

WHY 2 Y-AXES (Y2Y)

A Case Study for Visual Correlation with **Dual Axes**

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uncharted®



Cosaic

2 Y-axes are bad!

It's **not possible to use a dual-axis chart in ggplot2** because I believe plots with **separate y scales** (not y-scales that are transformations of each other) are **fundamentally flawed**. Some problems:

- They are relatively hard to read correctly compared to other options. See [A Study on Dual-Scale Data Charts](#) by Petra Isenberg, Anastasia Bezerianos, Pierre Dragicevic, and Jean-Daniel Fekete for details.
- They are easily manipulated to mislead: there is no unique way to specify the relative scales of the axes, leaving them open to manipulation. Two examples from the Junkcharts blog: [one](#), [two](#)
- They are arbitrary: why have only 2 scales, not 3, 4 or ten?

You also might want to read Stephen Few's lengthy discussion on the topic [Dual-Scaled Axes in Graphs Are They Ever the Best Solution?](#)

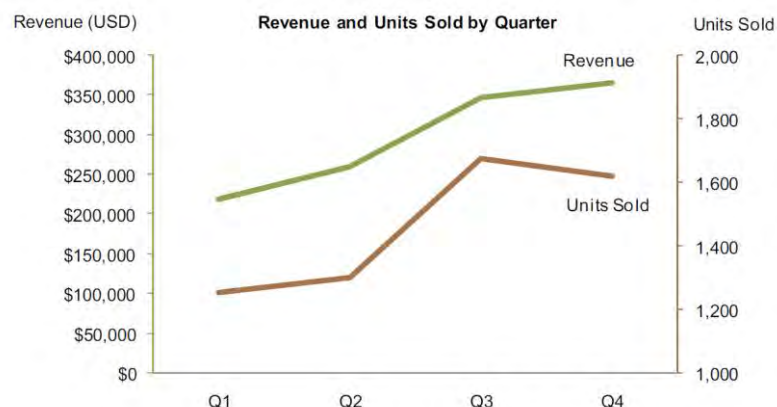
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edited Nov 5 '13 at 12:40

answered Jun 23 '10 at 13:10

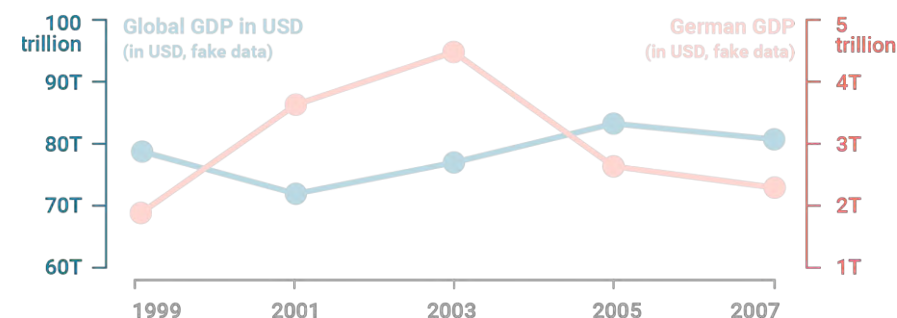
- Hadley Wickham, 2013

 **hadley**
90.7k ● 26 ● 165 ● 232



Today, I can't think of a single case when there isn't **a better solution than a graph with a dual-scaled axis**.

- Stephen Few, 2008



We believe that **charts with two different y-axes make it hard for most people to intuitively make right statements** about two data series.

- Lisa Charlotte Rost, 2018

Dual-Scale Charts Study

A Study on Dual-Scale Data Charts

Petra Isenberg, Anastasia Bezerianos, Pierre Dragicevic, and Jean-Daniel Fekete

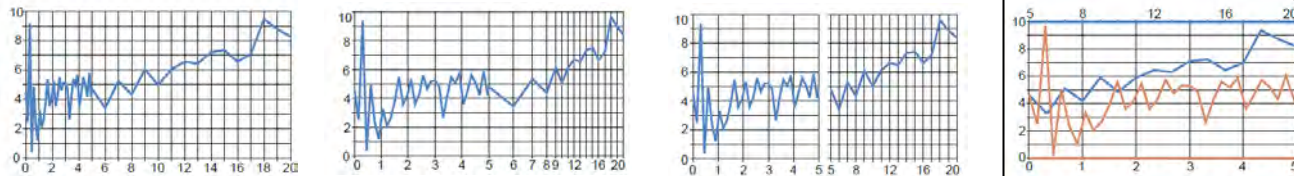
Abstract—We present the results of a user study that compares different ways of representing Dual-Scale data charts. Dual-Scale charts incorporate two different data resolutions into one chart in order to emphasize data in regions of interest or to enable the comparison of data from distant regions. While some design guidelines exist for these types of charts, there is currently little empirical evidence on which to base their design. We fill this gap by discussing the design space of Dual-Scale cartesian-coordinate charts and by experimentally comparing the performance of different chart types with respect to elementary graphical perception tasks such as comparing lengths and distances. Our study suggests that cut-out charts which include collocated full context and focus are the best alternative, and that superimposed charts in which focus and context overlap on top of each other should be avoided.

Index Terms—Focus+Context, Quantitative Experiment, Dual-Scale Charts.

1 INTRODUCTION

Data charts such as line charts, bar charts, and scatter plots are arguably among the most common data representations used today. They

but still briefly discuss how the different approaches can be generalized to more than two scales. Although the term dual-scale has been



a relatively quick glance across different data scales. We chose *position*, *length*, and *slope* tasks as the most highly ranked among Cleveland's tasks [7] and also because we hypothesized them to be most impacted by changes in scale. Cleveland's past work [7] and later work

Finally, the superimposed chart has the advantage that, for the same drawing space as the other charts, it allows for maximum display space for focus and context. It can be created relatively easily with Excel, one of the most common charting tools in use, and this is likely why it is quite common in practice. Despite these advantages, we recommend against using this chart due to our study results.

Fifteen participants (10 male, 5 female) were recruited from our research institute. Participants ranged from 24–39 years in age (median age 26) and all reported normal or corrected-to-normal vision. Eight participants were students and seven non-students with predominantly technical occupations. Nine participants reported at least weekly exposure to charts like the ones seen in the study; the remaining six participants reported monthly or less frequent exposure. Participants received instructions on how to read all charts and were not paid for their involvement in the study.

Study:

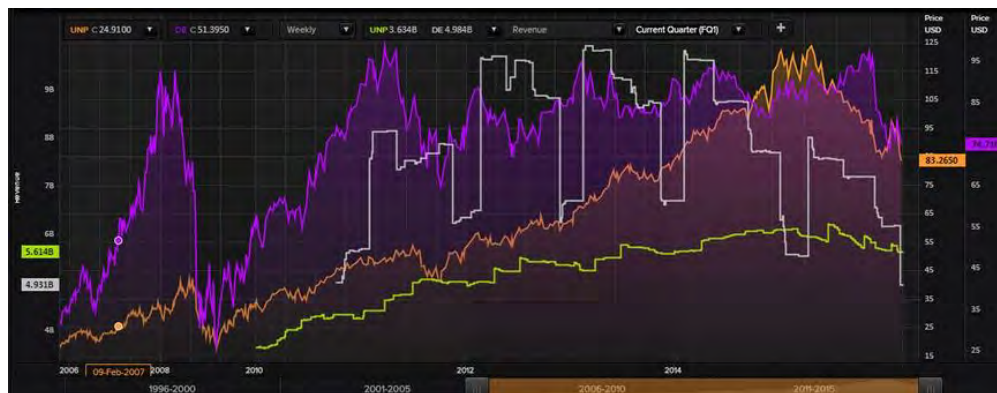
- Unconventional dual **x-axis** scale
- Task didn't match the correlation task used in dual-axis charts
- Only **15 participants**
- Participants have **low chart expertise**: six participants saw line charts only once a month or less.

Conclusions generalize into recommendation against any use of dual-axis charts

Our approach

- Disprove the over-generalization by counter-example
example from financial analysis, not solvable without dual axis
- Show the prevalence of dual axes charts in financial expert domain

Financial Case Study: Eugene Sorenson

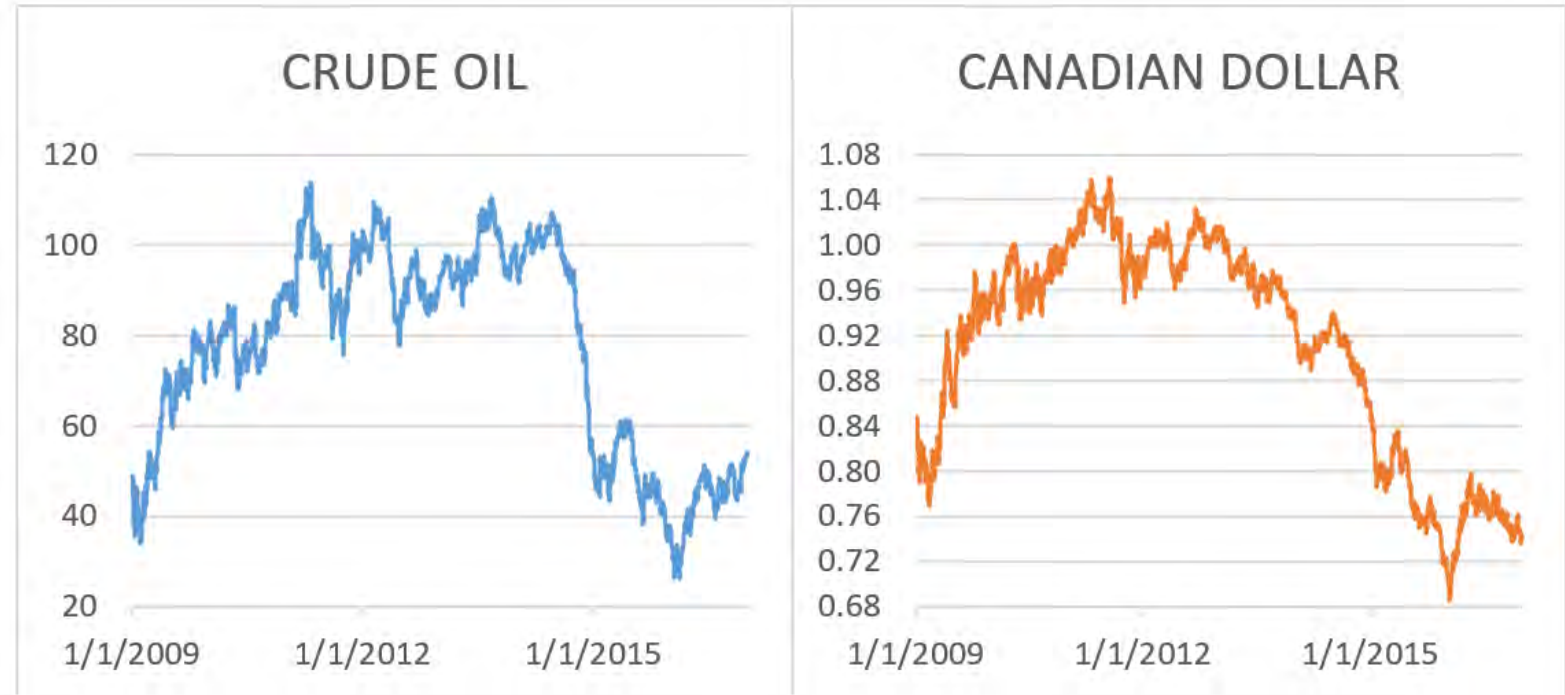


*Note, all these professional financial charts have two or more y-axes
snapshots from Cosaic, Refinitiv Eikon, Bloomberg Terminal, Bloomberg Terminal on Bloomberg TV

Case Study Canadian \$ vs Crude Oil

Traders, Economists, Research analysts need to assess correlation

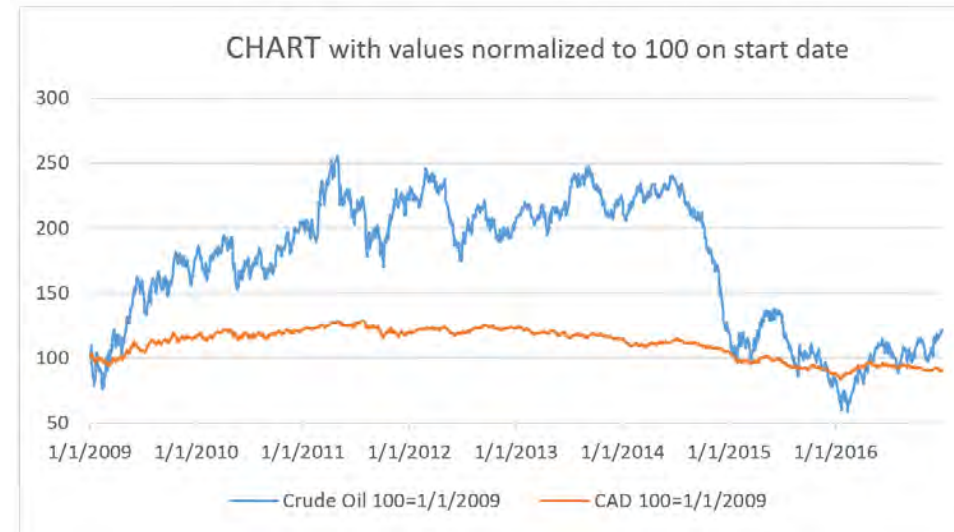
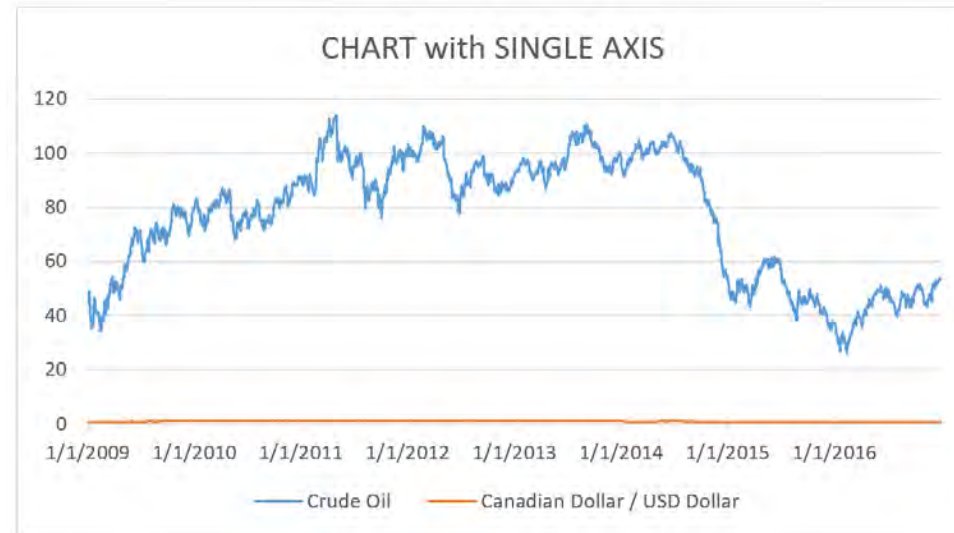
- 2 timeseries
- 2087 observations each
- Note the similar shapes:
 - both start low,
 - go high,
 - drop
- But can't tell which one started going up first, which ones peak locally first, etc. This is CRITICAL INFORMATION FOR TRADERS, ECONOMISTS, ...



Case Study Canadian \$ vs Crude Oil

Single Axis doesn't work

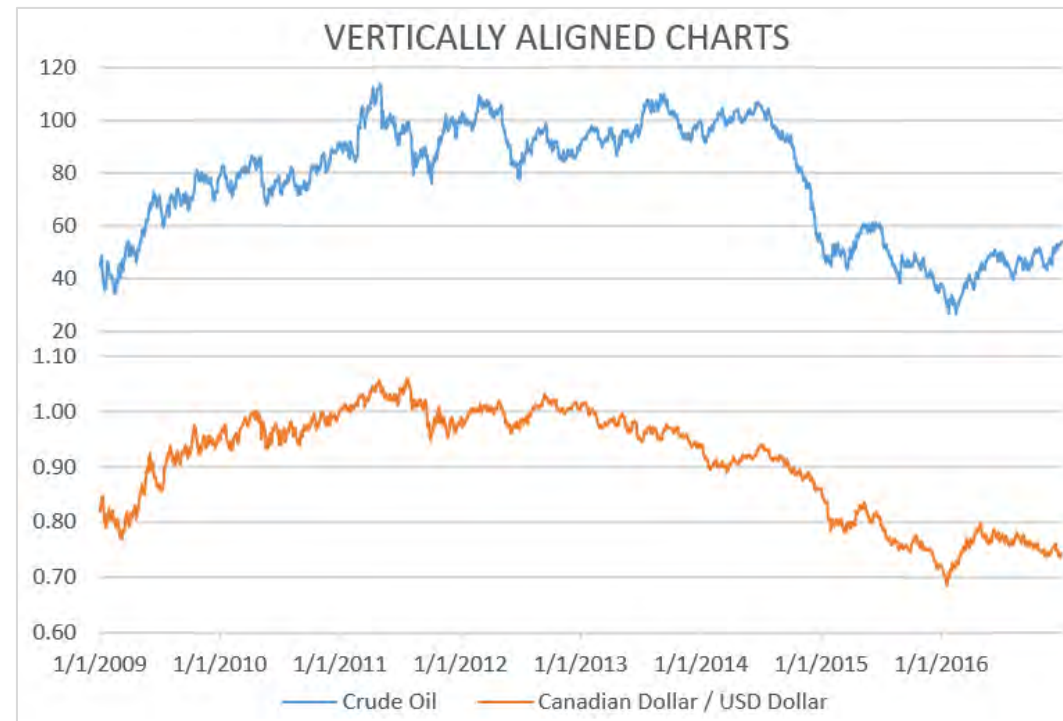
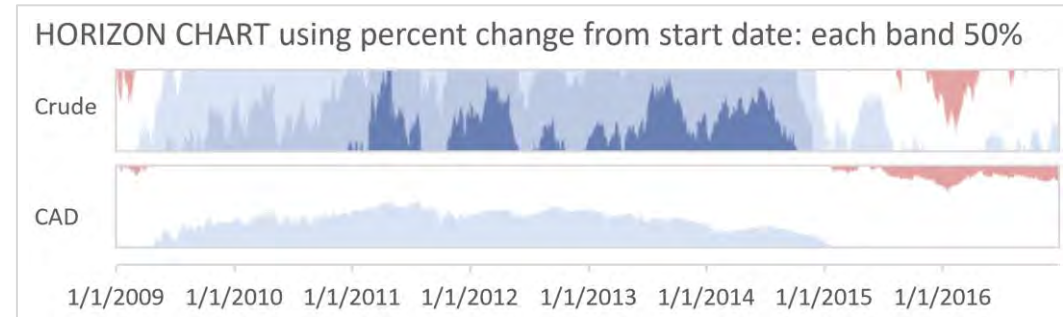
- Magnitude of Oil and \$ significantly different. \$ becomes flat line.
- Normalizing to percent change also significantly different: a move of 50% in oil may only have a 5% move in \$. Again \$ is flat line.



Case Study Canadian \$ vs Crude Oil

Time-aligned charts

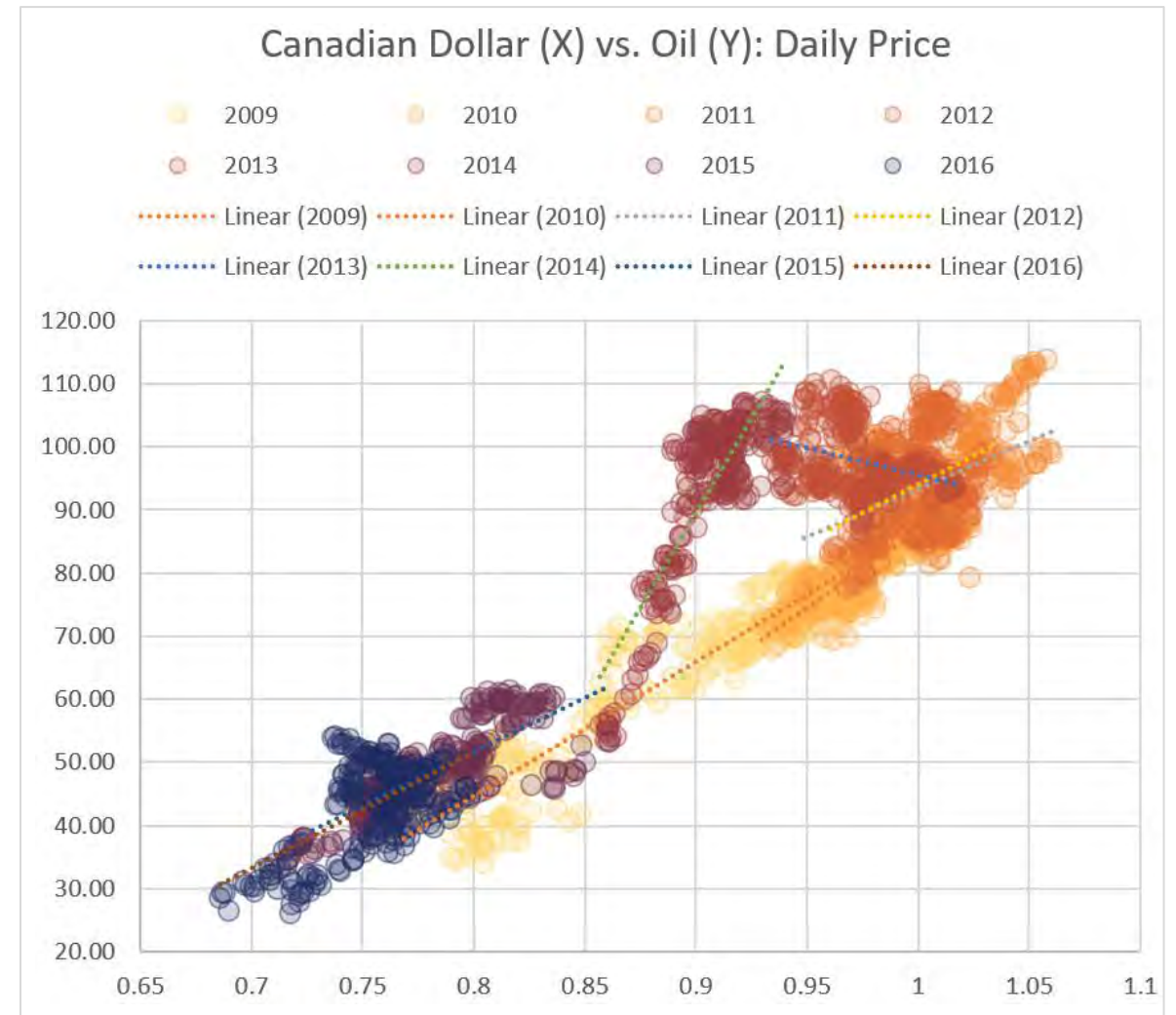
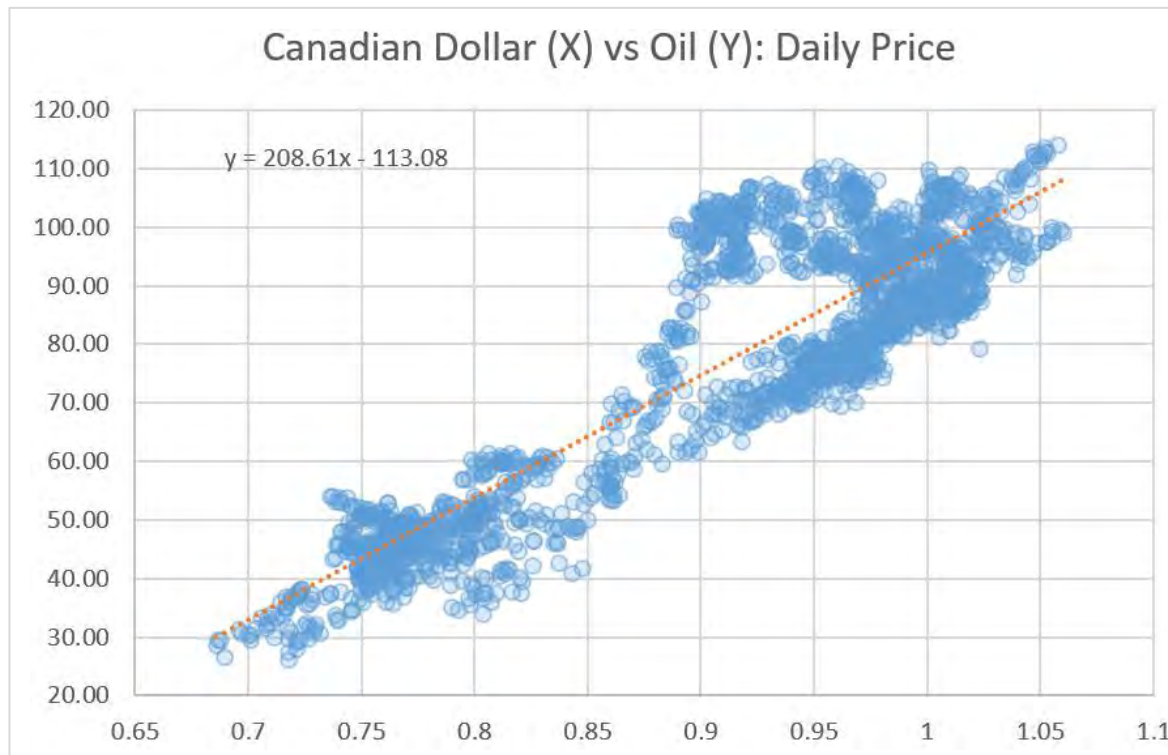
- Horizon chart.
Bands of color most salient, not which came first
- Stacked chart.
More clearly shows temporal alignment, but eye has to move back and forth to gauge divergence, lead/lag, etc.



Case Study Canadian \$ vs Crude Oil

Scatterplots and regression

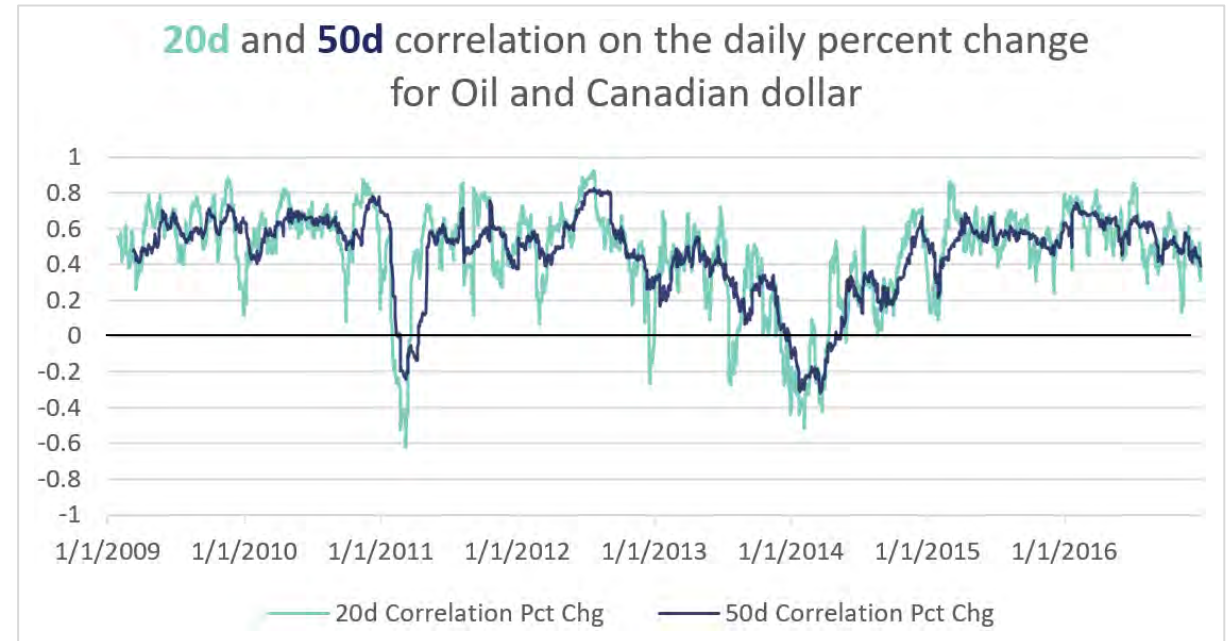
- Scatterplot: shows correlation and deviation but can only show long-term trend at best →



Case Study Canadian \$ vs Crude Oil

Rolling Statistical Correlation

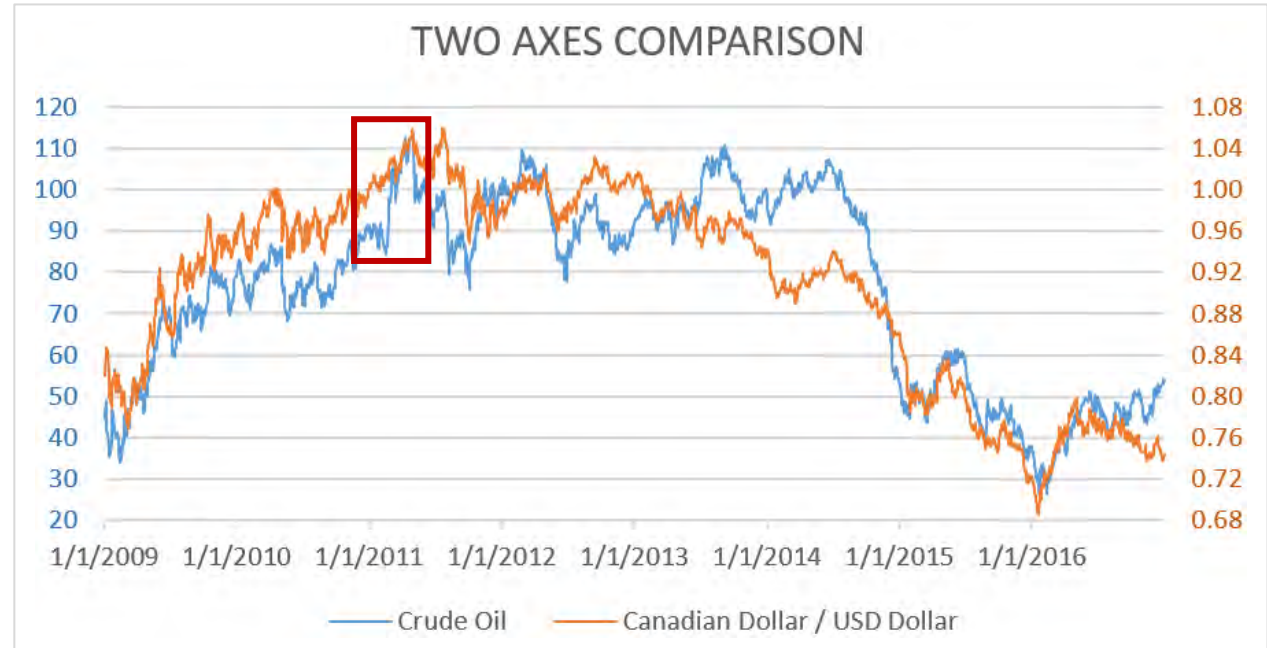
- 20 day and 50 day statistical correlation. 1.0 = perfect correlation, -1.0 = perfect negative correlation
- Useful, but rearward analysis: lags by 20 days or 50 days. Not effective for trading or forecasting.



Case Study Canadian \$ vs Crude Oil

Two Axes!

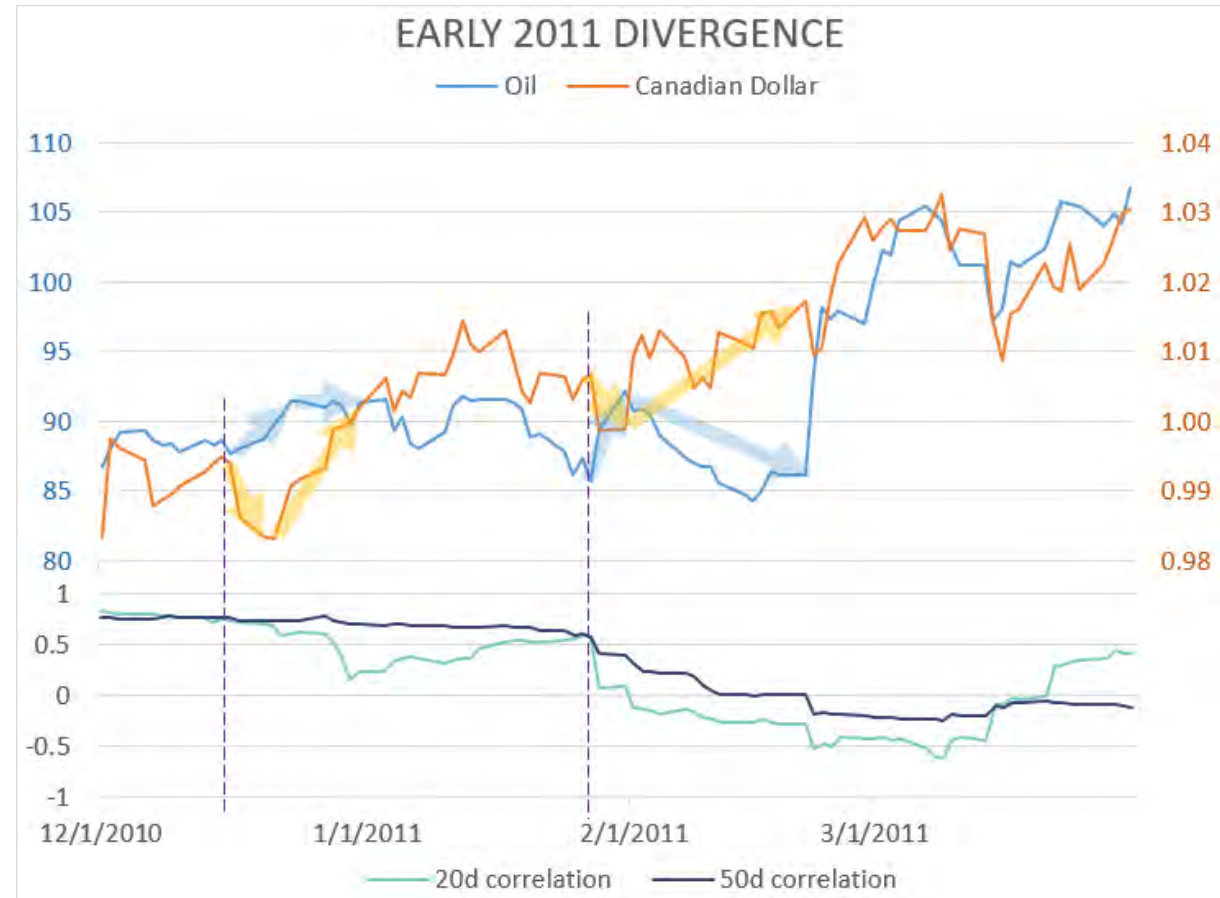
- Can see when the series move together and when they move apart.
- Can see which one turns first and which one follows



Case Study Canadian \$ vs Crude Oil

Two Axes, plus statistical correlation zoomed in

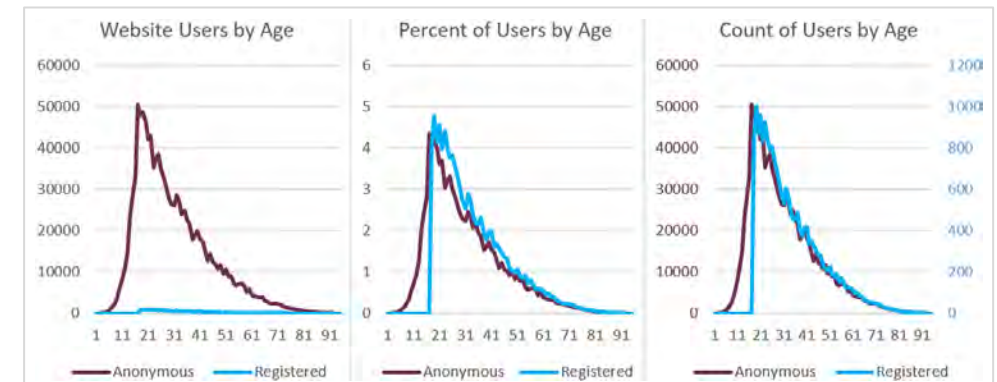
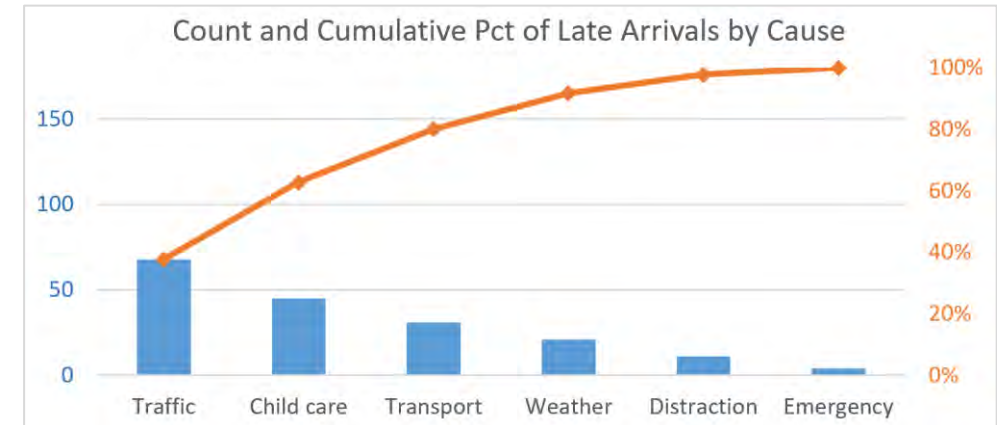
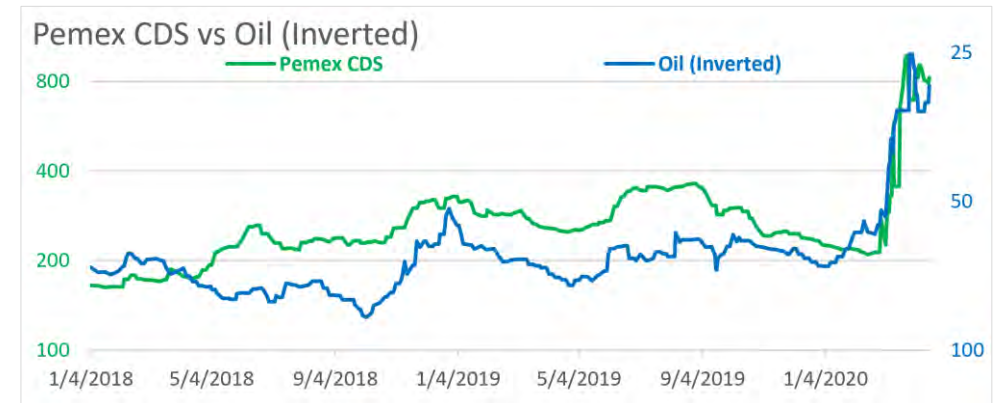
- Note how changes in the raw data (upper plot) may take a few days before becoming visible in the statistical correlation plot (lower series)



Other examples

See paper

- Inverted axes
- Pareto chart
- Distributions



And more...

Dual axes charts are prevalent among expert users in financial services

Table 1: Analysis of Dual Axis Charts from 25 financial publications by governments, banks and research firms

Publication	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Total
Number of Pages	8	8	10	11	14	15	16	18	19	20	21	22	22	24	42	47	52	52	55	56	60	72	85	85	90	924
Number of Charts	25	32	12	55	70	7	12	13	27	15	19	20	14	86	56	45	178	48	65	49	36	108	141	78	94	1305
Number of Timeseries Charts	23	30	4	55	40	6	5	13	3	15	17	8	6	70	20	24	151	48	57	42	31	58	114	43	61	944
No. of Dual Axis Timeseries Charts	3	10	4	11	4	2	2	11	0	2	4	2	2	5	2	5	57	7	9	9	5	8	0	4	11	179
Proportion of Dual Axis Charts (%)	13	33	100	20	10	33	40	85	0	13	24	25	33	7	10	21	38	15	16	21	16	14	0	9	18	19

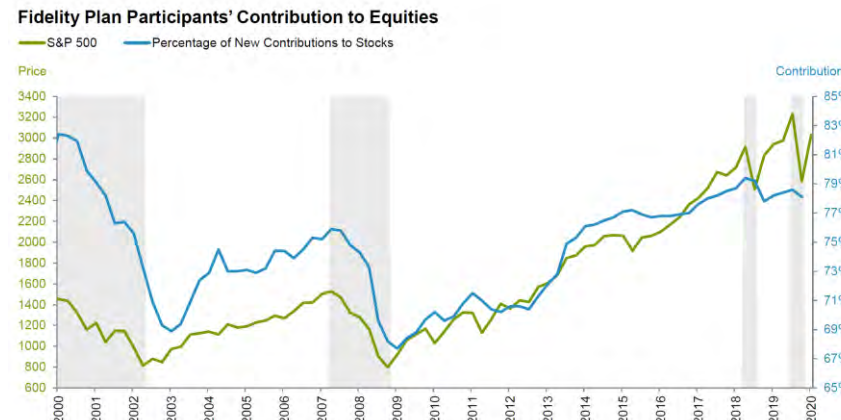
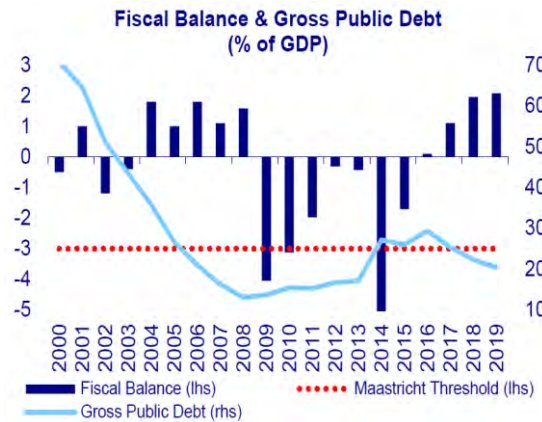
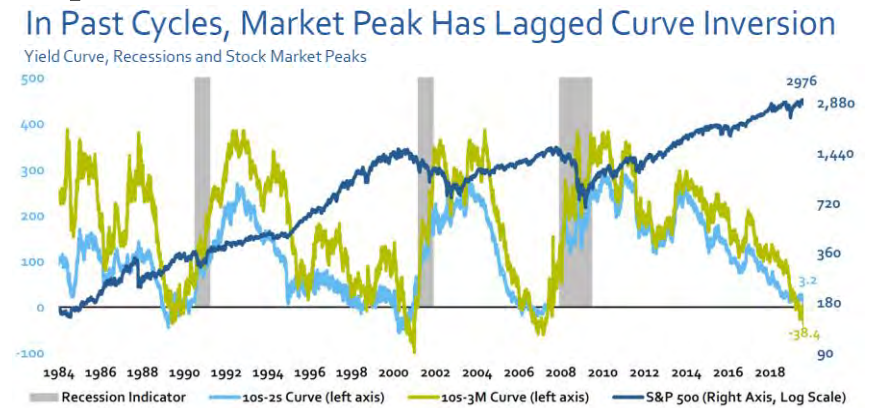
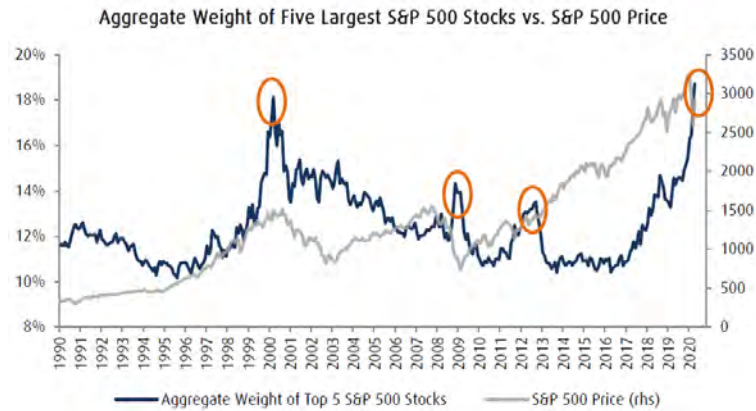
In **25** financial publications,

there were **944** timeseries charts,

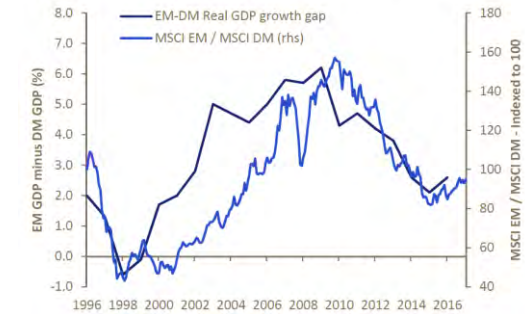
of which **179** were dual-axis,

meaning **19%** of professional financial timeseries charts are dual-axis

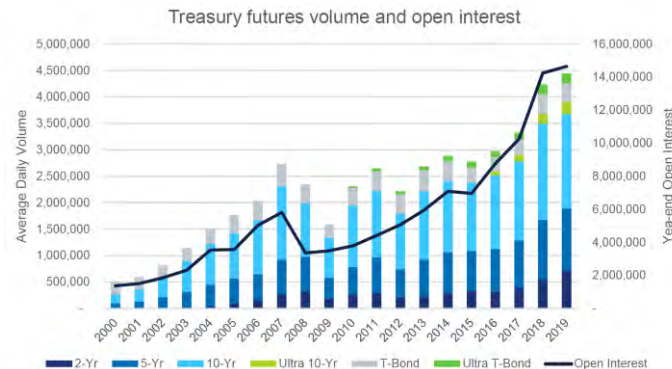
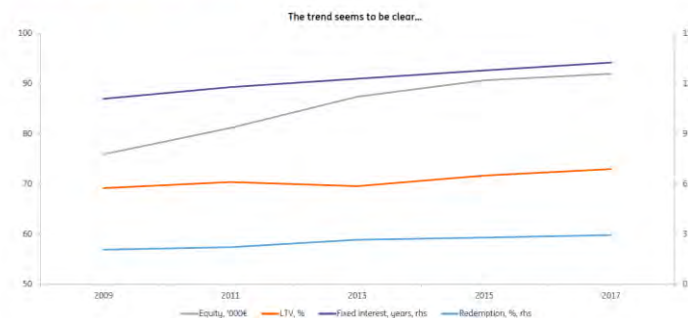
Small sample dual axis charts from financial publications



On a relative price basis, Emerging Markets appear to have plenty of runway for appreciation if they lead global economic growth



Housing bubble or not?



*see next page for publication list

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More info

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