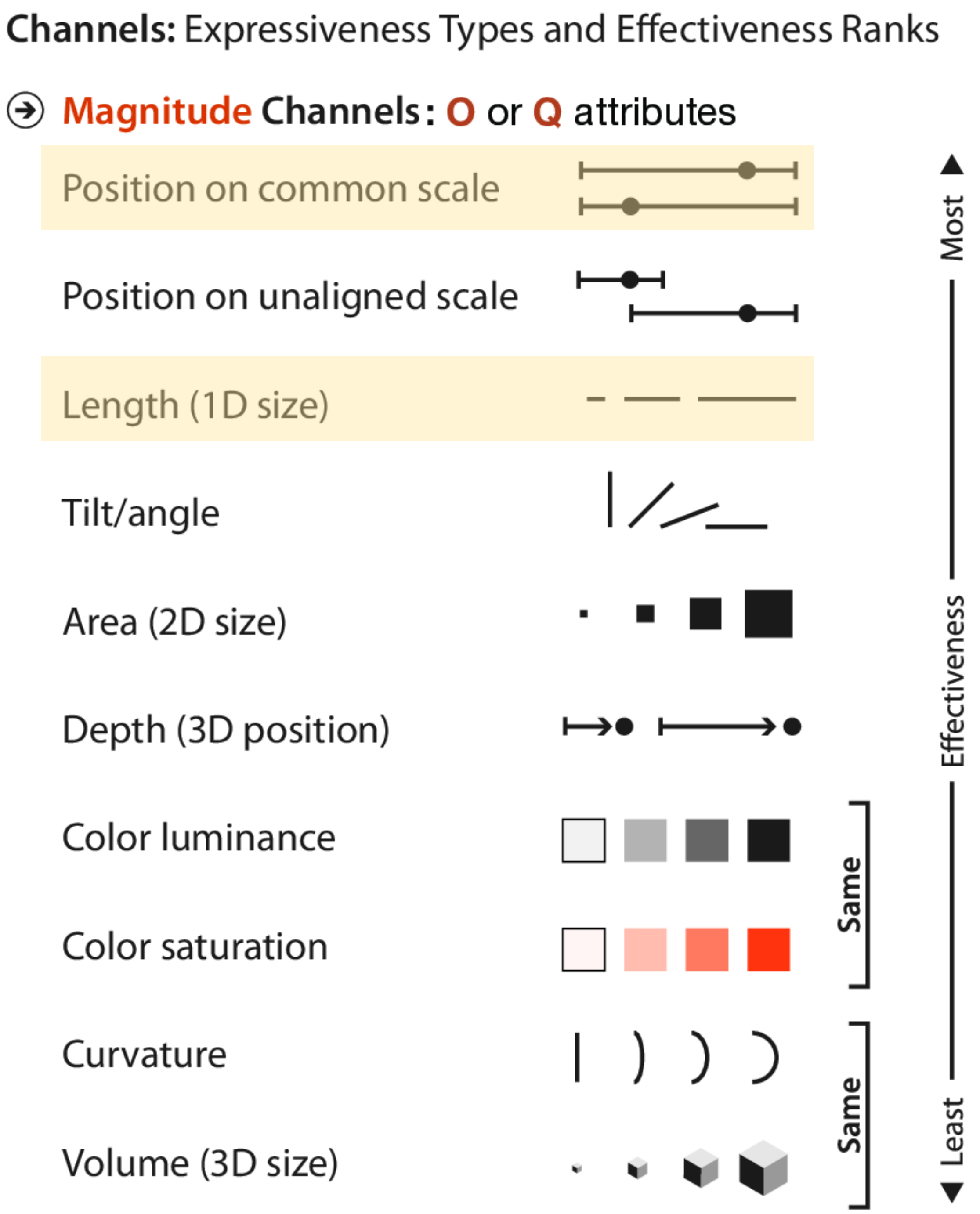
Graphical excellence

- Design a visualization that gives the viewer:
  - the greatest number of ideas,
  - in the shortest time,
  - with the least ink, and
  - in the smallest space.

A. Einstein, “An explanation should be as simple as possible, but no simpler.”

Effective Encoding


Channels: Expressiveness Types and Effectiveness Ranks
Magnitude Channels: O or Q attributes
Position on common scale
Position on unaligned scale
Length (1D size)
Tilt/angle
Area (2D size)
Depth (3D position)
Color luminance
Color saturation
Curvature
Volume (3D size)
Same
Same
Most
Effectiveness
Least
Identity Channels: N attributes
Spatial region
Color hue
Motion
Shape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Magnitude Channels: O or Q attributes
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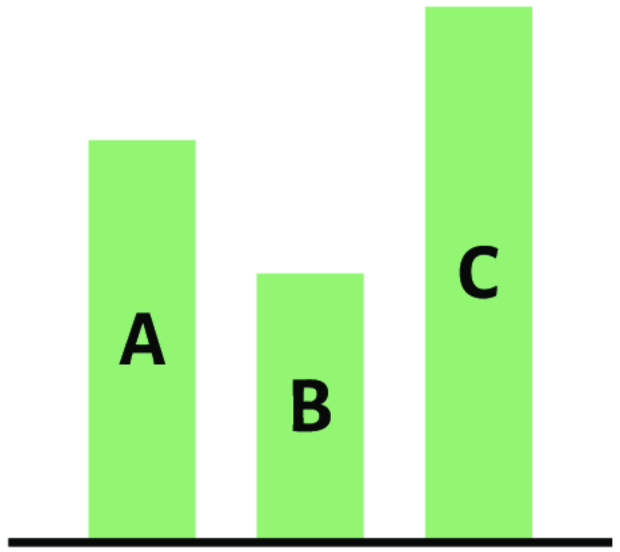
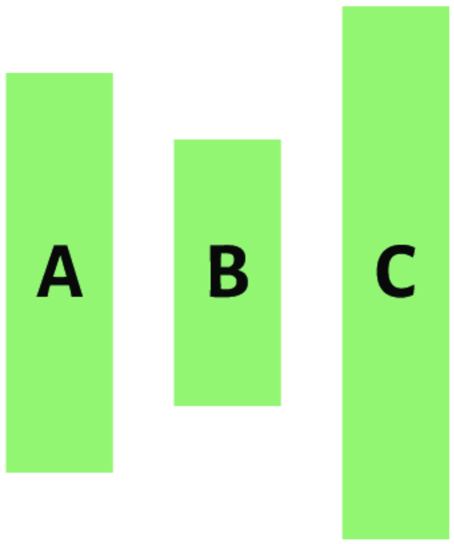
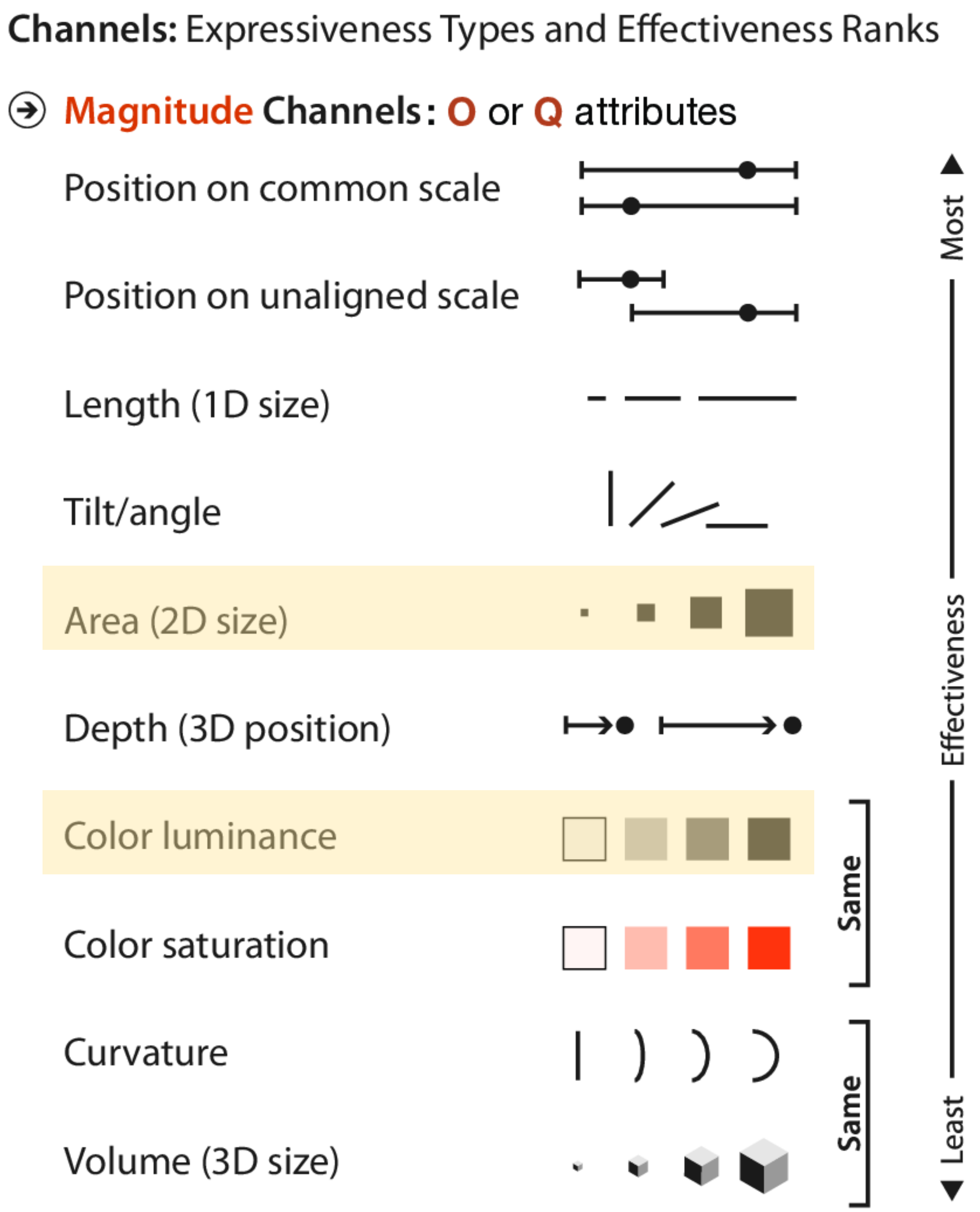
Area (2D size)
Depth (3D position)
Color luminance
Color saturation
Curvature
Volume (3D size)
Same
Same
Most
Effectiveness
Least


A
B
C


A
B
C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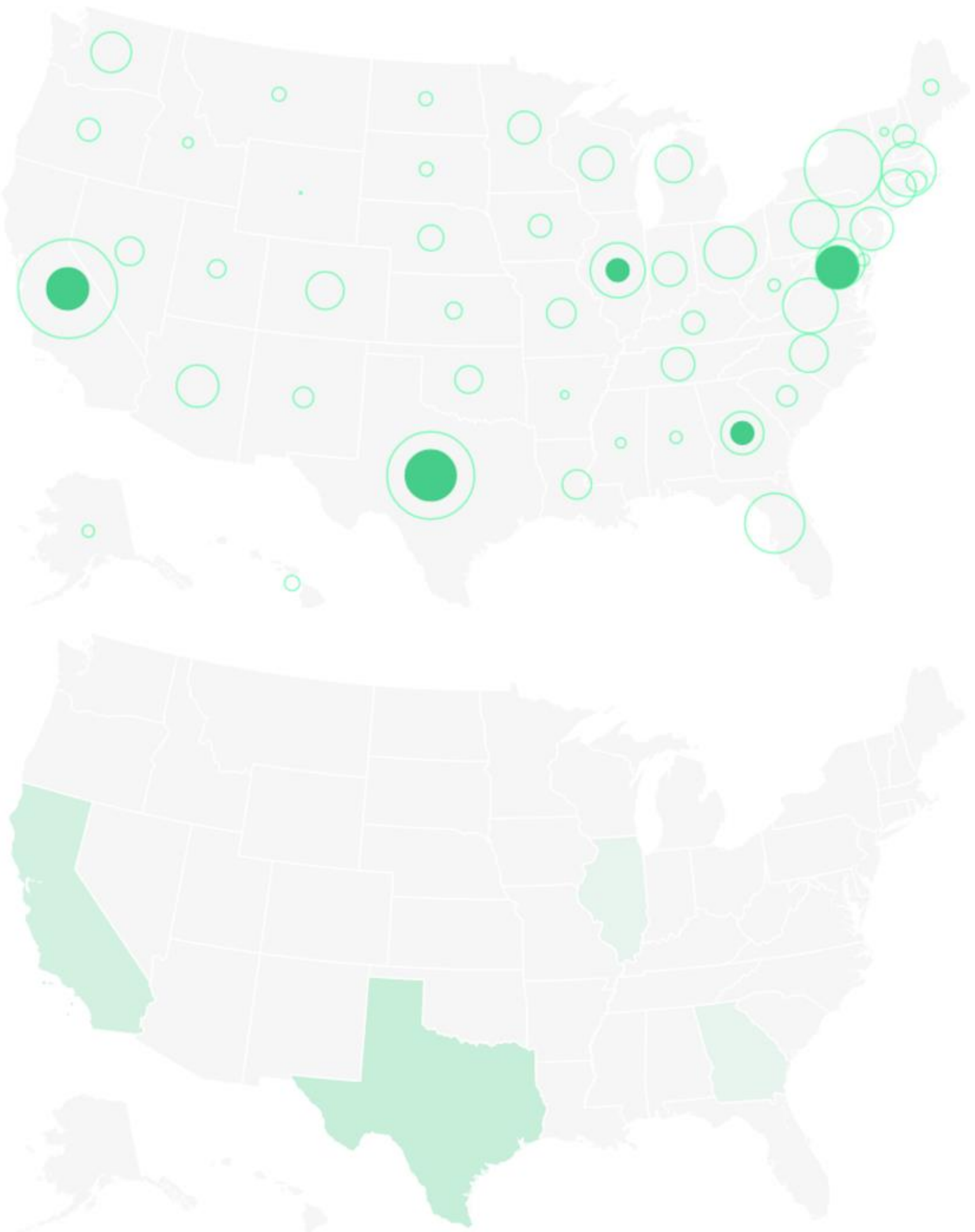
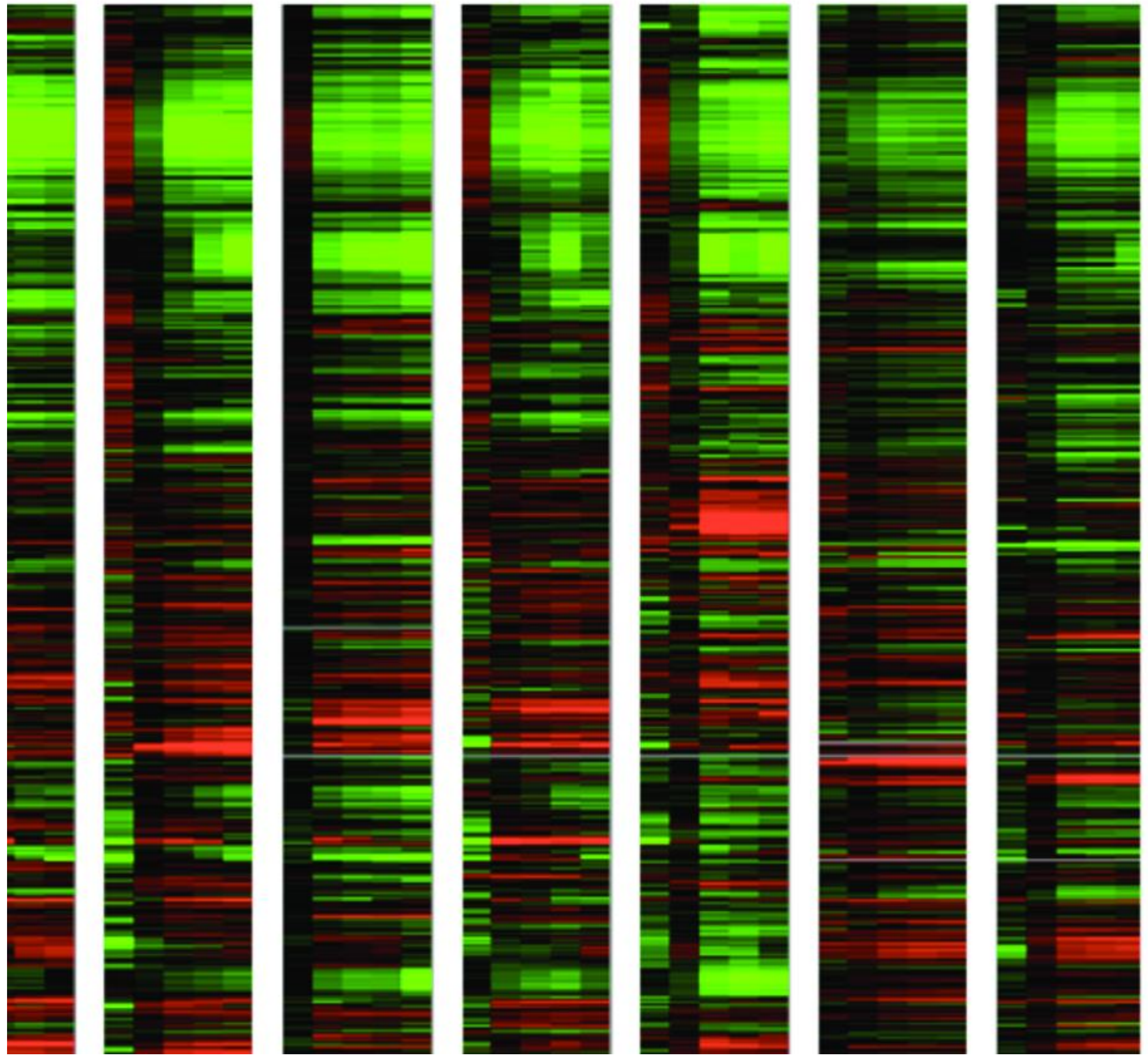
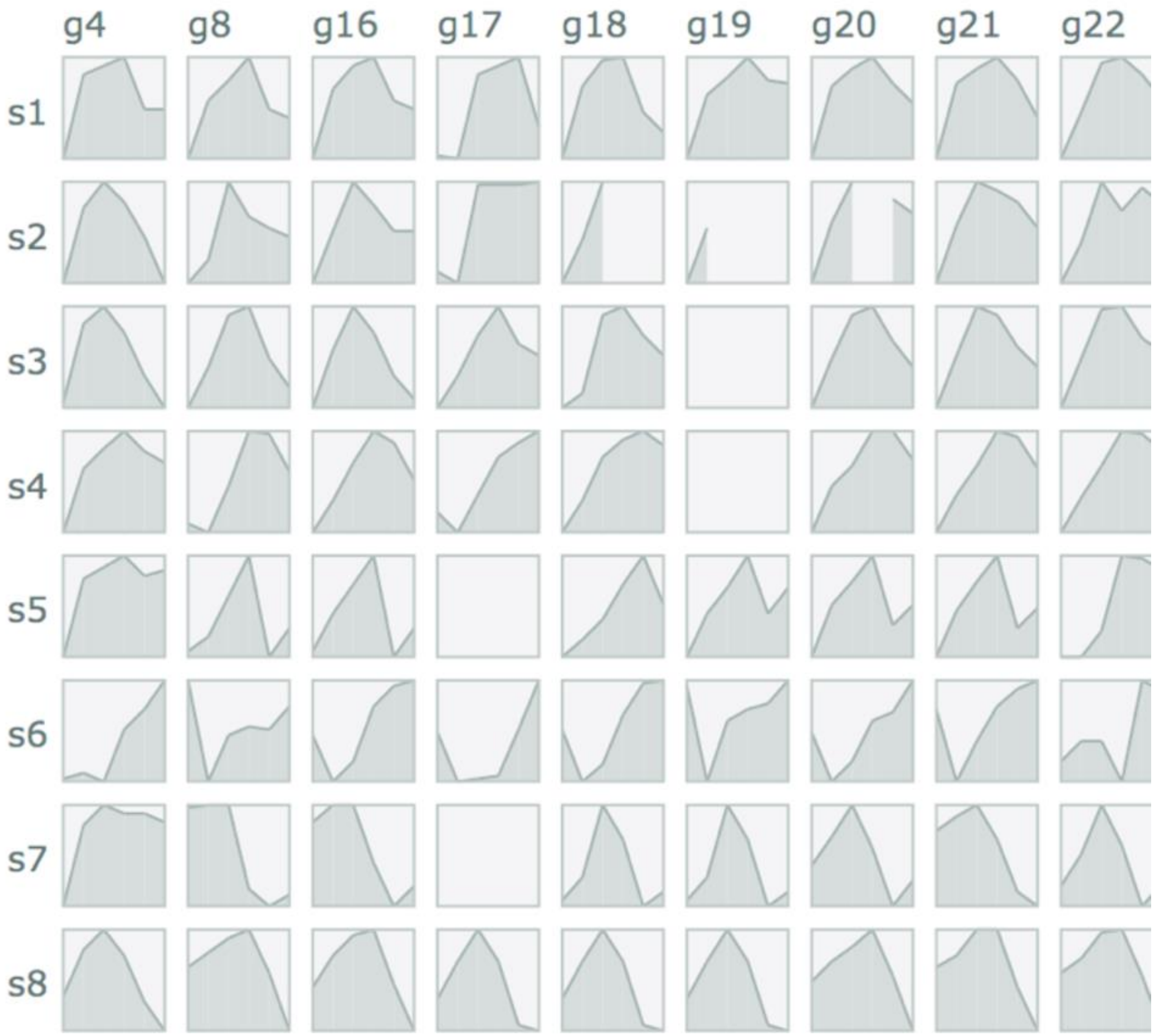


Gene Expression Time-Series [Meyer et al. '10]

Color Encoding

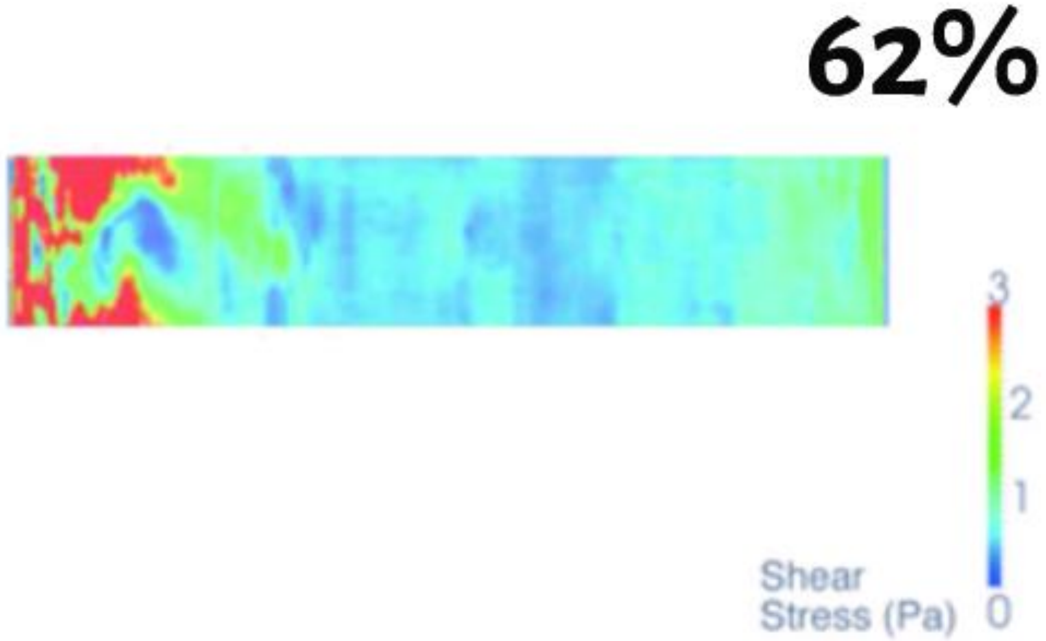


Position Encoding

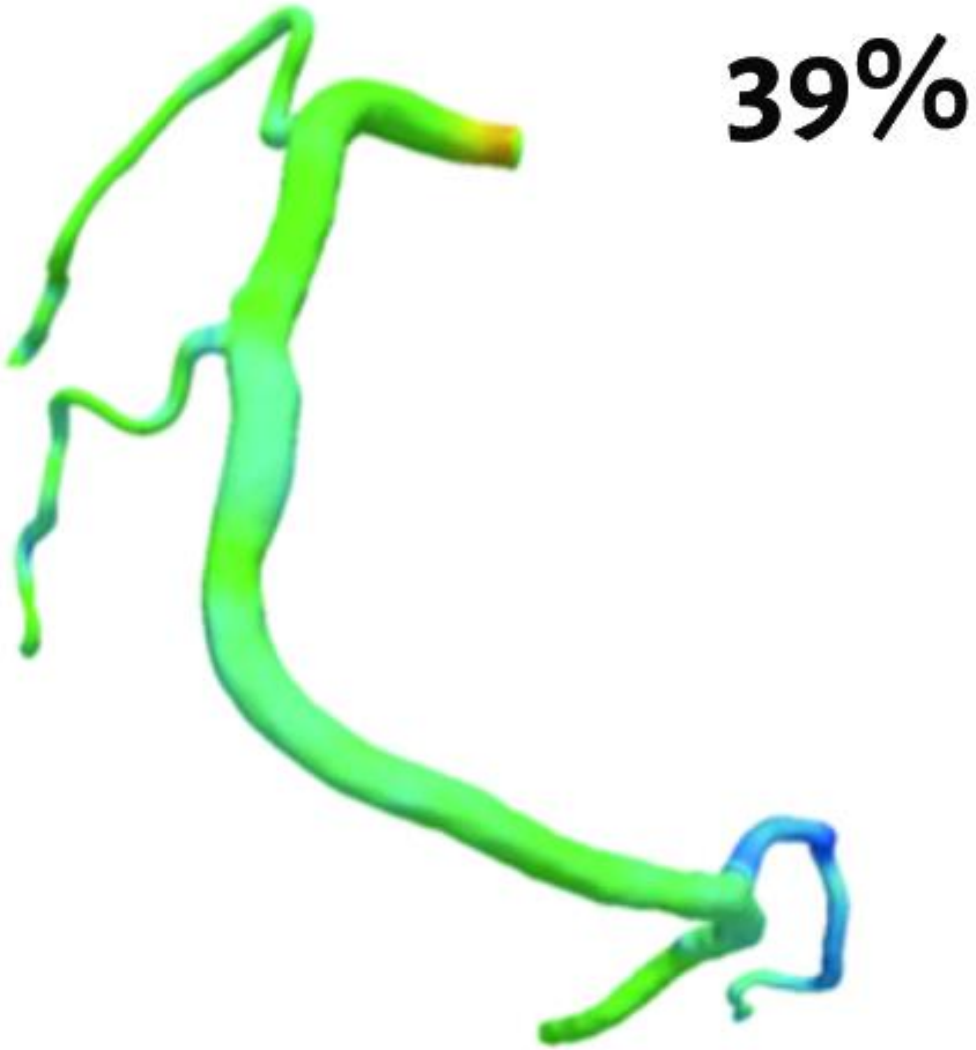


Artery Visualization [Borkin et al. '11]

2D



3D



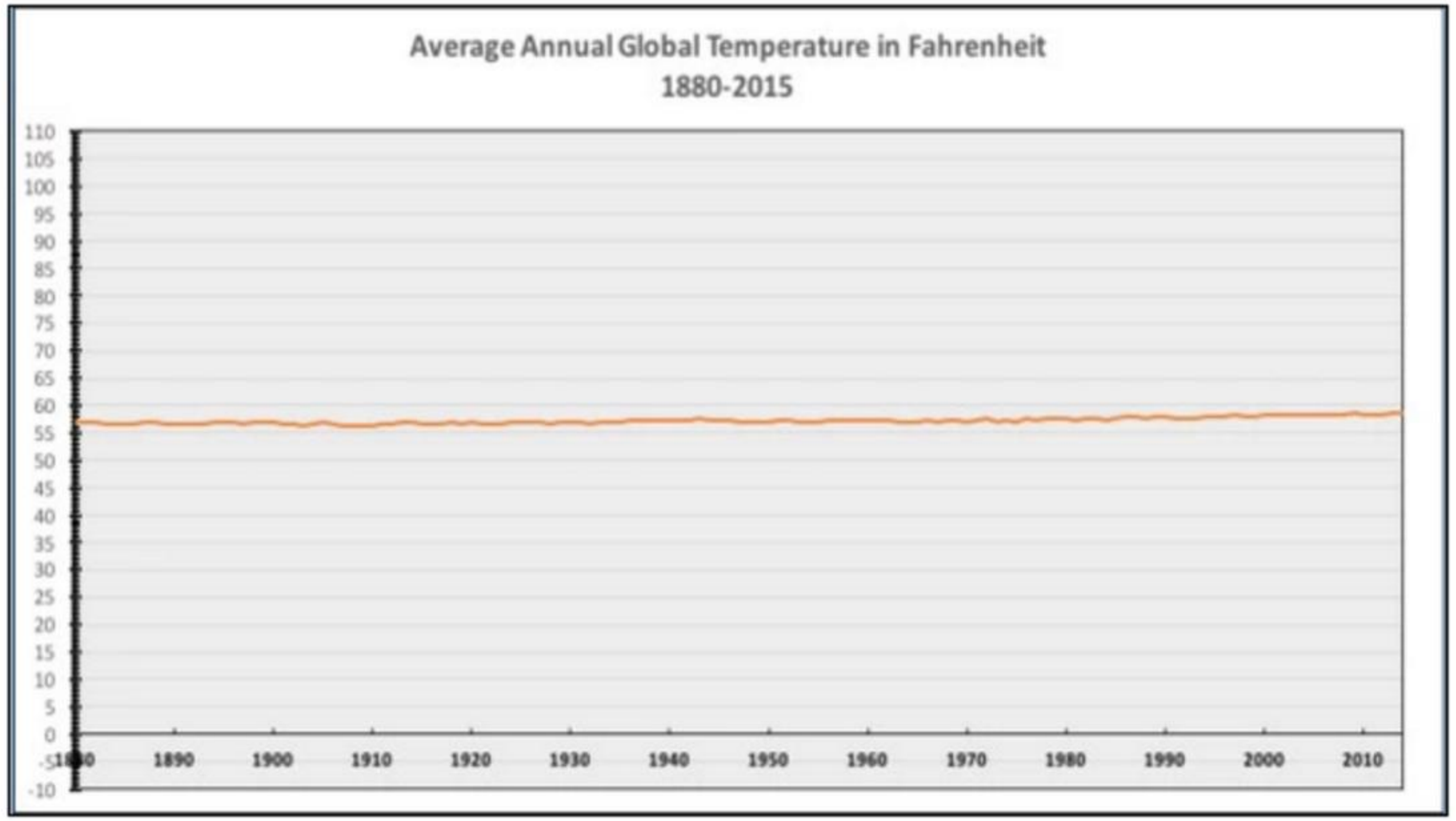
Scales

National Review @NRO

Follow

The only #climatechange chart you need to see. natl.re/wPKpro

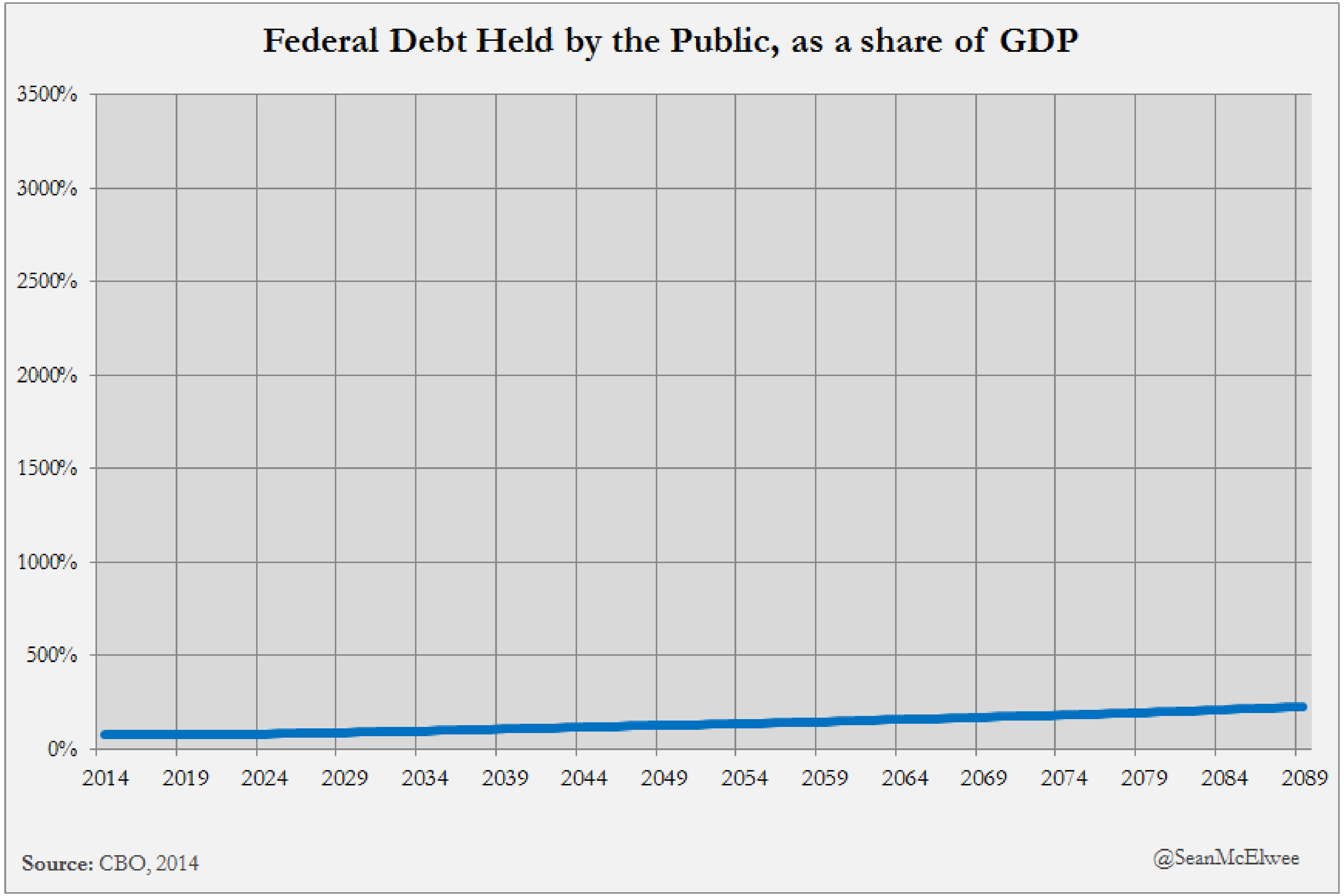
(h/t @powerlineUS)



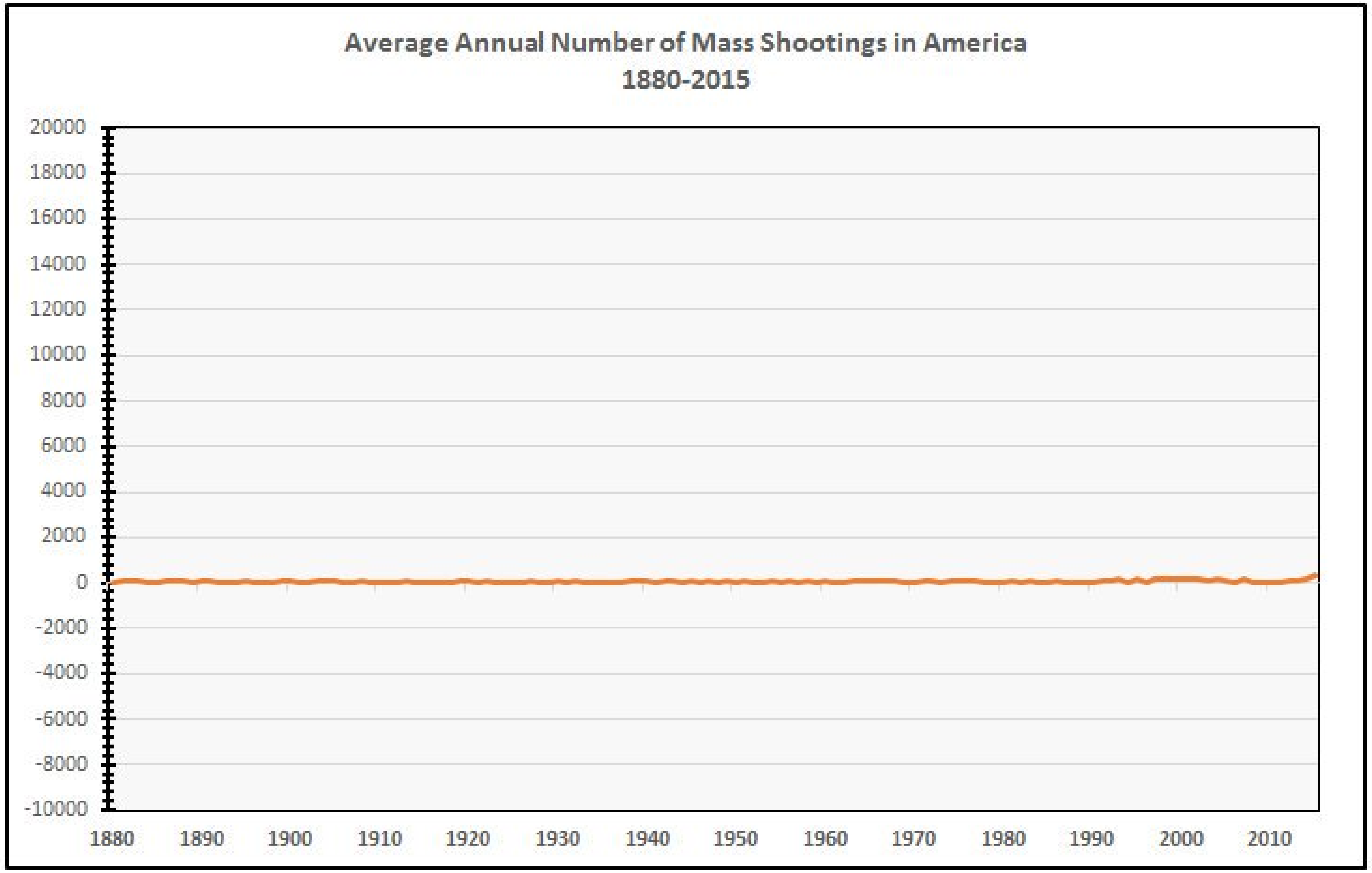
RETWEETS 408 LIKES 322

1:36 PM - 14 Dec 2015

http://www.vislies.org/

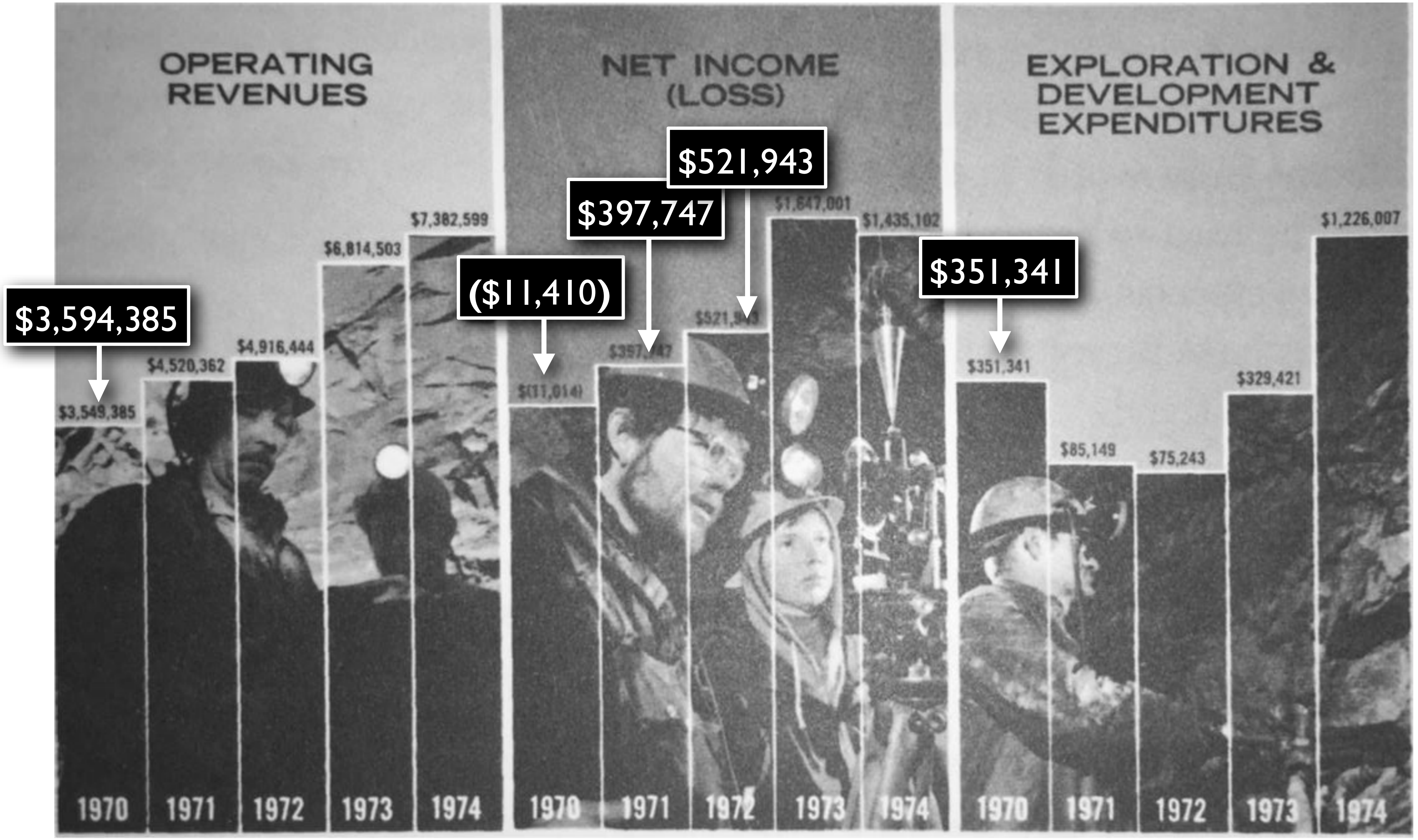


Federal Debt Held by the Public, as a share of GDP
3500%
3000%
2500%
2000%
1500%
1000%
500%
0%
2014
2019
2024
2029
2034
2039
2044
2049
2054
2059
2064
2069
2074
2079
2084
2089
Source: CBO, 2014
@SeanMcElwee

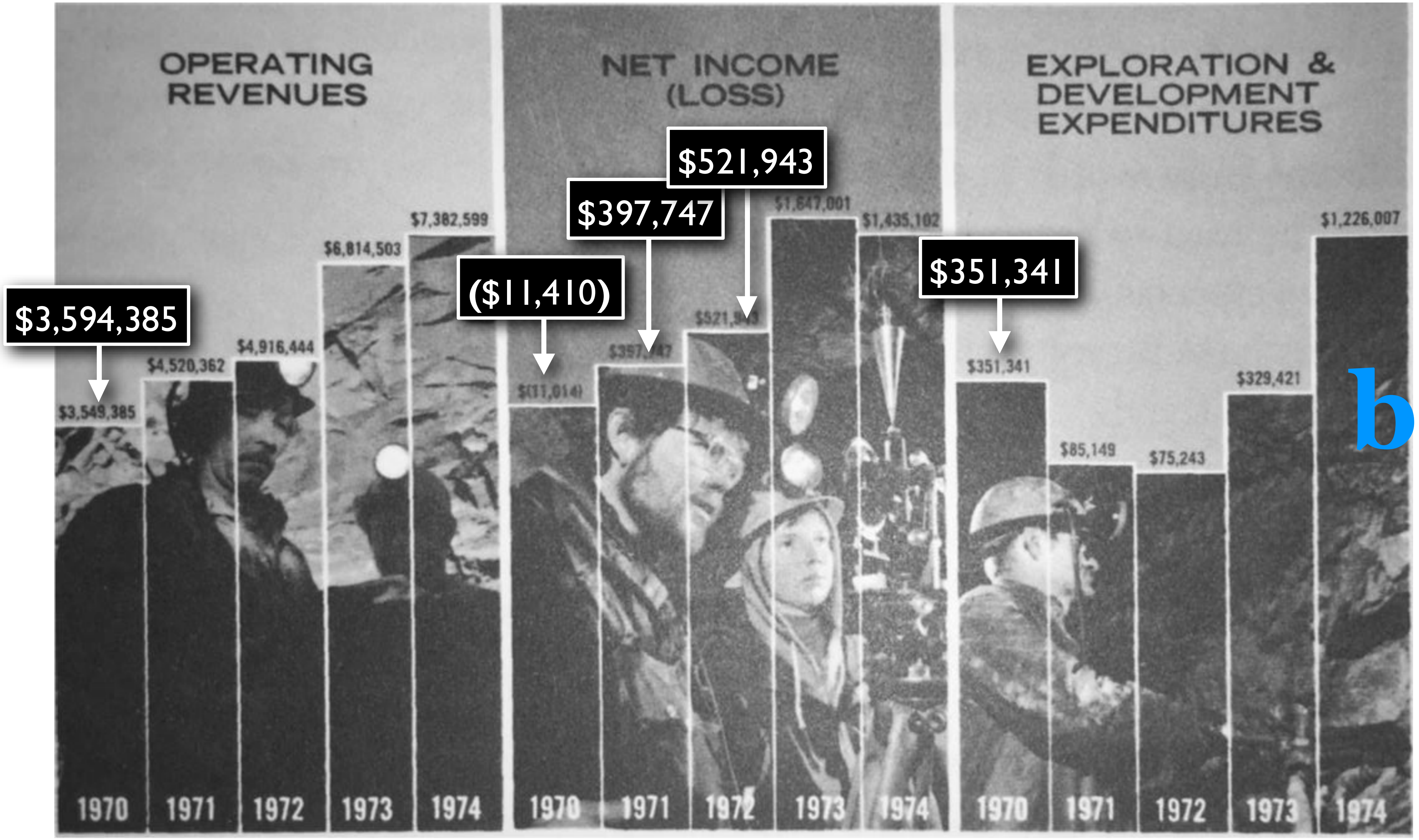

Average Annual Number of Mass Shootings in America
1880-2015
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
-10000
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010


World population from 10,000 BC to present
5,000,000,000,000
0
Population

MISSING SCALES



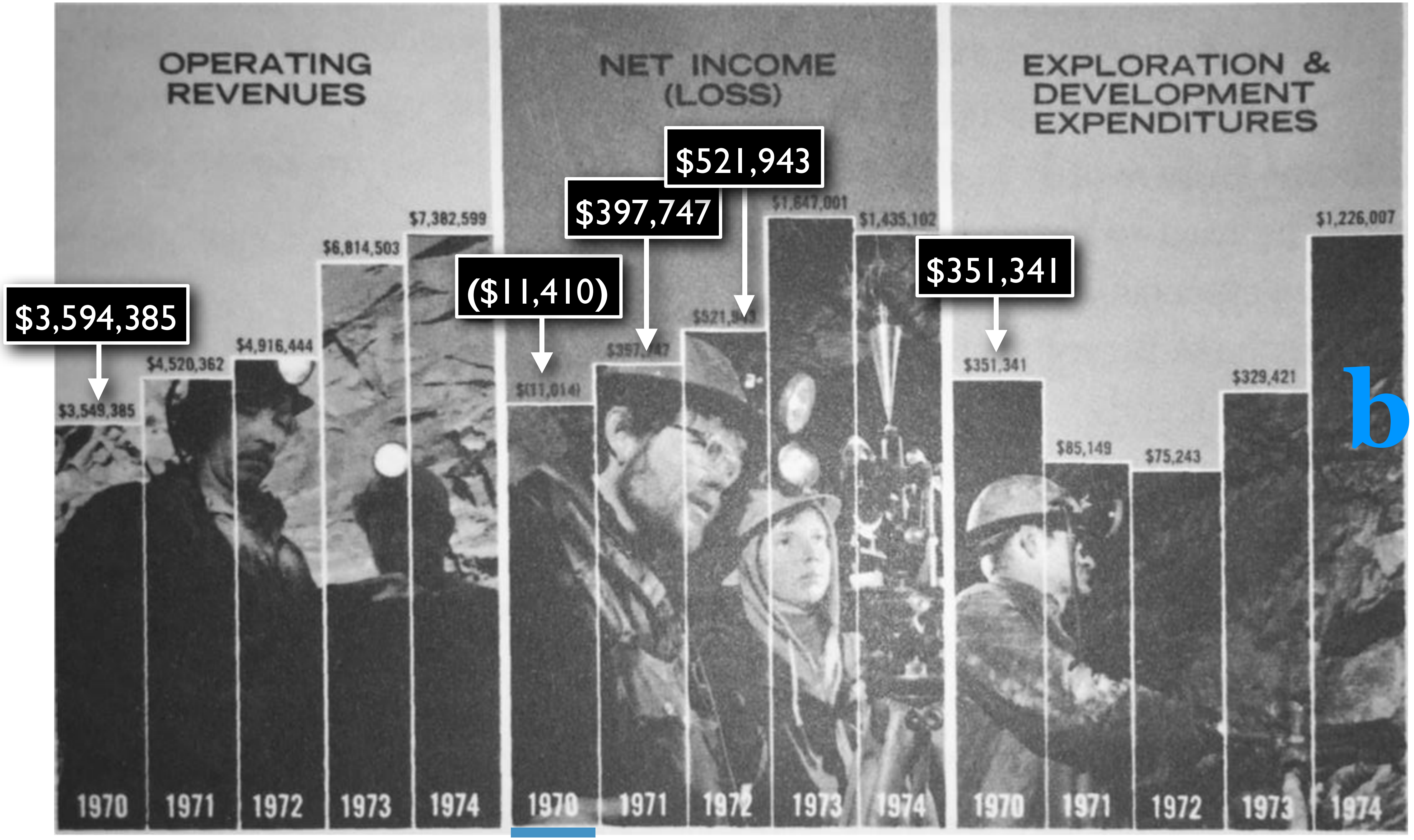
MISSING SCALES



baseline?

Tufte 2001

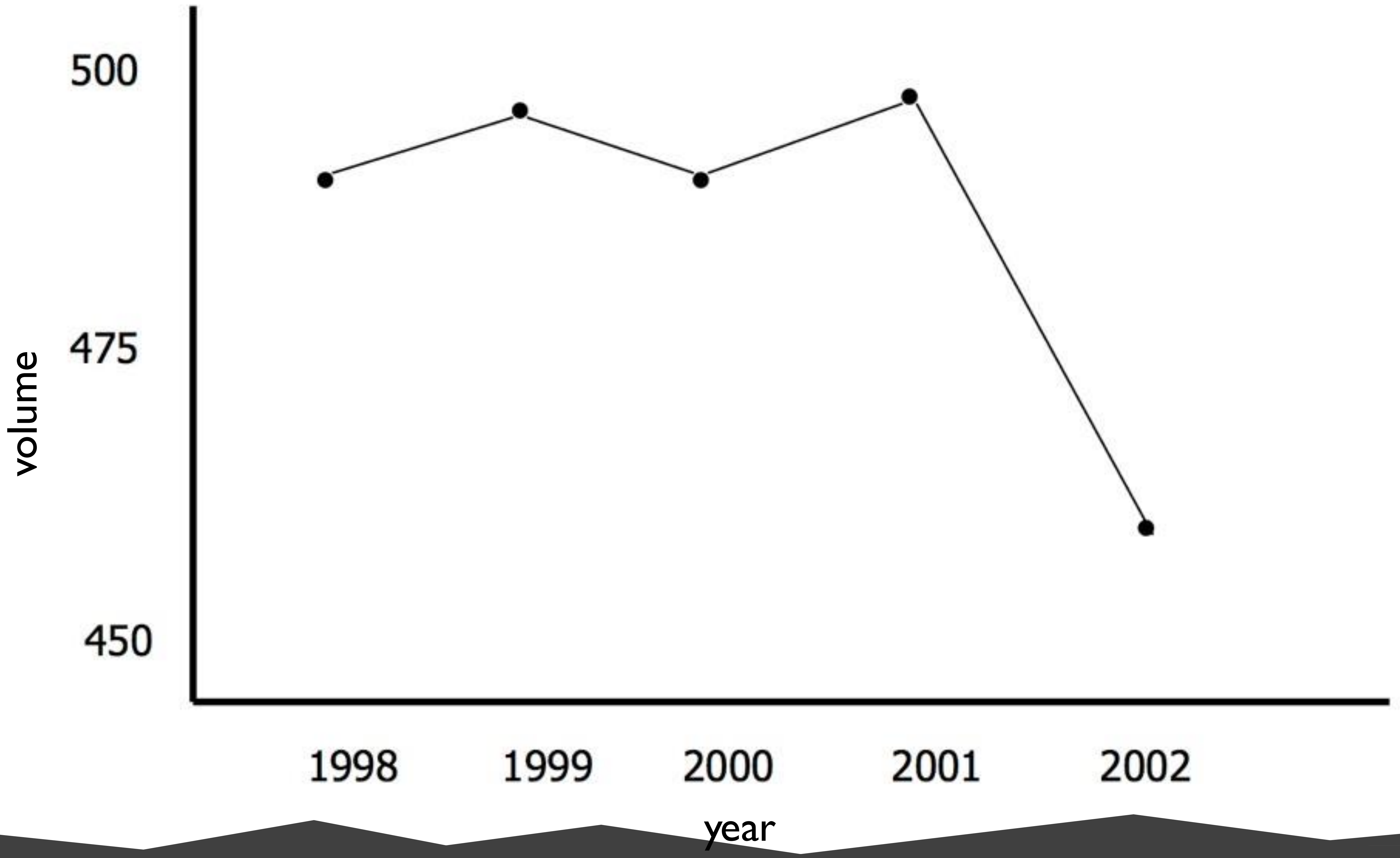
MISSING SCALES



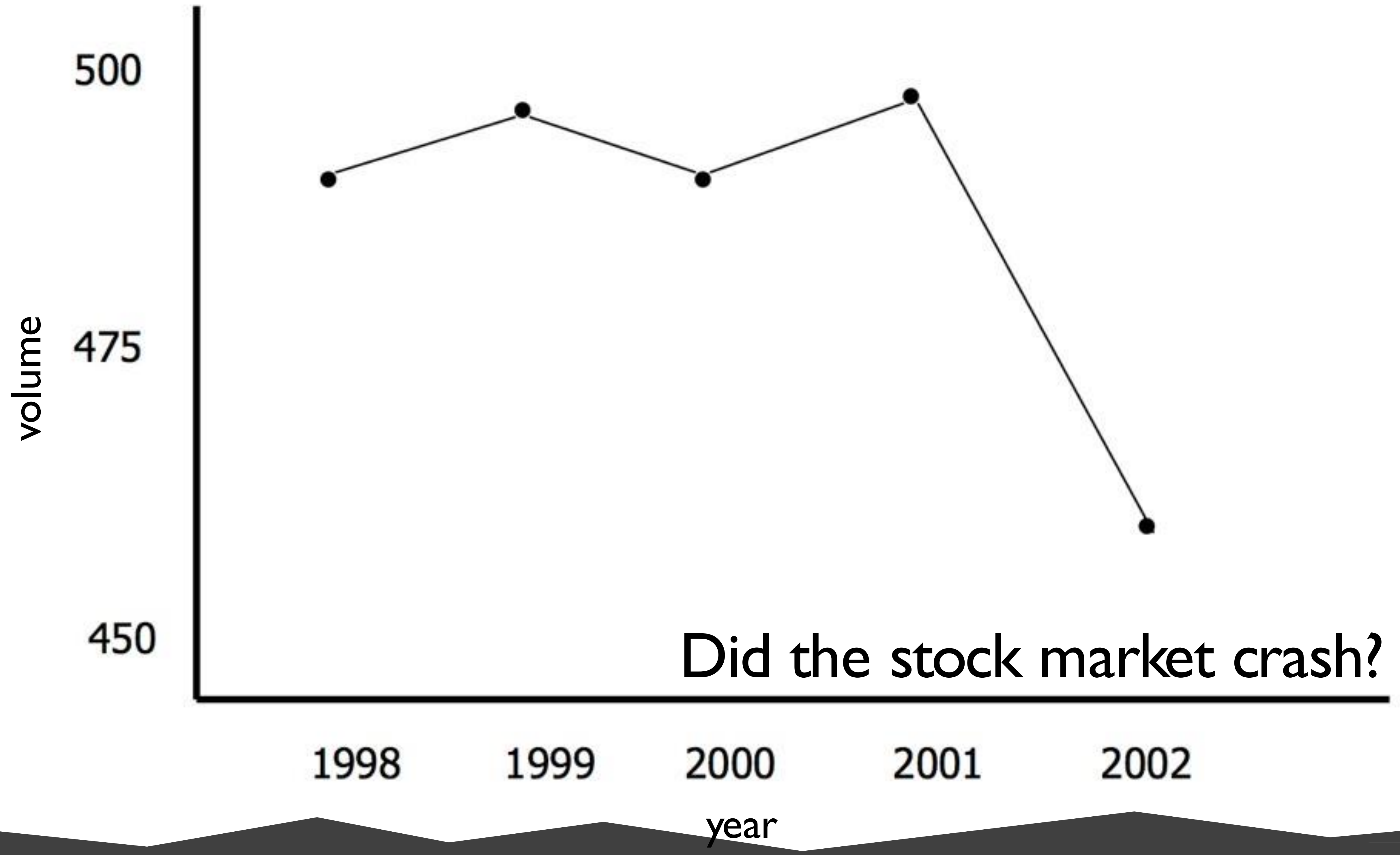
baseline?

-$4,200,000

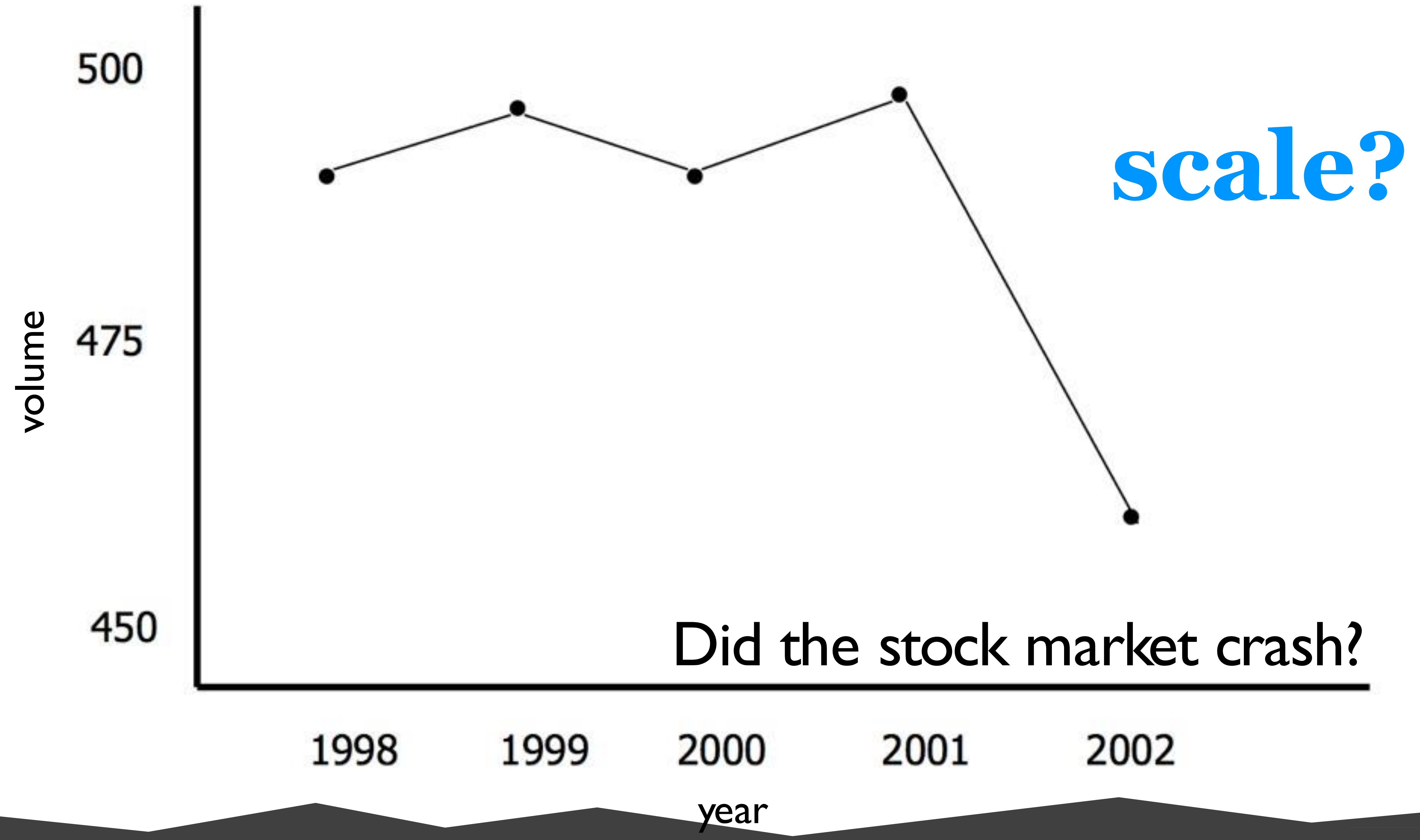
SCALE DISTORTION



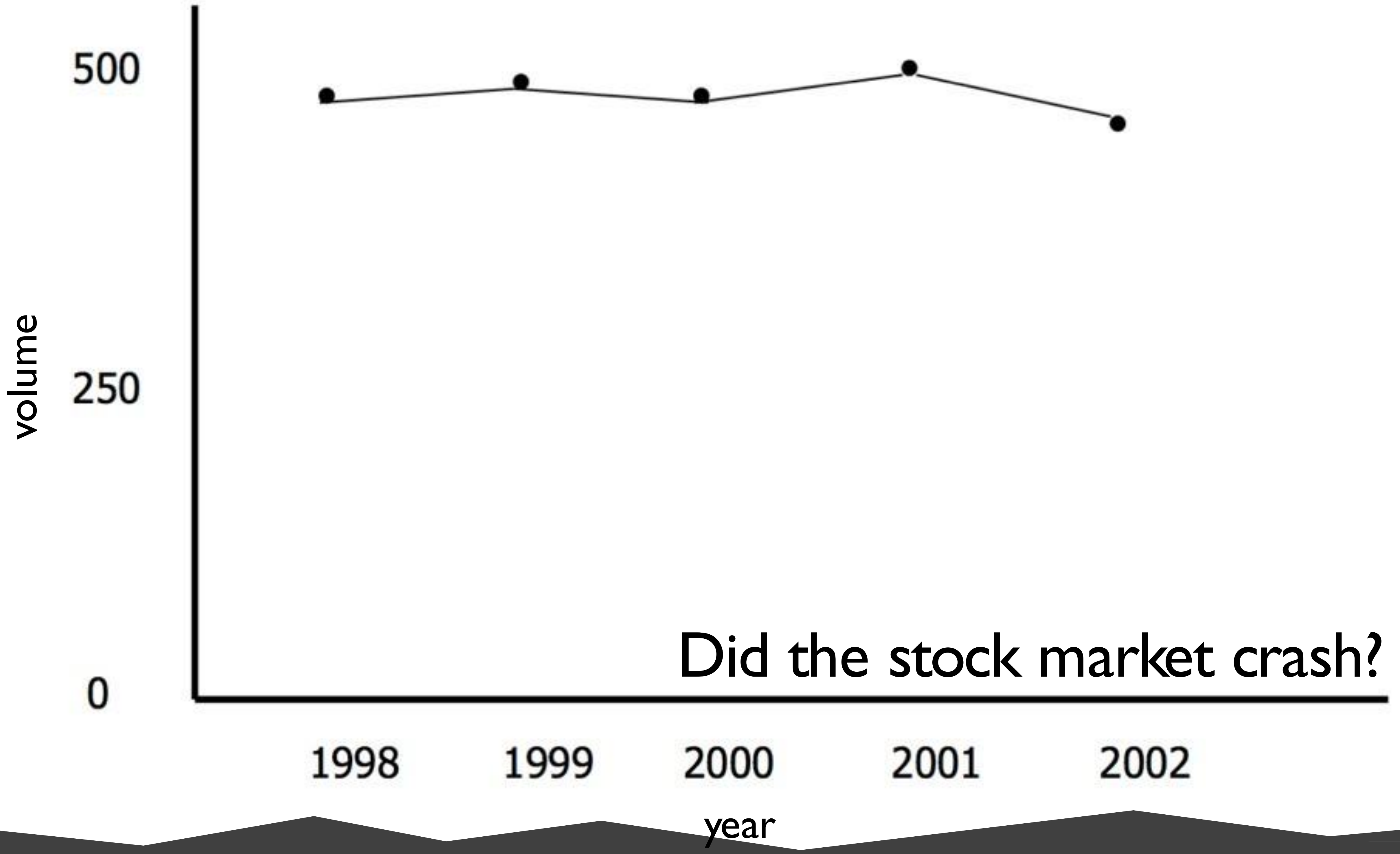
SCALE DISTORTION



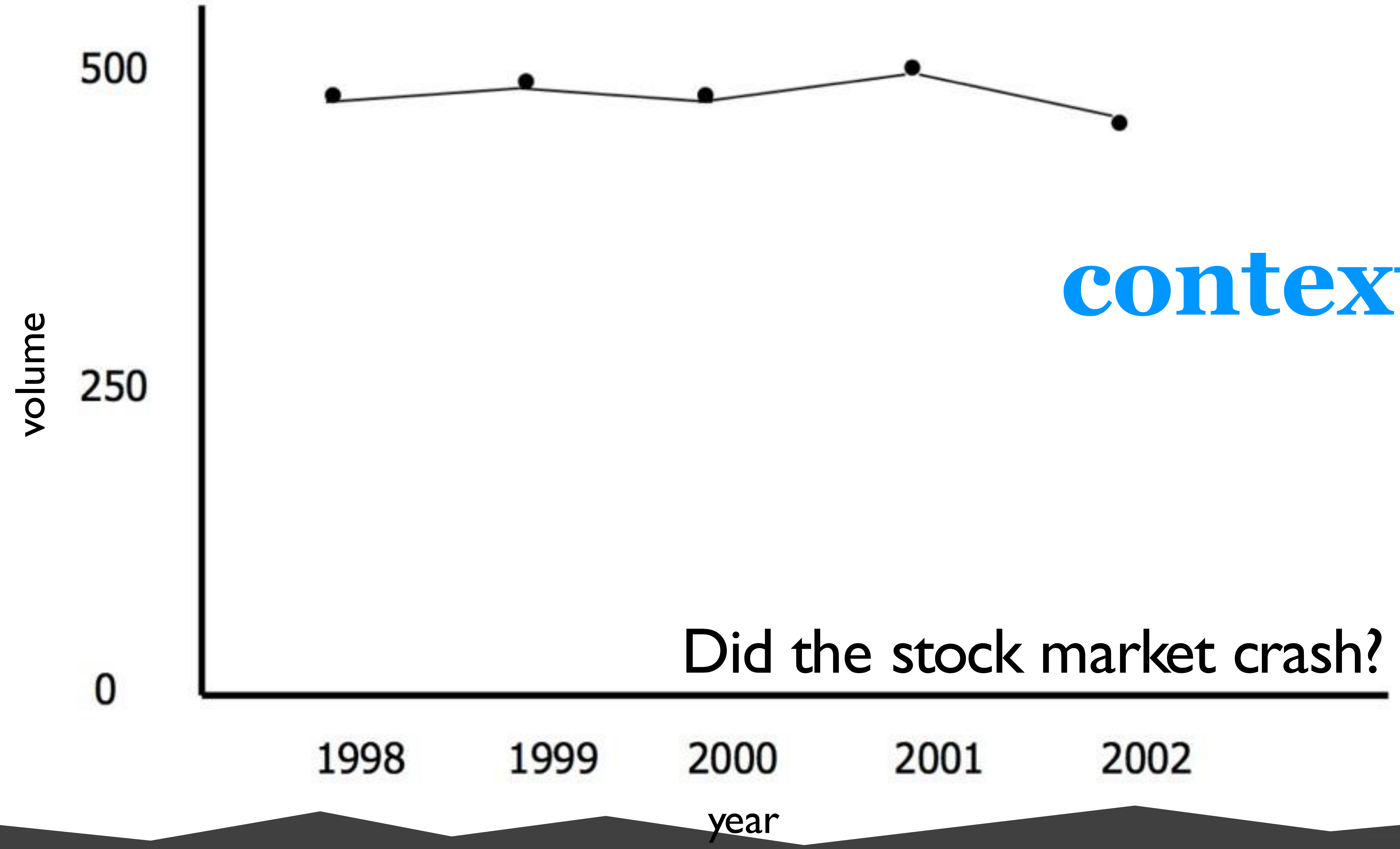
SCALE DISTORTION



SCALE DISTORTION

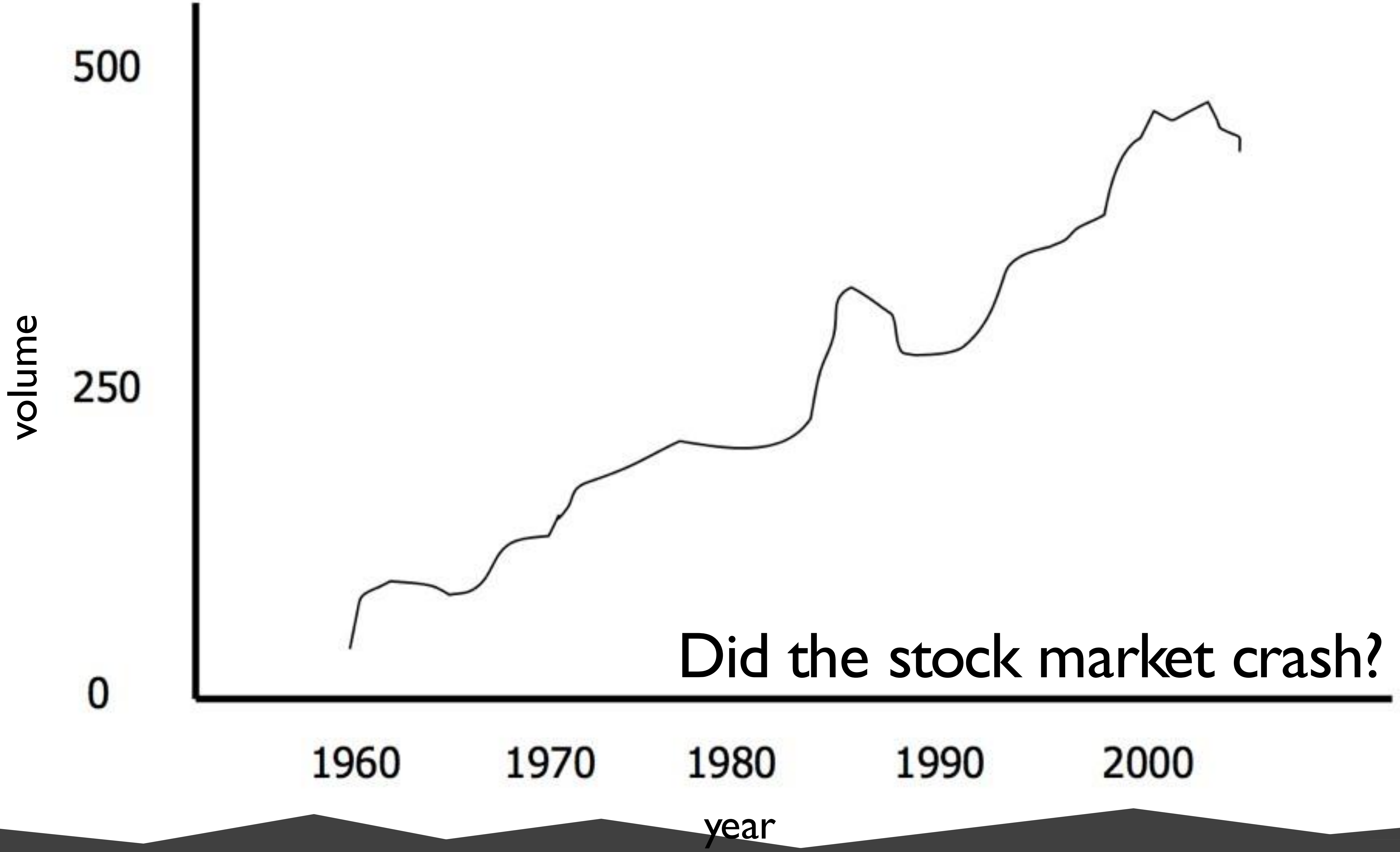


SCALE DISTORTION

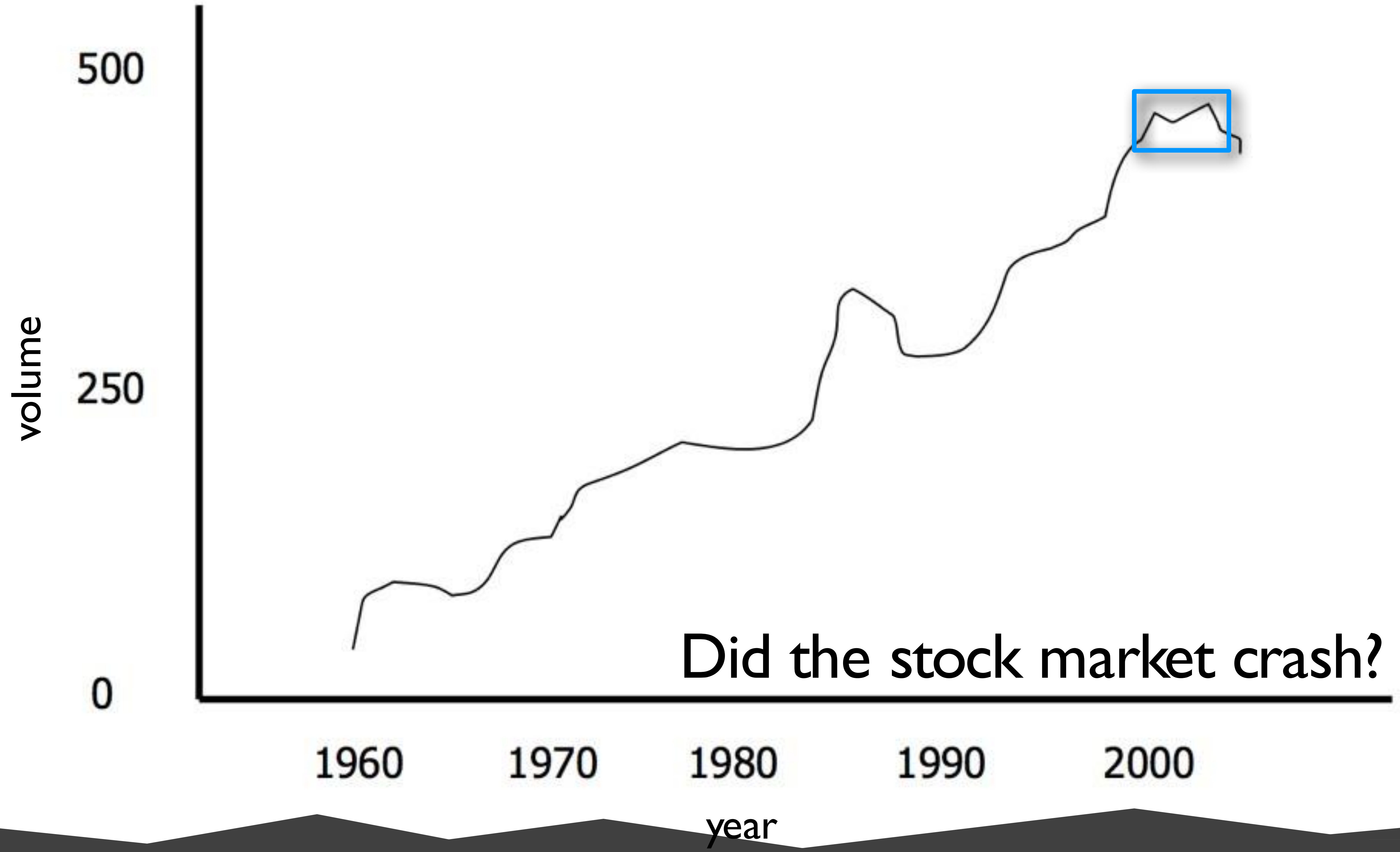


context?

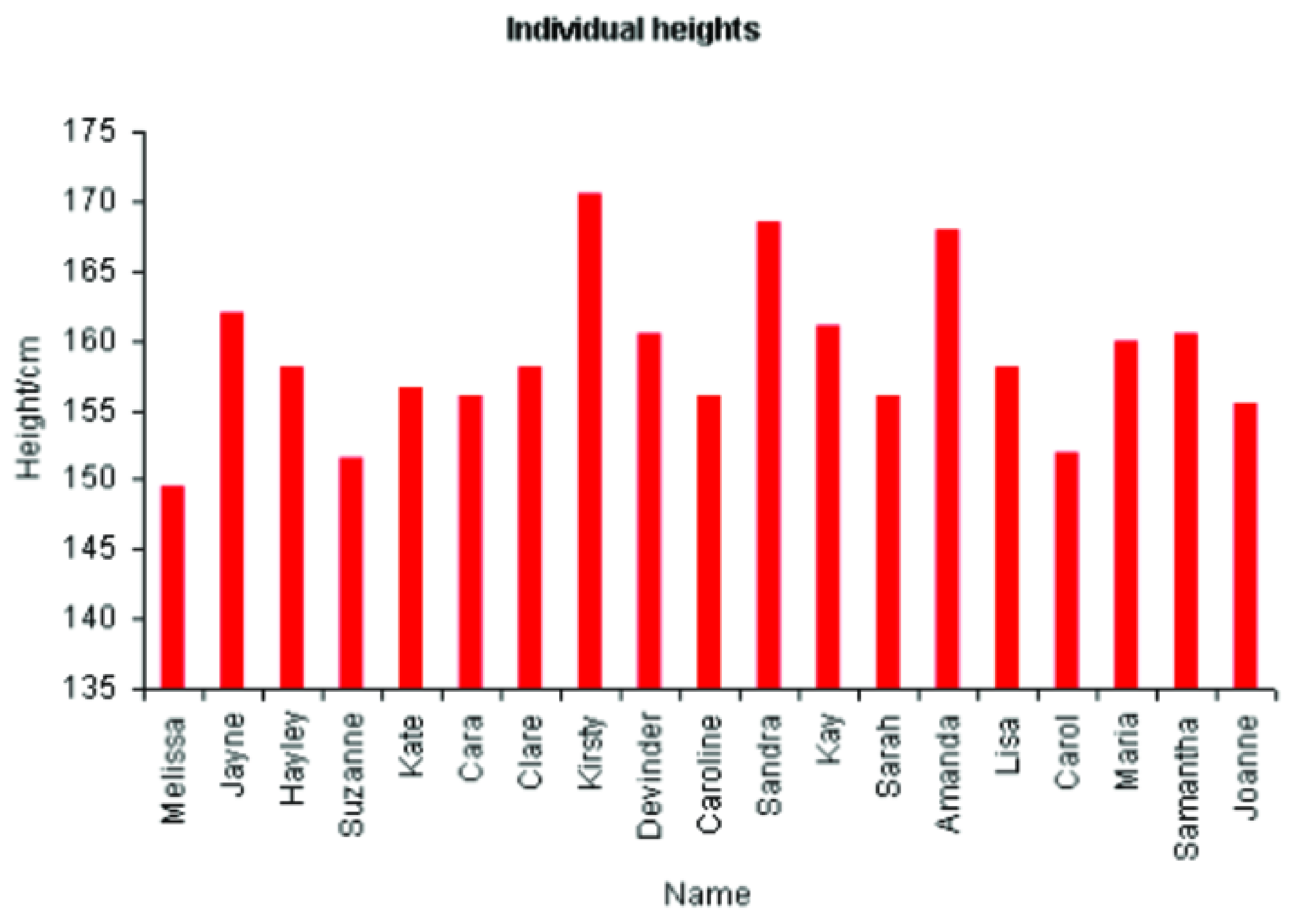
SCALE DISTORTION



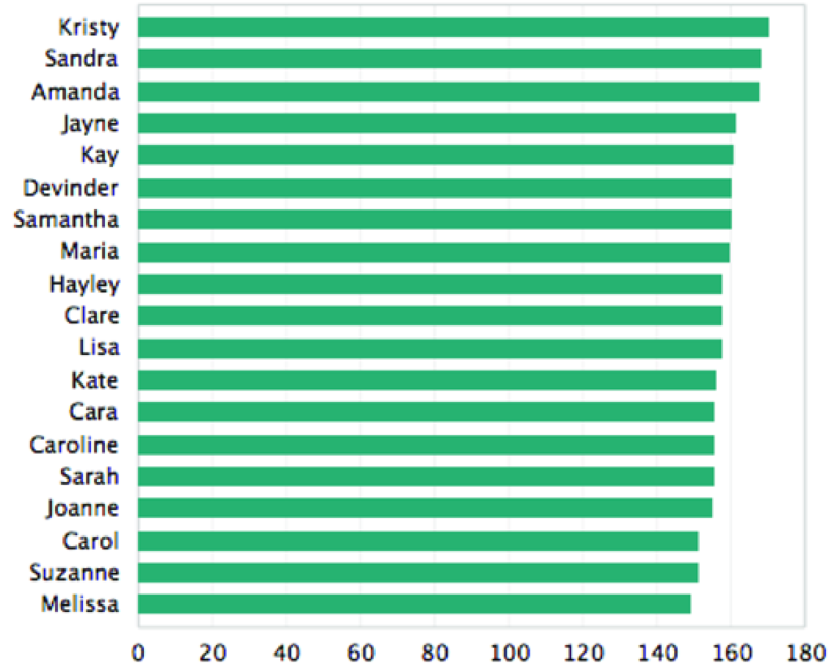
SCALE DISTORTION



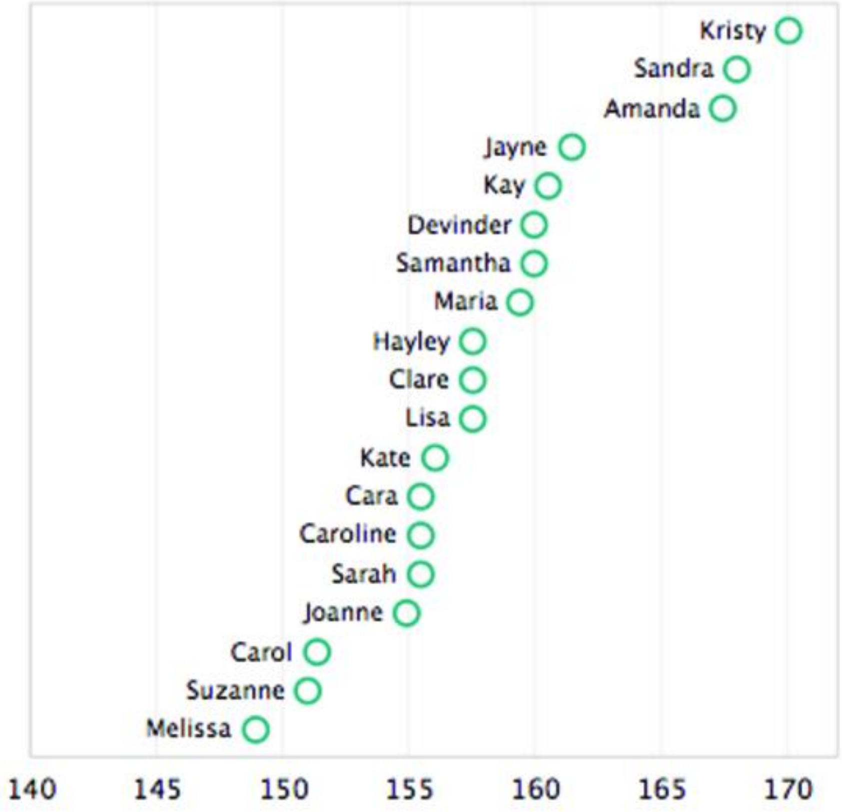
Zero Baseline



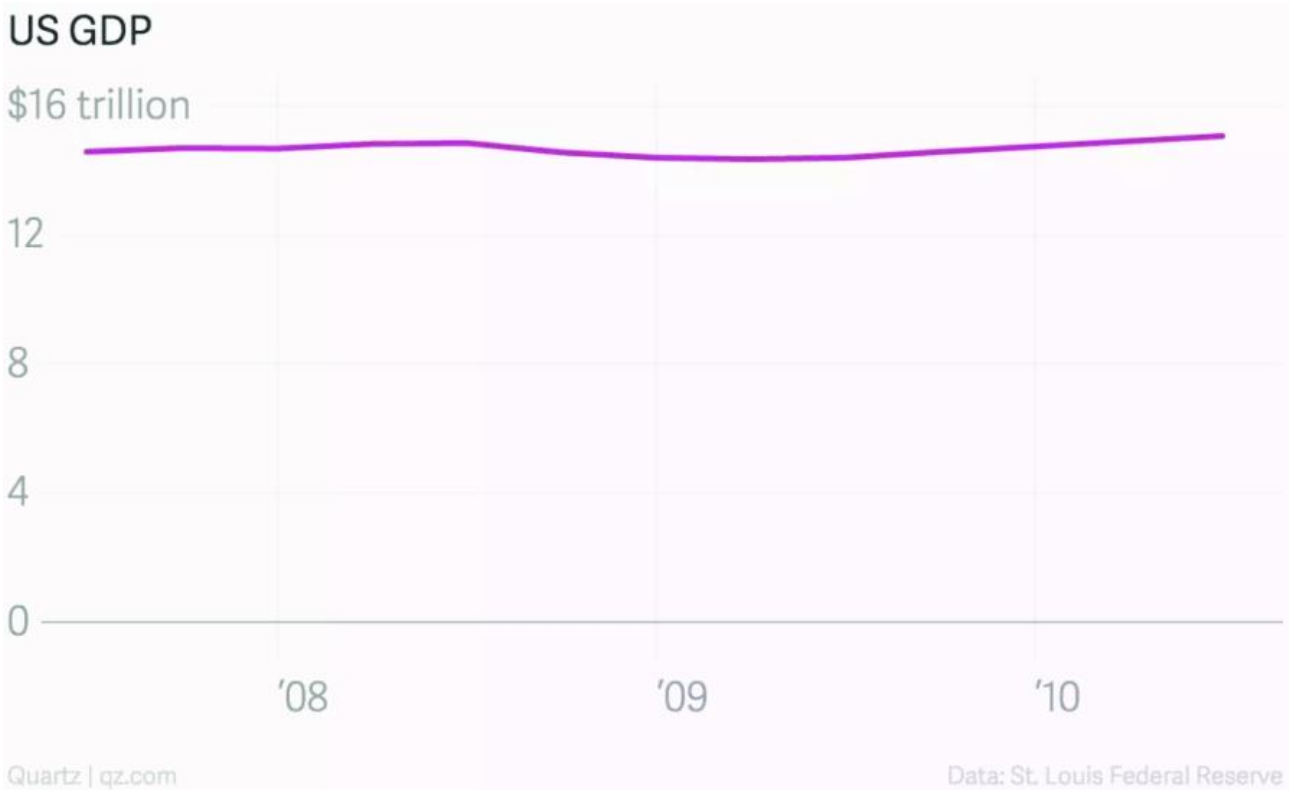
Compare Proportions

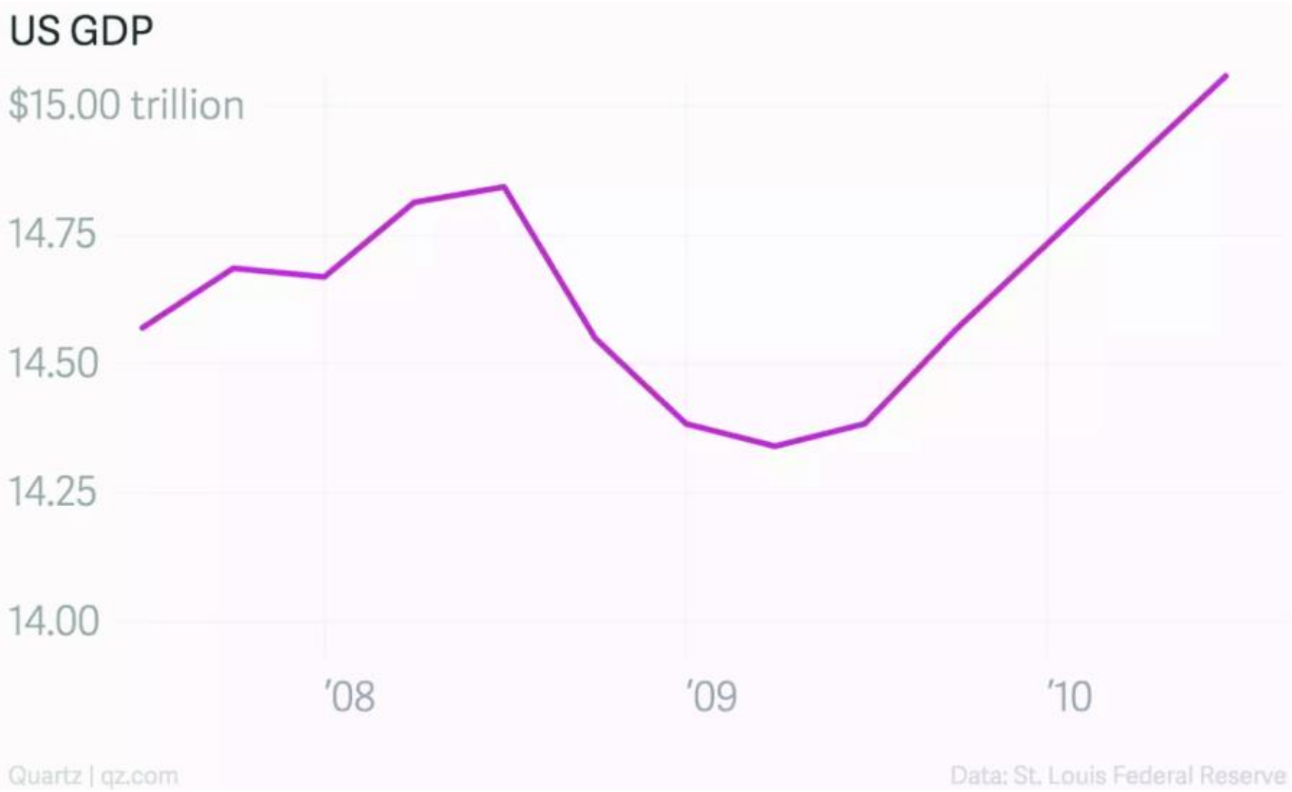


Compare relative positions



Zero Baseline



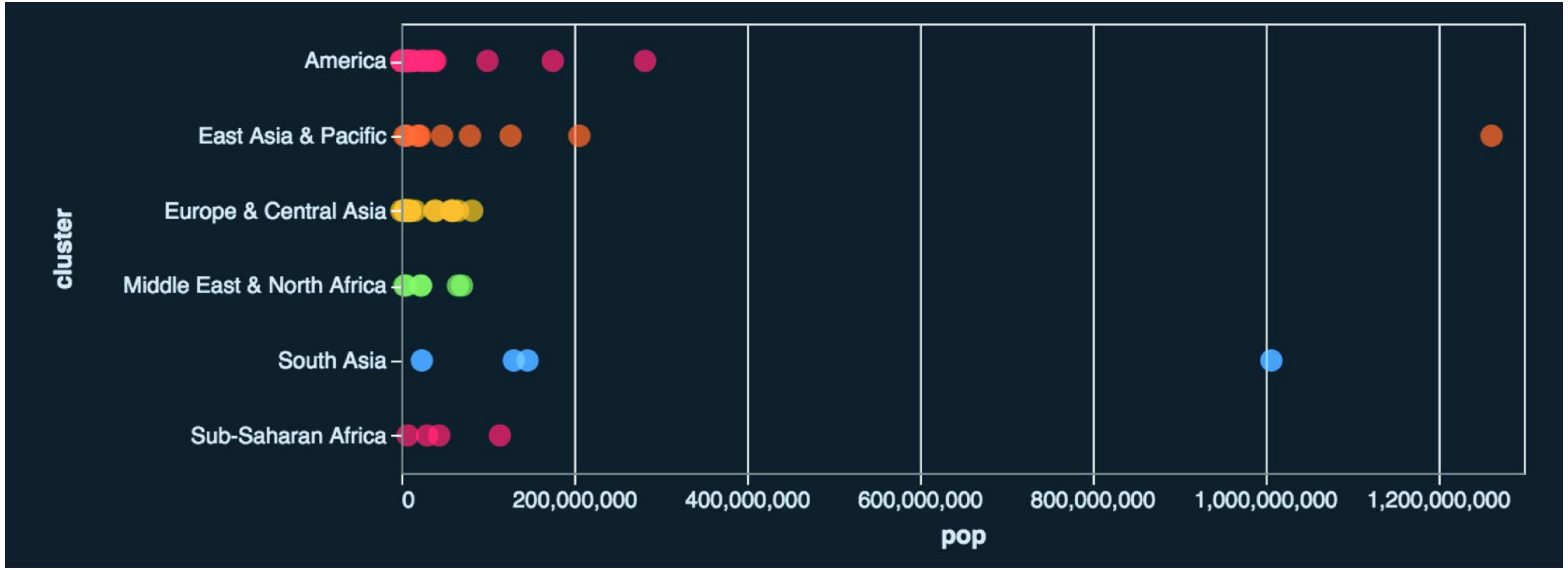


- Truncate the y-axis:
  - If the zero doesn't make sense
  - To emphasize the relative position comparisons
  - If it is the norm (e.g., stock charts)

Outliers

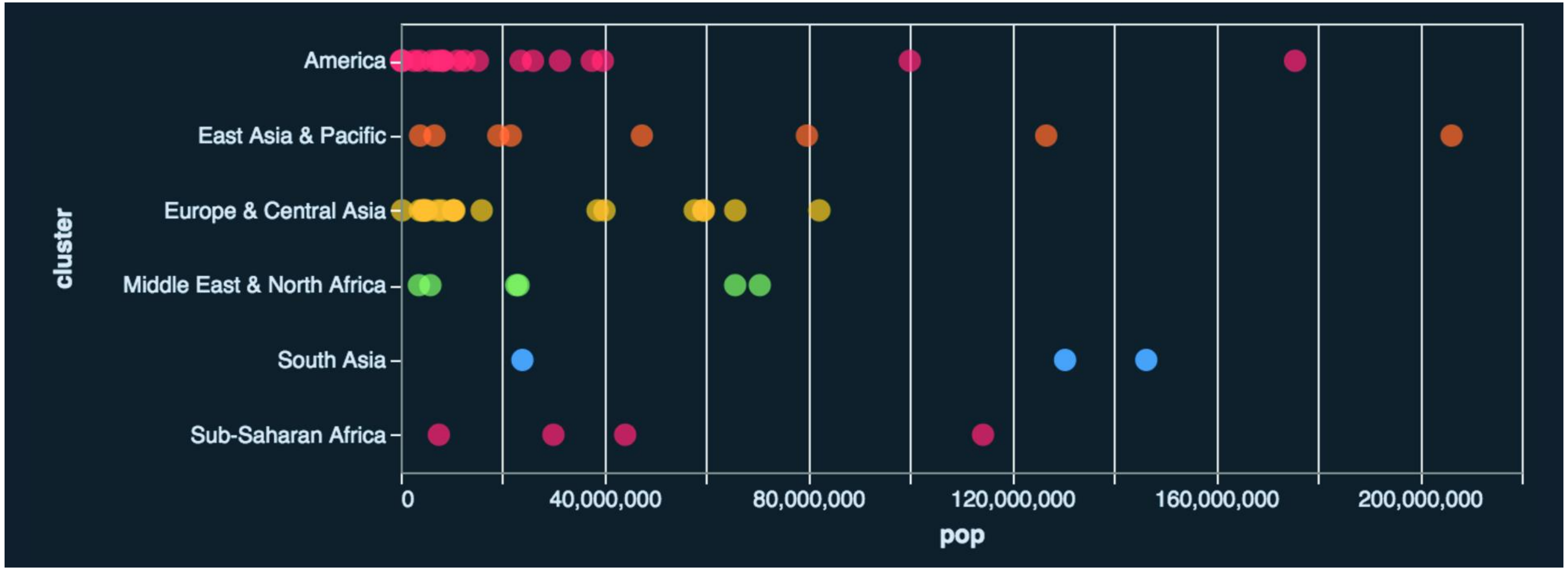
Outliers

- Option #1: Clip them out



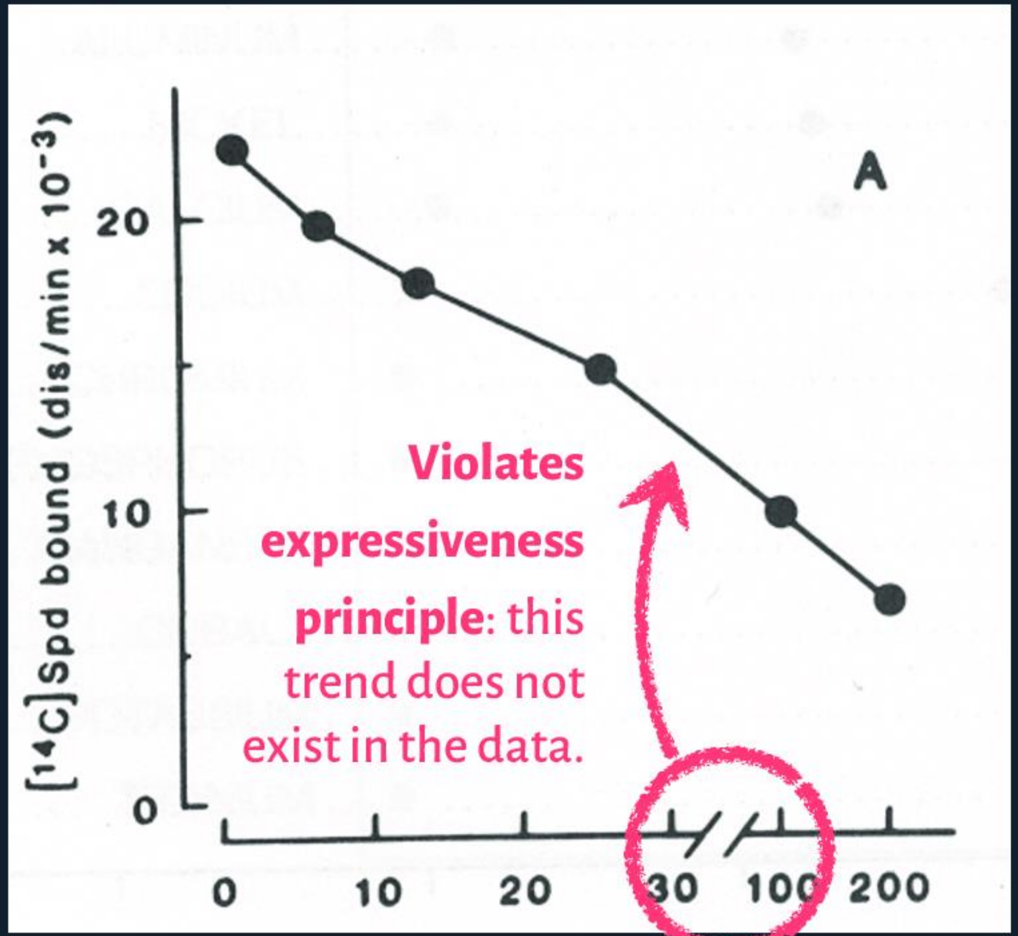
Outliers

- Option #1: Clip them out

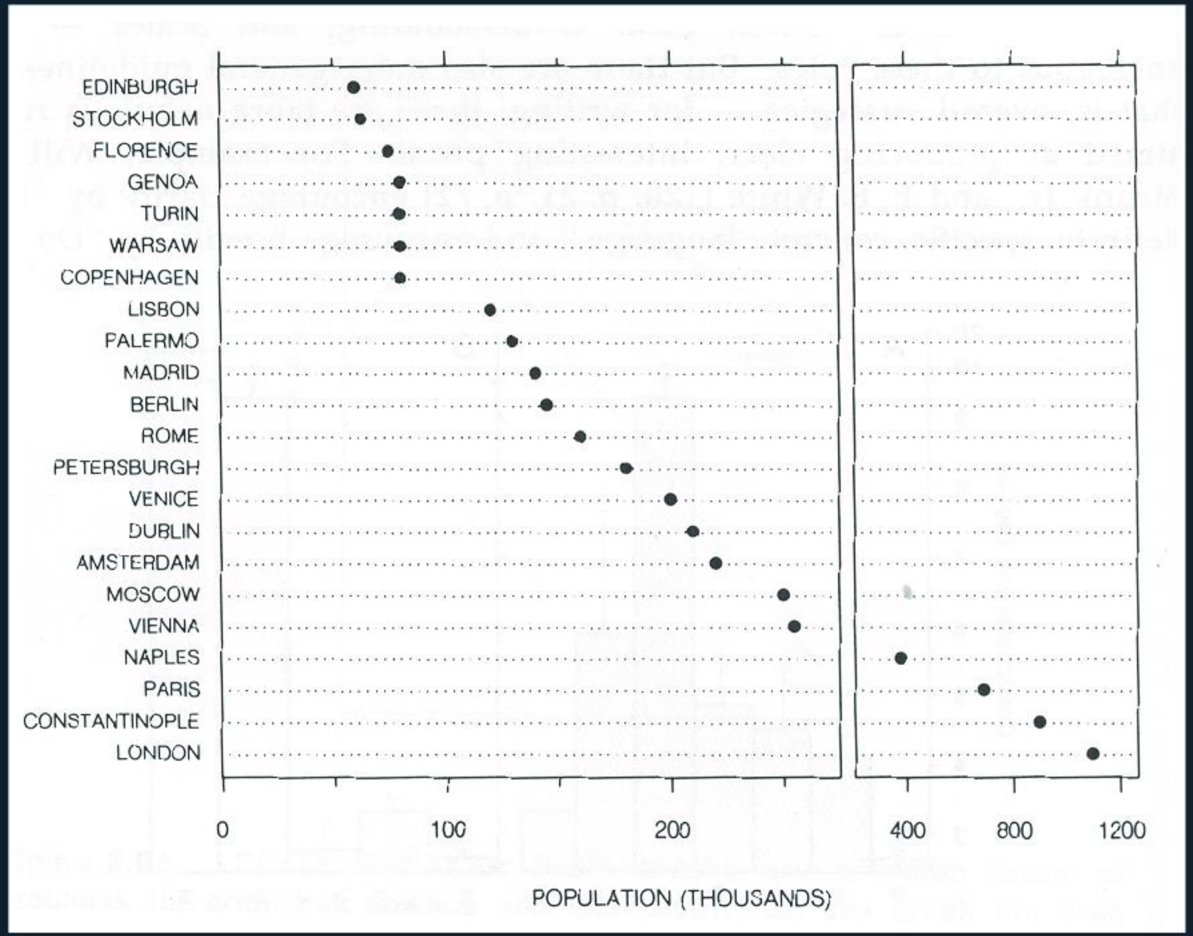


Outliers

- Option #2: Scale Breaks



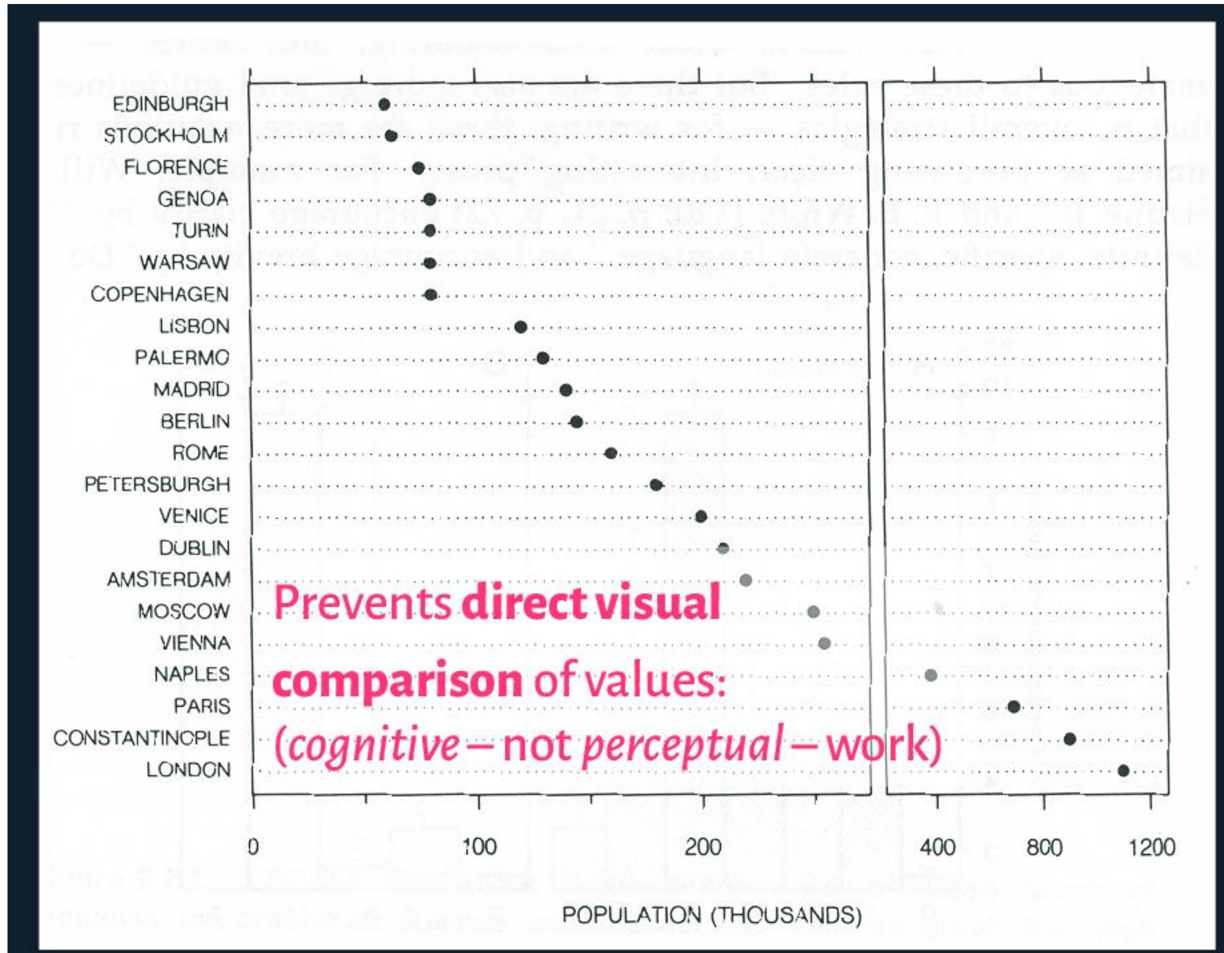
[Cleveland 85]



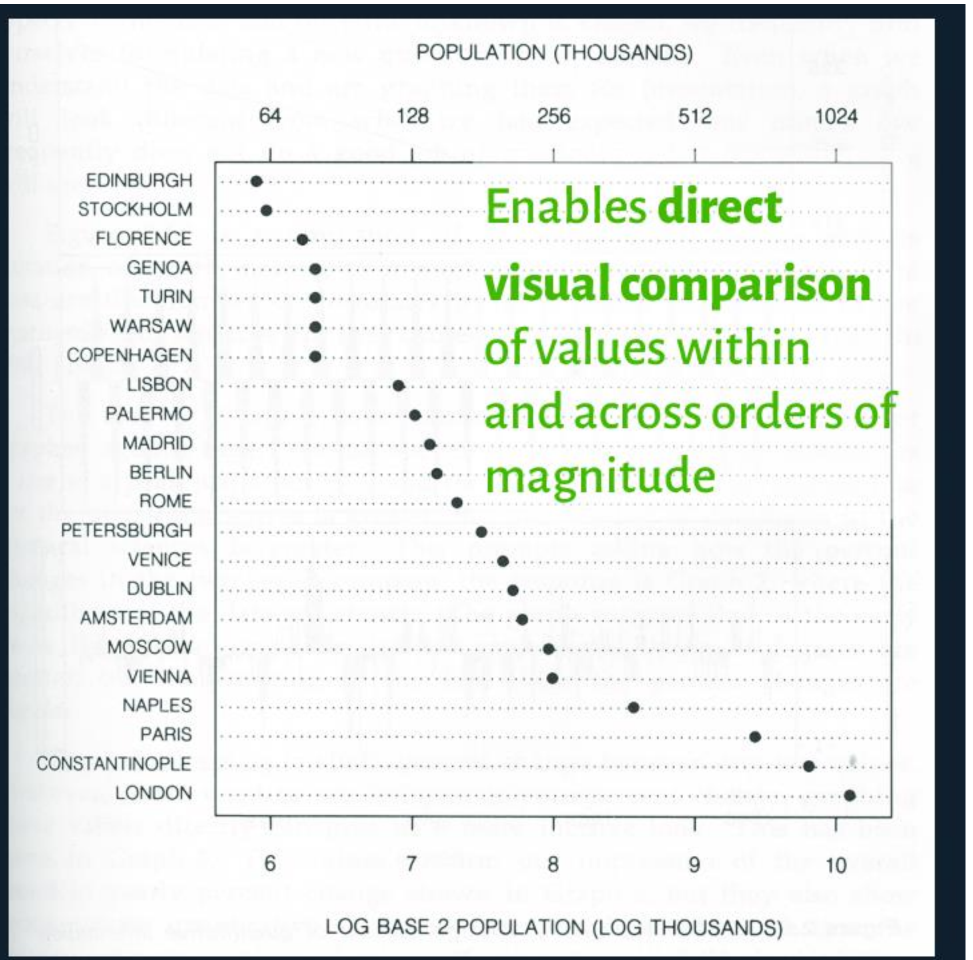
[Cleveland 85]

Outliers

- Option #3: Log Scales



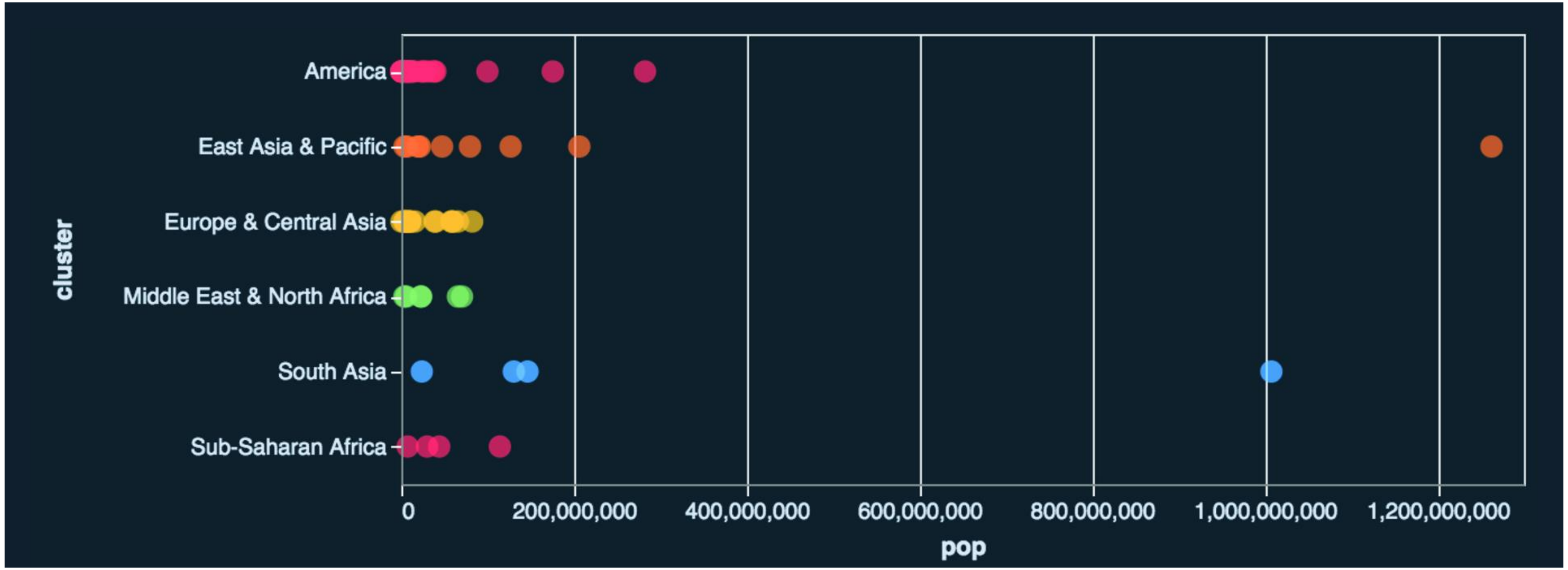
[Cleveland 85]



[Cleveland 85]

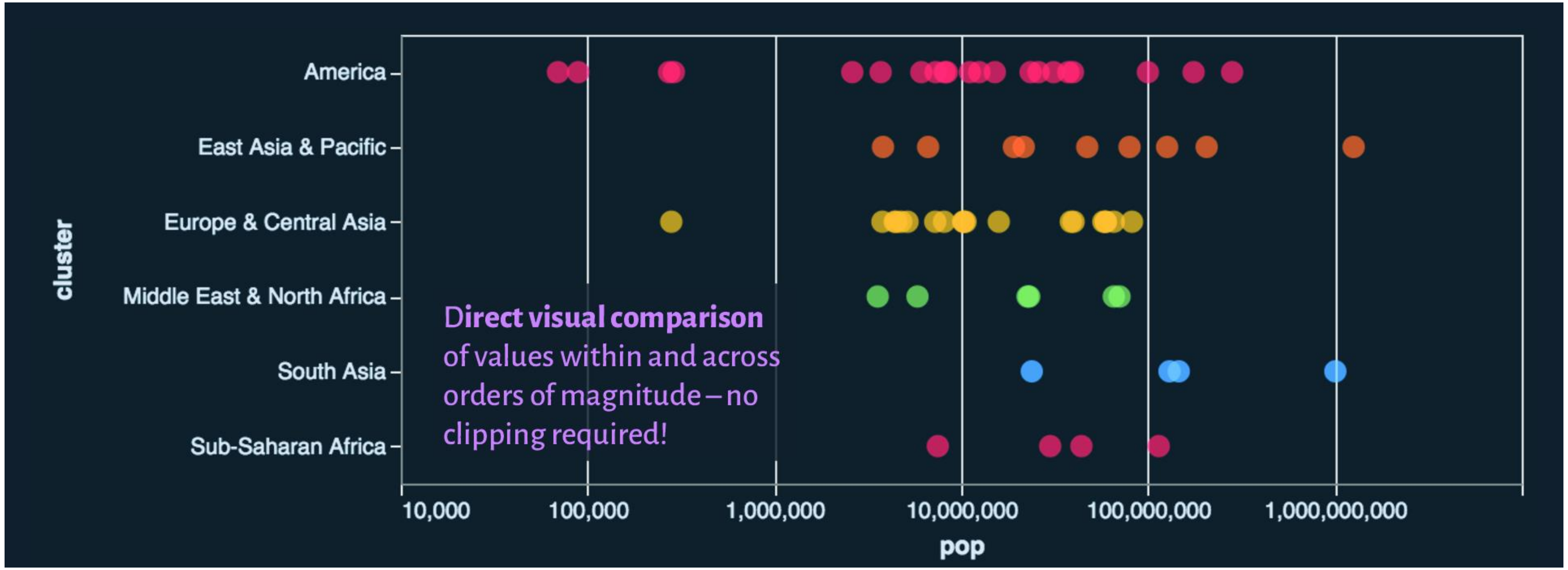
Outliers

- Option #3: Log Scales



Outliers

- Option #3: Log Scales



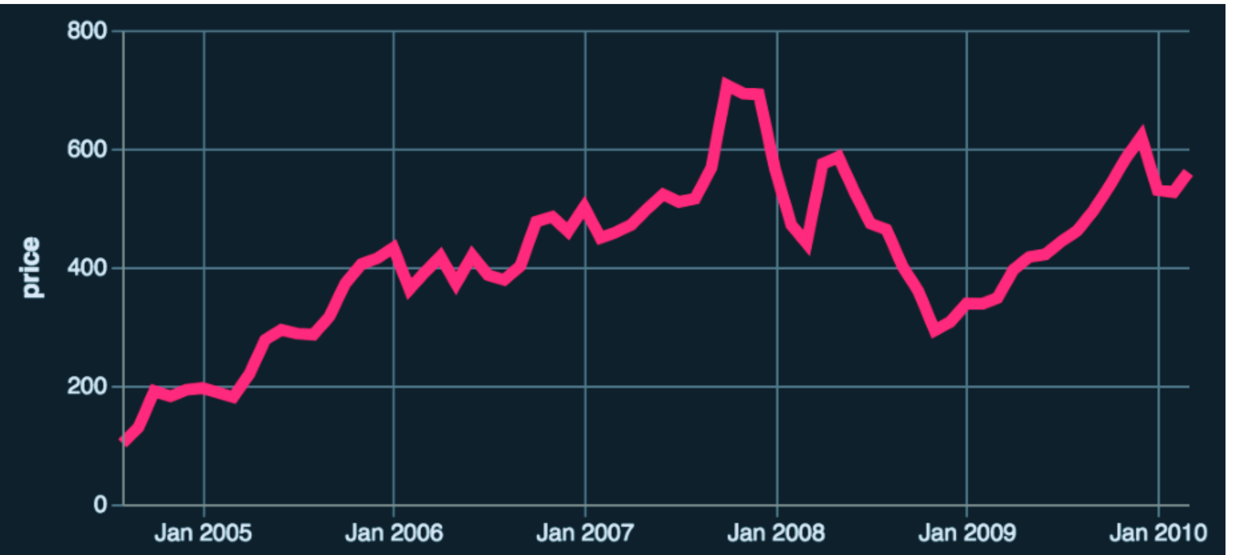
Outliers

- Option #3: Log Scales

Linear Scale

Absolute change

10 visual units (pixels) = 10 additional data units

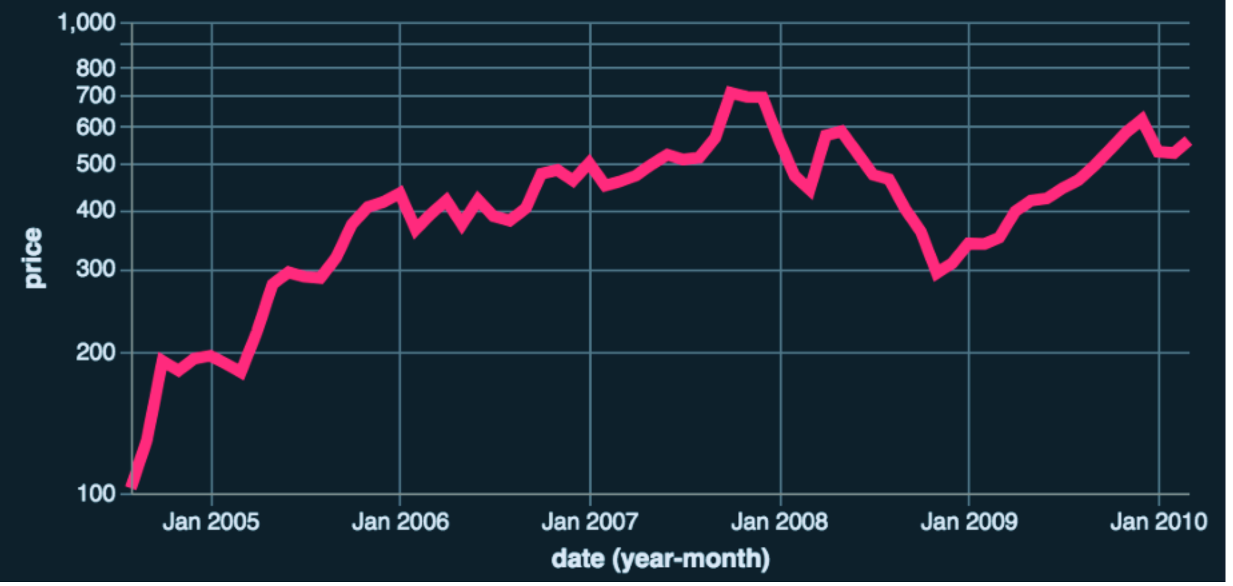


Log Scale

Percentage change

10 visual units = multiplication of 10 data units

```
log(u) + log(v) = log(u*v)
d(100, 200) = d(300, 600)
```



Outliers

- Option #3: Log Scales

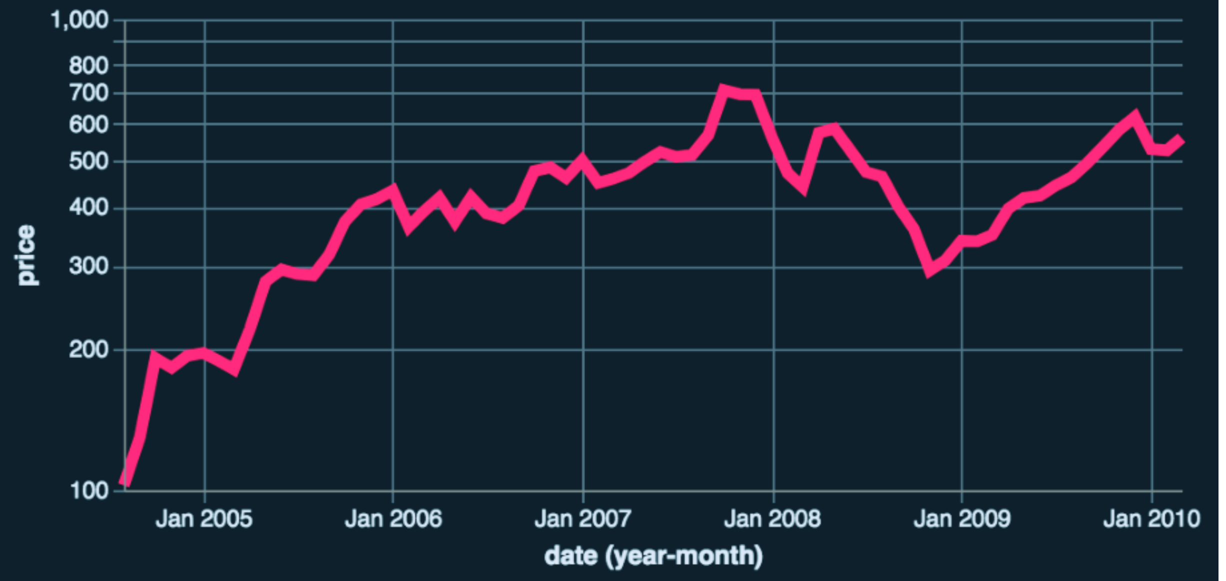
Log Scale

Percentage change

10 visual units = multiplication of 10 data units

`log(u) + log(v) = log(u*v)`

`d(100, 200) = d(300, 600)`

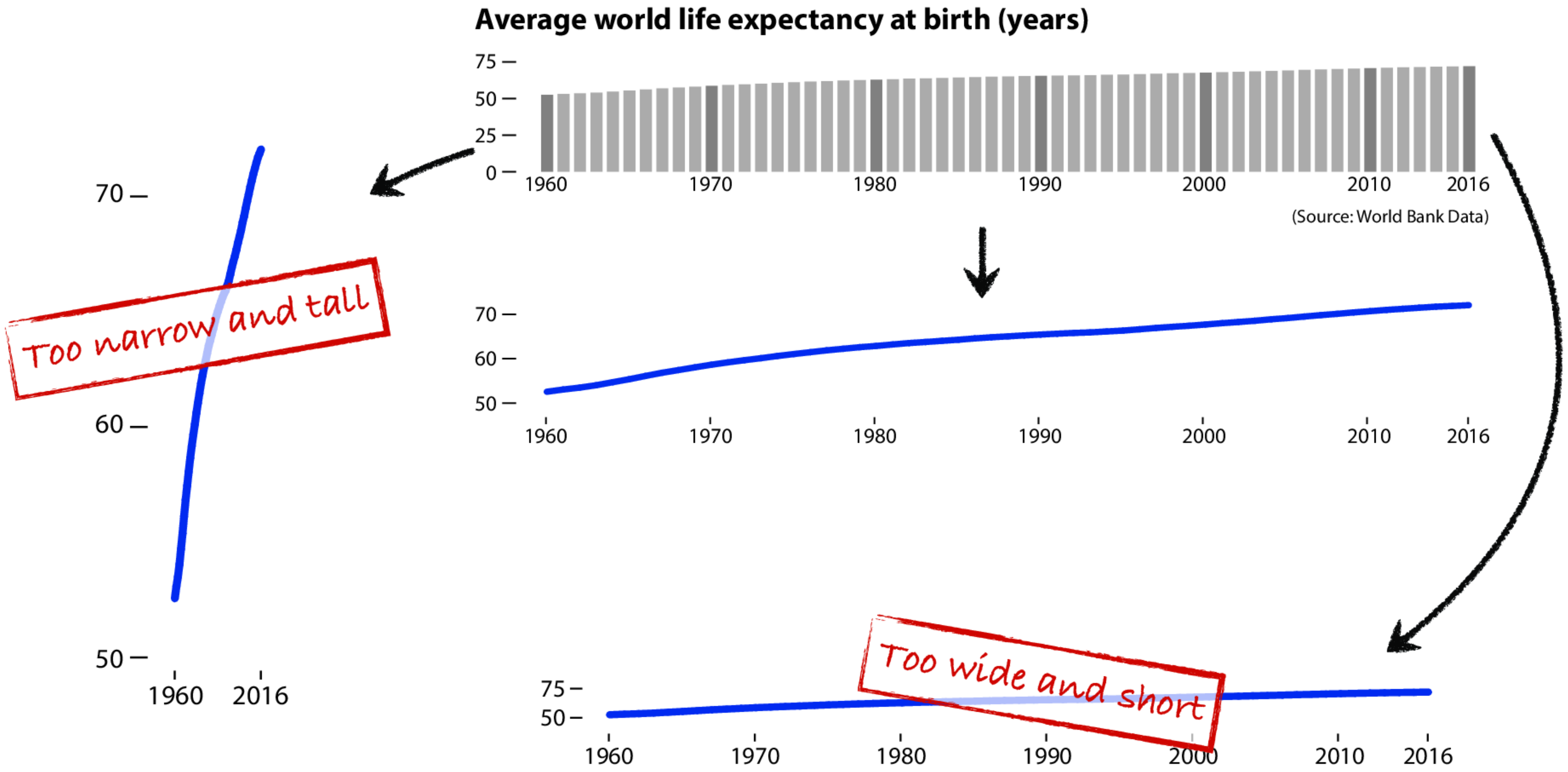


Constraints

Positive, non-zero values

Audience familiarity?

Aspect Ratio

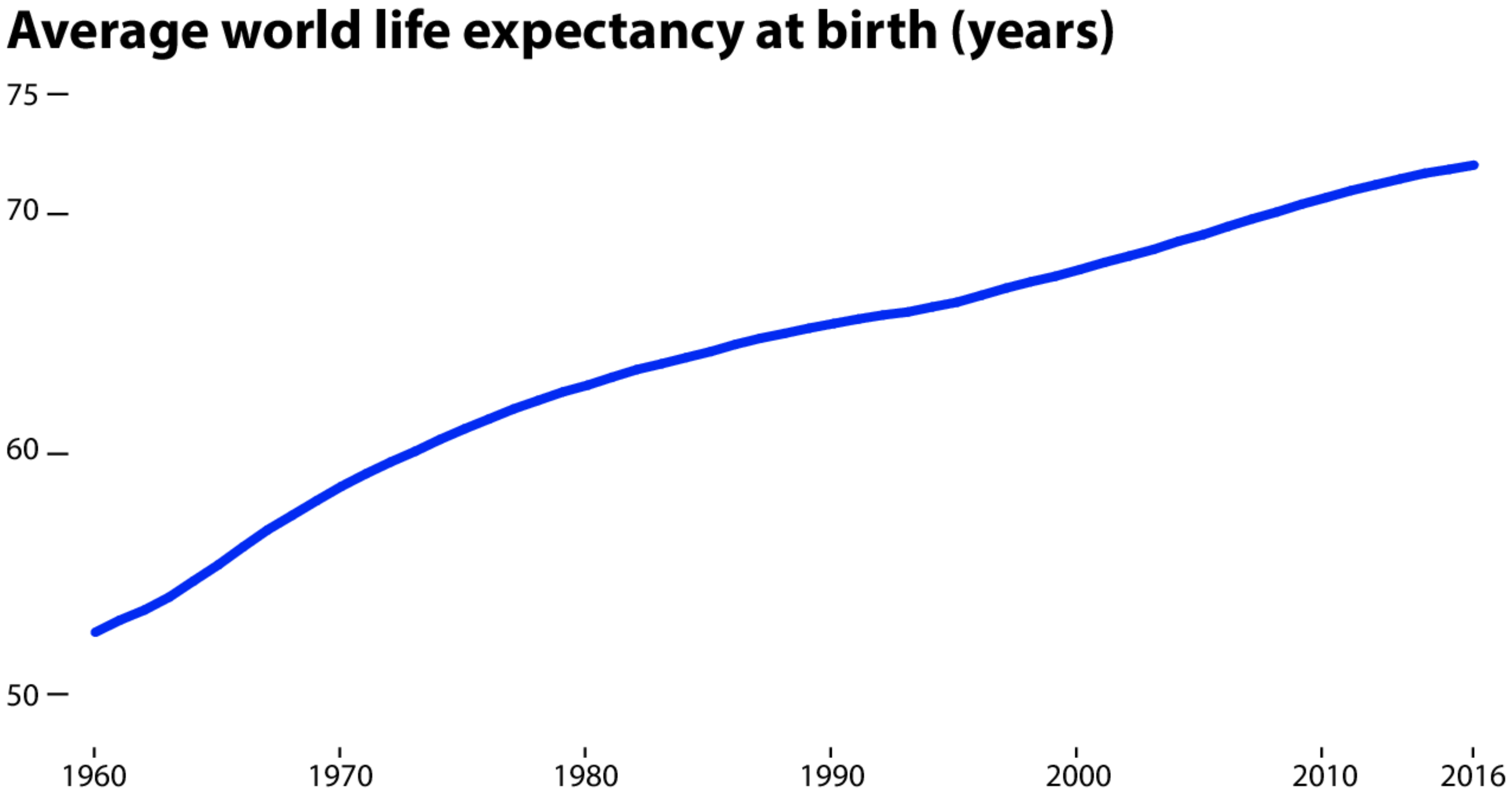


[Alberto Cairo. *How Charts Lie*, 2019]

Aspect Ratio

Approximate the proportion of the chart to match the depicted trend.

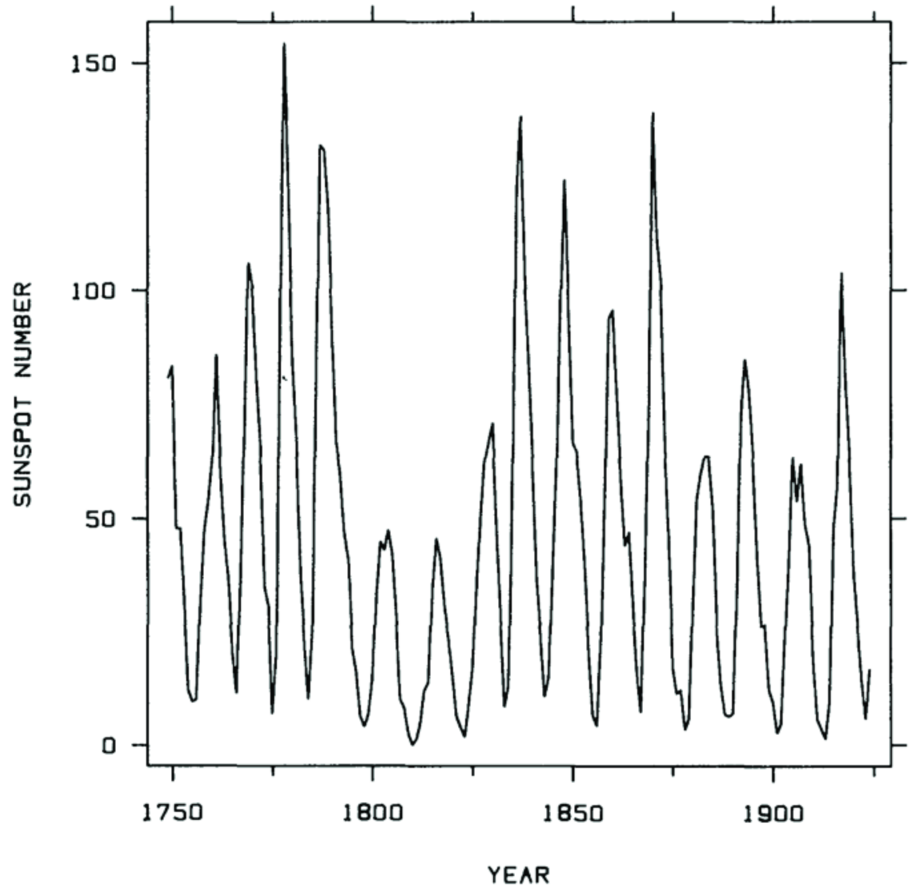
35% increase ≈ 1/3rd
≈ 3:1 aspect ratio

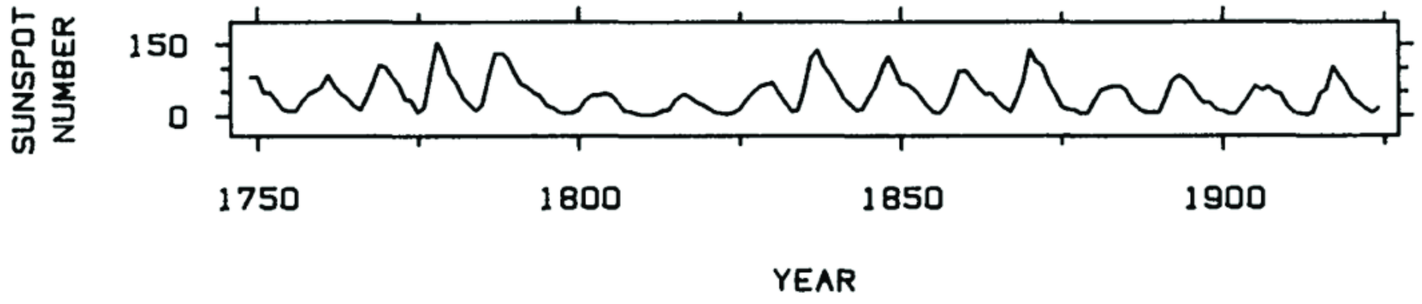


[Alberto Cairo. *How Charts Lie*, 2019]

Aspect Ratio

Approximate the proportion of the chart to match the depicted trend.



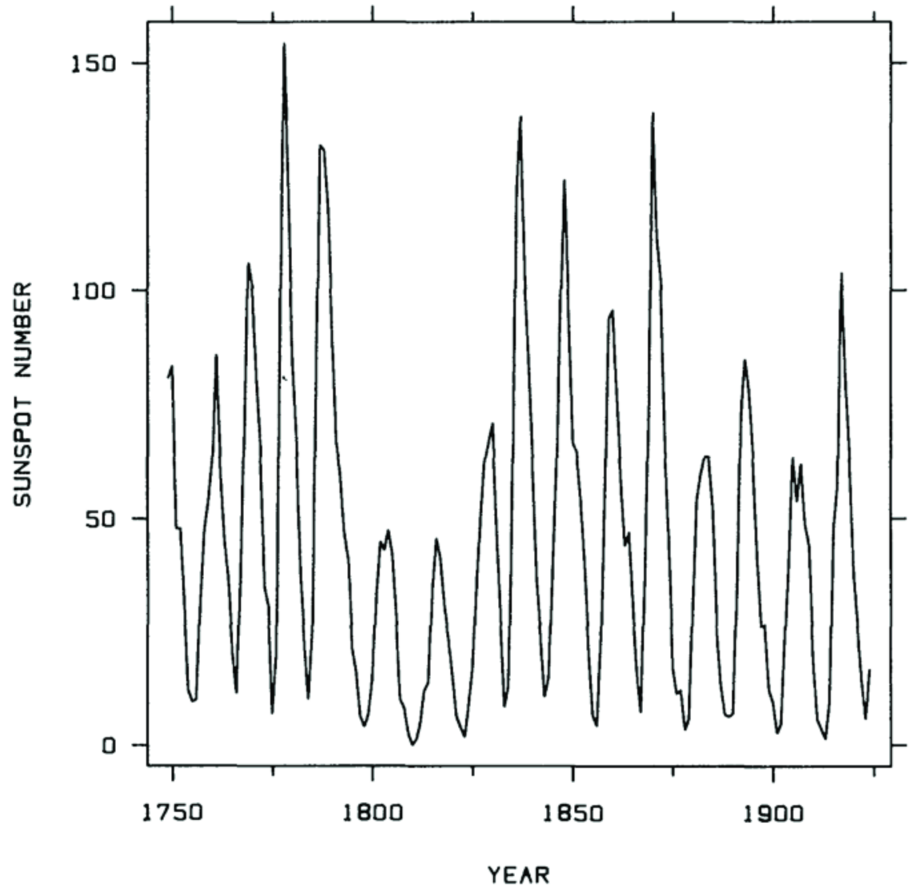


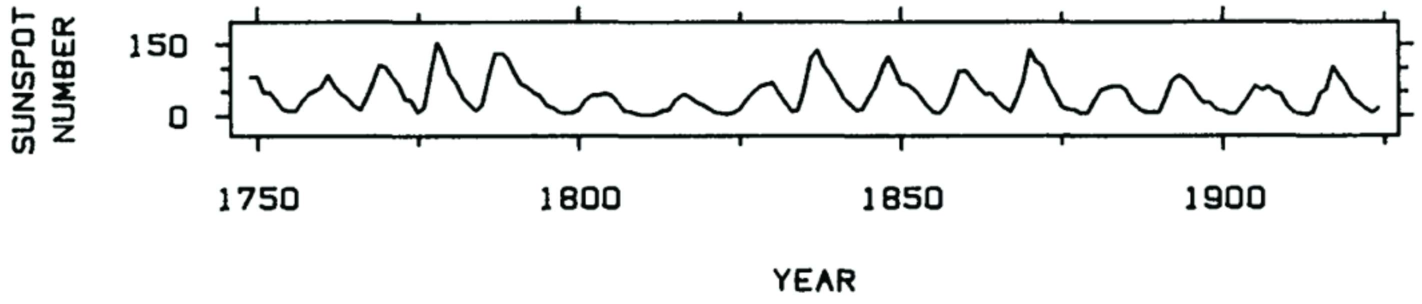
[Cleveland & McGill, 1987]

Aspect Ratio

(1) Approximate proportion of the chart to match the depicted trend.

(2) ***Bank to 45°***: aspect ratios with 45° avg. line segment orientation.





[Cleveland & McGill, 1987]

Aspect Ratio

(1) Approximate proportion of the chart to match the depicted trend.

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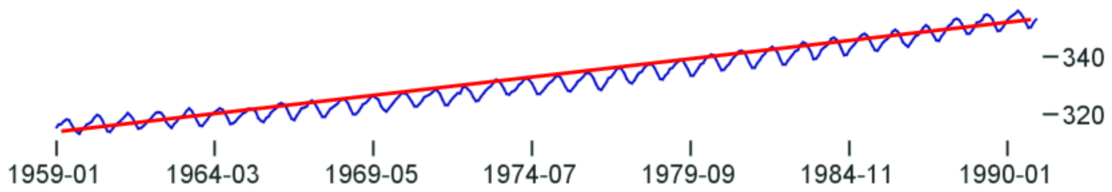
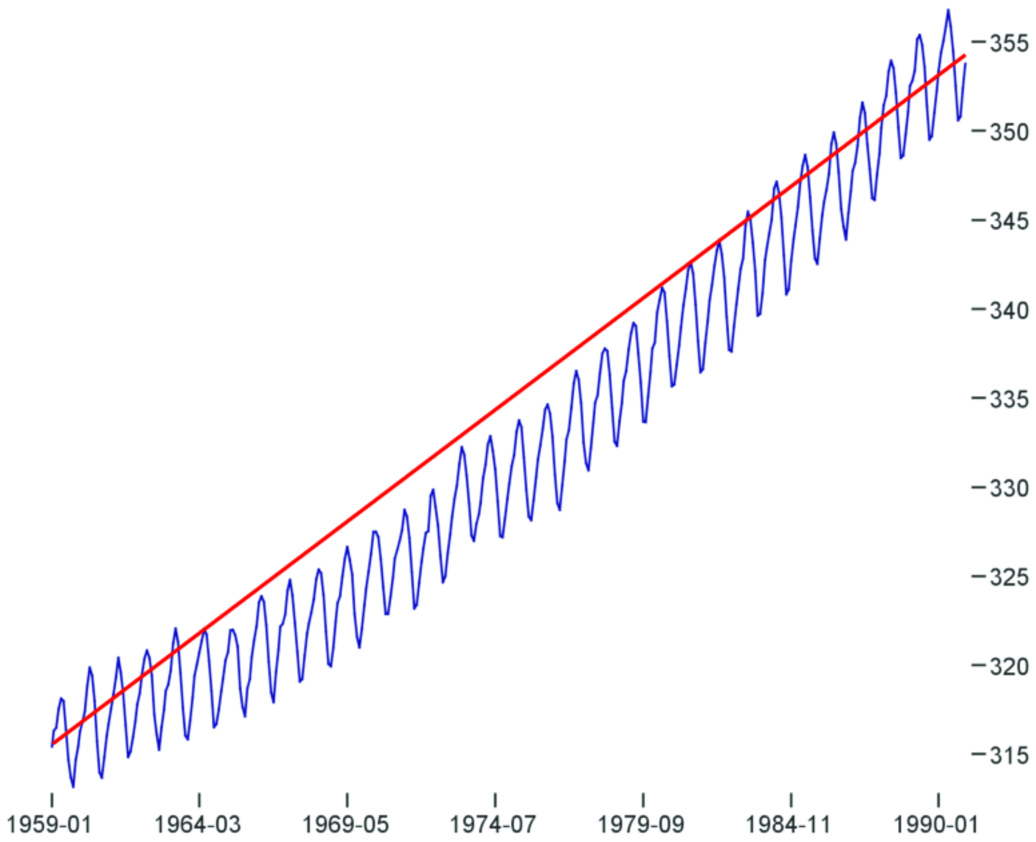


Aspect ratio = 7.87



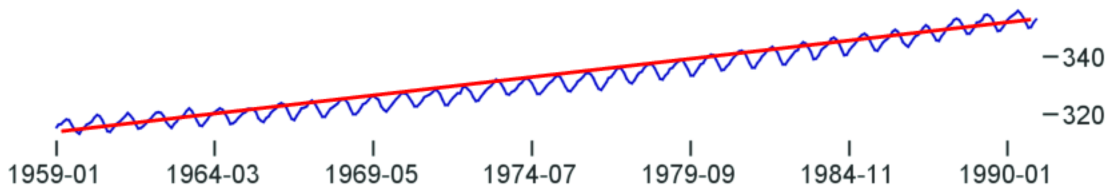
Aspect ratio = 1.17

[Heer & Agrawala, 2006]

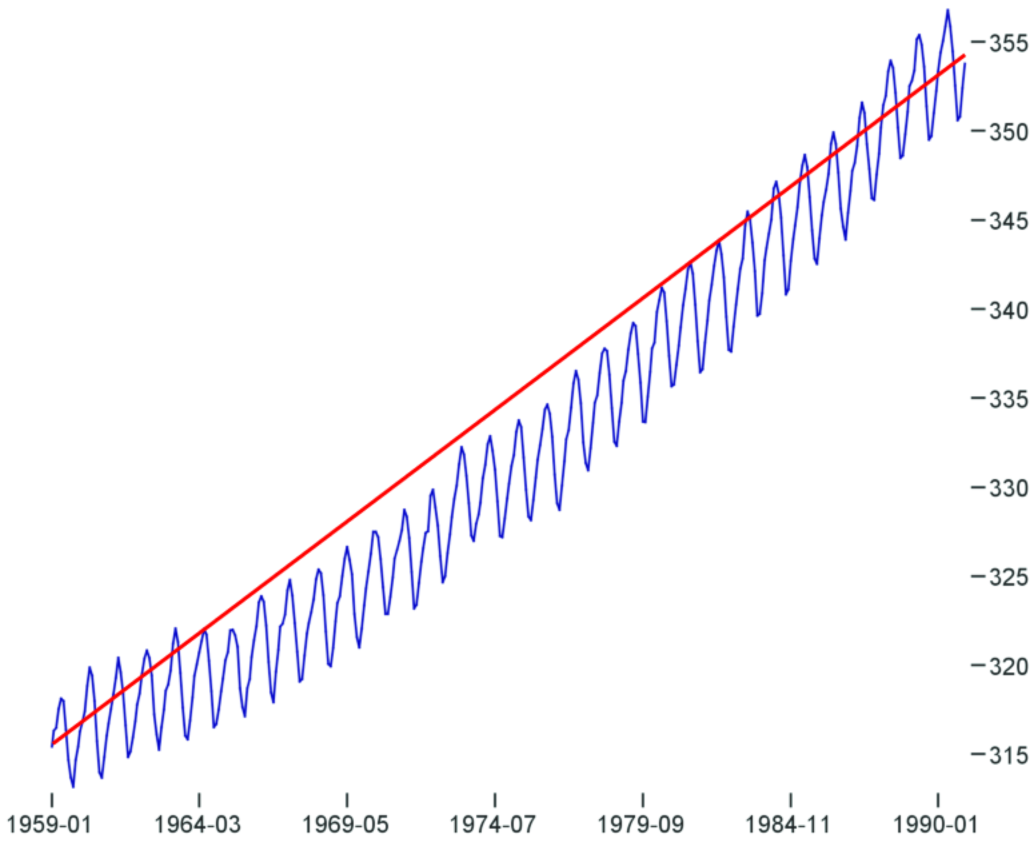
Aspect Ratio

(1) Approximate proportion of the chart to match the depicted trend.

(2) ***Bank to 45°***: original data ***or*** fitted trend lines.



Aspect ratio = 7.87



Aspect ratio = 1.17

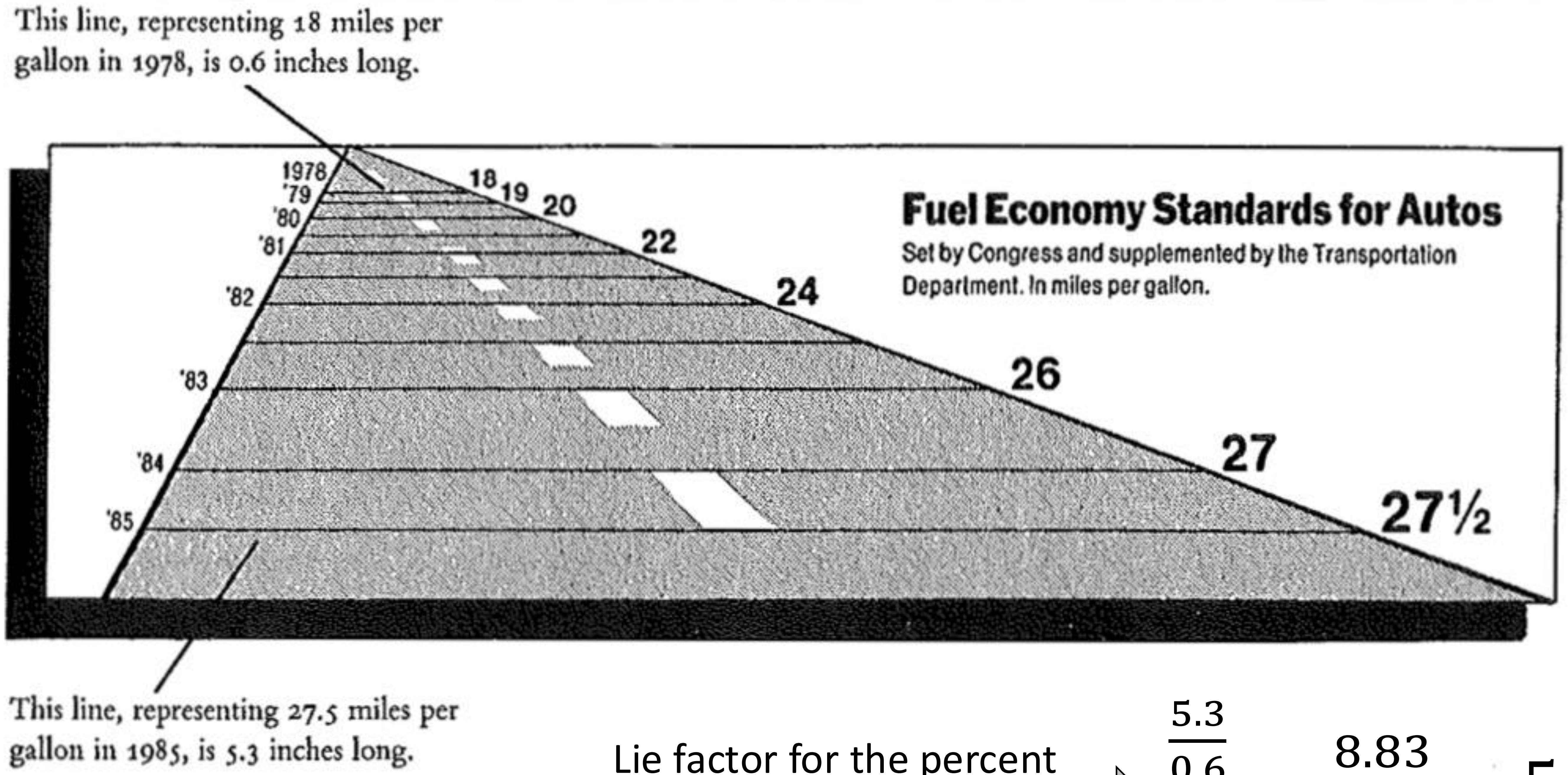
[Heer & Agrawala, 2006]

Tufte’s integrity principles

- the representation of numbers, as physically measured on the surface of the graphic itself, should be directly proportional to the numerical quantities represented.

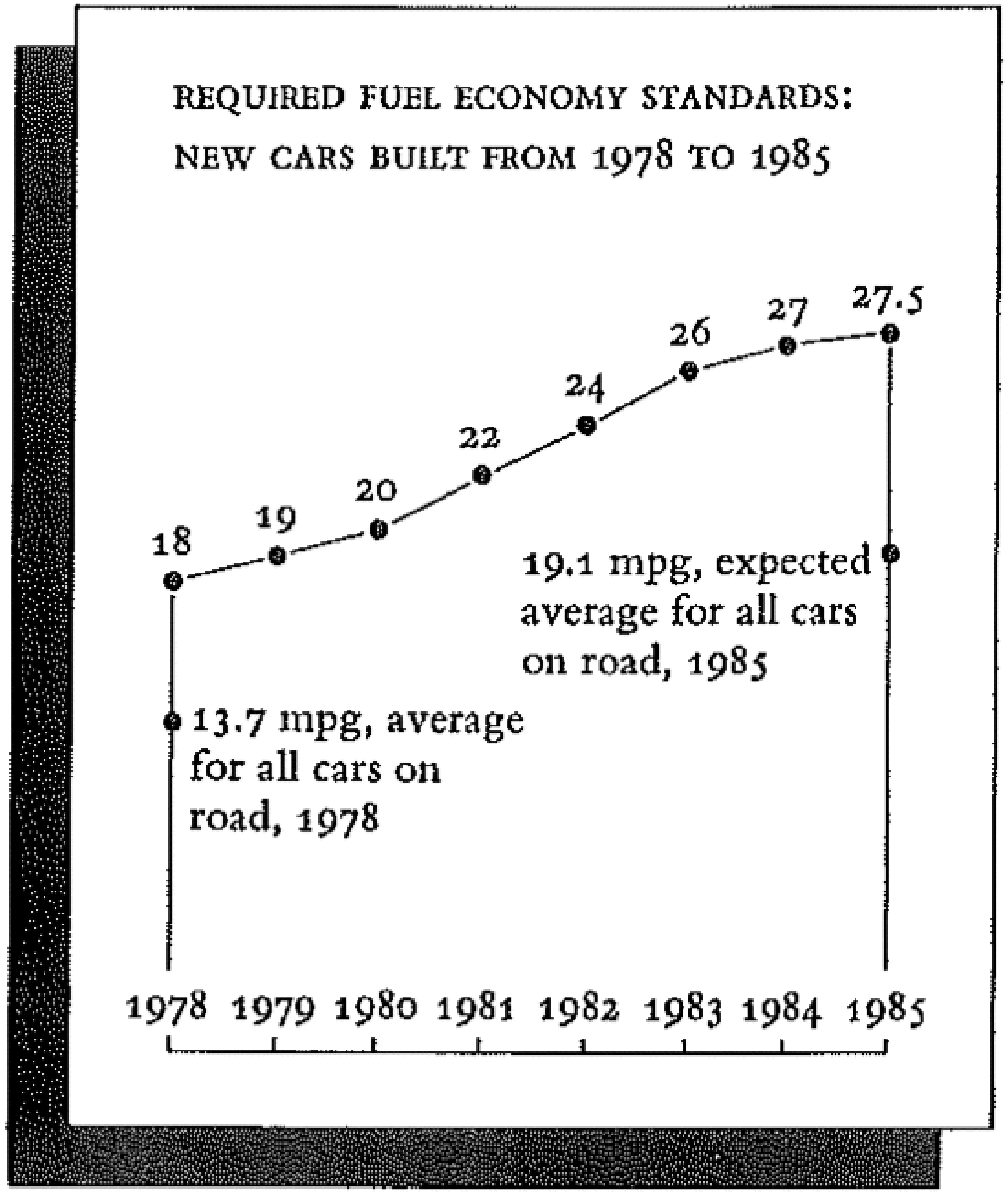
$$\textbf{The Lie Factor} = \frac{\text{size of effect shown in graphic}}{\text{size of effect in data}}$$

DISTORTION



Lie factor for the percent increase from 1978 to 1985

$$\frac{\frac{5.3}{0.6}}{\frac{27.5}{18}} = \frac{8.83}{1.53} = 5.8$$


REQUIRED FUEL ECONOMY STANDARDS:
NEW CARS BUILT FROM 1978 TO 1985
18
19
20
22
24
26
27
27.5
19.1 mpg, expected average for all cars on road, 1985
13.7 mpg, average for all cars on road, 1978
1978 1979 1980 1981 1982 1983 1984 1985

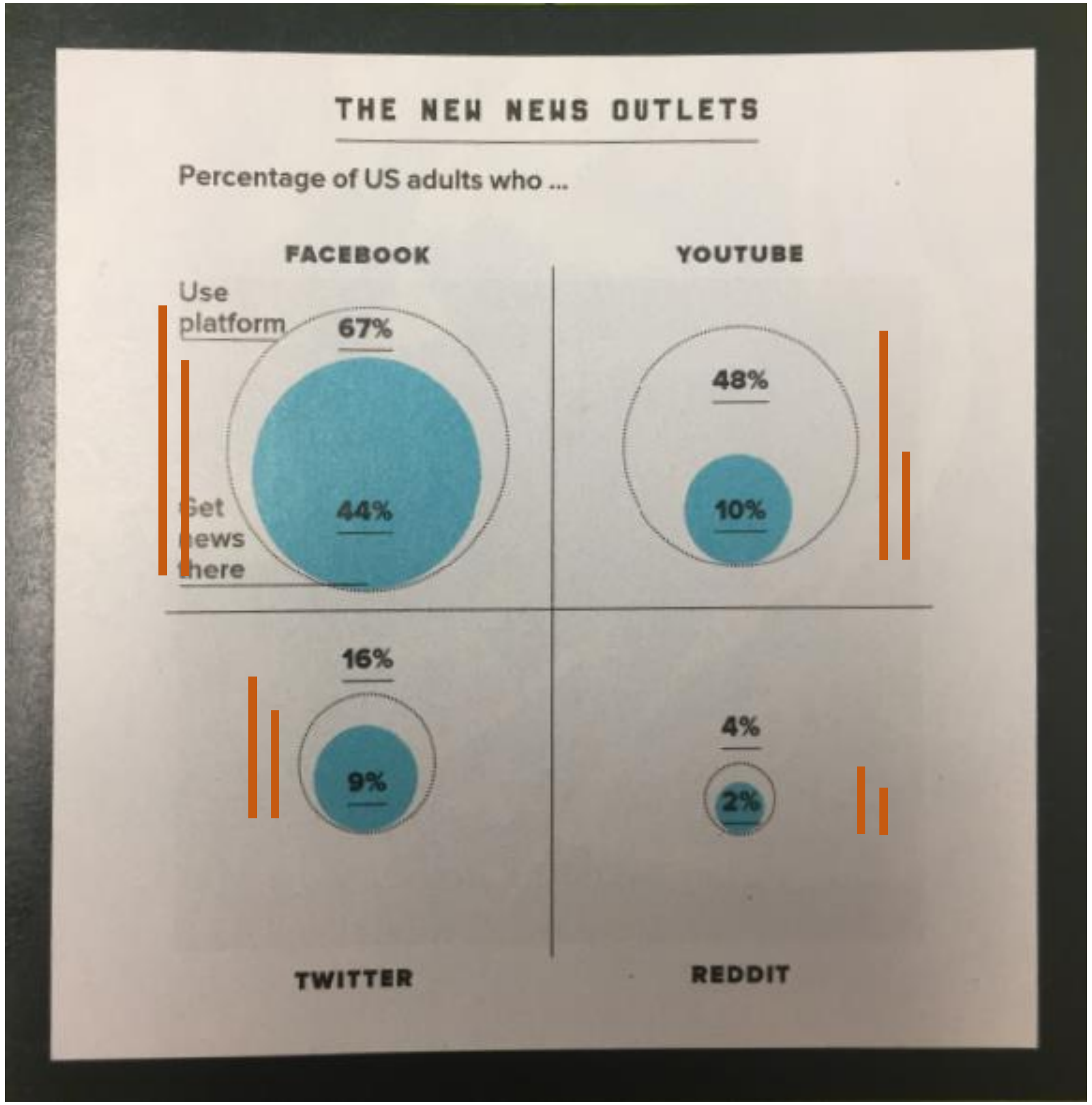
Tufte 2001

D = 2.0,   A = PI
D = 1.6,   A = 0.65*PI

Area Ratio = 0.65 (67%/43.5%)
Diameter Ratio = 0.8 (67%/53.6%)

D = 1.05, A = 0.28*PI
D = 0.8,   A = 0.16*PI

Area Ratio = 0.57 (16%/9.1%)
Diameter Ratio = 0.76 (16%/12.1%)



D = 1.7,   A = 0.73*PI
D = 0.8,   A = 0.16*PI

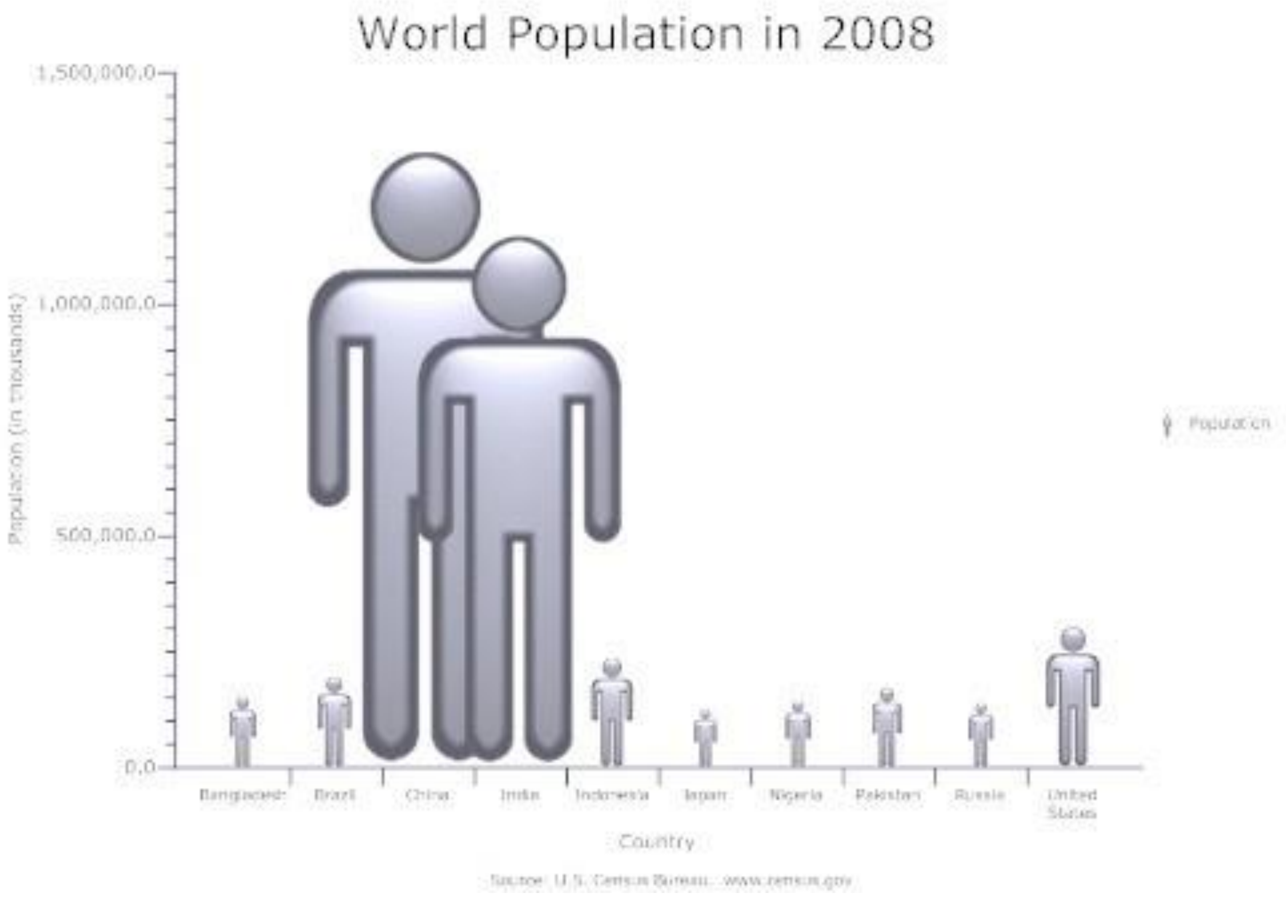
Area Ratio = 0.21 (48%/10.1%)
Diameter Ratio = 0.47 (48%/22.6%)

D = 0.5,   A = 0.06*PI
D = 0.35, A = 0.03*PI

Area Ratio = 0.5 (4%/2%)
Diameter Ratio = 0.7 (4%/2.8%)

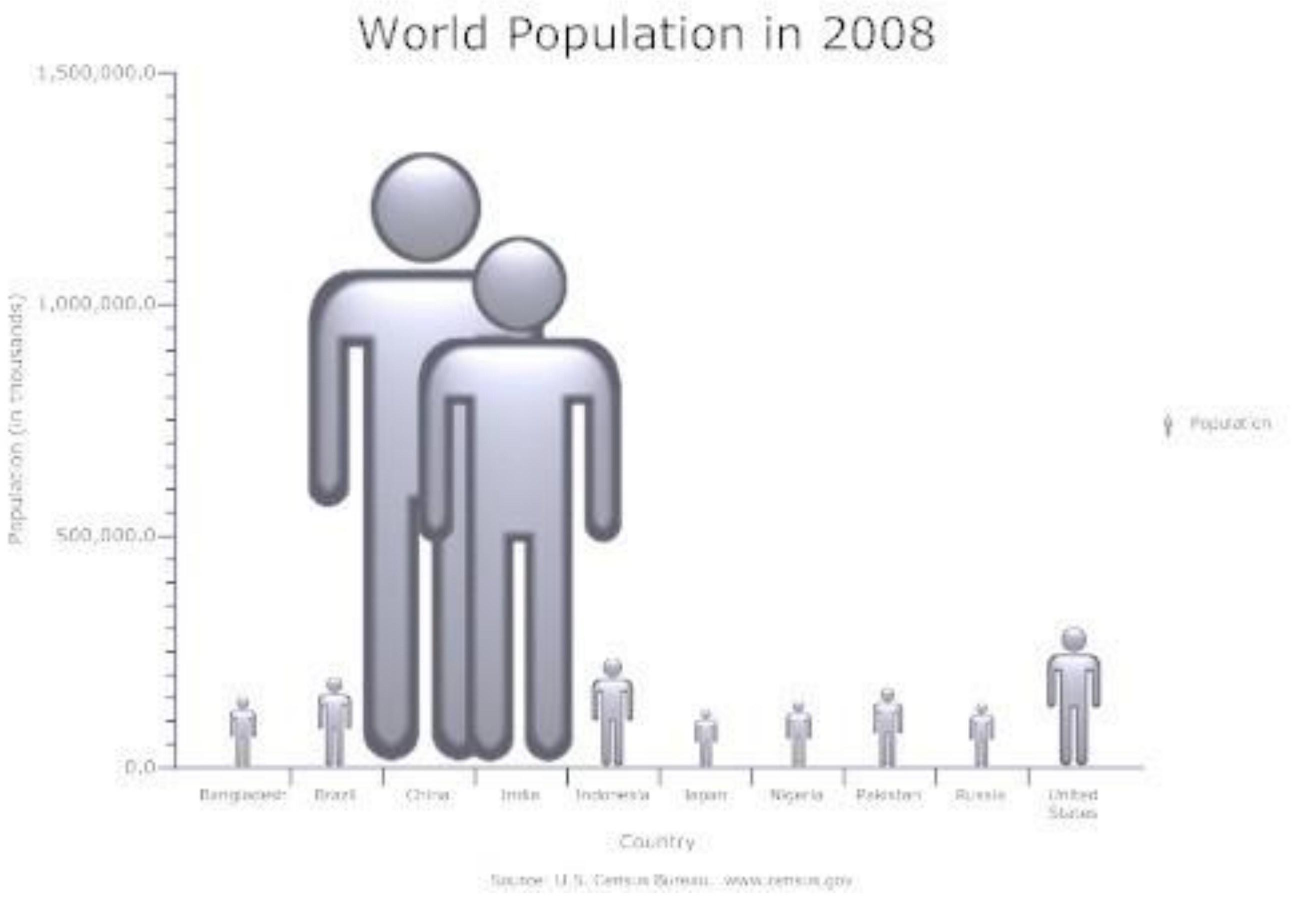
Tufte's integrity principles
show *data* variation, not *design*
variation

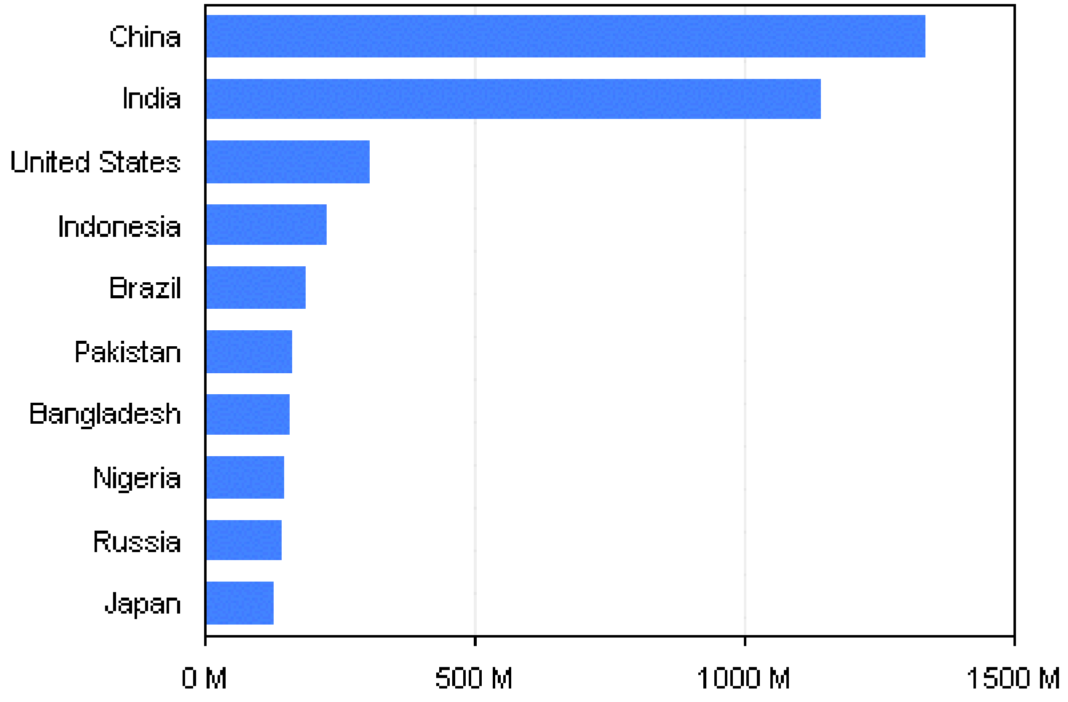
UNINTENDED SIZE CODING



- http://peltiertech.com/WordPress/bad-bar-chart-practices-or-send-in-the-clowns/

UNINTENDED SIZE CODING



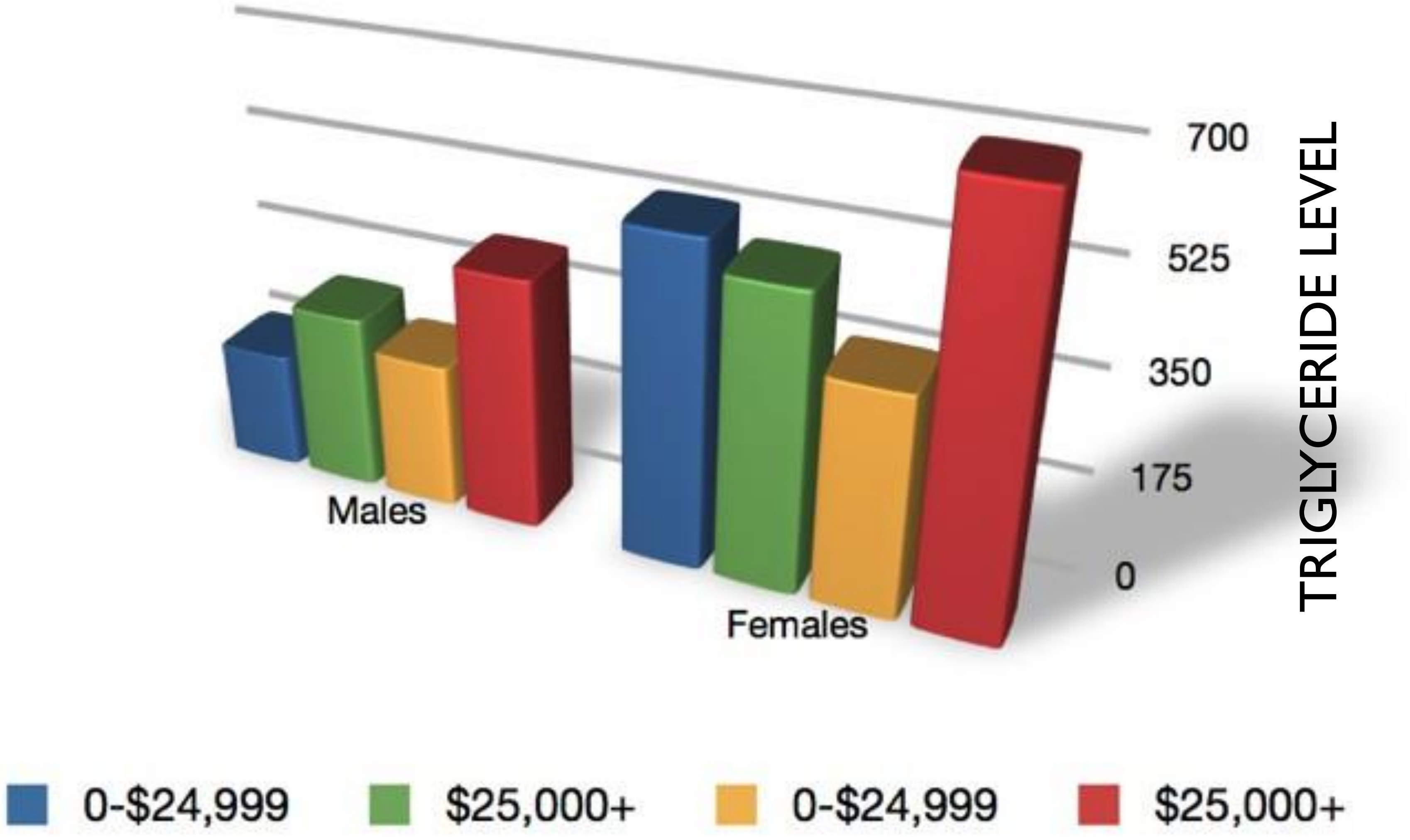


- http://peltiertech.com/WordPress/bad-bar-chart-practices-or-send-in-the-clowns/

DESIGN PRINCIPLES
(or how to achieve integrity and excellence)

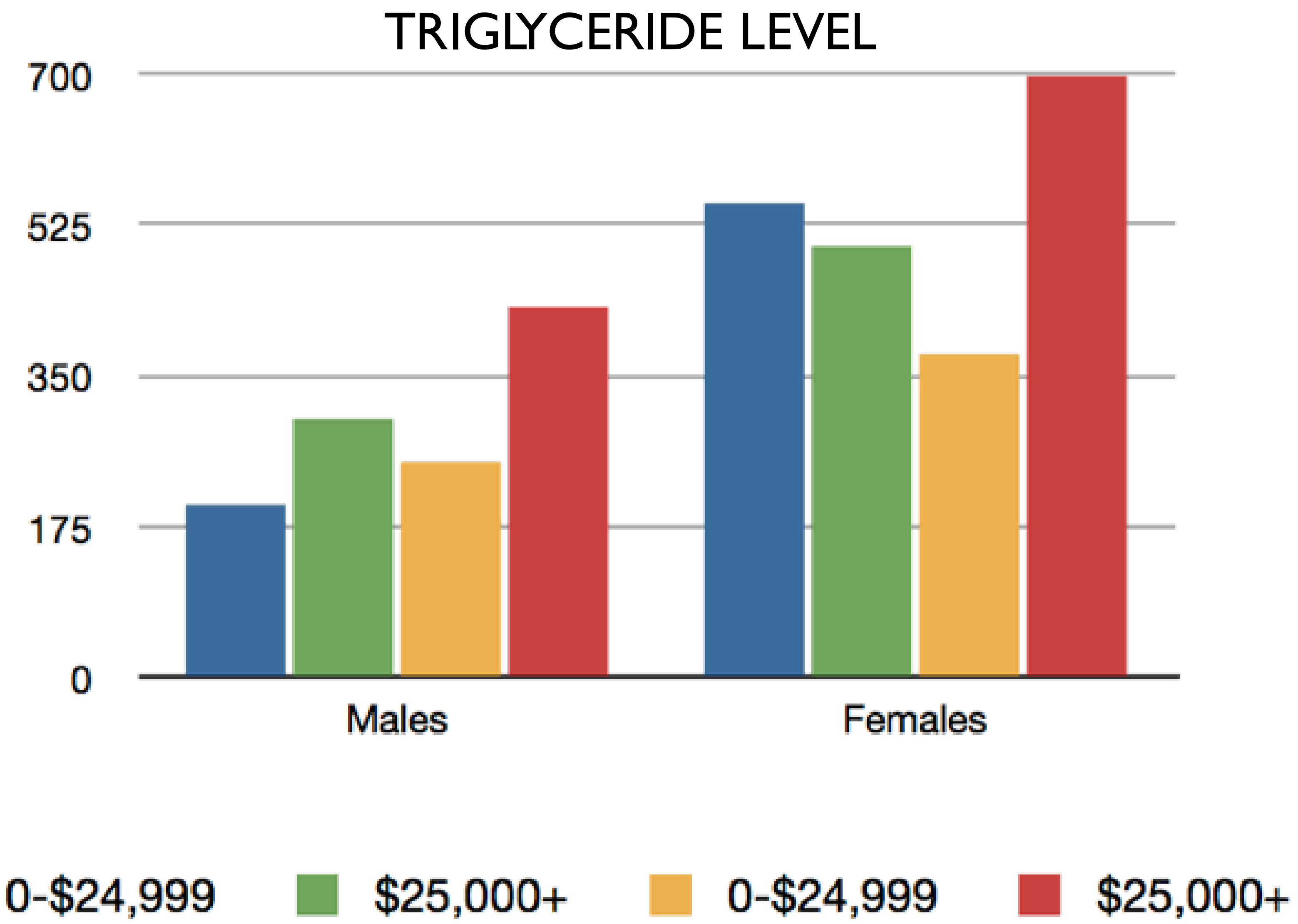
maximize the

$$\textbf{Data-ink Ratio} = \frac{\text{data-ink}}{\text{total ink used in graphic}}$$



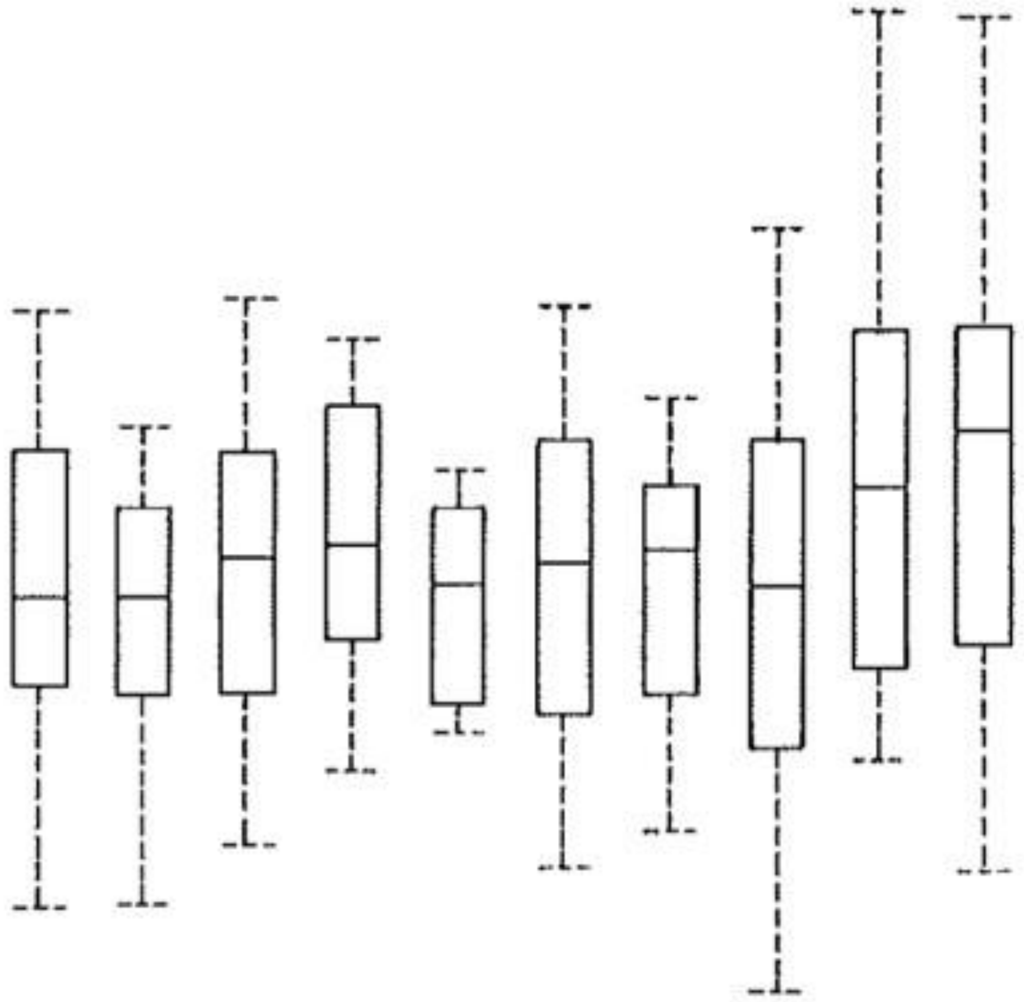
maximize the

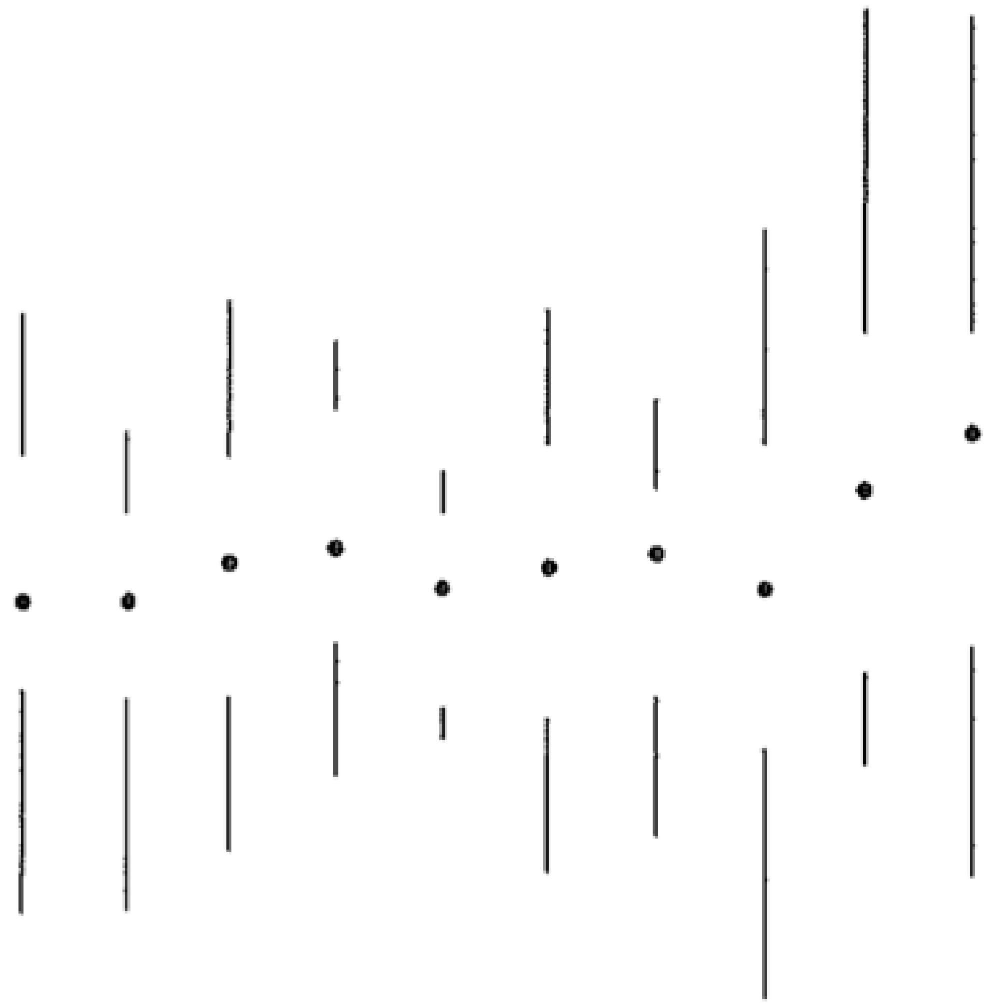
Data-ink Ratio = $\dfrac{\text{data-ink}}{\text{total ink used in graphic}}$



maximize the

Data-ink Ratio = $\dfrac{\text{data-ink}}{\text{total ink used in graphic}}$





- Tufte 2001

Eurographics / IEEE Symposium on Visualization 2011 (EuroVis 2011)
H. Hauser, H. Pfister, and J. J. van Wijk
(Guest Editors)

Volume 30 (2011), Number 3

A User Study of Visualization Effectiveness Using EEG and Cognitive Load

E. W. Anderson[1], K. C. Potter[1], L. E. Matzen[2], J. F. Shepherd[2], G. A. Preston[3], and C. T. Silva[1]

[1]SCI Institute, University of Utah, USA
[2]Sandia National Laboratories, USA
[3]Utah State Hospital, USA

Abstract

Effectively evaluating visualization techniques is a difficult task often assessed through feedback from user studies and expert evaluations. This work presents an alternative approach to visualization evaluation in which brain

COUNTER-POINT

This information is processed to provide insight into the cognitive load imposed on the viewer. This paper describes the design of the user study performed, the extraction of cognitive load measures from EEG data, and how those measures are used to quantitatively evaluate the effectiveness of visualizations.

Categories and Subject Descriptors (according to ACM CCS): I.3.3 [Computer Graphics]: General—Human Factors, Evaluation, Electroencephalography

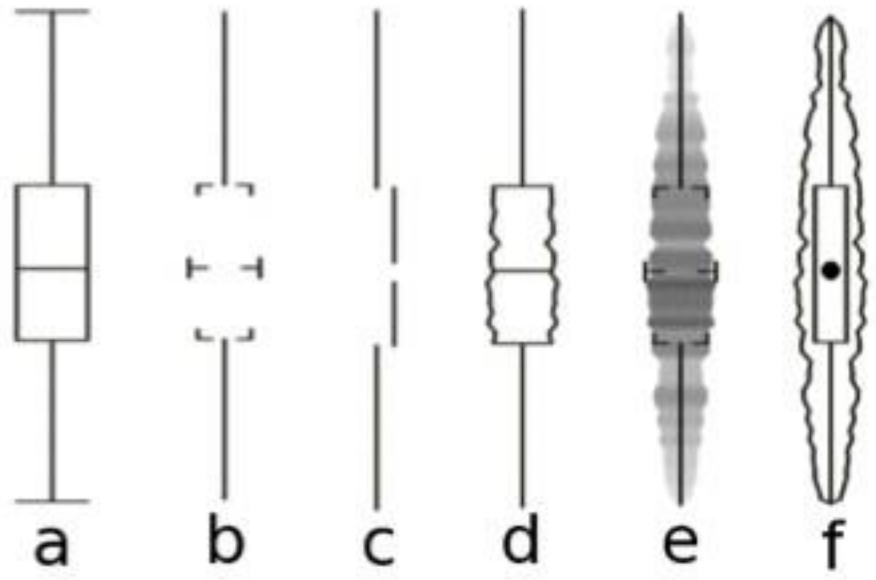
1. Introduction

Efficient visualizations facilitate the understanding of data sets through an appropriate choice of visual metaphor

this paper strives to evaluate visualization techniques objectively by using passive, non-invasive monitoring devices to measure the burden placed on a user's cognitive resources.

EXPERIMENT

- asked participants to choose box plot with largest range from a set
- varied representation
- measured cognitive load from EEG brain waves



EXPERIMENTAL RESULTS

- studies showed that the simplest (highest data-ink ratio) box plot is hardest to interpret
- paper focused on cognitive load as an evaluation method

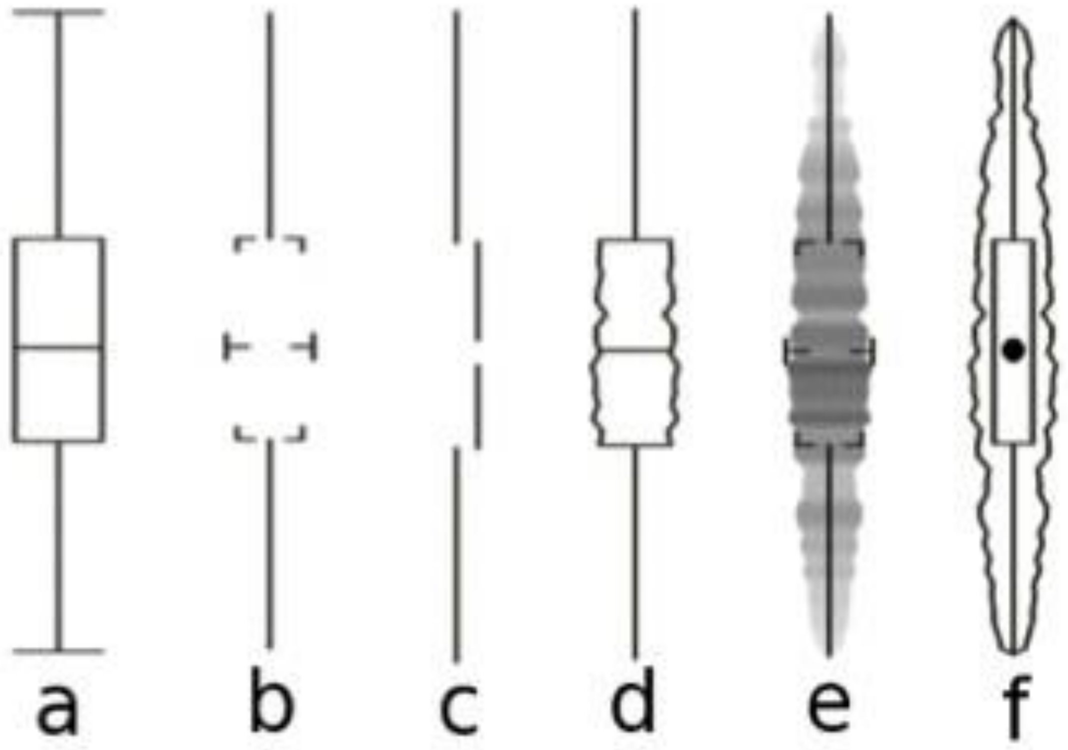
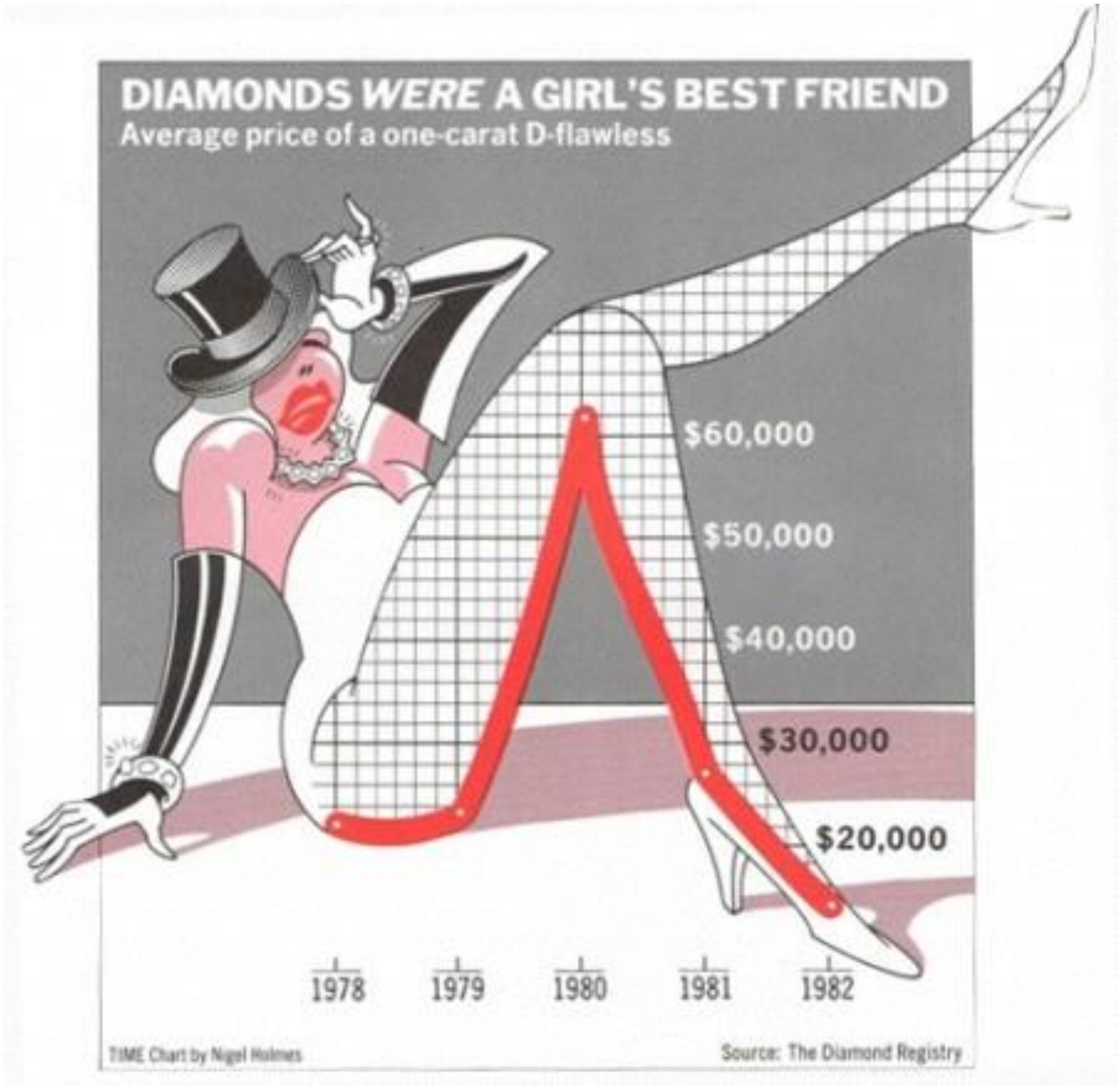
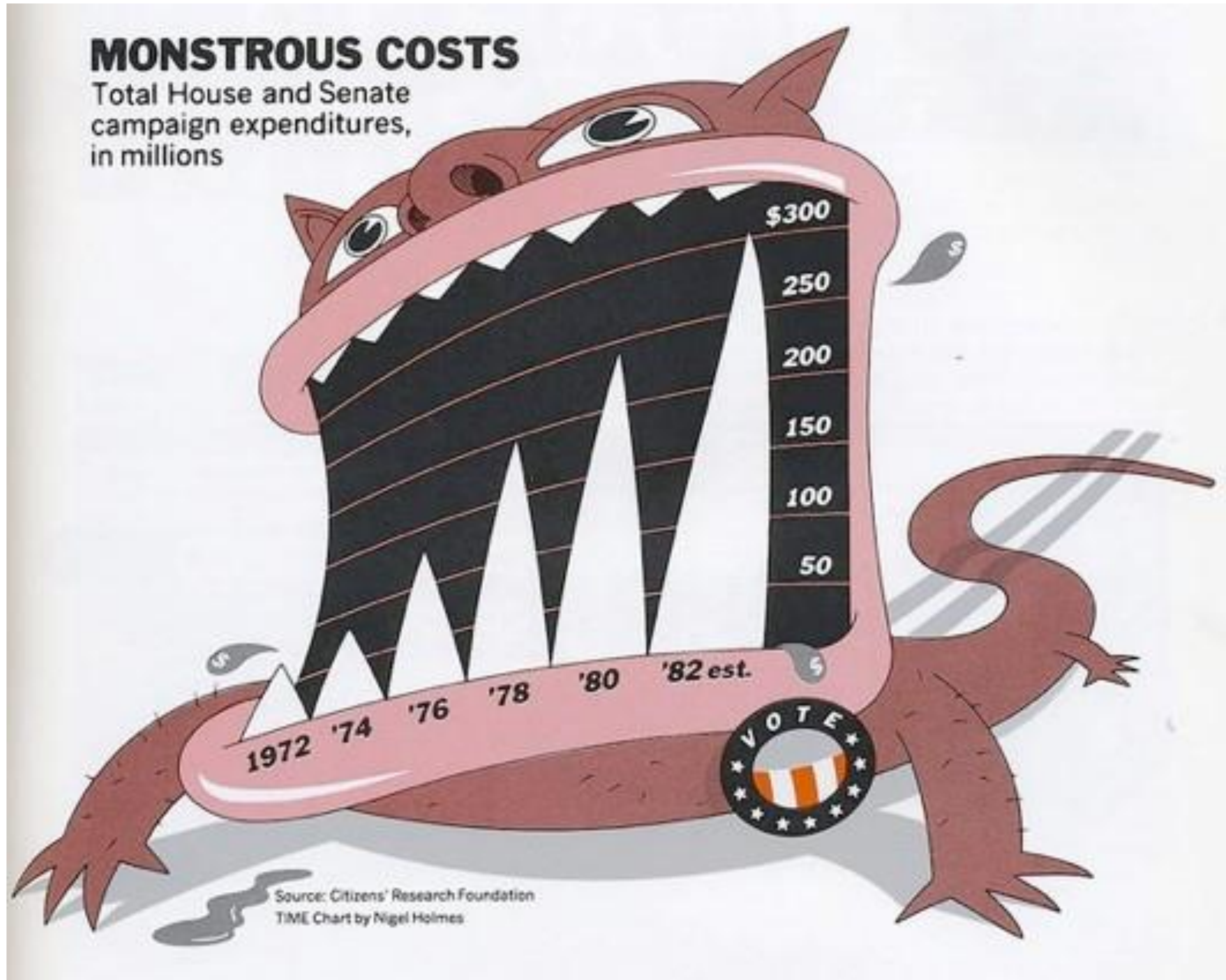


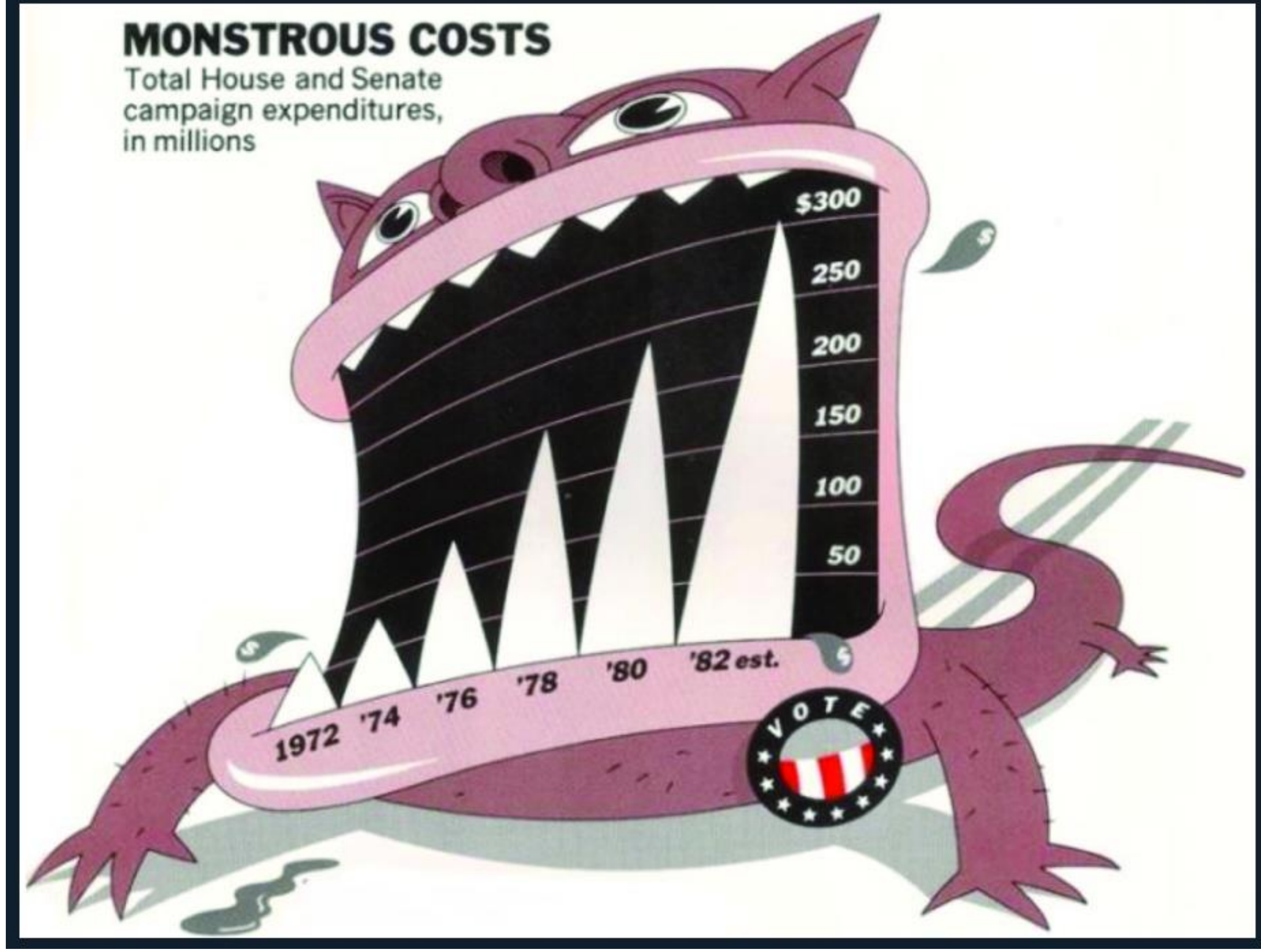
Chart Junk: attraction or distraction?





Nigel Holmes,TIME Magazine

Chart Junk


MONSTROUS COSTS
Total House and Senate campaign expenditures, in millions
$300
250
200
150
100
50
1972
'74
'76
'78
'80
'82 est.
VOTE

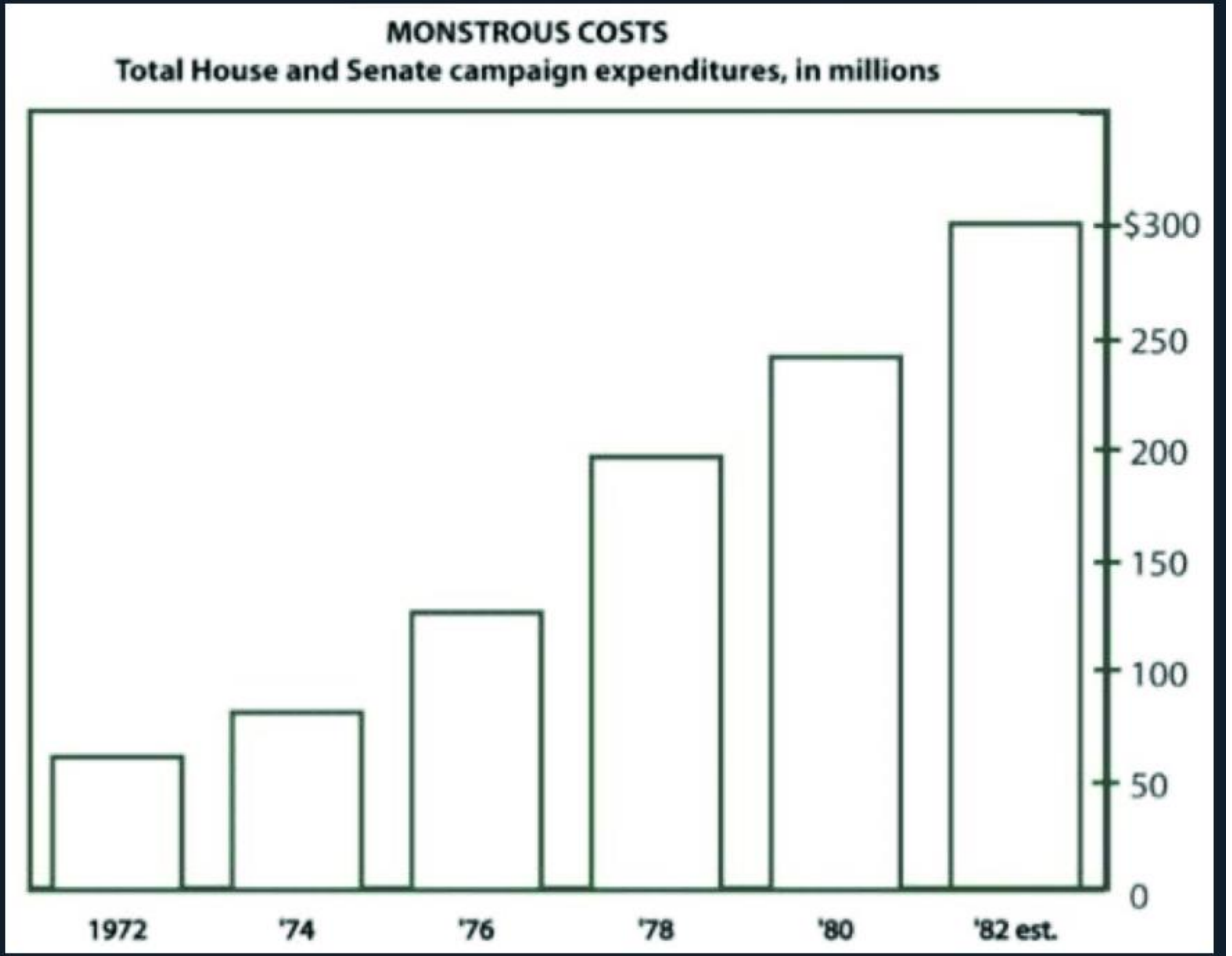
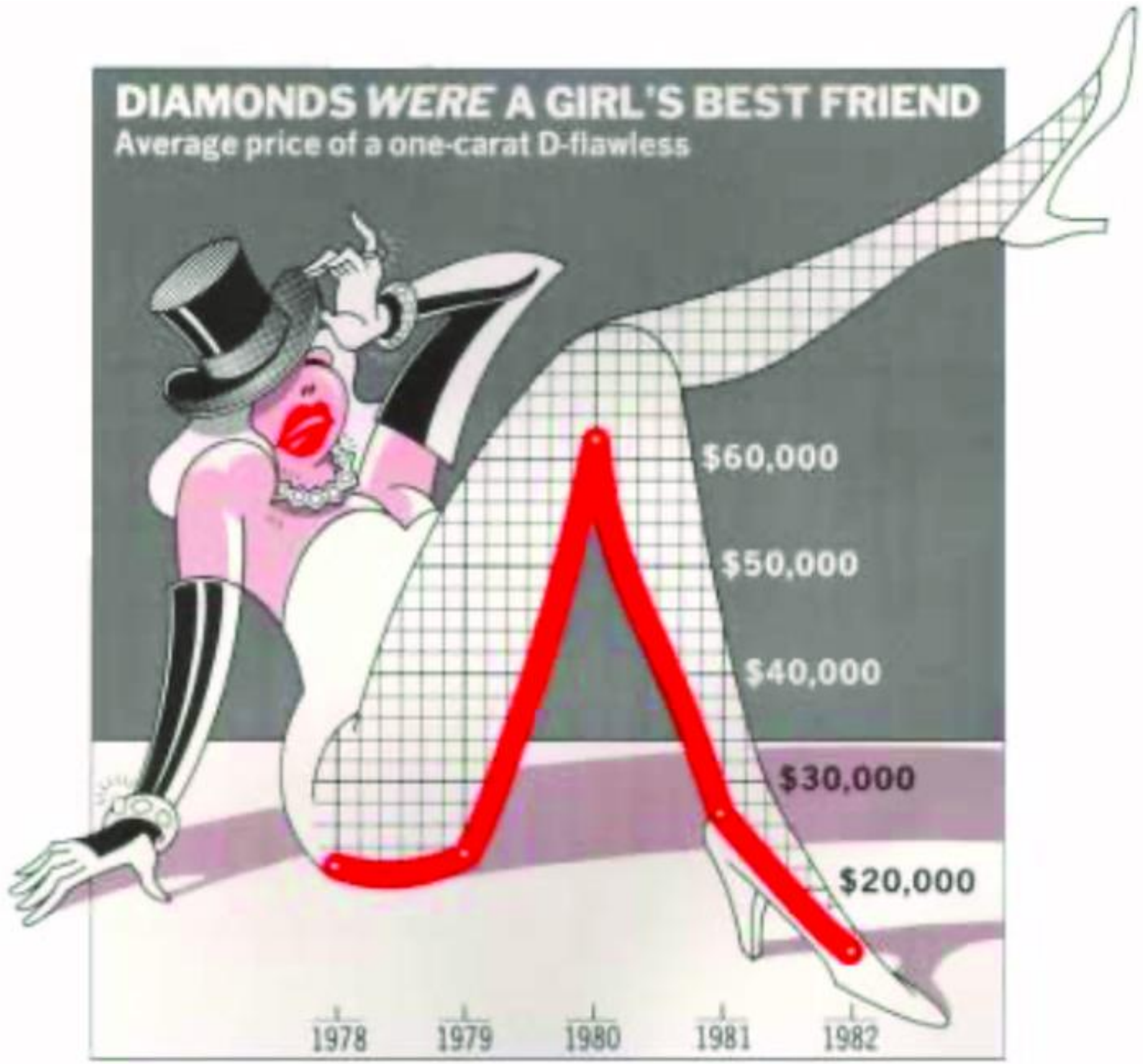
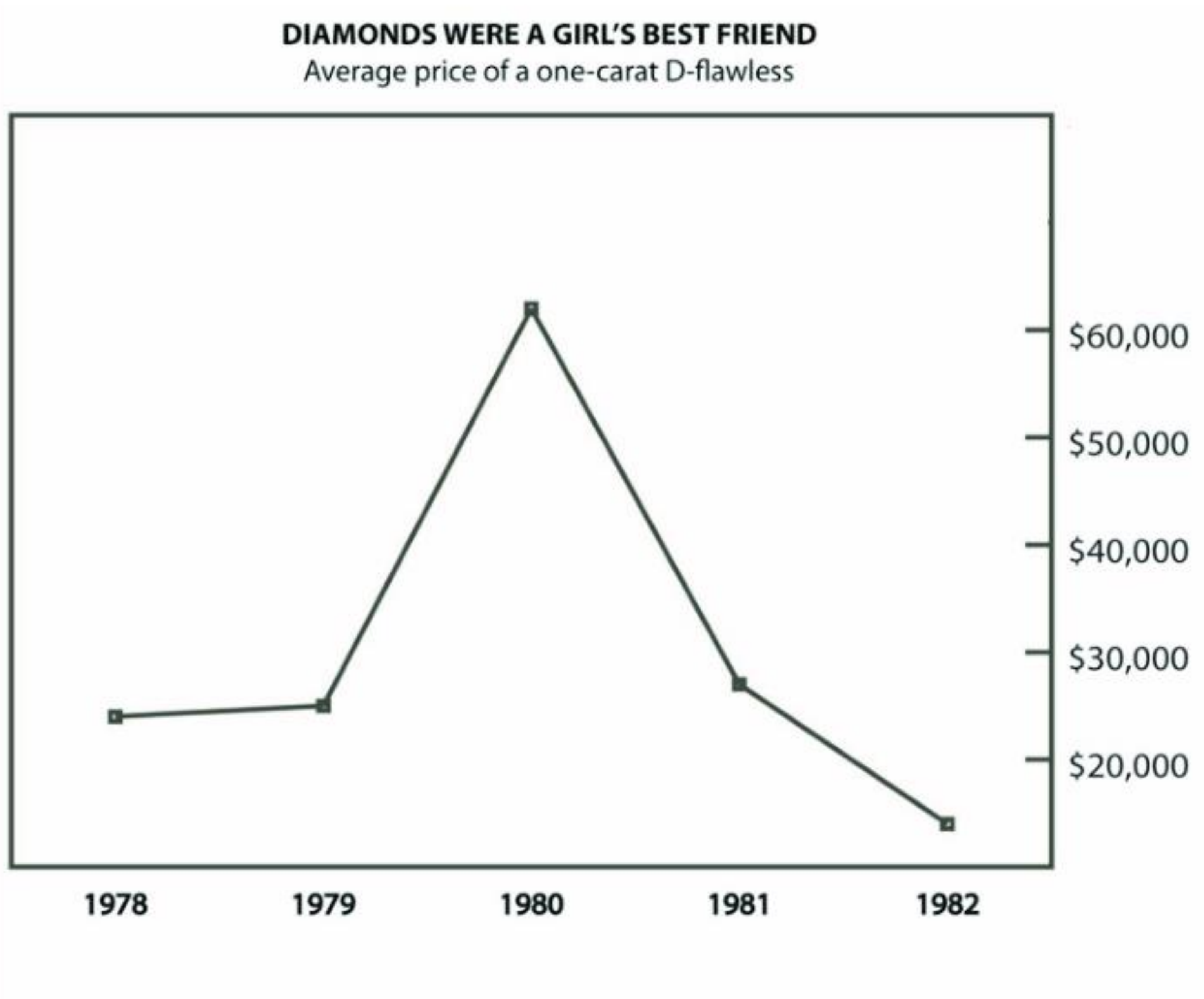

MONSTROUS COSTS
Total House and Senate campaign expenditures, in millions
$300
250
200
150
100
50
0
1972
'74
'76
'78
'80
'82 est.

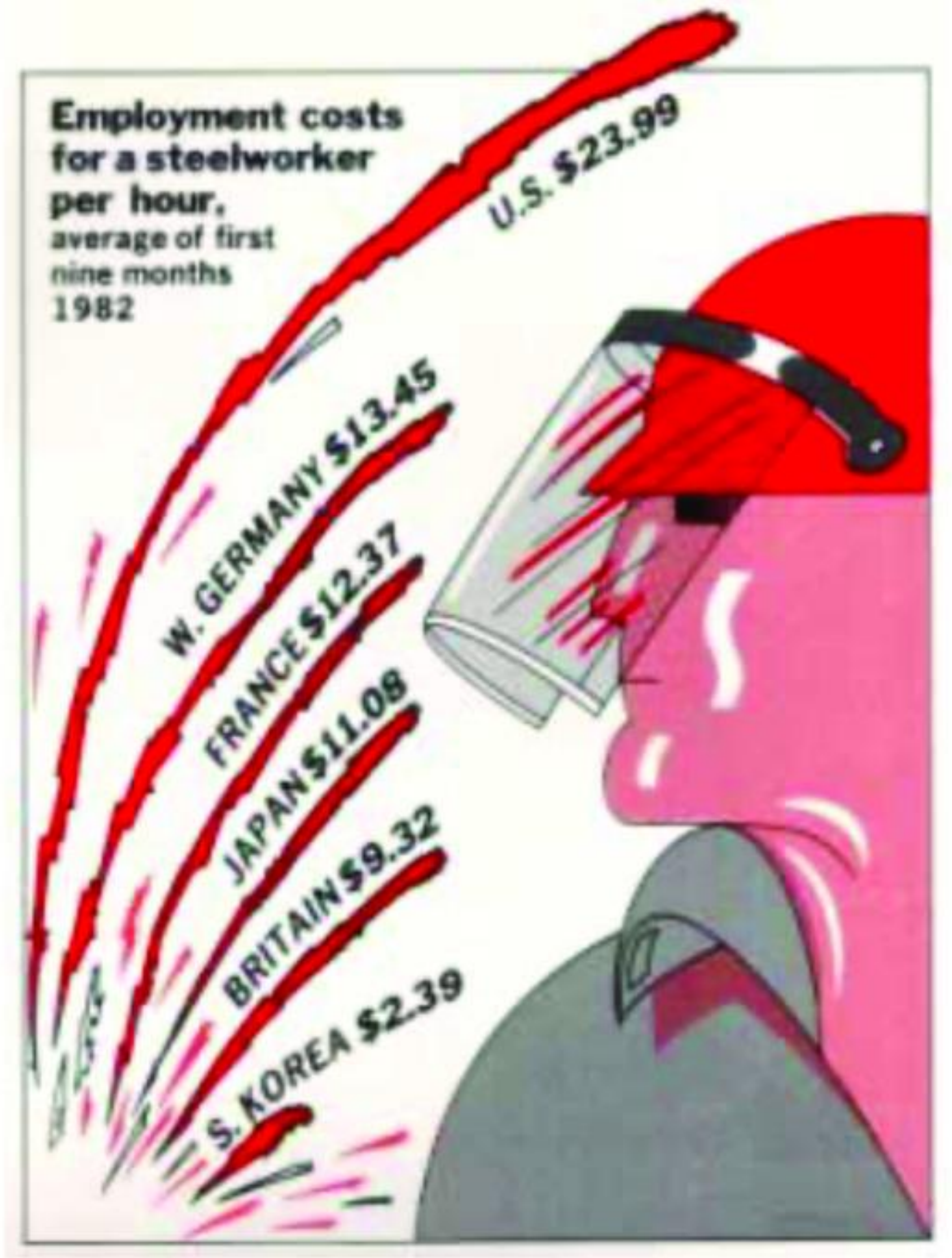
Chart Junk





Bateman et al. CHI 2010

Chart Junk


Employment costs for a steelworker per hour, average of first nine months 1982
U.S. $23.99
W. GERMANY $13.45
FRANCE $12.37
JAPAN $11.08
BRITAIN $9.32
S. KOREA $2.39

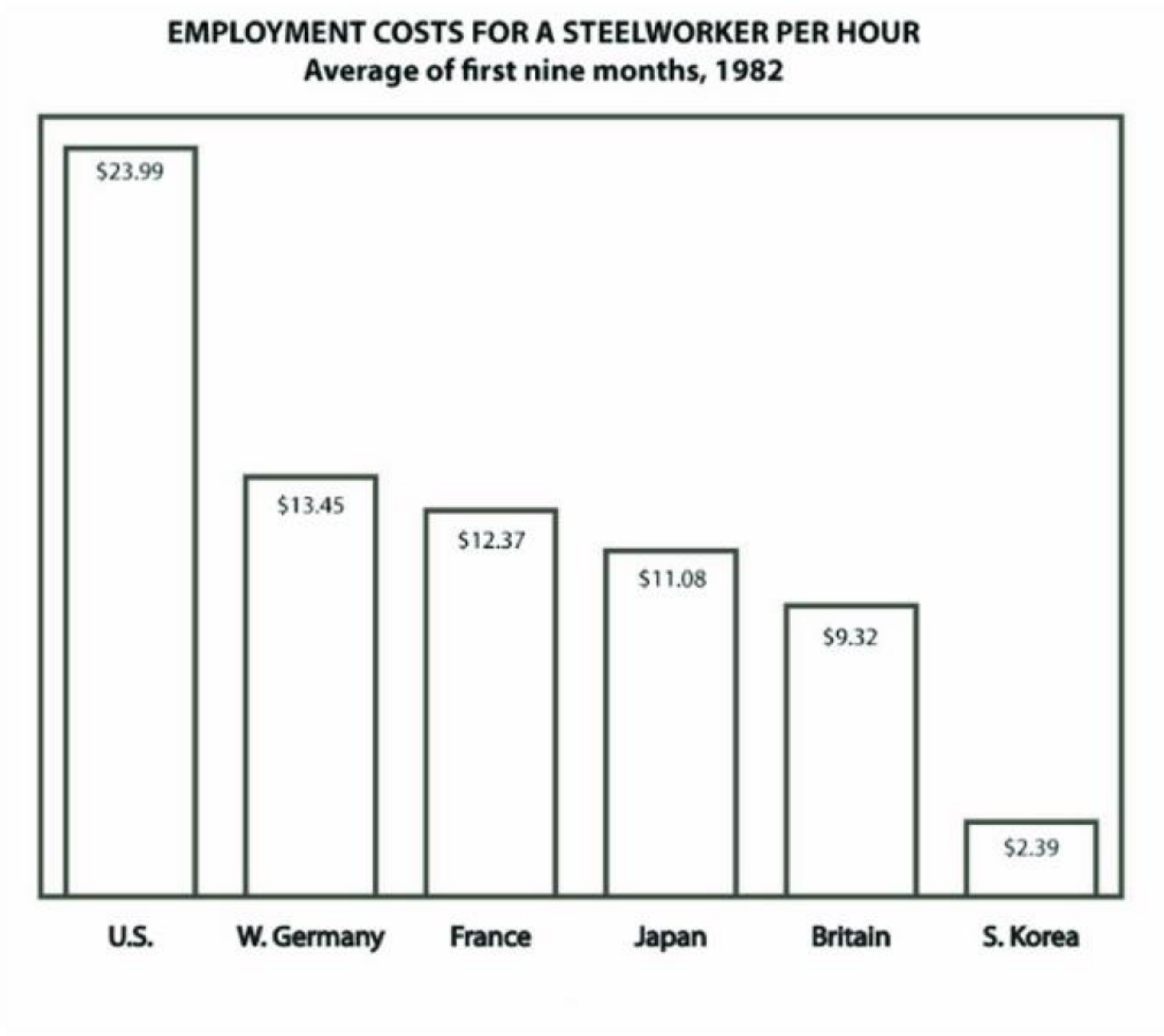
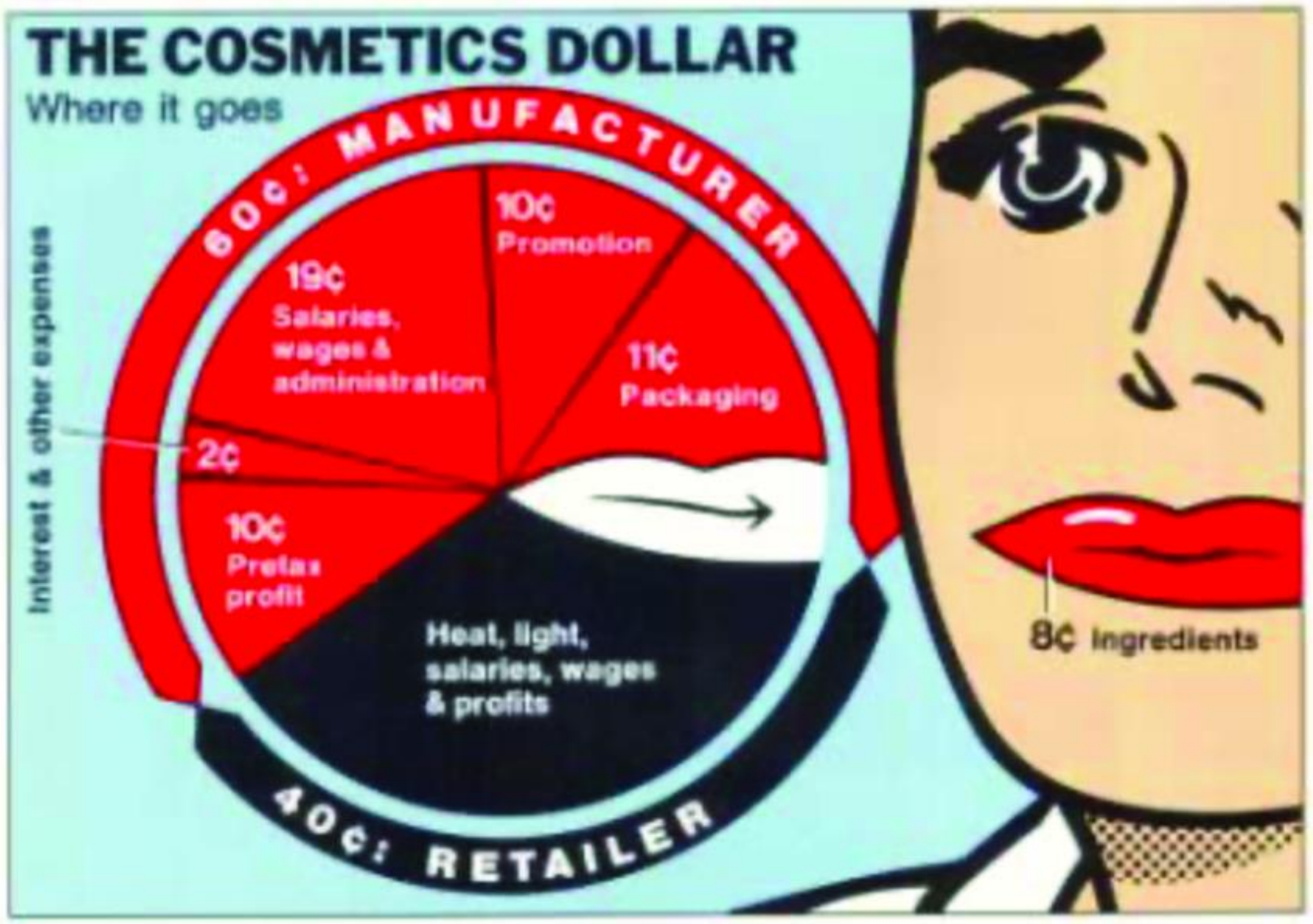

EMPLOYMENT COSTS FOR A STEELWORKER PER HOUR
Average of first nine months, 1982
$23.99
$13.45
$12.37
$11.08
$9.32
$2.39
U.S.
W. Germany
France
Japan
Britain
S. Korea

Chart Junk


THE COSMETICS DOLLAR
Where it goes
60¢: MANUFACTURER
10¢ Promotion
19¢ Salaries, wages & administration
11¢ Packaging
Interest & other expenses
2¢
10¢ Pretax profit
Heat, light, salaries, wages & profits
8¢ Ingredients
40¢: RETAILER

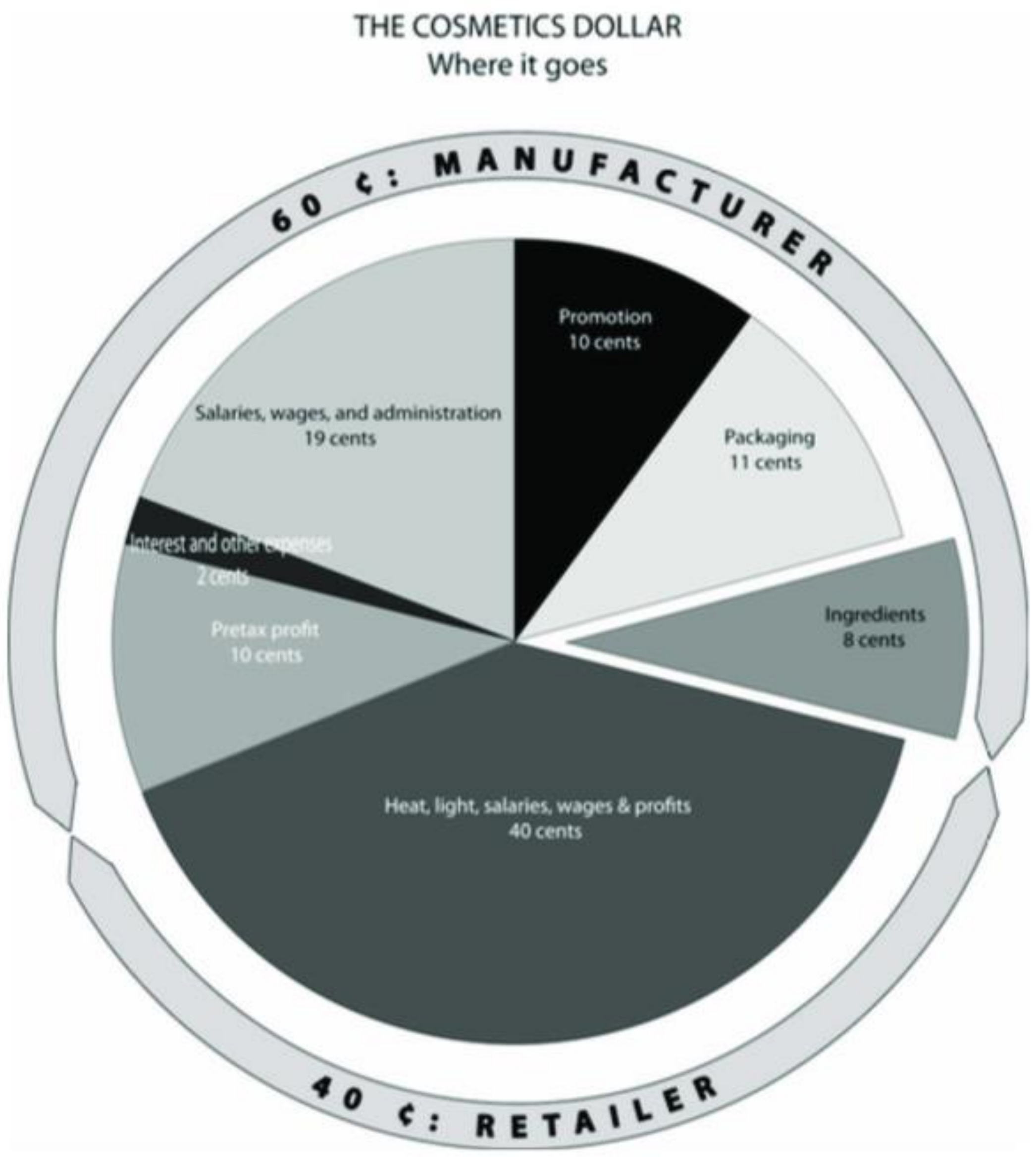
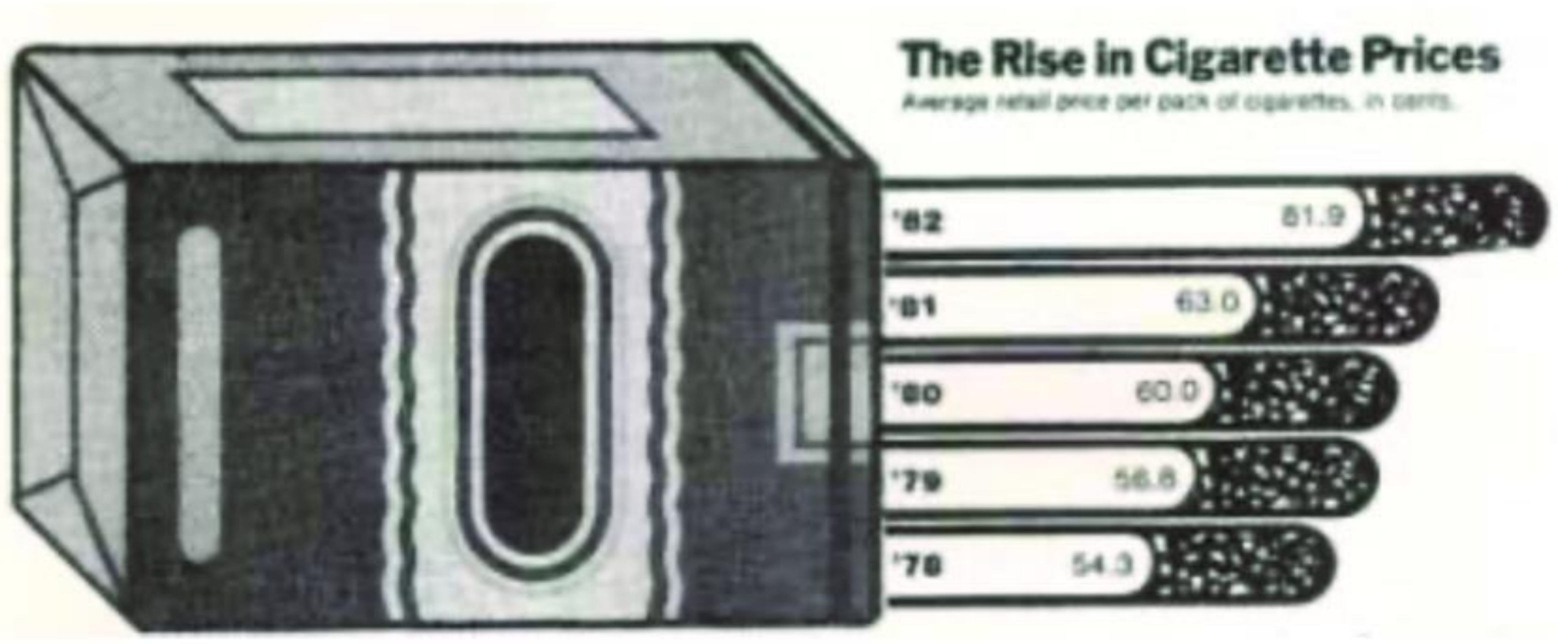
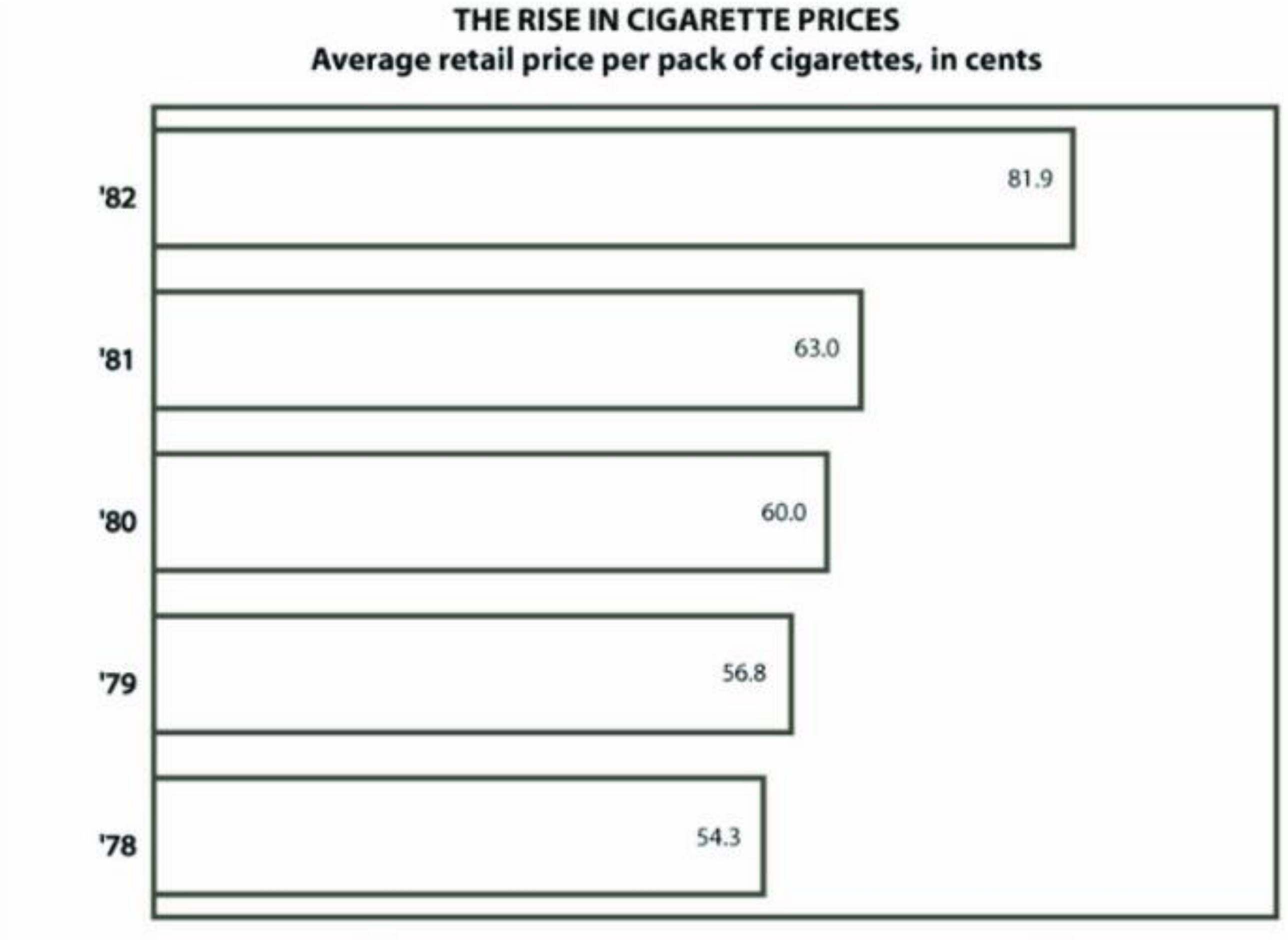

THE COSMETICS DOLLAR
Where it goes
60 ¢: MANUFACTURER
Promotion
10 cents
Salaries, wages, and administration
19 cents
Packaging
11 cents
Interest and other expenses
2 cents
Ingredients
8 cents
Pretax profit
10 cents
Heat, light, salaries, wages & profits
40 cents
40 ¢: RETAILER

Chart Junk

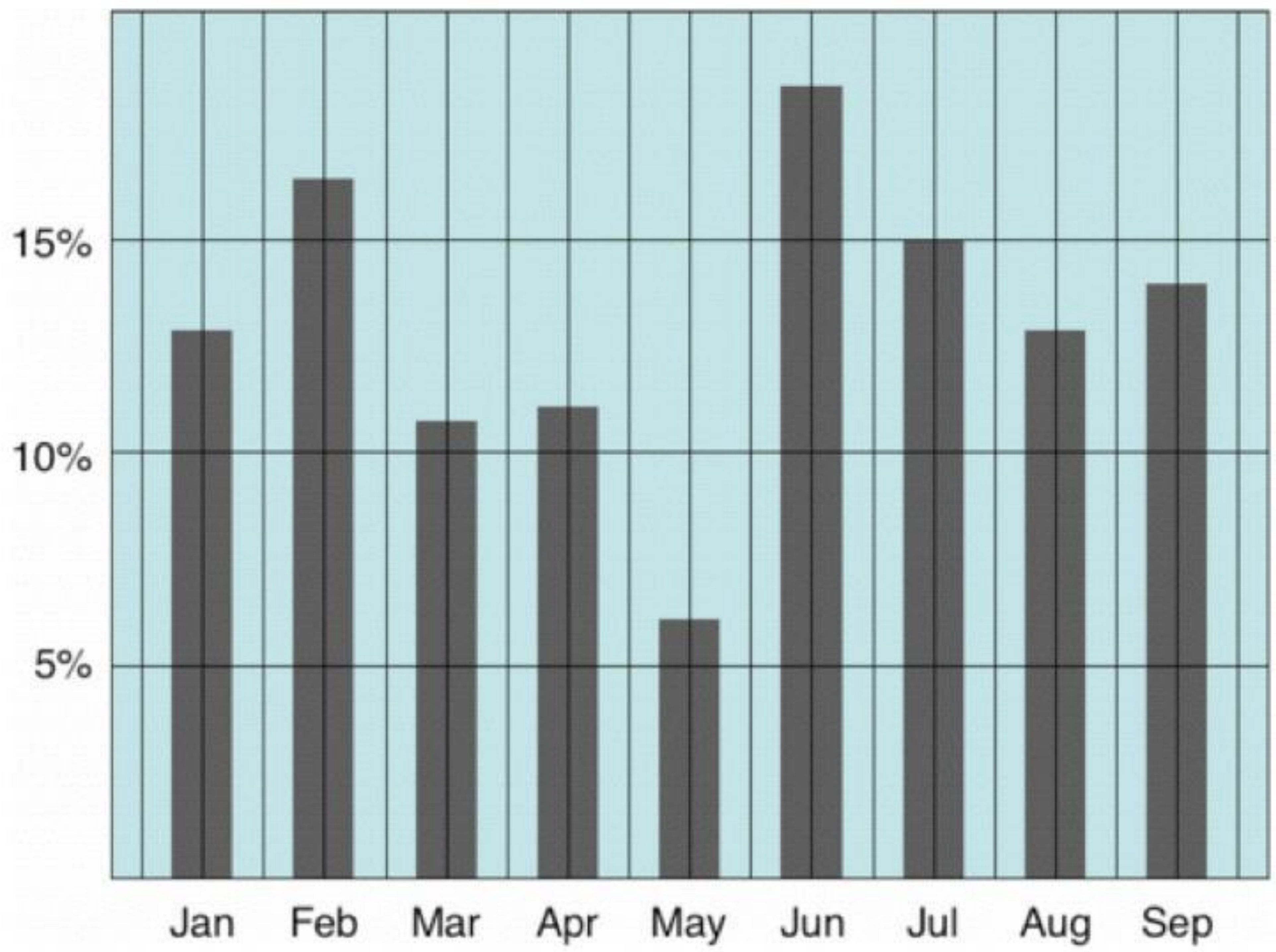


The Rise in Cigarette Prices
'82
81.9
'81
63.0
'80
60.0
'79
56.8
'78
54.3

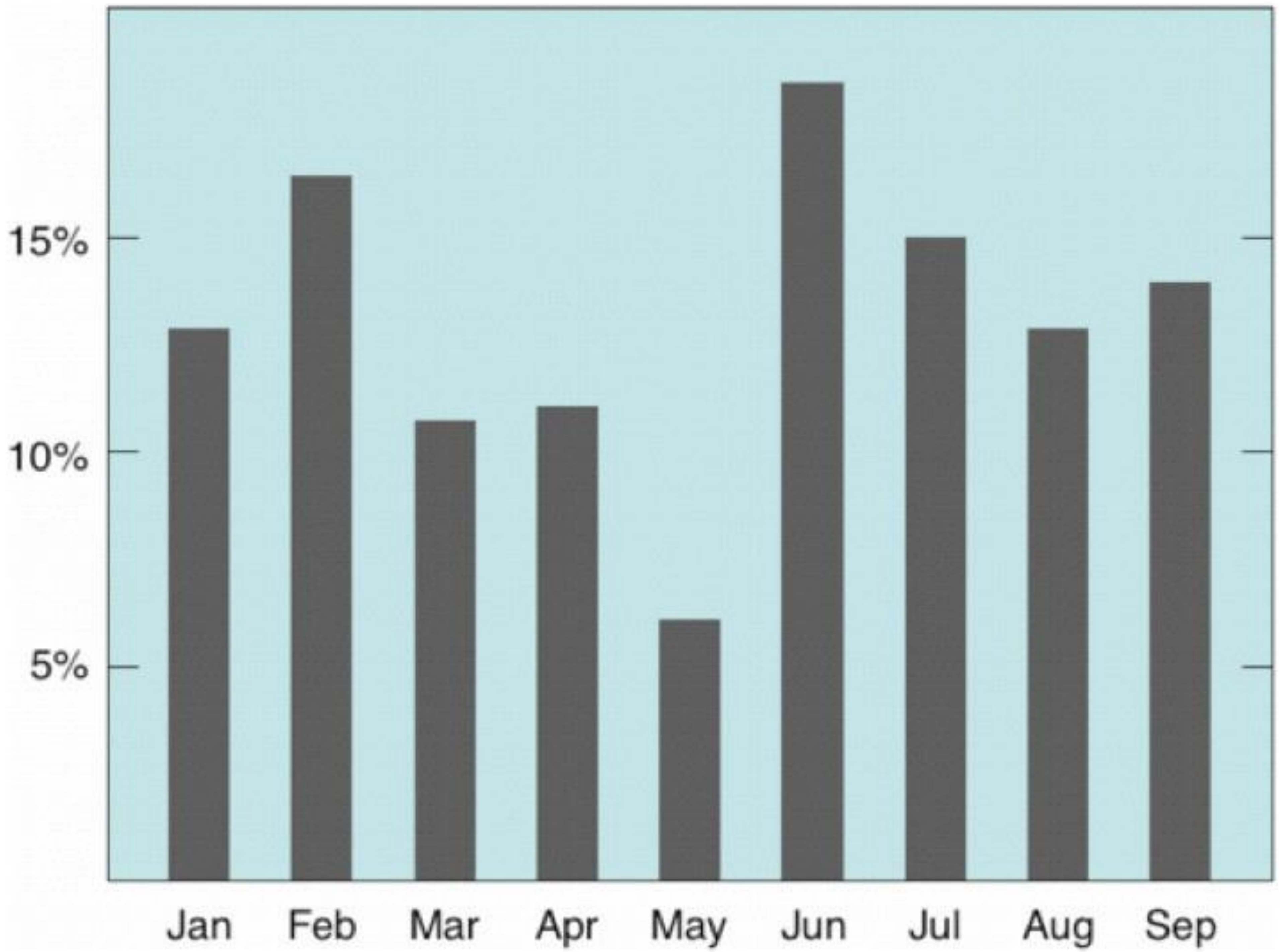


THE RISE IN CIGARETTE PRICES
Average retail price per pack of cigarettes, in cents
'82
81.9
'81
63.0
'80
60.0
'79
56.8
'78
54.3

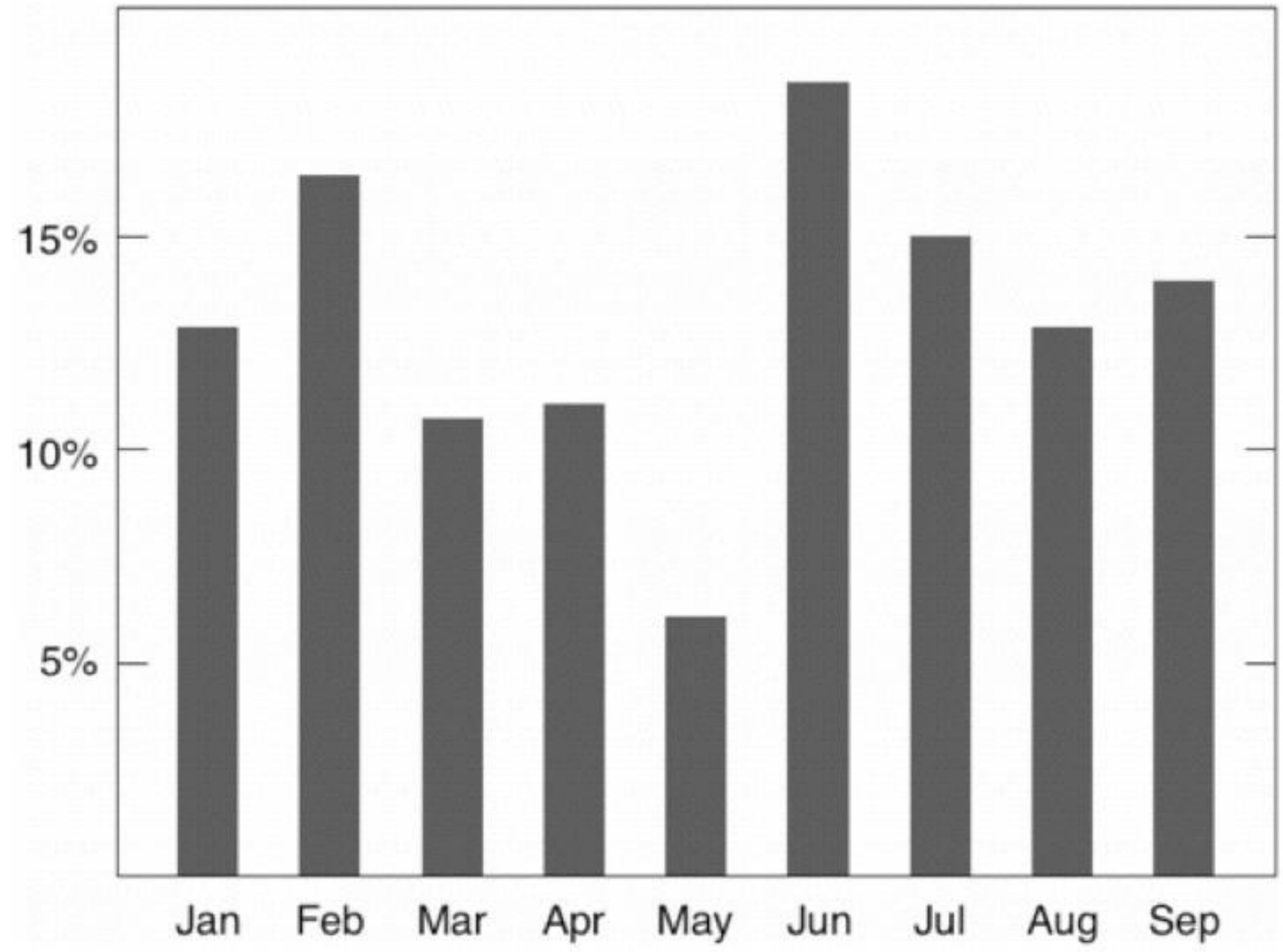
AVOID CHART JUNK



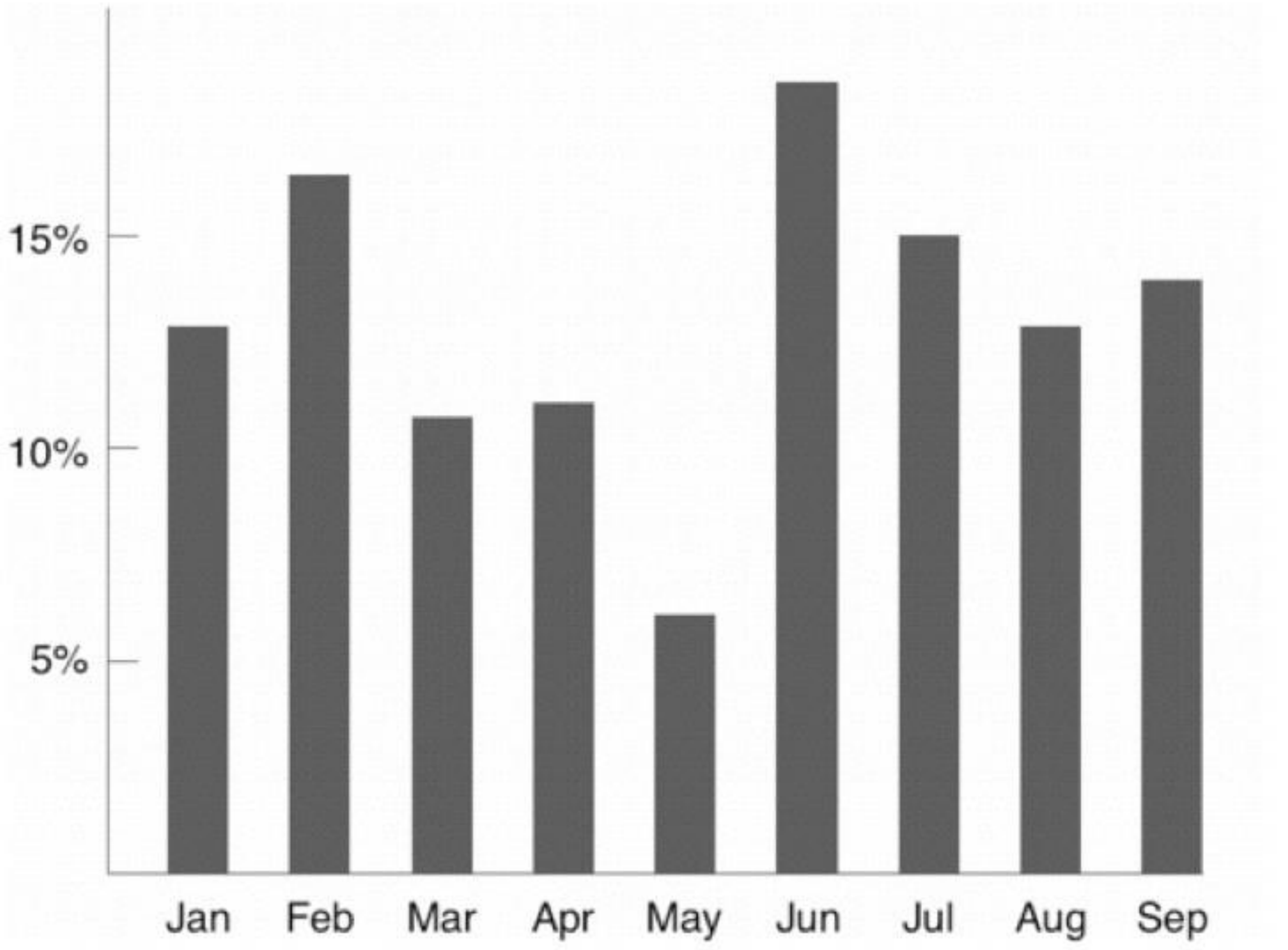
AVOID CHART JUNK



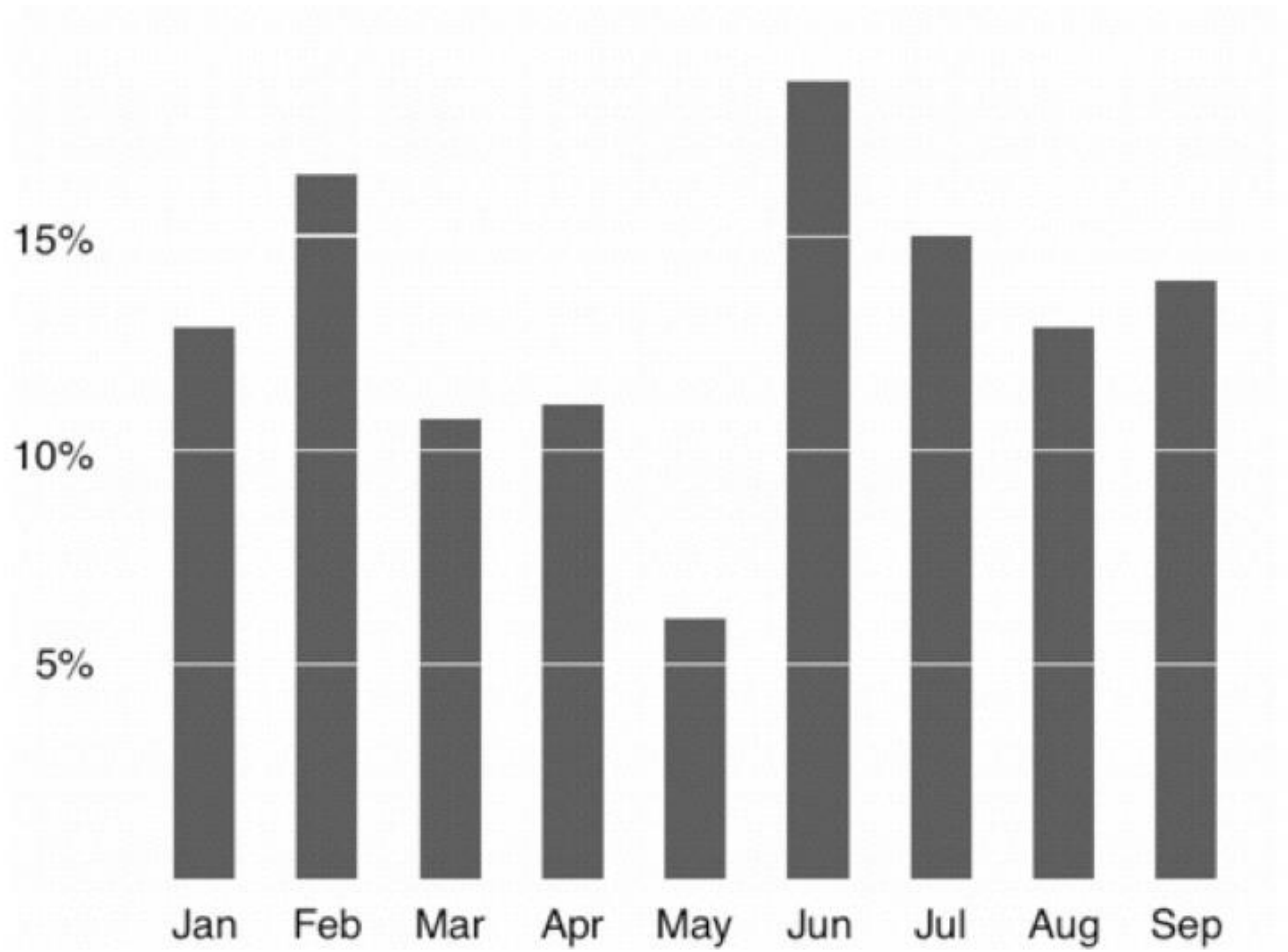
AVOID CHART JUNK



AVOID CHART JUNK



AVOID CHART JUNK



COUNTER-POINTS

CHI 2010: Graphs April 10–15, 2010, Atlanta, GA, USA

Useful Junk? The Effects of Visual Embellishment on Comprehension and Memorability of Charts

Scott Bateman, Regan L. Mandryk, Carl Gutwin,
Aaron Genest, David McDine, Christopher Brooks
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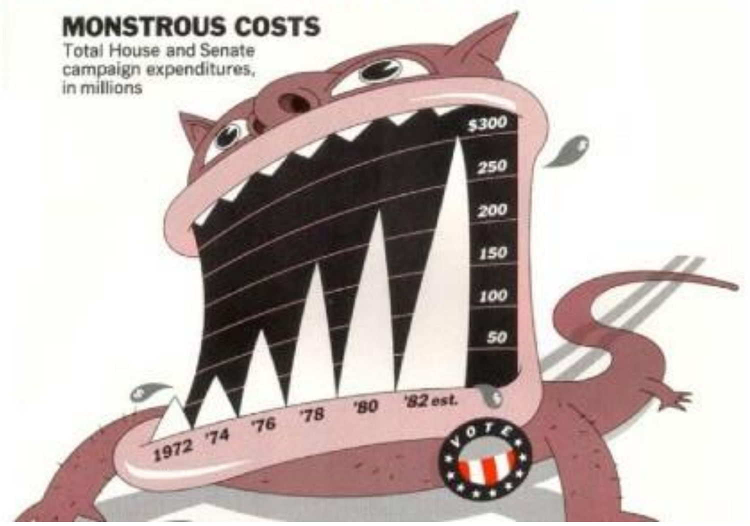
aaron.genest@usask.ca, dam085@mail.usask.ca, cab938@mail.usask.ca

ABSTRACT
Guidelines for designing information charts often state that the presentation should reduce 'chart junk' – visual embellishments that are not essential to understanding the data. In contrast, some popular chart designers wrap the presented data in detailed and elaborate imagery, raising the questions of whether this imagery is really as detrimental to understanding as has been proposed, and whether the visual embellishment may have other benefits. To investigate these issues, we conducted an experiment that compared embellished charts with plain ones, and measured both interpretation accuracy and long-term recall. We found that people's accuracy in describing the embellished charts was no worse than for plain charts, and that their recall after a two-to-three-week gap was significantly better. Although we are cautious about recommending that all charts be produced in this style, our results question some of the premises of the minimalist approach to chart design.

Author Keywords
Charts, information visualization, imagery, memorability.

Despite these minimalist guidelines, many designers include a wide variety of visual embellishments in their charts, from small decorations to large images and visual backgrounds. One well-known proponent of visual embellishment in charts is the graphic artist Nigel Holmes, whose work regularly incorporates strong visual imagery into the fabric of the chart [7] (e.g., Figure 1).



What Makes a Visualization Memorable?

Michelle A. Borkin, *Student Member, IEEE*, Azalea A. Vo, Zoya Bylinskii, Phillip Isola, *Student Member, IEEE*, Shashank Sunkavalli, Aude Oliva, and Hanspeter Pfister, *Senior Member, IEEE*

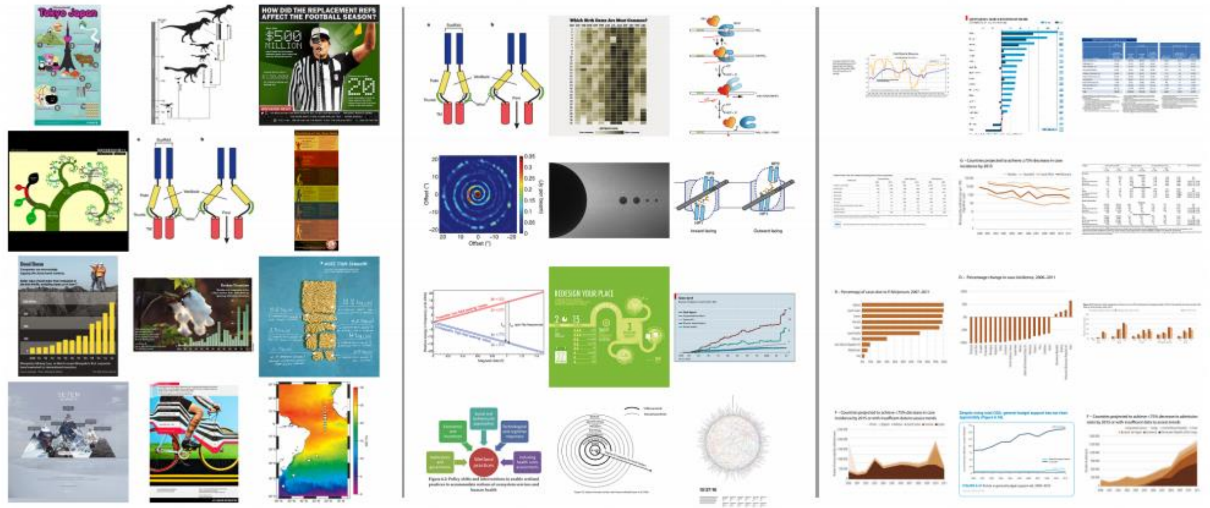


Fig. 1. **Left:** The top twelve overall most memorable visualizations from our experiment (most to least memorable from top left to bottom right). **Middle:** The top twelve most memorable visualizations from our experiment when visualizations containing human recognizable cartoons or images are removed (most to least memorable from top left to bottom right). **Right:** The twelve least memorable visualizations from our experiment (most to least memorable from top left to bottom right).

Abstract—An ongoing debate in the Visualization community concerns the role that visualization types play in data understanding. In human cognition, understanding and memorability are intertwined. As a first step towards being able to ask questions about impact and effectiveness, here we ask: "What makes a visualization memorable?" We ran the largest scale visualization study to date using 2,070 single-panel visualizations, categorized with visualization type (e.g., bar chart, line graph, etc.), collected from news media sites, government reports, scientific journals, and infographic sources. Each visualization was annotated with additional attributes, including ratings for data-ink ratios and visual densities. Using Amazon's Mechanical Turk, we collected memorability scores for hundreds of these visualizations, and discovered that observers are consistent in which visualizations they find memorable and forgettable. We find intuitive results (e.g., attributes like color and the inclusion of a human recognizable object enhance memorability) and less intuitive results (e.g., common graphs are less memorable than unique visualization types). Altogether our findings suggest that quantifying memorability is a general metric of the utility of information, an essential step towards determining how to design effective visualizations.

Index Terms—Visualization taxonomy, information visualization, memorability

Useful Junk? The Effects of Visual Embellishment on Comprehension and Memorability of Charts

Scott Bateman, Regan L. Mandryk, Carl Gutwin,
Aaron Genest, David McDine, Christopher Brooks
Department of Computer Science, University of Saskatchewan, Saskatoon, Saskatchewan, Canada
scott.bateman@usask.ca, regan@cs.usask.ca, gutwin@cs.usask.ca,
aaron.genest@usask.ca, dam085@mail.usask.ca, cab938@mail.usask.ca

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EXPERIMENTAL QUESTIONS

- do visual embellishments cause comprehension problems?
- do embellishments provide additional information that is valuable for the reader?

EXPERIMENTAL RESULTS

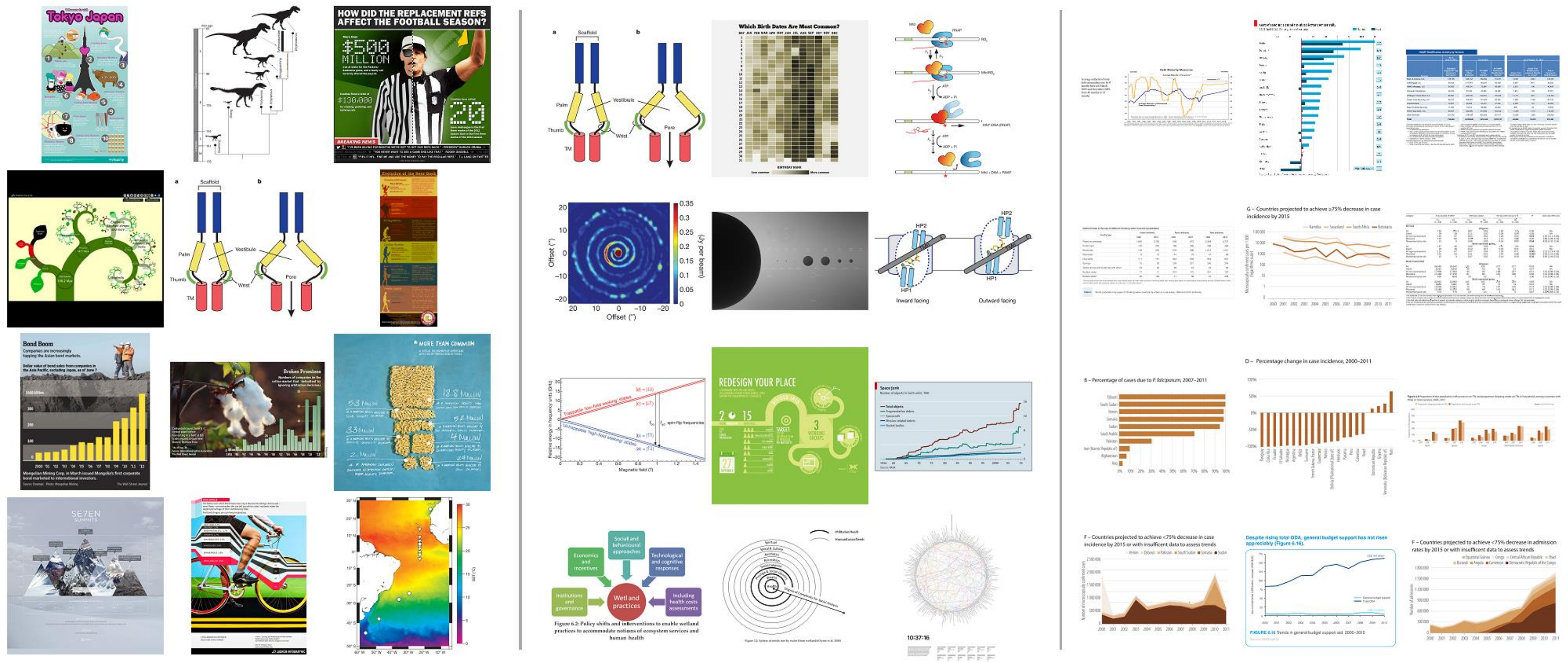
- No significant difference between plain and embellished charts for interactive interpretation accuracy
- No significant difference in recall accuracy after a five-minute gap

EXPERIMENTAL RESULTS

- Significantly better recall for embellished charts of both the chart topic and the details (categories and trend) after long-term gap (2-3 weeks)
- Participants saw value messages in the embellished charts significantly more often than in the plain charts
- Participants found the embellished charts more attractive, most enjoyed them, and found that they were easiest and fastest to remember

What Makes a Visualization Memorable?

Michelle A. Borkin, *Student Member, IEEE*, Azalea A. Vo, Zoya Bylinskii, Phillip Isola, *Student Member, IEEE*, Shashank Sunkavalli, Aude Oliva, and Hanspeter Pfister, *Senior Member, IEEE*



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Index Terms—Visualization taxonomy, information visualization, memorability

Results

- color and human recognizable objects enhance memorability
- common graphs are less memorable than unique visualization types

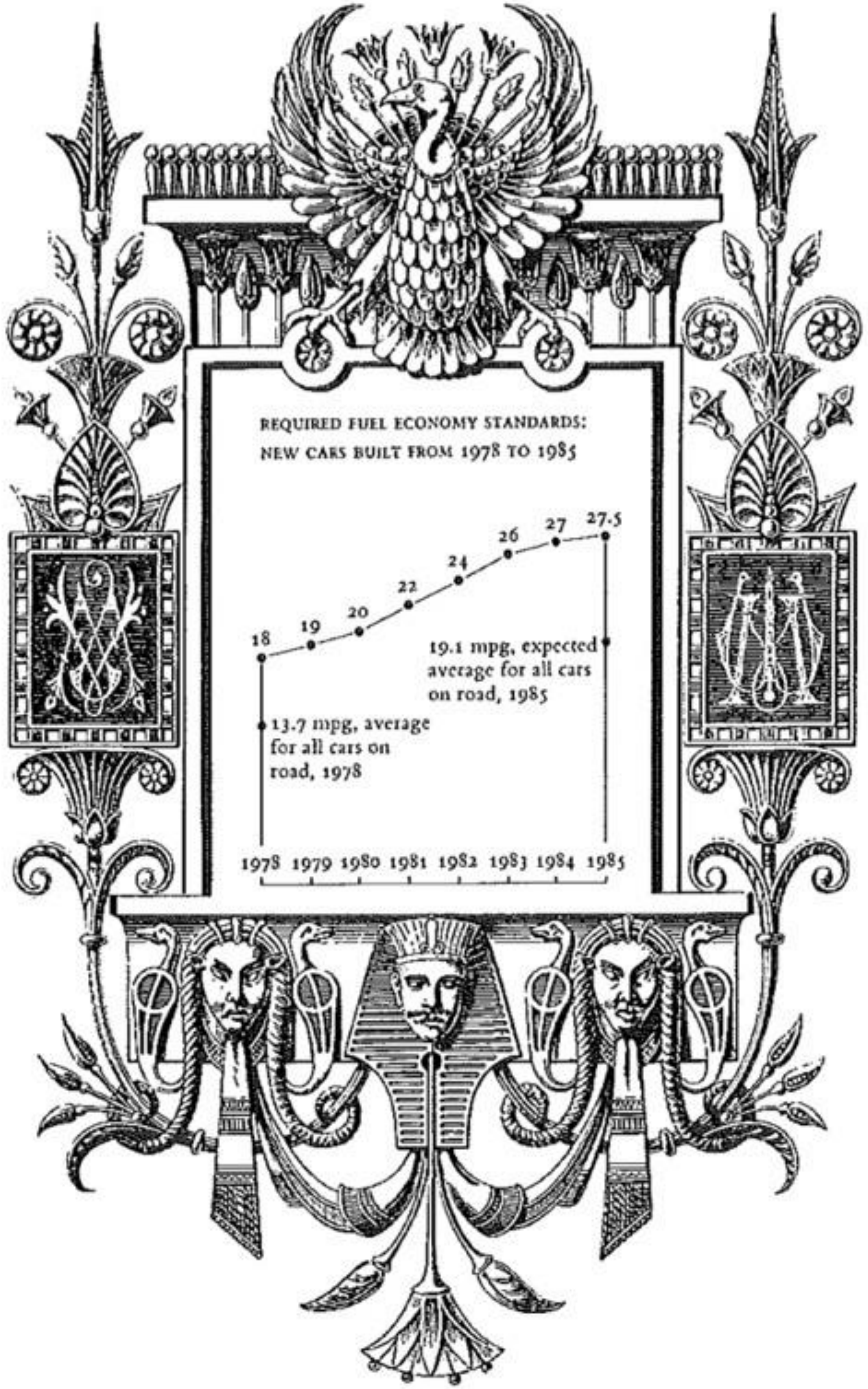
CHART JUNK? IT DEPENDS

- persuasion
- memorability
- engagement

PROS

- unbiased analysis
- trustworthiness
- interpretability
- space efficiency

CONS

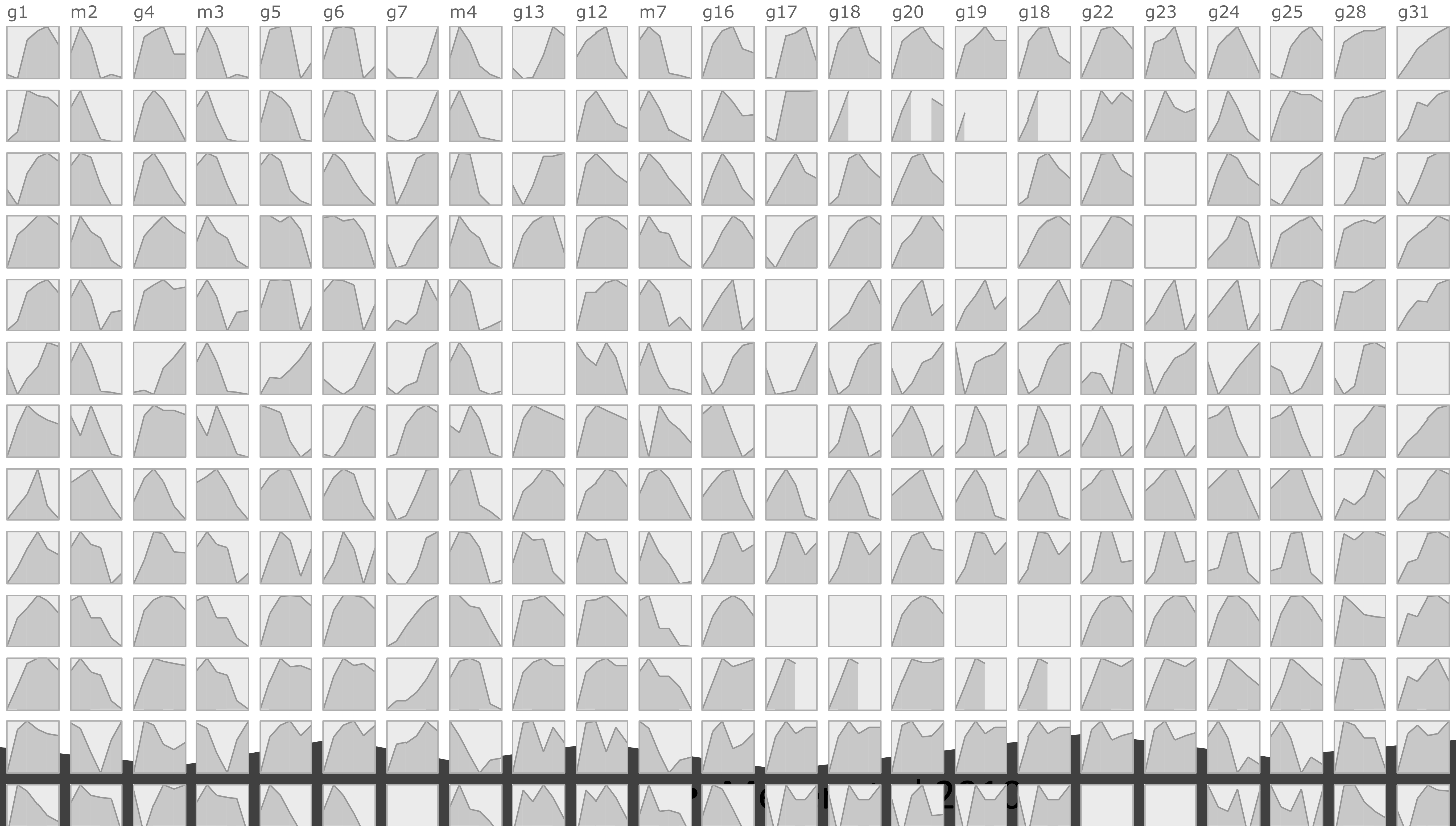


REQUIRED FUEL ECONOMY STANDARDS:
NEW CARS BUILT FROM 1978 TO 1985
18
19
20
22
24
26
27
27.5
19.1 mpg, expected average for all cars on road, 1985
13.7 mpg, average for all cars on road, 1978
1978 1979 1980 1981 1982 1983 1984 1985

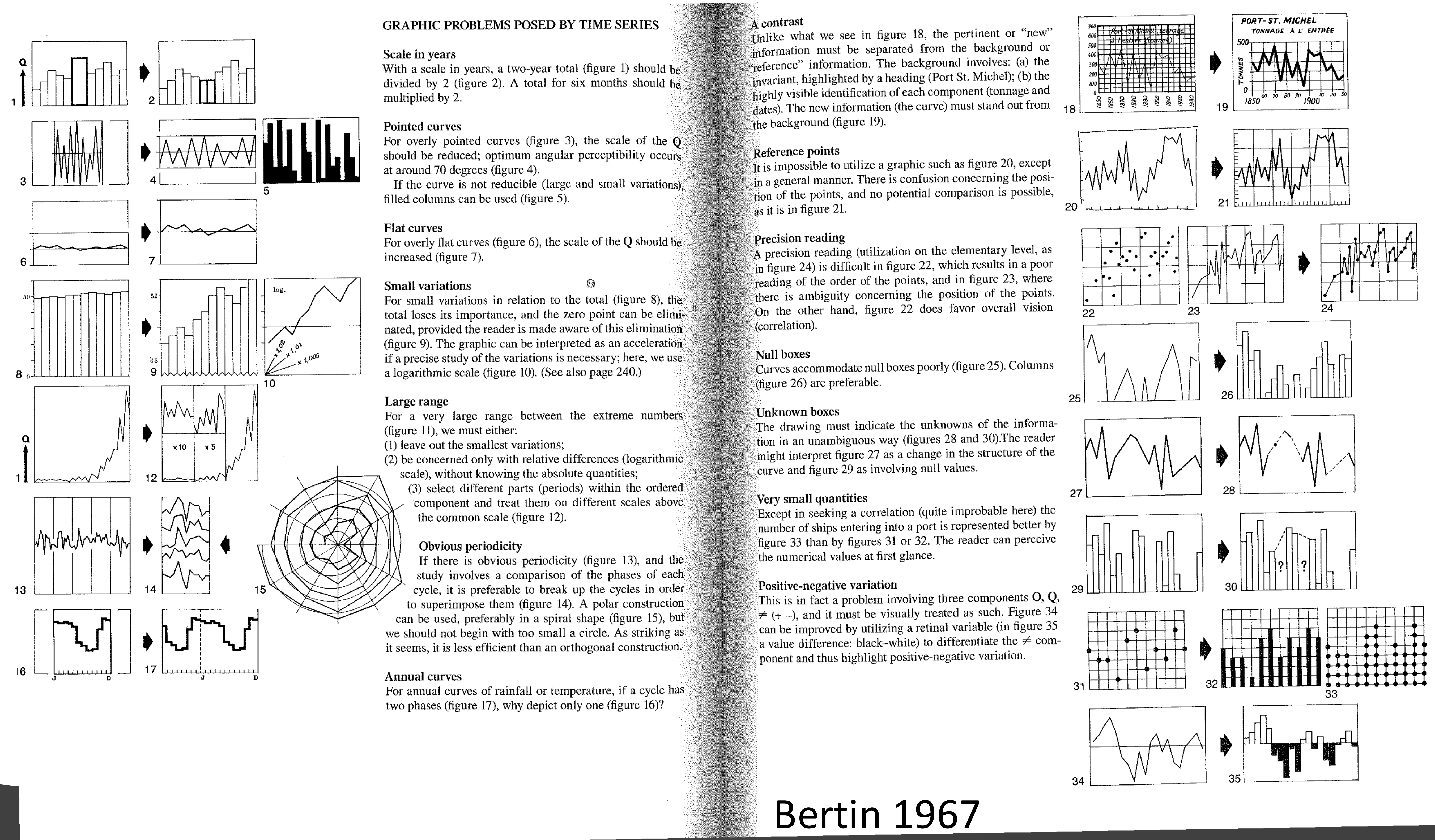
maximize the

$$\textbf{Data Density} = \frac{\text{number of entries in data array}}{\text{area of data graphic}}$$

SHRINK THE GRAPHICS – with small multiples



SHRINK THE GRAPHICS



GRAPHIC PROBLEMS POSED BY TIME SERIES

Scale in years
With a scale in years, a two-year total (figure 1) should be divided by 2 (figure 2). A total for six months should be multiplied by 2.

Pointed curves
For overly pointed curves (figure 3), the scale of the Q should be reduced; optimum angular perceptibility occurs at around 70 degrees (figure 4).
If the curve is not reducible (large and small variations), filled columns can be used (figure 5).

Flat curves
For overly flat curves (figure 6), the scale of the Q should be increased (figure 7).

Small variations
For small variations in relation to the total (figure 8), the total loses its importance, and the zero point can be eliminated, provided the reader is made aware of this elimination (figure 9). The graphic can be interpreted as an acceleration if a precise study of the variations is necessary; here, we use a logarithmic scale (figure 10). (See also page 240.)

Large range
For a very large range between the extreme numbers (figure 11), we must either:
(1) leave out the smallest variations;
(2) be concerned only with relative differences (logarithmic scale), without knowing the absolute quantities;
(3) select different parts (periods) within the ordered component and treat them on different scales above the common scale (figure 12).

Obvious periodicity
If there is obvious periodicity (figure 13), and the study involves a comparison of the phases of each cycle, it is preferable to break up the cycles in order to superimpose them (figure 14). A polar construction can be used, preferably in a spiral shape (figure 15), but we should not begin with too small a circle. As striking as it seems, it is less efficient than an orthogonal construction.

Annual curves
For annual curves of rainfall or temperature, if a cycle has two phases (figure 17), why depict only one (figure 16)?

A contrast
Unlike what we see in figure 18, the pertinent or "new" information must be separated from the background or "reference" information. The background involves: (a) the invariant, highlighted by a heading (Port St. Michel); (b) the highly visible identification of each component (tonnage and dates). The new information (the curve) must stand out from the background (figure 19).

Reference points
It is impossible to utilize a graphic such as figure 20, except in a general manner. There is confusion concerning the position of the points, and no potential comparison is possible, as it is in figure 21.

Precision reading
A precision reading (utilization on the elementary level, as in figure 24) is difficult in figure 22, which results in a poor reading of the order of the points, and in figure 23, where there is ambiguity concerning the position of the points. On the other hand, figure 22 does favor overall vision (correlation).

Null boxes
Curves accommodate null boxes poorly (figure 25). Columns (figure 26) are preferable.

Unknown boxes
The drawing must indicate the unknowns of the information in an unambiguous way (figures 28 and 30).The reader might interpret figure 27 as a change in the structure of the curve and figure 29 as involving null values.

Very small quantities
Except in seeking a correlation (quite improbable here) the number of ships entering into a port is represented better by figure 33 than by figures 31 or 32. The reader can perceive the numerical values at first glance.

Positive-negative variation
This is in fact a problem involving three components O, Q, ≠ (+ –), and it must be visually treated as such. Figure 34 can be improved by utilizing a retinal variable (in figure 35 a value difference: black–white) to differentiate the ≠ component and thus highlight positive-negative variation.

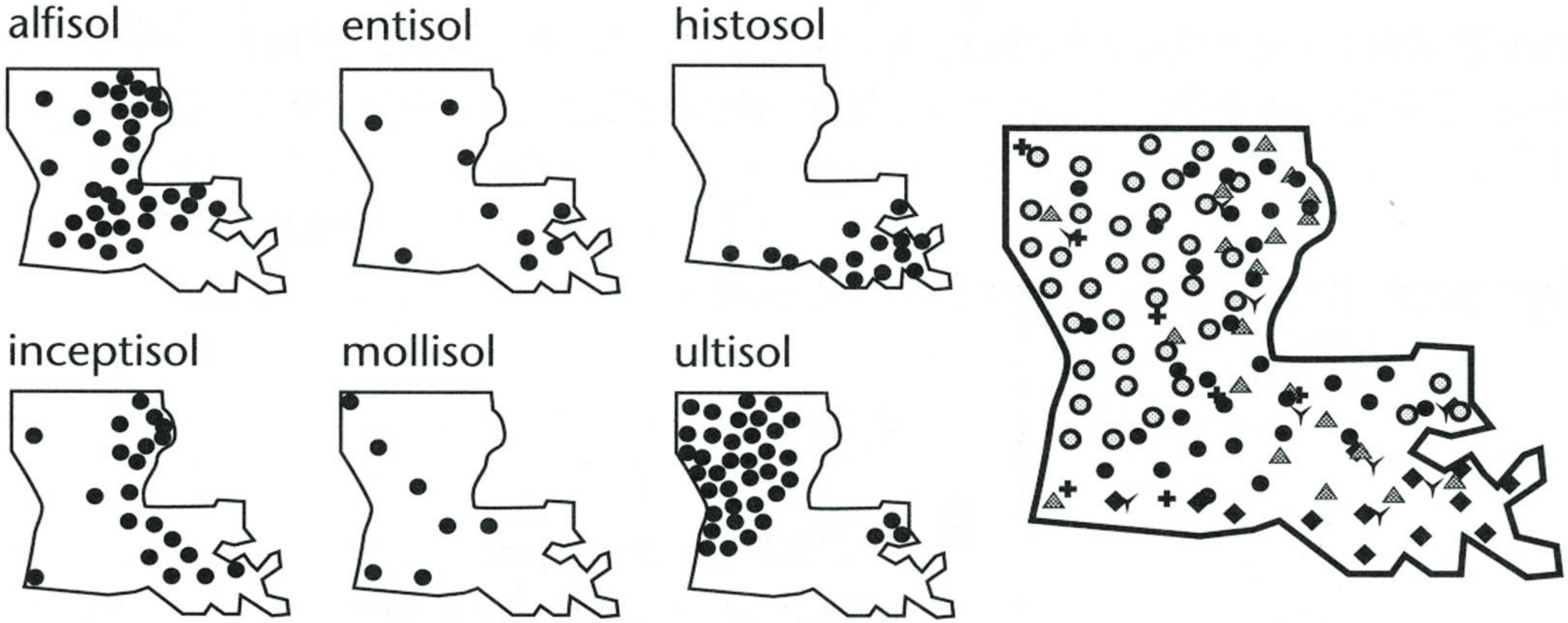
Bertin 1967

SHRINK THE GRAPHICS – with sparklines

Dequantification In exchange for an enormous increase in graphical resolving power, the wordlike size of sparklines precludes the overt labels and scaling of conventional statistical displays. Most of our examples have, however, depicted *contextual methods* for quantifying sparklines: the gray bar for normal limits and the red encoding to link data points in sparklines to exact numbers glucose 6.6; global scale bars and labels for sparkline clusters; and, probably best of all, surrounding a sparkline with an implicit data-scaling box formed by nearby numbers that label key data points (such as beginning/end, high/low) 1.1025 1.1907 1.0783 1.2858. And now and then sparklines might be scaled by very small type:

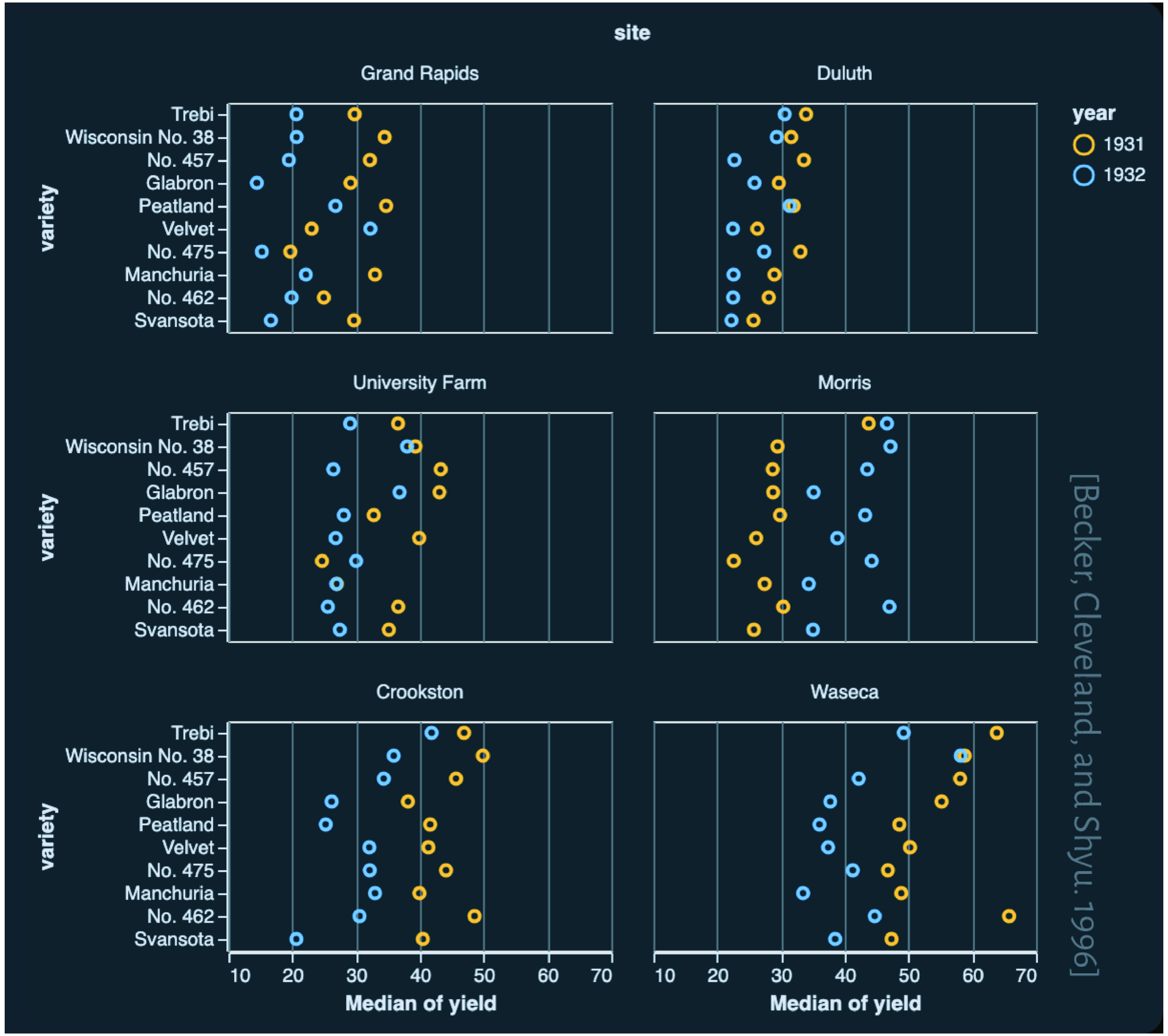
Production methods Data lines produced by conventional statistical graphics programs must be gathered together, rescaled, and resized into sparklines. Sometimes this can be quickly done by cutting and pasting data lines, then resizing the printed output to sparkline resolutions. To produce and display really elegant sparklines, however, currently requires elaborate software: (1) a *page layout* program, (2) a *graphic design* program that gives complete control over type, tables, linework, and (3) a *statistical analysis* program to generate hundreds of chartjunk-free sparklines for export into design and layout operations. Once the basic templates for sparklines are worked out, then ongoing production and

Small Multiples



Trellis Plots

- Subdivide space to enable comparison across multiple plots
- Typically, nominal or ordinal variables are used as dimensions for subdivision.



[Becker, Cleveland, and Shyu. 1996]

COUNTER-POINT

Unseen and Unaware: Implications of Recent Research on Failures of Visual Awareness for Human–Computer Interface Design

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Vanderbilt University

Roger Fidler
Kent State University

ABSTRACT

Because computers often rely on visual displays as a way to convey information to a user, recent research suggesting that people have detailed awareness of only a small subset of the visual environment has important implications for human–computer interface design. Equally important to basic limits of awareness is the fact that people often over-predict what they will see and become aware of. Together, basic failures of awareness and people's failure to intuitively understand

ILLUSIONS OF VISUAL BANDWIDTH

- people over-predict what they will see and become aware of

overestimate of breadth

- belief that viewers can take in all (or most) of the details of a scene at once
- adding extra visual features makes it harder to find specifics bits of information

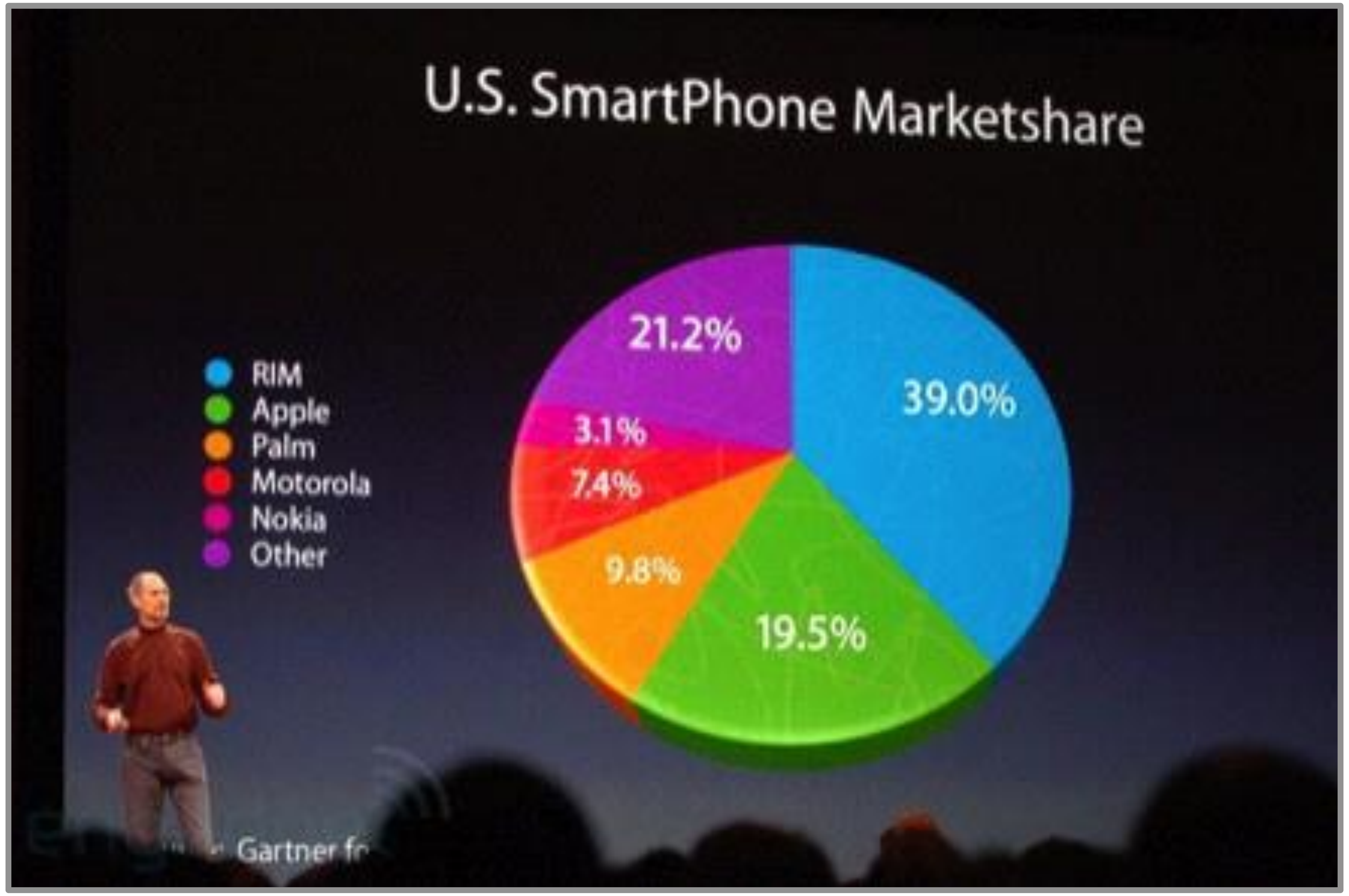
overestimate of countenance

- belief that user will attend to a higher proportion of the display than they do
- users typically have expectations about where in a display to look

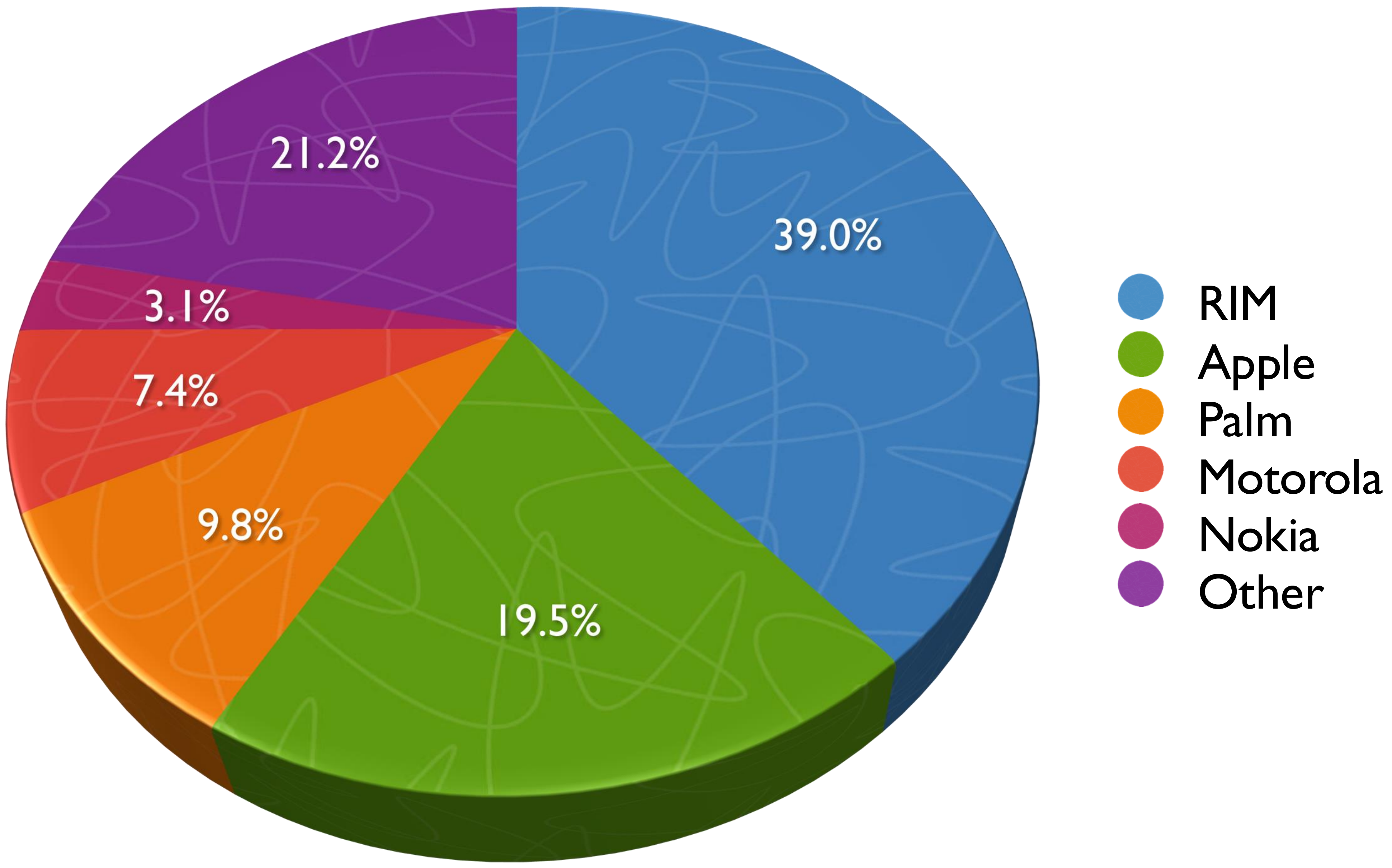
overestimate of depth

- belief that attending to an object leads to more complete and deep understanding than is the case

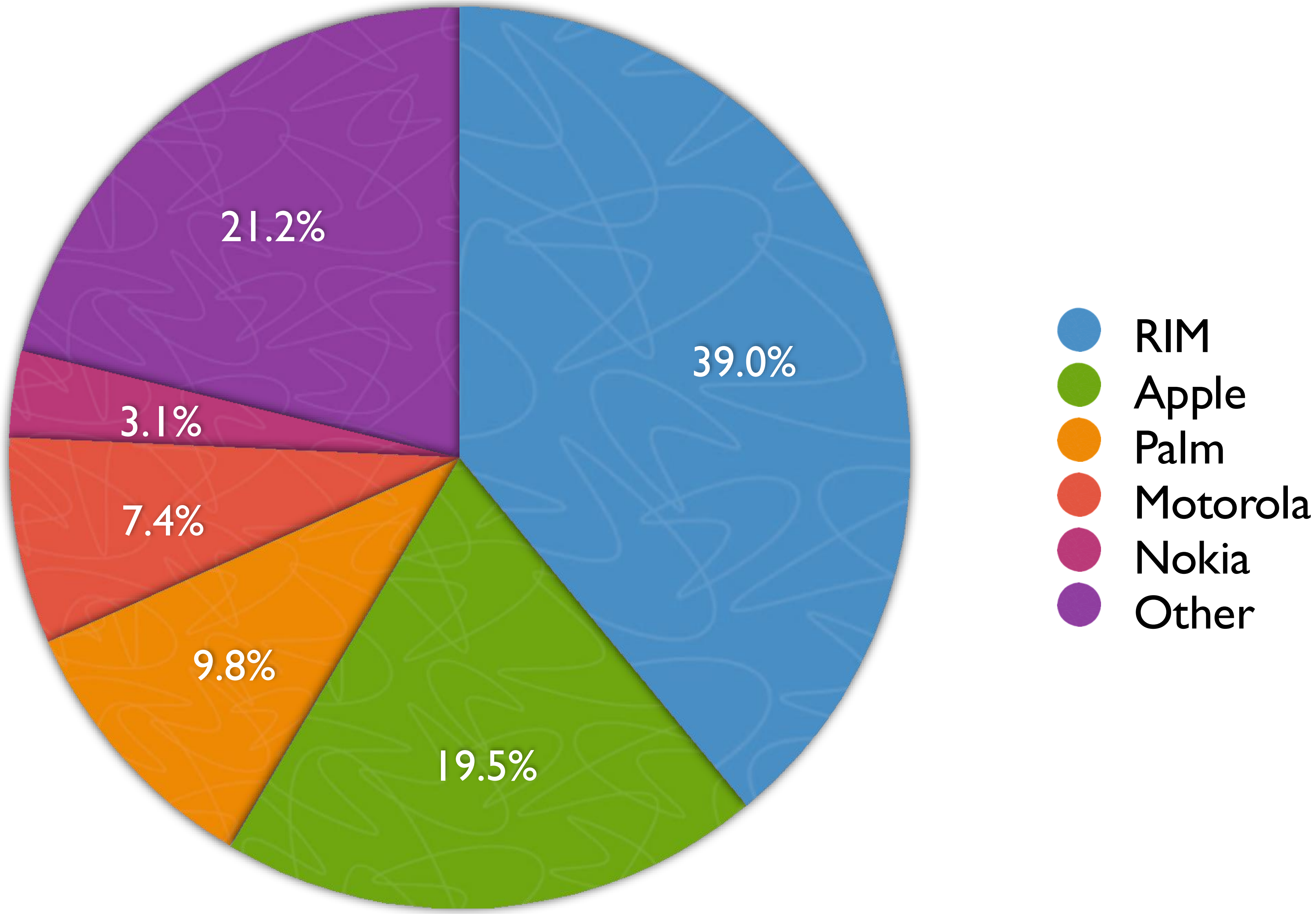
Misleading Encoding


U.S. SmartPhone Marketshare
RIM
Apple
Palm
Motorola
Nokia
Other
21.2%
39.0%
3.1%
7.4%
9.8%
19.5%

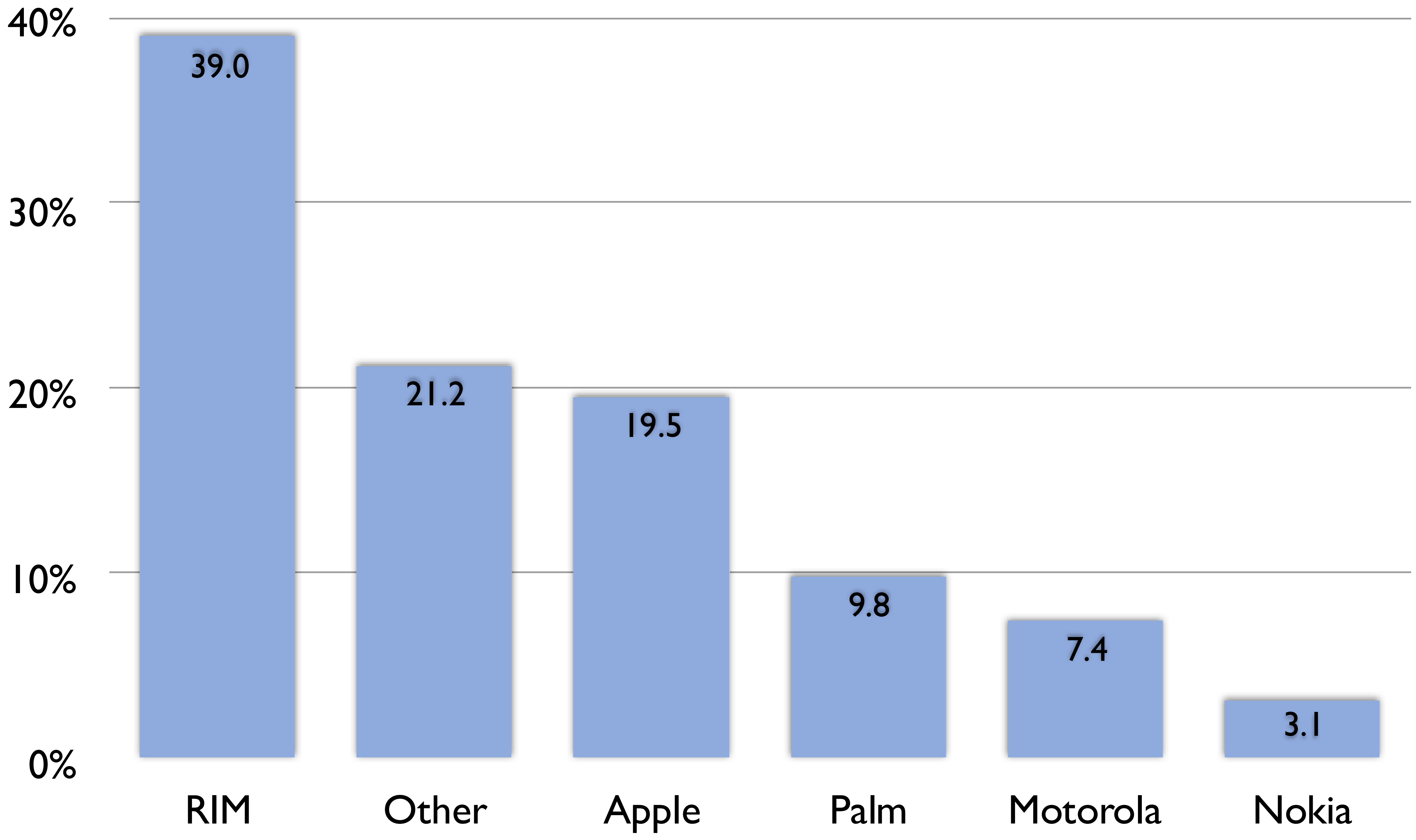
U.S. SmartPhone Marketshare



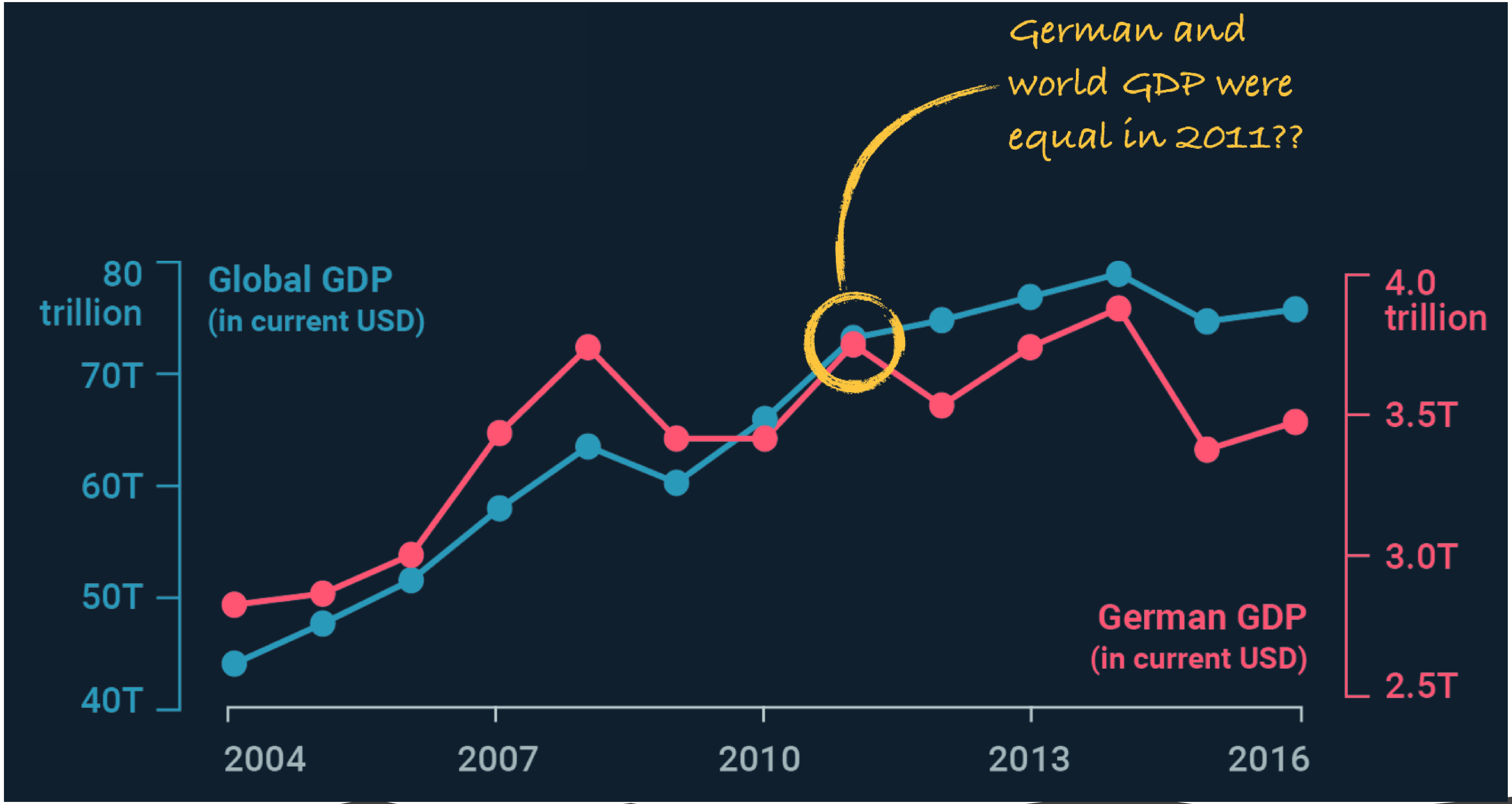
U.S. SmartPhone Marketshare



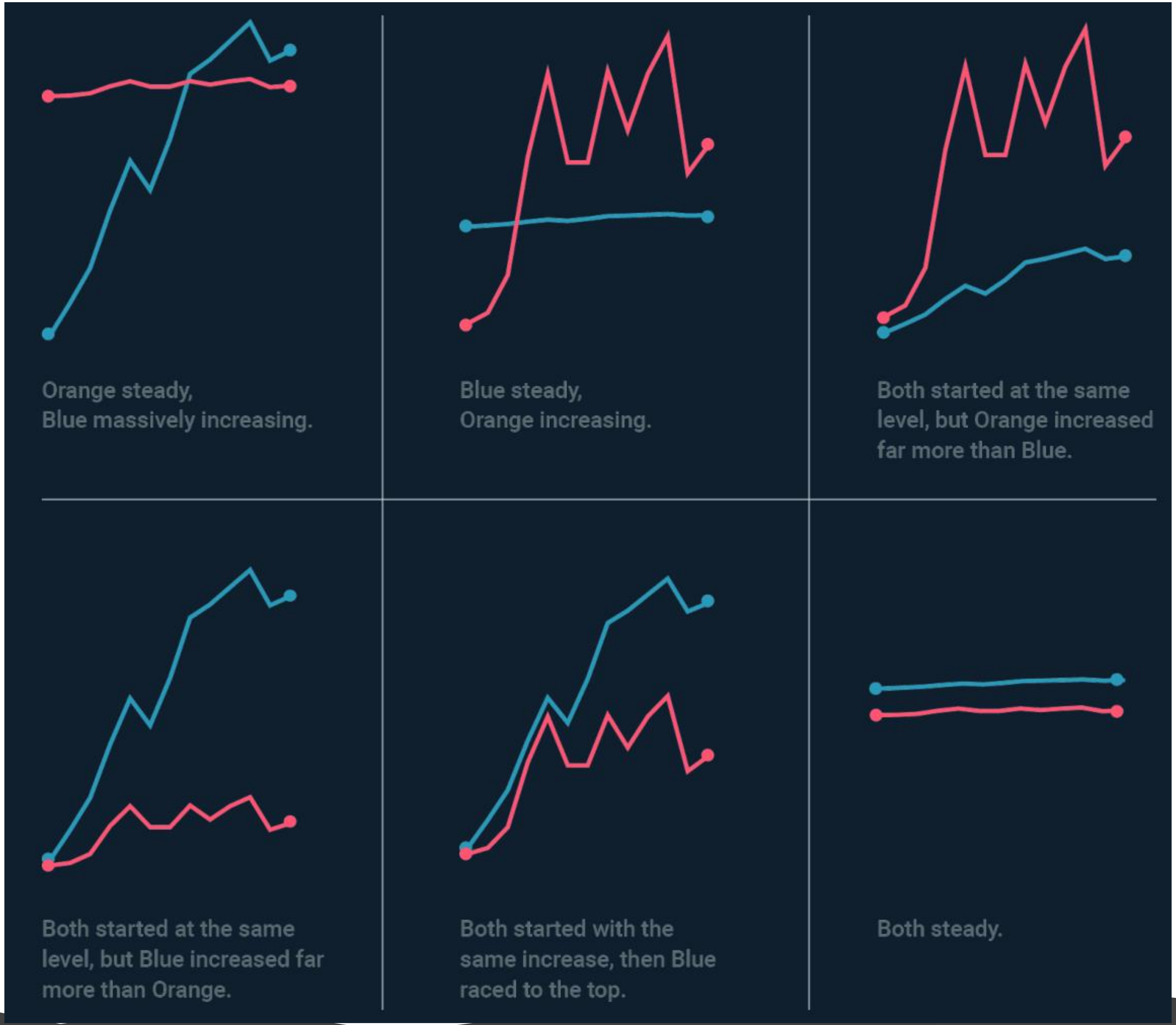
U.S. SmartPhone Marketshare



Dual Axis Charts

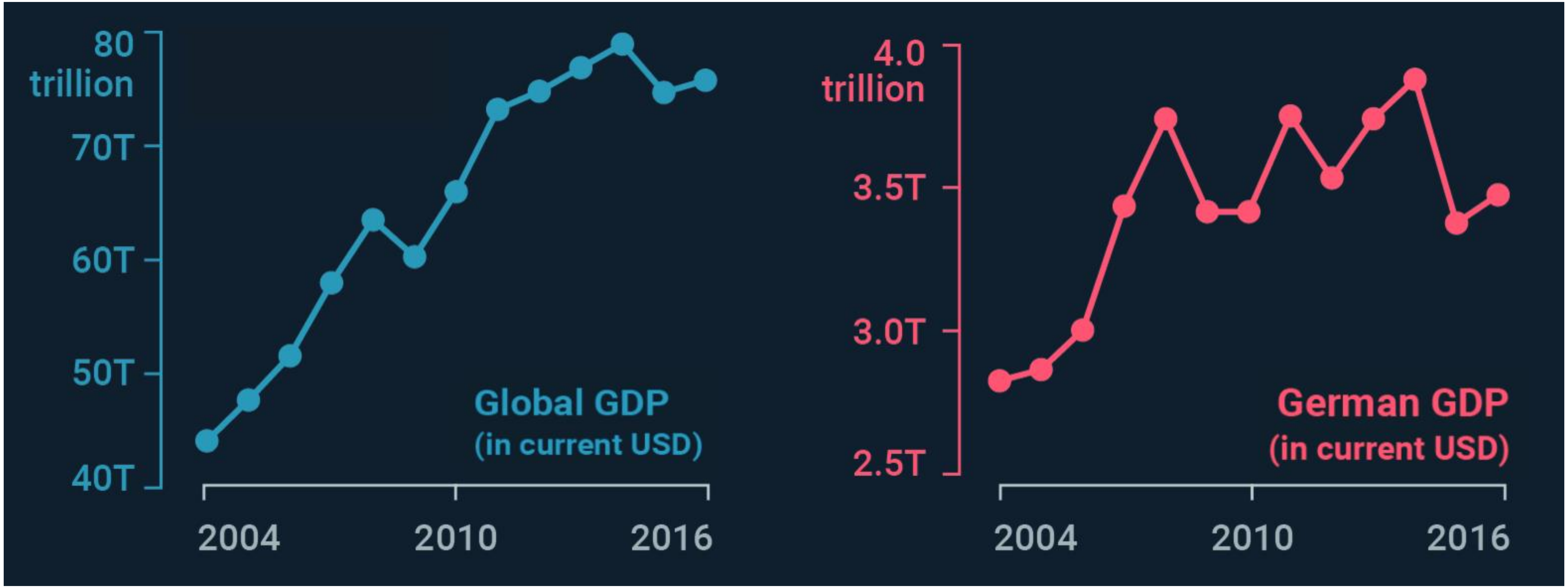


Dual Axis Charts



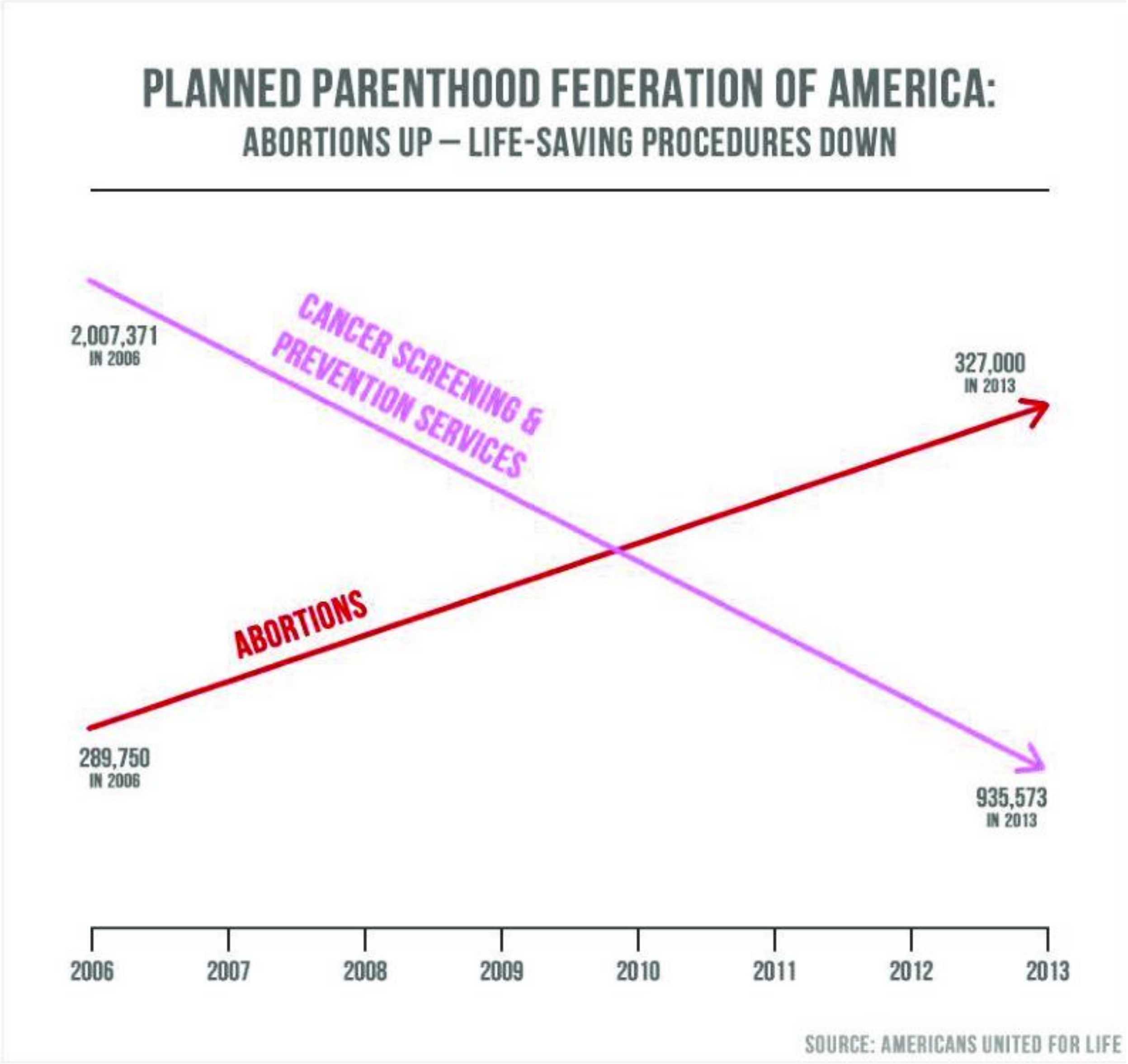
Lisa Charlotte Rost. DataWrapper, May ‘18

Dual Axis Charts



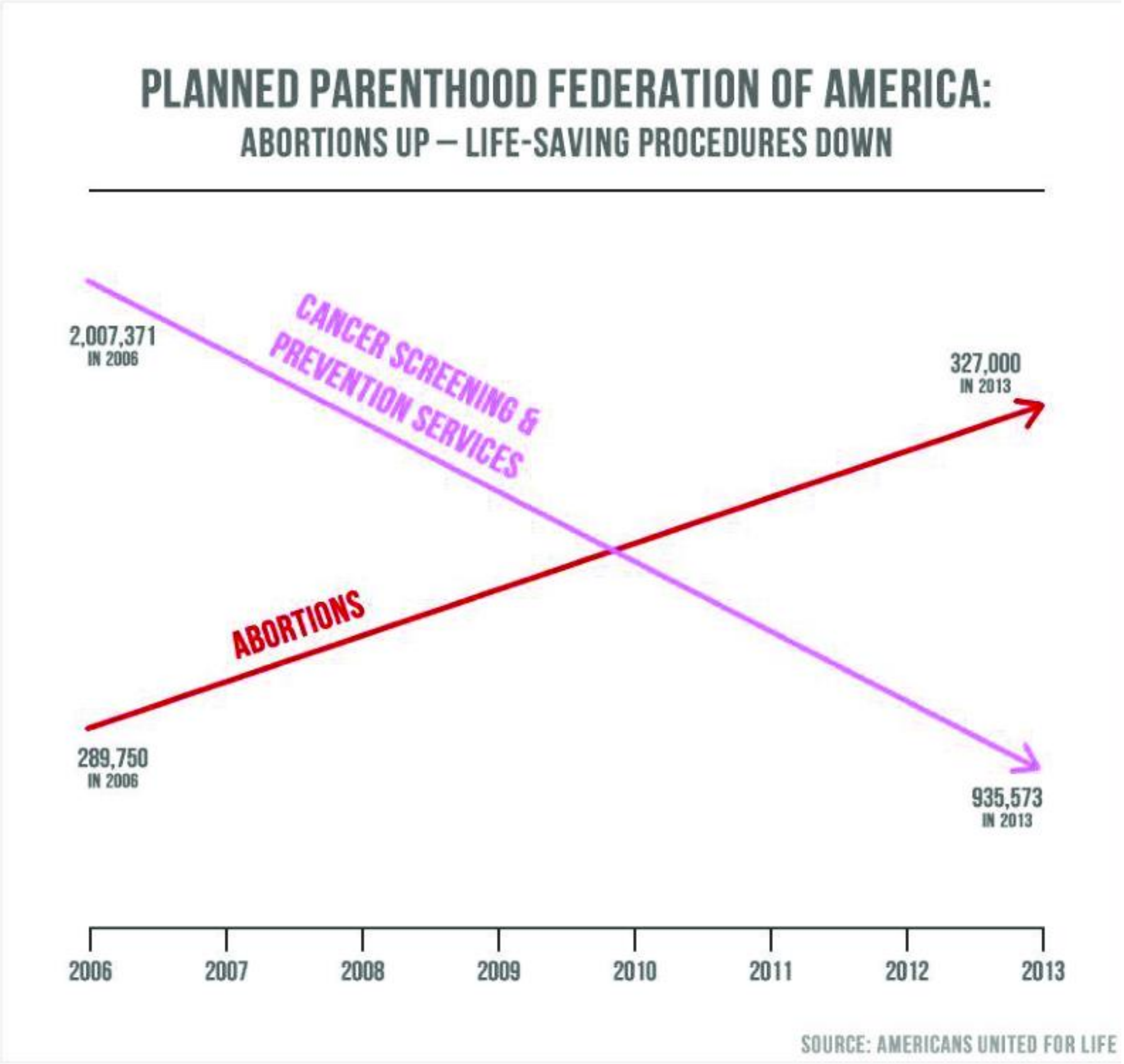
- Lisa Charlotte Rost. DataWrapper, May '18

Dual Axis Charts

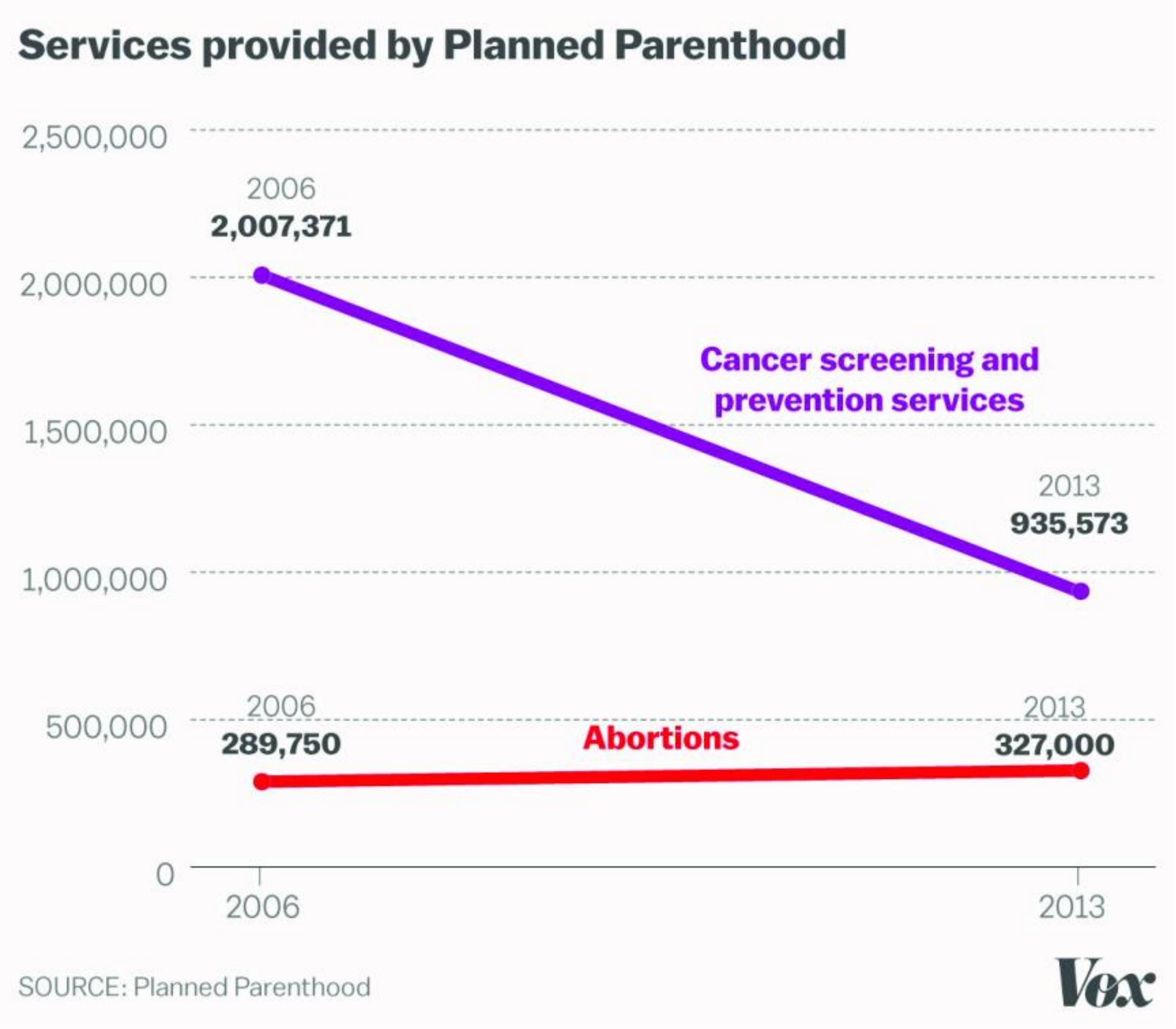


Presented by Rep. Jason Chaffetz. House Oversight Committee, Sept '15

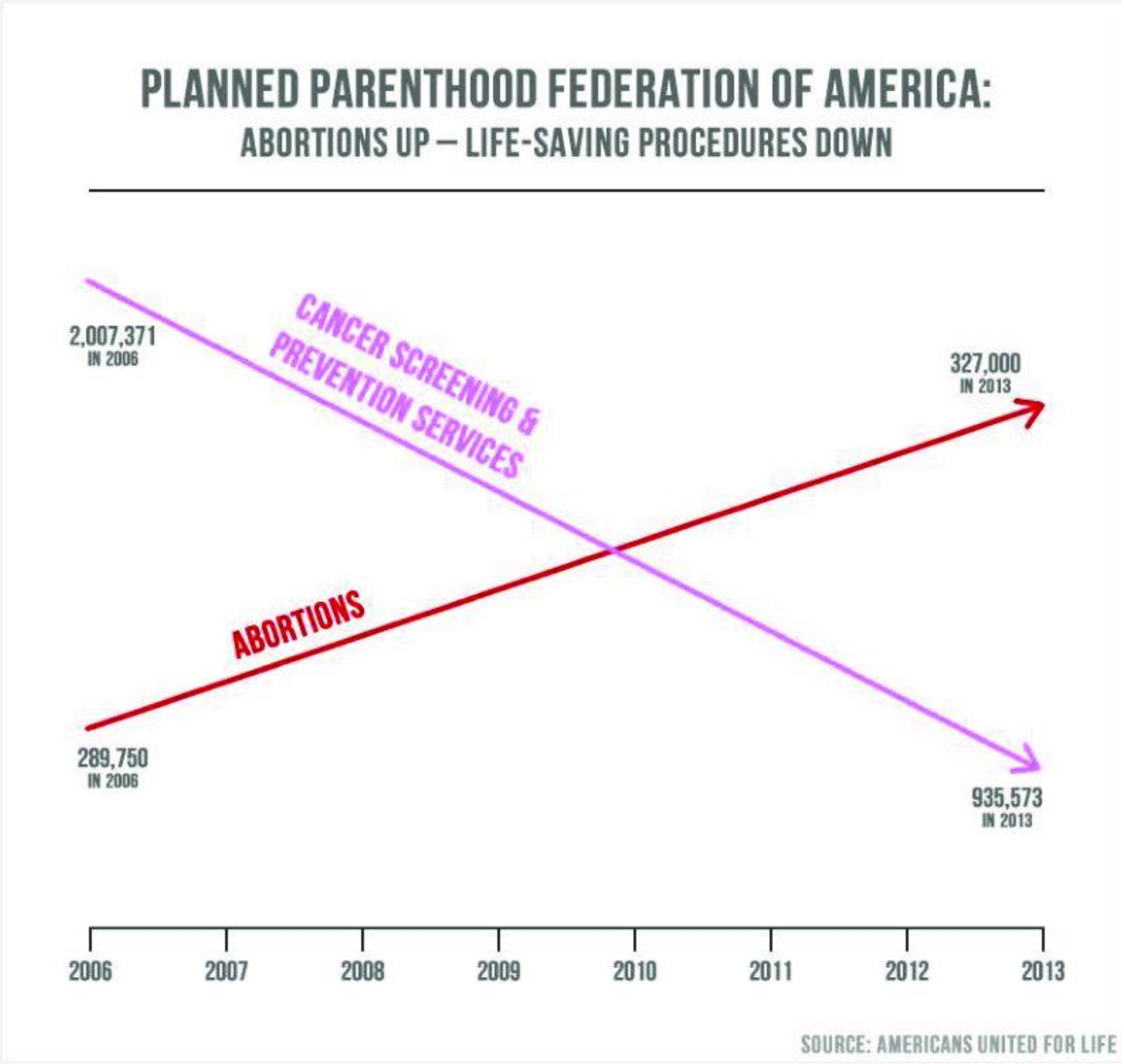
Dual Axis Charts



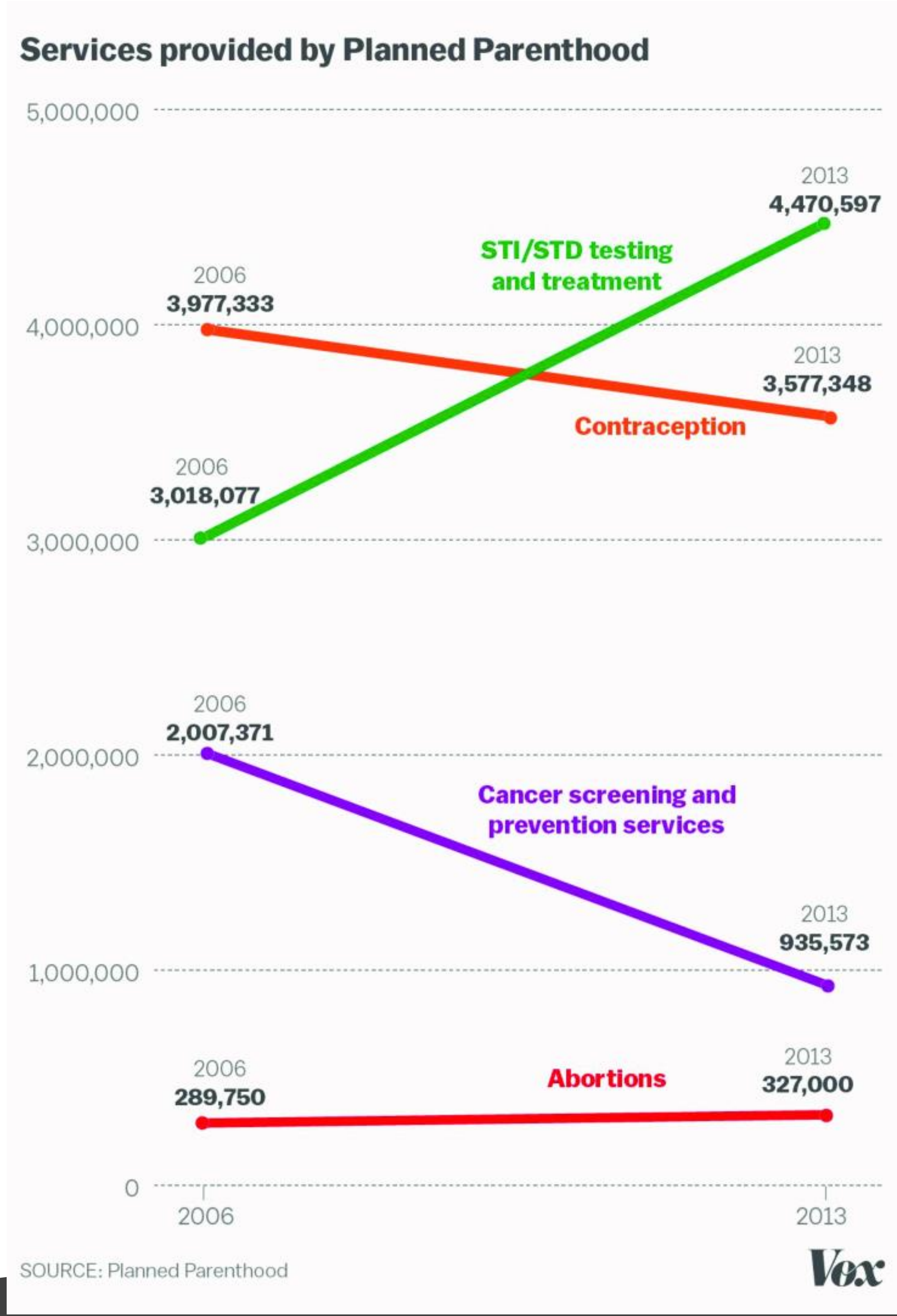
Presented by Rep. Jason Chaffetz. House Oversight Committee, Sept '15



Insufficient Context!



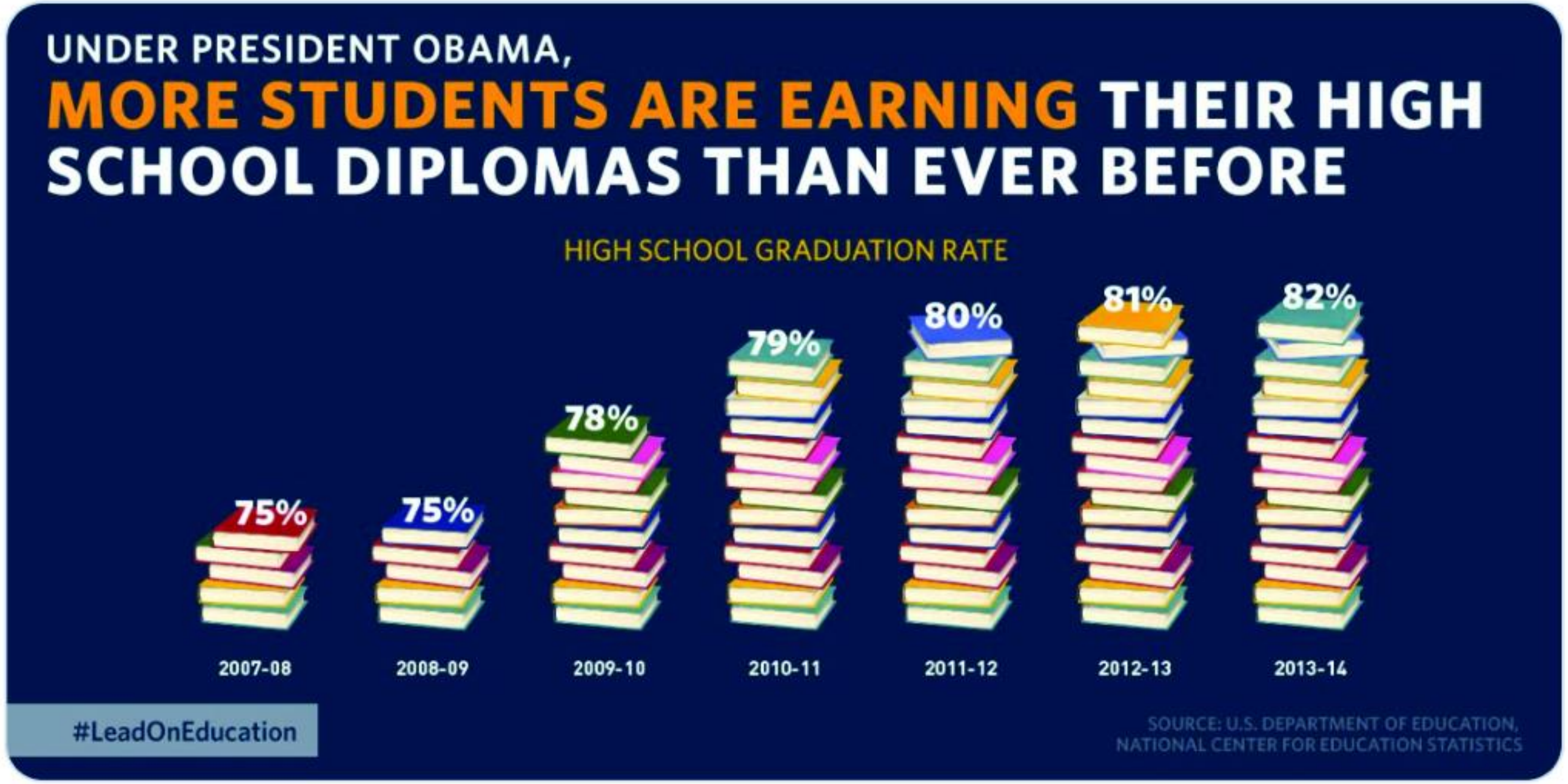
Presented by Rep. Jason Chaffetz. House Oversight Committee, Sept '15



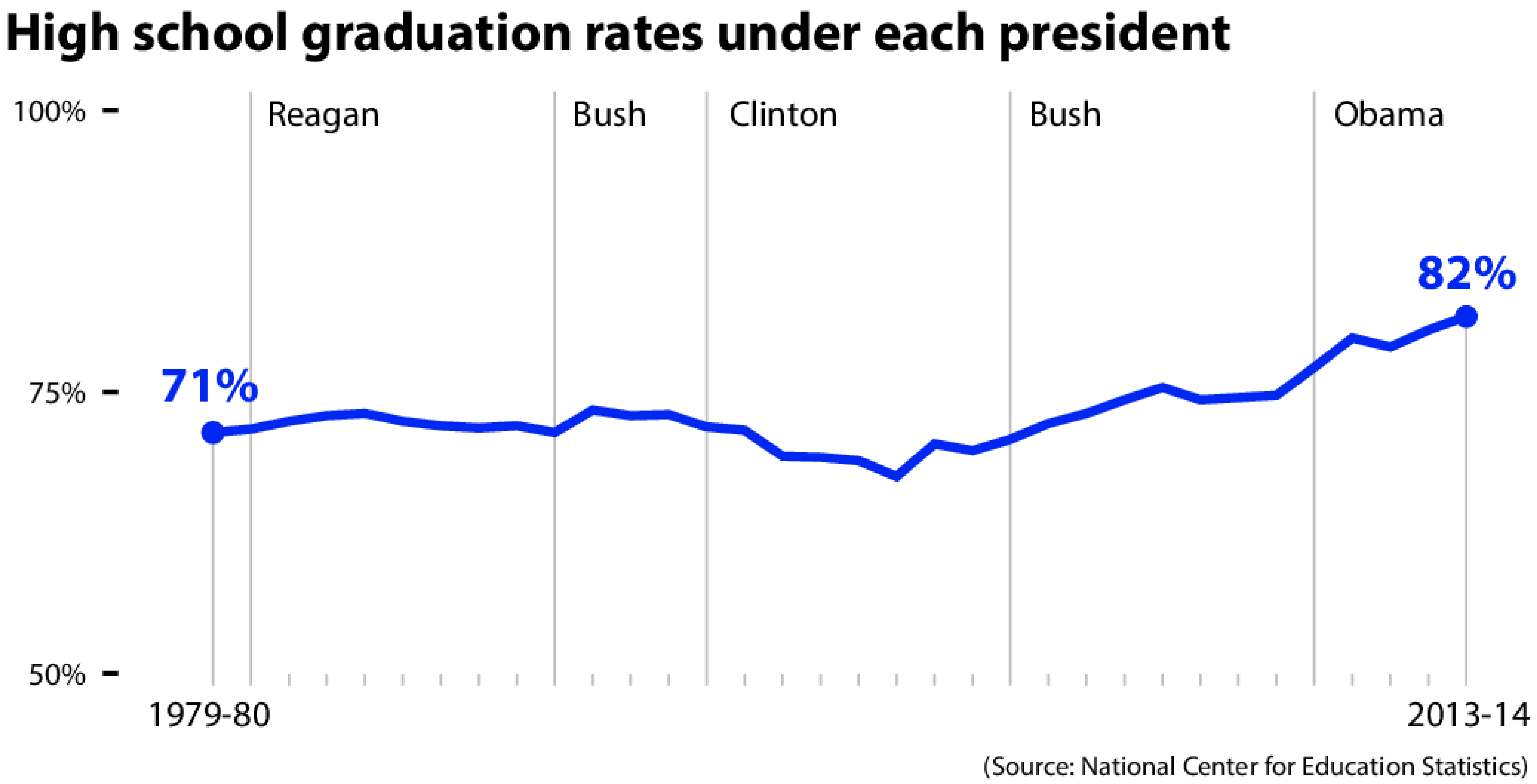
Insufficient Context

White House Archived
@ObamaWhiteHouse

Good news: America's high school graduation rate has increased to an all-time high. 🎓 wapo.st/1m40Mei



Insufficient Context



- Alberto Cairo, How Charts Lie, 2019

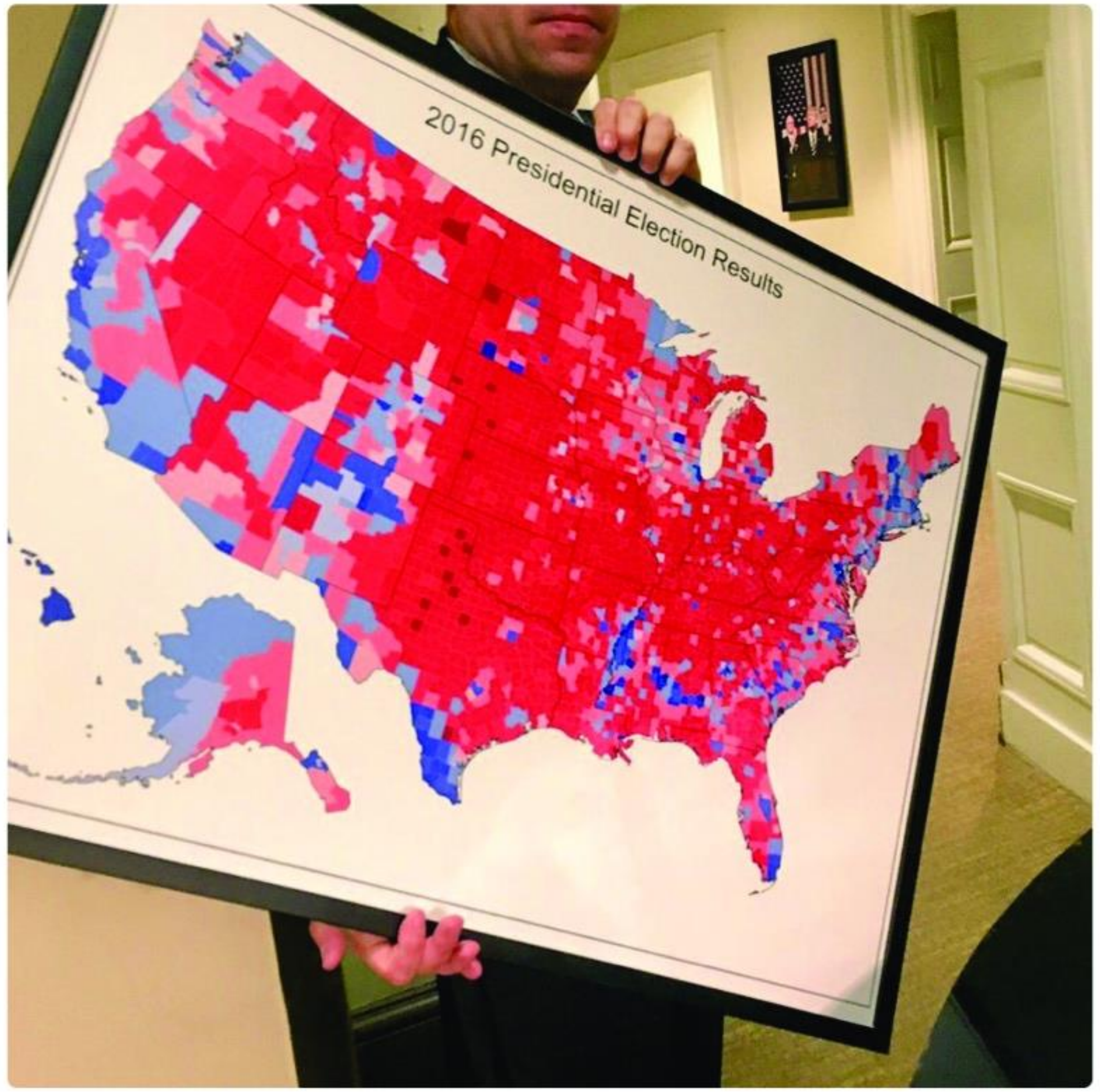
Insufficient Context

Donald J. Trump
@realDonaldTrump

236K 6:05 AM - Oct 1, 2019

Trey Yingst
@TreyYingst

Spotted: A map to be hung somewhere in the West Wing



8,013 9:03 AM - May 11, 2017

Insufficient Context