EXECUTIVE MBA
BUSINESS STATISTICS
HANKEN SHOOL OF ECONOMICS

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CENTER FOR ECONOMIC STATISTICS

INFORMATION ABOUT ME

- Ph.D. Econometrics; MS.c. Mathematics; MS.c. Business Administration; B.Sc. Statistics
- Associate Professor Econometrics at Stockholm School of Economics (SSE)
- Adjunct Professor Sapporo University, Japan
- Head of Center for Economic Statistics SSE
- Co-founder Stockholm Business Forecasting Group
- 20 years of experience teaching various statistical courses
- Reserach interests: Financial Econometrics; Forecasting; SEM
- Consultancies: CFI Group; SKB; Niam; Vattenfall Group; Swedbank; etc.
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TODAY'S SCHEDULE

- 09.00-10.30 Introduction/Part 1
- 10.30-11.00 Break
- 11.00-12.30 Part 2
- 12.30-13.30 Lunch
- 13.30-15.00 Presentation Peter Eriksson CFI Group
- 15.00-15.30 Break
- 15.30-17.00 Part 3

THE DIFFERENT PARTS

- Part 1: Quality of data; Basic Statistics
- Part 2: Correlation; Causality; Prediction; Measurements of Metrics
- Part 3: More Advanced Methods and Models

SOME LEARNING OBJECTIVES

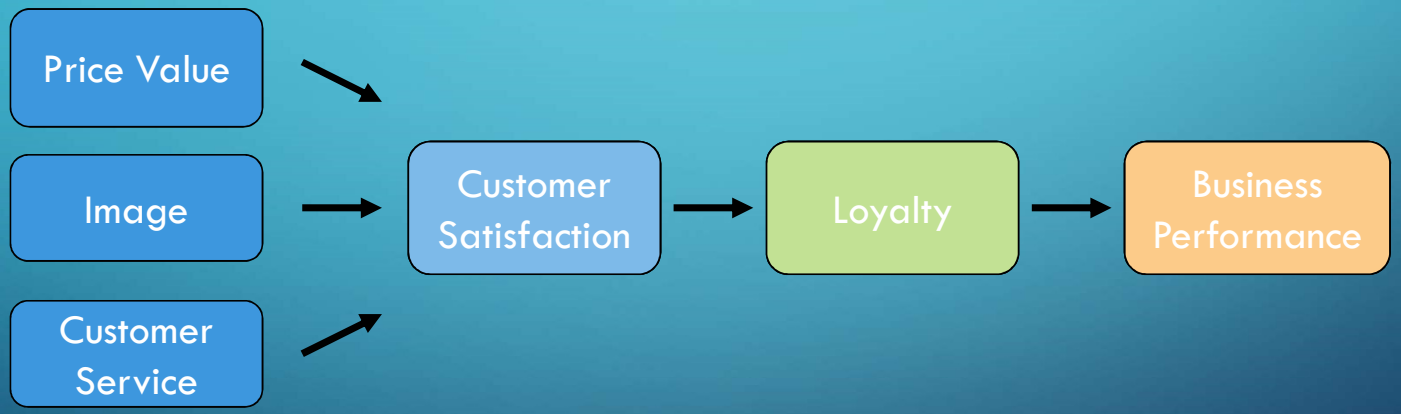
- Assess the quality of data
- How to create meaningful information from data (surveys, polls, market research, etc.)
- Statistics for decision making (from data to analysis to action)
- Improve your statistical competence

RESEARCH AND BUSINESS DATA

- Where the industry and the research meet
- Using models and methods in your analysis that have been validated via research may be worthwhile
- Provide support to distinguish between suitable and less suitable approaches

THE CENTERPIECE OF TODAY'S MODULE IS CUSTOMER SATISFACTION

- Why Customer Satisfaction?



CUSTOMER SATISFACTION…

- Is the metric managers use most widely to gauge customer loyalty
- Relates to retention, increased share of spending and positive word of mouth (i.e., loyalty), growth/profitability/market shares (improved financial performance)
- Is an indicator of a healthy company
- Is a measure of performance towards the future. Some even consider customer satisfaction to be the best indicator of a company's future profits (Kotler, 1988)
- Is a complement to traditional measures of performance such as return on investment, market share and profits
- Is a complement to the four marketing P's: product, price, place and promotion

- Provides information about industry comparisons
- Provides comparison of individual firms with the industry average
- Provides comparison over time
- Provides predictions of long-term performance
- Provides answers to specific questions

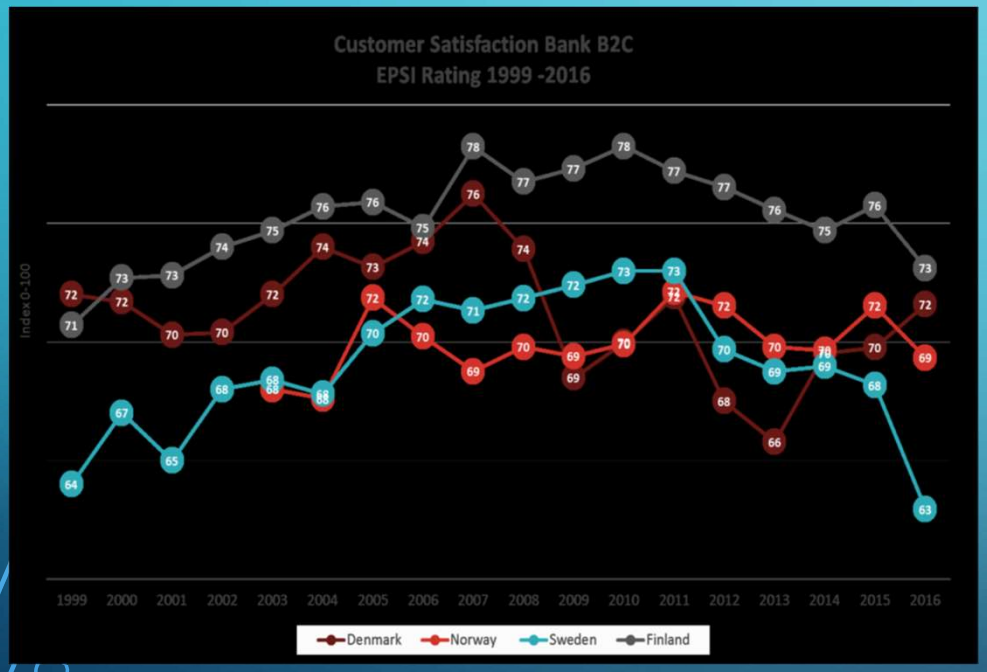
SECTOR/INDUSTRY ACSI

FIGURE 2
1994 Baseline ACSI Results

ACSI
National Score = 74.5

Manufacturing Nondurables 81.6	Manufacturing Durables 79.2	Transportation, Communications, Utilities 75.4	Retail 75.7	Finance, Insurance 75.4	Services 74.4	Public Administration, Government 64.3
82 Apparel	79 Automobiles	72 Airlines	77 Department Stores	74 Banks/ Commercial	74 Hospitals	Garbage Service:
79 Athletic Shoes	83 Consumer Electronics	77 Broadcasting, Television	77 Discount Stores	77 Insurance/ Life	75 Hotels	74 Central City
83 Beer	85 Household Appliances	75 Electric Service	69 Restaurants, Fast Foods	81 Insurance/ Property	77 Motion Pictures	74 Suburban
81 Cigarettes	78 Personal Computers, Printers	81 Express Delivery	76 Supermarkets			Police:
87 Canned Food		79 Phone/Local				61 Central City
87 Chocolate		82 Phone/Long Distance				65 Suburban
86 Milk, Ice Cream		60 U.S. Postal Service				55 Internal Revenue Service
84 Baked Goods						
82 Cold Meats, Cheese						
83 Cereal						
78 Gasoline						
72 Newspapers						
84 Personal Care						
86 Soft Drinks						

Source: Fornell (1996)



Source: EPSI Rating Group

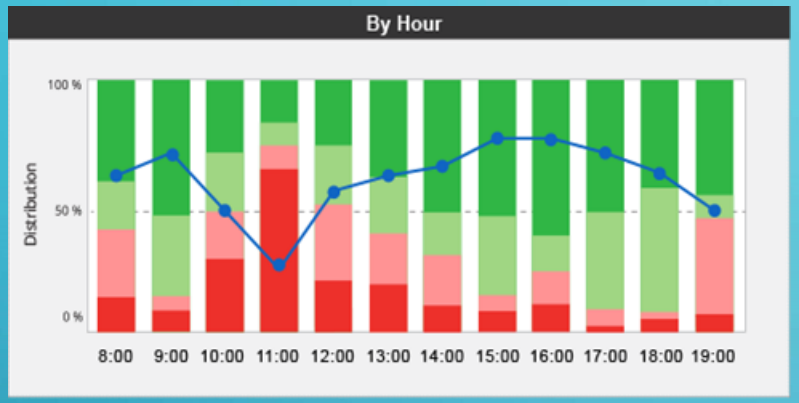
Företagskunder	2016	Jämfört med 2015 (indexenheter)
Sparbankerna	71,9	-1,9
Handelsbanken	69,4	-4,7
Övriga banker	69,3	3,5
Danske Bank	68,0	-2,6
SEB	67,6	-2,5
Branschen	64,5	-4,4
Swedbank	59,5	-4,9
Nordea	55,4	-9,5

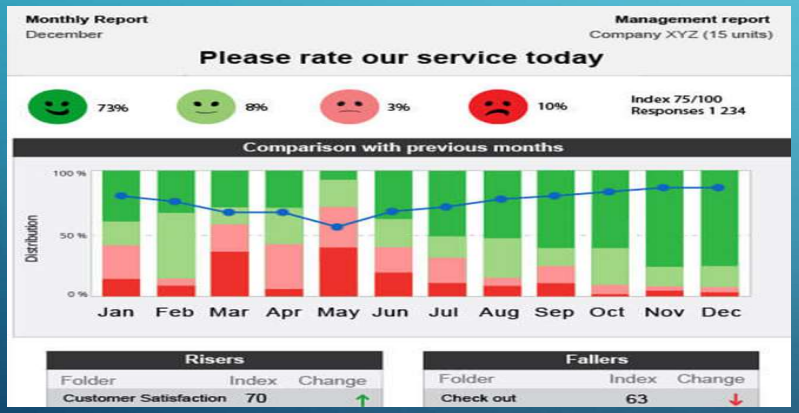
Source: EPSI Rating Group

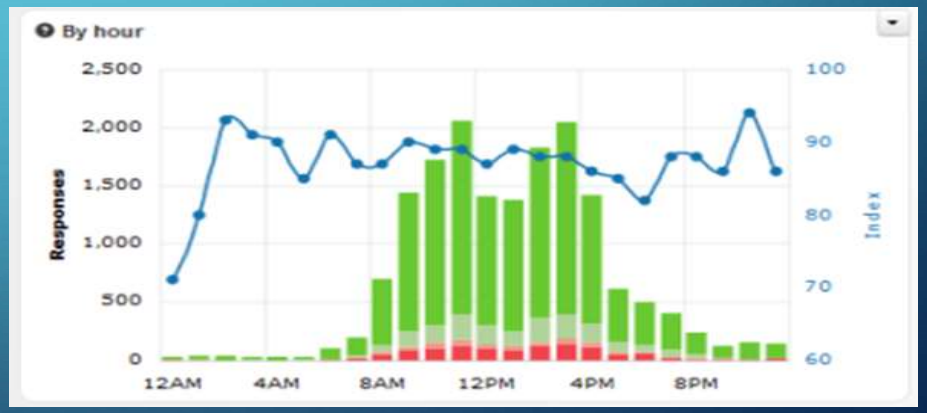
HAPPY OR NOT ANALYSIS

- And in the sequel of measuring Customer Satisfaction, can we for instance be more informative than a happy or not analysis?

NONETHELESS YIELDING RESULTS AS







MY "RELATIONSHIP" TO CUSTOMER SATISFACTION

- I was introduced to Customer Satisfaction related issues by Professor Emeritus Anders Westlund (SSE, Center for Economic Statistics).
- Anders is a research collogue of Claes Fornell, one of the world's leading experts on customer satisfaction measurement and customer asset management, the Donald C. Cook Distinguished Professor Emeritus of Business Administration at University of Michigan's Ross School of Business. Claes is the founder of CFI Group, the ACSI, etc. By 2013, Claes is also the author of 3 of the 20 most influential papers in marketing science and marketing practice published in leading academic marketing journals over a 20-year period
- My connections to Anders and Claes also led to my current role as senior advisor at the CFI Group, as well as my former role as senior advisor at the Vattenfall Group (at the Brand Management and Business Intelligence division)

CUSTOMER SATISFACTION AND BUSINESS STATISTICS

- Customer Satisfaction is also useful for the discussion of various statistcial concepts, methods and models critical for decision making
- Different measures of Customer Satisfaction (and measures of other variables such as Loyalty in the previous figure) will be discussed
- I will also mention some of the pitfalls using less suitable measures/models for Customer Satisfaction. I will also indicate some consequences of using less optimal measures/models (costly, missing opportunities, loosing market shares/less investments, etc.)

THE PRE-MODULE

- The objective of the pre-module was to critically reflect on the informational quality of statistics. And, you were supposed to select the most important or critical statistics in your job (KPI's), such as customer, financial, or industry related, information that is vital to the performance or quality of your job. Reflect on the following aspects of your chosen statistic:
    * Why is it critically important?
    * What decisions do you base on this information?
    * Are you confident with the accuracy and sources of data (size, timeline, method etc.)?
    * What is the quality and value of the information derived from this statistic?
    * Could it be developed to be even more valuable for your decision making? How?

EXAMPLE KPI'S

- Revenue growth
- Sales
- Market shares
- Indicators of shareholder value: operating cash flow; cash flow volatility (an indicator of financial risk)
- Tobin's Q (value of intangible assets such as knwoledge, IP, human capital, etc.)
- The price-to-book ratio (the ability to generate cash flows from assets)
- Financial performance measures: Market capitalization (stock value), Costs as a fraction of revenue; Return on Equity, Return on Asset, Return on Investment
- Etc.

EXAMPLE KPI'S CONTINUED

- Customer satisfaction
- Employee satisfaction
- Service quality
- Product quality
- Image
- Complaints
- word-of-mouth
- Etc.

SOME OF THE KPI'S YOU REPORTED

- Internal Rate of Return (IRR); Distribution to be Paid in capital (DPI); Total Value to be paid in capital (TVPI)
- Transportation and warehouse costs, inventory turns, product availability, timeliness of deliveries, demand forecast accuracy, personnel turnover
- Share of voice in media
- Customer amount
- Construction cost
- Sales opportunities, Profit margin, Cash flow
- Transactions/second
- Chargeability
- Itemized SKU Sales Report
- Earnings before interest, taxes, depreciation, and amortization (EBITDA), Earnings before interest and taxes (EBIT), Operating profit, Investments, Cash Flow
- Churn
- Revenue growth, Productivity improvements, Annual revenue/billable consultant
- Turn-Earn Index

THE NATURE OF THE KPI'S

- Some of the KPI's reported are directly observable
- Some are not directly observable
- Some are more critical than others
- Some are causing the other, some are being caused by another
- For some KPI's we can use data to figure out key drivers and establishing casual relationships
- Which KPI's to use? There are many? Some must be used! The ones that are easy to measure? The relevant ones? The ones that can be effected to trigger a bonus?

PART 1

1.1 DATA AND INFORMATION

1.2 THE QUALITY OF DATA

1.3 BASIC STATISTICS

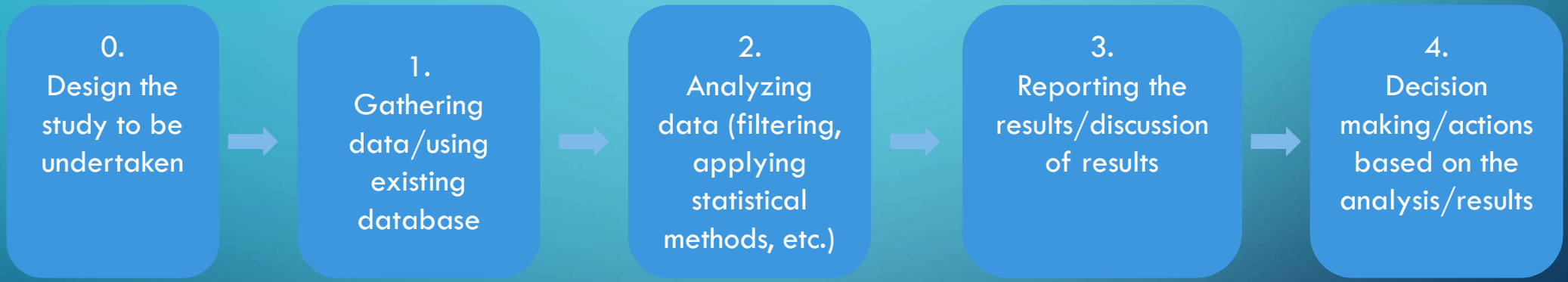
1.1 DATA AND INFORMATION

"LIES, DAMNED LIES, AND STATISTICS"

…BRITISH PRIME MINISTER BENJAMIN DISRAELI

…AND YES, YOU CAN LIE WITH STATISTICS. IN FACT, AND UNFORTUNATELY, THIS IS MUCH MORE FREQUENT THAN ONE MAY THINK

FROM DATA TO DECISION MAKING



TOO MUCH DATA

- We are living in a society with an overwhelming amount of data/information (TV, Radio, Newspapers, Reports, Social media, Internet, etc.)
- For instance, today the amount of existing consumer data is extremely large for some companies (like ICA, H&M, Klarna, etc.) – ”Big data”
- Very often we have to filter/transform the data to so it becomes useful/actionable
- How to filter/transform/interpret the data? Screening process by computers (algorithms/machine learning such as in the Big data case; Google Analytics, AI - Watson (IBM), analysis teams, yourself)

TOO LITTLE DATA

- Of course, in some circumstances we have too few data (e.g., when the number of respondents on a survey are few)

Example 1 (a simple eye-opener): A company statements like this is quite common: "80% of our customers are satisfied"

- What can we say about this statement?

- For instance, we do not now anything about the number of customers asked
- If many enough, the statement might be trustworthy. If too few, maybe not
- How are the customers selected? Randomly, by some selection criteria (everyone in a blue hat), haphazardly
- If a sample is too small there are some statistical computer based remedies for this (simulation based ones). But of course, you have to pay a price for this…uncertainty
- The previous example is a real example (from a US toothpaste company) where you may note the following:

  (i) only 5 customers were asked at the time

  (ii) when the first sample where 4 out of 5 customers where satisfied, the sampling stopped. That is, lying with statistics and using the principles of sampling/statistics in the wrong way

  (iii) should you really measure satisfaction on such a blunt scale?

ABOUT CORRECT AMOUNT OF DATA

- What is that?

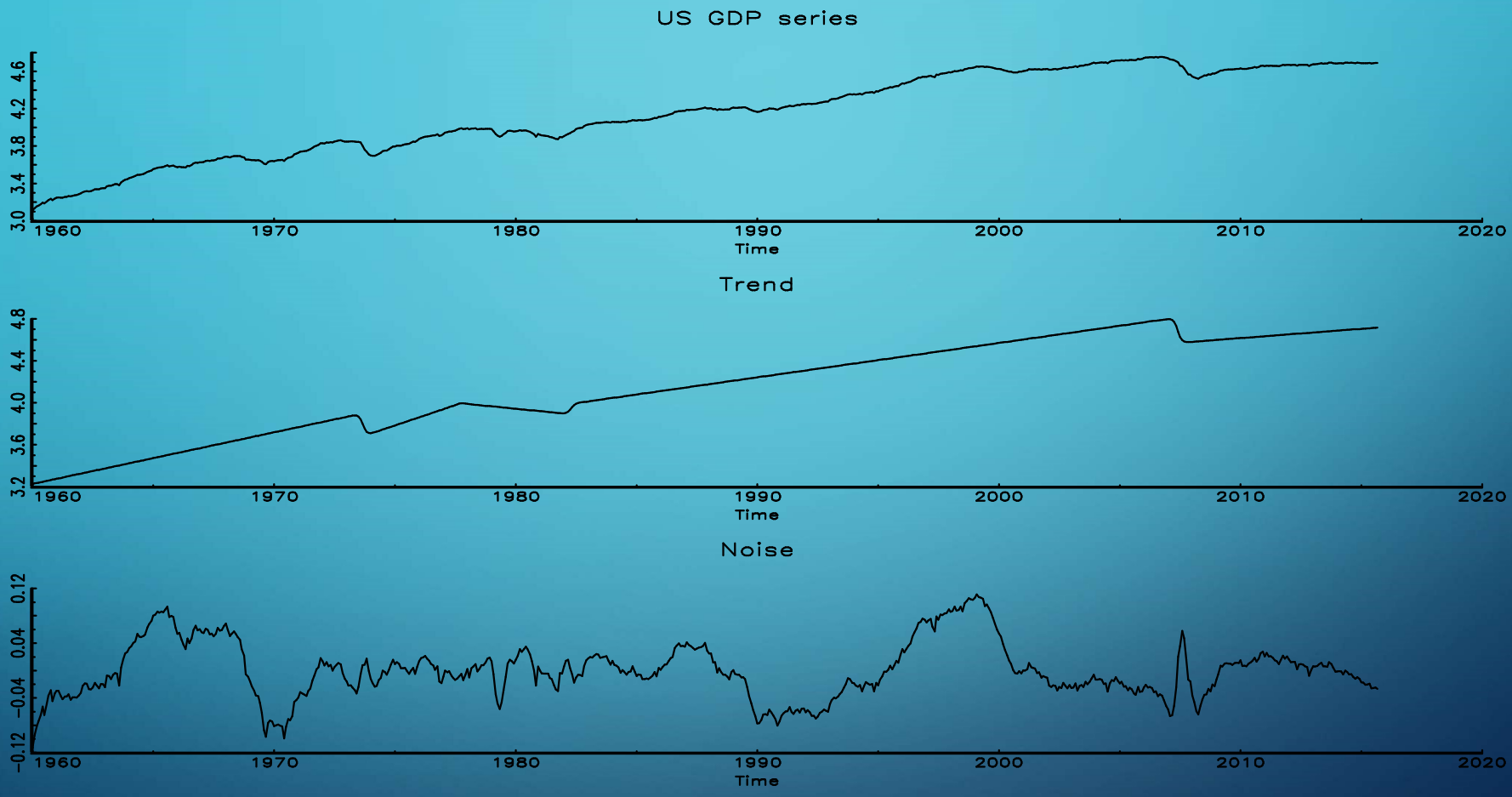
NOISY DATA

- Another problem is that data many times come with a noise (e.g., measurement errors, faulty recordings, etc.)
- Once we have obtained some suitable data we must, in one way or the other, do some ”Noise and Signal extraction”

Example 2 (signal extraction): In terms of long-term forecasts for the GDP, it is only the growth (the trend) that is of importance. As such, the original GDP data that are observed are decomposed into Trend and Noise component as:

$$\text{Data} = \text{Trend} + \text{Noise}$$

In this case, the noise itself contains important information about the business cycle, but that is another story. Using log US GDP data (1960 -2016), and my ”own” measurement/filter (in this case, method and model dependent), something like this can be obtained


US GDP series
3.0
3.4
3.8
4.2
4.6
1960
1970
1980
1990
2000
2010
2020
Time
Trend
3.2
3.6
4.0
4.4
4.8
1960
1970
1980
1990
2000
2010
2020
Time
Noise
−0.12
−0.04
0.04
0.12
1960
1970
1980
1990
2000
2010
2020
Time

- Remark that in the way raw data is processed into information (in this case about the trend) will vary with the analytics team (say) and the methods of measurements/filtering used (much more on measurements later on)
- Decison making in this context strongly depends on the filter/measurements used, and other long-term forecasts for the US GDP may be obtained if different filters/measurements are used
- And, bad measurements lead to bad information which leads to bad decisions

1.2 THE QUALITY OF DATA

EVEN THE "BIG ONES" DO MISTAKES

CPI AND SHOE PRICES BY STATISTICS SWEDEN (SCB) IN 2008

CPI 4.1% JULY. HOWEVER, THIS NUMBER WAS CORRECTED TO 4.3% BECAUSE SHOE PRICES WERE MEASURED/CALCULATED IN THE WRONG WAY

THE QUALITY OF DATA

- Needless to say, we must be critical to the data/information we get
- Can we trust what we hear, see, read?
- No matter how skillfull the analyis team is, if data are not accurate then there is little they can do to obtain sensible results (the garbage in, garbage out principle)
- Going to the extrems…

https://youtu.be/fmXv7aGrVUI

In this example we may think of:

- The team preparing (the analysis team) the material may be ignorant about the content of truth or even on purpose bias/falsify the information (fake facts)
- The user, Donald (you), may or may not be aware of the content of truth (quality) of the information
- The listeners (investors, board, etc.) may as well be ignorant, and they believe in what is told them

- Regarding the business data/information, it may not be a clear cut as in the previous example
- Of course, making decisions on data/information of low quality is not to recommend
- It may take a while until this shows up in e.g. the financial reports, and even though you are following some tentative conlusions and guidelines based on the data, you struggle to obtain sound, consistent and sensible results

WHAT YOU MAY WANT FROM YOUR KPI'S (OR FROM INFORMATION IN GENERAL)

- Comparability (internally/externally/over time)
- Reliability and Validity (in a sense, quality)
- Timely (and frequent enough)
- Actionability
- Relevance
- Objectiveness

THE REPORTING OF KPI'S

- Regarding the reporting of Customer Satisfaction, Loyalyt, Employee Satisfaction Indices, you may notice that:
  - They may be calculated in different ways
  - They may be based on different scales
  - Nonresponse may be treated in different ways
  - Different number of people may have been asked

- For other KPI's like the ones from accounting/balance sheets (ROA, ROI, sales, revenue growth, etc.), the story might be different, and they are also observable KPI's. Every now and then examples of misstatements in financial reports/ fraudelent accounting practices in order to e.g. inflate earnings to meet forecats/expectations are encountered. One example is Enron (a former american energy company in 2001). Enron's complex financial statements were confusing to shareholders and analysts. In addition, its complex business model and unethical practices required that the company use accounting limitations to misrepresent earnings and modify the balance sheet to indicate favorable performance

WHICH DATA DO YOU USE?

- Of course this depends on the purpose, but at the end of the day you would like to have some important facts, based on some data, that may help you to improve (say), in one way or the other, in various aspects
- Different types of data: balance sheet data, survey data, market research data; data from Census Bureau (e.g., Statistics Finland); data from interviews; cross-sectional data (consumer data/business unit data/stock returns for a portfolio), time-series data (e.g. KPI's recorded over time; company stock returns recorded over time), etc.
- How do you obtain your data (existing database or by an external supplier)?

A SHORT GUIDE TO SURVEY SAMPLING

- Random Sampling
- Sampling error
- Systematic error/bias
- Measurement errors
- No representative sample
- Timing of the surveys
- Respondent rate
- Total Sampling Error (TSE)

- Discuss random sampling…

- Discuss sampling error…

- Discuss systematic error/bias

- Discuss measurement errors

- Discuss representative sample…

- Discuss the timing of the surveys…

- Discuss respondent rates
- Why is a low respondent rate a problem?
- Satisfactory response rate. It depends, some say 60%, 70%, 95%
- A major bank in Sweden has problem with low response rate for the Net Promotor Score (NPS) – what to do?

- Discuss TSE…

TAKE AWAYS

- If the quality of the data is not assured, you cannot expect the outcomes to be adequate; the garbage in, garbage out principle
- Of course, having data of good quality is a necessary but not a sufficient condition to obtain adequate analysis of the data
- The quality of survey data may be improved by careful planning with the help of professionals

1.3 BASIC STATISTICS

DESCRIPTIVE STATISTICS

- Different location measures: mean, median (do you remeber the definitions?), etc.
- Sometimes the mean is an missleding measure. That is, the mean may leave out important information:…putting one hand in the oven the other in the freezer – on average we are fine! In other words, the mean values are of course essential and useful, but sometime we also would need information at a more refined level

Example 3 (using the mean and the median): The mean salary in Finland is (approximately) 3200 €/month. If Warren Buffet (finance guru; 625, 000, 000 € /month) would move to Finland, the mean salary would grow to about 3480 € /month (8.6% higher). However, the median is hardly affected

Example 3 (sales structure at company level):

	Dep.1	Dep.2	Dep.3	Company A
		Products		
	-10	-100	-500	
	100	200	1000	
	25		1500	
	34			
Total	*150*	*100*	*2000*	**2250**
Average	*37.5*	*50*	*667*	**250**

DESCRIPTIVE STATISTICS CONTINUED

- Different dispersion/uncertainty measures: min, max, standard deviation (std.), risk, volatility, etc.

Example 4 (stock returns and volatility): Consider three Companies X, Y, and Z with the following average montly returns over the last year:

X: 10%

Y: 4%

Z: 5%

Which one would you choose to invest in?

- Well, maybe the answer is not that easy just based on the limited information on the previous slide. In addition, we may want consider some facts about the dispersion of the returns

Return X (%): 7.0, 10.0, 13.0, -5.0, -10.0, 8.2, 10.0, 10.0, 10.0, 11.8, 25.0, 30.0

Mean=10 Min.=-10.0 Max.=30.0 Std.=10.67

Return Y (%): 4.0, 4.0., 4.0, 3.99, 4.0, 4.01, 3.97, 3.95, 4.0, 4.0, 4.03, 4.05

Mean=4 Min.=3.95 Max.=4.05 Std.=0.02

Return Z (%): 4.0, 5.0, 6.0, 4.8, 5.2, 5.0, 4.6, 5.4, 5.0, 4.1, 5.0, 5.9

Mean=5 Min.=4.6 Max.=6 Std.=0.60

- That is, the stock we choose to invest in depend on our risk profile
- Stock X generates highest return but is also the most risky (volatile) asset
- Y and Z generates ”similar” average returns, but the risk associated with returns for Y is much lower
- The return from stock Y is almost risk-free

PROPORTIONS AND UNCERTAINTY- (GERORGE) GALLUP POLL

- Confidence Intervalls (CI) and Margin of Error (ME)

Example 5 (US election 2016): One week before the US election, RealClear Politics asked about 1,000 US citizens if they would vote for Hillary Clinton or Donald Trump. The results from the poll became: 46.7% (Hillary) and 45.1% (Donald). Obviously, it appeared that Hillary Clinton should be the next president of US. BUT, was the difference in the polls significantly different from zero?

- One way to answer this question is to calculate CI's
- In this case one can show that a 95% CI for the proportion of Hillary supporters equals

46.7% +/- 3.2% or [43.5 : 49.9]

Or in words, the true proportion of Clinton supporters is in the intervall [43.5 : 49.9] with 95% confidence. Similarly, one can show that a 95% CI for Donald supporters equals

45.1% +/- 3.2% or [41.9 : 48.3]

Or in words, the true proportion of Trump supporters is in the intervall [41.9 : 48.3] with 95% confidence

- Notice that these intervals are overlapping meaning that the difference in opinion for the two president candidates one week for the election was not significant!

POLLS CONTINUED

- If #n customers are asked if they are satisfied or not, then a 95% CI for the proportion of satisfied customer can be calculated as

$$P \pm 1.96 \times \sqrt{(P(1-P)/n)}$$

where the +/- term $1.96 \times \sqrt{(P(1-P)/n)}$ is called Margin of Error (ME). The factor 1.96 assures that the confidence level is 95%

- Notice that the ME becomes smaller when the number of customers are asked
- Notice also that the ME becomes larger when the confidence level is increased; 99% confidence implies a factor of 2.57; 99.9% confidence implies a factor of 3.28
- What typically is reported in media is a 95% confidence level and a ME of 3% percentage units; this means that you have to survey about 1000 customers (or more exactly 1111)

MEANS AND UNCERTAINTY

- To take uncertainty about the means into account we can calculate 95% CI's using:

$$\bar{X} \pm 1.96 \times std.\bar{X}$$

- A good standard when reporting Customer Satisfaction, Employee Satisfaction, and Loyalty indices is to require the precision that a 95% CI for these indecies must have a width of no more than 4 units (refrering to an index scale of 0-100)
- My experience is that an uncertainty measures, regarding KPI's (say) many times are missing (of course, for some KPI's there is, more or less, no uncertainty)
- My experience is also that sample sizes and margin of errors are not well understood in business

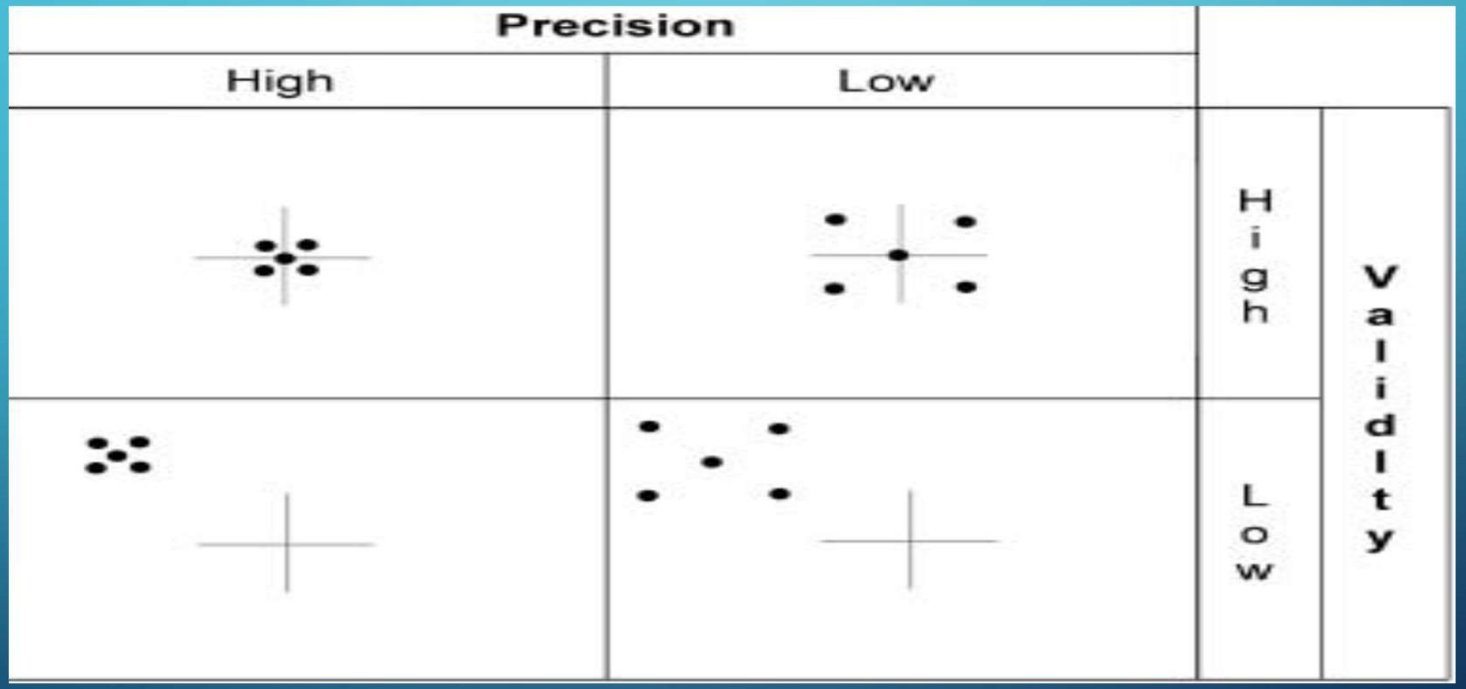
ACCURACY OF ESTIMATORS/INFORMATION

- In statistics we oftenly talk about estimators (proportions, means, etc., but KPI's can to some extents also be viewed as estimators). Of course, we hope the estimator used to be satisfactory. An estimator can be said to be satisfactory if it is accurate, where accuracy can be define as:

$$\text{Accuracy} = \text{Mean Square Error (MSE)} = Variance + Bias^2$$

where $Variance$ = Reliability/Precision, and $Bias$ = Validity

ACCURACY AND DRILLING AFTER OIL



TAKE AWAYS

- Reporting descriptive statistics: mean, median, min, max and some dispersion measures
- Calculating estimators (like the mean), it is also a “good manner” to report margin of errors and calculate confidence intervals
- “All you want” from your estimators is accuracy

TIME FOR CASE STUDY 1


TIME FOR A BREAK

PART 2

2.1 CORRELATIONS

2.2 CAUSALITY AND PREDICTIONS

2.3 MEASURING DIFFERENT METRICS

2.1 CORRELATIONS

THE ANALYSIS OF MORE THAN ONE VARIABLE

- The association between variables can be measured by a correlation metric
- The correlation between two variables X and Y – denoted $Corr(X,Y)$, is a measure of the strength for the relationship, ranges from -1 to 1
- A correlation of 1 signifies a maximum positive relationship between two variables, whereas a correlation of -1 signifies a maximum negative relationship
- A correlation of 0 signfies no relationship

CORRELATIONS AND THE RISK OF A PORTFOLIO

Example 6 (correlations and risk): Let $R_X = 5\%$ $\sigma_X = 12\%$ and $R_Y = 4\%$ $\sigma_Y = 2\%$. The return of the portfolio equals: $R_p = w_X R_X + w_y R_y$

- Assuming $w_X = 0.75$ and $w_Y = 0.25$, then the return of the portolio equals $0.75 \times 0.05 + 0.25 \times 0.04 = 0.048$
- The risk of the portfolio can be calculated by:

$$\sigma_p = \sqrt{w_X^2 \sigma_X^2 + w_Y^2 \sigma_Y^2 + 2 w_X w_Y \sigma_X \sigma_Y Corr(R_X, R_y)}$$

Three examples of portfolio risk when the correlation between *X* and *Y* is varied:

$Corr(X,Y) = 0.0 \Rightarrow \sigma_p = \sqrt{w_X^2\sigma_X^2 + w_Y^2\sigma_Y^2 + 2w_X w_Y \sigma_X \sigma_Y Corr(R_X, R_y)} = 0.090$

$Corr(X,Y) = 0.8 \Rightarrow \sigma_p = \sqrt{w_X^2\sigma_X^2 + w_Y^2\sigma_Y^2 + 2w_X w_Y \sigma_X \sigma_Y Corr(R_X, R_y)} = 0.094$

$Corr(X,Y) = -0.8 \Rightarrow \sigma_p = \sqrt{w_X^2\sigma_X^2 + w_Y^2\sigma_Y^2 + 2w_X w_Y \sigma_X \sigma_Y Corr(R_X, R_y)} = 0.086$

- It is seen that the risk of the portfolio increases when the correlation is positive (you have put all eggs in the same basket)
- It is seen that the risk of the portfolio decreases when the correlation is negative (you have **not** put all eggs in the same basket)
- Diversifying away the risk
- Do you know how to find optimal weights in your portfolio?

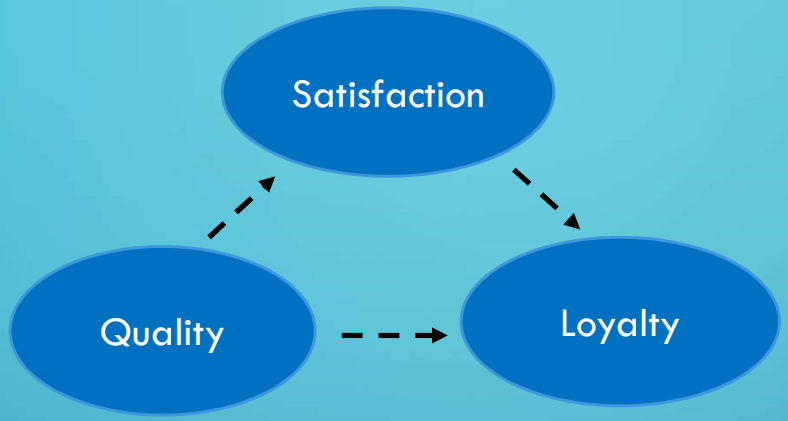
- Correlation says nothing about causality/causation
- Example of spurious correlations:

- There is a close relationship (strong positive correlation) between the salaries of Presbyterian ("Church-related") ministers in Massachusetts and the price of rum in Havana
- The correlation between the number of films Nicolas Cage (american actor) appeared in correlate with the number of people drowned falling into a pool (US data from 1999 – 2009; correlation 0.666)

- Can I then say that the price of rum in Havana causes the salaries of Presbyterian ministers in Massachusetts?
- Or, do salaries of Presbyterian ministers in Massachusetts cause the price of rum in Havana?
- Admittedly an awkward example, but it points at the risk only looking at correlations
- In this case there is a third factor yielding the correlation between salaries and price of rum (which one?)

MEDIATOR VARIABLE

Example 7 (correlation between quality and loyalty): First, Quality and Loyality variables are of interest. Do you think thess factors are correlated? In most cases they are! Do you think there is a direct link between them? Perhaps Satisfaction is left out the equation…



In this example, Satisfaction is a so called Mediator variable and causes the correlation between the two factors Quality and Loyalty

- More generally, if you find a correlation/link between variables but you are not sure why it exists, then the explanation can be that the correlation/link is caused by a third variable – the mediator

2.2 CAUSALITY AND PREDICTIONS

- Going beyond correlations and studying causes and effects is a natural next step
- It has been argued that loyal costomers are not necessarily satisfied, but satisfied customers tend to be loyal (Fornelll, 1992) indicating causes and effects like

- CAUTION! In general, how do we know what causes what? The egg and the hen discussion – who came first?

A SIMPLE REGRESSION MODEL

- A higher income will presumably lead to a higher consumption (and we expect these variables to be positively correlated)
- Being an economist a simple attempt to capture this would be via a so called regression model:

$$Y = b_0 + b_1 X + e$$

where Y and X would be the consumption and income variable, respectively, b_0 and b_1 are unknown parameters to be estimated using data, and e is an error term indicating that we do not have a perfect model. Note that X appears on right-hand side, and is therefore said to cause/explain Y appearing on the left-hand side

- In this model, b_0 would be a measure of the consumption without any income. The parameter b_1 is a slope parameter showing how much the consumption will increase when income is increased by one unit

PREDICTIONS USING THE REGRESSION MODEL

- If our regression model is a good model we expect that it can explan *Y* in a good way. For instance, if the model can explain the variation in *Y* then the model (in this case the *X* variable) might be a good model
- If a model is good or not is oftenly measured by the so called R^2-value (ranging from 0 to 1). An R^2-value of 1 indicates that the model at hand is very satisfactory. On the other hand, an R^2-value of 0 indicates that we should consider other models
- Regression type of models are commonly used in numerous areas in attempts to go beyond correlations and to establish key drivers (predictive variables) and cause and effect relationships

CUSTOMER SATISFACTION AS A PREDICTOR FOR PERFORMANCE

- Using a regression model, the linkage between Customer Satisfaction and performance can be established. Below are some results by Ittner and Larcker (1999)

Y:	Retention	Revenue	Revenue Change
X(CSIS):	0.002	19.464	0.003
Sign.	(***)	(***)	(***)

2.3 MEASURING DIFFERENT METRICS

”MEASURE WITHOUT THE BENEFITS OF SCIENCE – MEANINGLESS AT THE BEST AND MISSLEADING AT THE WORST”

…PROFESSOR EMERITUS CLAES FORNELL

DIFFERENT METRICS

- As already mentioned, we are interested in metrics (KPI's) like
- Customer Satisfaction
- Loyalty
- Employee Satsifaction
- Accounting and Balance Sheet Metrics

MEASURING THE KPI'S

- Measurements is about capturing information
- We should aim for adopting a measurement system such that the information retrieved from data are (we have heard this before)…

- Comparable (internally/externally/over time)
- Reliable and Validity (in a sense, quality)
- Timely (and frequent enough)
- Actionable
- Relevant
- Objective

CAPTURING INFORMATION ABOUT THE CUSTOMER

- I will focus on the measurements of the metrics: Customer Satisfaction and Loyalty (but the same logics apply to other metrics as well)

Example 8 (measuring customer satisfaction via one question): Measuring Customer Satisfaction via one question: Are you satisfied with Company ABC? Different scales are applied in practice: 1-4, 1-5, 1-7 or 0 – 10 ranging from unlikely to very likely. Sometimes the option do not know is given (what happened with the previous binary scale: satisfied not satisfied?). For illustration, I proceed by the latter scale 0-10

- Calculations and categorizations like the following are common: The share that answered 7-10 is defined as very satisfied customers (defining one of many Customer Satisfaction measures); 5-6 somewhat satisfied customers; not satisfied customers 1-4
- You may have seen graphs like

Example 9 (measuring customer satisfaction via three questions): Measuring Customer Satisfaction via the three question:

- Think of all the experience you have with Company ABC. How satisfied are you with that experience?

- To what extent does company ABC meet your expectations?

-Think of a company that is perfect in all respects. How close or far from the perfect company is Company ABC?

The scale is the same as in the previous example. Now, another commonly used Customer Satisfaction measure is to calculate the average of all answers for the three questions. For instance…

Respondent	Question 1	Question 2	Question 3
1	7	6	5
2	9	10	10
3	3	4	6
4	7	8	9
5	9	7	10
6	3	4	4
Average	6.33	6.5	7.33
CSI (grand average): 67.22%			

- So, you have two different CSI's – which one to use?
- Note that in the last example, all questions have the same weight (1/3) – they are a priori set as equally important (will that hold in general?)

- The “temperature” on the customers are now measured. Of course, the more satisfied customers the better
- However, what would the actions be if the share of satisfied customers are high? How is a high share defined?
- However, what would the actions be if the share of **not** satisfied customers are high? How is a low share defined?
- Relate this two attempts to measure Customer Satisfaction to the previous criteria for a sound measurement system

- Sometimes following up questions are typical for customers ending up ticking boxes 5-6 say (why not 1-4?)

  *What is your motivation for the given score? [open question]

  *What can we do in order to get a higher score next time? [open question]

- Sometimes a more qualitative analysis is undertaken using focus groups or one-to-one interviews to give straight answers about what caused the low scores
- Of course these remedies are good, but how do you act on them? Are they costly?

- In addition, follow up questions are common where you again tick a new set of boxes trying to explain why the customer is not so satisfied regarding (say) (again scales 0-10)
    * Price
    * Quality
    * Service

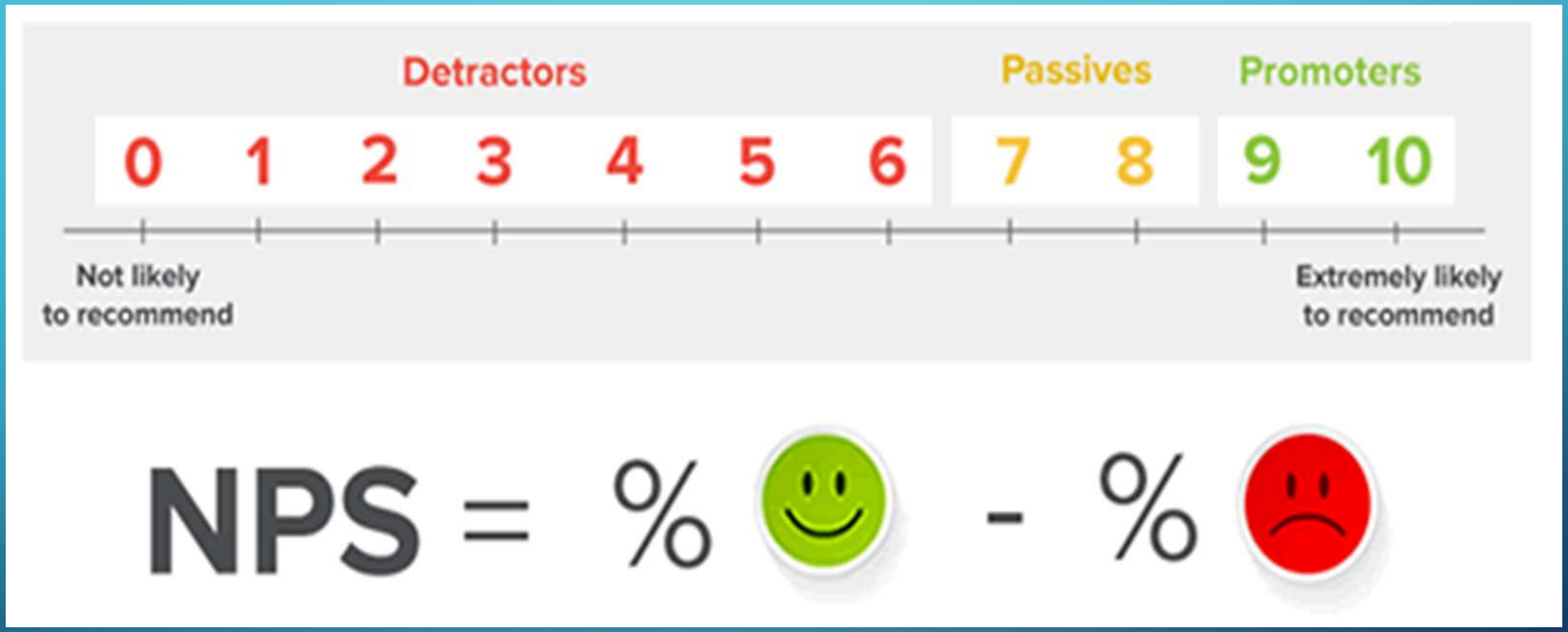
And you may for instance figure out that the share of respondents in the group 5-6 think that (on average) the price is the most important factor. Okay, good. But again, you now know that price is too high but you do not know the effects of cutting prices. Most likely Customer Satisfaction will increase in the short-run, but what about a medium-run perspective, can the quality be maintained? Moreover, how will the other groups of respondents react to this? Etc. That is, you get information upon the areas and direction of improvement, but you do not exactly know the impacts of such operations. To some extents, myopic result and the bigger picture may be missed

THE NET PROMOTOR SCORE (NPS)

- The NPS is a commonly used measure for Loyalty. It was introduced by Professor Frederick F. Reichheld (a Bain and Company Fellow) in 2003 and his article "The one number you need to grow" published in Harvard Business Review
- NPS is very simple, and the customers are just ask the single question:

How likely are you to recommend (our company) to a colleague or a friend?

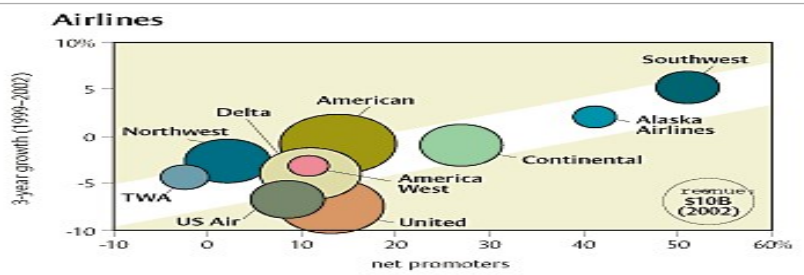
The scale used is 0-10, where we have the following classifications: 0-6 Detractors, 7-8 passives, 9-10 promotors. The NPS is now calculated as:

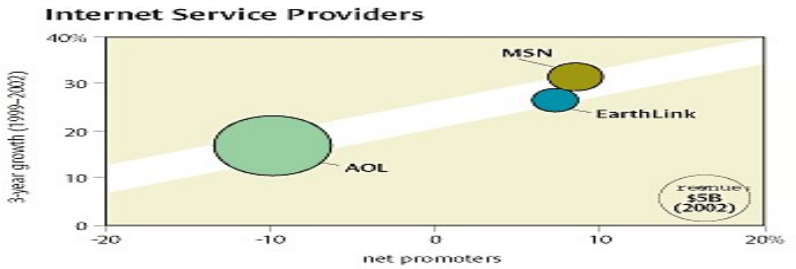

Detractors
Passives
Promoters
0 1 2 3 4 5 6 7 8 9 10
Not likely to recommend
Extremely likely to recommend
NPS = % - %

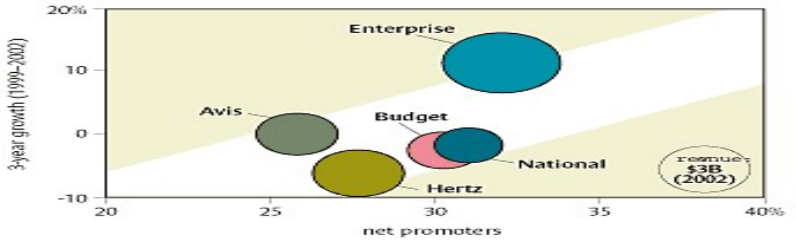
- Of course, the higher NPS the better
- And recall that Loyalty is important in the context of repeat purchase, retantion, word-of-mouth, let the customers do the marketing, you save money on less marketing expenses. And, Loyalty lead to growth/profitability/market shares (improved financial performance)
- Reichheld argues that this is the only one number you need to grow, and he base this on that the NPS is positively correlated with (revenue) growth
- Reichheld claims that the highest NPS in an industry results in growth rates avereging 2.5 times greater than that of competitors
- Reichheld also claims that a 12-point increase in NPS corresponds on average to a doubling of a company's rate of growth

Growth by Word of Mouth

RESEARCH SHOWS THAT, in most industries, there is a strong correlation between a company's growth rate and the percentage of its customers who are "promoters"—that is, those who say they are extremely likely to recommend the company to a friend or colleague. (The net-promoter figure is calculated by subtracting the percentage of customers who say they are unlikely to make a recommendation from the percentage who say they are extremely likely to do so.) It's worth noting that the size of companies has no relationship to their net-promoter status.







- Which NPS level should be aimed for? This depends on your industry, but Reichheld gave the example of eBay and Amazon having NPS of 75-80% - and he says that this is what you should aim for to obtain world class loyalty
- The Median NPS for US companies is about 18%

- Reichheld is also quite bold in his article. A snapshot of statements are:

i. Most customers satisfaction surveys are not very useful

ii. They tend to be long and very complicated, yielding low response rate and ambiguous implications that are difficult for operating managers to act on

iii. Senior executives, board members and investors do not take them seriously. That is because their results do not correlate tightly with profits and growth

iv. By substituting a single question for the complex black box of the typical customer satisfaction survey, companies actually put consumer survey result to use and focus employees on the task of stimulating growth

v. In general, it is difficult to discern a strong correlation between high costumer satisfaction scores and outstanding sales growth

vi. The ***only*** path to profitability growth may lie in a company´s ability to get its loyal customers to become, in effect, its marketing department

ACTIONABILITY AND THE NPS

- In the context of measuring Loyalty by NPS, we have again measured the "temperature" on our customers
- However, what would the actions be when the Loyalty index is high?
- However, what would the actions be when the Loyalty index is low?
- Relate this to the previous criteria for a sound measurement system

MY COMMENTS ON THE NPS

- I do not believe that the NPS is the one number you need to grow. And of course, it is challenging to claim that only one question is enough (for all type of industries)
- There are several peer-reviewed scientific studies showing the relationship between American Customer Satisfaction Index (ACSI – discussed in Part 3) and company financial performance. To my knowledge, there are none for NPS
- The NPS is flawed from a statistical point of view, and its lack precision (more on this in Case Study 2)

MEASURING LOYALTY CONTINUED

- In the context of measuring Loyalty, it may be worthwhile to consider more than one question. For instance, the following three questions to capture Loyalty are common:

- How likely is it that you recommend Company ABC to a colleague or a friend?
- How likely is it that you will change from Company ABC to another company within the next year?
- If you would choose a company today, how likely is it that you will choose Company ABC again

- The scale may be set to 0-10. Now, you can calculate a Loyalty index in the same way as the Customer Satisfaction Index was calculated in Example 9. The subsequent remarks for the CSI also, more or less, apply for the above type of Loyalty index

TAKE AWAYS

- Correlations describe relationship between variables. BUT, you cannot say anything about causation or do any predictions
- To be able to do predictions you most likely need a causal model
- Be careful when choosing a measurement system. Desirable requirements on retrieved information are: Comparability, Reliability, Validity, Timely (frequent enough), Actionability, Relevance and Objectiveness
- The NPS must be used with caution, and it is not the only one number you need to grow

TIME FOR CASE STUDY 2


TIME FOR A BREAK

PART 3

3.1 GOING BEYOND THE NPS

3.2 MOTIVATION FOR STRUCTURAL EQUATION MODELING

3.3 SEM IN MORE DETAIL

3.4 REFERENCES

3.1 GOING BEYOND THE NPS

- The sales of a product has increased. Good! Why has it increased? On the behalf of another product (cannibalism), drive, marketing, etc.
- Customer are (dis)satisfied. Good (bad)! Why are they (dis)satisfied? To which level are they (dis)satisfied? Why are (dis)satisfied customers important? What can (dis)satisfied customer lead to? How can (dis)satisfaction be (lowered)increased. If (dis)satisfaction is increased (lowered), how much will loyalty increase? Growth?
- After measuring the temperature on our customers, we need to know what to do next. We want to use the results for decision making/operative planning and strategic planning etc. We may want to consider the bigger picture using causal models, where potentially many of the KPI's (and other variables/factors) are (simultaneously) causally modelled

3.2 MOTIVATION FOR STRUCTURAL EQUATION MODELING

- Many of the previously addressed questions/issues may be addressed adopting Structural Equation Modeling (SEM)
- SEM has been around for some 50 years, and was made feasible (popularized) by Professor Karl Gustav Jöreskog (Uppsala University, Sweden). SEM has a strong scientific support, and has in practice been shown to be superior to many approaches – in fact, SEM falls remarkably well in practice
- SEM offers "State of the art" modeling. Also in an international perspective
- SEM offers a satisfactory measurement system
- SEM models offer a support for action and decision making (strategic level, tactical level, operational level, local level, etc.)

IF THE SEM NOW IS SO GOOD, WHY ARE NOT EVERYONE USING THEM?

- For understandable reasons, there are relatively few suppliers of SEM (CFI Group, SKI, and EPSI Rating Group are some). Instead, there is an abundance of suppliers offering results/reports on correlations, NPS, some CSI's (in a sense low hanging fruits)
- Although SEM falls well in practice, it requires a strong expertise (experienced statisticians, say, combined with "brain"-people)
- Companies have a tendency to stay with the methods they already use (reluctance to change), and they may also feel that they have to use what other companies are using (NPS, etc.)
- The implementation of NPS is instantaneous, whereas the implementation of SEM takes longer time (to me this is something positive considering the complex questions we want answers to)

- Even though SEM is said to be complex, it does not mean that resultant outcomes are difficult to interpret or to implement (in fact, in the context of outcomes, usability and simplicity is ensured)
- Admittedly, some people are worried for the "black-box" – recall one of the previous statement by Reichheld. Okay, right, but leave the "black-box" for the professionals and instead focus on management/decision making/strategy using the SEM outcomes. After all, most of you can drive a car but relatively few are knowledgeable about what is going under the hood. Of course, it may take some trust to adopt new methods, and it appears natural that you consult someone with a good track record. Note also that pre-tests/simulations are conducted before going "live" to ensure that the SEM is working

- The list of companies that have adopted SEM in a beneficial way is long, and they come from all around the globe (China, Denmark, Finland, Netherlands, Norway, Italy, Spain, Sweden, US, …)
- Note that the included variables (KPI's, etc.) and their relationships in the SEM are not directly observable (they must be estimated using data), as well as that some of the variables are latent (unobserved/intangibles such as Customer Satisfaction)
- Finally, have in mind that all models are approximations to some true (unknown) underlying model, and

  "…*All models are wrong. Some are useful*…" - George E.P. Box (famous statistician)

3.3 SEM IN MORE DETAIL

THE MODELING PROCESS

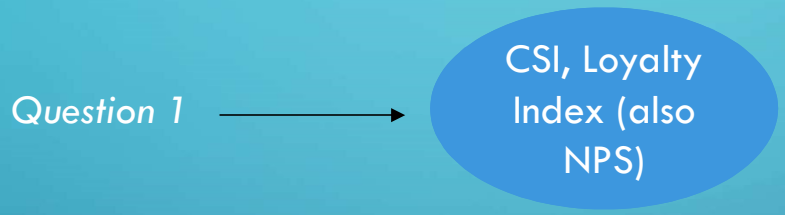
- It is important to proceed in a systematic (and repeatable) way. The steps of a sound modelling process:
- Purpose of the study
- Collect data or use existing data
- Select model/method
- Estimate the model
- Evaluate the model. Re-estimate model if needed. Conclude upon a terminal model
- Interpret, analyze and summarize the results
- Give directions for actions (at different levels, areas, etc.). Decision making and strategic planning (short-term, medium-term, long-term goals)
- Feedback loop over time, reassess/adjust the terminal model if needed (some relationships, impacts etc. do change over time)

THE INPUT

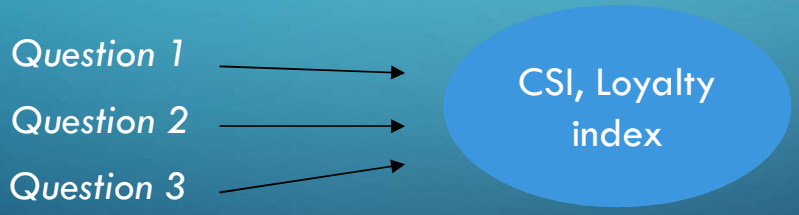
- Use existing database. Or, consult someone to collect the data for you (methods: telephone surveys, web-based surveys,…)
- As mentioned before, it is very important that random sampling is applied (e.g., to avoid less accurate results)
- Also remark that results obtained are reletive the target group. So if you sample from middle age people you may will, in general, not be able to draw conclusions about the older people (say)

CAPTURING INFORMATION: MEASUREMENT TECHNIQUES

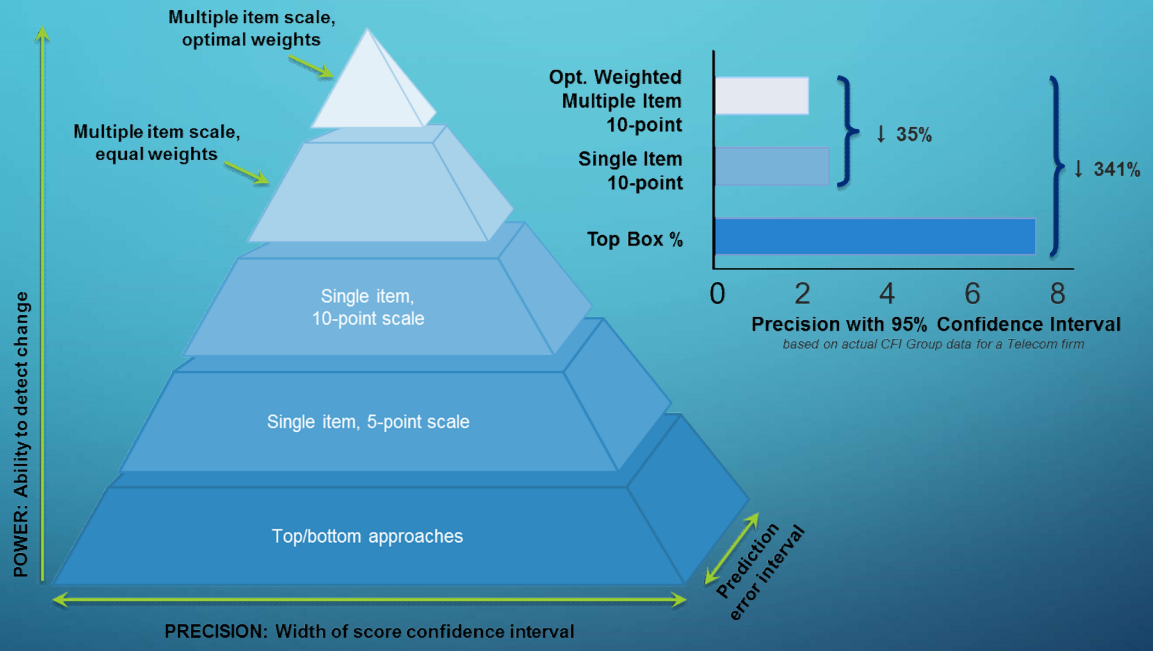
- In examples Examples 8 and 9, survey data were obtained as (note, in these examples we tried to capture information about unobservables)

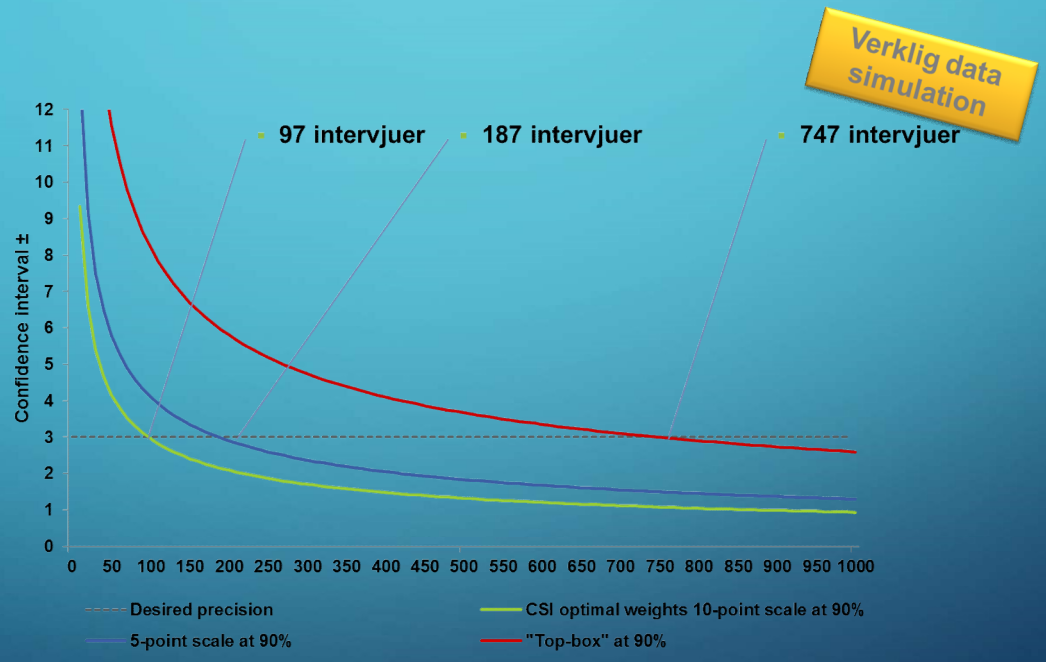


and…



- In general, more questions are better than too few (more information; higher reliability)
- However, too many questions are not good either…
- In general, it is also good if you have as large sample (number of persons asked/respondents) as possible
- But of course, time and costs of a surveys is an issue
- However, by clever measurement techniques/systems/models (SEM) we can, given a certain desired confidence level, ”minimize” the number of respondents that must be asked
- Conclusion, by carefully planning the survey and the methods of measurement used, the number of people asked can be reduced substantially (time- and cost effective)

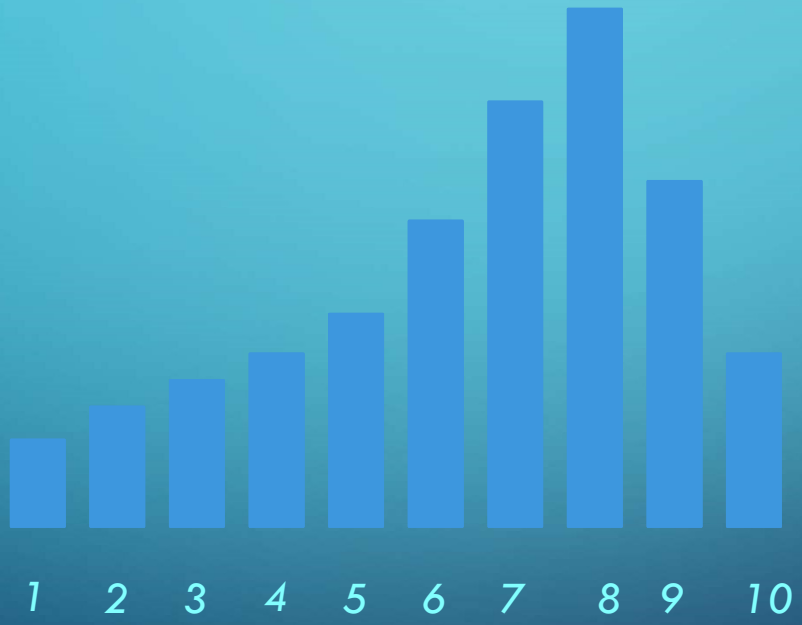

Multiple item scale, optimal weights
Multiple item scale, equal weights
Single item, 10-point scale
Single item, 5-point scale
Top/bottom approaches
POWER: Ability to detect change
PRECISION: Width of score confidence interval
Prediction error interval
Opt. Weighted Multiple Item 10-point
Single Item 10-point
Top Box %
↓ 35%
↓ 341%
0
2
4
6
8
Precision with 95% Confidence Interval
based on actual CFI Group data for a Telecom firm


Verklig data
simulation
97 intervjuer
187 intervjuer
747 intervjuer
Confidence interval ±
12
11
10
9
8
7
6
5
4
3
2
1
0
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000
Desired precision
CSI optimal weights 10-point scale at 90%
5-point scale at 90%
"Top-box" at 90%

SCALES

- Which scales should be used?
- Scientific studies has showned that a 0-10 point scale works fine (not to blunt not to fine)
- The distribution of the answers are typically skewed (this is an important fact to take into account when estimating a SEM)

EXEMPALE DISTRIBUTION ANSWERS

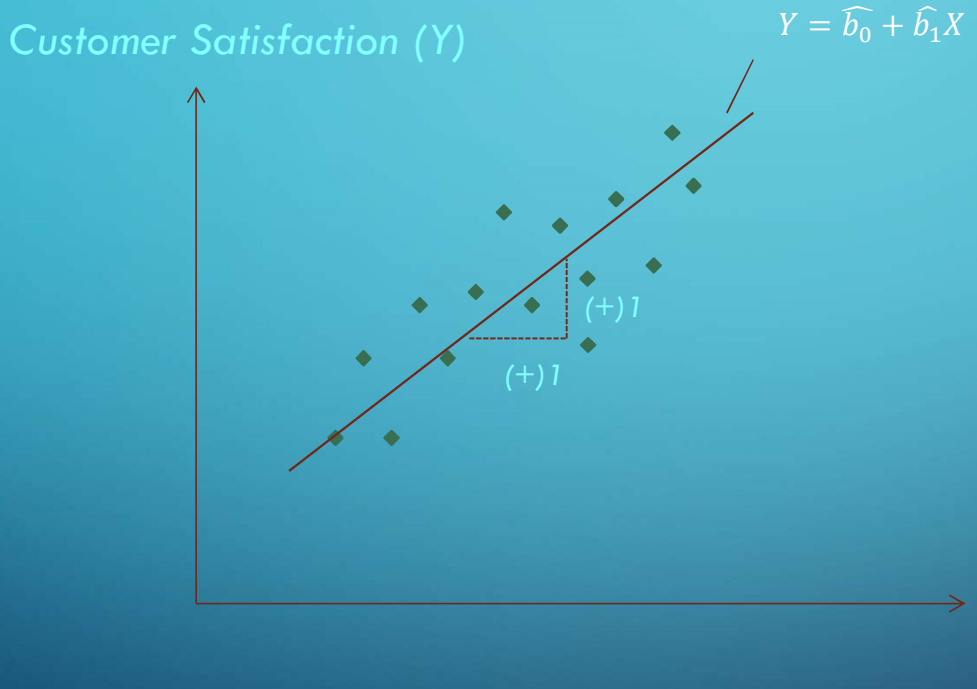


MODELING CAUSAL RELATIONSHIPS

- Suppose we want to analyze the variables *Image* and Customer Satisfaction (for simplicity, it is first assumed that they are observable)
- You may consider the analysis of correlations, but then ignoring the concept of causality and impact measures
- As already mentioned in Part 2, a commonly used tool to model causality is a regression modell where *X* (Image) effect *Y* (Customer Satisfaction) according to the linear relationship:

$$Y = b_0 + b_1 X + e$$

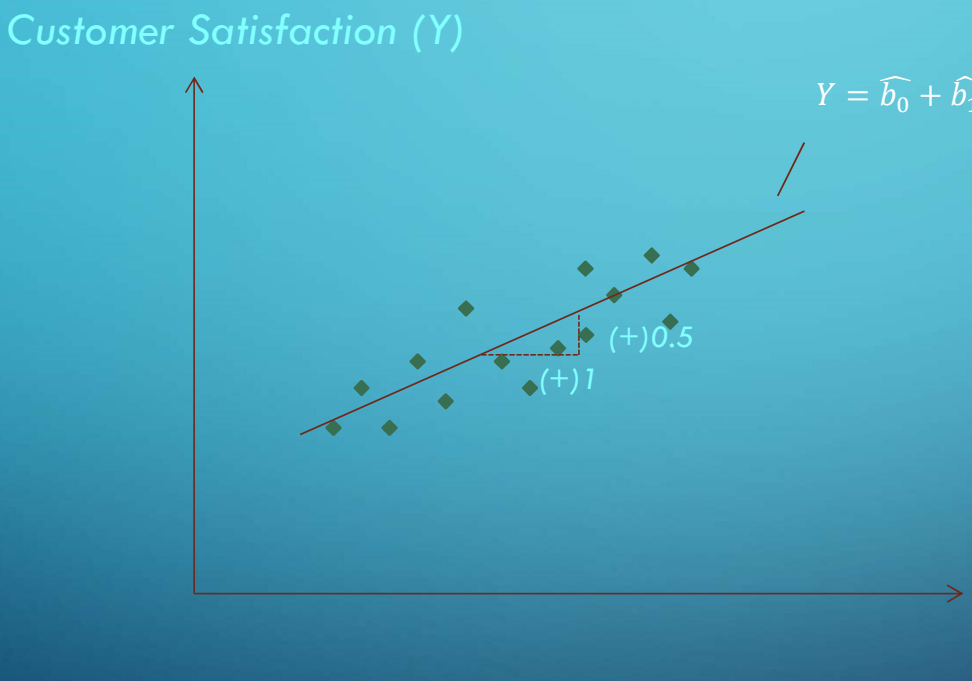
CORRELATION, REGRESSION AND IMPACT



corr(X,Y)=0.85

Impact=1.00

CORRELATION, REGRESSION AND IMPACT



corr(X,Y)=0.85

impact=0.50

MORE EXPLANATORY VARIABLES

- Of course we may think of other variables, say Price, also effecting Customer Satisfaction. This can be captured by the multiple linear regression model:

$$Y = b_0 + b_1 X_1 + b_2 X_2 + e$$

where X_1=Image and X_2=Price

SELECTING A SATISFACTORY MODEL

- Remark 1. In practice we often face more complex causations than the multiple regression model can manage/capture
- Remark 2. In practice we often have to inlcude variables that are not directly observable (Customer Satisfaction, Loyalty, etc.)
- Remark 3. Customer Satisfaction in the previous regression model is the dependent variable (the one we would like to explain using explanatory variables), whereas, in an extended context, it may be also be an explanatory varible for Loyalty. That is,…

EXPLANATORY AND DEPENDENT VARIABLES

STRUCTURAL EQUATION MODELING

- It is now time to go slightly technical and just have a glimpse of the engine under the hood. This may be helpful in the context of understanding the advantages with SEM and its impact measures
- A SEM consists conatin of two parts: the structural part (yielding the causal relationships bewteen the variables) and the measurement part (measuring the variables in the model)

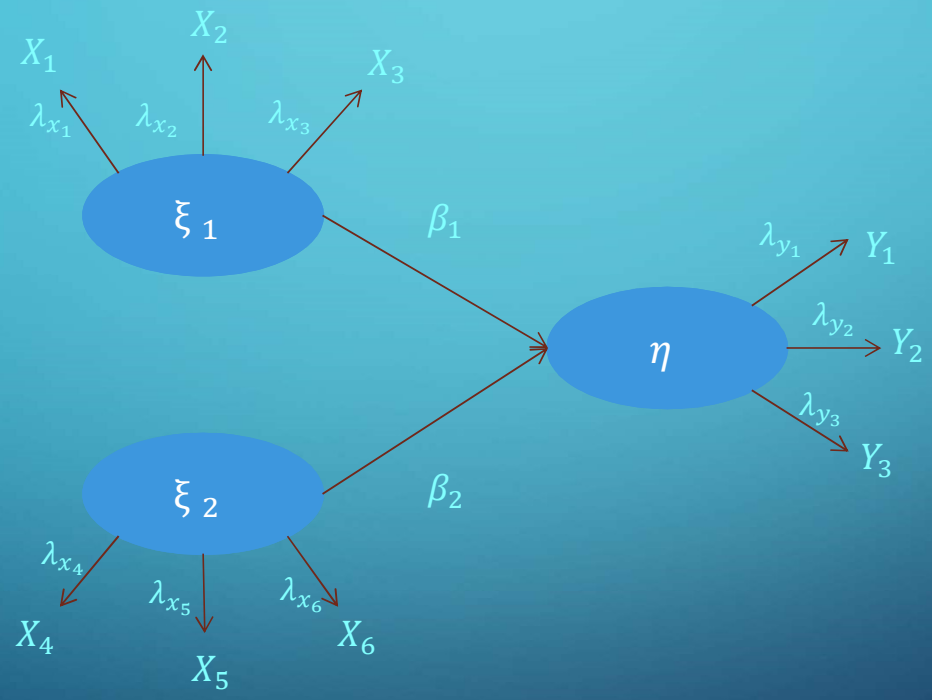
- Identify the main variables of the SEM; observable variables and latent variables (e.g., Image, Price, Customer Satisfaction, Loyalty, etc.)
- For each latent variable, decide upon a number of measurement equations. For instance, Customer Satisfaction was measured via the questions:

  - Think of all the experience you have with Company ABC. How satisfied are you with that experience?

  - To what extent does company ABC meet your expectations?

  -Think of a company that is perfect in all respects. How close or far from the perfect company is Company ABC?
- For the other latent variables in the SEM, specify similar measurements
- Finally, define the structural relationships between the variables
- Taken the two parts together, we obtain, using mathematical notations,…

MEASUREMENT AND STRUCTURAL EQUATIONS



…or using equations

$X_i = \lambda_{x_i}\xi_1 + e_{x_i}, \quad i = 1,2,3$ Measurement equation ξ_1 (e.g., *Image*)

$X_i = \lambda_{x_i}\xi_2 + e_{x_i}, \quad i = 4,5,6$ Measurement equation ξ_2 (e.g., *Price*)

$Y_i = \lambda_{y_i}\eta + e_{y_i}, \quad i = 1,2,3$ Measure equation η (e.g., *Customer Satisfaction*)

$\eta = \beta_1\xi_1 + \beta_2\xi_2 + e_\eta$ Structure equation for η, ξ_1 och ξ_2

- Note that the coefficents $\lambda_{x_1}, \lambda_{x_2}, \ldots, \lambda_{x_6}$ and β_1 och β_2 are weights that are estimated using data. A preferably method for estimation is called Partial Least Squares (PLS). Other methods exist, but they appear to yield results that are less robust against various violations of model assumptions
- It is noticed that simple averages are not used to obtain the weights. Instead, these weights will be dependent (and vary with) on the data at hand, and data will determine to which extents a coefficient is important/its impact. On the contrary, recall Example 9 (measuring Customer Satisfaction using three questions) where all questions had the same weights (in a sense, only picking low hanging fruits)

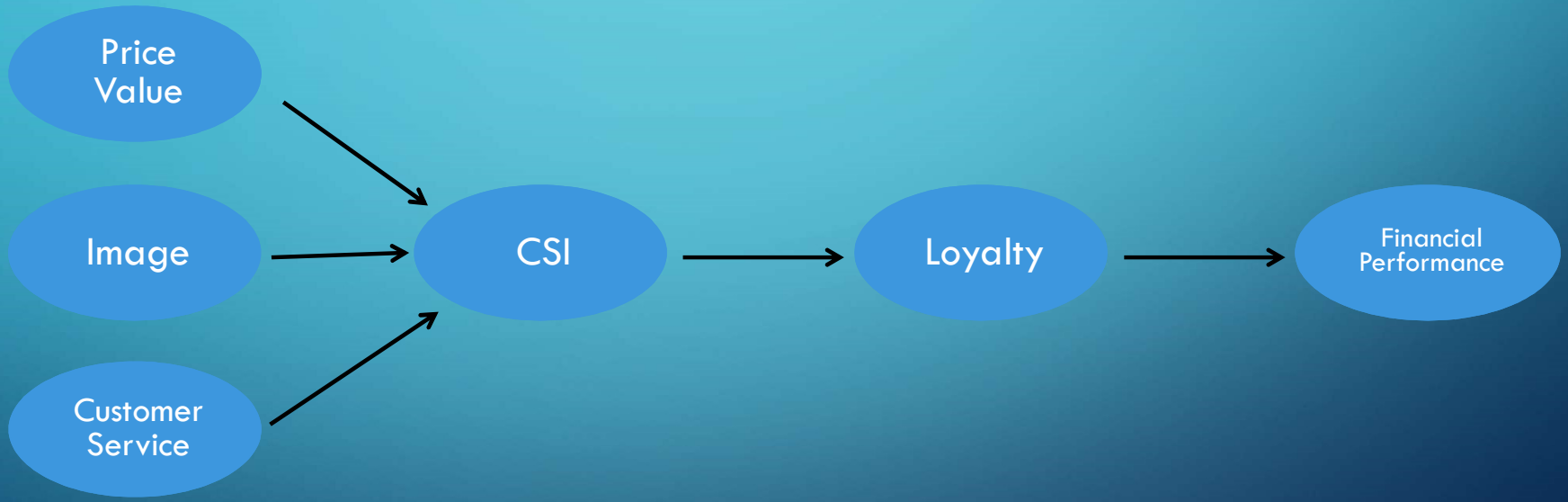
- It is now easy (and important) to test if the included variables are significant or not. For instance, we can test the hypothesis if Image has an impact on Customer Satisfaction. That is, testing the hypothesis if $\beta_1 = 0$ or not
- We can also test if Questions 1 is significant to describe e.g. Customer Satisfaction, or in other words if Question1 has a significant loading on Customer Satisfaction or not. That is, testing the hypothesis if $\lambda_{y_1} = 0$ or not
- Remark that impact measures on indiviudal levels are not obtained – instead they are for our sample population (we are not getting to close to the customer – "good"/we cannot have steering options on individual basis)
- Remark also that we do not ask the respondents directly about these impacts – they are instead obtained by a mathematical/statistical solution (again, there are no impact measures on individual levels). This also means that the number of questions on the survey can be reduced substantially (cf. a discussion about stated versus derived importance)

- Using the estimates of the SEM, indices (or scores) are constructed for each latent variable (this can be generated in an automatic way once SEM is implemented). In my opinion, this is how indices should be calculated
- Finally, for an index of say 75 for Custome Satisfaction, we can say that the true index value lies within the interval [73;77] with 95% confidence (this is of course useful for comparing CSI's over time). And, we controll both for sample and model uncertainty

EVALUATION OF A SEM

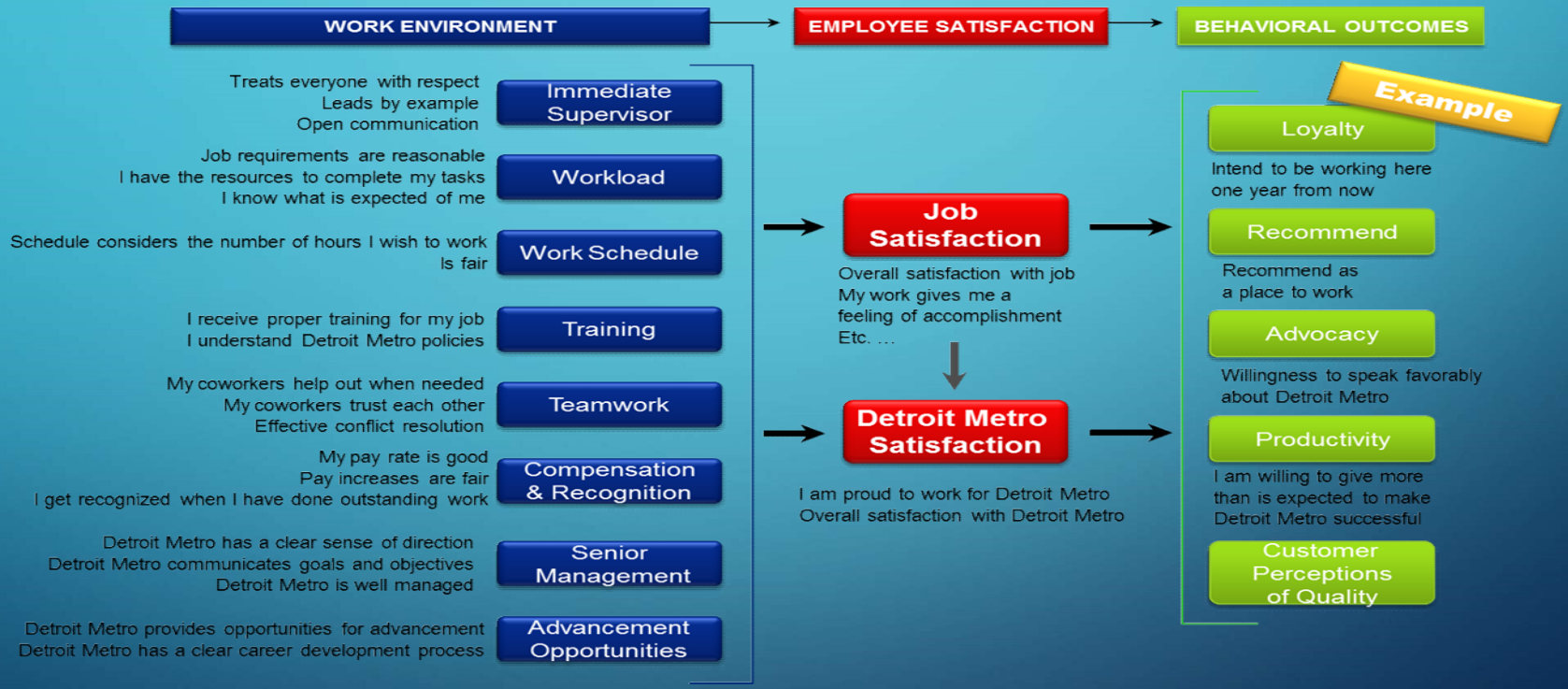
- How well does a SEM fit to the data? This is typically answered by using the coefficient of determination R^2 (discussed in Part 2), and gives the percentage of the variation in the data explained
- In a SEM we can (should) also look at R^2-values for measurement equations as well as R^2-values for structure equations

MODEL EXTENSIONS

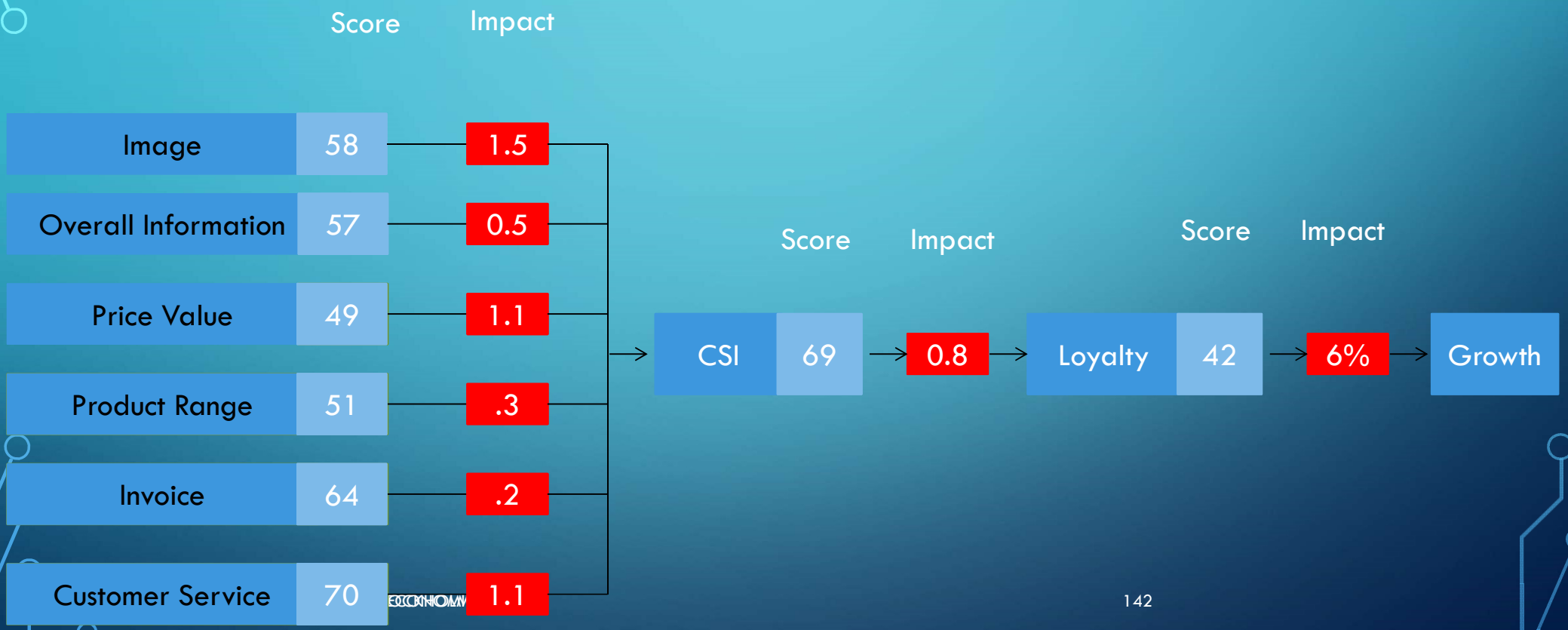


- The existence of above cause-effect relations are assured by well-documented scientific findings
- Sometimes you hear that the link to financial performance is weak – this may be explained that the wrong methods are used to test for the link, see Fornell et al (2006, Journal of Marketing), *"Customer Satisfaction and Stock Prices: High Returns, Low Risk"*
- Another remarkeble finding in this article is that companies with a high CSI tend to generate highe returns to a lower risk than those with a lower CSI

FURTHER EXTENSIONS: A CAUSE-AND-EFFECT MODEL FOR *DETROIT METROPOLITAN AREA*



PRACTICING WITH THE OUTCOMES OF A SEM

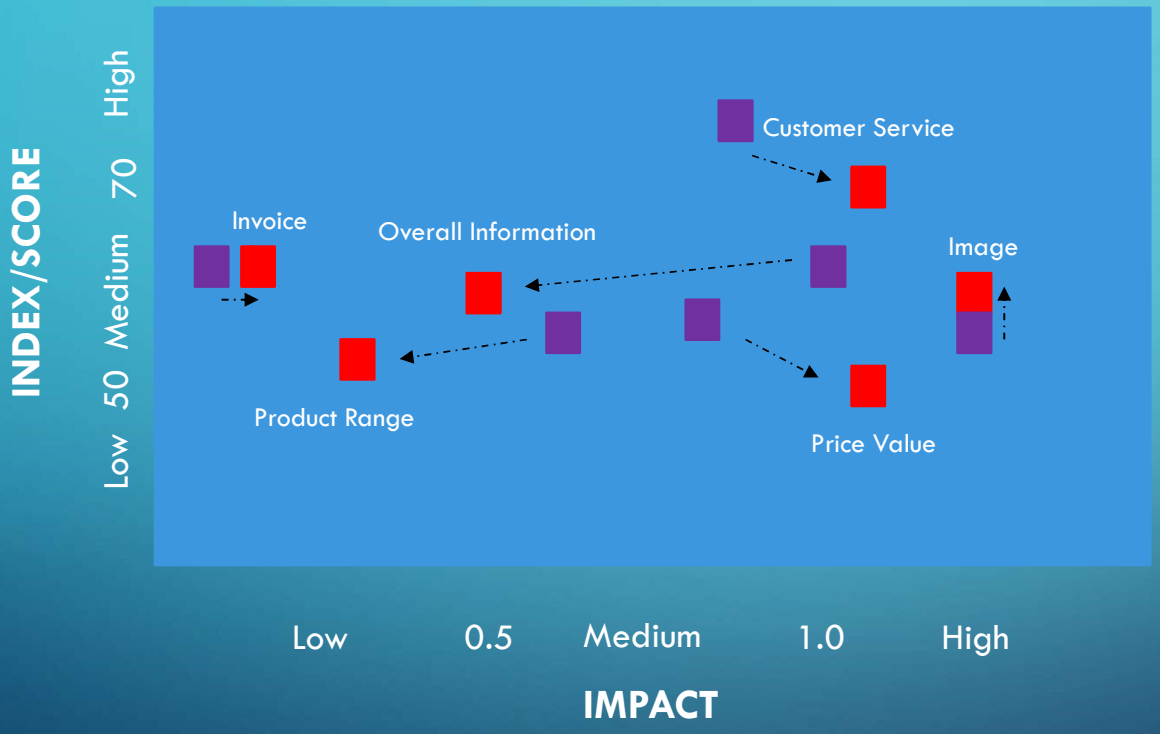


- You can now rank the factors after impact

Image:	1.5 impact: 58 score
Price Value:	1.1 impact: 49 score
Customer Service:	1.1 impact: 70 score
Overall Information:	0.5 impact: 57 score
Product Range:	0.3 impact: 51 score
Invoice:	0.2 impact: 64 score

- The impact measures are also of a direct use, i.e. Image is increasedd with **5** units, unit then Customer Satisfaction will increse by 1.5 units
- This comprises reports facilitating decisiong making, detecting areas of priority, strategic planning, etc. – see the next slide
- By these measures it is also ”easy” to see how long term targets can be achieved. For instance, the other companies in the same business may have a CSI of *75*, how should we reach that level? Several options exist, but will once again be facilitated by the priority matrix on the next slide
- Optimize, not maximize, Customer Satisfaction
- Customer Satisfaction may have a nonlinear impact on performance. For instance, it may be that scores over a certain level no longer has an impact (thresholds) – give example…
- Trends and levels in the Customer Satisfaction Index. A CSI of *75*, good – or? Track changes over time

EXAMPLE OF A PRIORITY MATRIX



Classifications:

Score/Index:
0-50 Low, 50-70Medium, 70-100 High

Impact:
0-0.5 Low, 0.5-1.0Medium, >1High

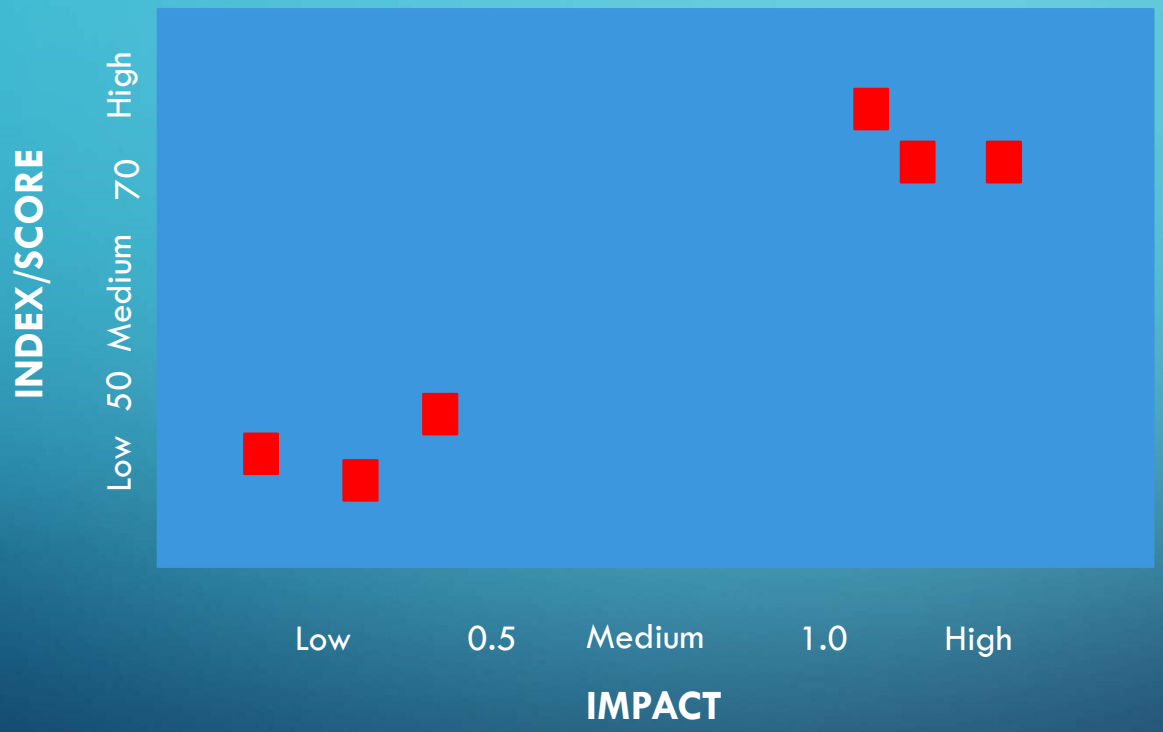
Actual score/impact

Previous periods score/impact

- North West: Low Priority – variables with low impact and high scores – preserve the standard
- South West: Low Priority – variables with low impact and low scores – preserve the standard
- North East: Medium Priority – variables with high impact and high scores. Important for a high level of overall customer satisfaction
- North West: High Priority – variables with high impact but low scores. Focus efforts and resources on these areas.

- In the previous figure it appears that we should focus on Price Value and perhaps also Image
- It seems less important to focus on Product Range and Invoice, and to some extents also Overall Information
- Customer service is a relative strength of our company, and it is important to maintain its position to yield an overall high Customer Satisfaction

A SUCCESS STORY



After some time…optimality

All strengths have an impact

All weaknesses without impact

- So, this was the primer for SEM and how it could be used for modeling Customer Satisfaction, Loyalty, etc.
- Of course, there is more to say, but I believe we are done for today…

THANK YOU FOR THE ATTENTION!

3.4 REFERENCES

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