Which Generation Cohort is more "Open to Change": An Ordinal Logistic Regression Model Analysis

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Abstract: *This paper tests and determines if generation cohorts – Baby boomers, Xers, and Millennials are significantly different when dealing with changes and challenges in Saudi Arabia. Results indicated that there is a significant difference among the generation cohorts. Millennials are more open to changes than Xers and Baby boomers. The results also indicated that even though Xers and Baby boomers are different, the difference is not statistically significant.*

Keywords: *Baby boomers, Generation X, Generation Y, Logistic regression model.*

I.   INTRODUCTION

Generation Cohorts is a form of divisions in our society that is related to a group of people with a common history, close birth year range, collective personality, and whose value orientation depicts significant culture/economic experiences [1]. Generation cohort can be divided into three distinct types; Baby Boomers, Generation X (Xers) and the Generation Y (Millennials). Baby Boomers are the generation that were born between the years of 1945 and 1964, while Generation X, the Xers' were born between the years of 1965 and 1980. The Millennials who are generally referred to as the Generation Y are the young and vibrant generation born between the years of 1981 and 2000 [2]. Baby Boomers are well known for their vibrant and "workaholic" attitudes. They are also known for deriving satisfaction from their work. Xers' take their pride from their comfort in using and applying technology. They are also known for their self-reliant and skeptical nature. The millennials are known for their entrepreneurial roles, multitasking and close-up relationships in terms of quick feedback and responses [3].

The main aim of this paper is to analyze and determine if these generation cohorts (Baby boomers, Xers and Millennials) are the same or different when it comes to "open to change", thus, if they react similarly or differently to changes or challenges.

1.1. Related Works

Generational theory suggests that as group of individuals are born into a culture or environment, they develop certain qualities, believes or values that are strong enough to support a measure of predictability [1]. Literatures on generational cohorts suggests that even though generational differences can be generalized, there are differences pertaining to different regions and markets [4,5]. logically it can be inferred that a person born between the ages of 1945 and 1965 is not expected to act or have the same attitude as a person born between the ages of 1990 and 2000. However, [6] indicated that there is evidence from the studies of psychological scales taken from eight decades that suggests that differences among generational cohort can be generalized to allow inferences and predictions with a low margin of error, after all, some individuals attach themselves to certain age groups or generations due to similar traits and values.

This paper intends to use the ordinal logistic regression model to analyze and determine the relationship between the various generation cohorts and their willingness to change. There are several works that inculcate the use of the ordinal logistic regression model in determining the relationship between ordinal categorical dependent variable and one or more independent variables by estimating probabilities using a logistic function [7]. Some of the applications of ordinal logistic regression includes determining the risk factor of child malnutrition in Bangladesh [8], study of students' achievement in external tests [9], and the relationship between maternal disease and preterm birth [10].

1.2. Problem Definition

Is there a significant relationship among the various generation cohorts and how they are willing to accept change?

1.3. Variables
Response variable: "Open to change"
Explanatory variable: Generation cohorts – Baby boomers, Xers and Millennials

II. METHODOLOGY

The shortened version of Schwartz's Value Survey (SVS) was used to collect the data on the response variable (open to change). SVS is a cross cultural psychological and socially determined items for measuring and studying individual differences in value. The original SVS has 57 items that has been shortened and categorized into 10 broad scales – power, achievement, hedonism, stimulation, self-direction, universalism, benevolence, tradition, conformity and security [11]. Openness to change will be measured using three scales under the SVS, thus self-direction, stimulation and hedonism. Stimulation and self-direction involves how an individual enjoy challenges in life, how curious and independent an individual is. Whereas, hedonism has got to do with pleasure and sensuous gratification for oneself. These items were measured on a 9-point Likert scale. The order of the scale was emphasized such that point 1 means 'opposed to my principles' or extremely disagree. And point 9 means 'of supreme important' or extremely agree.

The explanatory variable (generation cohort) was adopted from the age distribution of the questionnaire. Millennials were comprised of respondents between the ages of 18 and 37, Xers between the ages of 38 and 53, and Baby boomers above the age 53. Table 1. depicts the questionnaire for the main construct, openness to change.

Table 1. Questionnaire

Index	Questions	Source
	Openness to change	(Lindeman, &Verkasalo, 2005)
1	HEDONISM (gratification of desires, enjoyment in life, self-indulgence)	
2	STIMULATION (daring, a varied and challenging life, an exciting life)	
3	SELF-DIRECTION (creativity, freedom, curiosity, independence, choosing one's own goals)	

III. MODEL SELECTION

This paper uses the ordinal logistic regression model (proportional odds model) to fit and analyze the data. This model was selected because of the ordinal nature of the response variable. Respondents are to select one value on the scale of 1 to 9, where 1 represents 'opposed to my principles' or extremely disagree and point 9 represents 'of supreme important' or extremely agree. Among the various types of the ordinal logistic regression models, the proportional odds model was adopted for this paper because the explanatory variables (generation cohorts – Baby boomers, Xers and Millennial) were assumed not to depend on the various categories.
The logit (model) equation is then given as:

$$L_j = Log\left(\frac{P(Y \leq j)}{P(Y > j)}\right) = B_{0j} - B_1X_1 - B_2X_2, \qquad j = 1, 2, ..., 8$$

Thus, there are 8 different equations with two predictor variables, same slopes and different intercepts. X_1 represents Millennials and zero otherwise, X_2 represents Xers and zero otherwise. Baby boomers was fixed.

IV. ANALYSIS

The R Project for Statistical Computing [12] was used for the analysis of this paper. For easy identification and computation, the various generation cohorts were represented by an alphabet. Millennials were represented by "S", Xers were also represented by "T" and baby boomers were represented by "B". Exhibit 1 below represents the data set in R. The three questions (hedonism, stimulation and self-direction) used in measuring openness to change were summed and scaled back to the 9 point Likert scale. The column "Gen" represent the various generations cohorts, the column "Open" represents the various point scales from 1 to 9, and the column "N" represents the frequencies.

Exhibit 1.

```
> stat=read.table(file.choose(),header=T)
> stat
   Gen Open   N
1    S    1   2
2    S    2   3
3    S    3   5
4    S    4   5
5    S    5  15
6    S    6  20
7    S    7  10
8    S    8   5
9    S    9   5
10   T    1   3
11   T    2   7
12   T    3   5
13   T    4  10
14   T    5  10
15   T    6  10
16   T    7   5
17   T    8   2
18   T    9   1
19   B    1   5
20   B    2   2
21   B    3   3
22   B    4  10
23   B    5   5
24   B    6   4
25   B    7   3
26   B    8   3
27   B    9   1
```

Exhibit 2 and 3 show the results of the analysis. Exhibit 2 shows the actual R results and Exhibit 3 shows the confidence intervals.

From Exhibit 2, we obtained a residual deviance of 645.0463. This shows that the model is significantly different from the null hypothesis which is the model with just the intercept. Therefore, we reject the null hypothesis and accept our model (H_1).

That is, our hypothesis is:

$$H_0 : Log\left(\frac{P(Y \leq j)}{P(Y > j)}\right) = B_j \quad \text{versus} \quad H_1 : Log\left(\frac{P(Y \leq j)}{P(Y > j)}\right) = X_j^T B_j$$

By the Wald Statistics shown in Exhibit 2, our explanatory variable (X_1) – Millennials is significant and hence statistically different from zero. Moreover, the explanatory variable (X_2) – Xers was not significant and hence not statistically different from zero.

The significance of the explanatory variable can also be checked from Exhibit 3. It can be seen that the confidence interval for Millennials (represented by Gen S) does not contain zero which makes it significant but that of Xers (represented by Gen T) contains zero which does not make it significant.

Equally, the significance of the intercepts could be tested by the Wald Statistics. From Exhibit 2, it can be seen that all the intercepts are significant except the fourth intercept (equation 4|5).

Exhibit 2

```
> library(MASS)
> stat$Open=factor(stat$Open, ordered=T)
> result=polr(Open ~ Gen, weight=N, data=stat)
> summary(result)

Re-fitting to get Hessian

Call:
polr(formula = Open ~ Gen, data = stat, weights = N)

Coefficients:
       Value Std. Error t value
GenS 1.0817     0.3751  2.8836
GenT 0.1341     0.3851  0.3482

Intercepts:
     Value  Std. Error t value
1|2 -2.2801  0.4114     -5.5428
2|3 -1.3901  0.3422     -4.0625
3|4 -0.8117  0.3184     -2.5496
4|5 -0.0033  0.3106     -0.0108
5|6  0.8256  0.3222      2.5626
6|7  1.8726  0.3483      5.3766
7|8  2.7452  0.3902      7.0362
8|9  3.7107  0.4866      7.6255

Residual Deviance: 645.0463
AIC: 665.0463
```

Exhibit 3

```
> (ci <- confint(result))
Waiting for profiling to be done...

Re-fitting to get Hessian

            2.5 %     97.5 %
GenS  0.3501126 1.8235300
GenT -0.6220651 0.8905575
> exp(cbind(OR = coef(result), ci))
           OR      2.5 %     97.5 %
GenS 2.949673 1.4192274 6.193684
GenT 1.143469 0.5368347 2.436488
```

V. MODEL FITTING AND DISCUSSION

This section fits the model, explains, discusses and interprets the coefficients. Below is the model with the various parameters or coefficients.

$$L_1 = Log\left(\frac{P(Y \le 1)}{P(Y > 1)}\right) = -2.2801 - 1.0817X_1 - 0.1341X_2$$

$$L_2 = Log\left(\frac{P(Y \le 2)}{P(Y > 2)}\right) = -1.3901 - 1.0817X_1 - 0.1341X_2$$

$$\vdots$$

$$L_8 = Log\left(\frac{P(Y \le 8)}{P(Y > 8)}\right) = 3.7107 - 1.0817X_1 - 0.1341X_2$$

As indicated in the analysis section by the residual deviance, the test was significant and our analysis fit the data well. The coefficient of X_1 (1.0817) indicates that Millennials are more likely to accept change than baby boomers. This also tells us that, the odds of a Millennial accepting change as compared to a Baby boomer is Exp[1.0817]=2.9496. This value can be verified from Exhibit 3 above. In the analysis section the coefficient of X1 was shown to be significant and this confirms that Millennials are open to change than Baby boomers.

The coefficient of X_2 (0.1341) indicates that Xers are more likely to accept change than baby boomers. This also tells us that, the odds of a Xers accepting change as compared to a Baby boomer is Exp[0.1341]=1.1435. This value can be verified from Exhibit 3 above. In the analysis section the coefficient of X_2 was shown not to be significant and this confirms that Xers and Baby boomers are not different when it comes to challenges and changes (open to change).

The intercepts as shown in Exhibit 2, refer to the log odds of a Baby boomer not extremely open to change to the log odds of a Baby boomer being extremely open to change. Thus, from L1, the log odds of a Baby boomer not extremely open to change versus all other categories is -2.2801. Simply, it means that the odds of a Baby boomer not being extremely open to change versus all other categories (or as compared to drifting towards extremely open to change) is Exp[-2.28011]=0.102. By setting X_1 to 1 and holding X_2 zero we could also find the log odds of a Millennial not being extremely open to change versus all other categories (or as compared to drifting towards extremely open to change). Similarly, setting X_2 to 1 and holding X_1 zero we could also find the log odds of a Xers not being extremely open to change versus all other categories (or as compared to drifting towards extremely open to change). But we could easily find the probabilities of various generations being extremely open to change and not being extremely open to change to make the interpretation easier to understand. This can be done using the logit equation.

$$\log it[P(Y \le j)] = B_j - 1.0817X_1 - 0.134X_2, \qquad j = 1, 2, \ldots, 8$$

In the following we find the probability of the various generation being in the state of not extremely open to change, neutral, and the state of being extremely open to change.
Firstly, we begin with "not extremely open to change".

From the logit equation, if $j = 1$ and $X_1 = X_2 = 0$, then logit[$P(Y \le 1)$] = -2.28011; that is,

$$P(Y \le 1) = \frac{e^{(-2.28011)}}{1 + e^{(-2.28011)}} = 0.093$$.

This means that the probability of a Baby boomer not being extremely open to change is 0.093.

If $j = 1$ and $X_1 = 1, X_2 = 0$, logit[$P(Y \le 1)$] = -2.28011 − 1.0817(1) = -3.3618; that is,

$$P(Y \le 1) = \frac{e^{(-3.3618)}}{1 + e^{(-3.3618)}} = 0.034$$.

This means that the probability of a Millennial not being extremely open to change is 0.034.

If $j = 1$ and $X_1 = 0, X_2 = 1$, logit[$P(Y \le 1)$] = -2.28011 − 0.1341(1) = -2.41421; that is,

$$P(Y \le 1) = \frac{e^{(-2.41421)}}{1 + e^{(-2.41421)}} = 0.082$$.

This means that the probability of a Xers not being extremely open to change is 0.082.

Secondly, we find the probability of "neutral to change". From the logit equation, if $j = 5$ and $X_1 = X_2 = 0$

logit[$P(Y \le 5)$] = 0.8256; that is, $$P(Y \le 5) = \frac{e^{(0.8256)}}{1 + e^{(0.8256)}} = 0.695$$.

This means that the probability of a Baby boomer being neutral to change is 0.695.

If $j = 5$ and $X_1 = 1, X_2 = 0$, logit[$P(Y \le 5)$] = 0.8256 − 1.0817(1) = -0.2561; that is,

$$P(Y \le 5) = \frac{e^{(-0.2561)}}{1 + e^{(-0.2561)}} = 0.436$$.

This means that the probability of a Millennial being neutral to change is 0.436.

If $j = 5$, and $X_1 = 0, X_2 = 1$, logit[$P(Y \le 5)$] = 0.8256 − 0.1341(1) = 0.6915; that is,

$$P(Y \le 5) = \frac{e^{(0.6915)}}{1 + e^{(0.6915)}} = 0.666$$.

This means that the probability of a Xers being neutral to change is 0.666.

Thirdly, we find the probability of "extremely open to change". From the logit equation, if $j = 8$ and

$X_1 = X_2 = 0$, logit[$P(Y \leq 8)$] = 3.7107; that is, $P(Y \leq 8) = \dfrac{e^{(3.7107)}}{1 + e^{(3.7107)}} = 0.024$.

This means that the probability of a Baby boomer being extremely open to change is 0.024.

If $j = 8$ and $X_1 = 1, X_2 = 0$, logit[$P(Y \leq 8)$] = 3.7107 – 1.0817(1) = 2.629; that is,

$P(Y \leq 8) = \dfrac{e^{(2.629)}}{1 + e^{(2.629)}} = 0.067$.

This means that the probability of a Millennial being extremely open to change is 0.067.

If $j = 8$ and $X_1 = 0, X_2 = 1$, logit[$P(Y \leq 8)$] = 3.7107 – 0.1341(1) = 3.5766; that is,

$P(Y \leq 8) = \dfrac{e^{(3.5766)}}{1 + e^{(3.5766)}} = 0.027$.

This means that the probability of a Xers being extremely open to change is 0.027.

Now, it could be seen from the probabilities that Millennials (p = 0.067) are more likely to be open to change than Xers (0.027) and Baby boomers (0.024). In the opposite direction, it could also be seen that Millennials are less likely to resist challenges or changes. Looking at the neutral positions, it could also be seen that baby boomers and Xers are more likely to be in the neutral position (unsure of change) as compared to Millennials. This is an indication that Millennials are willing to change or decide whether to change or not than Baby boomers and Xers.

VI.   CONCLUSION

This paper has tested if generation cohorts – Baby boomers, Xers, and Millennials are significantly different when dealing with changes and challenges in Saudi Arabia. The ordinal logistic regression model (proportional odds model) is used to fit and analyze the data. Results indicated that there is a significant difference among the generation cohorts. Millennials are more open to changes than Xers and Baby boomers, which is consistent with our common sense. The results also indicated that even though Xers and Baby boomers are different, the difference is not statistically significant.

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