The Visual Display of Quantitative Information

Edward R. Tufte

Marvin A. Ruder

Heidelberg University

Seminar "How do I lie with statistics?"

The Book

The Visual Display of Quantitative Information, by Edward R. Tufte

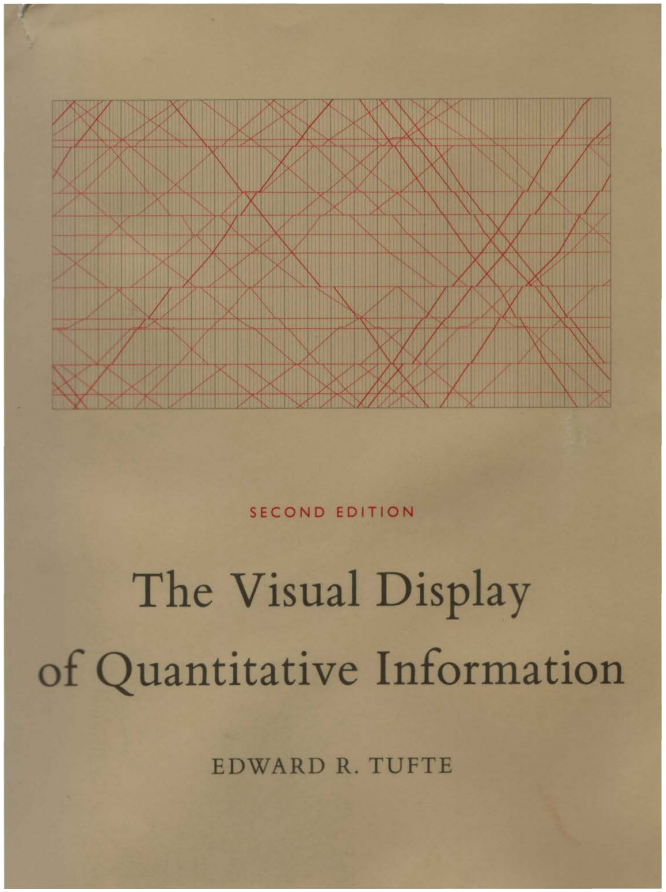

Figure: Tufte 2001, originally published in 1983.

1. Graphical Integrity
   - Distortion in Graphics
   - Design and Data Variation
   - The Case of Skyrocketing Government Spending
   - Visual Area and Numerical Measure
   - Context is Essential for Graphical Integrity
2. Sources of Graphical Integrity
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3. Literature

Graphical Integrity

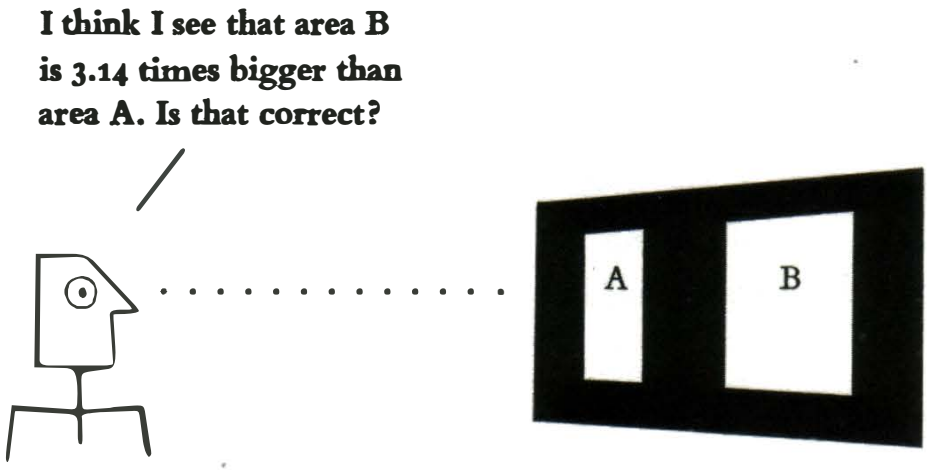
in·teg·ri·ty

the quality of being honest and having strong moral principles; moral uprightness: *he is known to be a man of integrity*.

Distortion in Graphics

- A graphic does distort if the visual representation of the data is not consistent with the numerical representation
- What is "visual representation"?
  - Physically measured surface of the graphic?
  - Perceived visual effect?

→ How do they relate?



Distortion in Graphics

- Experiments with large group of people help analyzing the "perceived visual effect"
- Experiments with the area of a circle lead to the power law: *reported perceived area* $= (\textit{actual area})^x, x = 0.8 \pm 0.3$
- Different people have very different perception

$\rightarrow$ What is a poor designer to do?

Distortion in Graphics

Principles on how to do it right?

Principles (Distortion in Graphics)

- The representation of numbers, as physically measured on the surface of the graphic itself, should be directly proportional to the numerical quantities represented.
- Clear, detailed, and thorough labeling should be used to defeat graphical distortion and ambiguity. Write out explanations of the data on the graphic itself. Label important events in the data.

Distortion in Graphics

The Lie Factor

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

- LF $= 1$: good job
- LF $\neq 1$: distortion
- most distortions involve overstating

Distortion in Graphics

The Lie Factor

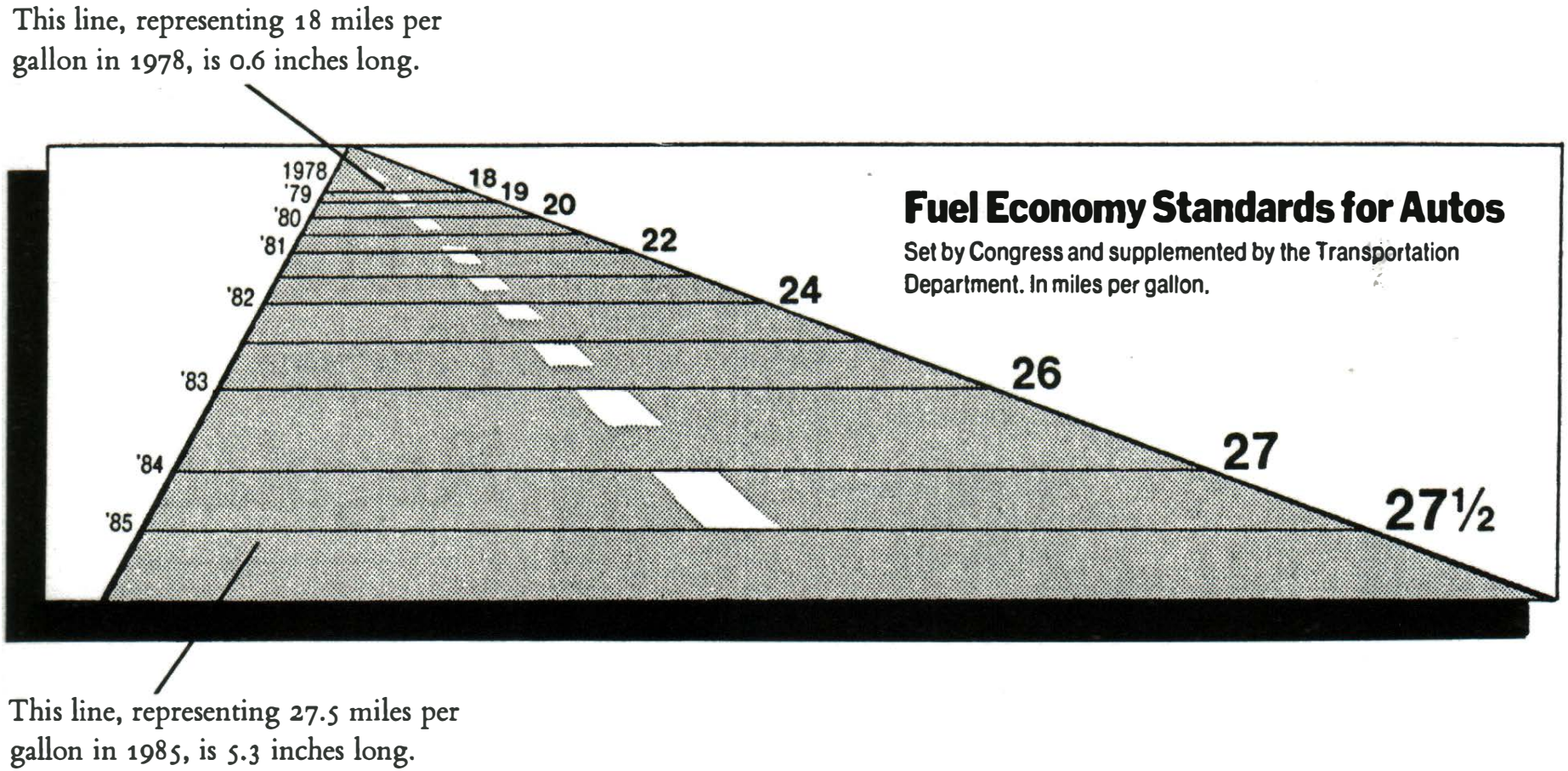


Figure: *New York Times*, August 9, 1978, p. D-2.

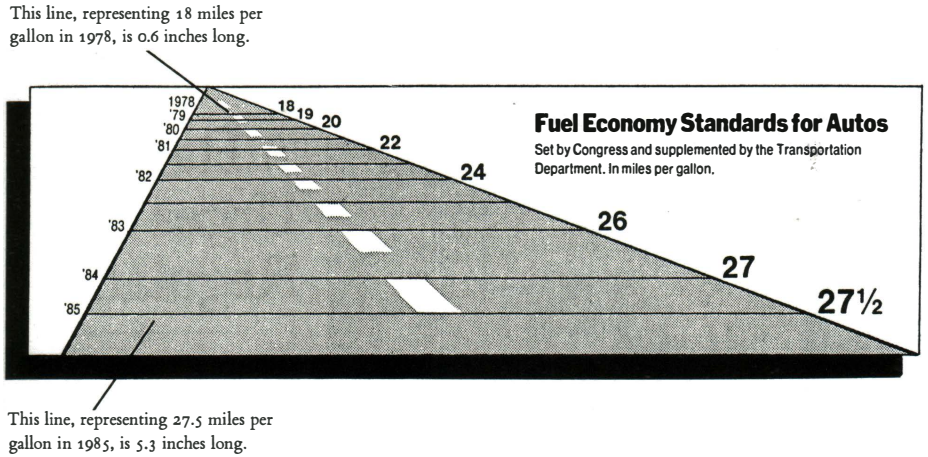


Figure: *New York Times*, August 9, 1978, p. D-2.

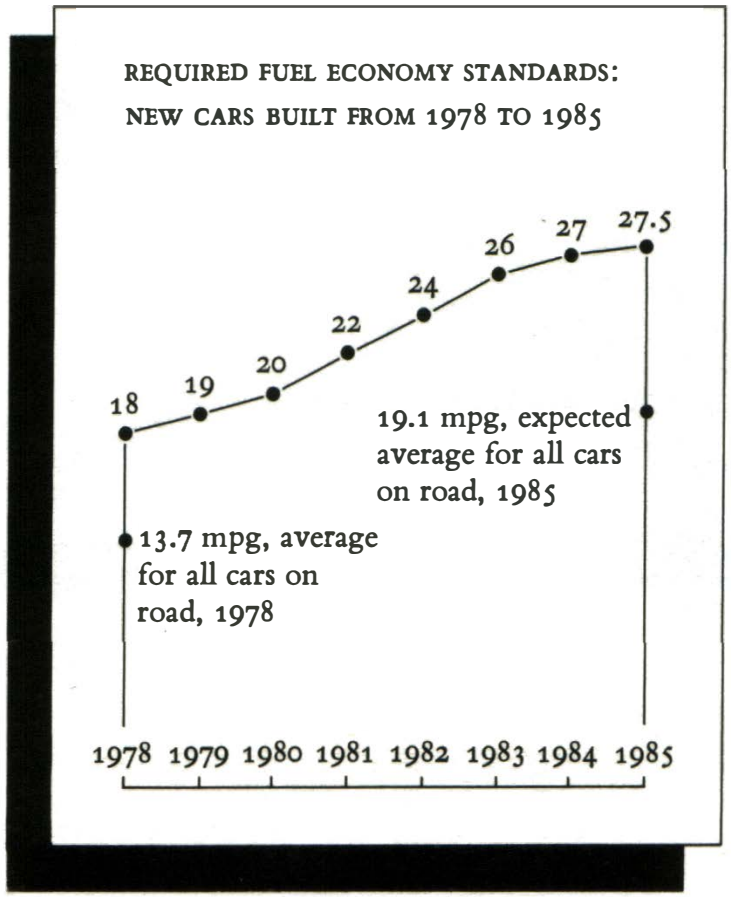
Reality: $\frac{27.5-18.0}{18.0} \times 100 = 53\%$

Graphic: $\frac{5.3-0.6}{0.6} \times 100 = 783\%$

$\rightarrow$ Lie Factor: $\frac{783}{53} = 14.8$

Distortion in Graphics

The Lie Factor



Design and Data Variation

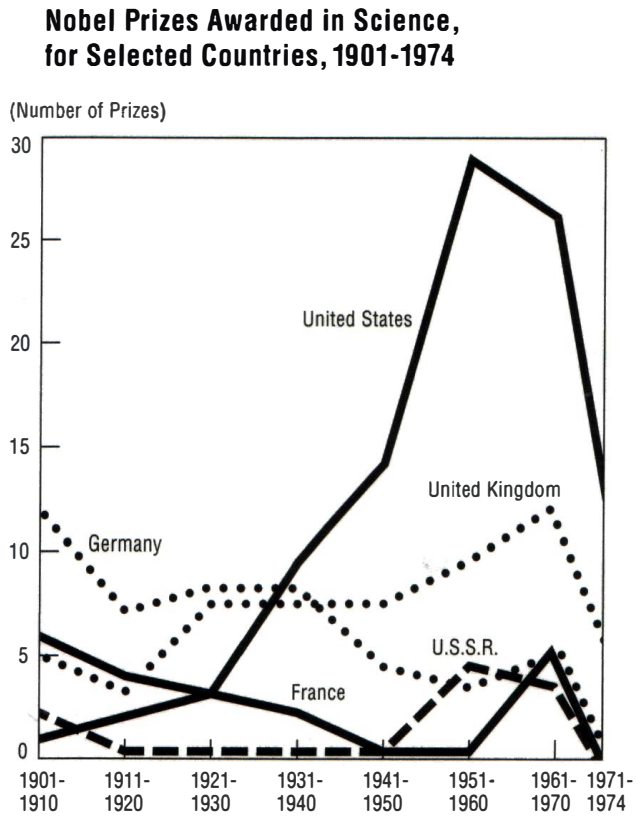


Figure: National Science Foundation, *Science Indicators, 1974* (Washington, D.C., 1976), p. 15.

Design and Data Variation

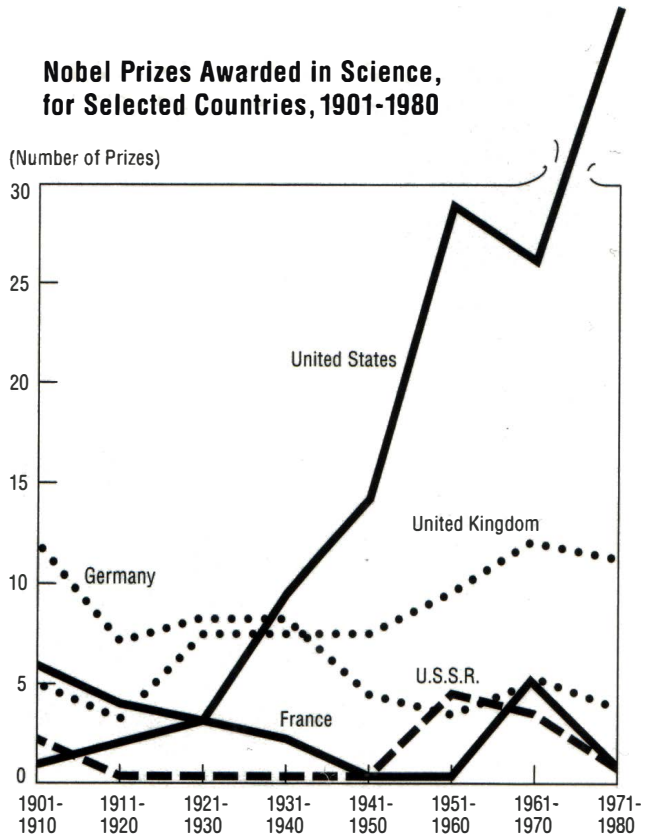


Figure: National Science Foundation, *Science Indicators, 1974* (Washington, D.C., 1976), p. 15, edited by Tufte.

Design and Data Variation

Principles on how to do it right?

Principle (Design and Data Variation)

- Show data variation, not design variation.

Design and Data Variation

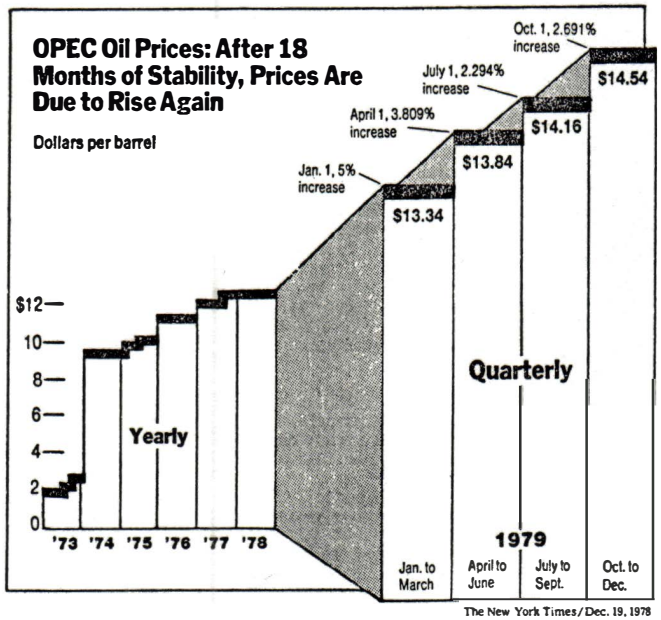


Figure: *New York Times*, December 19, 1978, p. D-7.

Five different vertical scales show the price:

During this time	one vertical inch equals
1973–1978	$8.00
January–March 1979	$4.73
April–June 1979	$4.37
July–September 1979	$4.16
October–December 1979	$3.92

And two different horizontal scales show the passage of time:

During this time	one horizontal inch equals
1973–1978	3.8 years
1979	0.57 years

Design and Data Variation

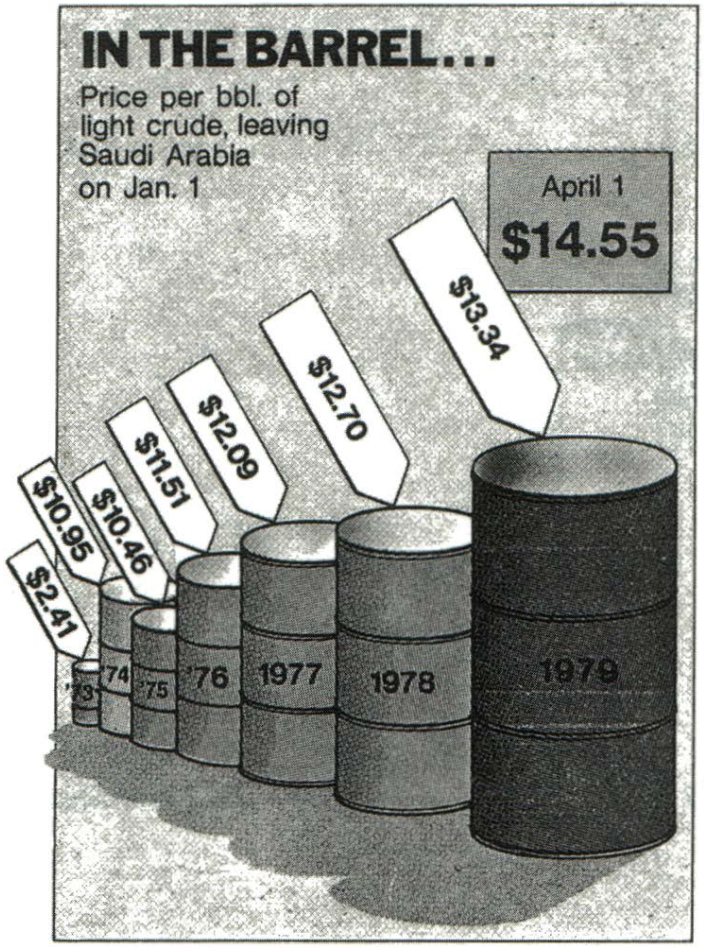


Figure: *Time*, April 9, 1979, p. 57.

Design and Data Variation

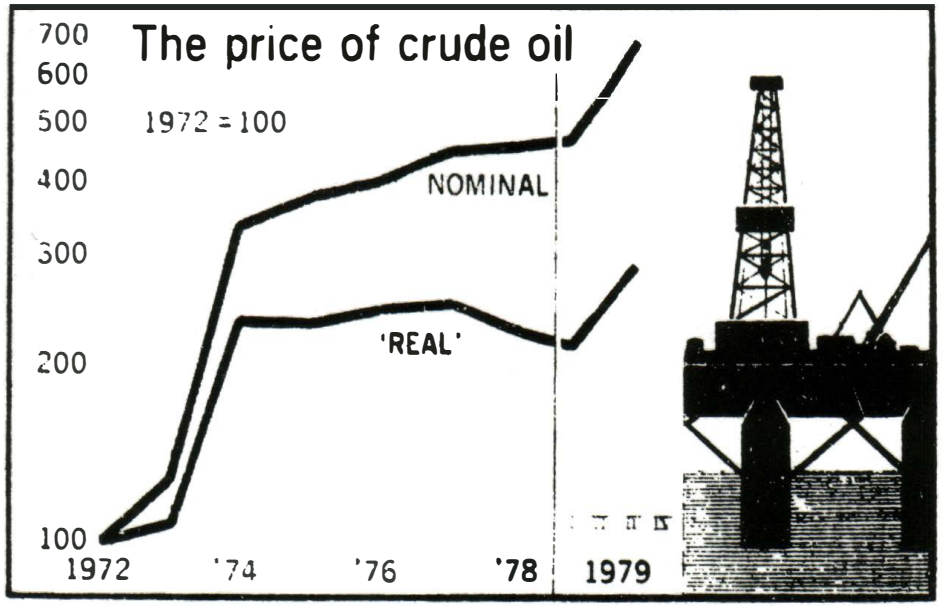


Figure: *Sunday Times* (London), December 16, 1979. p. 54.

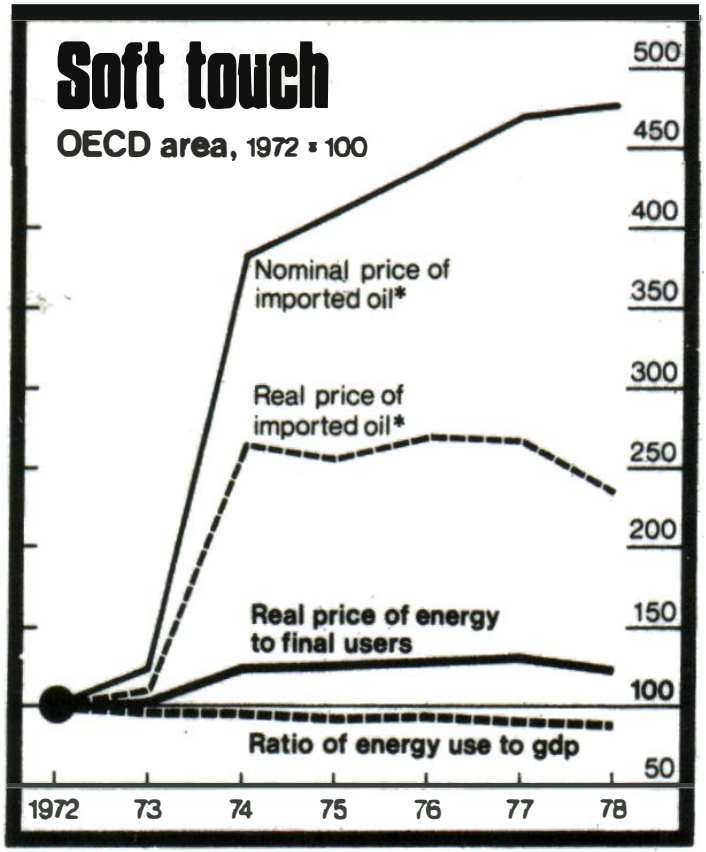
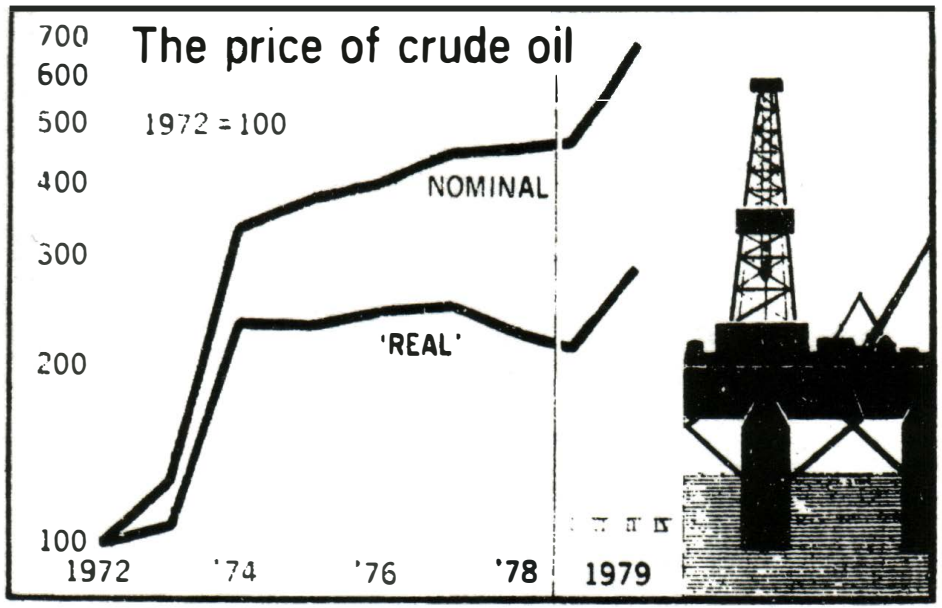


Figure: *The Economist*, December 29, 1979, p. 41.

Design and Data Variation



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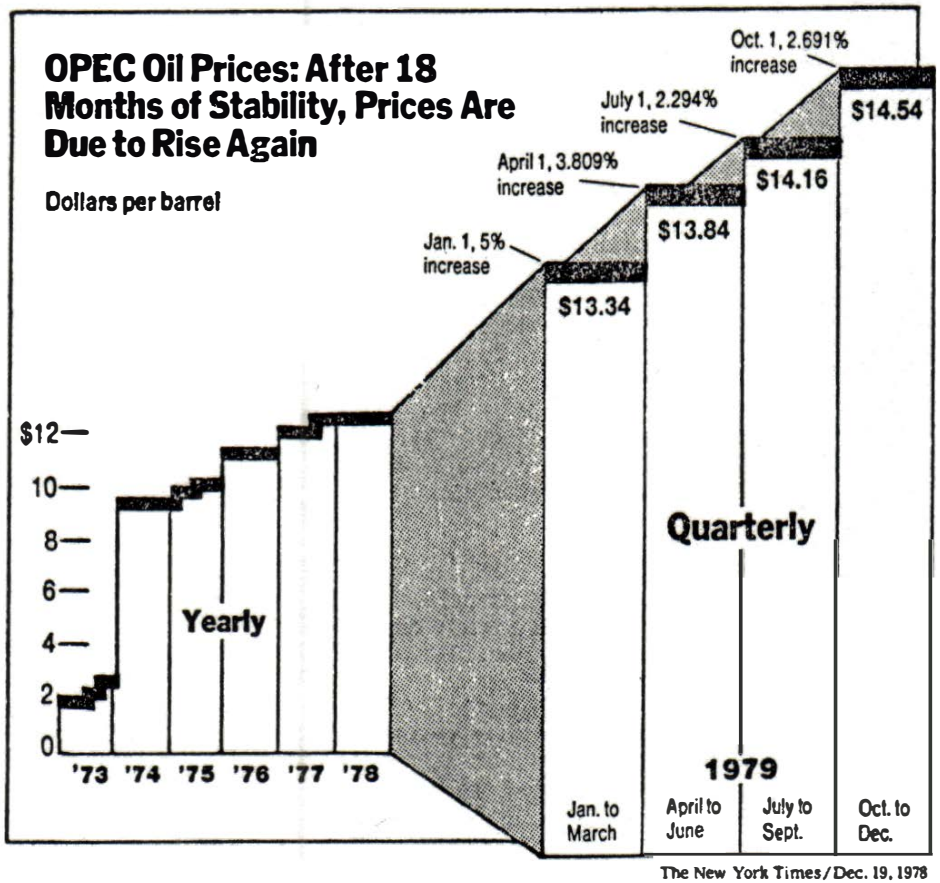

Figure: *New York Times*, December 19, 1978, p. D-7.

The Case of Skyrocketing Government Spending

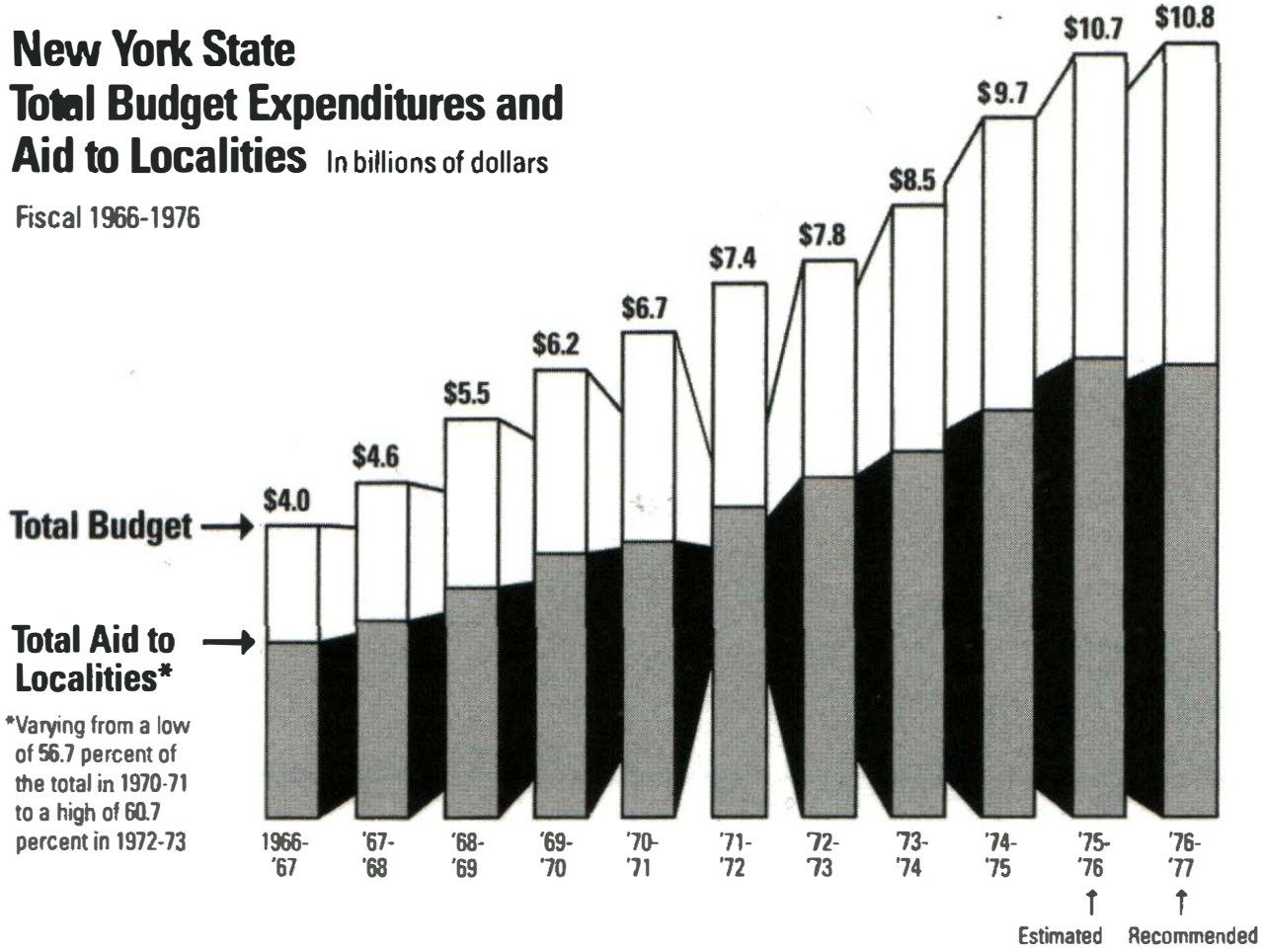

Figure: *New York Times*, February 1, 1976, p. iv-6.

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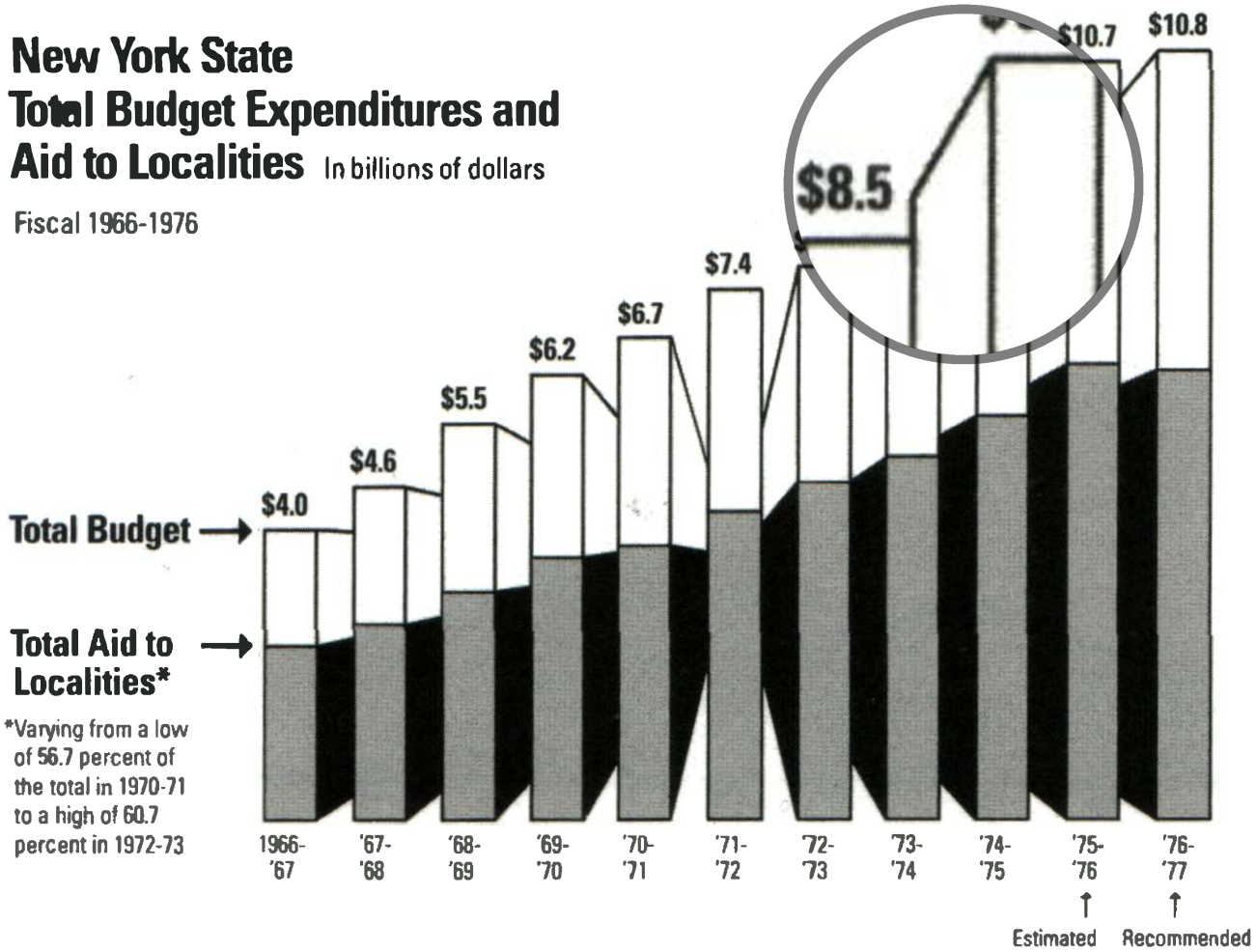
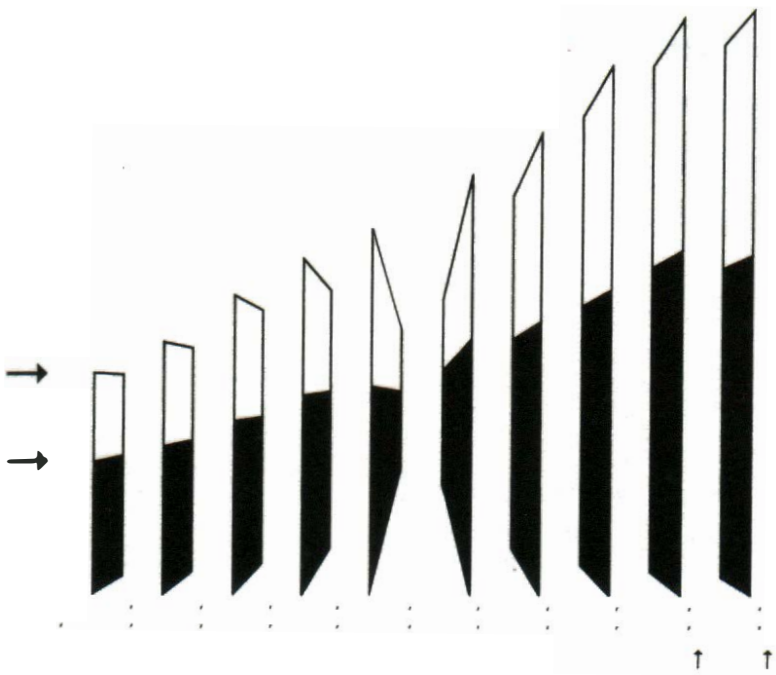


Figure: *New York Times*, February 1, 1976, p. iv-6, edited.

The Case of Skyrocketing Government Spending



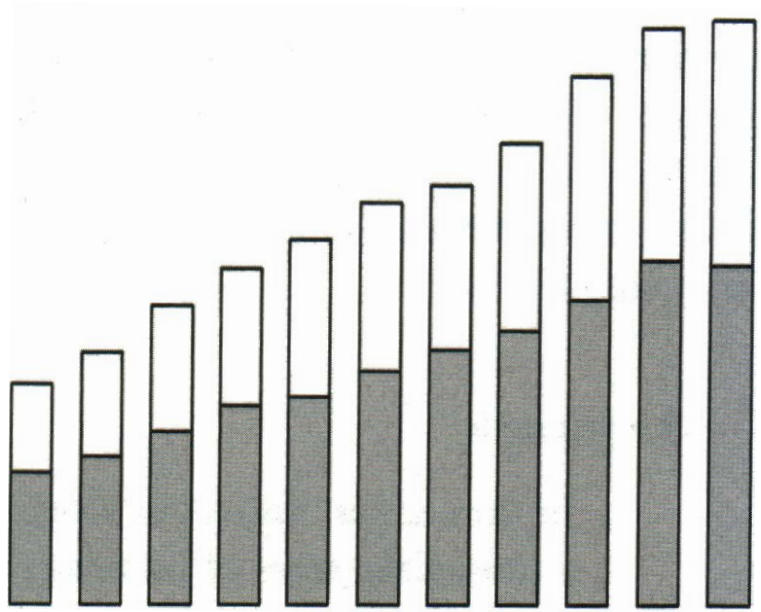
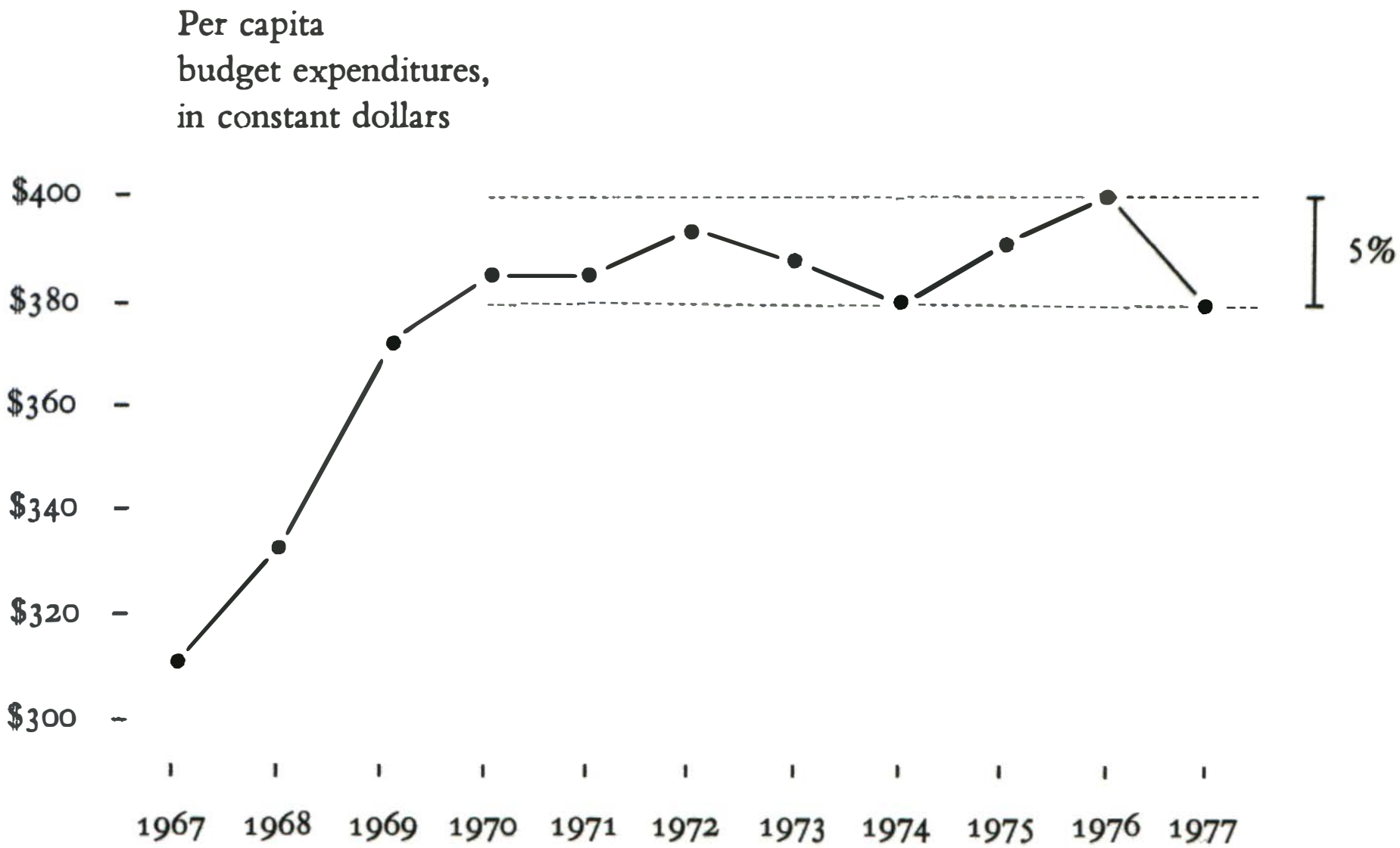


Figure: *New York Times*, February 1, 1976, p. iv-6, edited by Tufte.

The Case of Skyrocketing Government Spending



The Case of Skyrocketing Government Spending

Principles on how to do it right?

Principle (The Case of Skyrocketing Government Spending)

- In time-series displays of money, deflated and standardized units of monetary measurement are nearly always better than nominal units.

Visual Area and Numerical Measure

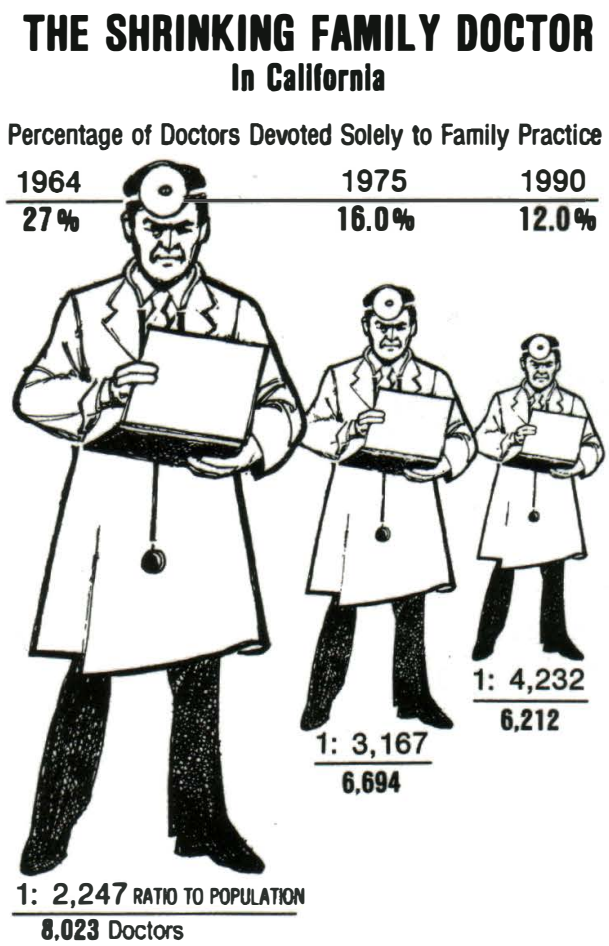


Figure: *Los Angeles Times*, Augusts. 1979, p. 3.

Visual Area and Numerical Measure

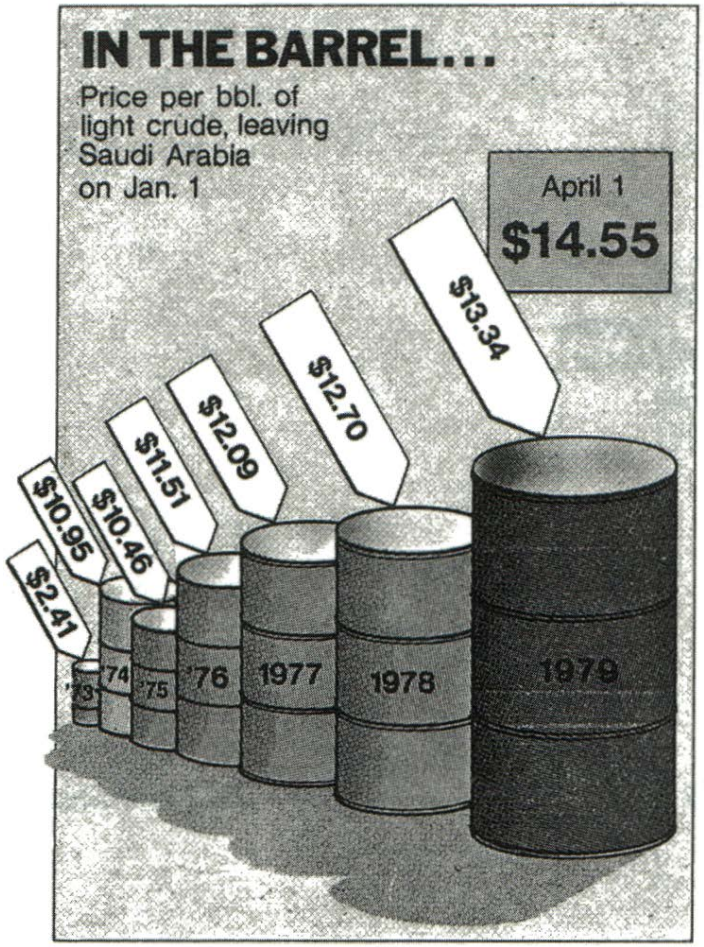


Figure: *Time*, April 9, 1979, p. 57.

Visual Area and Numerical Measure

Principles on how to do it right?

Principle (Visual Area and Numerical Measure)

- The number of information-carrying (variable) dimensions depicted should not exceed the number of dimensions in the data.

Visual Area and Numerical Measure

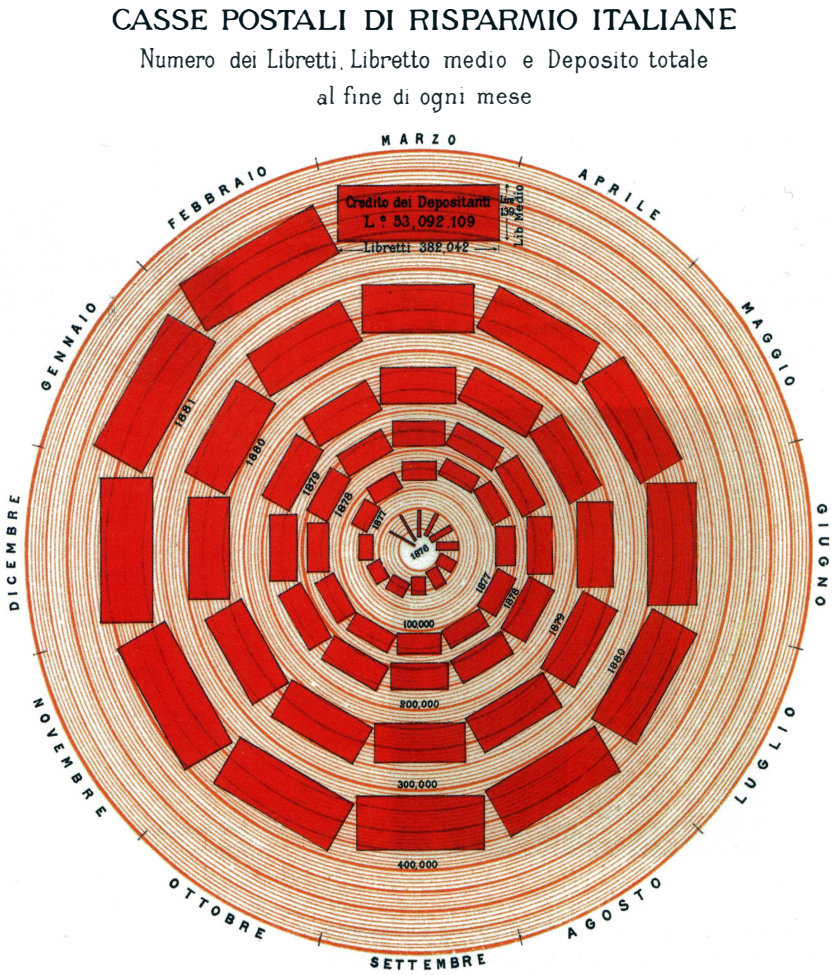
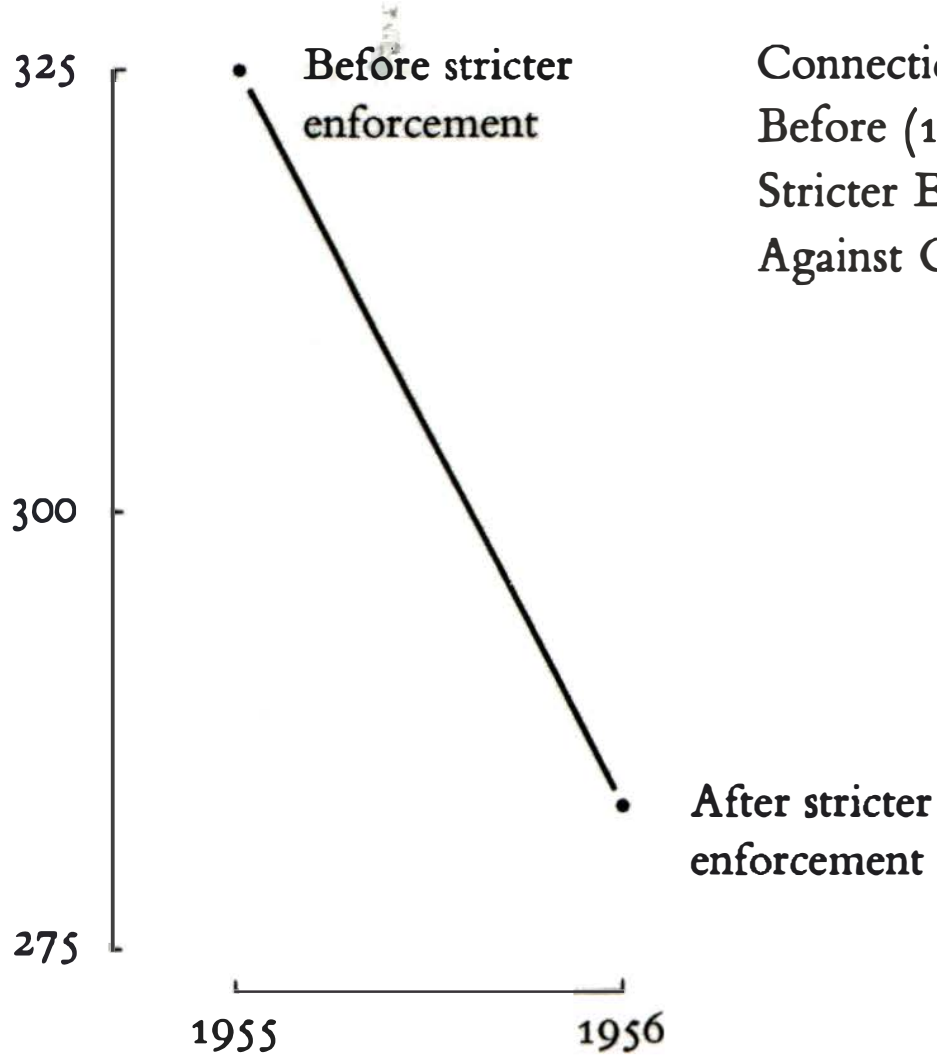


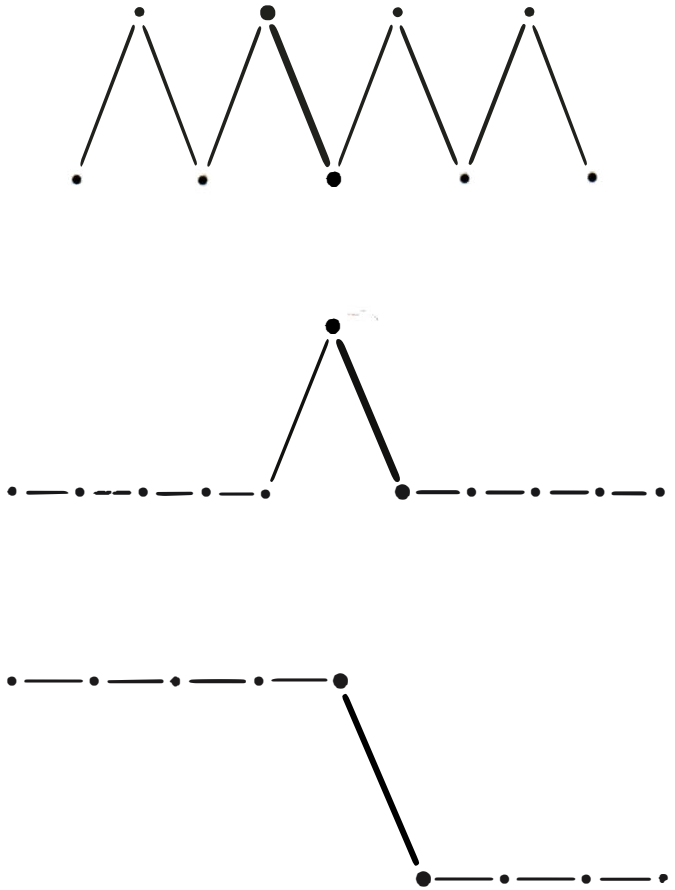
Figure: Antonio Gabaglio, *Teoria Generale della Statistica* (Milan, second edition, 1888).

Context is Essential for Graphical Integrity



Connecticut Traffic Deaths,
Before (1955) and After (1956)
Stricter Enforcement by the Police
Against Cars Exceeding Speed limit

Context is Essential for Graphical Integrity



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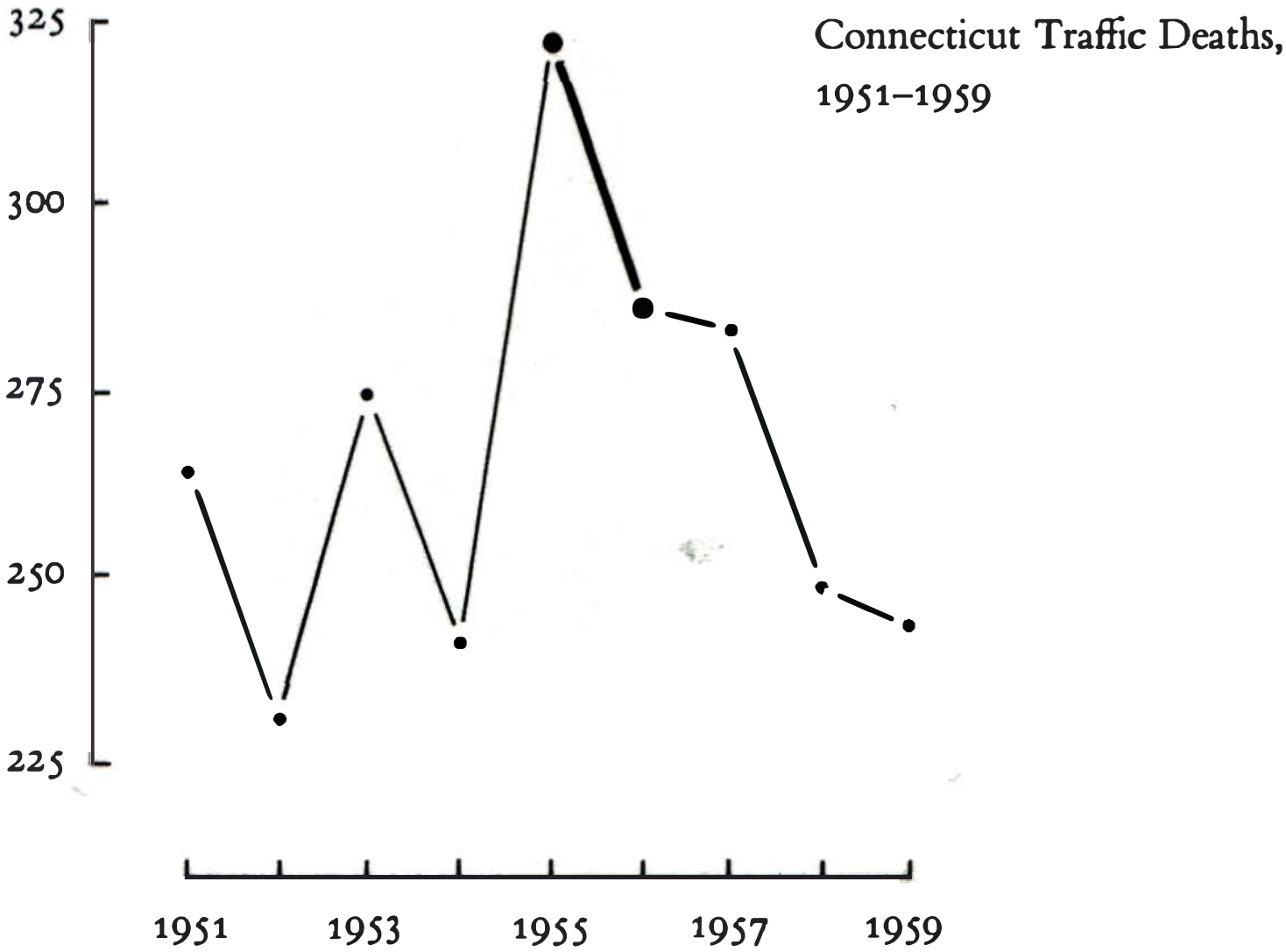

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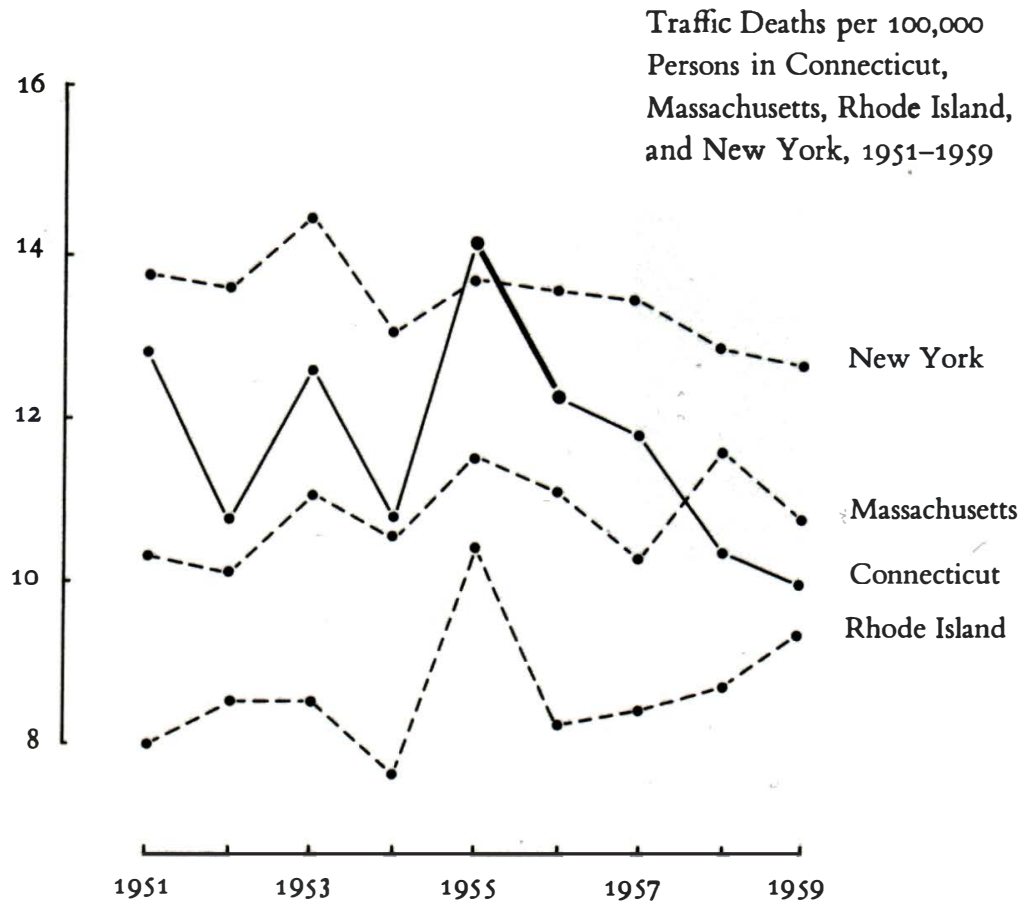

Figure: Donald T. Campbell and H. Laurence Ross, "The Connecticut Crackdown on Speeding: Time Series Data in Quasi-Experimental Analysis," in Edward R. Tufte, ed., *The Quantitative Analysis of Social Problems* (Reading, Mass., 1970), 110-125.

Context is Essential for Graphical Integrity

Principles on how to do it right?

Principle (Context is Essential for Graphical Integrity)

- Graphics must not quote data out of context.

Sources of Graphical Integrity

Why do artists draw graphics that lie? Why do the world's major newspapers and magazines publish them?

- Lack of Quantitative Skills of Professional Artists
- The Doctrine That Statistical Data Are Boring
- The Doctrine That Graphics Are Only for the Unsophisticated Reader

Sources of Graphical Integrity

Principles on how to do it right?

Conclusion (Sources of Graphical Integrity)

Graphical competence demands three quite different skills: the substantive, statistical, and artistic. Yet now most graphical work, particularly at news publications, is under the direction of but a single expertise – the artistic. Substantive and quantitative expertise must also participate in the design of data graphics, at least if statistical integrity and graphical sophistication are to be achieved.

Literature

Tufte, Edward Rolf (2001). *The Visual Display of Quantitative Information*. 2nd ed. Cheshire, Conneticut, U.S.A.: Graphics Press. Chap. 2–3, pp. 53–87. 197 pp. ISBN: 978-0-9613921-4-7. (Visited on 10/21/2019).

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