



CONJOINT ANALYSIS OF TREATMENT PREFERENCE

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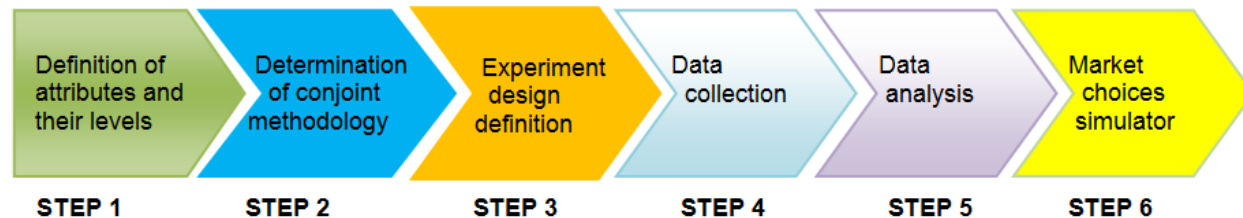
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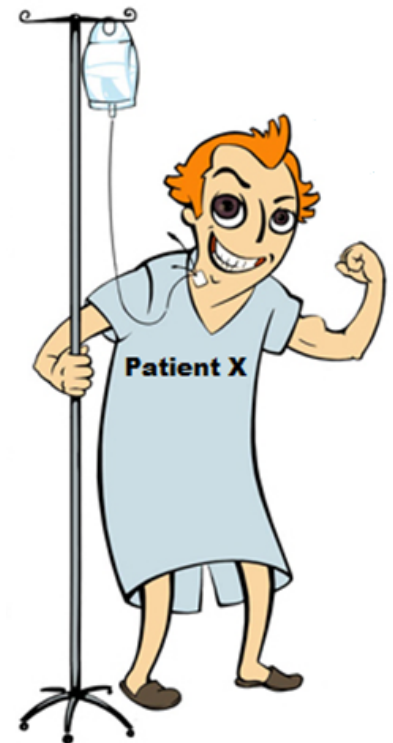
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PRESENTATION PLAN

- Preferences and utility function
- Few words about conjoint analysis method
- Steps in conjoint analysis:



- Analysis of Patient X and artificial treatment market preferences:
 - Metric analysis of Patient X preferences
 - Metric analysis of market preferences
 - Choice simulation and market share prediction
 - Which treatment to be introduced into the market?
- Conclusions



PREFERENCES AND UTILITY FUNCTION

- **Utility function** (target function which is maximized within established constraints) is subjectively felt by each person satisfaction from realization of given structure of consumption.

People choose the best things they can afford



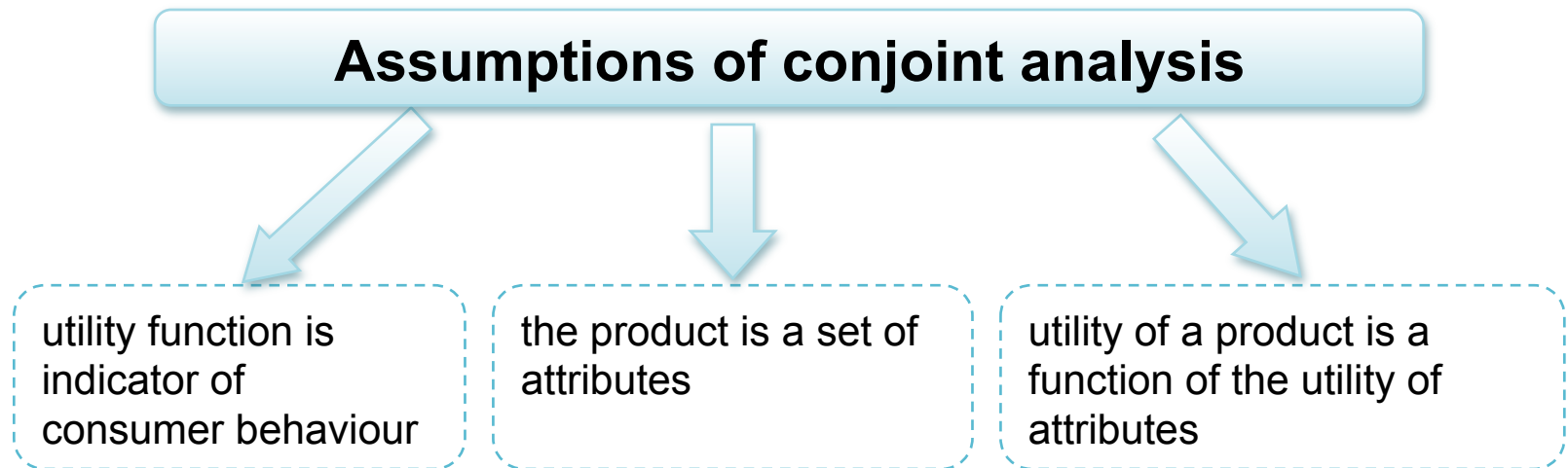
- A basket $(x_1, x_2, \dots, x_k)$ is preferred to a basket $(y_1, y_2, \dots, y_k)$ if and only if the utility of $(x_1, x_2, \dots, x_k)$ is larger than the utility of $(y_1, y_2, \dots, y_k)$, in symbols:

$$(x_1, x_2, \dots, x_k) \succ (y_1, y_2, \dots, y_k) \Leftrightarrow U(x_1, x_2, \dots, x_k) > U(y_1, y_2, \dots, y_k)$$

WHAT CONJOINT ANALYSIS IS?

- Conjoint analysis is ‘a multivariate technique developed specifically to understand how responders develop preferences for objects (products, services, or ideas)’.

(Hair J. Jr., Black W. Babin B., Anderson R., 2009, *Conjoint analysis. Multivariate Data Analysis*, New York: Prentice Hall.)



THEORETICAL BACKGROUND OF CONJOINT ANALYSIS

- General model used to measure customers' preference structure:

$$U_{ix} = f_x(u_{1(ix)}, u_{2(ix)}, \dots, u_{k(ix)})$$

where:

U_{ix} - total utility of i-th profile for x-th consumer (responder, purchaser),

$f_x(\cdot)$ - analytic form of preference function of x-th responder,

$u_{j(ix)}$ - utility of i-th profile on the grounds of j-th variable perceived by x-th responder.

- Additive simple main effect ANCOVA model:

$$\hat{U}_{ix} = \mu_x + \sum_{j=1}^m \sum_{p=1}^{m_j} u_{jp(x)} \cdot x_{jp(i)} + \varepsilon_{ix}$$

where:

$\hat{U}_{ix}$ - estimated total utility of i-th profile for x-th consumer,

μ_x - intercept,

$u_{jp(x)}$ - estimated coefficient (part-worth utility) of p-th level of j-th independent variable for x-th responder,

$x_{jp(i)}$ - artificial variable representing levels of explanatory variable. In case of zero-one coding:

$$x_{jp(i)} = \begin{cases} 1, & \text{if } p\text{-th level of } j\text{-th variable appearing in } i\text{-th profile,} \\ 0, & \text{otherwise.} \end{cases}$$

ε_{ix} - error term,

$j = 1, \dots, m$ - number of explanatory variables (attributes),

m_j - number of levels of j-th variable.

Conjoint procedure drives to decomposition of total utility into partial utilities – connected with the particular levels of independent variables.

STEPS IN CONJOINT ANALYSIS

STEP 1: Definition of attributes and their levels

STEP 2: Determination of conjoint methodology

STEP 3: Experiment design definition

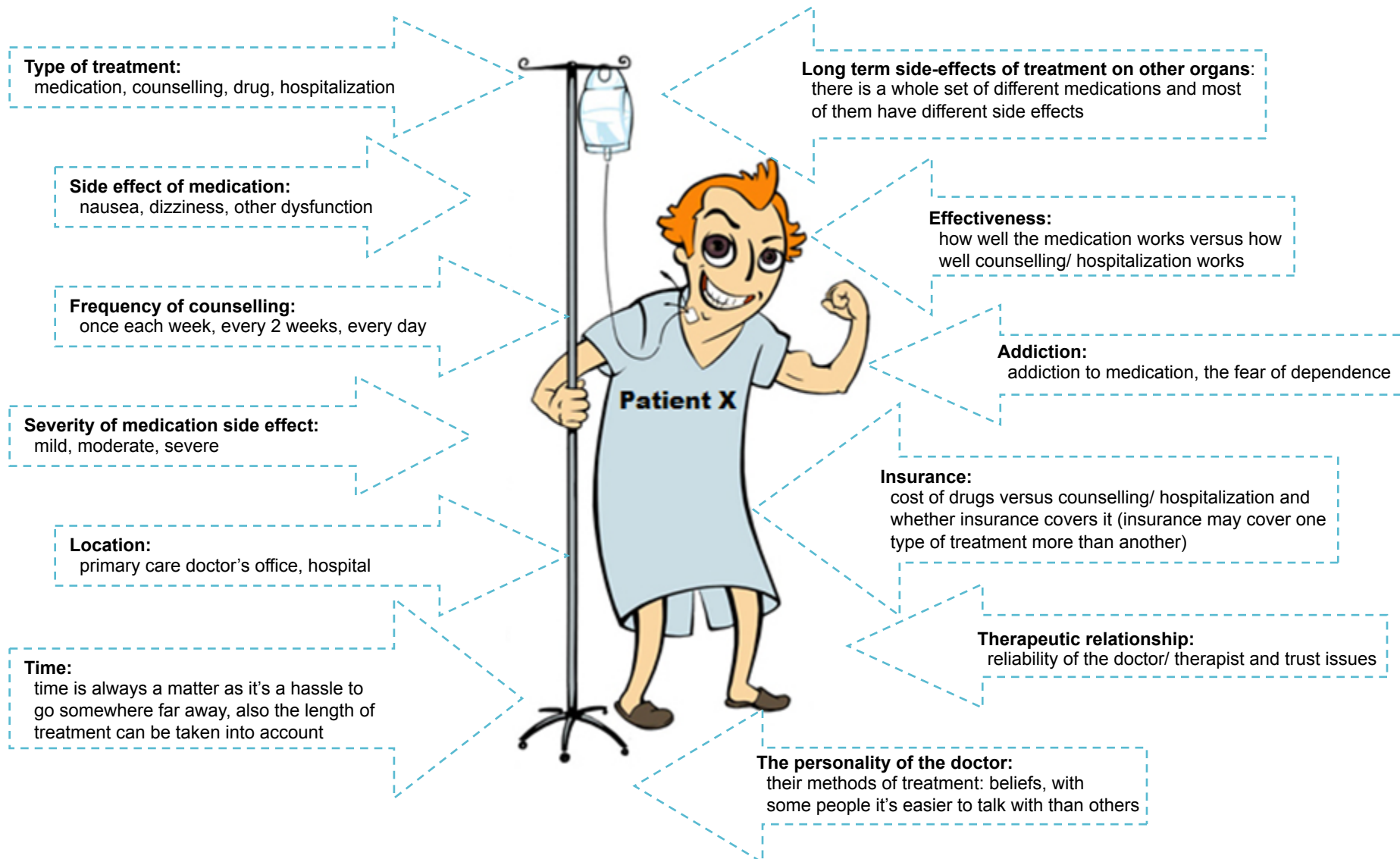
STEP 4: Data collection

STEP 5: Data analysis

STEP 6: Market choices simulator



WHICH TREATMENT WOULD YOU CHOOSE?



CONSIDERED TREATMENT ASPECTS AND THEIR LEVELS

Efficacy

Pain:

No Pain ---- Extreme Pain (0-10 scale):[1]

- 0-5 – no pain
- 6-10 – extreme pain

Side-effect

Severity of medication side effect:

- serious
- moderate
- mild

Cost

Cost of drugs:

- insurance covers it
- insurance does not cover it

Treatment characteristic

Location of health care service and frequency:

- hospital, once each week
- home, once each day

[1] To reduce number of alternatives, two levels of this variable were determined.

TREATMENT PROFILES

Efficacy	Side effect	Cost	Characteristic
no pain	serious	insurance cover it	hospital, once each week
no pain	serious	insurance cover it	home, once each day
no pain	serious	insurance does not cover it	hospital, once each week
no pain	serious	insurance does not cover it	home, once each day
no pain	moderate	insurance cover it	hospital, once each week
no pain	moderate	insurance cover it	home, once each day
no pain	moderate	insurance does not cover it	hospital, once each week
no pain	moderate	insurance does not cover it	home, once each day
no pain	mild	insurance cover it	hospital, once each week
no pain	mild	insurance cover it	home, once each day
no pain	mild	insurance does not cover it	hospital, once each week
no pain	mild	insurance does not cover it	home, once each day
extreme pain	serious	insurance cover it	hospital, once each week
extreme pain	serious	insurance cover it	home, once each day
extreme pain	serious	insurance does not cover it	hospital, once each week
extreme pain	serious	insurance does not cover it	home, once each day
extreme pain	moderate	insurance cover it	hospital, once each week
extreme pain	moderate	insurance cover it	home, once each day
extreme pain	moderate	insurance does not cover it	hospital, once each week
extreme pain	moderate	insurance does not cover it	home, once each day
extreme pain	mild	insurance cover it	hospital, once each week
extreme pain	mild	insurance cover it	home, once each day
extreme pain	mild	insurance does not cover it	hospital, once each week
extreme pain	mild	insurance does not cover it	home, once each day

List of all possible profiles:

```
proc plan ordered;
  factors efficacy=2 side_effect=3 cost=2 characteristics=2
    / noprint;
  output out=treatment_profiles
    efficacy
      cvals = ('no pain' 'extreme pain')
    side_effect
      cvals = ('serious' 'moderate' 'mild')
    cost
      cvals = ('insurance cover it' 'insurance does not cover it')
    characteristics
      cvals = ('hospital, once each week' 'home, once each day');
run;quit;
```

If patient endure allows him to rate maximally 15 profiles:

```
proc optex data=treatment_profiles coding=orth;
  class efficacy side_effect cost characteristics;
  model efficacy side_effect cost characteristics;
    generate n=15;
  output out=treatment_plan_orth;
run;quit;
```

PATIENT X RATES OF TREATMENT PROFILES



Efficacy	Side effect	Cost	Characteristic	Patient X rates
no pain	serious	insurance cover it	hospital, once each week	7
no pain	serious	insurance cover it	home, once each day	8
no pain	serious	insurance does not cover it	hospital, once each week	5
no pain	serious	insurance does not cover it	home, once each day	6
no pain	moderate	insurance cover it	hospital, once each week	19
no pain	moderate	insurance cover it	home, once each day	20
no pain	moderate	insurance does not cover it	hospital, once each week	16
no pain	moderate	insurance does not cover it	home, once each day	18
no pain	mild	insurance cover it	hospital, once each week	23
no pain	mild	insurance cover it	home, once each day	24
no pain	mild	insurance does not cover it	hospital, once each week	21
no pain	mild	insurance does not cover it	home, once each day	22
extreme pain	serious	insurance cover it	hospital, once each week	3
extreme pain	serious	insurance cover it	home, once each day	4
extreme pain	serious	insurance does not cover it	hospital, once each week	1
extreme pain	serious	insurance does not cover it	home, once each day	2
extreme pain	moderate	insurance cover it	hospital, once each week	11
extreme pain	moderate	insurance cover it	home, once each day	12
extreme pain	moderate	insurance does not cover it	hospital, once each week	9
extreme pain	moderate	insurance does not cover it	home, once each day	10
extreme pain	mild	insurance cover it	hospital, once each week	15
extreme pain	mild	insurance cover it	home, once each day	17
extreme pain	mild	insurance does not cover it	hospital, once each week	13
extreme pain	mild	insurance does not cover it	home, once each day	14

METRIC CONJOINT ANALYSIS FOR PATIENT X

Part-worth utility:

- The predicted utility of conjoint analysis model for the preference for treatment with efficacy level i , side-effect j , cost k and characteristic p : $\hat{U}_{ijkp} = \hat{\mu} + \hat{u}_i + \hat{u}_j + \hat{u}_k + \hat{u}_p$, $i,k,p=1,2$; $j=1,2,3$;

Utilities Table Based on the Usual Degrees of Freedom

Label	Utility	Standard Error	Importance (% Utility Range)
Intercept	12.5000	0.21472	
efficacy, extreme pain	-3.2500	0.21472	27.130
efficacy, no pain	3.2500	0.21472	
side_effect, mild	6.1250	0.30366	58.957
side_effect, moderate	1.8750	0.30366	
side_effect, serious	-8.0000	0.30366	
cost, insurance cover it	1.0833	0.21472	9.043
cost, insurance does not cover it	-1.0833	0.21472	
characteristics, home, once each day	0.5833	0.21472	4.870
characteristics, hospital, once each week	-0.5833	0.21472	

- For the **most preferred treatment** (no pain, mild side-effect, cost covered by insurance and drug taken every day in home), the predicted utility and actual preference value is:

$$\hat{U}_{1312} = 12.5 + 3.25 + 6.125 + 1.0833 + 0.5833 = 23.5416$$

- For the **least preferred treatment** (extreme pain, serious side-effect, cost not covered by insurance and drug taken every week in hospital), the predicted utility and actual preference values is:

$$\hat{U}_{2121} = 12.5 - 3.25 - 8 - 1.0833 - 0.5833 = -0.4166$$

```
proc transreg data=treatment_preferences  
    outtest=treatment_utility  
    utilities separators=",";   
    model identity(preference) =  
        class(efficacy side_effect cost characteristics / zero=sum);  
run;
```

METRIC CONJOINT ANALYSIS FOR PATIENT X

Importance value:

- The importance value is computed from the part-worth utilities for each feature of treatment:

$$I_a = \frac{\max \hat{U}_{ay} - \min \hat{U}_{ay}}{\sum_{a \in A} (\max \hat{U}_{ay} - \min \hat{U}_{ay})} \cdot 100\%$$

where:

I_a - importance value for feature a , $a \in A$,
 $A = \{\text{efficacy, side_effect, cost, characteristics}\}$,
 $\hat{U}_{ay}$ - part-worth utility for feature a with level y .

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characteristics, hospital, once each week	-0.5833	0.21472	

- The **most important** treatment attribute is side-effect with the importance value calculated:

$$\begin{aligned}
 I_{\text{side-effect}} &= \frac{(6.125 - -8)}{(3.25 - -3.25) + (6.125 - -8) + (1.0833 - -1.0833) + (0.5833 - -0.5833)} \cdot 100\% \\
 &= \frac{14.125}{23.9582} \cdot 100\% = 58.95685\% \approx 58.957\%
 \end{aligned}$$

MARKET PREFERENCES

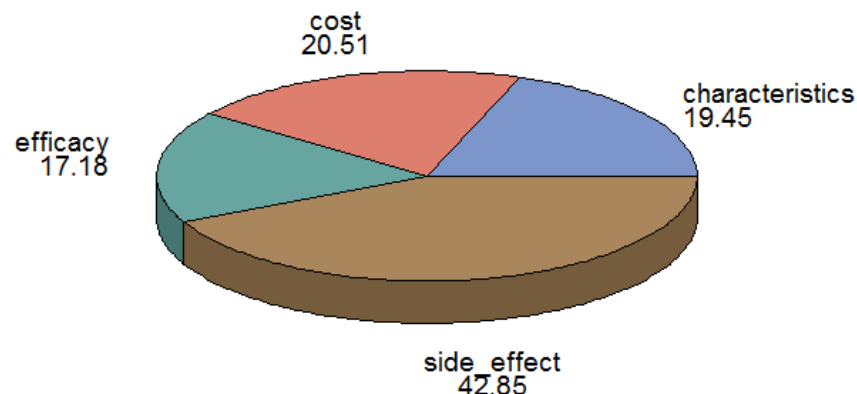
Efficacy	Side effect	Cost	Characteristic	Rates of Patient:									
				X	1	2	3	4	5	6	7	8	9
no pain	serious	insurance cover it	hospital, once each week	7	6	6	20	19	15	14	22	21	22
no pain	serious	insurance cover it	home, once each day	8	22	3	9	9	18	15	9	1	24
no pain	serious	insurance does not cover it	hospital, once each week	5	3	19	4	23	12	10	19	9	20
no pain	serious	insurance does not cover it	home, once each day	6	4	4	23	16	13	16	4	8	12
no pain	moderate	insurance cover it	hospital, once each week	19	11	20	1	22	24	23	17	6	6
no pain	moderate	insurance cover it	home, once each day	20	17	7	7	6	10	2	21	22	16
no pain	moderate	insurance does not cover it	hospital, once each week	16	14	15	2	7	5	11	18	20	19
no pain	moderate	insurance does not cover it	home, once each day	18	20	14	21	13	1	6	5	19	13
no pain	mild	insurance cover it	hospital, once each week	23	7	24	16	2	8	24	15	3	21
no pain	mild	insurance cover it	home, once each day	24	18	2	11	8	9	19	11	17	8
no pain	mild	insurance does not cover it	hospital, once each week	21	19	17	10	5	7	12	2	15	11
no pain	mild	insurance does not cover it	home, once each day	22	5	21	17	3	2	5	8	2	18
extreme pain	serious	insurance cover it	hospital, once each week	3	10	8	3	18	3	7	1	7	14
extreme pain	serious	insurance cover it	home, once each day	4	15	13	15	24	21	22	13	24	9
extreme pain	serious	insurance does not cover it	hospital, once each week	1	2	22	19	10	23	17	7	11	17
extreme pain	serious	insurance does not cover it	home, once each day	2	12	9	8	1	17	20	3	5	2
extreme pain	moderate	insurance cover it	hospital, once each week	11	23	11	14	20	6	8	12	23	23
extreme pain	moderate	insurance cover it	home, once each day	12	8	23	6	14	14	3	6	16	3
extreme pain	moderate	insurance does not cover it	hospital, once each week	9	9	5	12	4	19	13	10	12	15
extreme pain	moderate	insurance does not cover it	home, once each day	10	1	12	24	11	22	18	20	13	1
extreme pain	mild	insurance cover it	hospital, once each week	15	24	10	18	17	11	21	23	4	4
extreme pain	mild	insurance cover it	home, once each day	17	13	1	22	15	16	9	14	18	7
extreme pain	mild	insurance does not cover it	hospital, once each week	13	16	16	5	12	20	4	16	10	10
extreme pain	mild	insurance does not cover it	home, once each day	14	21	18	13	21	4	1	24	14	5



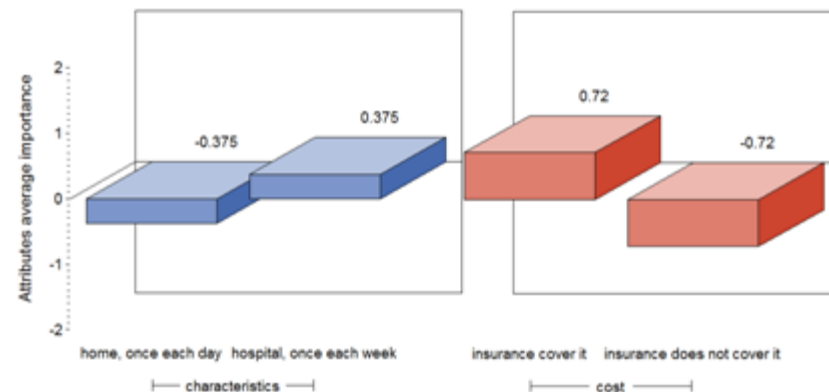
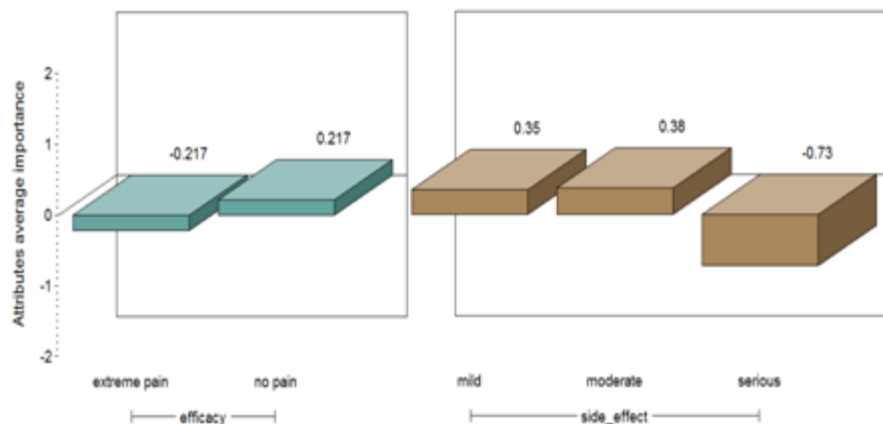
SUMMARY OF MARKET PREFERENCES

- Treatment attributes importance for the market:

SUM of Importance (% Utility Range) by Label



- Mean treatment attributes levels importance for the market:



CHOICE SIMULATION AND PREDICTION OF MARKET SHARE

Maximum utility model

Each patient will always choose and buy the product/ service with the highest utility

The most preferred combination (with the largest total utility) for each subject is found and probabilities with which each combination will be purchased is assigned

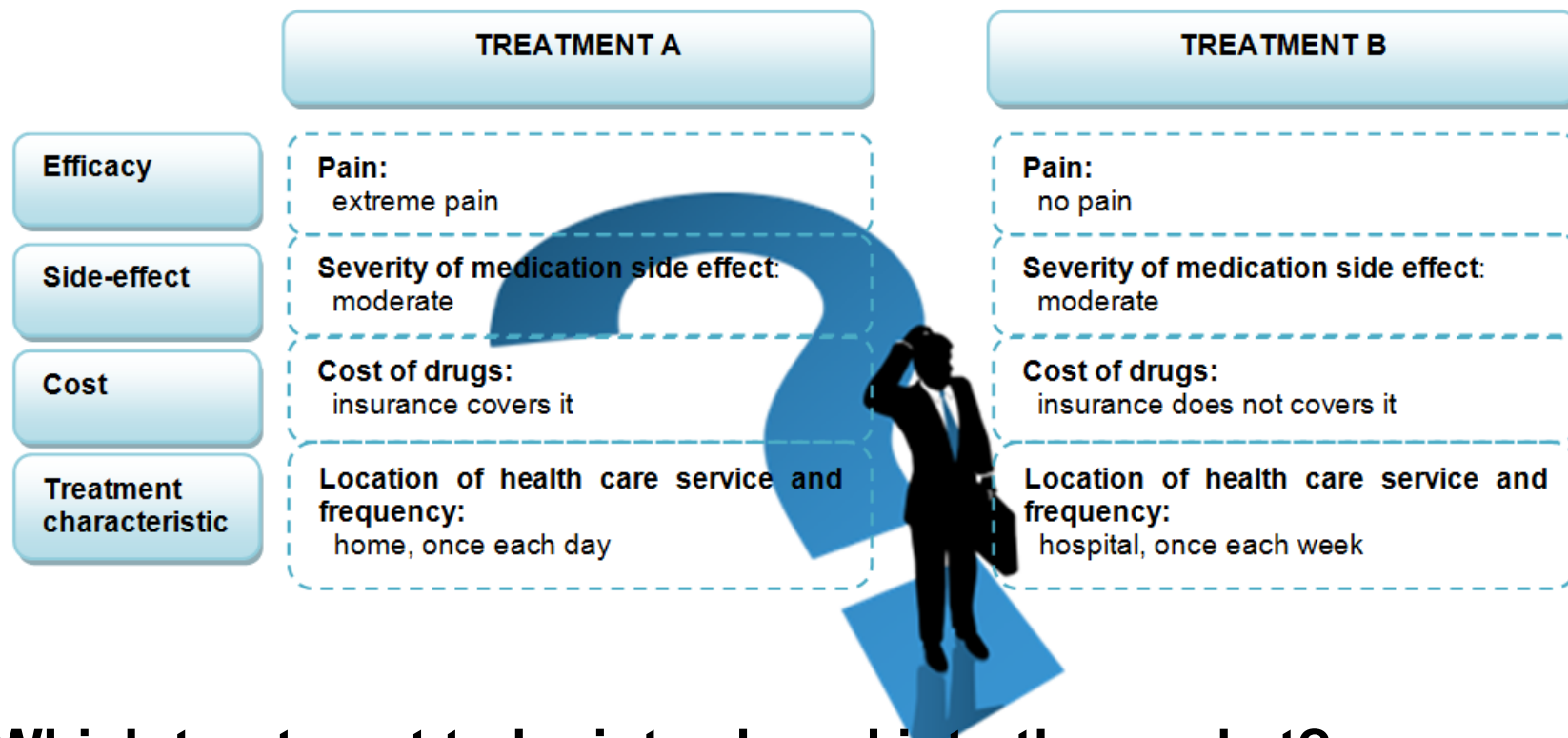
Received probabilities are averaged across subjects

Efficacy	Side effect	Cost	Characteristic	Market share
extreme pain	mild	insurance cover it	home, once each day	10
extreme pain	mild	insurance does not cover it	home, once each day	10
extreme pain	moderate	insurance cover it	home, once each day	10
extreme pain	serious	insurance cover it	hospital, once each week	20
no pain	mild	insurance cover it	home, once each day	10
no pain	mild	insurance cover it	hospital, once each week	10
no pain	mild	insurance does not cover it	hospital, once each week	10
no pain	serious	insurance cover it	hospital, once each week	20

To get market share

WHICH TREATMENT TO BE INTRODUCED INTO THE MARKET?

- The pharmaceutical company would like to introduce into considered market one from two treatments: A or B, having characteristics as described below:



- Which treatment to be introduced into the market?**

PATIENT X CHOICE

- Which treatment would Patient X choose if there were only those two options available?
- Predicted utilities of conjoint analysis model for Patient X for both treatments alternatives are equal respectively:



My choice

$$\hat{U}_{2212}^A = 12.5000 - 3.2500 + 1.8750 + 1.0833 + 0.5833 = 12.7916$$

$$\hat{U}_{1221}^B = 12.5000 + 3.2500 + 1.8750 - 1.0833 - 0.5833 = 15.9584$$

MARKET CHOICE

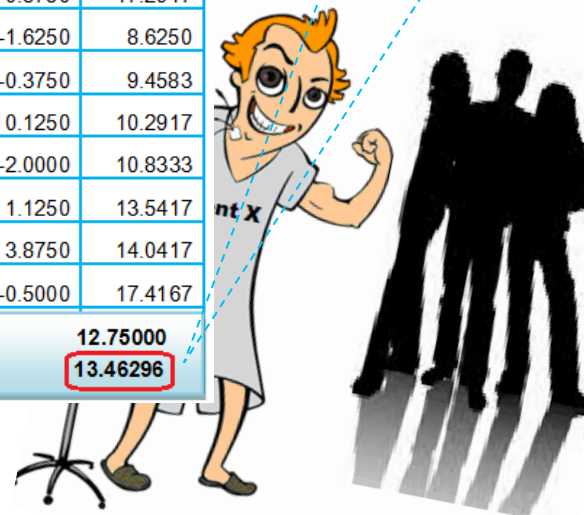
- Which treatment will be chosen by the market if there were only those two options available?

TREATMENT A						TREATMENT B					
Patient	Characteristic	Cost	Efficacy	Side effect	Utility	Characteristic	Cost	Efficacy	Side effect	Utility	
X	0.5833	1.0833	-3.2500	1.8750	12.7917	-0.5833	-1.0833	3.2500	1.8750	15.9583	
1	0.5000	2.0000	0.3333	0.3750	15.7083	-0.5000	-2.0000	-0.3333	0.3750	10.0417	
2	-1.9167	-1.8333	-0.1667	0.8750	9.4583	1.9167	1.8333	0.1667	0.8750	17.2917	
3	2.1667	-0.6667	0.7500	-1.6250	13.1250	-2.1667	0.6667	-0.7500	-1.6250	8.6250	
4	-0.7500	2.0000	1.4167	-0.3750	14.7917	0.7500	-2.0000	-1.4167	-0.3750	9.4583	
5	-0.2500	0.4167	2.1667	0.1250	14.9583	0.2500	-0.4167	-2.1667	0.1250	10.2917	
6	-1.1667	1.4167	-0.5833	-2.0000	10.1667	1.1667	-1.4167	0.5833	-2.0000	10.8333	
7	-1.0000	1.1667	-0.0833	1.1250	13.7083	1.0000	-1.1667	0.0833	1.1250	13.5417	
8	0.7500	1.0000	0.5833	3.8750	18.7083	-0.7500	-1.0000	-0.5833	3.8750	14.0417	
9	-2.6667	0.5833	-3.3333	-0.5000	6.5833	2.6667	-0.5833	3.3333	-0.5000	17.4167	
Equally weighted average utility:					13.0000	Equally weighted average utility:					12.75000
Not equally weighted average utility:					12.9537	Not equally weighted average utility:					13.46296

Intercept=12.5000.

All subjects are equally weighted.

If Patient X states 30% of demand for treatment service in the market.



CONCLUSIONS

- Characteristics with the largest value of part-worth utility are considered to be the most important in predicting patient preferences.
- Assuming that treatment concept can be expressed through the design parameters, estimated values of utility function allow to calculate the expected attractiveness of various treatment profiles for each person and can be used to determine which treatment profile would be the most favourable for the given patient with given preferences structure.
- In light of classical theories of economy, the greater utility from the given treatment concept, the more patient is willing to pay for it (if it is within his/her budget).



THANK YOU