THE DIFFUSION INDEX

WHAT IS IT?

In economics, a Diffusion Index is a statistical tool which measures the aggregate direction - improving or worsening – of a variety of underlying measurements.

- *Are more stocks in an index rising or falling?* This is called an **Advance/Decline Index** and can reinforce or dismiss a trend via technical analysis.

- A key economic datapoint, **Purchasing Managers' Index (PMI)** is a leading indicator answering: *Did business activity improve or worsen this month?* It is a survey of inventory, business output, purchases, new orders, and employment.

- *How are disparate economic indicators changing?* Diffusion indices help aggregate different datapoints into a single index that can act like an economic thermometer.

METHODOLOGY

A value above 50.0 indicates growth, below 50.0 indicates contraction. This formula is used:

$$\text{Index} = (P_{up} \times 1) + (P_{unch} \times 0.5) + (P_{down} \times 0)$$

Where:

- P_{up}: **percent of datapoints improving/rising** *e.g. PMI survey datapoint is improving*

- P_{unch}: **percent of datapoints unchanged** *e.g. unchanged economic datapoint*

- P_{down}: **percent of datapoints worsening/falling** *e.g. price datapoint is falling*

WHAT DOES IT MEAN?

Diffusion indices gauge broad based momentum and can signal when trends, be it up or down, are accelerating or running out of steam.

The index – which *counts* the direction and does not *measure* the direction of underlying datapoints – is able to aggregate disparate measures by homogenisation. Original units of measurement are no longer relevant, nor is accounting for differing "historically normal" magnitudes across measures. Units are dismissed; only "up" or "down" is measured.

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BE CAREFUL!

The measure can be misleading. For example, a stock index can fall even if most stocks are rising – which could be measured using an Advance/Decline Index. This can be due to (i) the large magnitude of the change of only a few stocks, or (ii) concentrated weightings within an index.

Looking at the S&P 500 since 2016, we find that 13%[1] of daily market moves contradicted the Advance/Decline Index. The count and percent of cases where the S&P500 rose/fell despite most stocks falling/rising is depicted in the chart

Contradicting Signals!
Rising/falling S&P 500 vs. falling/rising Advance/Decline Index

above. For example, 2021 YTD a total of 6 days, or 13% of days, daily market move was contrary to what the Advance/ Decline "diffusion" Index on the S&P500 suggested.
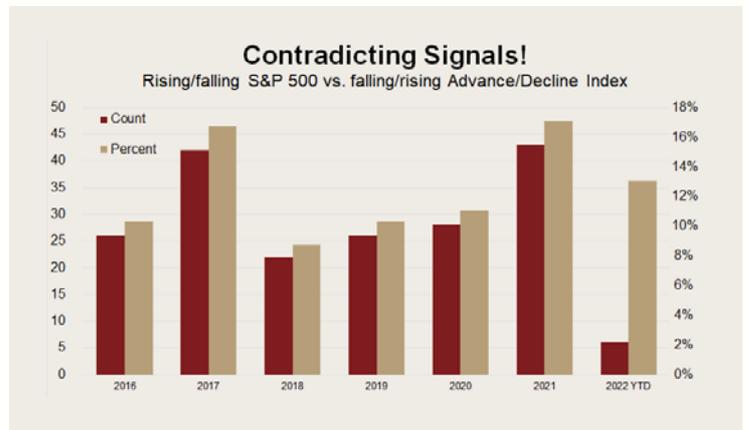
ADVANCE/DECLINE INDEX

At a 13% frequency, evidence suggests that it is not uncommon for the index to move in one direction whilst the majority of stocks move in another. This could occur (i) when important idiosyncratic news moves a small number

S&P 500 Market Capitalisation (USD bn)
Top 5 stocks have a greater market value than stocks 101-300

"Long Tail" of the S&P 500

Top 5	8,894
Top 100 (1-100th)	26,752
Second Next 100 (101-200th)	5,415
Third Next 100 (201-300th)	3,139
Fourth Next 100 (301-400th)	1,955
Bottom 100 (400-500th)	1,199

Source: Refinitiv

of stocks by a large magnitude, dragging the index with them, in the opposite direction to the majority of stocks. Alternatively, (ii) a small number of large market capitalisation stocks, which comprise a larger proportion of the index, can drive the benchmark solely due to a higher weighting. The S&P 500 is known for large technology names constituting a significant portion of the index.
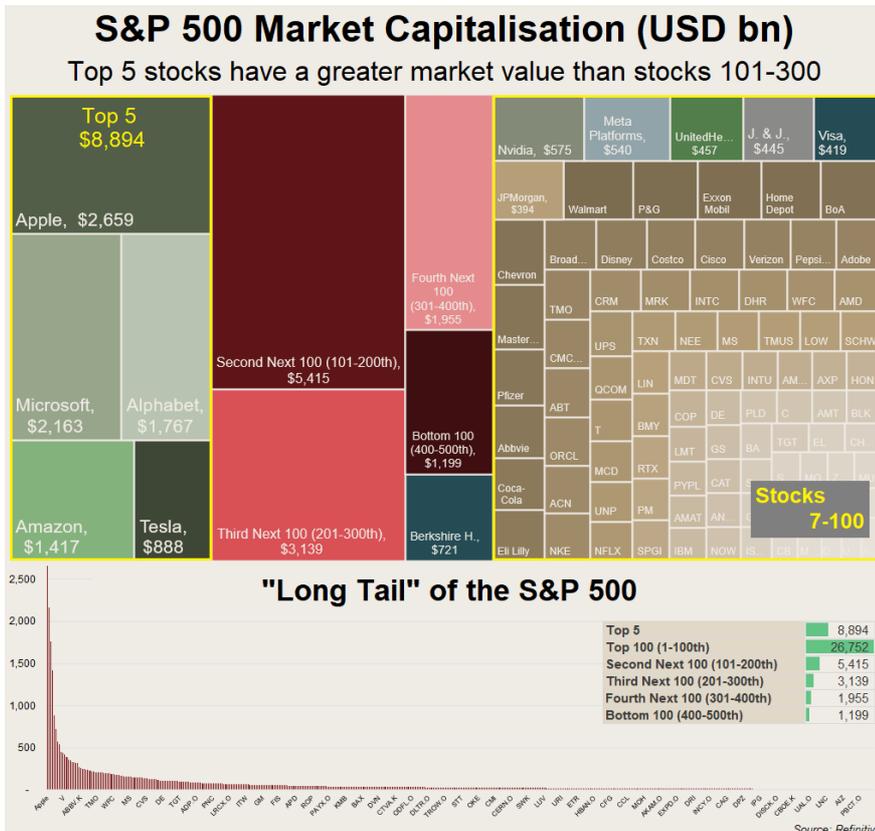
Instances of price vs. diffusion index contradiction can be exacerbated by the 'long tail' of a stock benchmark. We take a look at the 'long tail' of the S&P 500 below.

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PURCHASING MANAGERS INDEX (PMI)

PMI is an economic indicator derived from monthly surveys of private sector companies, and signals whether or not certain measures of business activity have increased, decreased, or are unchanged relative to the previous month. The adjacent table shows the weight of importance for each of the PMI sub-indices. ISM

PMI sub-index	ISM weights	Markit weights
New orders	20%	30%
Output	20%	25%
Employment	20%	20%
Supplier delivery time (inverted)	20%	15%
Purchases of inventories	20%	10%

conducts surveys in the US whereas Markit is more global in nature. Many other PMI providers exist.

Corporate representatives, usually purchasing managers, are asked a series of questions which do not consider opinion or outlook. For example: *"factually speaking, has your company seen an increase, decrease, or no change within the area of [a given business activity] versus last month?".*
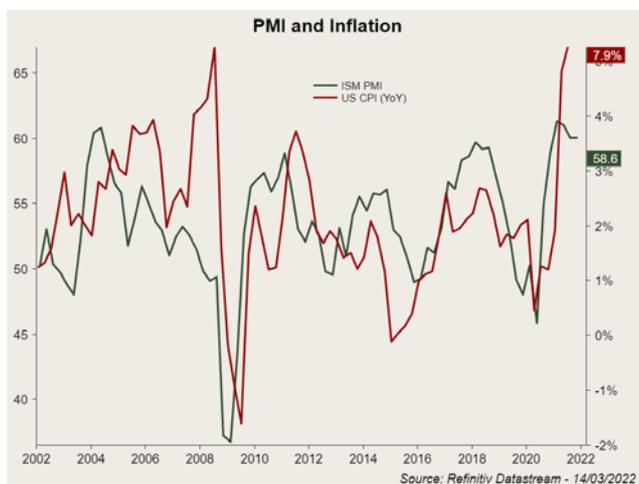

PMI is such an important measure because it is regarded as a leading indicator of economic performance. The chart on the left shows the strong correlation between ISM Manufacturing PMI and US inflation (year-on-year US CPI). It is important to note that inflation has outpaced PMI data, suggesting that price increases may partly be due to reasons other than economic overheating (e.g. supply chain shocks, energy shortages).

The histogram on the right highlights a few interesting points about US PMI data[2].

There is a strong expansionary bias:

- The average PMI reading was 53.
- The modal bucket is 54-56.
- Of the 890 monthly readings, 629 or 71% were above 50 i.e. expansionary territory.
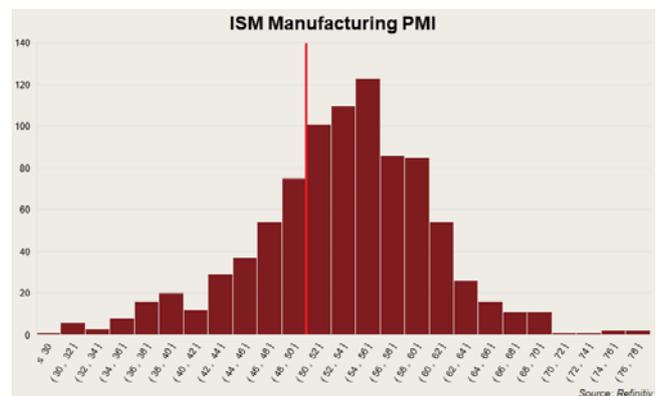
PMI readings can go from expansion to a deep contraction (i.e. worsen) more easily than rebound (i.e. expansion).

- The histogram distribution has a "fat left tail".
- Data gets worse faster than it gets better (about the mean).
- Despite a positive bias, a fat left tail suggests that PMI readings are prone to larger contractions (when they occur).
- However, the most extreme rebound had a ["best"] reading +28 points above 50 whereas the "worst" reading was -21 below 50.

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[1] Used 505 holdings in S&P 500 as of 9 March 2022. A proxy to the actual historical S&P 500 holdings was used by assuming the S&P 500 basket was identical to current holdings, which is not a fact. When there was no price data, for example for holdings were not publicly listed by the analysis start date of 1 Jan 2016, the Advance/Decline Index adjusted the weightings of percent up, down, unchanged to sum to 100%.
[2] Considers data from Jan 1948 to Feb 2022.

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