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Application of generalized estimating equations in the analysis of factors affecting consumers' readiness to purchase services

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Abstract:

Aim: The main aim of the paper is to define how the country of origin effect (COO effect) affects consumers' readiness to purchase services.

Design/Research method: The data was collected with the use of an auditorium survey technique. The questionnaire form was filled in by 264 students from Poland, Lithuania and Germany. In order to identify the factors affecting the readiness to purchase services in the context of the COO effect, generalised estimating equations were applied.

Conclusions/Findings: It is confirmed that the higher evaluation of the levels of innovativeness, diversity, quality and prestige of services, the higher consumers' readiness to purchase such services becomes. Moreover, the analysis also confirmed the influence of the respondents' gender and their declared familiarity with the origin country of services on their readiness to purchase foreign services. It is also revealed that consumers' readiness to purchase services is affected both by consumers' country of origin, and the country of origin of services. The results also show that for services which come from the consumers' home country, there are some differences in the strength of the influence exerted by the diversity of services on the readiness to purchase them declared by consumers, depending on the consumers' country of origin.

Originality/Value of the article: The analysis of the changes in the strength of influence exerted by the COO dimensions on the readiness to purchase services, depending on the factors discussed.

Research limitations: A relatively small sample of the respondents who come only from one university in each of the three analysed countries. The lack of the analysis of the dependence discussed referring to the particular services and particular countries of origin of services.

Keywords: logit model for ordered categories, generalised estimating equations, repeated measures, readiness to purchase, COO effect
JEL: C25, M31

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1. Introduction

The country of origin effect (COO) is defined as the influence exerted by an image of a particular country and its inhabitants on consumers' attitudes and behaviour towards the products and brands developed in or associated with that country (Sikora 2008: 174). The analysis of expert literature indicates that the phenomenon discussed is scarcely analysed in the context of services (Ahmed et al. 2002; Chattalas et al. 2008; d'Astous et al. 2008; Boguszewicz-Kreft 2014), and this fact refers both to original and replicative research.

The factors which affect the assessment of the COO effect can be divided into affiliative factors (including 1/endogenous factors – demographic and cultural elements: ethnocentrism, aversion to a particular country, stereotypes, dimensions of national cultures in accordance with Hofstede, personal and cultural dimensions, and 2/ exogenous factors – the level of economic development of consumers' country) and factors related to the product (intrinsic cues) which refer to the functionality of products (e.g. the type of a product and its complexity) and external factors (extrinsic cues) which include reputation of a particular brand and its vendors, prices, guarantees and promotion communications) (Ahmed et al. 2002; Pharr 2005; Sharma 2011).

The current analytical results indicate that the COO effect affects purchase intentions referring to services in the same way as it does in the case of material goods (Harrison-Walker 1995; Berentzen et al. 2008; Khare, Popovich 2010; Bose, Ponnam 2011; Morrish, Lee 2011); consumers prefer services coming from their home country or from the countries of an insignificant cultural distance (d'Astous et al. 2008; Bruning, Saqib 2013) and from the countries which represent a higher level of economic development. The research also indicates that there are some differences in the consumers' perception of the COO, depending on the country they come from (Narayana 1981; Nagashima 1970; Sharma 2011), and their actual familiarity with a particular country (which weakens the impact of stereotypes) affects the COO effect (d'Astous et al. 2008). The impact of demographic factors on the phenomenon is also suggested (Pharr 2005), including consumers' gender. The research presented by Bruning (1997) shows that women are more likely to prefer services offered by their home country than men.

In the paper, the following research questions were formulated:

1. Are there any differences in the declared readiness by respondents to purchase services coming from the analysed countries, depending on consumers' home country?

2. Are there any differences in the declared readiness to purchase services coming from various countries for the respondents who come from a particular country?
3. Is the declared readiness to purchase services from the analysed group of countries affected by the variables characterising the respondents (their gender, their home country, their familiarity with the evaluated country and their stay in that country)?
4. Is the declared readiness to purchase services affected by the evaluation of services coming from the analysed country provided by the respondents, in terms of the selected dimensions of the country image, namely: innovativeness, diversity, quality and prestige?
5. Does the strength of the influence of the analysed COO dimensions on the readiness to purchase services depend on the respondents' gender and their home country?
6. Are there any differences in the influence exerted by the respondents' gender, their home country and the dimensions of the country image on the declared readiness to purchase services, depending on the respondents' evaluation of services coming from a foreign country or from their home country?

Considering a scarce number of research studies which refer to the COO of services, some of the questions are of confirmative nature (questions 1-4) and some of them are of explorative nature (questions 5-6).

A question which still needs to be answered explicitly is whether the COO effect is a monolithic phenomenon (e.g. Hong, Wyer 1989) or a complex one (Dinnie 2004, as cited in: Meng 2007) and if so, what dimensions it is composed of. Therefore, two research approaches were developed to analyse the impact exerted by the COO, understood as a single category or divided into components. For the requirements of the analysis of the phenomenon as regards material goods, Roth and Romeo (1992) provide a model composed of four dimensions: 1/innovativeness, 2/ design, 3/ prestige, 4/ workmanship. Having adapted that model to the specificity of entertainment services, Bose and Ponnam (2011) also find it useful. It is worth noticing that the results of both analyses do not suggest a multi-dimensional character of the COO. However, the results turn out to be different when we consider the analysis carried out while adapting such models to the requirements of the research concerning broadly understood services. Here the following dimensions are suggested: 1/ innovativeness, 2/ diversity, 3/ prestige, 4/ quality. The multi-dimensional character of the COO is indicated in general services (Magier-Łakomy, Boguszewicz-Kreft 2015), medical services (Magier-Łakomy et al. 2016) and

transport services (Boguszewicz-Kreft et al. 2015). However, the following study is not focused on the issue of the multi-dimensional aspect or its lack, but on the impact of the assumed dimensions on consumers' readiness to purchase services.

2. Methodology of the research. Selection of variables

The paper presents the analysis of the factors which affect consumers' readiness to purchase services, considering their country of origin. In the research, the analysed phenomenon was compared across nine EU countries: France, Germany, Great Britain (the countries of highly developed economies), Spain, Italy (the countries of Southern Europe), Sweden (the country of Northern Europe), Lithuania, Hungary and Poland (the countries of Central and Eastern Europe, new EU countries). The survey was anonymous and respondents participated in it voluntarily. The data were collected from:

- 127 Polish students of WSB University in Gdańsk; 54 men (42.5%) and 73 women (57.5%); the average age was M=23.43; SD=6.51.
- 65 Lithuanian students of major courses in economics: 31 men (48.4%) and 33 women (51.6%); the average age was M=23.02; SD=6.60.
- 72 German students of major courses in economics: 27 men (37.5%) and 45 women (62.5%). the average age was: M=22.53; SD=2.75.

The survey was carried out in February 2014, with the use of auditorium questionnaire forms. The respondents were asked to fill in the questionnaire form composed of three main parts, with the use of a six-grade scale. The first part included four questions referring to the assessment of an image associated with nine countries in terms of innovativeness, diversity, quality and prestige (How do you assess the innovativeness, diversity, quality and prestige of products and services provided by a particular country?). Then, the respondents were asked to assess their readiness to purchase services in the countries analysed by giving their answer to the following question: Please, state your readiness to purchase services in a particular country. The second part of the questionnaire form included a question referring to the respondent's stay (the respondents were supposed to state whether they had ever been to a particular country (value 1) or not (value 0)) and their familiarity with a particular country. The level of the respondents'

familiarity with the particular countries was defined through the respondents' answers to the following question: How would you assess your familiarity with the following countries? At the end of the questionnaire form, the respondents were asked to provide some personal details such as their age, gender and employment status. In the first section of the paper, the authors find out whether the average of the readiness to purchase services in the analysed countries differs, depending on the respondents' *home country*, and whether the respondents from a particular country differ in terms of the average of their readiness to purchase services coming from various countries. Considering the fact that the second part of the research was focused on determining the factors which affect the declared readiness to purchase services, which came as a variable measured by the ordinal scale, it was decided to use a logit model for the ordered categories. The development and estimation of the logit models are described, among others, in the studies by Cramer (2001, 2003), Greene (2003, 2009) and Gruszczyński (2001, 2010). Moreover, as the assessment of the readiness to purchase services was measured nine times for each respondent (the respondents assessed services from nine countries), generalised estimating equations (GEE) were applied in order to consider the similarity of measurements provided by the same respondent. This method was first presented by Liang and Zeger in 1986 „to produce more efficient and unbiased regression estimates for use in analyzing longitudinal or repeated measures research design with non-normal response variables'' (Ballinger 2004: 128) The authors who adapted the GEE method for the model of proportional chances for the repeated measurements on the ordinal scale are, among others: Clayton (1992), Gange et al. (1993), Miller et al. (1993), Heagerty and Zeger (1996). The structural parameters of the model were estimated with the use of the quasi-likelihood and the IBM SPSS STATISTICS software.

3. Generalised estimating equations for the ordinal dependent variable

Let us consider a situation where the repeated measurements for a particular respondent are correlated. Let y_{ij} mean jth measurement $(1 \le j \le t_i)$ performed for the ith respondent $(1 \le i \le N)$, the answer vector for the ith respondent can be recorded as $\mathbf{y_i} = (y_{i1},...,y_{it_i})'$, whereas the vector of p independent variables corresponding to the jth measurement for the ith respondent

can be recorded as $\mathbf{x_{ij}} = \left(x_{ij1},...,x_{ijp}\right)'$. If $\mathbf{y_i}$ is a vector of the answers measured by the ordinal scale of the K+1 categories, then let $\mathbf{y_{ij}} = \left(y_{ij}^{(1)},y_{ij}^{(2)},...,y_{ij}^{(K)}\right)'$ be a vector of the K indicator variables, where $y_{ij}^{(k)} = 1$, if the answer $y_{ij} = k$ and 0 in the opposite case. Let $\boldsymbol{\pi}_{\mathbf{ij}}$ be the probability vector $\boldsymbol{\pi}_{\mathbf{ij}} = \left(\pi_{ij}^{(1)},...,\pi_{ij}^{(K)}\right)'$ where $\pi_{ij}^{(k)} = P\left(y_{ij} = k|\mathbf{x_{ij}}\right) = P\left(y_{ij}^{(k)} = 1|\mathbf{x_{ij}}\right)$, then the cumulative probability is $\eta_{ij}^{(k)} = P\left(y_{ij} \le k|\mathbf{x_{ij}}\right) = \sum_{s=1}^{k}\pi_{ij}^{(s)}$. Considering the logit model of proportional chances, the dependence of $\mathbf{y_i}$ on $\mathbf{x_{ij}}$ has a form of $ln\left[\eta_{ij}^{(k)}/\left(1-\eta_{ij}^{(k)}\right)\right] = \lambda_k + \mathbf{x}_{\mathbf{ij}}'\boldsymbol{\beta}$, where the intercepts meet the condition of $\lambda_1 \le \lambda_2 \le ... \le \lambda_K$.

This model assumes that the independent variables affect the increase in the value of the modelled variable between the subsequent thresholds λ_k in the same way. Let $\mathbf{Y_i} = \left(\mathbf{y_{i1}^{'}},\mathbf{y_{i2}^{'}},...,\mathbf{y_{it_i}^{'}}\right)'$, $\boldsymbol{\pi}_i = \left(\boldsymbol{\pi}_{\mathbf{i1}}^{'},...,\boldsymbol{\pi}_{\mathbf{it_i}}^{'}\right)'$. In the GEE method, the estimations of the $\boldsymbol{\beta}$ parameters are obtained by solving the following equation: $\sum_{i=1}^{N}\mathbf{D'_i}\left[\mathbf{V}_i\right]^{-1}\left(\mathbf{Y_i} - \boldsymbol{\pi}_{\mathbf{i}}\right) = \mathbf{0}$, where $\mathbf{D_i} = \frac{\partial \boldsymbol{\pi}_i}{\partial \boldsymbol{\beta}}$, $\mathbf{V}_{i[t_iKxt_iK]}$ is a working covariance matrix of $\mathbf{Y_i}$. For each pair of the response categories (k,l) the $\mathbf{V}_i$ is provided for all the pairs of the observation (j,j') for the ith respondent. The (K,K) dimensional blocks of the $\mathbf{V}_i$ matrix for the jth answer for the ith respondent are multi-nominal covariance matrices with $\pi_{ij}^{k}\left(1-\pi_{ij}^{k}\right)$ on the diagonal and $-\pi_{ij}^{k}\pi_{ij}^{l}$ off the diagonal. The remaining elements of $\mathbf{V}_i$ represent the covariance between, for example, the pairs $y_{ij}^{(k)}$ and $y_{ij'}^{(l)}$. Several various structures of the working correlation matrix $\mathbf{R}$ have been suggested and they correspond to the discussed covariance matrix (Liang, Zeger 1986):

- independent ($\mathbf{R} = \mathbf{I}$) – if the number of respondents is relatively big, comparing it to the number of measurements performed for one respondent; the impact of correlation is often so insignificant that a simple method of the least squares can be applied;
- exchangeable ($\mathbf{R}_{jj'} = \rho$ for $j \ne j'$) – it assumes that the correlations between the measurements obtained from one respondent are equal, $\mathbf{R}_{jj'}$ means $(j,j')^{\text{th}}$ element of the R matrix;

- the first order autoregressive model AR(1) – it assumes that the working correlation matrix includes the elements $\mathbf{R}_{jj'} = \rho^{|j-j'|}$- in such a model the correlation decreases when the distance between the measurements increases in time;
- unstructured – it estimates all the $t_{\mathbf{i}}(t_{\mathbf{i}} - 1)/2$ correlations of the $\mathbf{R}$ matrix, where $t_{\mathbf{i}}$- the number of measurements in time – the missing data complicate its estimation; it is most useful with the small number of temporal intervals during the observation..

The GEE model provides two approaches to the estimation of the variance-covariance matrix $\hat{\boldsymbol{\beta}}$

- a naive or model based estimator:

$$\mathbf{V}\left(\hat{\boldsymbol{\beta}}\right) = \left[\sum_{i=1}^{N} D'_{\mathbf{i}} \left[\hat{V}_{\mathbf{i}}\right]^{-1} D_{\mathbf{i}}\right]^{-1}$$

- robust or empirical estimator

$$\mathbf{V}\left(\hat{\boldsymbol{\beta}}\right) = \left(\sum_{i=1}^{N} D'_{\mathbf{i}} \left[\hat{V}_{\mathbf{i}}\right]^{-1} D_{\mathbf{i}}\right)^{-1} \sum_{i=1}^{N} D'_{\mathbf{i}} \left[\hat{V}_{\mathbf{i}}\right]^{-1} Var(\mathbf{Y}_{\mathbf{i}}) \left[\hat{V}_{\mathbf{i}}\right]^{-1} D_{\mathbf{i}} \left(\sum_{i=1}^{N} D'_{\mathbf{i}} \left[\hat{V}_{\mathbf{i}}\right]^{-1} D_{\mathbf{i}}\right)^{-1}$$

A robust or „sandwich" estimator provides consistent estimator $\mathbf{V}\left(\hat{\boldsymbol{\beta}}\right)$, even if the structure of the working correlation matrix $\mathbf{R}_{\mathbf{i}}$ is not a true correlation matrix of the $\mathbf{Y}_{\mathbf{i}}$. If the correlation structure is correctly modelled, then $Var(\mathbf{Y}_{\mathbf{i}}) = \hat{V}_i$ and the „sandwich" estimator is simplified to a naive estimator.

In order to test the goodness of fit referring to two nested GEE models, the Wald statistics was applied (Touloumis 2015: 5). Let M_0 and M_1 be two nested GEE models with the parameter vectors respectively $\boldsymbol{\beta}_{\mathbf{0}}$ and $\boldsymbol{\beta}_1 = \left(\boldsymbol{\beta}'_0, \boldsymbol{\beta}'_q\right)'$; let the $\mathbf{C}$ matrix be the matrix of the rank q so that $\mathbf{C}\boldsymbol{\beta}_1 = \boldsymbol{\beta}_q$. The hypotheses $H_0 : \boldsymbol{\beta}_q = 0$ and $H_1 : \boldsymbol{\beta}_q \neq 0$ test the goodness of fit referring to the M_0 model in relation to the M_1 model. H_0 is rejected at the level of significance α if $\left(\mathbf{C}\hat{\boldsymbol{\beta}}\right)' \left(C\hat{\mathbf{V}}\left(\hat{\boldsymbol{\beta}}\right)C'\right)^{-1} \left(\mathbf{C}\hat{\boldsymbol{\beta}}\right) \geq \chi_q(\alpha)$, where $\hat{\boldsymbol{\beta}}$ and $\hat{\mathbf{V}}\left(\hat{\boldsymbol{\beta}}\right)$ are estimated for the M_1 model and $\chi_q(\alpha)$ is a critical value obtained from the distribution of the chi-square for the q degrees of freedom and the level significance α.

The conclusions concerning the strength and direction of the impact exerted by the independent variables were drawn on the basis of the marginal effects. The marginal effects for the continuous variables are calculated in the following way:

$$MPE_{ijm} = \frac{\partial Pr(y_{ij} = k)}{x_{ijm}} = \left[f\left(\lambda_{k-1} - \mathbf{x}'_{\mathbf{ij}}\boldsymbol{\beta}\right) - f\left(\lambda_k - \mathbf{x}'_{\mathbf{ij}}\boldsymbol{\beta}\right)\right]\beta_m,$$

whereas for the dummy variables:

$$MPE_{ijm} = \left[F\left(\lambda_k - \mathbf{x}'_{\mathbf{ij}}\boldsymbol{\beta} - \beta_m\right) - F\left(\lambda_{k-1} - \mathbf{x}'_{\mathbf{ij}}\boldsymbol{\beta} - \beta_m\right)\right] - \left[F\left(\lambda_k - \mathbf{x}'_{\mathbf{ij}}\boldsymbol{\beta}\right) - F\left(\lambda_{k-1} - \mathbf{x}'_{\mathbf{ij}}\boldsymbol{\beta}\right)\right],$$

where β_m comes as the estimate of the parameter next to the dummy variable, f is density and F is a distribution function of the logistic distribution (Greene, Hensher 2010, March 2008) in this case.

For the calculation of the interaction effect of the continuous variable x_l and the dummy variable x_m, the following formula was applied (Norton at al., 2004):

$$MPE_{ijlm} = \left[(\beta_l + \beta_{lm}) f\left(\lambda_k - (\beta_l + \beta_{lm})x_l - \beta_m - \mathbf{x}'_{\mathbf{ij}}\boldsymbol{\beta}\right) - \beta_l f\left(\lambda_k - \beta_l x_l - \mathbf{x}'_{\mathbf{ij}}\boldsymbol{\beta}\right)\right] -$$
$$\left[(\beta_l + \beta_{lm}) f\left(\lambda_{k-1} - (\beta_l + \beta_{lm})x_l - \beta_m - \mathbf{x}'_{\mathbf{ij}}\boldsymbol{\beta}\right) - \beta_l f\left(\lambda_{k-1} - \beta_l x_l - \mathbf{x}'_{\mathbf{ij}}\boldsymbol{\beta}\right)\right].$$

For the marginal effects calculated for the dummy variables and the interaction effect, it was assumed that the β parameters were equal 0 for the analysed variables in the $\boldsymbol{\beta}$ vector.

4. Readiness to purchase services, the consumers' home country and the country of origin of services.

First, it was decided to determine whether the averages of readiness to purchase services in the countries examined differed among the respondents from Lithuania, Poland and Germany. Since the *readiness to purchase services* variable is measured on the ordinal scale, it was decided to use non-parametric tests. With the use of the Kruskal-Wallis ANOVA rank test, the following null hypothesis testing was carried out separately for each country or origin of services: there were no statistically significant differences between consumers coming from the 3 analysed countries in terms of their readiness to purchase services in one of the 9 countries. The obtained results are presented in Table 1.

Table 1. The results of the Kruskal-Wallis ANOVA rank test which estimates the significance of differences in the readiness to purchase services among the respondents coming from 3 analysed countries in one of 9 countries

The country whose services are assessed	The Kruskal-Wallis test	The p value for multiple comparison			Average ranks for each country assessed		
		Poland	Germany	Poland	Respondent's home country		
		Lithuania	Lithuania	Germany	Lithuania	Poland	Germany
France	H (2; 263) =9.28 p=0.0097	0.1866	1.0000	**0.0112**	139.46	*117.83*	***150.52***
Germany	H (2; 263) =38.15 p=0.0000	**0.0009**	0.1615	**0.0000**	145.38	*103.6*	***170.56***
GB	H (2; 263) =13.62 p=0.0011	**0.0089**	1.0000	**0.0063**	148.58	*114.12*	***148.8***
Hungary	H (2; 263) =23.77 p=0.0000	0.4593	**0.0000**	**0.0003**	***156.23***	139.66	*96.12*
Italy	H (2; 263) =17.79 p=0.0001	1.0000	**0.0022**	**0.0002**	143.65	***144.18***	*99.549*
Lithuania	H (2; 261) =68.85 p=0.0000	**0.0000**	**0.0000**	1.0000	***198.24***	*108.48*	109.09
Poland	H (2; 263) =64.11 p=0.0000	**0.0000**	0.3021	**0.0000**	107.72	***169.99***	*86.282*
Spain	H (2; 263) =7.20 p=0.0273	1.0000	0.0990	**0.0344**	139.2	***139.85***	*111.36*
Sweden	H (2; 263) =10.89 p=0.0043	0.1125	1.0000	**0.0055**	140.68	*116.55*	***151.68***

The level of rejection of the null hypothesis as regards multiple comparison lower than 0.05 is presented in bold; the highest average rank for the particular country of origin of a service is marked in bold and italics; the lowest average rank for the particular country of origin of a service is marked in italics.
Source: the authors' own calculations with the use of the IBM SPSS 21

It is possible to observe that the readiness to purchase services offered by the countries analysed significantly differed, depending on the respondents' *home country*, for all the countries whose services were assessed. Furthermore, it is also possible to observe that in the case of services coming from the respondents' *home country*, the highest average rank of readiness to purchase such services was characteristic for the respondents who came from that particular country. Considering Lithuanian services, there were statistically significant differences between the Lithuanian respondents' readiness to purchase such services and the Polish and German respondents' readiness to purchase Lithuanian services ($p<0.0001$). A similar relation could be observed when we considered the Polish respondents assessing Polish services, in comparison to German and Lithuanian respondents. Considering the assessment of the readiness to purchase German services, the assessments provided by the Lithuanian consumers were similar to those provided by the German consumers; however, some statistically significant differences could be observed between the assessments provided by the Polish consumers and those given by the German and Lithuanian respondents.

Considering the countries with high reputation, the highest readiness to purchase services was declared by the German respondents; these countries were France, Germany, Great Britain and Sweden. For those countries no significant differences could be observed in the average ranks referring to the readiness to purchase services between the German and Lithuanian

respondents. Considering other countries, the German respondents showed lower readiness to purchase services than the Polish and Lithuanian respondents. The Lithuanian services came as an exception for which the lowest average rank as regards the readiness to purchase was observed for the Polish respondents; however the differences between the Polish and German respondents were statistically insignificant.

The largest number of differences as regards the declared readiness to purchase services in the analysed countries could be observed between the Polish and German respondents; those differences were insignificant only in the case of the assessment referring to Lithuanian services. The least number of significant differences was observed between the German and Lithuanian respondents. The differences referred to such countries as Lithuania, Hungary and Italy, where the average rank for the Lithuanian respondents was higher than for the German consumers. Considering the Polish and Lithuanian respondents, significant differences were for such countries as Germany, Great Britain, Lithuania and Poland. Except for Poland, in all those countries the average rank of readiness to purchase services was higher for the Lithuanian respondents.

Table 2. The results of the Friedman rank test which refers to the significance of differences in the readiness to purchase services coming from 9 analysed countries, declared by the respondents who come from one of 3 analysed countries

The country whose services are assessed	The respondent's home country								
	POLAND			GERMANY			LITHUANIA		
	Average rank	Average	Standard deviation	Average rank	Average	Standard deviation	Average rank	Average	Standard deviation
France	5.48	4.04	1.01	6.51	4.44	0.77	5.89	4.31	0.96
Germany	7.09	4.48	0.79	8.41	5.16	0.63	7.62	4.86	0.94
GB	6.69	4.40	0.72	7.11	4.76	0.77	6.92	4.66	1.13
Hungary	2.94	3.33	0.84	2.59	2.87	0.80	2.93	3.51	1.06
Italy	5.01	3.94	0.72	3.91	3.51	0.77	4.36	3.86	1.03
Lithuania	*1.99*	*2.86*	0.93	2.60	2.90	1.02	5.27	4.16	0.98
Poland	5.08	3.90	0.89	*2.58*	*2.78*	0.95	*1.82*	*3.04*	1.05
Spain	4.45	3.78	0.81	4.19	3.55	0.88	3.62	3.71	0.95
Sweden	6.26	4.33	0.86	7.09	4.69	0.69	6.57	4.56	0.99
Test results	Chi square ANOVA (N=126, df=8) =403.50; p<0.00001			Chi square ANOVA (N=70, df=8) =400.33; p<0.00001			Chi square ANOVA (N=65, df=8) =281.47; p<0.00001		

Source: the authors' own calculations with the use of the IBM SPSS 21

Another research aim was to determine whether there were some significant differences in the readiness to purchase services coming from the countries under study, declared by the respondents who came from one country. Since in this case there were 9 dependent groups – as each respondent provided an answer to the question referring to their readiness to purchase services coming from all 9 countries, the Friedman rank test was performed (see Table 2).

The results of the analysis allowed us to state that for all three surveyed groups of the respondents there were some significant differences as regards the readiness to purchase services in the particular countries, which were declared by the respondents. The Table also presents the average values of the readiness to purchase services for the respondents coming from Poland, Germany and Lithuania, calculated separately for each of the 9 countries analysed. If they had been collected with the use of the ordinal scale, then their average should not be calculated; however, there are various approaches to that problem in science. Some statisticians treat measurements on an ordinal scale as a form of measurements performed with the use of an interval scale. An extensive discussion on that subject can be found in (Francuz, Mackiewicz 2005: 390). Considering all that, it was decided to calculate the average values of the readiness to purchase services to facilitate the process of comparison.

Based on the values obtained, it is possible to observe that regardless of the respondent's home country, the highest readiness to purchase was declared for German services, whereas the lowest readiness for Polish services (by the German and Lithuanian respondents) and for services from Lithuania (as declared by the Polish respondents). The high readiness to purchase was also reported for English, Swedish and French services and the lowest readiness to purchase services (in descending order) from Spain and Hungary (declared by the Polish and Lithuanian respondents), Italy and Hungary (the German respondents). Additionally, the Polish respondents reported a lower readiness to purchase services offered by France, Germany, Great Britain, Lithuania and Sweden, and the higher readiness to purchase services coming from Italy, Poland and Spain, as declared in comparison to the Lithuanian and German respondents.

5. The relations of the readiness to purchase services with other respondents' characteristics and with the COO dimensions – the results of regression analysis

The next research question was intended to check whether the declared readiness to purchase services from the analysed group of countries was affected by the variables which characterised the respondents, namely: their gender, *home country*, familiarity with the country analysed and the respondents' stay in the country in question, and also by the assessment of services offered by a country examined in terms of the selected dimensions referring to the image of the particular country, namely: innovativeness, diversity, quality and prestige. In order to achieve the above-mentioned aims, the generalised estimating equations (GEE) were applied. The model was estimated for the data selected in the following way: the respondents coming from a particular country assessed services coming from all the countries, except for the respondents' own *home country*, thus each respondent assessed services from 8 countries. The model was estimated with the use of two various forms of a working correlation matrix: an independent and exchangeable. The use of the autoregressive correlation model would make no sense, considering the fact that the repeated measurements carried out for each respondent were not taken at various points in time, but they were taken for various countries of origin of services. For each matrix the standard errors were estimated with the use of a robust estimator and a naïve estimator. Subsequently, in order to select the best working correlation matrix, the sum of the absolute differences between the standard errors calculated with the use of both methods was provided (Debusho, Sileshi 2012: 80).

This sum turned out to be the lowest for the independent correlation matrix, therefore the estimations of the parameters obtained with the use of that matrix were interpreted. The reduction of the model with all the independent variables was carried out with the use of the Wald statistics. The result of that test proved that the *stay* variable should be removed from the model. Table 3 presents the results of the test for the model estimated without that variable. Nor does the model consider the interaction between the *respondent's home country* and the *gender* variables, the *gender* variable and the *familiarity with the country of origin* variable, the *respondent's home country* and the *familiarity with the country of origin* variables. The interaction between the variables *innovativeness, diversity, quality and prestige* and the *gender* and the *respondent's home country* variables were not considered, because they proved to be insignificant.

Table 3 Tests of the model effects

Variable	Type III		
	Wald Chi-square	df	Significance
Prestige	68.46	1	0.000
Quality	50.84	1	0.000
Innovativeness	27.93	1	0.000
Familiarity	19.15	1	0.000
Diversity	8.01	1	0.005
Gender	4.31	1	0.038
the respondent's home country	4.64	2	0.098

The dependent variable: the readiness to purchase
Source: the authors' own calculations with the use of IBM SPSS 21

Table 4 presents the estimations referring to the parameters of the model obtained.

Table 4. The results obtained after the estimation of the GEE model for the dependent variable which comes as an assessment of the readiness to purchase services

Estimations of the parameters for the independent working correlation matrix			
Independent variable	**Coefficient**	**Standard error**	**Significance**
Intercept 1	1.457	0.316	0.000
Intercept 2	3.572	0.275	0.000
Intercept 3	6.048	0.320	0.000
Intercept 4	8.545	0.384	0.000
Intercept 5	11.217	0.432	0.000
Prestige	0.477	0.058	0.000
Quality	0.494	0.069	0.000
Innovativeness	0.351	0.066	0.000
Familiarity	0.227	0.052	0.000
Diversity	0.205	0.073	0.005
Gender=male	-0.301	0.145	0.038
Gender=female	0[a]	-	-
The respondent's home country =Lithuania	0.393	0.198	0.047
The respondent's home country =Germany	-0.061	0.170	0.721
The respondent's home country =Poland	0[a]	-	-
Dependent variable: the readiness to purchase Model: (Intercept), the respondent's home country, gender, familiarity, innovativeness, diversity, quality, prestige [a] The parameter is assigned with the 0 value because it is redundant.			

Source: the authors' own calculations with the use of IBM SPSS 21

Table 5 presents the marginal effects calculated for the average values of the independent variables. The only exception refers to the binary variables for which the effect of the value change was calculated from 0 to 1 (Gruszczyński 2010: 137).

Table 5. The marginal effects for the average values of the independent variables

variable	j=1	j=2	j=3	j=4	j=5	j=6
prestige	-0.002	-0.012	-0.079	0.019	0.065	0.007
quality	-0.002	-0.012	-0.082	0.020	0.068	0.008
innovativeness	-0.001	-0.009	-0.058	0.014	0.048	0.005
familiarity	-0.001	-0.006	-0.037	0.009	0.031	0.004
diversity	-0.001	-0.005	-0.034	0.008	0.028	0.003
gender=male	0.001	0.006	0.047	-0.004	-0.045	-0.005
Lithuania	-0.002	-0.012	-0.069	0.030	0.048	0.005
Germany	0.000	0.002	0.011	-0.007	-0.006	-0.001

Source: the authors' own calculations with the use of Excel

Having assumed the ceteris paribus, it was possible to observe that, considering the innovativeness, diversity, quality and prestige variables for the respondents who provided an average assessment of the above-mentioned characteristics (innovativeness = 3.96, diversity = 4.06, quality = 4.06, prestige = 4.12), an increase in the assessment of the particular country given for each of the above-mentioned variables by one unit will result in an increase in the probability referring to the choice of the *strong readiness to purchase services* category respectively by: 0.005, 0.003, 0.008 and 0.008, and a decrease in the probability referring to the choice of the *lack of the readiness to purchase services* category respectively by: 0.001, 0.001, 0.002 and 0.002. Furthermore, for the respondent whose declared familiarity with the country of origin of services was 3.52, the unit growth of the declared familiarity resulted in an increase in the probability referring to the choice of the strong readiness to purchase services category by 0.004 and a decrease in the probability referring to the choice of the lack of the readiness to purchase services category by 0.001.

Considering gender, the male respondents indicated the probability of declaring the lack of their readiness to buy services, which was higher by 0.001 than for the female respondents and the probability of declaring their strong readiness to buy services lower by 0.005 than the female respondents. Based on the variables which determined the consumer's home country, it was

possible to state that the Lithuanian respondents were less likely to report the lack of their readiness to purchase foreign services more likely to declare their readiness to purchase services than the Polish respondents. In comparison to the Polish respondents, this relation was inverted for the German respondents.

Table 6. The results obtained for the estimation of the logit model for the ordered categories referring to the dependent variable which comes as an assessment of the readiness to purchase services

Independent variable	Coefficient	Standard error	Significance
Intercept 1	0.075	0.890	0.933
Intercept 2	1.622	0.677	0.017
Intercept 3	4.219	0.691	0.000
Intercept 4	6.945	0.792	0.000
Intercept 5	9.297	0.856	0.000
The respondent's home country =Lithuania	4.301	1.008	0.000
The respondent's home country =Germany	4.891	1.890	0.010
The respondent's home country =Poland	0[a]	-	-
Diversity	0.518	0.142	0.000
Prestige	0.877	0.173	0.000
The respondent's home country =Lithuania*Prestige	-0.927	0.265	0.000
The respondent's home country =Germany*Prestige	-0.754	0.358	0.035
The respondent's home country =Poland*Prestige	0[a]	-	-
N	257		
LR	142.078		
p-value	0.000		
R^2Mcfadden	0.199		

The link function Logit. [a.] This parameter has been assigned with the 0 value because it is redundant.
Source: the authors' own calculations with the use of IBM SPSS 21

Then, in order to provide comparison, it was decided to estimate a model in which the dependent variable was the *readiness to purchase services* declared by a respondent coming from the country of origin of services, thus each respondent assessed their readiness to purchase services only once – for their home country which was also the country of origin of services. In that case, the *familiarity* and the *stay in the country of origin of services* variables were excluded from the set of the independent variables. Considering the fact that the dependent variable was measured with the use of the ordinal scale, a logit model for the ordered categories was used to estimate the model parameters. The reduction of the general model was provided with the use of the likelihood ratio (LR) test. Considering high correlation with the *diversity* and *prestige* variables, the *quality* and *innovativeness* variables were excluded from the model; the *gender* also proved to be insignificant. In comparison to the previous model, the interaction of the

respondent's home country and the *prestige* variables turned out to be significant. The estimation of the model parameters is presented in Table 6. Table 7 presents the marginal effects calculated for the average values of the independent variables.

Table 7. The marginal effects for the average values of the independent variables

Variable	j=1	j=2	j=3	j=4	j=5	j=6
Lithuania	-0.7835	0.099319	0.527663	0.144448	0.010909	0.001162
Germany	-0.81643	0.028971	0.535694	0.230078	0.019578	0.002106
Diversity	-0.03695	-0.06798	0.035688	0.062988	0.005649	0.000609
Prestige	-0.06263	-0.11522	0.060488	0.106757	0.009574	0.001032
Lithuania*prestige	0.138287	0.092489	-0.17301	-0.05345	-0.0039	-0.00041
Germany*prestige	0.068234	0.111846	-0.10417	-0.07392	-0.00188	-0.00012

Source: the authors' own calculations with the use of Excel.

It was therefore possible to observe that the Lithuanian and German respondents were less likely to declare their lack of readiness to purchase services in their own country, by 0.7835 and by 0.81643, respectively, and more likely to declare their strong readiness to purchase services (by 0.001162 and by 0.002106 respectively) than the Polish respondents. Considering the *diversity* and the *prestige* variables for the respondents who provided the average assessment of the above-mentioned characteristics (diversity = 4.15, prestige = 4.07), an increase in the assessment of services coming from the respondent's own *home country*, provided for each of the above-mentioned variables by a unit resulted in an increase in the probability referring to the choice of the *strong readiness to purchase services* category by 0.000609 and 0.001032 respectively, and a decrease in the probability referring to the choice of the *lack of the readiness to purchase services* category by 0.03695 and 0.06263, respectively. Based on the interaction between the *prestige* variable and the *respondent's home country* variable, it is possible to state that an increase in the assessment of the prestige of Lithuanian services by a unit results in a decrease in the probability referring to the choice of the *strong readiness to purchase services* category by 0.00041 in comparison to the impact exerted by the increase in the assessment of prestige on the probability referring to the choice of that category among the Polish respondents. Such a unit increase raised the probability referring to the choice of the *lack of the readiness to purchase services* category by 0.138287 in comparison to the impact exerted by the increase in the assessment of prestige on the probability referring to the choice of that category by the Polish respondents. A similar relation could be observed for the German respondents compared to the Polish respondents.

6. Summary

The readiness to purchase services offered by the countries analysed was significantly different, depending on the respondents' home country, for all the countries whose services were assessed. Considering the services which came from the respondents' home country, the highest average rank of the readiness to purchase such services was characteristic for the respondents who came from that particular country. Regardless of the respondents' home country, they declared their highest readiness to purchase German services of all the countries examined. The respondents declared their lowest readiness to purchase Lithuanian services (declared by the Polish respondents) and Polish services (declared by the Lithuanian and German respondents). The readiness to purchase services in the old EU countries was higher than in other countries.

Men declared lower readiness to purchase foreign services than women, in the case of services which came from the respondents' home country this difference was insignificant. The familiarity with the country of origin of services positively affected the declared readiness to purchase such services.

The Lithuanian respondents reported a higher readiness to purchase foreign services in comparison to the Polish respondents; considering the German and Polish respondents, this difference was insignificant. The highest readiness to purchase services coming from their own home country was declared by the German respondents, then subsequently by the Lithuanian respondents.

All the dimensions which refer to the image of the origin country of services, namely: innovativeness, diversity, quality and prestige significantly affected the readiness to purchase services declared by the respondents. The survey allowed the authors to compare the strength of the impact exerted by the particular factors on the readiness to purchase services. Considering the assessment of foreign services, the readiness to purchase them was most affected by the high assessment of services coming from a particular country in terms of quality, prestige, then innovativeness and, least of all, in terms of diversity. No differences in the strength of the influence exerted by these factors were observed in terms of the consumers' home country and their gender.

In the model obtained for services from the respondents' own country, the high assessment given to services in terms of the *diversity* variable, positively affected the probability of the choice of the *strong readiness to purchase services* category. The impact did not differ

among the respondents coming from the 3 analysed countries. Considering prestige, the strongest impact on the readiness to purchase services was identified among the Polish respondents; it was significantly weaker among the German respondents in comparison to the Polish ones and the weakest among the Lithuanian respondents.

Summing up, the results obtained are consistent with the results of other research on the COO effect in services, as well as on the COO effect in material products – where respondents prefer home services (offered by providers of the same nationality; however, some differences are observed among the respondents of various nationalities) (Harrison-Walker 1995; Javalgi et al. 2001; Bruning, Saqib 2013) and services offered by the countries of a high level of economic development (Javalgi et al. 2001). Considering domestic services, contrary to Bruning's research (1997), gender does not differentiate such an effect; considering foreign services, women indicate higher readiness to purchase. Nevertheless, the results of the presented analysis prove the influence of the endogenic factor, that is, gender, on the COO effect.

7. Limitations and future research.

In the future, it will seem interesting to analyse other demographic factors affecting the respondents' readiness to purchase services, in the context of the country of origin, such as respondents' age, education or income. It was impossible to do so for the sample applied in the survey, because there were no differences in terms of the respondents' education, and very few differences in terms of their age as well. It should also be noticed that the paper provides an analysis of intentions to purchase services and not an analysis of purchase behaviour. Although intentions are important in defining behaviour, there is a number of factors which affect the fact that such intentions come as an imperfect measure of purchase behaviour. Such factors include, for example, the price of the service, which is usually higher in developed countries. If the price is taken into consideration in the decision on the purchase, it can result in that the number of people ready to purchase will be lower than previously declared. Considering customers coming from poorer countries, the differences between intentions and purchase behaviour with respect to services from highly developed countries can be much larger. A higher cost involved in the search for information on services provided abroad may also result in the number of people ready

to purchase a service being much lower than the number declared before. Consequently, it may improve the preferences for services provided in consumers' home country. Moreover, previous experience and knowledge about some particular services may weaken the influence of the COO effect. Therefore, in the future the research should be carried out on various types of services provided by specific centres and which respondents know well. It would also be interesting to analyse the COO effect for multinational services. Additionally, it has been revealed that, considering foreign services, the strength of the influence exerted by the COO dimensions on the readiness to purchase services does not depend on the consumers' home country. In the future, it would therefore be advisable to analyse such a dependence in more detail– with regard to particular services and particular countries of origin of services.

Since the research sample consisted of the students of three universities – Polish, Lithuanian and German – it is impossible to provide any generalisation of the findings. It would be advisable to carry out some research on general population of a country and in a larger number of countries.

Bibliography

Ahmed Z.U., Johnson J.I., Ling C.K, Fang T.W., Nui A.K. (2002), Country-of-origin and brand effects on consumers' evaluations of cruise lines, „International Marketing Review", vol. 19 no. 3, pp. 279-302.

Ballinger G.A. (2004), Using generalized estimating equations for longitudinal data analysis, „Organizational Research Methods", vol. 7 no. 2, pp. 127-150.

Berentzen J.B., Backhaus C., Michaelis M., Blut M., Ahlert D. (2008), Does „made in…" also apply to services? An empirical assessment of the country-of-origin effect in service settings, „Journal Of Relationship Marketing", vol. 7 no. 4, pp. 391-405.

Boguszewicz-Kreft M. (2014), Efekt kraju pochodzenia w usługach (Country-of-origin effect in services), in: Sektor usług – uwarunkowania i tendencje rozwoju, „Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu", no. 353, pp. 79-89.

Boguszewicz-Kreft M., Magier-Łakomy E., Sokołowska K. (2015), The country-of-origin effect in the selected transport services, „Zeszyty Naukowe Uniwersytetu Szczecińskiego. Problemy zarządzania, finansów i marketingu", no. 41 p. 2: Rola podmiotów rynkowych w kształtowaniu wizerunku organizacji i postrzeganiu wartości marki. Zachowania współczesnych konsumentów, pp. 23-34.

Bose S., Ponnam A. (2011), Country of origin effect on services. An evaluation of entertainment, „Managing Leisure", vol. 16 no. 2, pp. 98-107.

Bruning E.R. (1997), Country of origin, national loyalty and product choice, „International Marketing Review", vol. 14 no. 1, pp. 59-74.

Bruning E., Saqib N.U. (2013), Cultural similarity and national bias. An assessment in an international service context, „Journal Of Global Marketing", vol. 26 no. 1, pp. 41-56.

Chattalas M., Kramer T., Takada H. (2008), The impact of national stereotypes on the country of origin effect. A conceptual framework, „International Marketing Review", vol. 25 no. 1, pp. 54-74.

Clayton D. (1992), Repeated ordinal measurements. A generalized estimating equation approach, Medical Research Council Biostatistics Unit Technical Report, Cambridge, UK.

Cramer J.S. (2001), An introduction to the logit model for economists, 2nd edition, Timberlake Consultants, London.

Cramer J.S. (2003), Logit models from economics and other fields, Cambridge University Press, Cambridge.

D'Astous A., Giraud Voss Z., Colbert F., Carù A., Caldwell M., Courvoisier F. (2008), Product-country images in the arts. A multi-country stud, „International Marketing Review", vol. 25 no. 4, pp. 379-403.

Debusho L.K., Sileshi G.W. (2012), Modelling of correlated soil animals count data, „South African Statistical Journal" no. 1, pp. 75-82.

Francuz P., Mackiewicz R. (2005), Liczby nie wiedzą, skąd pochodzą (Numbers do not know where they come from), KUL publishing house, Lublin.

Gange S.J., Linton K.L.P., Scott A.J., Demets D.L., Klein R. (1993), Analysis of correlated ordinal measures with ophthalmic applications, „Technical Report 71", University of Wisconsin Dept of Biostatistics.

Greene W.H. (2003), Econometric analysis, Prentice Hall, Upper Saddle River.

Greene W.H., Hensher D.A. (2010), Modeling ordered choices. A primer, Cambridge University Press, Cambridge.

Gruszczyński M. (2001), Modele i prognozy zmiennych jakościowych w finansach i bankowości (Models and forecasts of quality variables in finance and banking), SGH, Warsaw.

Gruszczyński M. (ed.) (2010), Mikroekonometria. Modele i metody analizy danych indywidualnych (Micro-econometrics. Models and methods of individual data analysis), Wolters Kluwer Business, Warsaw.

Harrison-Walker L.J. (1995), The relative effects of national stereotype and advertising information on the selection of a service provider. An empirical study, „Journal Of Services Marketing", vol. 9 no. 1, pp. 47-59.

Heagerty P.J., Zeger S.L. (1996), Marginal regression models for clustered ordinal Measurements, „Journal of American Statistical Association", vol. 91 no. 435, pp. 1024-1036.

Javalgi R.G., Cutler B.D., Winans W. (2001), At your service! Does country of origin research apply to services, „Journal of Services Marketing", vol. 15 no. 6-7, pp. 565-582.

Khare V.P., Popovich K. (2010), Country of origin of services. Are all services created equal?, „Proceedings of the Allied Academies Internet Conference", vol. 12, pp. 113-116.

Liang K.Y., Zeger S.L. (1986), Longitudinal data analysis using generalized linear models, „Biometrika" vol. 73 no. 1, pp. 13-22.

Lipsitz S.R., Kim K., Zhao L. (1994), Analysis of repeated categorical data using generalized estimating equations, „Statistics in Medicine" vol. 13 no. 11, pp. 1149-1163.

Magier-Łakomy E., Boguszewicz-Kreft M. (2015), Dimensions of the Country of Origin Effect and their Measurement, „Annales UMCS, Sectio H: Oeconomia", vol. 49 no. 3, pp. 125-134.

Magier-Łakomy E., Boguszewicz-Kreft M., Janiunaite B., Dimension of the country of origin effect in the perception of medical services in EU countries. An international comparison, ,,Proceedings of the 23rd International Academic Conference, Venice 27-30.04.2016", International Institute of Social and Economic Sciences, Venice International University, Prague 2016, pp. 306-317, http://www.iises.net/proceedings/23rd-international-academic-conference-venice/table-of-content/detail?article=dimension-of-the-country-of-origin-effect-in-the-perception-of-medical-services-in-eu-countries-an-internatio [6.01.2018].

Marzec J. (2008), Bayesowskie modele zmiennych jakościowych i ograniczonych w badaniach niespłacalności kredytów (The Bayesian models of quality variables and limited variables in the research on credit non-payment), ,,Zeszyty Naukowe Uniwersytetu Ekonomicznego w Krakowie" no. 188.

Miller M.E., Davis D.D., Landis J.R. (1993), The analysis of longitudinal polytomous responses: generalized estimation equations and connections with weighted least squares, ,,Biometrics", vol. 49 no. 4, pp. 1033-1044.

Morrish S.C., Lee C. (2011), Country of origin as a source of sustainable competitive advantage. The case for international higher education institutions in New Zealand, ,,Journal of Strategic Marketing", vol. 19 no. 6, pp. 517-529.

Nagashima A. (1970), A comparison of Japanese and U.S. attitudes toward foreign products, ,,Journal Of Marketing", vol. 34 no. 1, pp. 68-74.

Narayana C.L. (1981), Aggregate images of American and Japanese products. Implications on international marketing, ,,Columbia Journal Of World Business", vol. 16 no. 2, pp. 31-35.

Norton E.C., Wang H., Ai C. (2004), Computing interaction effects and standard errors in logit and probit models, ,,The Stata Journal", vol. 4 no. 2, pp. 154-167.

Pharr J.M. (2005), Synthesizing country-of-origin research from the last decade. Is the concept still salient in an era of global brands?, „Journal of Marketing Theory & Practice", vol. 13 no. 4, pp. 34-44.

Sharma P. (2011), Demystifying cultural differences in country-of-origin effects. Exploring the moderating roles of product type, consumption context, and involvement, ,,Journal of International Consumer Marketing", vol. 23 no. 5, pp. 344-364.

Sikora T. (2008), Znaczenie efektu kraju pochodzenia dla komunikacji w biznesie międzynarodowym (The significance of the COO effect for communication in international business), ,,International Journal of Management and Economics", vol. 23, pp. 173-194, http://bazhum.muzhp.pl/media//files/International_Journal_of_Management_and_Economics/International_Journal_of_Management_and_Economics-r2008-t23/International_Journal_of_Management_and_Economics-r2008-t23-s173-194/International_Journal_of_Management_and_Economics-r2008-t23-s173-194.pdf [6.01/2018].

Touloumis A. (2015), R Package Multgee. A generalized estimating equations solver for multinomial responses, „Journal of Statistical Software", vol. 64, pp. 1-14.

Zeger S.L., Liang K.Y. (1986), Longitudinal data analysis for discrete and continuous outcomes, ,,Biometrics" vol. 42 no. 1, pp. 121-130.