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Impact of Governance on Human Development

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Abstract

The governance has become a key issue over preceding two decades and it is very important component for good economic growth and human development. If countries want batter growth and human development then good reforms of governance is needed. The main objective of this study is to determine those significant governance indicators that effect the human development. Human development index (HDI) of different countries is taken as dependent variable and six indicators developed by Kaufmann, et al. (1999) to measure the governance named; Political Stability (PS), Voice and Accountability (VA), Regulatory Quality (RQ), Government Effectiveness (GE), Rule of Law (RL) and Control of Corruption (CC) are used as independent variables. Multi-Layer Perceptron (MLP) and Multiple Regression (Stepwise) are used to fulfill the objective. Further predictive ability of the Multiple Regression and MLP is compared. Evidence is provided that Government Effectiveness, Political Stability, Control of Corruption, and Regulatory Quality have significant effect on human development. Further MLP is suggested the most reliable prediction model to predict the HDI.

Key words: governance, governance indicators, human development, multiple regression and multilayer perceptron

1. Introduction

If economies want to increase the wellbeing of its people than countries has to improve its economic growth and human development. Governance is a primary element for prosperous development in any country, in particular good governance. That is for attaining the better economic growth and human development, in any economy, existence of good governance is crucial, especially in developing nations (Turner, 2011). Generally governance has an important role in the area for example infrastructure, economic stability, education, legal system, health, environment protection, creation of a good business environment and many more. All these mentioned areas are the basic requirement for a developed country (Landell-Mills and Seragedin, 1991; Brautigam, 1991; and Boeninger, 1992). The governance have significant effect on sustain the economic growth, development as well as human welfare, in a very long run. Many authors examined this massive effect such as Kaufmann and Kraay (2002), Pradhan and Sanyal (2011), Sebudubudu (2010) and Turner (2011).

Governance is quite an old concept. But in the recent development literature researchers are being increasingly used this term, particularly good governance. Generally the term governance cover all those aspects of the way a country are governed (Sharma, 2007). Governance term is variously defined by different authors and organization. Some definitions of governance are given below.

UNDP (2002) describes the term governance as the "implementation of economic, political and administrative authority to direct the affairs of a country at all levels. It encompasses the mechanisms, procedures and establishments through which citizens and groups express their interests' exercise their legal rights met their obligations and mediate their differences".

The World Bank economist Kaufmann, et al. (1999, 2002, 2009 and 2010) describes the term governance as "The traditions and institutions by which authority in a country is exercised". This definition further includes three perspectives 1) the procedure, by which governments are elected, monitored and replaced. 2) The ability of the government to efficiently formulate and exercised sound policies. 3) The respect of citizens and the state for the institutions that govern economic and social interactions between them. In sum, governance is a multidimensional concept which consists of political, economic and socio-cultural variables.

1.1. Good Governance

After the first introduction of the term good governance in 1989 by the World Bank, has become gradually more admired and preferred by the donors. Now it is taken as a crucial aspect of countries to promoting the economic growth and reducing the poverty by creating the encouraging environment for investors, providing incentives to producers, establishing certainty in markets and enhancing the competitiveness (Haq and Zia, 2009). The donors and international financial associations are now considering the good governance for the development assistance to less develop and developing countries (see Santiso, 2001). It is also assumed that lacking good governance the benefits of the improvements will not reach to the needy people and the funds will not be used in effective way (Sharma, 2007). In addition, foreign investors are also concentrating on the good governance for their decisions regarding investments (Fayissa and Nsiah, 2010).

Currently many studies are conducted that represent the strong correlation between the good governance and economic performance having long term benefit. The authors Ojima and Iimi (2005) and Sharma (2007) also conclude in their studies that good governance is important to development as well as a leading factor in determining whether a country has an ability to use resources efficiently to support economic growth and decrease poverty.

As good governance is a wide concept it has been define differently by different organizations and others. Some definitions consider four dimensions of governance others six, yet others eight. Good governance has been defined as consisting of all or some combination of the following dimensions that are considered by Abdellatif (2003) and others: Participatory/Voice, Transparent, Consensus Oriented, Responsive, Accountable, Effective and Efficient, Regulatory Quality, Equitable and Inclusive, Political Stability and Rules of Law/Predictability. But in this study six governance indicators developed by Kaufmann, et al. (1999) are considered. The description of these indicators is defined below.

1.2. Description of Governance Indicators

For the purposes of this study we are considering that definition of governance which is defined by the Kaufmann, et al. (1999, 2002, 2009 and 2010). The Kaufmann, et al. (1999, 2002, 2009 and 2010) defines some dimension of governance as follow.

- Voice and Accountability
- Political Stability
- Government Effectiveness
- Regular Quality
- Rule of Law
- Control of Corruption

These indicators are used to measure the six dimensions of governance that are listed above. These dimensions can also be called the quality of governance. They cover more than 200 countries of the world. These six dimensions and indicators of governance are defined as follow by Kaufmann, et al. (1999, 2002, 2009 and 2010) and Haq and Zia (2009).

1.2.1 Voice and Accountability (VA)

Measure the extent to which a country's citizens are able to participate in electing their government, as well as freedom of expression and association, and free media. It contains number of indicators measuring different features of civil liberties, political process and political rights.

1.2.2 Political Stability (PS)

This indicator measures the perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism.

1.2.3 Government Effectiveness (GE)

Measure the quality of the civil services, the quality of public services, the quality of policy formulation, implementation, the degree of its independence from political pressures and the credibility of the government's commitment to such policies.

1.2.4 Regulatory Quality (RQ)

Measures the capacity of the government to formulate and execute sound policies and regulations that permit and promote private sector development.

1.2.5 Rule of Law (RL)

Measure the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.

1.2.6 Control of Corruption (CC)

Measure the extent to which public power is exercised for private gain, including both petty and grand forms of corruption.

The six indicators of governance are further divided into three parts that is first two indicators “Voice and Accountability” and “Political stability” used to measure the first

perspective of definition that is the procedure, through which governments are elected, monitored and replaced. Subsequently "Government Effectiveness" and "Regulatory Quality" are used to measure the second perspective of the definition which is the ability of the government to efficiently formulate and exercised sound policies. Last two indicators "Rule of Law" and "Control of Corruption" measures the last perspective of the definition namely the respect of citizens and the condition for the institutions that administrate economic and social interactions between them. The indicators follow the standard normal distribution with mean zero and variance one. Value of these indicators for mostly countries is lie in between -2.5 to 2.5. Large positive value of any indicator represents good conditions of that indicator in the country and vice versa.

1.3 Objectives of Study

In this study our basic purpose is to determine significant governance indicators that effect the human development, and to predict the value of HDI on the bases of these governance indicators. Further predictive ability of the Multiple Regression and MLP model is compared.

2. Literature Review

This section contains the researcher from the past that are carried out by different people in the world that examine the effect of governance in different years.

Brautigam (1991) concluded that if governments are assumed to be unbiased and devoted to serving their people, then through policy reforms divergences from optimum economic performance can generally be corrected. Governments can play an important role politically to understand the economic performance. Further it is stated that to creating and continuing the formal and informal structure of the institutions, governments uses their power and authority, which adjust social and economic relations.

Kaufmann, et al. (1999b) represented some new governance indicators that are based on a variety of existing sources. These six aggregated governance indicators are capturing the six basic concepts of governance. PPP-adjusted per capita GDP, infant mortality and adult literacy are taken as development indicators. By utilizing regression it clarify that there is large and highly significant positive effects of governance on GDP. There is negative effect of good governance on the infant mortality and it also leads to a significant increase in the adult literacy. In the end it is concluded that governance matters for better development outcomes.

Kaufmann and Aart (2002) suggested that there exist a strong positive correlation among per capita income and the quality of governance across countries. An empirical study is proposed which allow two separate part of this correlation. In the first part, there is running a strong positive effect from better governance to higher per capita. The existing evidence on income also supports the result, which is good governance is importance for economic development. The second part of the relation is inverse of the first one that is opposite direction from per capita income to governance but it is a weak even negative casual effect.

Punyartabandhu (2007) examined the attitude of citizens towards the control of corruption and their trust in government, the relationship between the trust and corruption is also explored. A sample of 3600 respondents is taken. The empirical findings identify that approximately three out of four quarters of the respondents said that petty and routine

corruption was acceptable. There is positive but weak relationship exists between the trust and control of corruption. Further it is signify that higher educated and urban citizens did not accept petty and routine corruption and they are less likely to trust public officials, than persons with less education living in the rural areas.

Uddin and Joya (2007) concentrated on whether good governance matters in development. It is mentioned that it is without enhancing the good governance it is not easy to attain rapid per capita income or improve the social indicators. Further it is concluded that strong accountable and effective political institutions are needed and a strong and lone term commitment is required by aid agencies to provide funds and expertise to support governance reform project.

Haq and Zia (2009) conducted a study to examine the relation between the pro-poor economic growth and governance in Pakistan for 1996 to 2005 period. The six governance indicators formulated by Kaufmann is taken. Poverty and income inequality is taken as dimensions of the pro-poor governance. Empirical evidence is provided that good governance in Pakistan can lead to the decline in poverty and income inequality. Further it is suggested that Pakistan needs to implement sound and effective governance polices to achieve higher growth and millennium developmental goals.

Charron, et al. (2010) maps out the variation in the quality of governance, for 27 European countries, for the national and regional level. The dimension of quality of governance is defined by the low levels of corruption; government effectiveness and accountability, protection of rule of law. Strong relation is signifying between the quality of governance index and important socio-economic variables such as internet availability, GDP per capita, long-term unemployment or infant mortality rates. On the whole there is significant variation between countries quality of governance and between regions within these countries. A joint and targeted effort, with lower levels, to improve quality of governance in those regions, could significantly improve the economic prospects of these regions and the lives of their residents.

Pradhan and Sanyal (2011) investigated the effect of governance on the human development. By utilizing the secondary data it represents that which states are best performing states and which are low performing states on the basis of Human development index (HDI). On the basis of empirical facts it is uncover that good governance is the latent factor by which any contrary can achieve high economic growth and human development. Their study also proposes that country can put its development process in the upper ranking of growth and human development with better institutional mechanism and good governance.

3. Data Source and Analysis Techniques

This section includes the source from where data is obtained. Description of techniques for the purpose of analysis is also given.

The data on governance indicators is taken from the World Bank's project of Worldwide Governance Indicators (WGI), under this project Kaufmann, et al. (1999) develop the six indicators to measure the governance. Data on Human Development Index (HDI), for 168 countries, is taken from United Nation Development Program (UNDP). Human development is measured by the HDI as it is indicated by other authors (Pradhan and Sanyal (2011)), so HDI is taken as a dependent variable. Moreover Multiple Regression Analysis (Stepwise estimation) and MLP, a neural network model, is utilized to fulfill the

objectives. Performances indices, Coefficient of Correlation between the measured and predicted values, Values Account For (VAF), Root Mean Square Error (RMSE) and Mean Absolute Percentage Error (MAPE), are used to compare the Multiple Regression and Multilayer Perceptron model that is obtained from Kaynar and Yilmaz (2011). Description of these analysis techniques are given below.

3.1 Multiple Regression Analysis (Stepwise Estimation)

Multiple regression analysis is a statistical technique that is used to predict the value of the single dependent variable on the bases of the known values of the several independent variables. To ensure the maximum prediction from the set of independent variables the regression analysis procedure provides weights to each independent variable. In prediction the relative contribution of each independent variable is determine by these weights. The set of weighted independent variables forms the regression variate, a linear combination of the independent variables that best predicts the dependent variable, most widely known as the regression equation or regression model. The regression variate has the form

$$y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ,..., + \beta_k x_k ,$$

Where y_i represents the dependent variable β_0 is the regression Constant mostly known as intercept $\beta's$ are the weights of the each independent variable mostly known as slop and k is the number of independent variables.

3.2 Neural Network

From the last some year neural network models are used extensively over the variety of problems. For example the areas like geology, finance, physics, medicine, and engineering. The neural network models are used efficiently where there are problems related to prediction/estimation, classification, etc.

3.2.1 Multilayer Perceptron (MLP)

Multilayer Perceptron is one of the most well-known types of neural network that are frequently used now a day. It is the supervised, feed-forward learning network and it is a function of one or more predictors (also called inputs or independent variables) that minimizes the prediction error of one or more target variables (also called dependent variables or outputs). Predictors and targets can be a mix of categorical and scale variables.

3.2.1.1 Architecture of Multilayer Perceptron (MLP)

As many other NN models MLP is also arranged in layers where these layers are consists of nodes. These nodes are the processing elements of the network. Information flows through each element in an input-output manner. In other words, each node in a given layer receives an input signal, operates it and forwards an output signal to the other connected elements in the adjacent layer. An illustration of MLP network is given in figure 1 below.

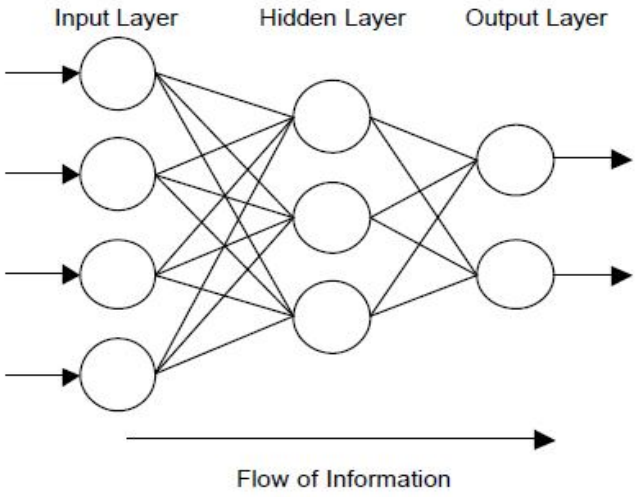

Figure 1: Multilayer Perceptron Feed Forward Network

MLP networks generally have three layers of processing elements. Different functions of these layers are given below.

Input layer: The function of input layer is to receive the raw information from the external stimuli and forward it to the next layer that is hidden layer.

Hidden layer: This layer receive weighted sum of the inputs $\sum_{i=1}^{n} x_i w_i$ sent by the previous layer. The weighted sum is fed to an activation function which outputs a value. The outputs from the hidden layer are distributed to the next layer. the next layer can be another hidden layer or output layer.

Output layer: Function of the output layer is same as the hidden layer. This layer also receives the weighted sum of inputs from the hidden layer and utilizes an activation function to produce a value from the network.

Activation Function: The purpose of an activation function is to links the weighted sums of units in a layer to the values of units in the succeeding layer. Activation functions can be of different types.

Identity function: This function has the form $f(x) = x$. It takes real-valued arguments and returns them unchanged.

Sigmoid function: This function has the form $f(x) = 1/\left(1+e^{-x}\right)$. It takes real-valued arguments and transforms them to the range (0, 1).

Hyperbolic function: This function has the form $f(x) = \left(e^{x} - e^{-x}\right)/\left(e^{x} + e^{-x}\right)$. It takes real-valued arguments and transforms them to the range (–1, 1).

Softmax function: This function has the form $\gamma\left(x_k\right) = e^{x_k} \Big/ \sum_j e^{x_j}$. It takes real-valued arguments and transforms them to the range (0, 1).

Further which type of activation function is used for output layer is depend on which type of dependent variable is being predicted by the MLP model.

3.3 Measures to Compare the Multiple Regression and Multilayer Perceptron:

Some measures are defined to compare both models (Multiple Regression and MLP). To determine the prediction performance of the model, correlation of observed and predicted values is a good indicator. Root Mean Square Error (RMSE) and Values Account For (VAF) indices are also calculated for the determination of prediction capacity of predictive model. Another measure, Mean Absolute Percentage Error (MAPE) which is a measure of accuracy in a fitted series value in statistics was also used for comparison of the prediction performances of the models. MAPE usually expresses accuracy as a percentage. These are given below in table.

Table 1: Performance Indices:

Measure	Formula
Value Account For (VAF)	$VAF = \left[1 - \text{var}\left(y - y'\right) / \text{var}\left(y\right)\right] \times 100$
Root Mean Square Error (RMSE)	$RMSE = \sqrt{\sum_{i=1}^{N} \left(y - y'\right)^2 / N}$
Mean Absolute Percentage Error (MAPE)	$MAPE = \left(1/N\right) \sum_{i=1}^{N} \left\lvert \left(y - y'\right) / y \right\rvert \times 100$

Where *y* and *y'* are the observed and predicted values, respectively. If the VAF is 100 and RMSE is 0, then the model will be excellent. That model will be considered a good predictive model which has large value of VAF and Correlation Coefficient and small value of RMSE and MAPE.

4. Results and Discussion

This section contains discussion on the results that is obtained from the data analysis and results are given in the appendixes.

4.1 Multiple Regression Analysis (Stepwise Estimation):

The multiple regressions analysis is performed to extract those indicators that are significantly affect the Human Development Index (HDI). A stepwise estimation approach is used so that the equation that best predict the value of the HDI can be determined.

Final results are shown in Table 2. This table shows that a total of three variables (government effectiveness, control of corruption and political stability) are involve in the equation to predict the value of the HDI. Results representing that, from Adjusted R square, a total of 66.9% approximately 70% variation is explained by the model. The Analysis of Variance Shows that regression sum of square is much greater than the residual sum of square which is an indication of a good portion of variation in HDI is explained by the model. Over all, model appears to be significant as p-value (0.000) is very close to zero. As the variable in the equation shows that all previous indicators with a new one control of corruption represents a significant effect. As all indicators have the p-value less then alpha 0.05. From the variables not in the equation further no variable is capable for the inclusion in the model, because no measure provides the evidence in their fervor. So the final model to predict the value of the HDI on the bases of significant variables is

HDI = 0.637 + 0.211(GE) - 0.085(CC) + 0.032(PS)

Further the assumption of this regression model is also checked. To check the assumption of this regression model diagnostics tests are performed. The p-value of Shapiro-Wilk test of normality is greater than alpha (0.05) which is strong indication that data is normal. Further Durbin-Watson test of autocorrelation and Collinearity Diagnostics are also provided in Table 2. Values of these diagnostics are seems to be reasonable and indicating that there is no autocorrelation and multicollinearity.

Table 2: Regression Analysis

Overall Model Fit (Model Summary and Analysis of Variance)					
R	R Square	Adjusted R Square	Std. Error of the estimate	Durbin-Watson	
0.821	0.675	0.669	0.107438	2.092	
ANOVA					
	Sum of Squares	d.f	Mean Square	F	p-value
Regression	3.930	3	1.310	113.407	0.000
Residual	1.895	164	0.012		
Total	5.825	167			

Variables in the Equation Step-3					
		Constant	GE	CC	PS
Unstandardized Coefficient	Beta	0.637	0.211	-0.085	0.032
	Std. Error	0.008	0.026	0.026	0.013
Standardized Coefficient	Beta		1.137	-0.473	0.162
t value		75.539	8.072	-3.295	2.465
p-value		0.000	0.000	0.001	0.015
95% Confidence Interval	Lower Bound	0.621	0.159	-0.137	0.006
	Upper Bound	0.654	0.263	-0.034	0.057
Correlations	Zero-order		0.804	0.723	0.632
	Partial		0.533	-0.249	0.189
	Part		0.359	-0.147	0.110
Collinearity Statistics	Tolerance		0.100	0.096	0.462
	VIF		9.999	10.383	2.166

Variables not in the Equation				
		VA	RQ	RL
Beta ln		-0.008	-0.011	0.293
T		-0.104	-0.085	1.457
p-value		0.917	0.932	0.147
Partial Correlation		-0.008	-0.007	0.113
Collinearity Statistics	**Tolerance**	0.373	0.120	0.049
	VIF	2.681	8.348	20.478

VA = Voice and Accountability PS = Political Stability GE = Government Effectiveness

RQ = Regulatory Quality RL = Rule of Law CC = Control of Corruption

The results of regression analysis depicts that government effectiveness and political stability have significant positive effect on human development whereas control of corruption have negative effect.

4.2 Multilayer Perceptron Network:

MLP is applied to predict the value of the HDI for any given country. Total number of cases available is 168 out of which 113 cases are used for training sample and 55 cases are for testing sample. The graphical presentation of Multilayer Perceptron Network Model is shown in Figure 2.

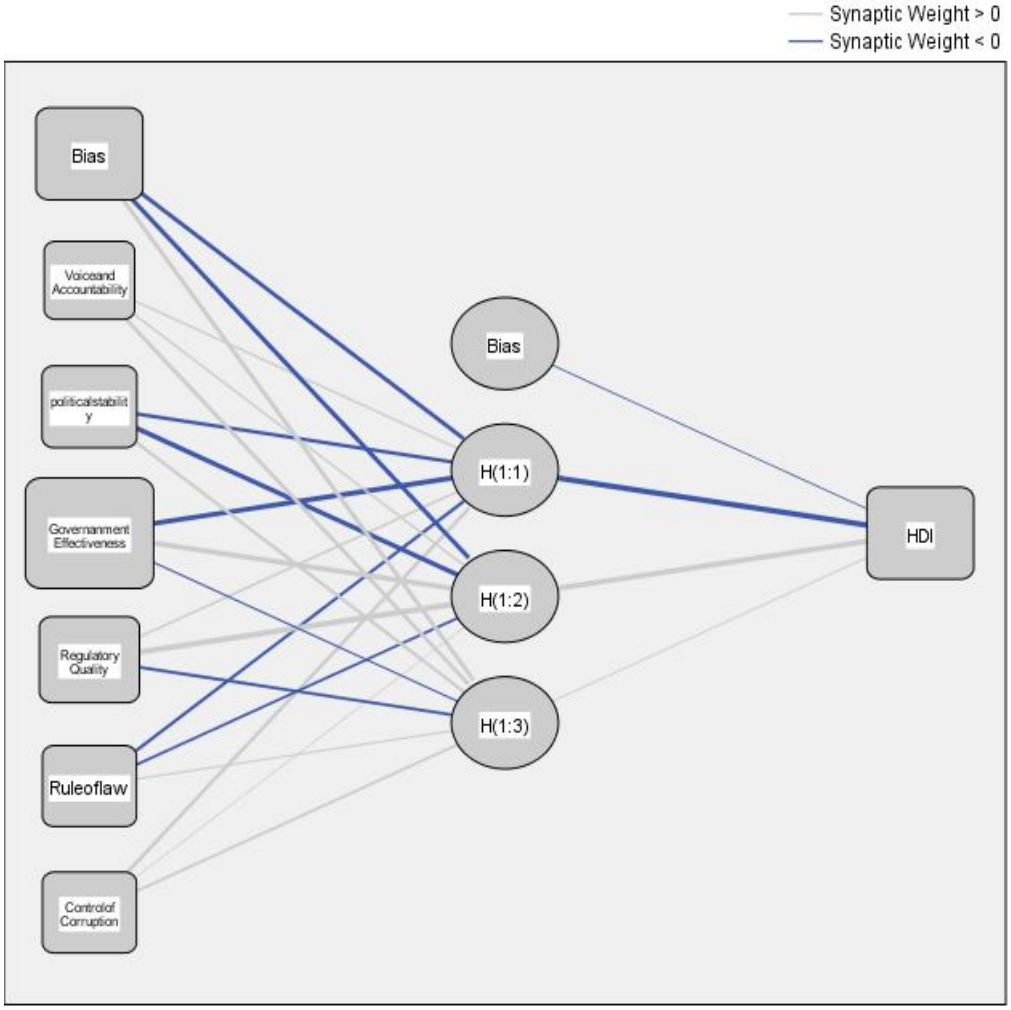

Figure 2: Multilayer Perceptron Architecture

Model Summary is shown in Table 3. The error function sum of squared has been used and its value of the training sample is 18.723 and for testing sample is 8.333. This value is greater than the value of residual sum of square in regression. The overall average relative error (relative to the mean model) is 0.334 for the training sample and 0.273 for the testing sample.

Table 3: Model Summary

Training	Sum of Squares Error	18.723
	Relative Error	.334
Testing	Sum of Squares Error	8.333
	Relative Error	.273

From the figure we can see that HDI have the negative relation with second node of hidden layer, because this second node is also getting more negative weights from the input layer. The weights that are assigned to these connections are given in Table 4.

Table 4: Parameter Estimates

Predictor		**Predicted**			
		Hidden Layer 1			**Output**
		H(1:1)	**H(1:2)**	**H(1:3)**	**HDI**
Input Layer	(Bias)	-.416	-.547	.436	
	Voice and	.239	.253	.368	
	Political stability	-.330	-.568	.320	
	Government	-.687	.755	-.147	
	Regulatory Quality	.261	.849	-.298	
	Rule of law	-.303	-.263	.220	
	Control of Corruption	.349	.069	.280	
Hidden Layer	(Bias)				-.087
	H(1:1)				-.828
	H(1:2)				.827
	H(1:3)				.134

From the predicted by observed scatter plot (Figure 3), it is signify that predicted value of the HDI have an increasing trend as the observed value of the HDI is increasing. Residual by predicted scatter plot (Figure 4) shows that at starting more variation is exist in the data, and moving forward less variation exist, showing some departure from homoscedasticity.

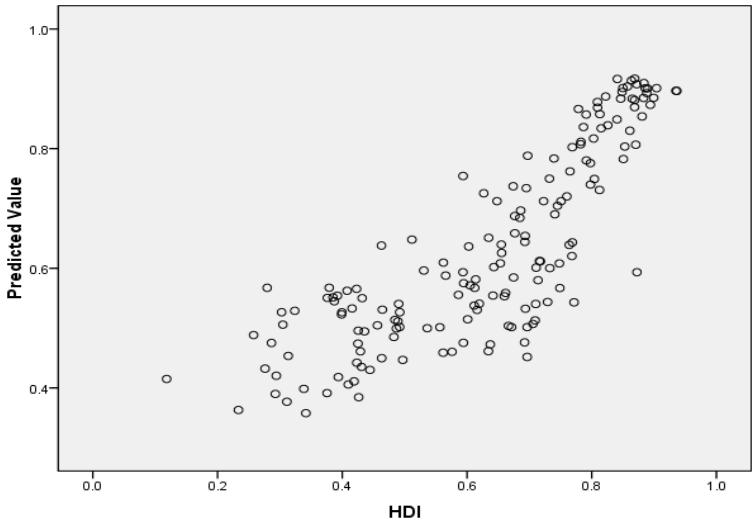

Figure 3: Predicted by Observed Chart

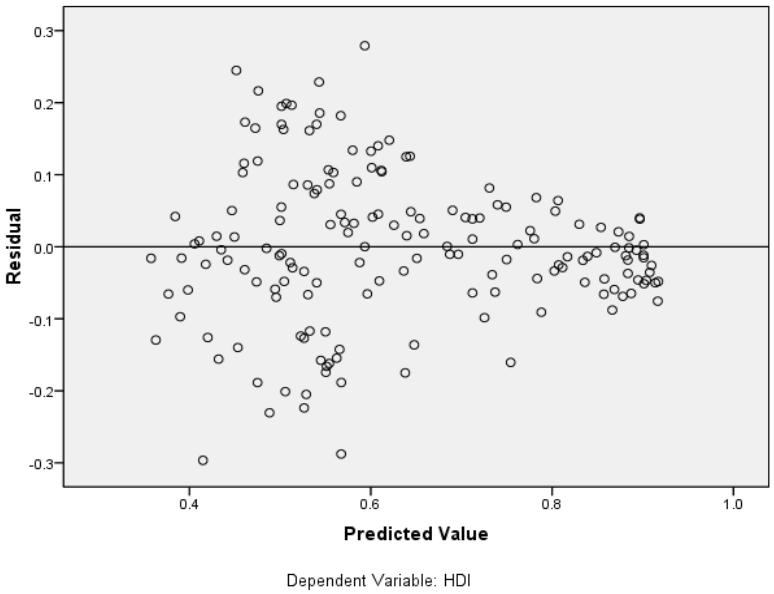

Figure 4: Residual by Predicted value Plot

The Table 5 can be used to reveal the importance of the independent variables. It can be visualized from and Figure 5. The variable government effectiveness is more contributive to the network model because it has the highest value of importance that is 0.483. Normalized importance is also given to show the importance of the independent variables. Consequently after the government effectiveness the next important independent variables are regulatory quality, political stability, rule of law, control of

corruption and voice and accountability. This same order can be seen in the Figure 5 of normalized importance.

Table 5: Independent Variable Importance

Variables	Importance	Normalized Importance
Voice and Accountability	.056	11.6%
political stability	.106	22.0%
Government Effectiveness	.483	100.0%
Regulatory Quality	.162	33.6%
Rule of law	.097	20.1%
Control of Corruption	.095	19.5%

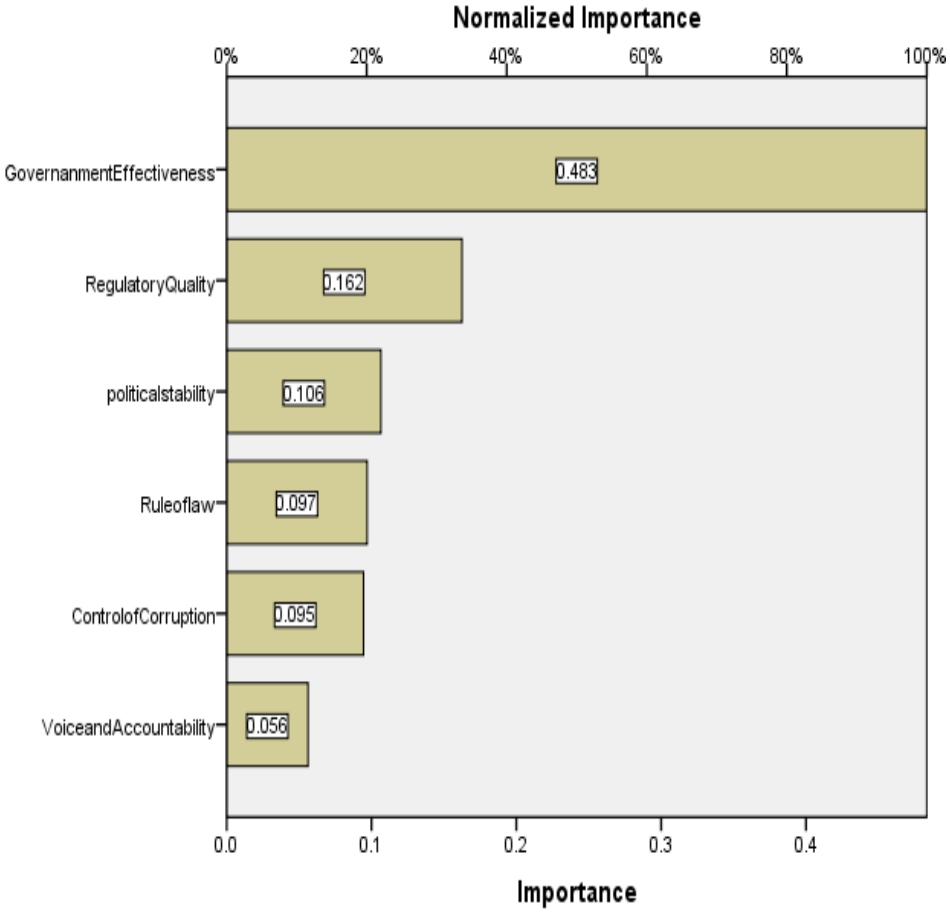

Figure 5: Variable Importance Chart

To compare the predictive accuracy of the both models, the performance indices are also given in Table 6. The value of the VAF is same for both models (68.57). The results of RMSE and MAPE are also small for MLP than regression analysis that is 0.106 and 16.93 for regression and 0.105 and 16.7 for MLP. Further the R Square has batter value for the MLP model (0.828) as compare to the regression model (0.821). So these performance indices provide evidence that MLP models are better to predict the value of HDI as compare to the traditional statistical methods.

Table 6: Performance Indices

Model	VAF	RMSE	MAPE	R Square
Regression	68.57	0.106	16.93	0.821
MLP	68.57	0.105	16.7	0.828

From Neural Network results, again government effectiveness greater role in the prediction of HDI. This result is parallel with the multiple regressions. Further MLP is identifying as the best predicted model for HDI.

The manual calculation and further detail of MLP model to estimate the HDI is also given in the Appendix C. The purpose of this manual calculation is that by using this model one can predict the value of HDI when governance indicators for recent year are available.

4.2 Final Remarks

The objective of this study was to identify the important governance indicators that affect the human development. Consequently, Government Effectiveness, Political Stability, Control of Corruption and Regulatory Quality has significant effect on human development, more over performance indices shows that MLP network is better for prediction of HDI as compare to Multiple Regression Analysis. Thus it is noted that Government Effectiveness, Control of Corruption, Political Stability and Regulatory Quality are playing a vital role in human development. The country that will focus on these governance indicators will improve human development. Thus governments should concentrate on these indicators for to improve the well beings of its people.

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APPENDIX

Prediction or Estimation using MLP Model

To estimate or predict the value form the MLP model, original values of the independent variables and weights estimated by the model is required. As the current model have three layers; input layer, hidden layer and output layer. So in first step hidden layer receives the weighted sum of incoming signals (information from independent variables) sent by the input layer and processes on it in the hidden layer by means of an activation function. In the existing model hyperbolic tangent activation function is used for hidden layer. The form of hyperbolic tangent activation is $f(x) = \frac{e^{x} - e^{-x}}{e^{x} + e^{-x}}$. The hidden layer in turn sends an output signal towards the neurons in the next layer that is an output layer.

So processing on the weighted information received by the output layer is done on the same way as in hidden layer that is by applying an activation function on it. In this model output layer utilize an identity activation function because HDI is a scale dependent variable. In the end model provide a rescaled value depends upon which type of rescaling method is utilized for the scale variables. In existing architecture of the MLP standardized method is employed to rescale the variables. Detailed manual calculation for each layer is given below.

Estimation of HDI for Pakistan by Using MLP Model

As to obtain the value from the model, information on independent variables and weights are required. The table given below is providing the information on Governance score of the Pakistan for each indicator and weights are given in table B-1.

Indicators	Pakistan's Score of Governance
Voice and Accountability	-1.00
Political Stability	-2.76
Government Effectiveness	-0.93
Regulatory Quality	-0.50
Rule of Law	-0.93
Control of Corruption	-1.10

Calculations for input to output layer

$$y_j = bias + \sum_{i=1}^{n} w_{ij} x_i \qquad \text{for} \qquad i = 1, 2, \ldots, n,$$

where n is the number of input variables w_{ij} denotes the weights for *ith* variable and x_i is the *ith* variable

$$y_1 = bias + w_{11}x_1 + w_{21}x_2 + w_{31}x_3 + w_{41}x_4 + w_{51}x_5 + w_{61}x_6$$

= - 0.416 + (0.239)(-1.00) + (-0.33)(-2.76) + (-0.687)(-0.93) + (0.261)(-0.50) + (-0.303)(-0.93) + (0.349)(-1.10)
= 0.664

$$y_2 = bias + w_{12}x_1 + w_{22}x_2 + w_{32}x_3 + w_{42}x_4 + w_{52}x_5 + w_{62}x_6$$

= - 0.547 + (0.253)(-1.00) + (-0.568)(-2.76) + (0.755)(-0.93) + (0.849)(-0.50) + (-0.263)(-0.93) + (0.069)(-1.10)
= -0.195

$$y_3 = bias + w_{13}x_1 + w_{23}x_2 + w_{33}x_3 + w_{43}x_4 + w_{53}x_5 + w_{63}x_6$$

= 0.436 + (0.368)(-1.00) + (0.32)(-2.76) +(-0.147)(-0.93) + (-0.298)(-0.50) + (0.22)(-0.93) + (0.28)(-1.10)
= - 1.038

Calculation for hidden to output layer

As the activation function for hidden layer is hyperbolic tangent so

$\tanh(y_1)$ = tanh(0.664) = 0.581

$\tanh(y_2)$ = $\tanh(-0.195)$ = - 0.192

$\tanh(y_3)$ = $\tanh(-1.038)$ = - 0.777

Calculation to obtain value from Output layer

$$z = bias + w_{14}\tanh(y_1) + w_{24}\tanh(y_2) + w_{34}\tanh(y_3)$$

= -0.087 - 0481 - 0.159 - 0.104
= - 0.831

Activation function for output layer is identity so the value remains same.

The MLP model provides the standardized value for the scale dependent variable. So there is need to unstandardized this value by $x = \mu + z\sigma$. Here μ and σ are obtained from the predicted values from the model to unstandardized the value. Hence μ = 0.634 and σ = 0.160. Thus unstandardized value of z is $(-0.831 - 0.634)/0.160 = 0.501$. So the estimated value of HDI for Pakistan is 0.501. By this way we can predict HDI on the basis of governance indicators of any country whose data is uses in this analysis