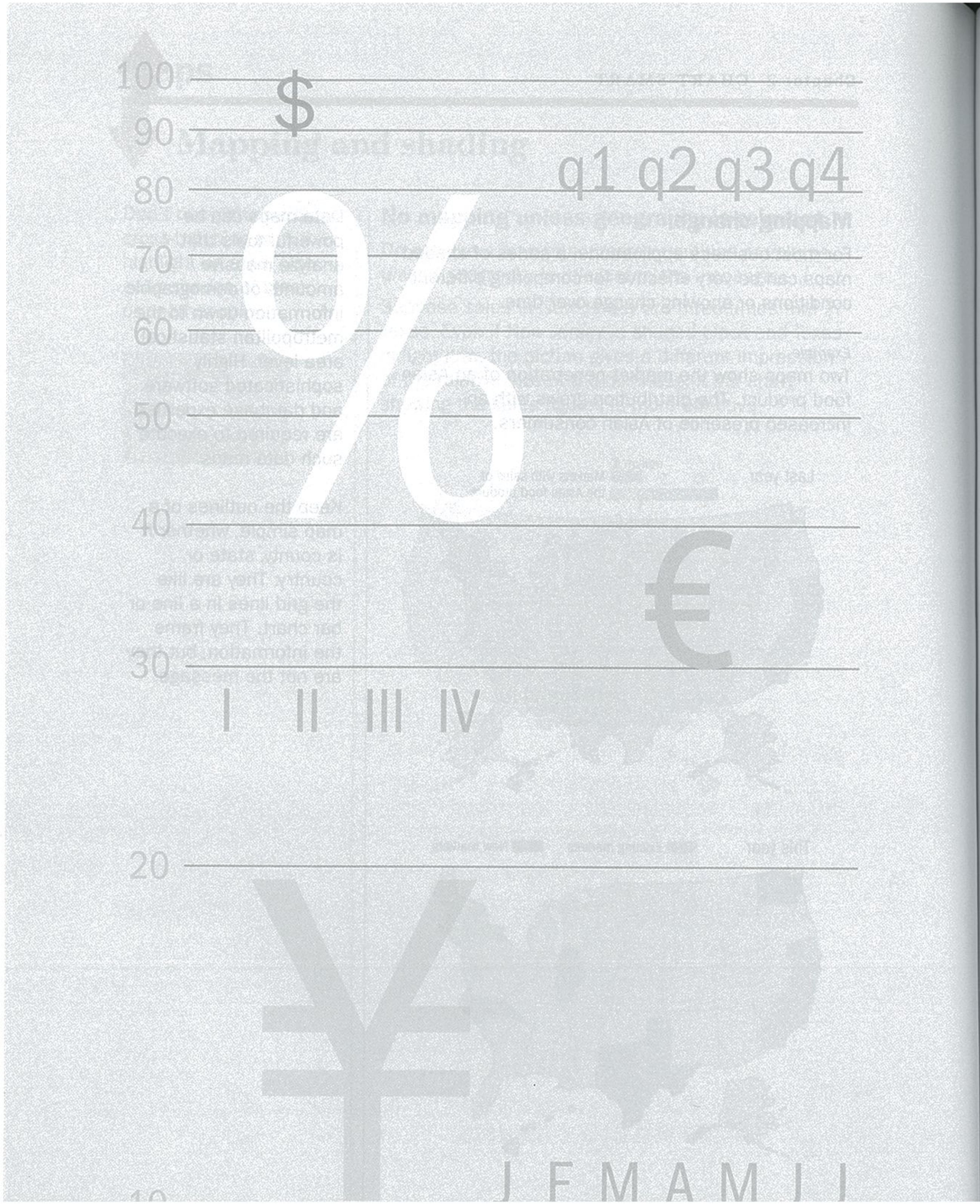


CHAPTER 3

Ready Reference

Most of the math we use in charting is fundamental algebra and statistics. Yet most of us continue to make simple mistakes. Should we ever take an average of two percentages? How do we calculate percentage change: the new number minus the old number divided by the new number? Or divided by the old number? What is a log scale?

In addition to basic math skills, we also need knowledge of the market — the more, the better. What are the major stock indexes? How do we chart currency fluctuations that affect our global business?

These are all formulas and facts that save you time when you need to deliver quality work on a tight deadline. You will find them all here at your fingertips in this chapter.

Mean, median, mode

Which one to use?

The mean (average) is most useful when measuring the total impact of the complete data set since all the values are used to compute it. If the extreme outliers are not relevant, the mean may not be representative.

The median is useful for ranking outcomes. It is not influenced by outliers at the extremes of the data set. For instance, the median is a good representation for data on home prices and income level.

The mode helps focus on the typical outcome. It gives the value that users are most likely to see.

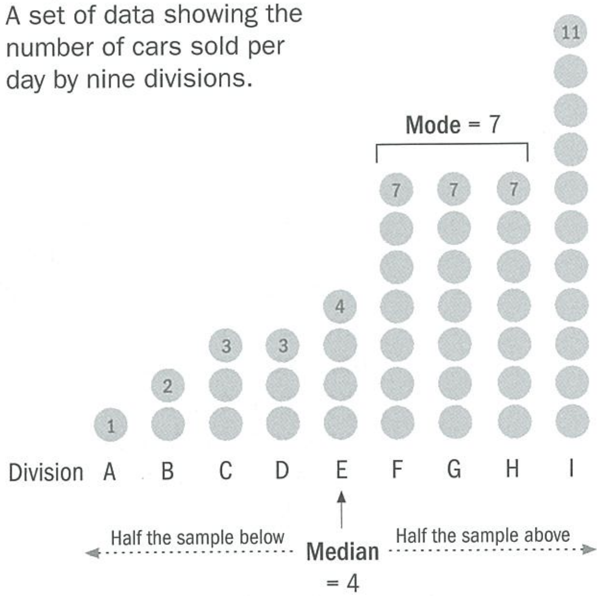
The **mean** is the simple average. It is the sum of all the values divided by the number of data points.

The **median** is the middle value in a distribution of data. Half of the sample is below that value and half is above. To find the median, the data has to be listed in numerical order. If the number of data points is an even number, the median is the average of the two middle values.

The **mode** is the value that occurs most often.

Example

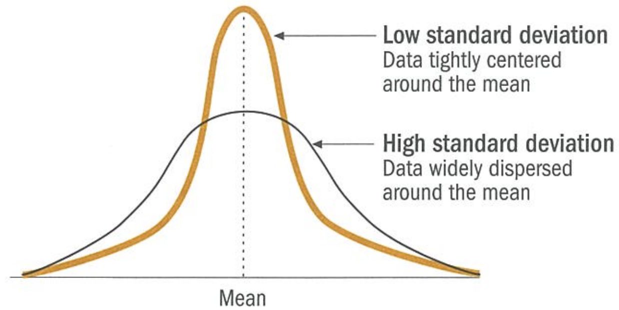
A set of data showing the number of cars sold per day by nine divisions.



$$\text{Mean} = \frac{1+2+3+3+4+7+7+7+11}{9} = 5$$

Standard deviation

Standard deviation shows how tightly the data is dispersed around the mean. A highly volatile stock has a high standard deviation.



$$\text{Standard deviation} = \sqrt{\frac{\text{sum}\,(x-\bar{x})^2}{n}}$$

x = each data point
$\bar{x}$ = mean
n = number of data points

Example

One common business application for standard deviation is to represent the volatility of a series, based on percentage changes in prices.

Percent change in price	$x-\bar{x}$	$(x-\bar{x})^2$
3%	-5	25
1	-7	49
9	1	1
19	11	121
mean 8		*sum* 196

$$\text{Standard deviation} = \sqrt{\frac{196}{4}} = 7\%$$

The volatility is 7%.

For the quants:

Volatility is usually quoted on an annualized basis.

To calculate annualized volatility:

$$\text{Daily standard deviation} \times \sqrt{\text{Number of trading days in a year}}$$

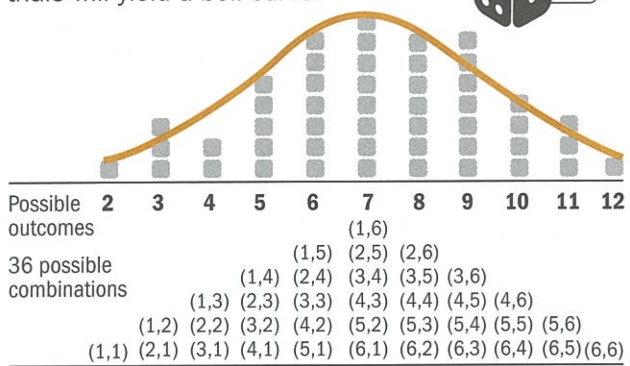
Probability

Probability can be interpreted as the relative number of occurrences. While one cannot predict with certainty the result of any one trial, the collective outcomes of a large number of trials can display some recurring patterns. Probability theory is widely used in many areas from actuarial estimates of mortality risk to clinical trials of new drugs.

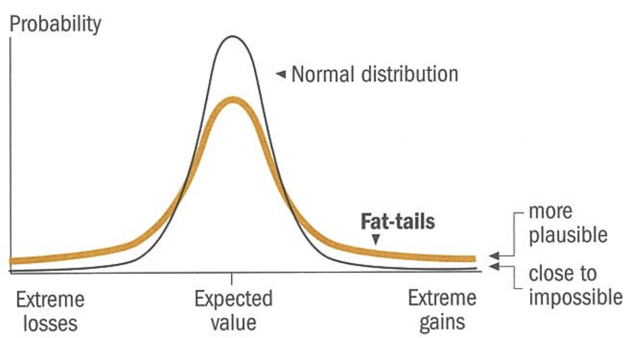
Symmetric probability distributions

Symmetric distributions arise in many circumstances. For instance, test scores often fall along a bell-shaped curve.

Example. Toss 2 dice and plot the outcome. Enough trials will yield a bell curve:



Fat-tails (kurtosis) indicate that extreme gains or losses are more frequent than the normal bell curve distribution might predict. The normal distribution is often used but it can significantly understate the risk of extreme events, for instance, the 1987 stock market crash.

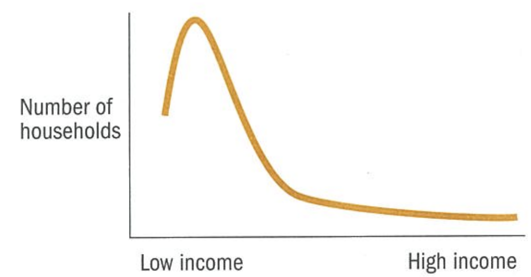


Skewed probability distributions

Skewed distributions occur in many practical applications, such as the distribution of income and credit default losses.

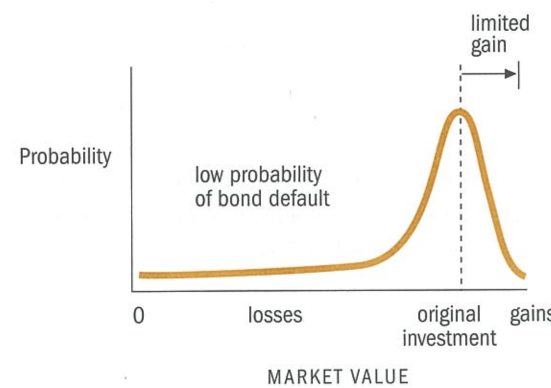
Uneven distribution of income

Personal income is one of the most studied and debated skewed distribution charts. It is used in socioeconomic studies that relate to inequality, poverty levels and economic growth.



Small chance of a large loss

Bonds are unlikely to default, but there is a small chance of losing principal during the holding period.



Psychology of risk

The risk taker believes in the one-in-a-million chance of winning the lottery. The risk averse person worries about the slim chance of getting hit by lightning.

They both are motivated by outlier scenarios. They "live" in the tails of the distribution.

Average vs. weighted average

The Dow Jones Industrial Average is a price-weighted index. The index is therefore affected by the changes in the components' stock prices.

Weighted averages can improve upon simple averages by making the significant data points count for more. Be sure to use judgment in assigning importance. For instance, weights can be based on length of time, volume or monetary value. Weights need not be linear.

Example

The simple average of stock prices may include unrepresentative data from thin trading periods. Weighting the average based on volume corrects this bias.

	Share prices	Trading volume	Price x Volume
	$22	700 shares	15,400
	19	1,000	19,000
	15	200	3,000
	18	400	7,200
	16	300	4,800
sum	90	2,600	49,400

Simple average

$$= \frac{\text{sum(share price)}}{5} = \frac{90}{5} = \$18$$

Volume-weighted average

$$= \frac{\text{sum(share price x volume)}}{\text{total volume}} = \frac{49{,}400}{2{,}600} = \$19$$

Volume-weighted average price

Occasionally, buyers and sellers agree to execute their transactions at the volume-weighted average price, known as a VWAP trade.

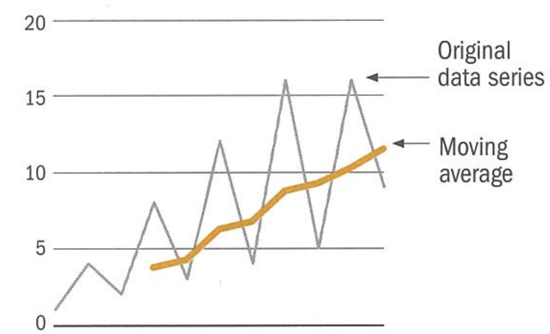
Moving average

When a series is volatile, a moving average can help illustrate the underlying trend.

Example

A 4-day moving average of a volatile data series

Data series	Formula	Moving average
1		
4		
2		
8	(1+4+2+8)/4	3.75
3	(4+2+8+3)/4	4.25
12	(2+8+3+12)/4	6.25
4	(8+3+12+4)/4	6.75
16	(3+12+4+16)/4	8.75
5	(12+4+16+5)/4	9.25
16	(4+16+5+16)/4	10.25
9	(16+5+16+9)/4	11.50



The moving average can be plotted at either the midpoint or the endpoint of the data used to compute the average.

Logarithmic scale

Perception of time is not linear. In our mind, time speeds up the farther into the future we go. One year from today definitely feels closer than two years away. On the other hand, 10 years from today feels about the same as 11 years away. Both periods are one year apart, but we perceive them differently. Using a log scale to show time on the x-axis reflects that perceived duration.

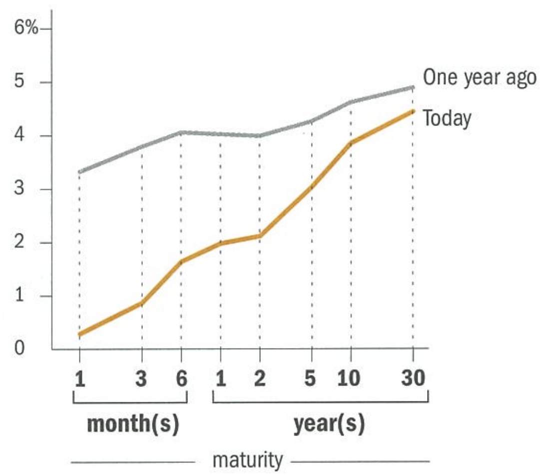
X-axis log scale

A log scale allows you to include values that span many orders of magnitude.

We naturally are more interested in events closer to the present. Using a log scale for the timeline on the x-axis allows you to show more detail in the short term on the chart.

Example

The yield curve of Treasury bills, notes and bonds

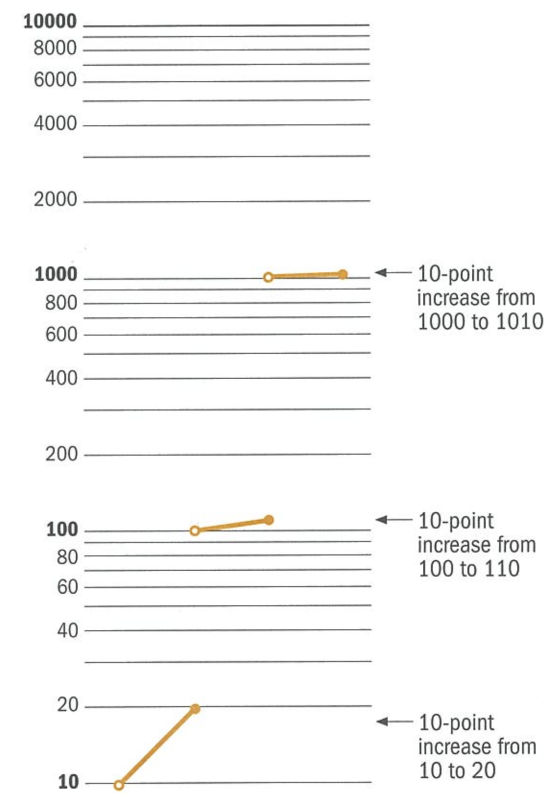


Y-axis log scale

Setting the y-axis on a log scale adjusts the grid lines so that incremental change at different values of the y-axis reflects its relative significance.

Example

A y-axis log scale can reflect a 10-point increase that has a much bigger impact when the index is at 10 than at 100. The same 10-point increase at 1,000 is negligible.



A y-axis log scale is most useful when plotting stocks or indexes over a long time horizon.

A logarithmic scale can use any base. In most graphics, base 10 is practical and intuitive.

$\log_{10}10 = 1$

$\log_{10}50 = 1.7$

$\log_{10}100 = 2$

$\log_{10}500 = 2.7$

$\log_{10}1000 = 3$

$\log_{10}5000 = 3.7$

$\log_{10}10000 = 4$

Comparable scales

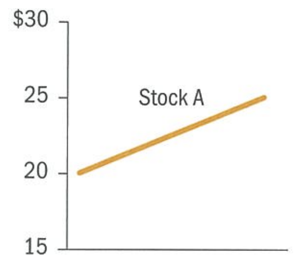
When comparing and contrasting two or more data series, it is important to chart them on comparable scales. Readers expect **a flat line for small increases and a steeper slope for bigger increases.** The example below illustrates how comparable y-axis scales can give an accurate picture of the relative performance of two stocks.

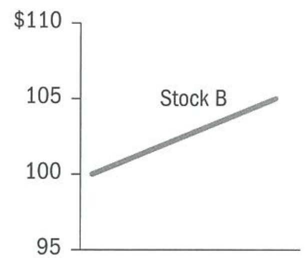
Example

Stock A increased from $20 to $25. It is a 25% increase.

Stock B increased from $100 to $105. It is a 5% increase.

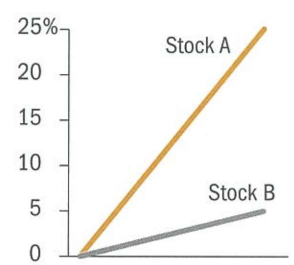
Noncomparable scales
Even though both stocks increase by $5, the charts are misleading when a 25% increase in the stock price is visually the same as a 5% increase.



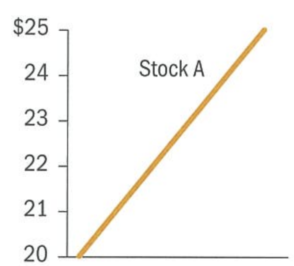


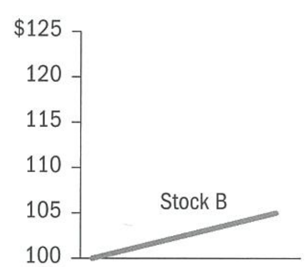
Percentage changes
Stock A with a 25% increase is a steep line. Stock B with a 5% increase is a much flatter line.

	Stock A	Stock B
Year 0	$20	$100
Year 1	$25	$105
Percentage change	+25%	+5%



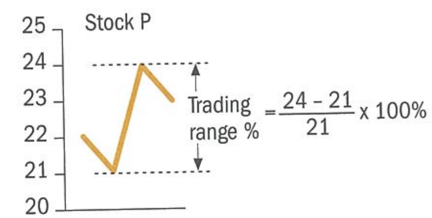
Comparable scales
Adjust the y-axis scales to reflect the relative slopes of the two lines. The picture immediately shows stock A outperformed stock B.



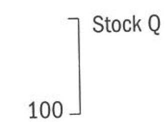


Deriving comparable scales step by step
The trading range of stock P is from $21 to $24, while stock Q ranges from $105 to $110.

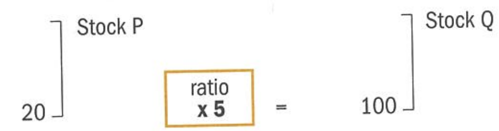
1 Calculate which trading range is larger in percentage terms and determine the scale for that chart first. The range of stock P is about 14% while stock Q's range is less than 5%.



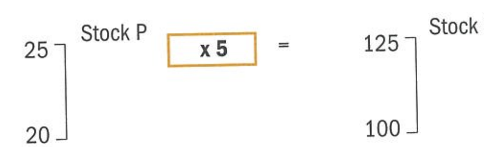
2 Set the bottom value of the scale of the other chart using natural counting increments, such as 1, 2, 5, 10, 50 and 100.



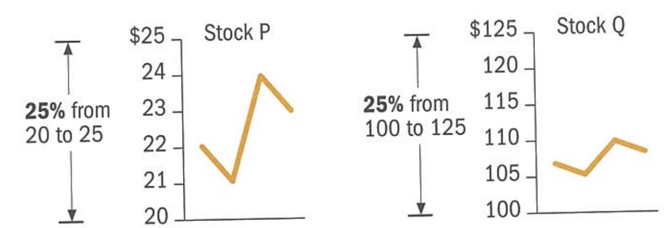
3 Calculate the ratio between the bottom values of the two scales.



4 Multiply the top value of the first scale by the same ratio to get the top value of the other scale.



5 Double check the comparable scales by verifying that the percentage change between the top and bottom values of each scale is the same.



Both graphs are now on comparable scales that show the relative performance of the two stocks clearly.

Percentage change

When the new value is smaller than the original value, the result is a percentage decrease.

Example
If the value changes from 100 to 90,

Percentage change

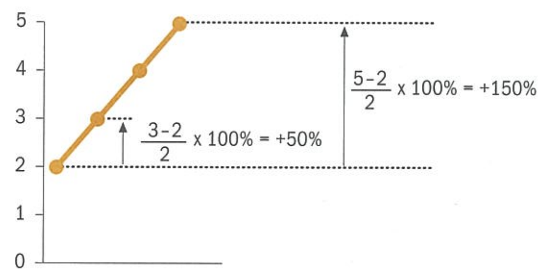
$$= \frac{90 - 100}{100} \times 100\%$$

$$= -10\%$$

The change in values can be expressed as a percentage change from the original value.

$$\textbf{Percentage change} = \frac{\text{New number} - \text{Old number}}{\text{Old number}} \times 100\%$$

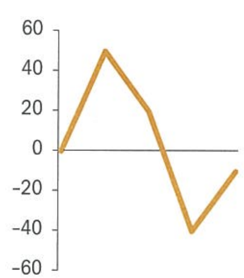
Example

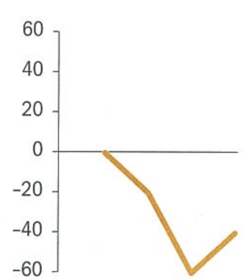


When calculating percentage changes from a data series, a different starting point will yield different numerical values for the percentage changes.

Example

	Data	Percent change since January	Percent change since February
Jan.	10	0 %	
Feb.	15	+50	0 %
March	12	+20	-20
April	6	-40	-60
May	9	-10	-40



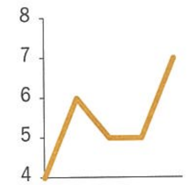


Re-indexing to 100 or 0

It is more intuitive to gauge the change when the baseline is 0 or 100. For example, it is obvious that the change from 100 to 113 is a 13% increase. However, a 13% increase from 123 to 139 is not immediate.

Example

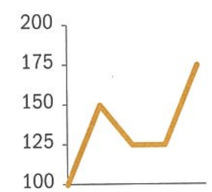
Data
4
6
5
5
7



Re-indexing to 100 is scaling the data to start at 100.

(Current value/Initial value) x 100

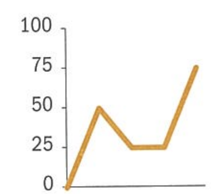
Data	Formula	Re-indexed to 100
4	(4/4) x 100	100
6	(6/4) x 100	150
5	(5/4) x 100	125
5	(5/4) x 100	125
7	(7/4) x 100	175



Rebasing to 0 essentially gives the percentage change from the first data point. Here's another way to calculate it.

[(Current value/Initial value) x 100] – 100

Data	Formula	Rebased to 0
4	[(4/4) x 100] – 100	0
6	[(6/4) x 100] – 100	50
5	[(5/4) x 100] – 100	25
5	[(5/4) x 100] – 100	25
7	[(7/4) x 100] – 100	75



We are accustomed to the round multiples of 10, so it is also relevant to rebase data to 1,000 or 10,000 depending on the subject. For instance, the performance of a stock can be charted in terms of a $10,000 initial investment.

Expressing percentages

There are several ways to express a change in values. For example, an increase from 2 to 6 can be described as follows:

The value triples from 2 to 6.

The value increases by 200%.

Percentages vs. Percentage points vs. Basis points

The difference between two percentages is expressed in percentage points or basis points.

1 percentage point = 100 basis points

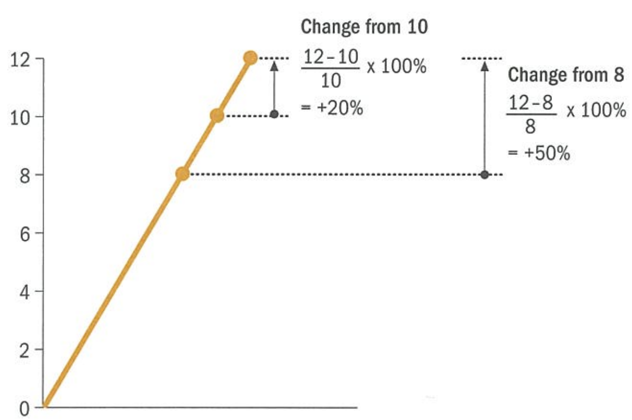
Example

2.00%
less 1.75%

= 0.25 percentage points
= 25 basis points

Baseline number

It is very important to include a baseline number when expressing percentage change. For example, describe a 20% change as a 20% increase **from $10** or 20% increase **to $12**. Presenting the percentage number without reference to a base number is ambiguous. We would not give directions such as "drive 20 miles" without noting the direction north or south.



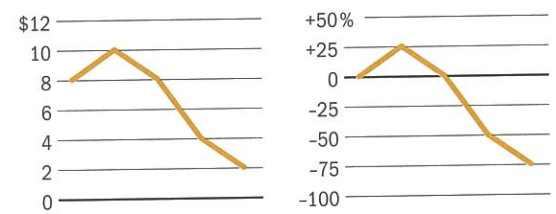
Absolute values vs. percentage changes

Same curve, different message

Charting the absolute values or the percentage changes from the initial data point yields the same shape for the graphs. The chart plotting the percentage changes accentuates the changes from the baseline.

Example

Plotting the percentage changes brings the line into the negative territory, which accentuates the drop in prices.

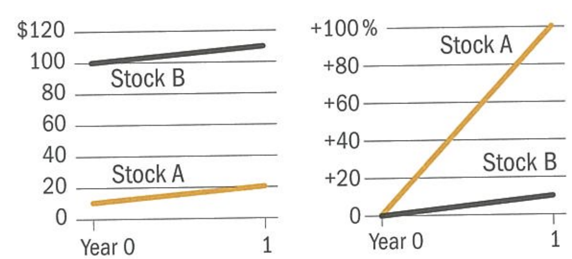


Comparing two or more data series

When comparing different data series, plotting percentage changes from the initial data point can be more telling than absolute values.

Example

Both stock A and stock B increase by $10 in the same period. By plotting the percentage changes from the same start date, the chart immediately conveys stock A outperformed stock B.



Don't compare percentage changes for two entities that are not comparable in size. For example, comparing the percentage change in revenue of a large company with $100 million in revenue to a small company with only $10,000 is misleading. Even a 100% increase in sales for that small company can still be a small sliver of the total market.

Percent of a percentage

Don't make your readers work. Do the math for them.

$$A\% \text{ of } B\% = \frac{A}{100} \times B\%$$

Example 1

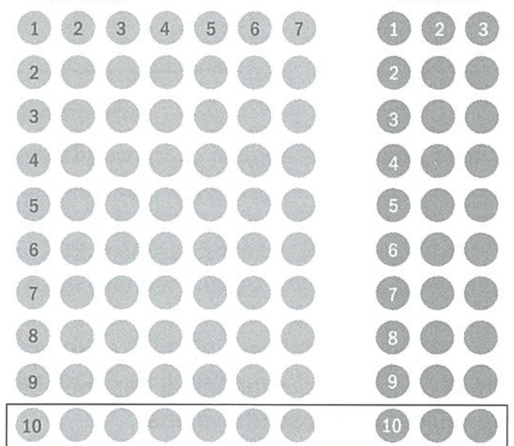
50% of 8% = 50/100 x 8% = 4%

Example 2

Total number of units = 100

A owns 70%
= 70 units

B owns 30%
= 30 units



Each pays 10% fee:

10% fee of 70%
= 10/100 x 70%
= 7%

10% fee of 30%
= 10/100 x 30%
= 3%

A pays 7 units
or 7% of 100 units

B pays 3 units
or 3% of 100 units

Don't average percentages

When it comes to averaging, percentages should not be treated like ordinary numbers. You must always **go back to the original data source to recalculate a new percentage.**

Myth Average of A% and B% = $\frac{A + B}{2}$%

$$A\% = \frac{c}{e} \qquad B\% = \frac{d}{f}$$

$$\text{New percentage} = \frac{c + d}{e + f} \times 100\%$$

Example 1

The average of 10% and 14% is NOT 12%.

Going back to the original data source:

10% = 30/300; 14% = 28/200

$$\text{New percentage} = \frac{30 + 28}{300 + 200} \times 100\% = 11.6\%$$

Example 2

The percent of population in each state that holds bank Z credit card:

Alabama	12.3%
Alaska	3.3%
⋮	
Wyoming	4.1%

$$\text{National average} \neq \frac{(12.3 + 3.3 + \cdots + 4.1)\%}{50}$$

$$\text{National market} = \frac{\text{Sum of credit card Z holders in 50 states}}{\text{Total population}} \times 100\%$$

Exception: It is okay to average percentages if they are calculated from the same base. For example, the average grade of a class is the simple average of the students' grades, since they are all based on 100%.

Copy Style in Charts

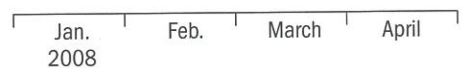
Words

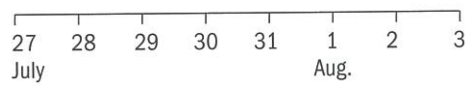
In tables, spell out the full name of the companies and organizations. Don't assume readers know the acronyms. The Bureau of Labor Statistics is still more informative than BLS. An acronym can be used only when it is so widely recognized that it has replaced the full name in the public eye, such as IBM for International Business Machines.

Months

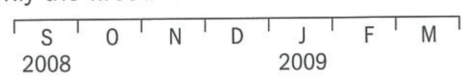
On the x-axis, either use the first three letters or present the names of the months as follows.

Jan.	Feb.	March	April	May	June
July	Aug.	Sept.	Oct.	Nov.	Dec.





When charting a time period six months or longer, use only the first initial.



In tables, spell out the months when using them alone or with a year, for example, January 2009. Don't separate the year with a comma. For a specific date, abbreviate or spell out the months as shown above and set off the year with a comma, for example, Jan. 1, 2009.

State and city names

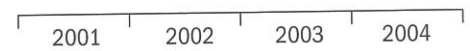
In tables, spell out the names of the 50 U.S. states when they stand alone without a city name. U.S. city names should be used in conjunction with the state name. Add a comma after the city name, for example, Louisville, Ky. Spell out Alaska, Hawaii, Idaho, Iowa, Maine, Ohio, Texas and Utah. Abbreviate others as listed.

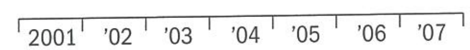
Ala.	Ariz.	Ark.	Calif.	Colo.	Conn.	Del.
Fla.	Ga.	Ill.	Ind.	Kan.	Ky.	La.
Mass.	Md.	Mich.	Minn.	Miss.	Mo.	Mont.
N.C.	N.D.	N.H.	N.J.	N.M.	N.Y.	Neb.
Nev.	Okla.	Ore.	Pa.	R.I.	S.C.	S.D.
Tenn.	Va.	Vt.	W.Va.	Wash.	Wis.	Wyo.

Numerals

Years

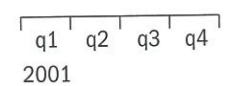
Write out the full year when there is space. When space is limited, the first reference should be in full and the rest in two digits.

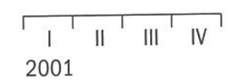




Quarters

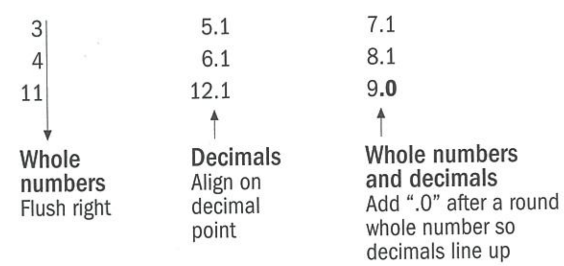
Always indicate the year with quarterly figures.





Whole numbers and decimals

Never center numbers or align numbers flush left.



Units

Keep the units to the highest reasonable denomination. Don't make the reader do the math.

Correct	Incorrect
$3 billion	$3,000 million
2	2,000
1	1,000
0	0

In the description that accompanies a chart, spell out numbers one to twelve. For figures 13 or higher, use numerals. For all percentage numbers, it is more readable to use numeral figures rather than words, such as 1% and 12%.

Major stock indexes

The stock market activity is reported daily in market indexes. These indexes reflect investors' sentiment. Since no single index can represent a complete picture of the economy, some countries have several indexes to track different sectors of the market.

North America

Nation	Main market indexes
U.S.	Dow Jones Industrial Average
	Nasdaq Composite
	Standard & Poor's 500
	Russell 2000
	Dow Jones Wilshire 5000
Canada	S&P/TSX Composite

Latin America

Brazil	Bovespa
Chile	IPSA
Colombia	IGBC General
Mexico	IPC All Share

Asia/Pacific

Australia	S&P/ASX 200
China	Shanghai Composite
Hong Kong	Hang Seng
India	Bombay Sensex
Indonesia	Jakarta Composite
Japan	Nikkei Stock Average
Malaysia	Kuala Lumpur Composite
Singapore	Straits Times
South Korea	KOSPI
Taiwan	Weighted
Thailand	SET

Europe

Nation	Main market indexes
All Europe	Dow Jones Euro Stoxx 50
Belgium	Bel 20
Britain	FTSE 100
Denmark	OMX Copenhagen 20
Finland	OMX Helsinki 25
France	CAC 40
Germany	Xetra DAX
Greece	Athens General
Italy	S&P/MIB
Luxembourg	LuxX
Netherlands	AEX
Norway	OSE All Share
Poland	WIG
Portugal	PSI 20
Russia	RTS
Spain	IBEX 35
Sweden	OMX Stockholm 30
Switzerland	Swiss Market
Turkey	ISE National 100

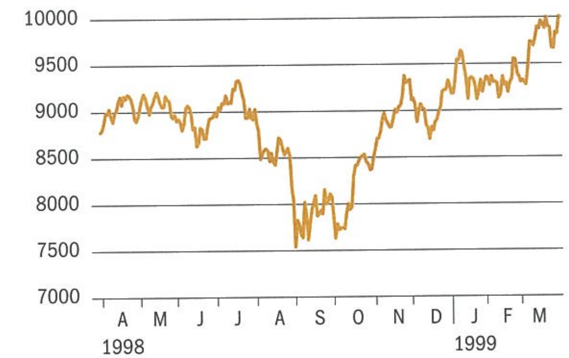
Africa/Middle East

Egypt	CASE 30
Israel	Tel Aviv 25
South Africa	FTSE/JSE All Share

Source: WSJ Market Data Group

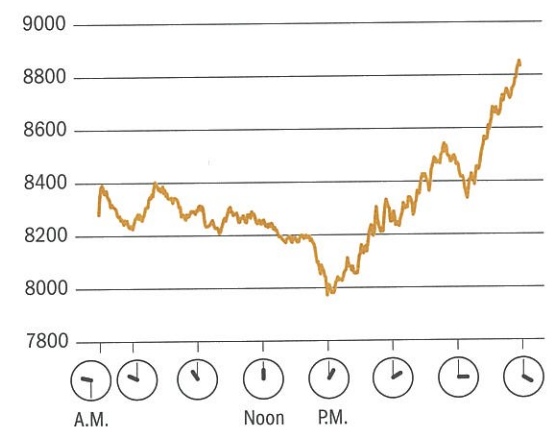
Dow Jones Industrial Average

A chart showing the daily closes of the Dow in the 52-week period leading up to March 29, 1999.



The Dow at one-minute interval

A minute-by-minute chart of the Dow shows the movements of the stock market throughout a one-day trading period.



Source: WSJ Market Data Group

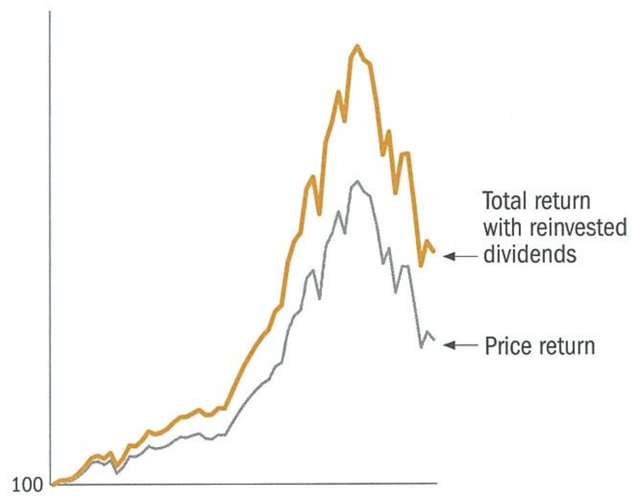
"The Dow" is the world's most frequently quoted and longest-serving market indicator of its kind, measuring the U.S. market since its creation by Charles Dow in 1896. The index first closed above the 10,000 point milestone on March 29, 1999.

Measuring performance

The price return shows the growth in the value of a stock or an index excluding dividends. An investor can see a more accurate picture of an index's actual investment return using a total return index. A total return index captures both the price change and the reinvested dividends.

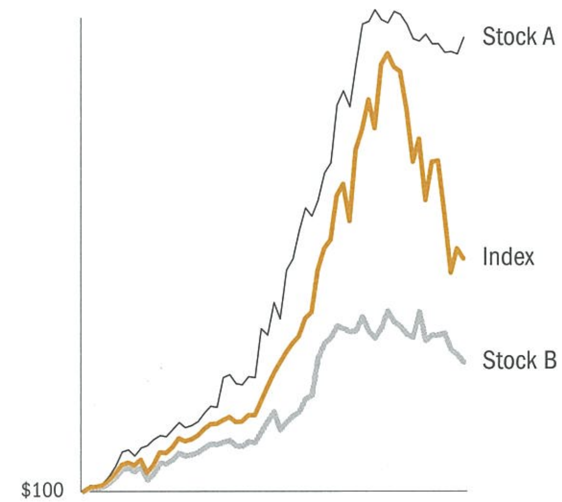
Price return vs. Total return

To illustrate the total return of investment in the index, the dividends of the component stocks have to be included. Typically, the dividend is reinvested in the same index or held in cash.



Showing relative performance

To show the performance of a stock against an index and its peer group, it is common to plot the return with reinvested dividends of a hypothetical \$100 investment in each of them. The original data series was rebased to 100.



Stock indexes are averages weighted by price or by market capitalization or other characteristics of the component stocks.

See page 98 for weighted average.

Arithmetic vs. geometric rate of return

Each year's investment return is dependent on prior years' return. For instance, if you have a big gain one year, you have much more capital to generate returns during the following years, and vice versa. Geometric return is therefore a more accurate measurement of how an investment does over a period of time.

Arithmetic rate of return
Simple average of the rate of return in each year

Geometric rate of return
Compounded rate of return of initial investment

Example
How well did stock A perform?

Year	Price	Annual rate of return
0	$100	
1	150	+50%
2	75	-50
3	90	+20
4	72	-20

Arithmetic return = Average of annual rates of return
= (+50% - 50% + 20% - 20%) /4
= 0%

Geometic return = Annualized appreciation over four years

$$= \sqrt[4]{\frac{72}{100}} - 1 = -7.9\ \%$$

This means stock A loses 7.9% per year.

How the math works:

Year	Annualized rate	Stock value
0		$100
1	– 7.9%	92
2	– 7.9%	85
3	– 7.9%	78
4	– 7.9%	72

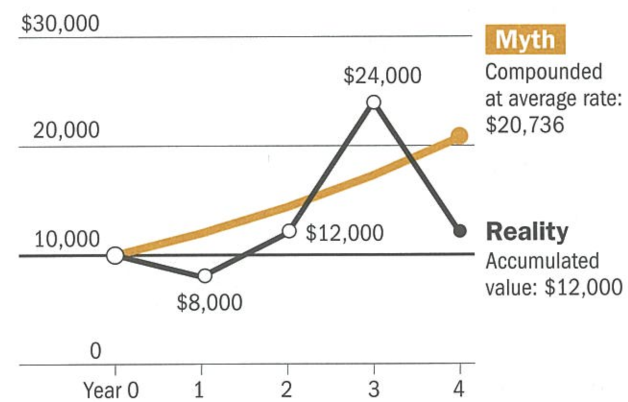
Example
Imagine an investment of $10,000 growing at a 20% average rate of return.

Year	Return
1	-20%
2	+50
3	+100
4	-50
Average rate of return: →	+20% or 0.2

Myth It would be a mistake to believe the investment is compounding at 20% a year:

$$\$10{,}000 \times (1 + 0.2)^4 = \$20{,}736$$

Reality The investment compounds at 4.7%. Based on the geometric return, the account will be worth only $12,000. Compounding the arithmetic return grossly overstates the growth by more than $8,000.



For the quants:

The difference between arithmetic return and geometric return is due to the dispersion of annual returns.

Geometric return

= **Arithmetic return** – Adjustment factor

where adjustment factor

$$= \frac{\left(\text{Standard deviation of annual returns}\right)^2}{2}$$

The adjustment factor is a numerical approximation to the exact difference between the two.

Expressing currencies

There is a large and active market in foreign exchange. Anyone involved in a global enterprise will need to use the standard conventions for translating results into different currencies. Here's a sample table of spot exchange rates.

	$ **U.S. Dollar** 1 USD	€ **Euro** 1 EUR	¥ **Japanese Yen** 1 JPY	£ **British Pound Sterling** 1 GBP	C$ **Canadian Dollar** 1 CAD	圓 **Hong Kong Dollar** 1 HKD
USD	1	1.4165	0.009537	1.7802	0.9313	0.1286
EUR	0.7060	1	0.006733	1.2568	0.6574	0.0908
JPY	104.85	148.53	1	186.66	97.65	13.48
GBP	0.5617	0.7957	0.005357	1	0.5231	0.0722
CAD	1.0738	1.5211	0.010241	1.9117	1	0.1381
HKD	7.7761	11.0150	0.074161	13.8430	7.2414	1
Conventional market quote		USD per euro	Yen per USD	USD per British pound	Canadian dollars per USD	Hong Kong dollar per USD

Note: Traders' screens often do not align numbers on decimal points. The number of decimal points are based on conventional quotes.

Converting currencies

When converting a foreign currency into U.S. dollars, either multiply or divide the foreign currency by the exchange rate, depending on the standard conventions for each rate. Since currencies fluctuate, use the exchange rate that is relevant to the time period.

Example. Converting 100 Canadian dollars into U.S. dollars

Convention	Exchange rate	Algebra	Conversion
Currency unit per U.S. dollar	C$1.0738 = US $1	1.0738 = 1 100 = ? = (100 x 1) / 1.0738	Divide by the exchange rate C$100 / 1.0738 C$100 = US $93.13

Example. Converting 100 British pounds into U.S. dollars

Convention	Exchange rate	Algebra	Conversion
U.S. dollar per currency unit	US$1.7802 = £1	1 = 1.7802 100 = ? = (100 x 1.7802) / 1	Multiply by the exchange rate £100 x 1.7802 £100 = US $178.02

A windfall gain

Exchange rates need to be taken into consideration when presenting financial data for overseas operations.

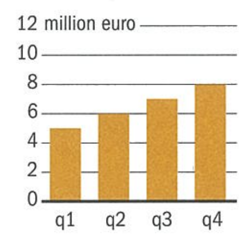
When presenting assets and liabilities such as inventory and loans, use the **exchange rate at the end of each period** (e.g. Dec. 31) to show the value accumulated to date.

When presenting profits and losses, use the **average exchange rate** during each period to show the impact of currency on the performance during that period.

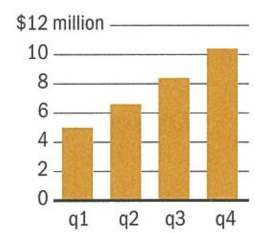
Example. Profit of a German subsidiary

Period	Quarterly profit (million)	Average exchange rate	Profit in U.S. dollar (million)
q1	5 euro	1 euro = US$1.00	$ 5.0
q2	6	1 euro = US$1.10	6.6
q3	7	1 euro = US$1.20	8.4
q4	8	1 euro = US$1.30	10.4

Profit in euro



Profit in U.S. dollar



When the euro gets stronger, the profit in U.S. dollars reflects a windfall gain.

For the inquisitive:

In accounting, a fudge factor known as the cumulative translation adjustment (CTA) is used to reconcile the differences that arise from using average and end-of-period exchange rates together.

Currency charts

It is important to chart currencies in a way that is intuitive for the readers. Readers expect to see **an upward trend line as the currency strengthens and a downward trend line as the currency weakens.**

Conventional market quote

- U.S. dollar per euro
- Yen per U.S. dollar
- U.S. dollar per British pound
- Canadian dollar per U.S. dollar
- Hong Kong dollar per U.S. dollar

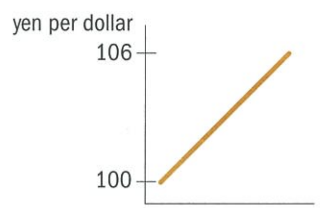
With globalization, many business presentations include currency charts to reflect how currency fluctuations are affecting performance.

Strength/weakness of the U.S. dollar against the other currency

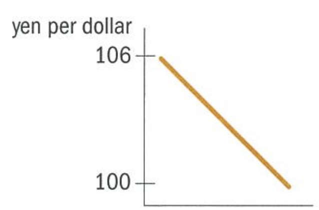
If the focus of the message is linked to the U.S. dollar, the chart should show the number of foreign currency units $1 can buy.

Example

The U.S. dollar strengthens against the yen, i.e. $1 buys more yen. The line trends up to show a stronger dollar.



The U.S. dollar weakens against the yen, i.e. $1 buys fewer yen. The line slopes down to show a weaker dollar.

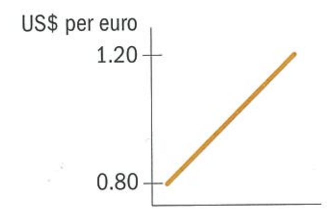


Strength/weakness of a foreign currency against the U.S. dollar

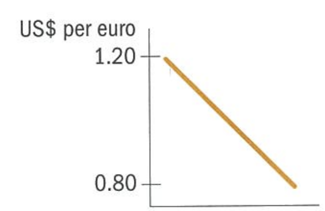
If the focus of the message is linked to the foreign currency, the chart should show how many U.S. dollars one unit of foreign currency can buy.

Example

The euro strengthens against the U.S. dollar, i.e. 1 euro buys more dollars. The line trends up to show a stronger euro.



The euro weakens against the U.S. dollar, i.e. 1 euro buys fewer dollars. The line slopes down to show a weaker euro.

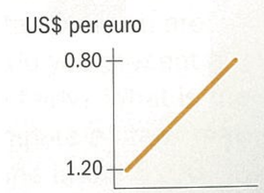


Inverse scale

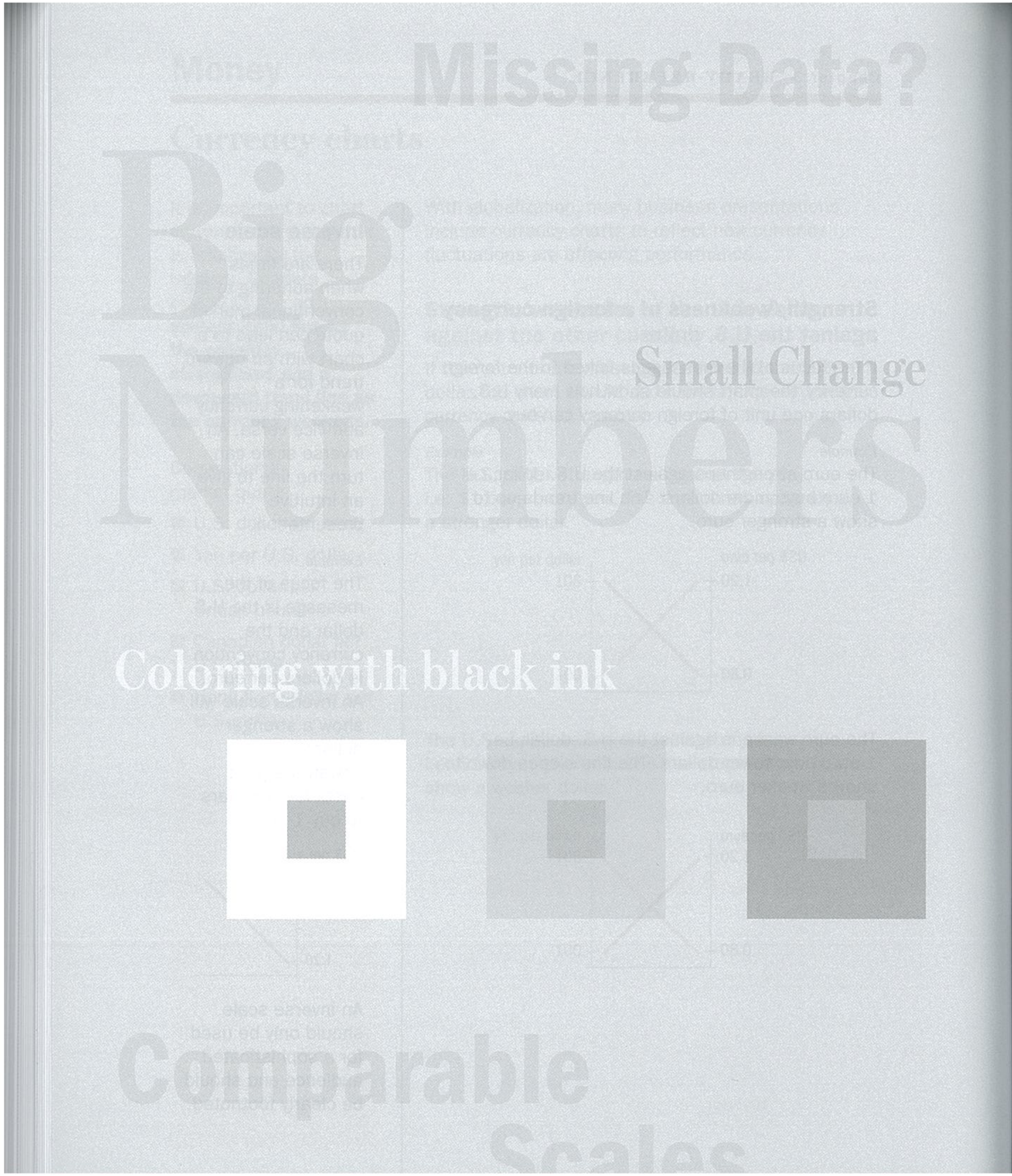
There are times when adhering to the conventional market quote can lead to a chart with an upward trend for a weakening currency and vice versa. An inverse scale can turn the line to give an intuitive presentation.

Example

The focus of the message is the U.S. dollar and the currency convention is dollars per euro. An inverse scale will show a stronger dollar with an upward trend. It costs fewer dollars to buy 1 euro.



An inverse scale should only be used for a sophisticated audience and should be clearly footnoted.



CHAPTER 4

Tricky Situations

Raw data is like a diamond in the rough — it needs to be polished and mounted before it can be shown to the world. There are times when you can present just your data. But, in most instances, you should be prepared to reorganize your information so as to convey your intended message effectively.

In the real world, unexpected issues are bound to arise. Should you throw out a data set if you are missing some data points? How do you present a small increase from a large base fairly? What is the most effective way to visually compare a stock that trades in the $10 range versus one in the $100 range? When color is not available to you, how do you use black ink to your advantage?

Finding the right solution within a particular set of parameters comes down to judgment and experience. In this chapter, I shed light on these topics to provide you with a foundation for working through even more complicated situations.

Missing Data

Is it still worth charting?

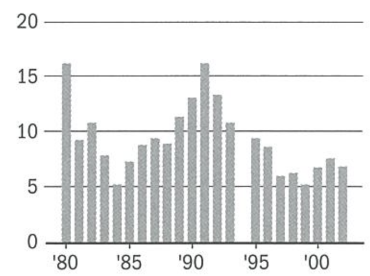
After you have exhausted all your resources and still find your data set incomplete, should you still chart your information? If your objective is to show a broad trend and you are missing only a few data points, it is still worthwhile to plot the data.

Assess whether the chart presents an unbiased story overall despite missing data points.

It is acceptable to combine several sources to complete a data set, as long as the sources have the same general methodology for data collection.

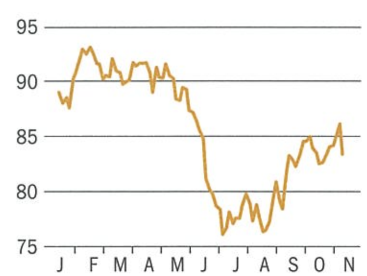
One or two data points missing
In most cases, a chart with one or two missing data points still has value. The exception is when the missing data point is crucial to your message, for instance, December sales figures of a toy store.

For a bar chart, leave a space for the missing data point. Make a footnote. If more than two out of ten data points are missing, do not make a bar chart.

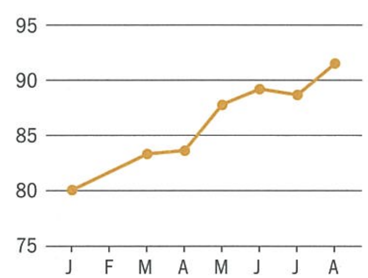


Note: 1994 data is unavailable.

For a line chart with a long data series, span the gap and continue the line. Since the objective is to show a trend, a few missing data points do not have a big effect.



For a line chart with a short data series, span the gap and mark the data points. Do not plot the line if more than two out of ten data points are missing.

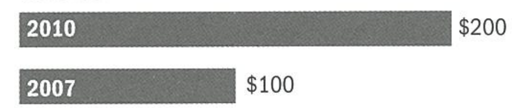


Scattered data points

If a data series has several missing data points, select a sample of directly relevant data points that convey the message. Research additional data to substantiate the chart.

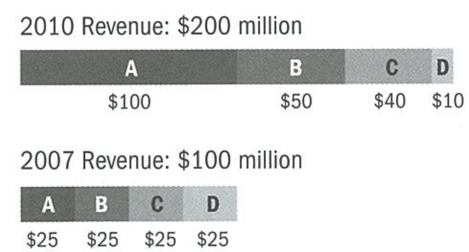
Example
Plot the most recent value and select a historical data point that is directly relevant to the message, for instance the year that the product was first launched.

Revenue in millions of dollars



In addition, incorporate new information, such as revenue breakdown by division, to make the chart more illuminating.

Revenue by division



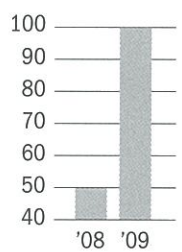
Do not make a pie chart if the data for any one segment is unavailable. A pie chart always represents a whole and adds up to 100%.

Big Numbers, Small Change

Accentuate without exaggeration

Always plot vertical bars from a zero baseline. Vertical bars that start at values other than zero exaggerate the changes, obscure the discrete total value of each bar and make comparison of the data difficult.

In the example below, the chart appears to show that the value in 2009 is six times that of 2008. In reality, it is only twice the value of the previous year. The reader cannot infer the truth by visual inspection of the height of the two bars.



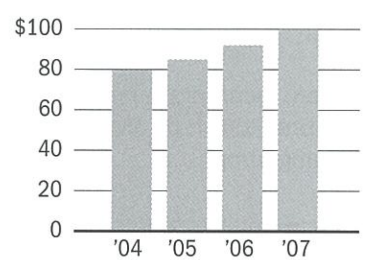
Show changes vs. absolute values

If your data points are large numbers or are close in value, the vertical bars can be indistinguishable in height. In such instances it may be more effective to plot the point changes or percentage changes. Do not change a bar chart to a line chart to exaggerate a trend. Always use bars to represent discrete quantities.

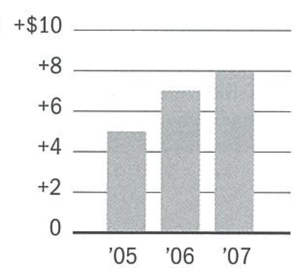
Example

Year	Revenue	Change from a year ago
2004	$ 80 million	
2005	85	+$ 5 million
2006	92	+ 7
2007	100	+ 8

Plotting the absolute values shows the actual revenues.



Plotting the changes from a year ago accentuates the increase in revenue from year to year.

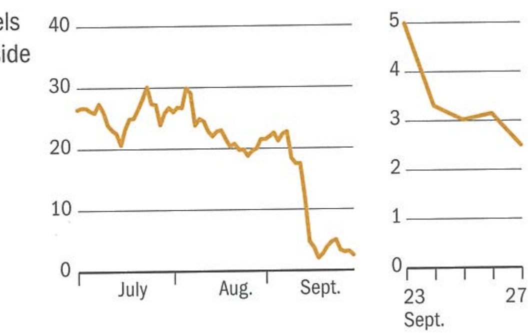


Show recent changes with historical perspective

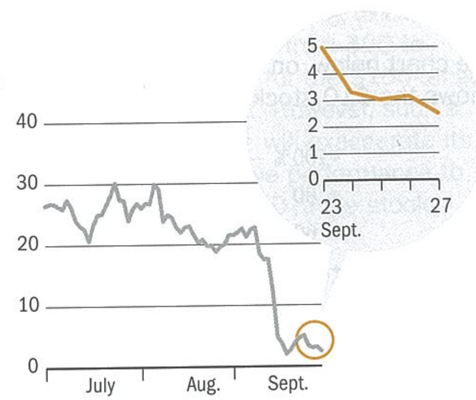
Sometimes a chart needs to serve dual purposes — to show a historical trend and to show recent peaks or troughs. In a chart with a long time horizon, it could be difficult to see small changes in the latest data points. In such instances, plot the historical data series with an additional chart or an inset to magnify the points of interest.

In the example below, the chart plotting the most recent data points highlights that the value drops in half in the last five days.

Two panels side by side



Magnifying visual effect



The time frame for both the longer horizon chart and the close-up should directly relate to the message, whether it is a ten-year trend or a one-week period. The purpose for magnifying the recent data points is to show any significant changes that would otherwise be missed in the main chart. Do not zoom in for decorative purposes.

Ant vs. Elephant

Percentage changes are often more telling than absolute values, since investors can apply the percentage change to the dollar amount of their initial investment.

How to fairly compare the performance of a $10 stock to a $100 stock

A $10 increase for a $10 stock is not the same as a $10 increase for a $100 stock. The former doubles in value whereas the $100 stock increases by only 10%.

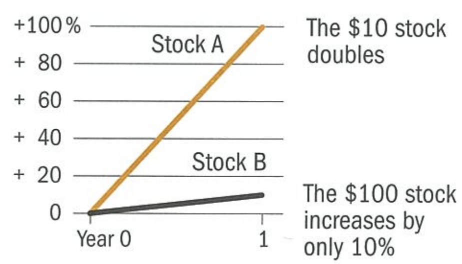
Plotting the percentage changes

Example

Year	Stock A	Stock B
0	$10	$100
1	$20	$110
Percent change from a year ago	+100%	+10%

Plotting the actual values of the stocks is technically correct but it is impossible to judge visually the relative performance of the two stocks.

The chart below, on the other hand, immediately shows the $10 stock outperformed the $100 stock.



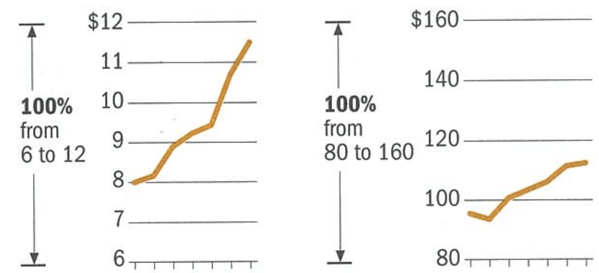
Choosing comparable scales

Sometimes, it is more relevant to show the actual values instead of the percentage changes. In such instances, plotting the charts on comparable scales is the only fair way to compare the data series.

A quick and easy method to derive comparable scales is to determine the upper and lower y-axis values that increase by the same percentage for both charts.

Example

The y-axis scale for the $10-range stock can go from $6 to $12 and the $100-range stock goes from $80 to $160. Both ranges increase by 100%.



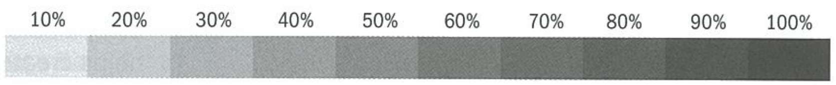
It is tempting to choose a scale from $90 to $120 for the $100-range stock. However, such a scale will exaggerate its relative performance to the $10-range stock.

Readers expect a flat line for small increases and a steeper slope for bigger increases. Plotting the charts on comparable scales helps create the right comparison.

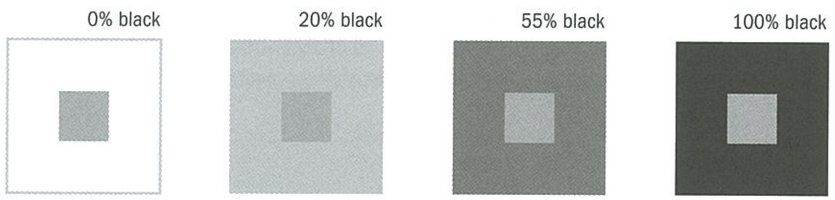
Coloring with Black Ink

Creating contrast and highlights

A graphic can be "colorful" even in black and white.
The use of different shades of black can create layers of texture. The contrast with light and dark shades can be used to emphasize the focal point.

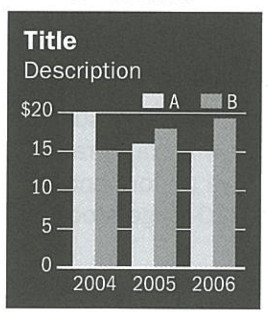


The same shade of black can look different against a different shaded background. In the example below, the small squares in the center of the four panels are all 30% black, but they look different depending on the surrounding gray background.

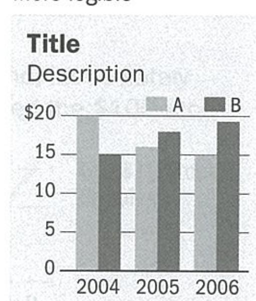


Contrast and readability
There is a trade-off between contrast and readability. Too little contrast makes it hard to differentiate between elements. Too much contrast creates vibration that diminishes readability, such as images on a black background. Black text or graphics on a white or light-colored background is most legible.

Too much contrast



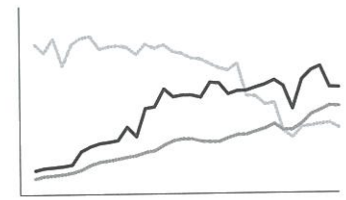
More legible



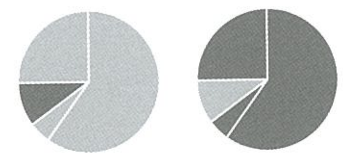
Highlighting with shades of black

Shades of black can be used to separate different levels of information. Sufficient contrast brings out the important message.

The important line is in black.



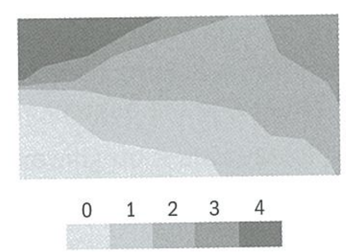
The highlighted segment can either be a lighter shade or a darker shade.



Moderate use of boldfaced type and shading can help emphasize the important data.

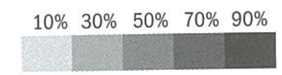
Name	Data	Data	Data	Data
Company A	0.0	0.0	**12.0**	0.0
Company B	0.0	0.0	**11.0**	0.0
Company C	0.0	0.0	**10.0**	0.0
Company D	0.0	0.0	**9.0**	0.0
Company E	0.0	0.0	**8.0**	0.0

A gray scale can be used to differentiate levels of gradation.



Determine visually, and not numerically, the graduating steps of gray. Strictly using equal increments of the percentage numbers may yield an uneven gray scale. Start with numerical steps and adjust visually.

Numerical steps yield an uneven gradation.



Adjust visually for a more effective gray scale.