

## A Comparison of Canonical Correlation Analysis Results on 2015-2016 Social Progress Indexes<sup>1</sup>

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### Abstract

Social Progress Index aims to form a systematic basis to guide strategy for inclusive growth which requires achieving both economic and social progress. This study has aimed to compare the relations among “Basic Human Needs” and “Foundations of Wellbeing” dimensions of 2015 and 2016 Social Progress Indexes through “Canonical Correlation Analysis” for 130 countries. The first (and the highest) canonical correlation coefficients which are 0.926 and 0.935 for 2015 and 2016 respectively imply that there is a high relationship between “Basic Human Needs” and “Foundations of Wellbeing” dimensions. In case the Wilk’s Lambda statistics are considered, the whole model has been regarded as statistically significant with a considerably high overall effect size of 0.89 and 0,896 values for 2015 and 2016 respectively. Besides, according to the findings associated with canonical loadings, the largest contribution to “Basic Human Needs” set has come from “Nutrition and Basic Medical Care” variable and the most effective variable in “Foundations of Wellbeing” has been revealed to be “Access to Basic Knowledge”. The best performance for both the year 2015 and 2016 has been observed in “Basic Human Needs” dimension with “Nutrition and Basic Medical Care” and “Water and Sanitation” components which lie at the core of the United Nations Millennium Development Goals. Having evaluated two dimensions together, it can be inferred that “Personal Safety” and “Health and Wellness” fields should be prioritized in order to trigger social progress.

**Keywords:** *Social Progress Index, Basic Human Needs, Foundations of Wellbeing, Canonical Correlation Analysis.*

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## 2015-2016 Sosyal Gelişim Endekslerine İlişkin Kanonik Korelasyon Analizi

### Sonuçlarının Karşılaştırılması

#### Öz

Sosyal Gelişim Endeksi hem ekonomik hem de sosyal anlamda gelişmeyi başarmayı gerektiren içsel büyüme stratejisine öncülük etmek için sistematik bir temel oluşturmayı amaçlar. Bu çalışma, sosyal gelişim endeksinin içinde yer alan “Temel İnsani İhtiyaçlar” ve “Refahın Temelleri” boyutları arasındaki ilişkileri, 130 ülke için kanonik korelasyon analizi kullanarak 2015 ve 2016 yılları için karşılaştırmayı amaçlamaktadır. 2015 ve 2016 yılları için sırasıyla 0.926 ve 0.935 olarak elde edilen birinci (ve en yüksek) kanonik korelasyon katsayıları, bu iki değişken kümesi arasında yüksek bir ilişkinin olduğuna dikkat çekmektedir. Wilk’s Lambda istatistiklerinin ele alındığı durumda, tüm model 2015 ve 2016 yılları için sırasıyla 0.89 ve 0.896 değerleri ile oldukça yüksek bir genel etki büyüklüğü göstererek istatistiksel olarak anlamlı kabul edilmiştir. Ayrıca kanonik yüklerle ilişkili bulgulara göre, “Temel İnsani İhtiyaçlar” kümesine en fazla katkı “Beslenme ve Temel Tıbbi Bakım” değişkeninden gelmiş olup, “Refahın Temelleri” kümesine en fazla katkının ise “Temel Bilgiye Erişim” değişkeni tarafından sağlandığı ortaya konmuştur. Hem 2015, hem de 2016 yılı için en iyi performans “Temel İnsani İhtiyaçlar” boyutunda, Birleşmiş Milletler Milenyum Kalkınma Hedefleri’nin de temelinde yatan “Beslenme ve Temel Tıbbi Bakım” ile “Su ve Temizlik” bileşenlerinde gözlenmiştir. Endeksin iki boyutu birlikte değerlendirildiğinde ise, sosyal gelişmeyi harekete geçirmek için “Kişisel Güvenlik” ve “Sağlıklı Yaşam” alanlarının önceliklendirilmesi gerektiği sonucuna varılabilir.

**Anahtar Kelimeler:** Sosyal Gelişim Endeksi, Temel İnsani İhtiyaçlar, Refahın Temelleri, Kanonik Korelasyon Analizi.

## **Introduction**

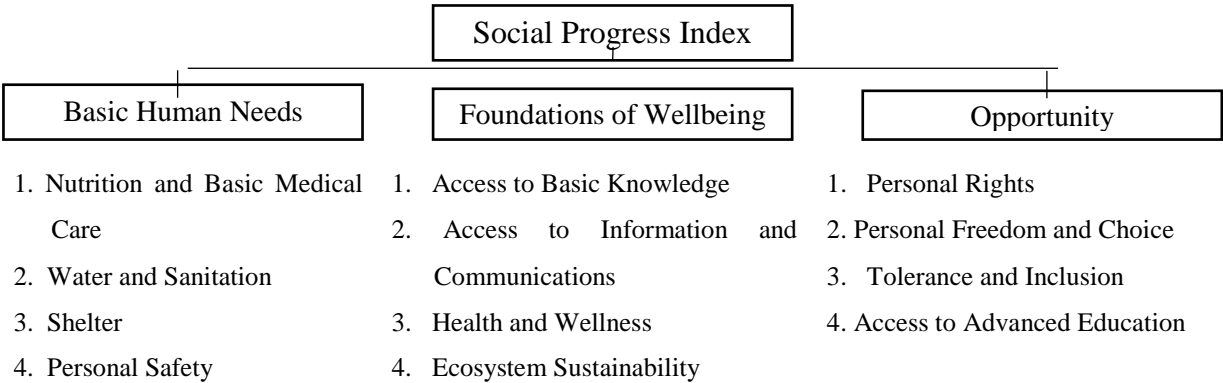
In daily life, while talking about a country or a city, we do not make much of a distinction between the income level and the level of development. However, when looked from the economic point of view, these two concepts are seen to have very huge differences between them. While income expresses monetary possibilities in the ownership in the most basic sense; development, although not have a single definition, refers to human life quality and the rights and opportunities that people can access. A group of prominent economists -who think that the national income per capita remains insufficient to explain the development level- have developed the Human Development Index (HDI) that is published by the United Nations since 1990. HDI which has been prepared based on education, health and income indicators is one of the most widely used development indicators. Together with this, the new indices using different methodologies over time have also been derived. Social Progress Index (SPI) -whose fundamentals have been thrown in the World Economy Forum and prepared under the leadership of Michael Porter who is a business professor at Harvard University- is also a new example which pays attention to the alternative development indicators like HDI. While Nobel Prize winning - development economist Amartya Sen describes the concept of development in his book called 'Development as Freedom'; in addition to the access to income and social services, he has underlined the managerial and social factors like economic and political freedoms and security and government transparency. Most of the HDI and indices similar to it do not include a measure associated with these conditions. Therefore, SPI has been created (Sökmen, 2014).

SPI provides a holistic and the first comprehensive measurement framework in order to create a succeeding society, accelerate and measure social progress which is independent of GDP and complementary to it and aims to form a systematic basis for guiding strategy for inclusive growth which requires achieving both economic and social progress. It is of great importance with respect to presenting a palpable method to assign a priority to an actionable agenda advancing both social and economic performance (Porter et al., 2015). SPI expresses a total measure which is created from various indicators extracted from a wide range of associations going from very large establishments (like the United Nations) to non-governmental associations - for example, Transparency International (Stern et al., 2015). It is first released in 2014 and social development contributions of Amartya Sen which provide a basis for future development have been an urge in the formation of SPI methodology (Porter et al., 2015). This index mentions about four key principles:

1. *Exclusively Social and Environmental Indicators*: It tries to evaluate social progress directly and to analyze the relationship between economic development and social development in a precise manner rather than utilize economic proxies.
2. *Outcomes, Not Inputs*: It tries to measure the outcomes that are associated with the lives of real people like a country’s health and wellness achieved rather than how much the country spends on healthcare.
3. *Holistic and Relevant to All Countries*: It aims to create a holistic measure of social progress that incorporates the many aspects of health of societies within its scope for any country, including higher-income countries.
4. *Actionable*: It aims to help leaders and practitioners in government, business and civil society for carrying out policies that will faster combine efforts to accomplish social progress. With this target, the index enables us not only to provide an aggregate country score and ranking, but also to provide an opportunity for granular analyses of specific areas of strength and weakness.

Moving from these explanations; since economic performance alone does not explain social progress completely, Porter et al. (2015) have presented the definition of the concept of social progress in a large scale as: *“Social progress is the capacity of a society to meet the basic human needs of its citizens, establish the building blocks that allow citizens and communities to enhance and sustain the quality of their lives, and create the conditions for all individuals to reach their full potential.”*

By taking this definition as basis, SPI has been constructed around three dimensions of “Basic Human Needs”, “Foundations of Wellbeing” and “Opportunity” and 12 components which take place under these dimensions. Each component consists between three and five specific outcome indicators (totally 52 indicators) which are measured in a consistent manner by the same organization for all countries included:



Source: Porter et al. (2015).

**Figure 1:** Social Progress Index Component-Level Framework.

This framework in Figure 1 makes easier to capture and compare interrelated factors that underlie social progress (Porter et al., 2015). The first dimension “Basic Human Needs” deals with to which extent people’s essential needs are fulfilled by a given country by measuring access to nutrition and basic medical care, whether they have access to safe drinking water, sufficient housing with fundamental utilities and whether the society is free from danger and feels secure. Whether the society has an access to basic education, an access to information and internal and external communications, whether healthy living conditions are available to citizens and how well a country protects its natural environment -air, water and land- are measured in the second dimension, “Foundations of Wellbeing”. Measurements concerning with the degree to which a country’s citizens have personal rights and freedoms, their ability to make their own personal decisions as well as whether prejudices or hostilities within a society prohibit individuals from reaching their potential and also the degree to which citizens can have an access to advanced forms of education are incorporated into the third and final dimension “Opportunity” (Porter et al., 2015).

Calculating the social progress index requires factor analysis. Before performing factor analysis, initially the fit between the individual indicators inside a component has been assessed through the computation of Cronbach's alpha -which gives a measure of internal consistency across indicators - for the indicators of every component. As a general guideline, an alpha value that is above 0.7 is accepted for grouping variables (Bland and Altman, 1997) (Stern et al., 2015). Factor analysis utilizes the mutual covariance across all indicators within each component in order to be able to compute a sequence of weights that enables to obtain one aggregate value (also called a factor) from various indicators (Manly, 1994). In the case of indicators to be detected rigorously, this factor (aggregate value) will extract a score that can be utilized as an acceptable synthetic gauge of the component across countries. Subsequent to executing factor analysis in each component, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy has been utilized for evaluating goodness of fit.

Dimension scores are computed by taking the average of the four components which constitute the dimension in interest. Countries that do not have scores in all four components of a given dimension will not be able to get a dimension score.

Finally, the overall SPI is calculated through the simple average of the three dimensions. The overall index scores and ranks do not include countries which do not have scores in all three dimensions. While higher index scores mean higher social progress, lower scores point to the reverse (Porter et al., 2015).

The calculation of 2015 SPI has been limited to 2005-2015 data for any given indicator and country and the average year of data utilized in 2015 index is expressed to be 2013. On the other hand, while the use of data in 2016 SPI is limited to 2005–2016 data for any given indicator and country; the average year of data in this index is expressed to be 2014 (Stern et al., 2015; Stern et al., 2016).

Although the high-level structure of the 2016 SPI does not differ from 2015 index, some modifications have been applied on individual indicators with the aim of making measurements better for component-level concepts and adjusting alterations in data availability. One drastic modification realized by name shows itself in ‘Environmental Quality’ component: The ‘Ecosystem Sustainability’ which takes place under the dimension of ‘Foundations of Wellbeing’ in 2015 index has been renamed ‘Environmental Quality’ in 2016 index to be able to better reflect the concept being measured (Porter et al., 2016).

In this study, 130 countries which take place in the web site of ‘Social Progress Imperative’ and which do not include any missing observations for 8 components have been considered. The number of countries has remained unchanged for both 2015 and 2016 years. It should be expressed here that there is no specialty of choosing the year 2015 and 2016 in the study. The framework of our study has been formed in the year 2016 and the last up-to-date two years have been asked to be compared with the aim of finding out if there are huge differences or not regarding the evidence of the study. That is why these years have been chosen. In this research, it has been mainly aimed to determine the relations among “Basic Human Needs” and “Foundations of Wellbeing” sets by carrying out canonical correlation analysis (CCA) technique.

In this section, a brief summary of the methodology of social progress index has been mentioned. The rest of this paper has been organized as follows: Section 2 considers the literature study, Section 3 provides the background for the analytical approach to ‘Canonical Correlation Analysis’, Section 4 gives the information about the data set and application results. Finally, Section 5 presents the discussion part on the comparison of CCA for 2015 and 2016 years with brief conclusions.

## 1. Conceptual Frame

There are many past and recent studies available regarding social progress and its components. As the outset of the researches regarding the links between sub-dimensions of sustainable development, the link between income inequality and economic development has been raised with an inverted U-shaped pattern by Kuznets (1955).

According to the study of Bonair et al. (1989), basic judgements on the issue of striking improvement realized in the general health status have put the role of the rapid increment in the standard of living in a primary position relative to the role of the biomedical health care system.

Altafin (1991) mentions about a specific type of communication –which is participatory communication- as it provides the main contribution in the stage of Social Development Evaluation by triggering the common interaction and dialogue amongst the poor people, external and local agents in the case of making contribution in the social development process established upon human activities.

On the other hand, Madu (1992) has associated the rises in the socioeconomical problems like lack of basic food required for meeting daily nutritional and energy requirements or environmental contamination with worsening health conditions and death.

In the study by Kahn (1995), the paradigm of sustainable development in Agenda 21 - which is a globally broad-in-scope action plan implemented by United Nations that aims to struggle with the concerns of 21<sup>st</sup> century- is covered expressing that environmental sustainability incorporates eco-system integrity, carrying capacity and biodiversity in itself and three pillars underlying this paradigm which are economic, social and environmental sustainability are also stated to be interrelated.

Hediger (2000) presents a precise description of sustainable development based on integrated economic, social and ecological perspectives and puts emphasis on sustainability-based social value function that is consistent with the chief principles of sustainable development by taking an aggregate of individual preferences as basis. In the study, the distinction between strong sustainability and Solow sustainability is discussed in that the former is expressed in terms of aggregation of the ecosystem capital and non-renewable resource stocks while the latter focuses on keeping per capita income constant over time. Also, social welfare function proposed by the study is offered as an integrated structure in order to cope with trade-offs between the distinct social, economic and ecological objectives by combining ecological capital, socio-cultural system, principles of basic human needs and macroeconomic objectives like full employment or price stability.

Brocklehurst (2011) highlights the importance of water, sanitation and hygiene on achieving not only Millennium Development Goals but also far reaching long-term development based on the associations with health, nutrition, equity, gender equality and economic progress.

The study of Zimmerman and Woolf (2014) underlines that education and health benefits are strongly related in that being more educated contributes to navigating health care systems and personal health behaviors, adopting important decisions about lifestyle choices in order to hinder health risks, also to increasing the inclination for having greater social resources like social support based on communication network and economic resources like earnings and wealth (which are main determinants of health status [CSDH, 2008; Braveman et al., 2010]) for a healthier way of living, then concluding in better health indicators (Zimmerman and Woolf, 2014: 5-8).

In their study, Gazzola and Querci (2017) emphasize that sustainable development stands for sustaining economic growth based on providing required integration of economy and environment and upgrading living standards.

Rao and Min (2018) have proposed decent living standards which express a global set of material conditions of basic human needs in order to attain basic human wellbeing benefiting from the conceptualizations of basic justice and multidimensional poverty indicators.

Ünal and Tatlıdil (2018) have examined the relationship between first variable set which is human investments (mortality rate (MR), expected years of schooling (ES), health expenditure (HE), female labor force ratio (LF)) and second variable set which is economic indicators of countries (net capital stock (CS), imports (IG), exports (EG), gross domestic product (GDP), consumer price index (CPI), Private Final Consumption Expenditure (FCE), net national savings (NS)) using canonical correlation analysis (CCA) approach and subsequent to this, this relationship has been discussed through the partial canonical correlation analysis (PCCA) approach by adding a third variable set of economic development indicators (expenditure on research and development, energy use and renewable energy consumption) in the analysis. For both approaches, first pair of canonical variables has been found to be significant. According to the standardized canonical coefficients of CCA; MR, CPI and NS variables provide the largest contribution to first pair of canonical variables.

Wang et al. (2018) have aimed to detect the primary factors of total water use and energy-related CO<sub>2</sub> emissions in Beijing at the regional level for the period 1996-2016 using a partial least squares STIRPAT model and emphasized the importance of balancing economic development, water and energy security, and environmental sustainability at the city level.



Findings have revealed that the population, per capita gross domestic product (GDP), urbanization level, technology level, and service level have a significant effect on the total water use and energy-related CO2 emissions.

Vikram (2018) covers the relationship between social capital and child nutrition using the India Human Development Survey for 2005–2006 years based on multilevel logistic models. According to the findings, there is a positive association between household based bridging social capital as related to development- oriented organizations and child nutrition. However, bonding social capital is negatively connected with child nutrition. As a general result, socio-economic development and social capital have been found to be interdependent.

Reyes and Useche (2019) have examined the relationship between competitiveness, economic growth and human development index for 20 countries of the Latin America and Caribbean region during the 2006-2015 period through the cluster analysis tests and linear correlation coefficients. Findings revealed that low rates in competitiveness and economic growth indicators display the typical status since 2009 and at the individual country level, there has been found no statistically significant relationship between economic growth and human development.

## 2. Method

The development of the basic theory regarding the Canonical Correlation Analysis (CCA) has been initially thanks to Hotelling (1936). Contemporarily, the advent of statistical software programs has made possible the applicability of CCA quite easily. It would be wrong, however, to consider the analysis apart from the multiple regression analysis.

$$U_1 = a_{11}X_1 + a_{12}X_2 + \dots + a_{1p}X_p \quad (1)$$

$$V_1 = b_{11}Y_1 + b_{12}Y_2 + \dots + b_{1q}Y_q \quad (2)$$

Equation (1) shows the linear combination of the X variables that is denoted by the new variable  $U_1$  and Equation (2) shows the linear combination of the Y variables that is denoted by the new variable  $V_1$ . These new variables which include sets of dependent and independent variables and thus are derived from the original variables are known as canonical variates. CCA is an analytical framework that aims to measure the association between composites of two multivariate sets of variables whereby more than one variable by estimating  $a_{11}, a_{12}, \dots, a_{1p}$  and  $b_{11}, b_{12}, \dots, b_{1q}$  in such a way that maximizes the correlation between  $U_1$  and  $V_1$ , namely canonical correlation shown as  $C_1$ . Here,  $C_1$  is the first canonical correlation and  $a$ 's and  $b$ 's

are called raw canonical coefficients. The word ‘raw’ is used since canonical variates are obtained from unstandardized data. Subsequent to determining  $C_1$ , the same procedure is applied in order to obtain second canonical correlation  $C_2$  in a manner that will maximize the correlation between new linear composites  $U_2$  and  $V_2$  created for  $X$  and  $Y$  sets of variables. It is noteworthy to say that the canonical variate sets  $(U_1, V_1)$  and  $(U_2, V_2)$  are required to be uncorrelated with each other. Following this procedure, the process is carried out until the correlation between  $m$ th canonical variates, namely  $C_m$  is maximized. The new composites can be shown as

$$U_m = a_{m1}X_1 + a_{m2}X_2 + \dots + a_{mp}X_p \quad (3)$$

$$V_m = b_{m1}Y_1 + b_{m2}Y_2 + \dots + b_{mq}Y_q \quad (4)$$

The underlying procedure of CCA is dependent upon the following constraints:

$$Cor(U_j, U_k) = 0 \text{ for all } j \neq k \quad (5)$$

$$Cor(V_j, V_k) = 0 \text{ for all } j \neq k \quad (6)$$

and this case is realized to be nothing more than a maximization problem (Sharma, 1996).

Canonical correlations can be calculated through both correlation and covariance matrices (Alpar 2011). In case the measurement units and variances of variables in data set differ, both variables are required to be standardized or CCA should be carried out by taking the correlation analysis as basis. Since, while there are dissimilarities between the results obtained according to the covariance matrix and the correlation matrix for data sets with different variances; data standardization eliminates the solution differences between the two methods (Çankaya, 2005).

Before interpretations of the canonical variates and correlations, the first step is to detect the statistical significance of the canonical correlations or in other saying to detect if there is any association between  $r$  pairs of canonical variates. There are different approaches being developed for significance of canonical correlations. The most popular technique is Wilks’s Lambda ( $\Lambda$ ) which is provided by Bartlett (1941). The value of Lambda varies from 0 to 1 and it is interpreted as the opposite of the squared multiple correlation,  $R^2$ ; this is because it represents the error variance, the variance not accounted for by the independent variables. Depending on this fact, the implication of ‘1’ value of  $\Lambda$  is that none of the variance in the dependent variable is explained by the independent variables and in case  $\Lambda = 0$ , the opposite case is valid such that all of the variance in the dependent variable is explained by the independent variables. Therefore, the value of one minus lambda corresponds to the  $R^2$  (Munro, 2005).

Standardized canonical coefficients indicate the amount of change in the canonical variable in terms of the standard deviation when a one standard deviation increase occurs in the original variable. To say differently, these coefficients show the amounts of influence of original variables in that set on the formation of the canonical variables. In the case that sample size is too small or there is the problem of multicollinearity between variables, it is recommended that correlation coefficients (also known as canonical loadings) between canonical variable and original variables that take place in that set should be used instead of standardized canonical coefficients (Sharma, 1996; Çankaya, 2005).

### 3. Findings

In this research, data associated with 8 components of “Basic Human Needs” and “Foundations of Wellbeing” dimensions of both 2015 and 2016 SPIs have been used with the aim of providing a dual comparison based on the years and have been obtained from the website of “Social Progress Imperative”. For the application, SPSS package program has been utilized. 8 components in the study have been grouped into two sets. First set (*Set 1*) contains the components of “Basic Human Needs” dimension which are “Nutrition and Basic Medical Care ( $X_1$ )”, “Water and Sanitation ( $X_2$ )”, “Shelter ( $X_3$ )” and “Personal Safety ( $X_4$ )”. On the other hand, second set (*Set 2*) contains the components of “Foundations of Wellbeing” dimension which are “Access to Basic Knowledge ( $Y_1$ )”, “Access to Information and Communications ( $Y_2$ )”, “Health and Wellness ( $Y_3$ )” and “Ecosystem Sustainability (or it is remained Environmental Quality for 2016) ( $Y_4$ )”. In this part, primarily CCA application results for 2015 SPI will be mentioned and subsequent to this, 2016 results will be given.

#### 3.1. CCA Results for 2015 SPI

In the study, since the number of variables in both *Set 1* ( $X_1, X_2, X_3, X_4; p = 4$ ) and *Set 2* ( $Y_1, Y_2, Y_3, Y_4; q = 4$ ) are the same, four canonical correlations have been calculated ( $\min(p, q) = 4$ ).

<b>Pairs of Canonical Variates</b>	$(U_1V_1)$	$(U_2V_2)$	$(U_3V_3)$	$(U_4V_4)$
<b>Canonical Correlation</b>	0,926	0,399	0,289	0,027

**Table 1:** Canonical Correlations.

In Table 1, canonical correlation coefficients that are obtained through CCA being applied with the aim of determining the relationships between “Basic Human Needs” and “Foundations of Wellbeing” variable sets have been presented. Accordingly, when the first canonical correlation coefficient (0,926) is examined, a high relationship has been found between basic human needs and foundations of wellbeing variable sets. As it is seen, canonical correlations between the canonical variables have been calculated in descending order from the largest to the smallest.

In Table 2, from  $X$  and  $Y$  variable sets, four different pairs of canonical variates and four different canonical correlation coefficients between these have been obtained. Since only statistically significant canonical correlations are necessary to be interpreted, the significance tests are of great importance.

Number	Pairs of Canonical Variates	Wilk's Lambda	Chi-Square	d.f.	Sig.
1	$U_1V_1$	0,110	281,970	16	0,000
2	$U_2V_2$	0,770	33,305	9	0,000
3	$U_3V_3$	0,916	11,233	4	0,024
4	$U_4V_4$	0,999	0,096	1	0,757

**Table 2:** Statistical Significance of Canonical Correlations.

Thus, when chi-square values associated with Wilk's Lambda statistic which specifies one of the significance tests related to canonical correlation coefficients are examined in Table 2, it has been concluded that the first (0,926), second (0,399) and third (0,289) canonical correlation coefficients which are calculated through the first four pairs of canonical variates are seen to be statistically significant. Since probability values that take place in the “significance” column are smaller than 0.05 for the first three canonical correlations and the result of the high relationship between ‘Basic Human Needs’ and ‘Foundations of Wellbeing’ is significant in 95% confidence interval has been revealed. On the other hand, as expressed in Sherry and Henson (2005), Wilk's Lambda has a very practical quality with respect to reflecting the amount of the variance that is not shared between the sets of variables. Hence, subtracting lambda value from 1 gives an overall effect of 0,89 ( $1 - 0,110$ ) for the full model. With the movement from this explanation, it can be said that an overall effect size of 0,89 is highly large for the full model in order to be counted as statistically significant.

Nevertheless, since the first canonical correlation coefficient (0,926) is higher with an obvious difference than the second (0,399) and third (0,289) coefficients; it is of great importance to take the first pair of canonical variates calculated in a way to have the highest canonical correlation between two variable sets into consideration. In this situation, revealing the structure of the relationship with the first pair of canonical variables and examining the coefficients of this relationship structure discovers the structure of the relationship between two variables set.

As the result of CCA, canonical loadings among canonical variables and original variables in their own set have been presented in Table 3. When canonical loadings are examined from Table 3; it is seen that the largest contribution to the  $U_1$  canonical variable (when absolute effects are considered) has come from “Nutrition and Basic Medical Care ( $X_1$ )” which has the highest canonical loading ( $-0,967$ ) and it is followed by “Water and Sanitation ( $X_2$ )” and “shelter ( $X_3$ )” variables which have equal canonical loadings( $-0,966$ ).

	<i>Set 1</i>					<i>Set 2</i>			
	$X_1$	$X_2$	$X_3$	$X_4$		$Y_1$	$Y_2$	$Y_3$	$Y_4$
$U_1$	-0,967	-0,966	-0,966	-0,675	$V_1$	-0,969	-0,895	-0,147	-0,197
$U_2$	0,185	0,097	-0,237	-0,336	$V_2$	0,142	-0,241	-0,918	-0,497
$U_3$	-0,007	-0,005	-0,103	0,657	$V_3$	-0,134	0,352	-0,362	0,473
$U_4$	0,176	-0,241	-0,004	0,021	$V_4$	0,149	-0,128	-0,062	0,701

**Table 3:** Canonical Loadings for “Basic Human Needs” and “Foundations of Wellbeing”.

For the  $V_1$  canonical variable, the largest contribution ( $-0,969$ ) has been provided by “Access to Basic Knowledge ( $Y_1$ )” and this is followed by “Access to Information and Communications ( $Y_2$ )” ( $-0,895$ ). In that case, when canonical loadings that belong to canonical variables are examined, it can be said that a relationship in the same direction is available between “Basic Human Needs” and “Foundations of Wellbeing” sets of variables. For the sake of saving space, results regarding standardized canonical coefficients have not been shared here. However, it should be known that these results have shown consistency with the results for canonical loadings.

### 3.2. CCA Results for 2016 SPI

In accordance with 2015 study, all variables have been remained constant. The only difference here shows itself in the studied year, 2016. Therefore, once again four canonical correlations have been obtained.

Pairs of Canonical Variates	$(U_1V_1)$	$(U_2V_2)$	$(U_3V_3)$	$(U_4V_4)$
Canonical Correlation	0,935	0,364	0,199	0,045

**Table 4:** Canonical Correlations

When the first canonical correlation coefficient (0,935) obtained for 2016 year is examined, it has been found to be greater than the first canonical correlation coefficient (0,926) obtained for 2015. As consistent with previous results, it can be inferred from here that again there is a high relationship between “Basic Human Needs” and “Foundations of Wellbeing” variable sets.

When chi-square values associated with Wilk’s Lambda statistic which specifies one of the significance tests related to canonical correlation coefficients are examined in Table 5, it has been concluded that only the first (0,935) and the second (0,364) canonical correlation coefficients which are calculated through the first four pairs of canonical variables have been found to be statistically significant (since probability values are smaller than 0,05 level).

Number	Pairs of Canonical Variates	Wilk’s Lambda	Chi-Square	d.f.	Sig.
1	$U_1V_1$	0,104	288,271	16	0,000
2	$U_2V_2$	0,832	23,496	9	0,005
3	$U_3V_3$	0,959	5,396	4	0,249
4	$U_4V_4$	0,998	0,262	1	0,608

**Table 5:** Statistical Significance of Canonical Correlations.

As expressed before, because Wilk’s Lambda statistic reflects the proportion of the variance not shared between the variable sets; subtracting lambda value from 1 gives an overall effect of 0,896 ( $1 - 0,104$ ) for the full model which is greater than 0,89 value obtained for the 2015 year. Thus, it can be said that an overall effect size of 0,896 is highly large for the full

model in order to be counted as statistically significant (or in other saying, the high relationship between “Basic Human Needs” and “Foundations of Wellbeing” is significant for 95% confidence interval).

	<i>Set 1</i>				<i>Set 2</i>				
	$X_1$	$X_2$	$X_3$	$X_4$	$Y_1$	$Y_2$	$Y_3$	$Y_4$	
$U_1$	-0,981	-0,944	-0,920	-0,641	$V_1$	-0,957	-0,883	-0,342	-0,674
$U_2$	-0,168	0,132	0,141	0,650	$V_2$	-0,020	0,359	0,065	0,644
$U_3$	0,079	-0,302	-0,176	0,408	$V_3$	-0,290	0,268	0,481	-0,040
$U_4$	0,056	0,032	-0,320	0,018	$V_4$	-0,010	0,139	-0,805	-0,360

**Table 6:** Canonical Loadings for “Basic Human Needs” and “Foundations of Wellbeing”.

When canonical loadings are examined from Table 6; it is seen that the largest contribution to the  $U_1$  canonical variable (when absolute effects are considered) has come from “Nutrition and Basic Medical Care ( $X_1$ )” which has the highest canonical loading (-0,981) and it is followed by “Water and Sanitation ( $X_2$ )” which has the second highest canonical loading (-0,944). For the  $V_1$  canonical variable, the largest contribution (-0,957) has been provided by “Access to Basic Knowledge ( $Y_1$ )” and this is followed by “Access to Information and Communications ( $Y_1$ )” (-0,883). In that case, when canonical loadings that belong to canonical variables are examined, it can be said that a relationship in the same direction is available between “Basic Human Needs” and “Foundations of Wellbeing” sets of variable s. All these results are consistent with the 2015 results.

#### 4. Discussion

In this study, with the aim of determining the relations among “Basic Human Needs” and “Foundations of Wellbeing” sets for 130 countries, discussions on the comparison of CCA for 2015 and 2016 years have been presented. In the interpretation of results of the analysis, the first pair of canonical variates pointing to the highest canonical correlation has been taken into account. When the first canonical correlation coefficient (0,935) obtained for 2016 year is examined, it has been found to be greater than the first canonical correlation coefficient (0,926) obtained for 2015. It can be inferred from these results that there is a high relationship between “Basic Human Needs” and “Foundations of Wellbeing” variable sets. According to the Wilk’s Lambda statistics, an overall effect of 0,896 for the full model of 2016 year has been detected

to be greater than 0,89 value obtained for the 2015 year. The high relationship between “Basic Human Needs” and “Foundations of Wellbeing” has been found to be significant for 95% confidence interval.

According to the standardized canonical coefficients, the largest contribution to “Basic Human Needs” set of variables has come from “Nutrition and Basic Medical Care” variable. The contribution in 2016 is more than the contribution in 2015. The most effective variable in “Foundations of Wellbeing” set of variables has been revealed to be “Access to Basic Knowledge”. The signs of all coefficients obtained for variables of X and Y sets in equations associated with the first pair of canonical variates ( $U_1$  and  $V_1$ ) are the same as 2015 results as expected. However, in equations associated with the second pair of canonical variates; the signs of coefficients for 2016 have differed greatly than they are for 2015.

When canonical loadings are examined; it is seen that the largest contribution to  $U_1$  has come from “Nutrition and Basic Medical Care” and it is followed by “Water and Sanitation”. For the  $V_1$  canonical variable, the largest contribution has been provided by “Access to Basic Knowledge” and this is followed by “Access to Information and Communications”. A relationship in the same direction is available between “Basic Human Needs” and “Foundations of Wellbeing” sets of variables.

When canonical cross loadings are examined, the largest contribution to the canonical variable  $U_1$  has come from “Access to Basic Knowledge” and it is followed by “Access to Information and Communications”. For 2016 year, the largest contribution to the canonical variable  $V_1$  has been provided by “Nutrition and Basic Medical Care” and for 2015 year, the largest contribution had been shared commonly by “Nutrition and Basic Medical Care” and “Shelter” variables which have the same canonical loadings. When looked at the second pair of canonical variates ( $U_2$  and  $V_2$ ); the largest contributions have been provided by “Environmental Quality” and “Personal Safety” variables, respectively. These results are also different from 2015 as follows: In 2015, the largest contribution to  $U_2$  has come from “Health and Wellness”.

The values of structure coefficients of function 1 imply that primary contributors for “Basic Human Needs” set are “Nutrition and Basic Medical Care”, “Water and Sanitation” and “Shelter” with a secondary contribution by “Personal Safety”. For “Foundations of Wellbeing” set, primary contributors are “Access to Basic knowledge” and “Access to Information and Communications” with a secondary contribution by “Environmental Quality” which does not appear as greater than 0.45 for 2015 results. For 2016 year, it can be reached to the results of “Personal Safety” may not have been strongly related to “Foundations of Wellbeing” set and “Health and Wellness” has been observed not to be associated with “Basic Human Needs”.



Briefly, these variables can be said not to be useful in the model according to the communalities. All of the other variables in the model which are “Nutrition and Basic Medical Care”, “Water and Sanitation”, “Shelter”, “Access to Basic knowledge”, “Access to Information and Communications” and “Environmental Quality” (“Ecosystem Sustainability” does not take place as a useful variable in 2015 results) can be concluded to be useful in the model. On the other hand, according to the redundancy index results, although the second function is statistically significant; it has a little practical significance. Since it does not account for a large proportion of the variance of the variables in the other set. The second function has a substantially lower canonical R- squared and both variable sets have low shared variance in the second function. To summarize, 2016 results are in general consistent with 2015 results.

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