

Inventory Analytics

From problem solving to problem discovery

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Paradigm Shift

- EOQ models
- Newsboy models
- (R,Q) models
- ...



- Do I have an inventory problem?
 1. Is inventory important to me?
 2. Does inventory impact finance?
 3. Do I have room for improvement?



Data analytics can answer these questions!

Agenda

- Macy's vs. Amazon story.
- Teaching analytics w/o coding.
- Inventory analytics – problem discovery.
- ... pick an industry / company / country ...



The Darkest Time for Macy's in 162 Years

- On 3/31/2020, Standard & Poor's announced to remove Macy's from the SP500 index.
- Macy's market cap: \$23 billion (start of 2015) → \$1.45 billion (4/1/2020).
- COVID-19 pandemic is the last straw.
- It would furlough the majority of its 125,000 employees.



The America's Dept. Stores

The Busiest Time for Amazon in 24 Years

- 4/13/2020, Amazon plans to hire 75,000 more workers to keep up with demand during pandemic.
- It has hired 100,000 new workers for its distribution centers since announcing plans to do so in mid-March.



Stock Prices – What Was The Problem?



Driving Forces Behind Retailing Industry

- The challenge
 - You do not know what customers want when they enter your online or offline stores.
 - You still need to provide the right product at the right price.

- Price
- Product variety
- Delivery
- Cash cycle



Inventory

Amazon vs Macy's: Pricing

Comparing 27 products in 8 different categories, Macy's, on average, is **26% more expensive** than Amazon.

Amazon vs Macy's: Product Variety

- 353 million*

- < 1 million**

*** "Amazon has about 19 million apparel-related SKUs, 1.2 million SKUs that qualify for Prime, and about 343,000 SKUs related to leading brands ...,"

"Walmart has 292,000 apparel-related SKUs"

"Nordstrom and Macy's carry 85,000"

"Target 35,000"

* <https://retailtouchpoints.com/resources/how-many-products-does-amazon-carry> May, 2016

** <https://www.macysinc.com/investors/news-events/press-releases/detail/1582/macys-hosts-brand-partner-summit-highlighting-business> Oct., 2019

*** <https://www.mediapost.com/publications/article/254671/amazon-poised-to-pass-macys-in-clothing-sales.html> July 23, 2015

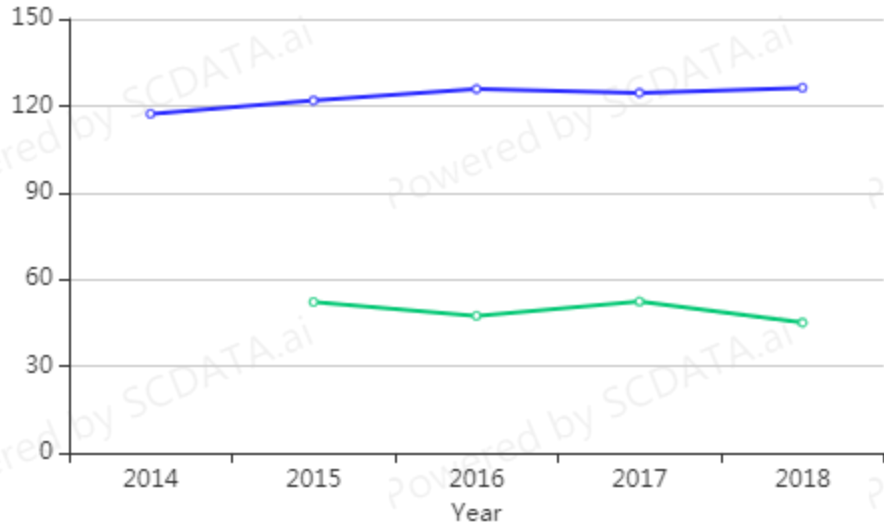
Amazon vs Macy's: Delivery

- Amazon charge little or no shipping costs (shipping is free for most items for Amazon prime subscribers).
- Macy's charges \$10.99 for shipping if the customer spends \$99 or less.

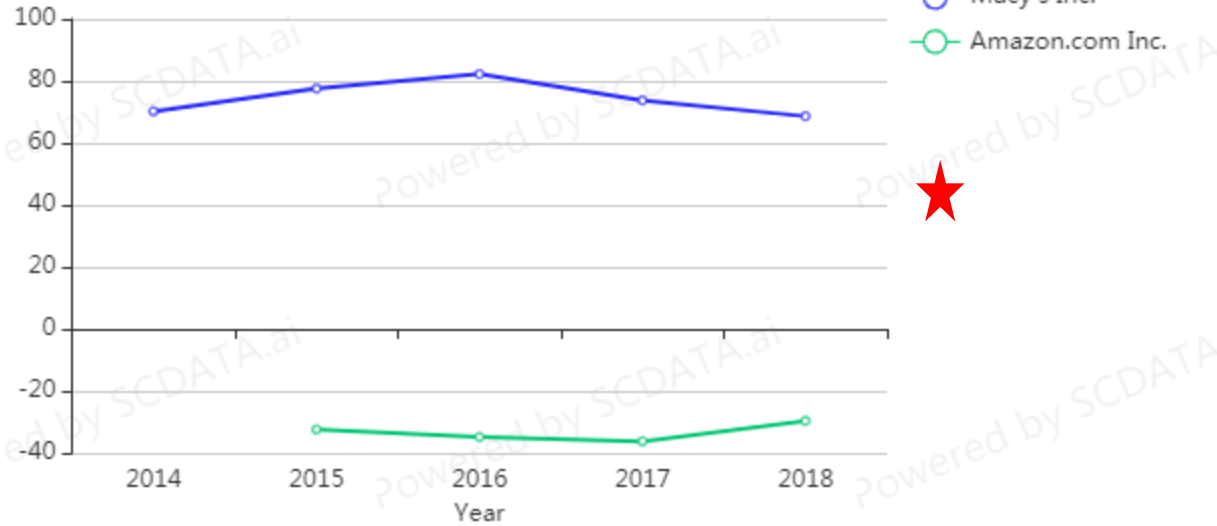
Given the data, which company provided a better product at a better price to customers?

Amazon vs Macy's: Cash Cycle

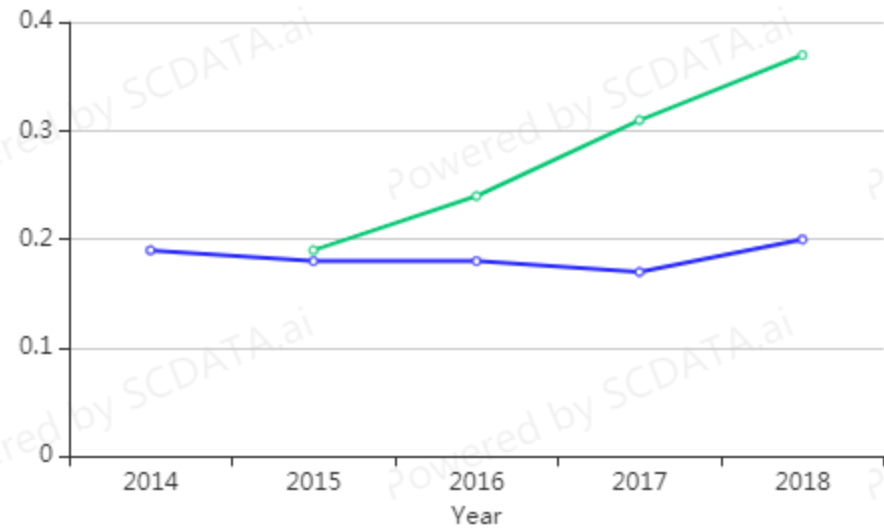
Inventory Days (Day)



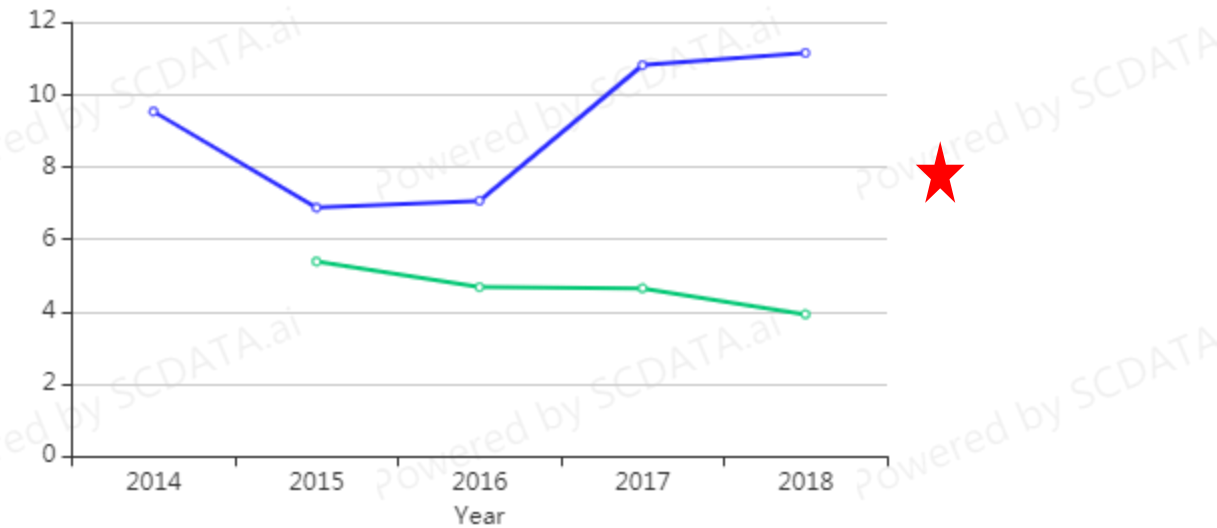
Cash Conversion Cycle (Day)



Total Revenue / Number Of Employees (Million USD)



Payable Days / Receivable Days



Teaching Objective

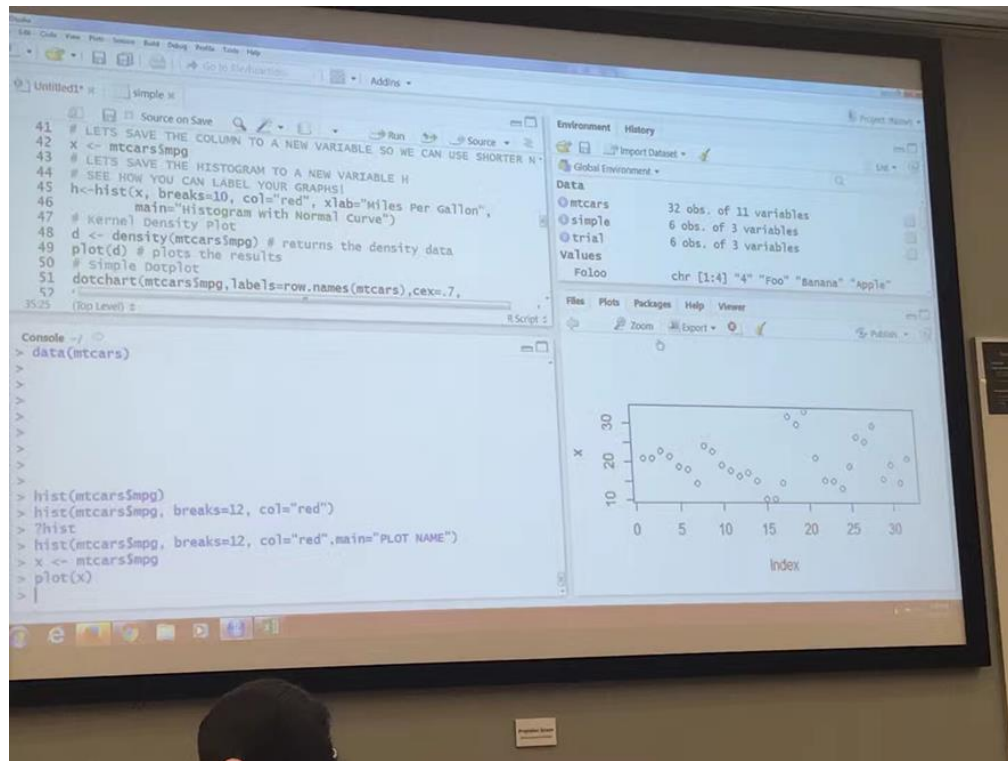
- Discover (& solve) inventory problems by data analytics
 - For which industries is inventory important?
 - How may inventory affect a company's financial performance?
 - How do I know if I have an inventory problem?



Perspectives of students, employers and instructors

TEACHING ANALYTICS W/O CODING

Everyone Likes Analytics, But Few Likes Coding



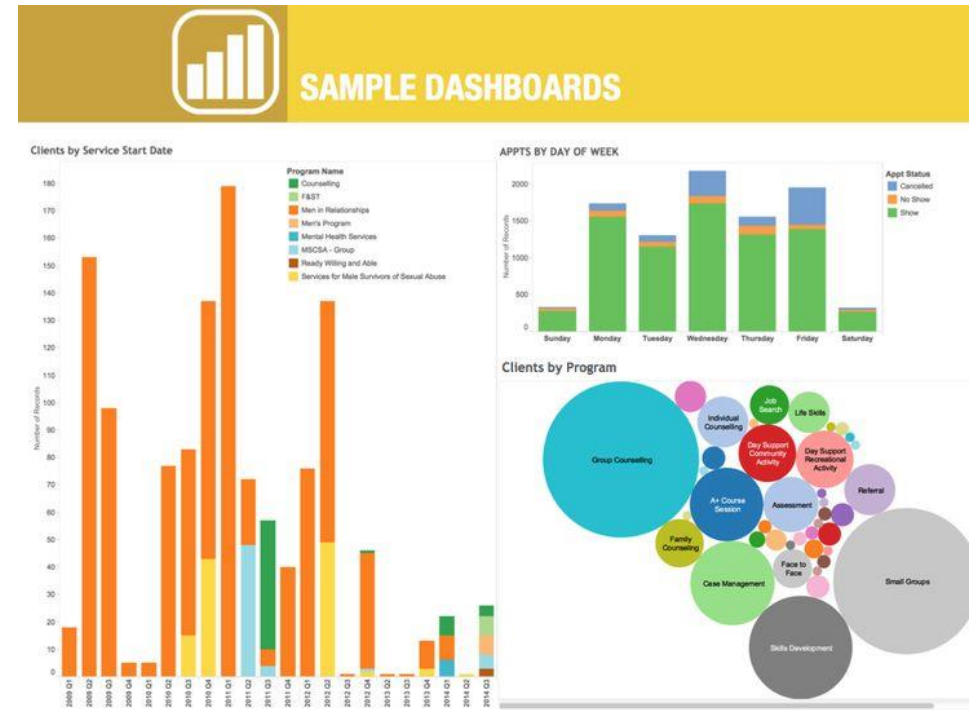
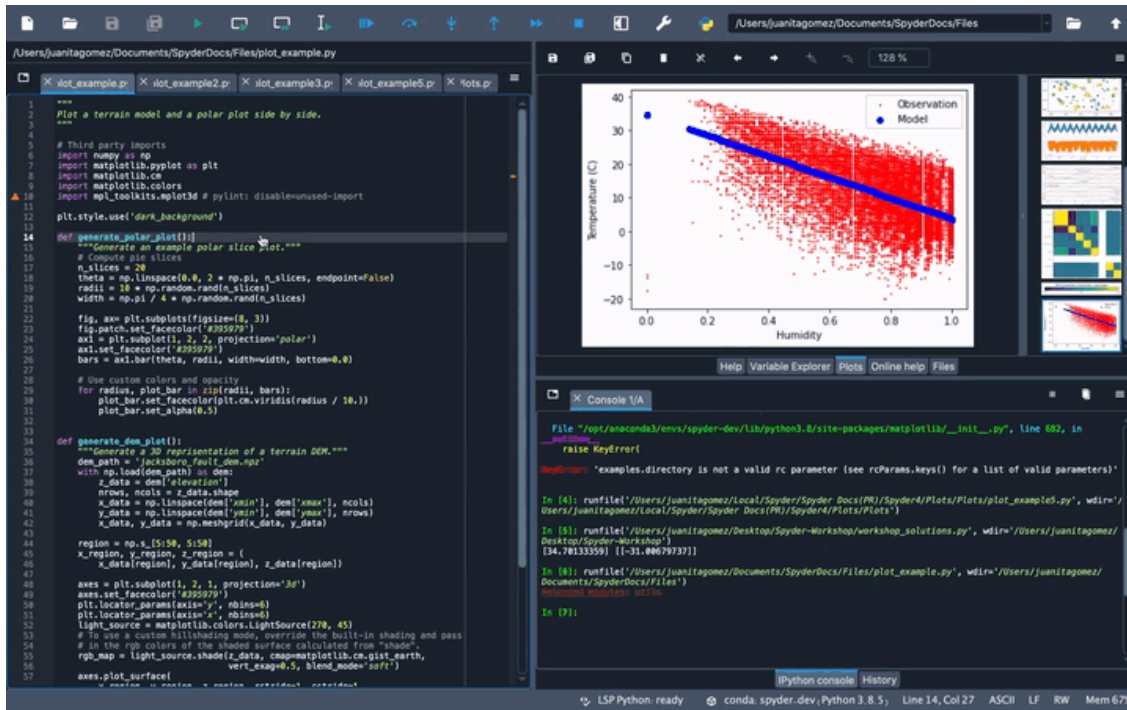
“After this class, the whole person is not feeling well!”



A Point and Shoot camera

INFORMS Definition of Analytics:

“Transforming data into insights for making better decisions”



Teach this?

Or teach that?

“We don’t need more data weenies and we don’t need more strategic marketing (supply chain) planners. What we really need are more people with **a foot in each camp** who can **make some sense** of all of this new technology.”

–Don E. Schlutz

Source: *Big Data: Prospects and Challenges*.

Available from: https://www.researchgate.net/publication/275035912_Big_Data_Prospects_and_Challenges

Inventory Analytics w/o Coding: Problem Discovery.

**IN WHICH INDUSTRIES IS
INVENTORY IMPORTANT?**









Inventory Importance

- A \$4.0B sports retailer may hold \$1.0B of inventory. A \$45B pharmacy chain may invest \$8.5B in inventory.
- SP500 retailing companies typically have 25-40% of their total assets in inventory.
- Other industries? Other countries? Other years?



For which industries is inventory important?








Benchmark by KPI - Inventory / Total Assets

Industry	90th Percentile	75th Percentile	Median	25th Percentile	10th Percentile
Capital Goods-United States	0.35	0.22	0.13	0.08	0.04
Automobiles & Components-United States	0.41	0.27	0.17 	0.08	0.05
Consumer Durables & Apparel-United States	0.73 	0.37	0.23 	0.13	0.07
Retailing-United States	0.44	0.34	0.24 	0.13	0.07
Food & Staples Retailing-United States	0.28	0.21	0.14 	0.1	0.06
Food, Beverage & Tobacco-United States	0.43	0.22	0.12	0.06	0.03
Banks-United States					
Software & Services-United States	0.14	0.05	0.01 	0	0
Technology Hardware & Equipment-United States	0.35	0.22	0.13	0.07	0.03
Semiconductors & Semiconductor Equipment-United States	0.22	0.16	0.1	0.06	0.04
Real Estate-United States	0.2	0.06	0.01 	0	0

Inventory / Total Assets. United States 2019

For which industries is inventory important?

Benchmark by KPI - Inventory / Total Assets

Industry	90th Percentile	75th Percentile	Median	25th Percentile	10th Percentile
Capital Goods-China	0.28	0.19	0.14	0.08	0.04
Automobiles & Components-China	0.2	0.15	0.11	0.08	0.05
Consumer Durables & Apparel-China	0.3	0.22	0.14 	0.09	0.04
Retailing-China	0.37	0.25	0.13 	0.04	0.01
Food & Staples Retailing-China	0.32	0.24	0.15 	0.07	0.02
Food, Beverage & Tobacco-China	0.29	0.21	0.13	0.07	0.04
Banks-China					
Software & Services-China	0.18	0.11	0.05 	0.01	0
Technology Hardware & Equipment-China	0.23	0.17	0.12	0.08	0.05
Semiconductors & Semiconductor Equipment-China	0.24	0.16	0.09	0.05	0.03
Real Estate-China	0.68 	0.55	0.35 	0.09	0

Inventory / Total Assets. China 2019

For which industries is inventory important?

Benchmark by KPI - Inventory Days (Day)

Industry	90th Percentile	75th Percentile	Median	25th Percentile	10th Percentile
Capital Goods-United States	172.29	109.68	72.57	44.42	20.32
Automobiles & Components-United States	404.92	119.52	63.72	42.64	24.58
Consumer Durables & Apparel-United States	356.96	188.34	114.2	76.49	45.14
Retailing-United States	189.16	128.86	85.72	56.49	27.4
Food & Staples Retailing-United States	55.23	41.1	31.9	26.28	15.8
Food, Beverage & Tobacco-United States	296.64	128.65	66.47	45.29	28.86
Household & Personal Products-United States	598.21	238.37	133.83	87.25	46.76
Pharmaceuticals, Biotechnology & Life Sciences-United States	702.19	291.68	149.94	72.32	31.72
Technology Hardware & Equipment-United States	213.68	132.2	83.04	50.62	26.38
Semiconductors & Semiconductor Equipment-United States	273.82	154.22	110.19	75.22	45.45
Real Estate-United States	1,339.56	130.63	28.81	8.4	2.28

Inventory Days. United States 2019

For which industries is inventory important?

Benchmark by KPI - Inventory Days (Day)

Industry	90th Percentile	75th Percentile	Median	25th Percentile	10th Percentile
Capital Goods-China	318.03	204.37	122.34	70.49	32.12
Automobiles & Components-China	177.04	128.67	91.14	60.34	37.78
Consumer Durables & Apparel-China	289.33	162.1	86.92	55.24	26.72
Retailing-China	402.76	187.33	80.92	31.7	15.18
Food & Staples Retailing-China	321.3	103.74	66.22	48.24	22.58
Food, Beverage & Tobacco-China	505.03	182.7	87.48	52.82	30.89
Household & Personal Products-China	241.27	178.87	101.13	68.42	38.29
Pharmaceuticals, Biotechnology & Life Sciences-China	489.57	266.8	165.56	111.65	65.91
Technology Hardware & Equipment-China	261.61	157.63	92.29	53.21	33.79
Semiconductors & Semiconductor Equipment-China	377.63	175.14	114.53	63.36	36.58
Real Estate-China	5,236.89	2,509.61	1,374.47	682.13	10.25

Inventory Days. China 2019

For which industries is inventory important (2019)?

US



Retailing

Median: 24% of assets is inventory, 85 days



Food / staple retailing



Consumer durables / apparel

China



Real estate

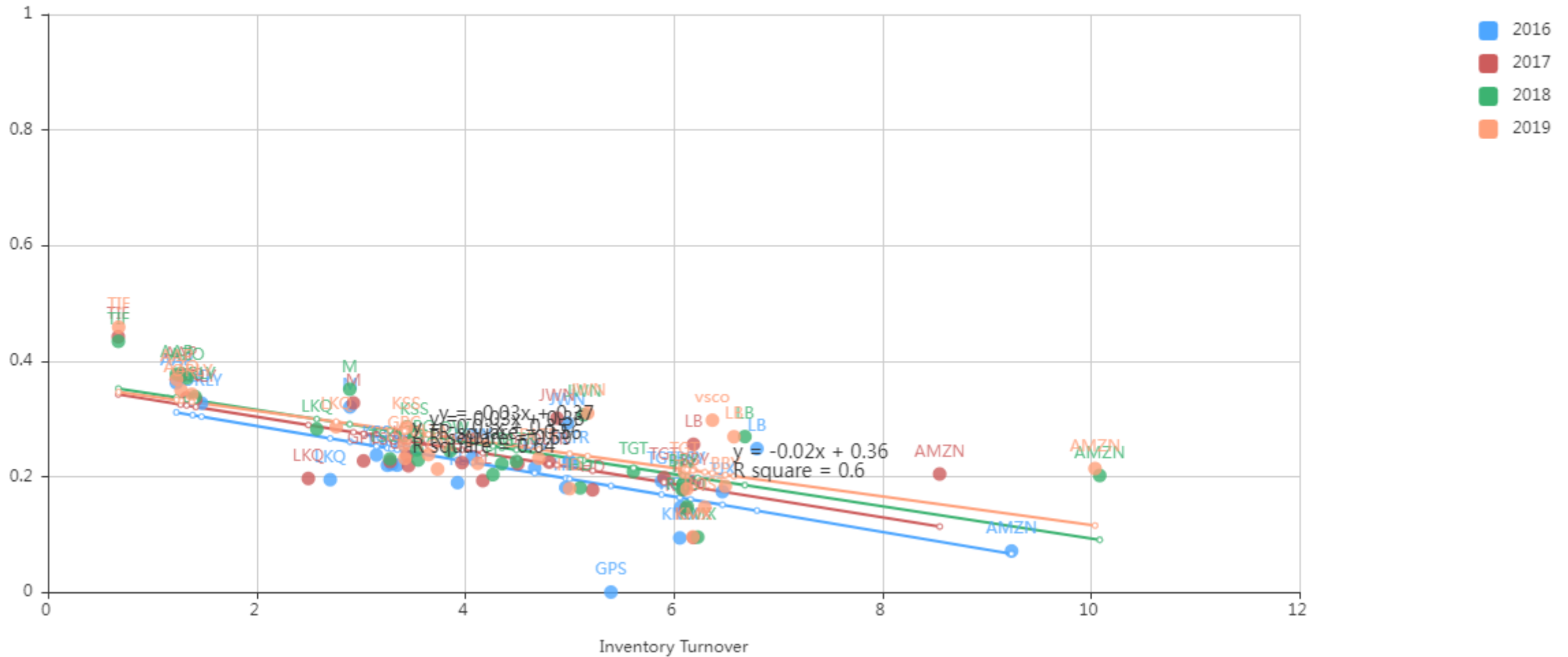
Median: 35% of assets is inventory, 1374 days.

Inventory Analytics w/o Coding: Problem Discovery.

HOW MAY INVENTORY AFFECT FINANCIAL PERFORMANCE?

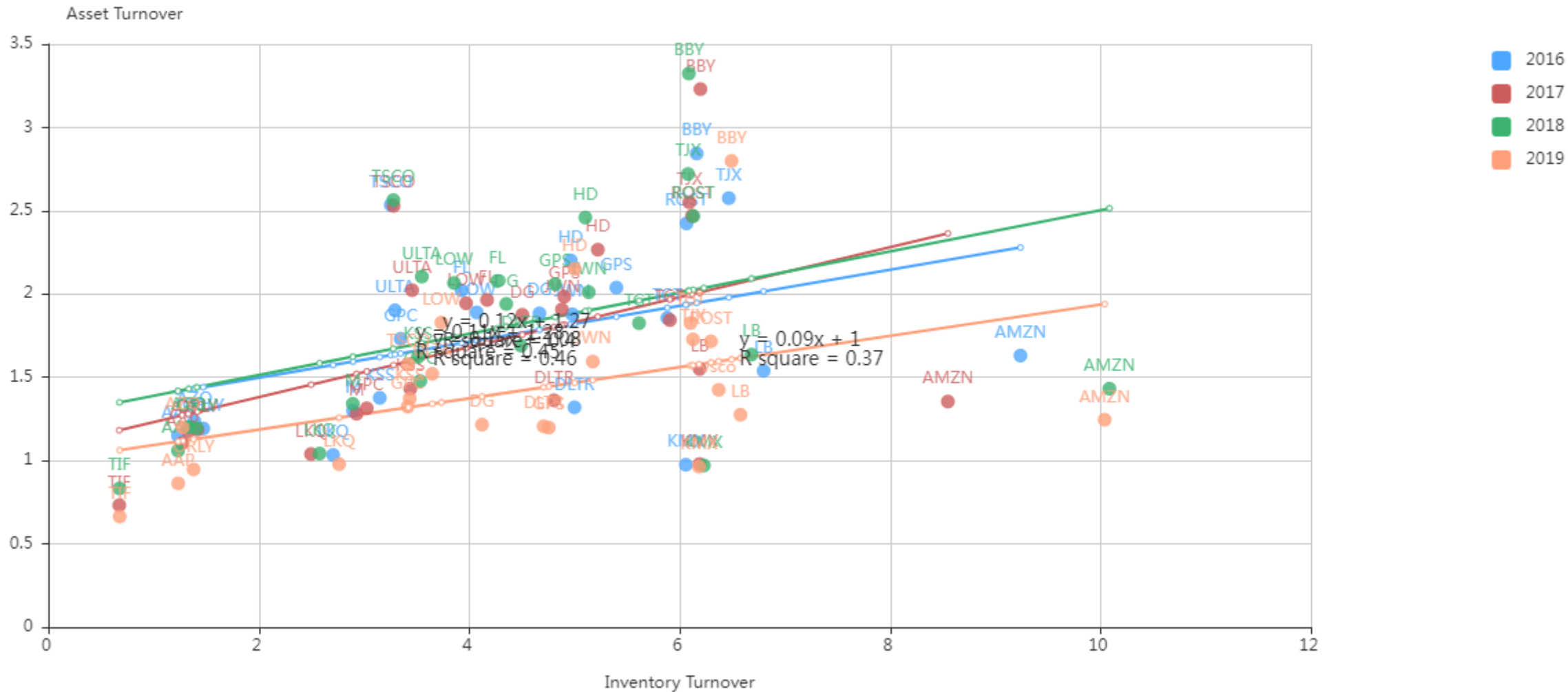
Inventory negatively correlates with SG&A cost / revenue

Sales General Admin Cost / Total Revenue



US retailing (S&P500)

Inventory positively correlates asset turnover



US retailing (S&P500)

Inventory Analytics w/o Coding: Problem Discovery.

**HOW DO I KNOW IF I HAVE AN
INVENTORY PROBLEM?**

Benchmarking

If my revenue is half of yours but I hold the same amount of inventory as you do, then I must have an inventory problem!

amazon

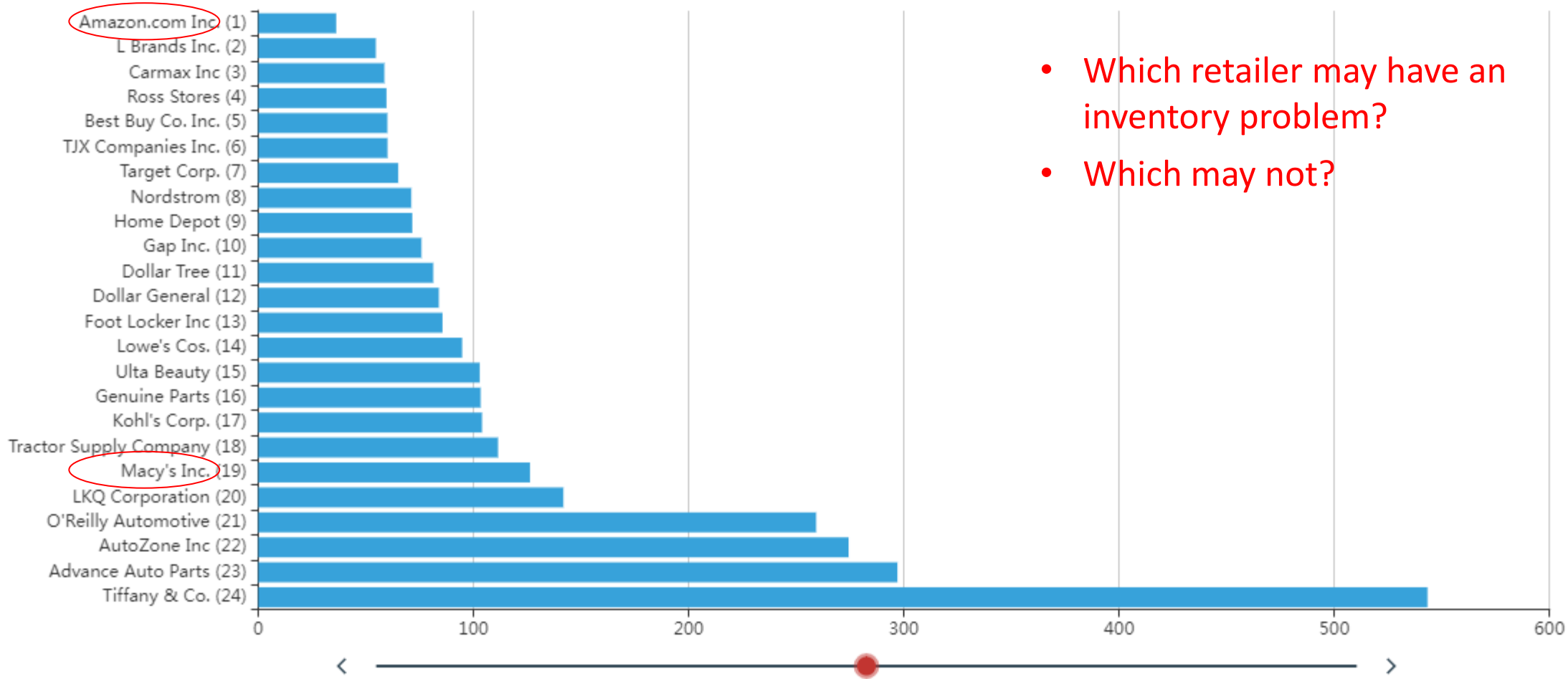
The Amazon logo consists of the word "amazon" in a bold, black, lowercase sans-serif font. Below the text is a curved orange arrow that starts under the letter 'a' and points to the right, ending under the letter 'n'.

vs.



How do I know if I have an inventory problem?

Enterprise Ranking - Inventory Days (Day)

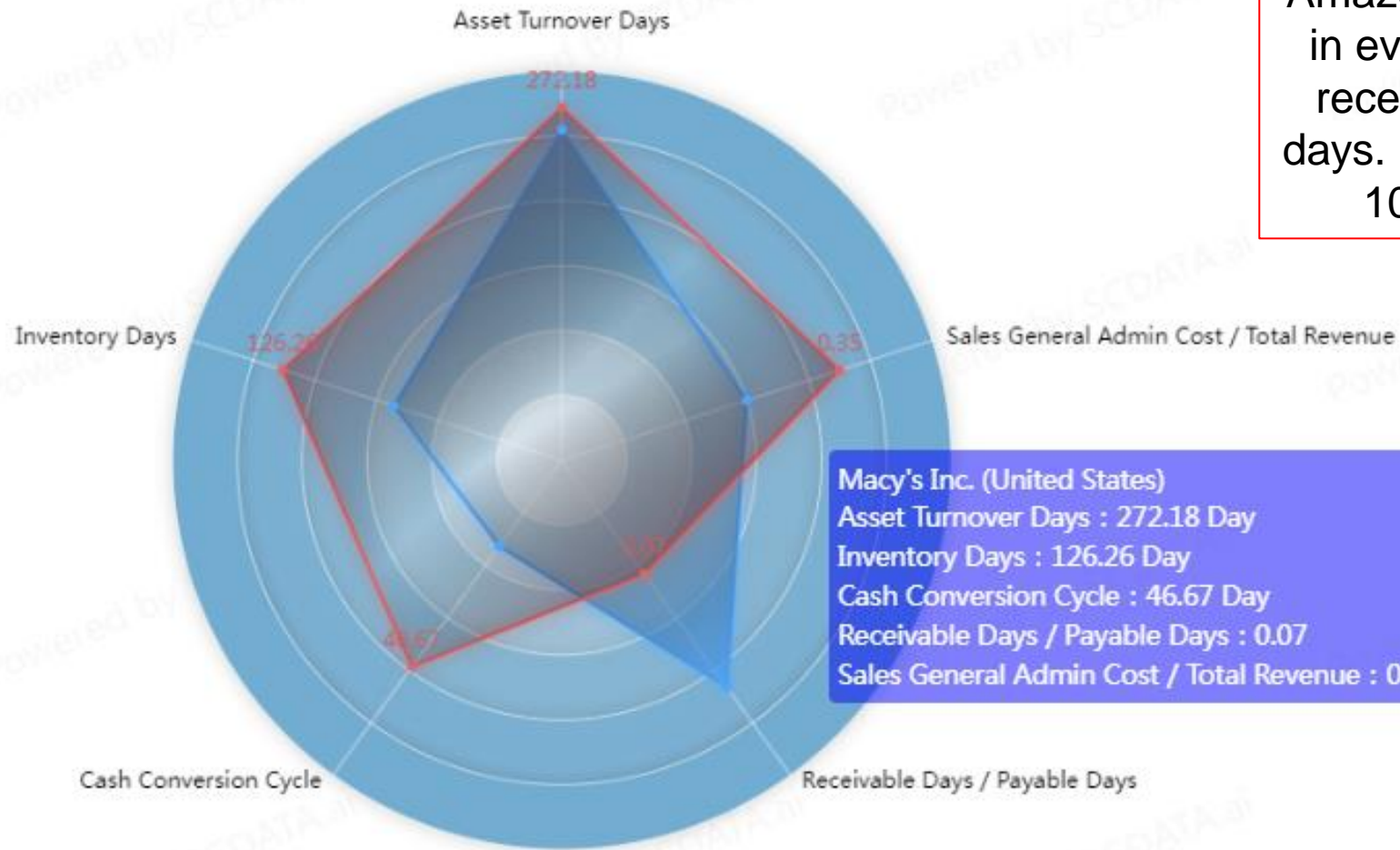


- Which retailer may have an inventory problem?
- Which may not?

US retailing, 2018, S&P500.

Enterprise Comparison - Efficiency

(Smaller the better)

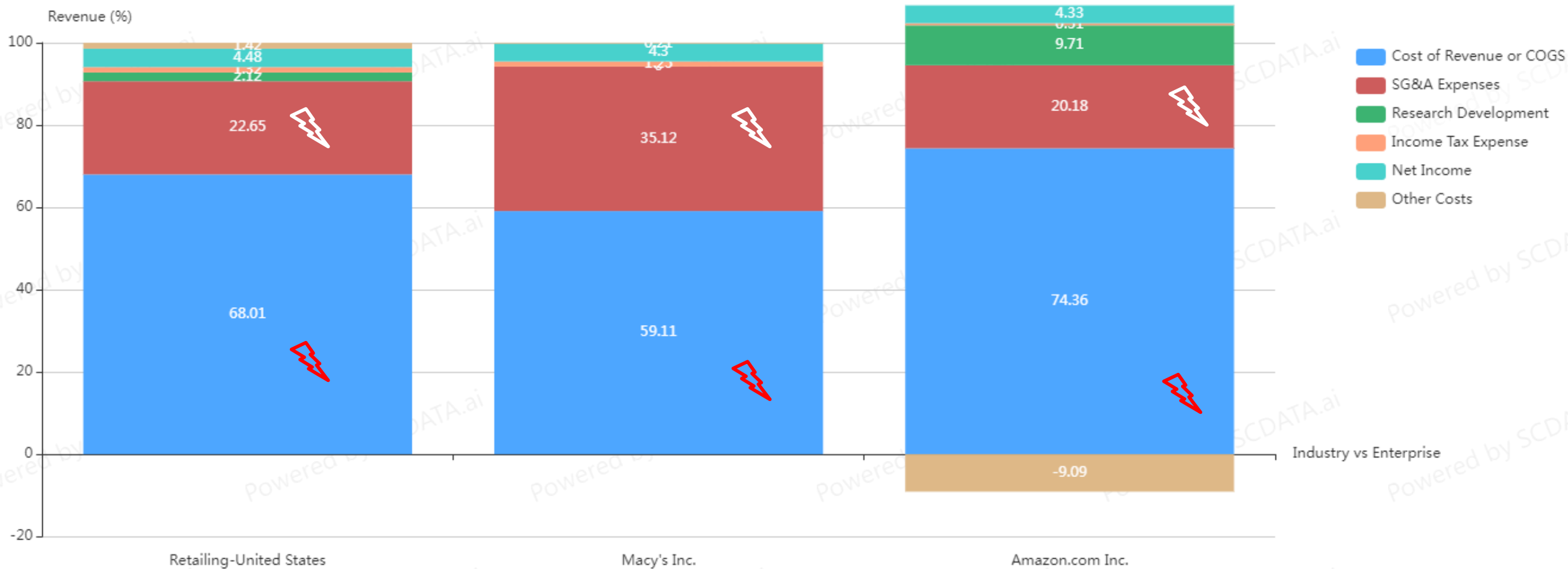


Macy's Inc. (United States)
Asset Turnover Days : 272.18 Day
Inventory Days : 126.26 Day
Cash Conversion Cycle : 46.67 Day
Receivable Days / Payable Days : 0.07
Sales General Admin Cost / Total Revenue : 0.35

Amazon outperforms Macy's in every dimension except receivable days / payable days. Macy's payable days > 10x receivable days!

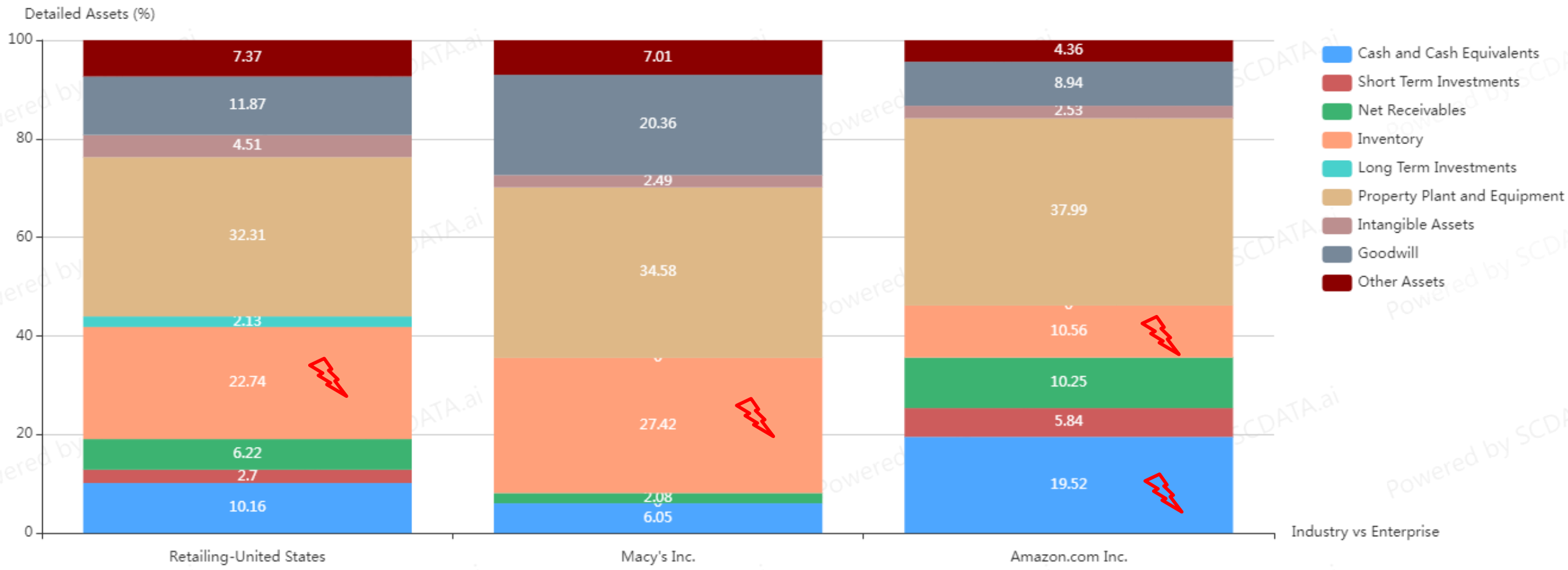
● Amazon.com Inc. (United States)
● Macy's Inc. (United States)

Macy's high pricing & SG&A vs. Amazon low pricing & SG&A.



US Retailing – Revenue Breakdown 2018

Industry average 23%, Macy's 27%, Amazon 11%
 Macy's clearly has an inventory problem!



US Retailing – Asset Breakdown 2018

KPI Examination of An Enterprise



Physical examination of a person



KPI examination of an enterprise

Objectives

- Where you stand in the population



- Warning signals for potential issues.



Class	The Value of Amazon.com Inc.	The Percentile Rank of Amazon.com Inc.	90th Percentile	3rd Quartile (75th Percentile)	Median	1st Quartile (25th Percentile)	10th Percentile	Status	Unit
Profitability									
Gross Margin	0.256	0.21	0.66	0.49	0.36	0.28	0.16	Low	
Operating Margin	0.053	0.59	0.12	0.08	0.04	0	-0.15	Normal	
Net Margin	0.043	0.68	0.09	0.05	0.02	-0.03	-0.18	Normal	
Return on Assets	0.061	0.64	0.15	0.09	0.04	-0.06	-0.35	Normal	
Return on Invested Capital	0.15	0.74	0.31	0.16	0.07	-0.02	-0.2	Normal	
Financial Health									
Free Cash Flow / Total Cost	0.078	0.83	0.1	0.07	0.03	-0.02	-0.23	High	
Current Ratio	1.098	0.22	3.77	2.29	1.69	1.14	0.82	Low	
Liability Asset Ratio	0.732	0.65	1.31	0.82	0.65	0.46	0.31	Normal	
Growth									
Total Revenue Growth Rate	0.309	0.87	0.45	0.14	0.05	0.01	-0.07	High	
Operating Income Growth Rate	2.025	0.98	0.49	0.18	0	-0.21	-0.68	High	
Net Income Growth Rate	2.321	0.95	0.77	0.28	0	-0.48	-2.33	High	
Free Cash Flow Growth Rate	1.669	0.88	1.74	0.6	0.09	-0.46	-1.55	High	
Operational Efficiency									
Sales General Admin Cost / Total Revenue	0.201	0.19	0.69	0.44	0.3	0.23	0.15	Low	
Inventory Days	36.195	0.1	192.6	135.43	87.98	59.82	33.16	Low	day
Cash Conversion Cycle	-68.032	0.13	134.46	73.96	28.79	-9.48	-170.96	Low	day

Quite profitable

Fine health

Highest growth

Very efficient

Amazon KPI Examination

Class	The Value of Macy's Inc.	The Percentile Rank of Macy's Inc.	90th Percentile	3rd Quartile (75th Percentile)	Median	1st Quartile (25th Percentile)	10th Percentile	Status	Unit
Profitability									
Gross Margin	0.408	0.64	0.66	0.49	0.36	0.28	0.16	Normal	
Operating Margin	0.057	0.62	0.12	0.08	0.04	0	-0.15	Normal	
Net Margin	0.043	0.67	0.09	0.05	0.02	-0.03	-0.18	Normal	
Return on Assets	0.057	0.61	0.15	0.09	0.04	-0.06	-0.35	Normal	
Return on Invested Capital	0.099	0.62	0.31	0.16	0.07	-0.02	-0.2	Normal	
Financial Health									
Free Cash Flow / Total Cost	0.033	0.51	0.1	0.07	0.03	-0.02	-0.23	Normal	
Current Ratio	1.423	0.39	3.77	2.29	1.69	1.14	0.82	Normal	
Liability Asset Ratio	0.664	0.56	1.31	0.82	0.65	0.46	0.31	Normal	
Growth									
Total Revenue Growth Rate	0.036	0.41	0.45	0.14	0.05	0.01	-0.07	Normal	
Operating Income Growth Rate	-0.045	0.43	0.49	0.18	0	-0.21	-0.68	Normal	
Net Income Growth Rate	-0.284	0.32	0.77	0.28	0	-0.48	-2.33	Normal	
Free Cash Flow Growth Rate	-0.322	0.3	1.74	0.6	0.09	-0.46	-1.55	Normal	
Operational Efficiency									
Sales General Admin Cost / Total Revenue	0.351	0.61	0.69	0.44	0.3	0.23	0.15	Normal	
Inventory Days	126.256	0.71	192.6	135.43	87.98	59.82	33.16	Normal	day
Cash Conversion Cycle	46.67	0.62	134.46	73.96	28.79	-9.48	-170.96	Normal	day

Less profitable

Fine health

Little growth

Very inefficient

Macy's KPI Examination

Summary

Amazon

Quite profitable

Fine health

Highest growth

Very efficient

Macy's

Less profitable

Fine health

Little growth

Very inefficient

Efficiency allows Amazon to make more profit with a lower price, and grow much faster than Macy's

Interactive session:

**PICK AN INDUSTRY / COMPANY /
COUNTRY ...**



For more information

<https://www.scddata.ai/project/70>