ECONOMETRIC ASSESSMENT OF CUSTOMERS' PERSONALITY BIASES AND COMMUNICATION PREFERENCES CORRELATION

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Introduction

In everyday life, people tend to make various choices, which directly or indirectly bare consequences to a person's economic welfare. One of those choices is the communication preference. Given that the communication is one of the essential pillars of the marketing science, the importance of the analysis of the communication and related topics is imperative. Given the digitalization of the modern world we encounter a situation of data overload while real, "face-to-face", communication diminishes. At this point, it is necessary to gain as much as possible information from the data, especially if the communication is digital. That is one of the reasons for the necessity of quantification of the influencing factors on communication. Therefore, it is relevant to pursue the quantification of the traits and biases which influence people's rationality and consequentially their choices.

Even though the previous research of Roozmand (2011), Nassiri-Mofakham (2008; 2009) and Kostelić (2017) explicitly proved correlation (and/ or causation) of behavioral and psychosocial elements to decision–making in sales process, the link to communication preference prediction is missing. Given that this area has not already been investigated from this approach, it represents a research gap. With this research, we aim to contribute to closing the stated gap.

The data for this research has been gathered online in period of 2013-2015, and previously used for dissertation thesis. For this research, the dependent variable is re-coded, and will be analyzed as a binary variable. That enables the use of prediction models, namely logistic regression with binary dependent variable. Logistic regression with binary dependent variable will be used with both personality traits and personality traits estimators. Although one could assume that models with personality traits as independent variables will offer better predictability, it is not what the analysis shows.

The rest of the article is structured as follows: theoretical overview provides an insight into the topic, methodology section provides details about analysis, results section presents overview of communication preference models, discussion emphasizes implications of the findings and conclusion section provides short summarization with limitations, contributions and possibilities for future research.

1. Theoretical Overview

The research regarding people's biases and traits, their influences on rationality and consequentially people's choices is area which covers a part of the marketing science and behavioral economy. Behavioral economists, Camerer (1998) and Rubinstein (1998) have been modelling bounded rationality, while Kahneman (2002) showed groups of possible influences. Njegovanović and Ćosić (2016) emphasize that in our minds, we have a magnificent structure that governs our actions and, in some way, causes awareness of the world around us. Mohlin (2012) provided an overview of development of the thoughts on the theory of the mind. At individual level, boundaries of rationality are characteristics of the individual, heuristics and biases forming a subjective rationality, namely a unique set of boundaries that lead to a specific choice for each individual (Kostelić, 2017). Davis et al. (2007) define the nexus of personality traits and the decision – making. Relevant individual's characteristics for economic decision – making are composed of psychological, sociological and economical elements. Psychosocial elements can be defined by quantification of personality traits, cognitive capacity and value scales. Roozmand et al. (2011) approach to decision-

making modelling to define the process of the purchase decisions. While designing decision-making formal model at interpersonal level, they used the MASQ meta model. Nassiri-Mofakham et al. (2008; 2009) analyzed the bargain process in e-commerce using OCEAN personality type model. Kostelić (2017) and Škare and Kostelić (2016) used quantification of personality traits based on Jung typology and general attitudes to model bounded rationality and consequently decision preferences. In addition, Kostelić (2017) proved OLS and Logit Ordered modelling not to be accurate enough to predict consumers' decisions, while dynamic game theory of asymmetrical information model provided better results. Previous research explicitly proved correlation (and/or causation) of behavioral and psychosocial elements to decision-making.

Pratt (1996) proposed the "electronic personality", a term which denotes that people present themselves differently using computer mediated communications. He found that there is a significant shift in introversion-extraversion and judging – perceiving personality trait in electronic compared to real life personality. Hence, in assessing the population who engage in online activities, whether it is socializing or purchase, their actions will be better assessed using their electronic personality. Villaume and Bodie (2007) examined the relationship between trait-like personality variables, communicator style, and individual listening preferences. They found that people who reported higher levels of psychoticism preferred friendlier and more open communication style, while "more masculine" personality tended to engage in impression – leaving arguments. Amiel and Sargent (2004) used the Big Five personality model to assess the motives of internet users. They found that individuals who scored high in neuroticism felt the sense of belonging in the online world, while extraverts reject the community aspect of internet. Ryan and Xenos (2011) examined the link between the personality traits and the use of Facebook. They found that the Facebook users were more extraverted and narcissistic than nonusers, who were more conscientious and lonely. It is interesting to notice that this result collides with Amiel and Sargent's (2004) result, where they found that extraverts reject the community aspect of internet. Johnson and Johnson (2006) examined the relationship of personality traits and internet experience to e-commerce preferences. They found that those who preferred face-to-face communication, were less extroverted, but they found no significant correlation of introversion – extraversion personality trait to communication choices. Xiao and Benbasat (2007) examined how recommendation agents (software that gathers information about user, so it could offer recommendations) information and consumer characteristics influence the consumer decision-making process. Horwitz and Pennock (2000) suggest a content recommendation technique based on personality diagnosis using probabilistic determination. Zafari et al. (2017) offer a new solution for a highly accurate hybrid component-based factorized preference model in recommender systems. Their research belongs to the information science field, but they state that they use consumer biases and preferences as model input.

Provided overview shows that personality trait analysis has been investigated from many approaches, in order to explain or predict people's decisions, preferences or behavior. Some of the stated researches investigate the online dimension of people's choices and preferences, up to the level where software gathers information to offer more precise recommendations based on people personality characteristics. Given the overview it can be noticed that there still exists a gap in quantification of the estimators and determination of correlated variables regarding the prediction of communication preferences.

2. Methodology

2.1 Data Collection

Two of the most commonly used personality tests are Myers-Briggs Type Indication model (MBTI) based on Jung personality typology and the Big-Five model (also known as OCEAN) based on Goldberg typology. MBTI model measures four personality traits with the extremes on each pole: extraversion – introversion, sensing – intuitive, thinking – feeling, and judging – perceiving. Four of the Big-Five traits correlate to MBTI traits, and the fifth one is the neuroticism. The Big-Five model is primarily used for measurement in psychiatric population due to examination of neuroticism trait. The most commonly used personality measurement for non-psychiatric population is the MBTI test. Murray (1990) pointed out a critique of the MBTI model stating that the test can rather show the preferences

over real choices (however, he never empirically proved it).

MBTI model, as well as Keirsey's and Bates' (1984) are based on the Jung (1971) personality typology. Those models have been a starting point for the questionnaire composition. The data has been gathered online, from March 2013 until May 2015 in Croatia. During that time, 244 complete questionnaires have been collected. Given that the questionnaire has been distributed online, the conclusions should be made only for the population which uses online services. Respondents' age ranges from 15 to 56 years, with the average age of 28 years. First part of the survey examines the types of personality, while the second part examines communication preferences.

2.2 Data Analysis

Personality traits are represented as combined and weighted relative frequencies of the estimators, while choices of consumer preferences act as a binomial variable where a certain choice occurs or doesn't occur.

Binomial dependent variables enable the use of the econometric prediction models, such as logit and probit linear models. Prediction models are stochastic probability models, so they involve a certain amount of inherited randomness which arises from imperfect information. The data analysis has been conducted using both logit and probit prediction modelling with binary dependent variable (Using Gretl GNU software), but logistic analysis provided models with higher percentages of correctly predicted cases and will be presented in this research.

After the analysis of the relative frequencies of the individual traits, the analysis of the answers to specific questions is used to provide an in-depth analysis and to offer practical and direct guideline for approach to customer.

The dependent variable represents choices of communication preferences regarding the communication approach, language use, and information sharing. While answering the question about communication approach preferences respondents ranked: friendly and cordially, professional and cordially, professional and kind, and strictly professional and distanced communication. While choosing the preferred language use, respondents ranked options: simple language with clarifications on examples, simple and common language, expert language with clarifications, and expert language without clarifications. Regarding the information sharing during the interpersonal communication, respondents ranked options: presenting own situation in detail regarding the motives, aims and desires; present the problem, motives and goal in a nutshell; present the problem in short lines, keeping the rest of information; and present the minimum of the necessary information.

For this research, only first-choice preferences are used, and implemented in each choice model as a binomial dependent variable. Dependent variables (communication choice outcomes) are defined as follows:

$$O_i = \begin{cases} 1 & if\ the\ i-th\ person\ made\ a\ choice \\ 0 & otherwise \end{cases}, \quad i = 1, \ldots, 12$$

The outcome follows Bernoulli distribution, defined with the number of occurrences and the probability of desired outcome.

Hypothesis for each model are set as:

$$H_o \ldots p_i = \hat{p}_{oi}(O_i = 1)$$
$$H_1 \ldots p_i \neq \hat{p}_{oi}(O_i = 0)$$

Based on a standard probability threshold, the hypothesis interpretation is as follows: if $\hat{p} \geq \tilde{p}$, then $O_i = 1$, else $O_i = 0$.

The logistic equation can be stated as:

$$O_i' = \ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1(i-e) + \beta_2(n-s) + \beta_3(t-f) + \beta_4(j-p)$$

or, in terms of probability, it is:

$$\hat{p} = \frac{e^{\beta_0+\beta_1(i-e)+\beta_2(n-s)+\beta_3(t-f)+\beta_4(j-p)}}{e^{\beta_0+\beta_1(i-e)+\beta_2(n-s)+\beta_3(t-f)+\beta_4(j-p)}+1} = \frac{e^{O_i'}}{e^{O_i'}+1}.$$

To test hypothesis, commonly used tests will be conducted: log likelihood test and Wald test statistics. In addition, confusion matrix will be discussed.

To test hypothesis, likelihood ratio test is used. It is statistic test which provides ratio of the likelihood for the hypothesized parameter values to the likelihood of the data at maximum likelihood estimate, where degrees of freedom are equal to the number of observations for big data sets. The test values are approximately equal to χ_i^2.

Wald test statistics is a function which measures ratio of squared difference of the maximum likelihood estimate and hypothesised value and estimate of the standard deviation of maximum likelihood estimate. The result provides the z-score for the observed variable, namely the deviation from the mean expressed in standard deviation.

McFadden R squared ($R^2_{McFadden}$) is not going to be used as the criteria for the model rejection. $R^2_{McFadden}$ is based on log-likelihood and while a certain variable can have reasonable effect on the outcome, that diminishes when applying logarithm. That is one of the reason why $R^2_{McFadden}$ takes rather small values for fitted logistic models. To increase $R^2_{McFadden}$ value, it is necessary to increase the difference in probability of certain event occurrence, hence influence data – which would rather be avoided in this research.

Model prediction will be discussed using results of confusion matrix.

As a hypothesis rejection criterion, p-value is going to be discussed at 95% confidence level, respectively 0.05 significance level.

3. Results

3.1 Independent Variables: Personality Traits

Tab. 1 contains an overview of the analysis of personality traits and the first-choice communication preferences modelling using binomial logistic regression. There are twelve models, divided into three sets of four models, regarding the dependent variables: communication approach/style, language use, and information sharing preferences.

The first set of four models (M1-M4) relate to question of communication approach preferences. First model describes "friendly and cordially" first-choice communication preference.

According to the calculation, first model (M1, first column) is derived as follows (Eq. 1):

$$\hat{p}_1 = \frac{e^{-1.70323+1.24374(i-e)+0.963116(n-s)-1.70946(f-t)+0.106833(p-j)}}{e^{-1.70323+1.24374(i-e)+0.963116(n-s)-1.70946(f-t)+0.106833(p-j)}+1} = \frac{e^{O_1'}}{e^{O_1'}+1} \quad (1)$$

Tab. 1: Models of first-choice communication preferences based on personality traits

Independent variables (personality traits estimators)	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
Const	−1.703 *	−0.774	0.119	−4.499	0.31	−1.124	−2.0749*	−2.237	−2.825 ***	0.782	−1.428	−1.744
i-e	1.244 *	−0.186	−0.583	−3.738	−0.087	−0.236	0.623	−0.572	1.775 **	0.0368	−1.102	−2.651 *
n-s	0.963	0.292	−1.28	6.441 *	−0.332	2.431 **	−4.393 ***	2.891	2.672 **	−0.144	−2.406 *	−2.32
f-t	−1.709 *	−1.211	1.933 **	−0.066	−0.371	−0.507	1.626	−1.497	−0.817	−0.085	0.385	1.572
p-j	0.107	−0.332	0.378	−2.447	0.149	−0.673	1.951	−4.53	−0.313	−1.149	2.485 **	0.297
Number of cases 'correctly predicted'	189 (77.5%)	199 (81.6%)	148 (60.7%)	241 (98.8%)	126 (51.6%)	161 (66.0%)	207 (84.8%)	241 (98.8%)	183 (75.3%)	124 (51.0%)	193 (79.4%)	232 (95.5%)
f(beta'x) at mean of independent vars	0.169	0.149	0.243	0.006	0.25	0.216	0.121	0.009	0.179	0.25	0.158	0.032
Likelihood ratio test: Chi-square	8.57322 [0.0727]	1.71255 [0.7884]	10.3718 [0.0346]	4.61145 [0.3295]	0.394559 [0.9829]	6.67677 [0.1540]	12.9734 [0.0114]	2.72622 [0.6046]	15.6127 [0.0036]	1.88027 [0.7578]	10.9361 [0.0273]	7.21233 [0.1251]
McFadden R-squared	0.032919	0.007341	0.031211	0.14253	0.001167	0.021834	0.060503	0.084261	0.057013	0.005582	0.043796	0.080506
Correctly predicted 1	0	0	117	0	85	0	2	0	2	54	1	0
Correctly predicted 0	189	100	31	241	41	161	205	241	181	70	192	232
Predicted 1 Actual 0	0	0	72	0	79	5	0	0	1	53	0	0
Predicted 0 Actual 1	55	45	24	3	39	78	37	3	59	66	50	11

Source: own calculation

Statistically significant variables at 0.1 significance level are the constant, and personality traits: intuitive – sensing and feeling – thinking. The exact marginal effect to the dependent variable can be read out from the slopes at the mean. However, coefficients point out the same direction of the influence of the statistically significant variables. The coefficients suggest that the more intuitive (or less sensing) and more feeling (or less thinking) traits expressed, the outcome converges to occurrence of the first-choice of the friendly and cordially communication preference. Simulation shows that 189 or 77.5% of the outcomes are correctly predicted. $R^2_{McFadden}$ points out to a very small prediction level. The confusion matrix shows that the model has failed to predict 55 choices of this communication preference which denotes the type II error. The hypothesis should be rejected at 0.05 significance level.

Simulation of the "professional and cordially" communication preference (M2) shows that 199 or 81.6% of the outcomes are correctly predicted. However, there are no significant variables. Confusion matrix shows that there are 45 outcomes predicted as 0, but actual value is 1 which points out to a type II error. Given the likelihood ratio test, the probability that the $\chi^2 data$ value exceeds the χ^2 is 0.7884, and the null-hypothesis should be rejected at 0.05 significance level.

The analysis of the "professional and kind" communication preference (M3) shows that statistically significant variable at 0.05 significance level is personality trait thinking – feeling. Confusion matrix points out that 72 outcomes are predicted as value 1 while their actual value is 0, which points out to type I error. The other 24 miss-predicted outcomes represent the type II error of this model. There are only 148 correctly predicted outcomes, but likelihood ratio test leads to conclusion that the null hypothesis should not be rejected at the 0.05 significance level.

The analysis of the "strictly professional and distanced" communication preference (M4) points out to the personality trait intuitive – sensing as a statistically significant variable. The number of correctly predicted cases is 98.8%, with only 3 miss-predicted cases. However, the likelihood ratio test leads us to conclusion that the hypothesis should be rejected.

The next set of four models (M5-M8), regards to the preferred language use.

The analysis of the "simple language with clarifications on examples" (M5) points out that there are no statistically significant independent variables and there is barely over half of the cases correctly predicted. Likelihood ratio test points out that the null-hypothesis should be rejected at the 0.05 significance.

The M6 column provides an analysis for the communication preference of the "simple, common language". The personality trait intuition – sensing is a statistically significant variable at 0.95 confidence level. Simulation shows that there are 66% of the correctly predicted cases by the model. Both type I error (78 cases) and type II error (5 cases) are present in this model. In addition, likelihood ratio test suggests that the null – hypothesis should be rejected at 0.05 significance level.

The M7 column contains the analysis of the "expert language with clarifications" communication first-choice. Statistically significant variables are the constant and intuitive – sensing personality trait. There are 84.8% correctly predicted outcomes. Type II error is present in the model. LRT suggests that the null-hypothesis should not be rejected at the 0.05 significance level.

Even though there are no statistically significant variables, the model of "expert language use without clarifications" simulation (M8) predicted 98.8% outcomes correctly, with only 3 miss-predicted outcomes. However, LRT leads to conclusion that the null-hypothesis should be rejected at the 0.05 significance level.

Following set of four models (M9-M12) regards to information sharing.

The analysis of the "presenting own situation in detail regarding the motives, aims and desires" (M9) points out that the constant, as well as personality traits introversion – extraversion and feeling – thinking are statistically significant variables. The simulation provides information that the model correctly predicted 75.3% outcomes. LRT points out that the null – hypothesis should not be rejected at the 0.05 significance level.

The analysis presented in M10, does not point out any significant variable. Both type I and type II errors are large in this model. LRT shows that the null-hypothesis should be rejected.

Statistically significant variables for model presented in M11, are the intuition – sensing and perceiving – judging personality traits. The

simulation shows that 79.4% of the cases are correctly predicted. Miss – predicted cases represent the error type II in this model. LRT shows that the null – hypothesis should not be rejected at 0.05 significance level.

The analysis of the first-choice of "minimum of information exposure" preference (M12) points out that introversion – extraversion personality trait is a statistically significant variable with negative coefficient. That means that if extraversion is more expressed it will lead to smaller value of the dependent value, that is, to zero as the choice of this communication preference. The simulation shows that 95.5% cases are correctly predicted by this model, but the LRT shows that the null – hypothesis should be rejected at 5% significance.

3.2 Independent Variable: Personality Estimators

To provide a more thorough analysis of the biases which influence communication preferences, personality estimators are used as independent variables, while the dependent variables stay the same. The results are summarized in Tab. 2. The table contains a list of the personality traits estimators, precisely, a set of claims with Yes/No responses (for this analysis, "Yes" is coded as 1, and "No" as 0). Models are stated in the columns, with statistically significant variables emphasised with significance level.

All the twelve models presented in the Tab. 2 show significantly low LRT p-values, which leads to conclusion that the null-hypothesis should not be rejected. The correctly predicted

Tab. 2: Models of first–choice communication preferences based on personality estimators (Part 1)

Independent variables	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
Q1	2.85 **	2.28	−2.56**		0.42	−1.25	2.13		2.64	−1.87*	−1.07	
Q2	−0.45	2.05	0.102		0.393	0.008	−0.82		0.67	0.21	−1.96*	
Q3	−0.32	0.92	0.198		0.293	0.903	−5.91***		−1.69*	1.828**	−1.26	
Q4	2.207***	1.513	−2.10***		0.544	−0.12	−1.96*		1.008	−0.17	−0.33	
Q5	0.822	4.013	−1.299***		0.084	−0.58	0.734		1.506**	−0.17	−2.41**	
Q6	0.074	0.082	−0.04		0.471	−1.02**	0.291		0.547	0.281	−1.39	
Q7	1.258**	3.870	−1.80***		0.332	−0.53	−0.295		−0.999	−0.03	2.206**	
Q8	0.135	−2.37	1.088**		0.653	−0.59	−0.91		1.26 *	−0.49	−0.56	
Q9	−1.39**	−2.58	1.43***		0.749*	−0.93*	1.64 *		1.344**	−0.68	0.420	
Q10	−0.29	−0.8	0.34		−0.3	0.158	−0.49		−0.88	−0.18	1.504	
Q11	1.165*	−1.1	−0.23		−0.13	−0.07	−0.31		0.022	0.502	−1.09	
Q12	−1.55**	3.193	0.011		−0.46	0.252	0.385		0.388	−0.08	−1.29	
Q13	−0.46	−1.08	0.52		1.22 **	−2.03***	1.506		2.462***	−1.23**	−3.56**	
Q14	−0.17	−1.59	0.287		−0.46	0.404	0.089		1.269**	−0.4	−0.26	
Q15	−0.94	1.84	−0.27		−0.53	0.793	0.323		−2.39 ***	1.53 ***	−0.88	
Q16	0.887	−1.36	−0.56		0.001	−0.07	0.138		−0.26	0.326	−1.59	
Q17	1.763***	−1.11	−0.5		−0.58	1.096**	−0.04		−0.79	1.48 ***	−2.41**	
Q18	0.811	2.42	−0.99 *		−0.35	0.267	−2.39**		0.453	0.66	−4.13 ***	
Q19	−1.19	0.293	0.281		0.084	0.629	−1.32		−0.67	0.197	0.917	
Q20	0.61	−3.52	−0.30		−0.12	0.667	−0.69		−0.91	−0.42	2.276**	
Q21	−0.96*	1.193	0.156		−0.76*	0.970*	1.902*		−0.41	0.617	−1.06	
Q22	1.732	2.464	−1.61 **		−0.33	−0.68	−0.19		1.584	−0.62	−1.83	
Q23	−2.21***	0.617	0.981*		−0.80	0.662	2.187**		0.729	0.537	−0.51	
Q24	−0.47	−1.07	0.468		0.644	0.032	−1.88*		−0.14	−0.12	−0.06	
Q25	0.567	−1.04	−0.02		0.403	−0.19	−0.61		−1.51**	0.784	0.114	
Q26	1.967**	−1.36	−1.15*		0.375	−0.33	−1.34		1.267	−0.28	1.041	
Q27	0.278	0.923	−0.1		−0.43	0.346	0.205		−0.28	−0.21	0.887	

Tab. 2: Models of first–choice communication preferences based on personality estimators (Part 2)

Independent variables	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
Q28	−0.64	−0.59	0.613		−0.50	0.011	2.414**		1.021	−0.46	−0.05	
Q29	0.499	−0.44	−0.17		1.033**	−0.52	−1.96**		−0.31	0.473	−1.54*	
Q30	0.787	−2.10	0.06		3.401**	0.199	−2.84		1.677	−1.27	−11.6	
Q31	−1.75***	−0.01	1.122**		−1.48***	1.502***	0.777		−1.01	0.101	2.178*	
Q32	−1.91*	5.084	−0.81		0.304	−0.23	0.955		0.486	0.198	2.16	
Q33	0.174	−2.19	0.656		0.237	−0.43	0.903		−0.15	0.406	−1.37	
Q34	0.177	−0.97	−0.27		−0.28	0.631	−1.18		−0.27	1.11 *	−2.06*	
Q35	1.111	−5.99	0.966		−0.15	1.452	−1.81		−8.96***	2.473*	3.948	
Q36	−1.24	2.136	0.2		−2.41*	−1.59	4.603*		−0.61	0.127	15.22	
Q37	−1.48**	−3.15	2.369***		0.423	−0.53	1.228		−1.84**	0.87 *	2.879**	
Q38	−0.25	−1.56	0.625		0.412	−0.52	1.015		0.398	−0.95**	2.287**	
Q39	−0.15	4.225	−1.04*		0.585	−1.32**	1.887*		−0.66	0.18	1.158	
Q40	−0.61	1.794	0.04		−0.63	−0.6	3.02 ***		1.389**	−0.37	−2.61**	
Q41	0.121	1.776	−0.47		0.54	0.148	1.13		−0.03	−0.08	1.214	
Q42	−0.22	4.59	−1.29***		0.595	−0.44	−1.99**		−0.14	−0.17	−0.29	
Q43	0.198	3.503	−0.96**		0.745*	−0.37	−0.14		0.378	−0.2	1.387	
Q44	2.679***	0.086	−1.43**		−0.004	1.687**	−3.86***		0.218	−0.09	0.12	
Q45	−1.17*	−0.8	0.764		0.055	0.449	0.644		0.44	−1.46***	2.207**	
Q46	1.38	8.025	−0.98		0.798	−0.25	−3.33**		−1.13	0.463	−0.25	
Q47	−0.52	−4.33	1.63 ***		0.528	−1.36**	1.605*		0.048	−0.35	0.8	
Q48	−0.53	−0.61	0.643		−0.04	−0.57	0.367		1.696**	−0.59	−1.22	
Q49	0.097	−3.28	0.651		0.269	−0.29	0.725		−0.08	−0.40	1.706*	
Q50	0.583	−2.65	0.341		−0.26	0.458	−0.47		−0.43	0.079	0.65	
Q51	−0.44	−1.03	0.797*		−0.36	1.185**	−0.14		−1.28**	0.268	0.879	
Q52	−0.16	−0.96	−0.08		0.383	−1.69***	2.716***		0.42	−0.51	−0.39	
Q53	1.436**	−0.32	−0.87		−0.77	1.606***	−0.99		0.864	−0.19	−0.97	
Q54	−2.54***	2.338	0.616		0.36	−0.84	1.416		0.923	−0.96*	2.522*	
Q55	0.175	−1.32	−0.64		−0.55	−0.46	2.983**		0.627	−0.6	1.85	
Q56	−0.49	2.06	−0.24		−0.54	1.087	−0.95		0.005	−0.31	1.016	
Q57	0.396	−1.95	0.815		−0.07	−0.23	0.195		−0.28	0.452	−0.64	
Q58	0.446	−1.59	0.138		−0.37	0.164	0.285		−0.34	−0.28	1.153	
Q59	−1.11*	−0.6	0.893*		−0.9 **	0.996*	−0.45		−0.2	−0.16	2.017**	
Q60	1.063	0.861	−0.55		0.224	−1.2 *	1.541		−0.48	0.112	−0.18	
Q61	1.437**	−0.01	−0.74		−0.59	1.719***	−2.82***		−1.15*	0.81	0.736	
Q62	−0.51	1.005	0.156		−0.44	−0.06	−0.24		−1.03	1.169**	−3.47**	
Q63	−0.72	−0.61	0.41		−0.07	0.134	0.065		1.223**	−0.7	−0.16	
Q64	−0.04	−2.37	0.569		−0.39	−0.08	0.968		−0.89	−0.38	2.243**	
Q65	−0.46	−0.62	0.243		−1.66***	2.038***	−0.5		−0.33	0.333	−3.58***	
Q66	−0.33	1.006	−0.01		−0.19	0.453	−0.53		−1.23**	−0.76*	4.564***	
Q67	0.628	−0.69	−0.19		0.006	−0.19	1.304		1.03 *	−0.15	−1.2	
Q68	−0.53	1.524	−0.3		0.785*	0.339	−3.96 ***		−0.05	−0.49	−0.4	
Q69	1.321	−1.43	0.413		−0.05	−0.35	1.172		−1.12	0.205	0.110	
Q70	1.006	1.957	−0.7		0.176	−0.25	−0.17		0.044	0.502	−1.88	

Tab. 2: Models of first–choice communication preferences based on personality estimators (Part 3)

Independent variables	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
Q71	−0.13	−3.07	1.208*		0.408	−0.16	−1.13		0.514	−0.02	0.409	
Q72	−0.84	−2.53	1.432*		−0.66	0.823	0.580		−1.37	1.026	−0.21	
Constant	−6.58**	−7.14**	1.583		−0.43	−2.12	−1.97		3.712	−1.43	−6.91**	
Number of cases 'correctly predicted'	202 (87.8%)	204 (88.7%)	183 (79.6%)	Perfect prediction obtained: No MLE exists	170 (73.9%)	191 (83.0%)	205 (89.1%)	Perfect prediction obtained: No MLE exists	197 (86.0%)	179 (78.2%)	210 (91.7%)	Perfect prediction obtained: No MLE exists
f(beta'x) at mean of independent vars	0.419	0.384	0.494		0.501	0.466	0.372		0.438	0.501	0.414	
Likelihood ratio test: Chi-square	94.2336 [0.0405]	107.914 [0.0039]	108.265 [0.0037]		86.1317 [0.1224]	93.5176 [0.0451]	92.1817 [0.0547]		106.398 [0.0052]	100.904 [0.0139]	136.144 [0.0000]	
McFadden R-squared	0.383	0.5	0.346		0.27	0.325	0.447		0.407	0.318	0.566	
Correctly predicted 1	30	22	113		86	47	19		38	82	38	
Correctly predicted 0	172	182	70		84	144	186		159	97	172	
Predicted 1 Actual 0	6	7	26		30	13	6		11	22	7	
Predicted 0 Actual 1	22	19	21		30	26	19		21	28	12	
H_0	Prob (Friendly Cordially = 0 | Q35 = 0) = 1	Prob (Professionally Cordially = 1) = 1	Prob (Professionally Kind = 1) = 1	Prob (Strictly Professionally = 0) = 1	Prob (Simple Clarific = 1) = 1	Prob (Simple Common = 1) = 1	Prob (Expert with Clarification = 1) = 1	Prob (Expert No Clarification = 0) = 1	Prob (Detail = 1) = 1	Prob (Problem Motives Goal = 1) = 1	Prob (Problem strict lines = 1) = 1	Prob (Minimum Information = 0) = 1
Notes	Dropping Q35	Incomplete obs. dropped: 13	Incomplete obs. dropped: 13		Incomplete obs. dropped: 13	Incomplete obs. dropped: 13	Incomplete obs. dropped: 13		Incomplete obs. dropped: 14	Incomplete obs. dropped: 14	Incomplete obs. dropped: 14	

Source: own calculation

cases vary from 73.9% to 91.79%. If we observe the models within each set as complementary, it ostensibly increases the overall predictivity. $R^2_{McFadden}$ shows significantly higher values and points out that in this set of models, variations of independent variables explain from 27.015% to 56.642% of variations of dependent variables, while the rest remains unexplained (model error, inherited randomness or circumstantial influences). Models could not be derived for three dependent variables, given that maximum likelihood estimators could not be calculated due to perfect prediction obtained.

The model of the "friendly and cordially" communication preferences correctly predicted 87.8% of the outcomes. Statistically significant variables with positive coefficients (respectively, slopes at the mean) are: Q1, Q4, Q7, Q11, Q17, Q26, Q44, Q53, Q61; while significant variables with negative coefficients are: the constant, Q9, Q12, Q21, Q23, Q31, Q32, Q37, Q45, Q54, Q59. For example, that means that the person who stated that the claim Q1 "You like to be involved in active and dynamic activities and jobs" (and/ or other significant variables with positive coefficients) refers to her/ him-self, will also be more likely to choose this communication preference. As opposed to first situation, the person who stated that the claim Q12 "You believe that the best decisions are those which are easy to change" (and/ or other significant variables with negative coefficients) refers to her/ him-self, will be more likely not to choose friendly and cordially communication preference (statements for each independent variable can be found in the Tab. 2 and Appendix and interpreted in a similar manner).

The model of the "professional and cordial" first-choice communication preference correctly predicted 88.7% of cases. Statistically

significant variables with positive coefficients are: Q2, Q5, Q7, Q12, Q15, Q18, Q32, Q39, Q42, Q43, Q46, Q70; and statistically significant variables with negative coefficients are: the constant, Q8, Q9, Q20, Q33, Q35, Q37, Q47, Q49, Q50, Q64, Q71.

The model of the "professional and kind" first-choice communication preference correctly predicted 79.6% of cases. Statistically significant variables with positive coefficients are: Q8, Q9, Q23, Q31, Q37, Q47, Q51Q59, Q71, Q72; and statistically significant variables with negative coefficients are: Q1, Q4, Q5, Q7, Q16, Q22, Q26, Q39, Q42, Q43, Q44.

The model of the "simple language with clarifications" first-choice communication preference correctly predicted 77% of cases. Statistically significant variables with positive coefficients are: Q9, Q13, Q29, Q30, Q43, Q68; statistically significant variables with negative coefficients are: Q21, Q31, Q36, Q59, Q65, Q65. However, the LRT values suggest that the null – hypothesis should be rejected.

The model of the "simple, common language" first-choice communication preference correctly predicted 83% of cases. Statistically significant variables with positive coefficients are: Q17, Q21, Q31, Q44, Q51, Q53, Q59, Q60, Q61, Q65; and statistically significant variables with negative coefficients are: Q6, Q9, Q13, Q39, Q47, Q52.

The model of "expert language with clarifications" first-choice communication preference correctly predicted 89.1% of cases. Statistically significant variables with positive coefficients are: Q9, Q21, Q23, Q28, Q36, Q39, Q40, Q47, Q52, Q55; and statistically significant variables with negative coefficients are: Q3, Q4, Q18, Q24, Q29, Q42, Q44, Q46, Q61, Q68.

The model of "presenting own situation in detail regarding the motives, aims and desires" first-choice communication preference correctly predicted 86% of cases. Statistically significant variables with positive coefficients are: Q5, Q8, Q9, Q13, Q14, Q40, Q48, Q63, Q67; and statistically significant variables with negative coefficients are: Q3, Q15, Q25, Q35, Q37, Q51, Q61, Q66.

The model of "presenting the problem, motives and goal in a nutshell" first-choice communication preference correctly predicted 78.2% of cases. Statistically significant variables with positive coefficients are: Q3, Q15, Q17, Q34, Q35, Q37, Q62; and statistically significant variables with negative coefficients are: Q1, Q13, Q38, Q45, Q54, Q66.

The model of "presenting the problem in a short line, keeping the rest of information" first-choice communication preference correctly predicted 91.7% of cases. Statistically significant variables with positive coefficients are: Q7, Q20, Q31, Q37, Q38, Q45, Q49, Q54, Q59, Q64, Q66; and statistically significant variables with negative coefficients are: Q2, Q5, Q13, Q17, Q18, Q29, Q34, Q40, Q62, Q65.

Discussion and Conclusion

Given the digitalization of the modern world we encounter a situation of data overload while real, "face-to-face", communication diminishes. At this point, it is necessary to gain as much as possible information from the communication data, especially if the communication is digital. That might be one of the reasons for the necessity of quantification of the influencing factors on communication. Hence, it is only logical to pursue the quantification of the traits and biases which influence people's rationality and consequentially their choices.

The data used refers to 244 filled up questionnaires which have been collected online in period from March 2013 until May 2015 for Croatian population. Given that the questionnaire has been distributed online, the conclusions should be made only for the population which uses online services, which is in line with the research purpose. However, the conclusions should be derived only for a Croatian population, which represents a limitation of the study. Consumer behaviour is still heterogeneous due to cultural and income differences among countries (Anić et al., 2016).

Marketing experts should pay attention to the role of personal characteristics and demographics when formulating the communication messages (Mihić & Kursan Milaković, 2017). Personality traits are represented as combined and weighted relative frequencies of the individual traits, and personality trait estimators are categorical variables coded as binary variables. The dependent variable represents choices of communication preferences regarding the communication approach, language use, and information sharing. Choices of consumer preferences act as a binomial variable where a certain choice occurs or doesn't occur. Binomial dependent variable enables the use of the logistic prediction models.

This paper offers an econometric assessment of the personality estimators and traits correlation to consumer's first-choice communication preferences using linear logit model with binomial dependent variable. Beside the prediction of the communication style preferences, the research question of the paper was how deep analysis is necessary to increase prediction of communication preferences given the customers' personality traits/ biases and customers' personality estimators. The results point out that the more detail data provides more accurate predictions, to the point where is possible to determine correlation of specific personality estimators to a communication choice.

Even though there are many assessments using personality traits, the logistic regression showed that if we only have the knowledge of personality traits, communication preferences prediction will be low and inadequate.

Personality trait estimators can be used directly as communication preference predictors (as in second subsection of the results) and provide more relevant models with higher levels of prediction. That finding can be important nowadays, especially in digital marketing. It is hard to gather a full report on consumers' personality traits/type, but it is possible to gather or buy big data about some previous consumer choices and preferences. The list of statistically significant variables in model can be used as an assessment list for determination of communication approach, language use and information. Given that only personality traits/ biases are used, it represents a limitation of the study. From that limitation arises the possibility for the further research and to examine the influences of other biases, heuristics and cognitive illusions to communication choices.

Practical implications relate to the use of the findings in communication with consumers in face-to-face communication, but especially in online communication using the results as an input for the recommendation agents.

Theoretical implications of the findings request questioning of the use of the personality traits as an interim stage in decision-making predictions. In addition, these findings fill the gap in the field of communication preference based on personality traits and personality estimators.

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Appendix: Personality traits estimators (Part 1)

Q1	You like to be involved in active and dynamic activities and jobs.
Q2	You are almost never late for your meetings.
Q3	You enjoy having a wide circle of acquaintances.
Q4	You feel involved while watching TV soaps and series.
Q5	You are the first to react to sudden events, such as phone ringing or unexpected question.
Q6	You are more interested in general idea than the details regarding the implementation.
Q7	You tend to remain impartial even if it could endanger your good relations to people.
Q8	You find that following the rules strictly will probably prohibit good outcome.
Q9	It is hard to upset you.
Q10	It comes natural for you to take over responsibility.
Q11	You often think about mankind and its future.
Q12	You believe that the best decisions are those which are easy to change.
Q13	Constructive criticism is always useful.
Q14	You rather react immediately, than to estimate possible actions.
Q15	You prefer to trust reason over emotions.
Q16	You rely on improvisation, rather than on careful planning.
Q17	You spend your time actively socializing in a group of people.
Q18	Usually, you plan your activities ahead.
Q19	You often react based on emotion.
Q20	You are reserved and distanced person in communication.
Q21	You know how to use each minute in a day.
Q22	You willingly help people without asking anything in return.
Q23	You often consider complexities of life.
Q24	After longer socializing, you feel the need to leave and be alone for a while.
Q25	You often do chores in a hurry.
Q26	You easily notice general principles underlying certain event.
Q27	You express your feelings and emotions often and easily.
Q28	It is hard for you to speak up.
Q29	You find reading theoretical books boring.
Q30	You empathize with other people's situations.
Q31	You value the justice more over mercy.
Q32	On a new job, you will make friends very quickly.
Q33	You feel better when communicating with many people.
Q34	You prefer to rely on your own experience rather on theoretical possibilities.
Q35	You like to check how things progress during any process.
Q36	You easily empathize with other people worries.
Q37	You will prefer to read a book over going to the party.
Q38	You enjoy being under spotlight in events which include many people.
Q39	You prefer to try out something new, over doing the same thing over again.
Q40	You avoid being bounded by a commitment.

Appendix:	Personality traits estimators (Part 2)
Q41	You are deeply touched by other people's stories.
Q42	You find deadlines to be rather a relative than a final due.
Q43	You prefer to isolate yourself from the outer sounds.
Q44	It is important for you to try out something with your own hands.
Q45	You think anything can be analysed.
Q46	You try hard to finish your obligations in time.
Q47	You find joy in establishing the order.
Q48	You feel relaxed in a crowd.
Q49	You are in control over your desires and temptations.
Q50	You easily understand theoretical principles.
Q51	The process of finding the solution is more important than the solution itself.
Q52	You rather place yourself in a corner of a room than in the centre.
Q53	When solving problems, you will rather use an already tested approach, than to try out a new one.
Q54	You firmly stick to your principles.
Q55	You are often eager for new adventures and events.
Q56	You rather spend time with a few chosen people than in a bigger company.
Q57	When thinking about a situation, you pay more attention to current situation over possible future events.
Q58	You think that scientific approach is the best approach.
Q59	It is hard for you to talk about feelings.
Q60	You often spend time thinking how something could be improved.
Q61	Your decisions depend more on a current mood than careful planning.
Q62	You like to spend your spare time alone or in a peaceful family atmosphere.
Q63	You find more comfort in following usual, generally accepted patterns.
Q64	You get under influence of the fierce emotions.
Q65	You always search for the new opportunities.
Q66	Your work place or working table are usually clean and neat.
Q67	In general, you are more concerned about current activities than the future events.
Q68	You enjoy lonely walks.
Q69	You easily communicate in the social interactions.
Q70	You are consistent in your habits.
Q71	You love to include in conversations about the topics which interest you.
Q72	You easily anticipate the ways of how the situation can develop.

Source: adjusted from Kostelić (2017)

Abstract

ECONOMETRIC ASSESSMENT OF CUSTOMERS' PERSONALITY BIASES AND COMMUNICATION PREFERENCES CORRELATION

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The tendency of bias identification and quantification with the goal of better estimation and prediction, grows. The purpose of this paper is to question how deep analysis is necessary to increase prediction of communication preferences given the customer's personality traits/biases. Examined communication preferences regard to the communication approach, language use and information sharing.

This paper offers a psychometric assessment of the personality estimates and traits, as well as econometric examination of correlation to consumer first-choice communication preferences using linear logit model with binomial dependent variable.

The results point out that the more detail analysis provides more accurate predictions, to the point where estimators as regressors for communication choices provide more accurate prediction than the use of the personality traits as independent variables.

Paper delivers empirical assessment of consumers' communication preferences using primary data set. Practical implications relate to the use of the findings in communication with consumers in online and/ or digital marketing communication. One of the possible practical use of the results can be as an input for the recommendation agents. Theoretical implications of the findings request questioning the use of the personality traits as an interim stage in decision-making predictions. In addition, these findings fill the gap in the field of communication preference based on personality traits and personality estimators.

The data set has been previously used for the doctoral thesis research. For the purpose of this research, data was re-coded and analyzed using different approach, namely binomial logistic regression.

Key Words: *Personality traits/biases, logistic regression, consumer decision-making, communication preferences.*

JEL Classification: *C35, D91, M31.*

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