Governance and Economic Development:

Good Governance and Millennium Development Goals

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Abstract

This study examined whether the Good Governance (Boeninger, 1991) reforms recommended by the World Bank have been successful in helping countries to achieve the United Nation’s (UN) Millennium Development Goals (MDGs) implemented in 2000 to encourage development by improving the socioeconomic conditions of the world’s poorest countries (Raykar, 2011; UN, 2000).

In this study, a new methodology was developed for the construction of a new governance indicator. This new methodology extended Goldberger’s (1972) Multiple Indicators Multiple Cause (MIMC) methodology. This study used the ‘raw’ data of Kaufmann et al.’s (1999) and a simulation study to compare the results of the new methodology with Kaufmann’s (1999) methodology. The new methodology was found to deliver a better governance indicator with higher precision and lower variance.

To enable more in-depth research to be undertaken, the scope of this study was limited to an examination of a number of carefully selected MDGs. Specifically, this study examined the effect of governance and health aid on child mortality rates and found that governance has an important role in reducing child mortality rates. Additionally, this study considered the environmental aspect of the MDGs, CO₂ emissions, and found that while governance as a whole has a statistically significant role in reducing Carbon Dioxide (CO₂) emissions, Control of Corruption (CC) has a much larger role in reducing CO₂ emissions. The role of CC on CO₂ emissions was found to be robust across different models and methodologies. Overall, the findings suggested that levels of governance are deterministic in achieving the MDGs. Thus, Good Governance should be considered as strategy for achieving MDGs.
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List of Abbreviations

Acquired Immune Deficiency Syndrome          AIDS
Bertelsmann Transformation Index             BTI
Carbon Dioxide                                CO$_2$
Cingranelli Richards Human Rights Database   HUM
Control of Corruption                        CC
Corruption Perception Index                  CPI
Data Generating Process                      DGP
Demographic and Health Surveys               DHS
Diphtheria, Pertussis and Tetanus             DPT
Economist Intelligence Unit-Index            EIU
Environmental Kuznets Curve                  EKC
European Union                               EU
Expectation Maximisation                     EM
Freedom House Democracy Index                FRH
Gallup World Poll                            GWP
Global Insight Business Condition and Risk Indicators   WMO
Government Effectiveness                      GE
Growth Domestic Product                      GDP
Heritage Foundation Index of Economic Freedom  HER
Human Development Index                      HDI
<table>
<thead>
<tr>
<th>Term</th>
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<tr>
<td>Human Immunodeficiency Virus</td>
<td>HIV</td>
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<td>iJET Country Security Risk Ratings</td>
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<td>Least Square</td>
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<td>PRS</td>
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<td>Political Stability and Absence of Violence</td>
<td>PV</td>
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<td>Principal Component Analysis</td>
<td>PCA</td>
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<td>Regulatory Quality</td>
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<td>Reporters without Borders Press Freedom Index</td>
<td>RSF</td>
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<td>Rule of Law</td>
<td>RL</td>
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<td>Generalised Method of Moments</td>
<td>GMM</td>
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<td>United Nations</td>
<td>UN</td>
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<td>United Nations Development Programme</td>
<td>UNDP</td>
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<td>United States</td>
<td>US</td>
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<tr>
<td>Unobserved Component Method</td>
<td>UCM</td>
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<td>US State Department Trafficking in People report</td>
<td>TPR</td>
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Voice and Accountability (VA)

World Governance Indicators (WGIs)
Certificate of Authorship/Originality

I certify that the work in this thesis has not previously been submitted for a degree, nor has it been submitted as part of requirements for a degree, except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis, itself, has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Yashar Tarverdimamaghani

Date: 22 February 2015
Dedication

I would like to dedicate this thesis to my lovely and beautiful wife, Sanaz, without whom this project would still remain another dream.
Acknowledgements

Here we are, after three years and some ups and even more downs! The journey that started a few years ago comes to an end with the writing of these lines. When I started my PhD, I was under an enormous amount of pressure, mostly financial; however, despite this, I met the challenges and moved forward, always remembering what Albert Einstein said ‘Never give up on what you really want to do. The person with big dreams is more powerful than one with all the facts’

My family are the first people whose support I would like to acknowledge. Without their confidence in my abilities and their unfaltering support, I would never have been able to begin and continue this journey. Similarly, I am deeply grateful to my supervisors, Professor Anu Rammohan and Assistant Professor Leandro Magnusson. During my candidature, I received incredible support from my supervisors and I am sincerely indebted to them both.

Also, my I would like to offer my thanks to Winthrop Professors, Peter Robertson and Ken Clements who have each given me their time and a chance to teach and work during these financially difficult times. Further, I wish to thank the Research Team Manager, Robyn Oliver who was always there to listen to my problems and difficulties. Over these last years at UWA, I was lucky to meet wonderful people and make great friendships. I have also worked with extraordinary people who believed in me and have given me the chance to contribute to their academic studies; Dr Shrabani Saha, Dr Ishitta Chattarjee, Dr Andrew William are just a few of those people.

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months of my candidature, it provided me with peace of mind and enabled me to finish the final stage of my thesis.
Chapter 1: Introduction

1.1 Background

Economic growth refers to an increase in a country’s level of national output either via an increase in primary production factors (e.g., capital and labour) or by an increase in secondary factors (e.g., levels of technology). Economic growth is usually measured by increases in Gross Domestic Product (GDP). Changes in per capita income (i.e., GDP per capita) can provide insight into a country’s economic status; however, GDP does not measure changes in standards of living and the wellbeing of people. Thus, a fundamental difference exists between economic growth and economic development, as economic development refers to improvements in people’s economic and social lives and economic growth refers to increases in a country’s production levels.

The strategies and methods used to achieve increases in economic growth and economic development also differ. In economic development, market inefficiency is justifiable. Conversely, economic growth is solely concerned with market productivity and increases in production levels. Many economists, including Amartya Sen, view economic growth as just one aspect of economic development (Sen, 1983). Economic development can lead to changes in several areas of people’s lives. Thus, several indicators (e.g., education and health measures) can be used to evaluate a country’s level of economic development.

Since its introduction by the United Nations Development Programme (UNDP) in 1990, the Human Development Index (HDI) has been used as an indicator of economic development in many studies (e.g., Anand & Ravallion, 1993; Cypher & Dietz, 2008; Eusufzai, 1996; Myrskyla et al., 2009; Ranis et al., 2000; Srinivasan, 1994). However, the HDI does not provide a complete picture of a country’s economic development, as
it only considers factors relating to the development of human capital (e.g., education and life expectancy) and fails to consider sustainability aspects. The development of human capital is irrefutably important; however, a more comprehensive measurement of economic development is needed that considers other aspects such as health and the environment. At the United Nations (UN) summit in 2000, countries from around the world agreed to a set of goals and indicators known as the Millennium Development Goals (MDGs).

The MDGs consist of eight goals (see Table 1.1) and 21 sub-target goals measured by a set of indicators (Raykar, 2011; UN, 2000). Compared to other similar indicators (including the HDI), the MDGs consider aspects of human wellbeing and the infrastructure needed for development. The eighth MDG states that developed countries should be involved in the economic development process and are expected to assist developing countries to achieve better outcomes.

Table 1.1: Millennium Development Goals

<table>
<thead>
<tr>
<th>Goals and Targets (from the Millennium Declaration)</th>
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<tr>
<td>Goal 1: Eradicate extreme poverty and hunger</td>
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<td>Goal 2: Achieve universal primary education</td>
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<td>Goal 3: Promote gender equality and empower women</td>
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<td>Goal 4: Reduce child mortality</td>
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<td>Goal 5: Improve maternal health</td>
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<tr>
<td>Goal 6: Combat HIV/AIDS, malaria and other diseases</td>
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<td>Goal 7: Ensure environmental sustainability</td>
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<td>Goal 8: Develop a global partnership for development</td>
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Following the UN’s introduction of the MDGs, it was left to countries to determine and implement appropriate policies to achieve these goals. The World Bank suggested a number of strategies to improve economic outcomes and proposed a number of ‘Good Governance’ reforms aimed at increasing levels of democracy and accountability, reducing corruption and improving political transparency.

Since North’s (1990) seminal work, highlighting the importance of socioeconomic institutions, many studies have examined the effects that institutions have on the economic performance of countries. Following, Boeninger’s (1991) study,
developing countries began implementing governance reforms to achieve better economic outcomes. The importance of governance in economic development is widely acknowledged; however, within the literature, no consensus exists in relation to a single definition of governance. According to Boeninger (1991), good governance requires greater responsiveness to the present and future needs of society in the most efficient way of working. Boeninger (1991) identified eight major characteristics of ‘Good Governance’ (see Figure 1.1):

- Participatory;
- Consensus oriented;
- Accountability;
- Transparency;
- Responsiveness;
- Effectiveness and efficiency;
- Equitability and inclusiveness; and
- Rule of law.

![Figure 1.1: ‘Good Governance’ Dimensions](image)

Theoretically, governance should have a positive effect on economic performance and, consequently, increase the achievement of the MDGs; however, this is not always the case. Indeed, real practices show that the achievement of the MDGs is not always dependent on the level of governance; for example, countries without the characteristics of ‘Good Governance’ (e.g., Saudi Arabia and Qatar) have achieved a considerable
number of the MDGs and are in a better position than countries with comparatively ‘better’ forms of governance. This raises questions about the effect of governance on the MDGs. This study sought to examine the relationship between the MDGs and governance. Specifically, this study asked whether improved governance could assist countries in achieving the MDGs.

1.2 Good Governance Indicators

Despite previous studies on the effects of governance on the socioeconomic status of countries, until Kaufmann et al.’s (1999) study there was no known indicator for the concept of governance as a whole. Governance is a multi-dimensional concept and numerous indicators have been used to measure different dimensions of governance. For example, researchers studying the impact of democracy on economic outcomes have used indicators such as the Polity IV or Freedom of House Index. While researchers examining the effect of corruption or controlling corruption on economic outcomes have used indicators such as the Corruption Perception Index (CPI) or Bribery Index.

The choice of data sources in any research is personal to researchers; however, the use of different data sources can affect the numerical results of studies and, in some instances, these quantitative differences have caused ambiguity as to the magnitude of relationships. Kaufmann et al.’s (1999) World Governance Indicators (WGIs) allowed researchers to study several aspects of governance using just one data source. Further, as it appears that the World Bank developed the WGIs,¹ they are impliedly reputable and credible. The WGIs include the following six aspects of good governance:

¹ For this reason, the WGIs are also referred to as the ‘World Bank Governance Indicators’.
a) Voice and Accountability (VA);

b) Political Stability and Absence of Violence (PV);

c) Government Effectiveness (GE);

d) Regulatory Quality (RQ);

e) Rule of Law (RL); and

f) Control of Corruption (CC).

The WGIs capture different aspects of governance; however, a single indicator measuring governance would assist researchers and policy makers. Additionally, in studies examining the relationship between economic outcomes and governance, a single indicator would decrease ambiguity in relation to the multi-dimensionality of governance. Such an indicator would also be more practical for policy makers, as the use of several indicators can suggest different outcomes. In the absence of a single governance indicator, common statistical methods offer a convenient and time efficient approach (e.g. see Al-Marhubi, 2004).

Chapter 2 of this thesis focuses on identifying an aggregation methodology suitable for concepts (such as governance) that cannot be directly observed. In Chapter 2, the shortcomings of known aggregation methods are discussed and a new methodology is proposed to aggregate numerous indicators. This new methodology was developed to overcome the shortcomings of existing methodologies. The results of this new methodology were compared with existing WGIs. This study also considered several statistical aggregation methods to create a governance indicator. In Chapters 3 and 4, a common aggregation methodology called the Principal Component Analysis (PCA) was used to create a ‘proxy’ for governance.

Ultimately, the new methodology proposed in Chapter 2 was not used in later stages of this study for a number of reasons. First, any proper discussion on the link between governance and MDGs (see Chapters 3 and 4) depends on the use of
established, publicly released indicators. Given its novelty, the methodology proposed in Chapter 2 has not yet been sufficiently developed to accommodate more relevant indicators. Second, to enable the methodologies to be compared and discussed, the new methodology used the same raw data as that used by the WGIs; however, before it can be officially used in other empirical studies, the new methodology needs to be established and reviewed in more depth. Third, the main goal of many empirical studies (see Chapters 3 and 4) is to examine relationships while accepting that errors may occur due to the choice of proxy indicators.

1.3 Governance and Millennium Development Goals

A consideration of the relationship between all the MDGs and governance indicators would be beyond the scope of any one study. Thus, this study elected to focus upon the following:

1. The effect of governance on the mortality rate of children under five-years-old (i.e., ‘the Under Five Mortality Rate’) as an indicator of the health aspect of the MDGs; and

2. The effects of governance and its aspects on CO₂ emissions as an indicator of the environmental aspect of the MDGs.

1.3.1 Governance and Child Mortality

The alarming rate of child mortality in underdeveloped countries has led to significant research and debate. Today, reported child mortality rates remain high (despite some decreases since 1990). Researchers in the fields of economics and health science have identified several factors affecting the Under Five Mortality Rate. At a micro level, this includes socioeconomic factors such as household economic status, parental education levels, maternal health, parental health knowledge (particularly,
maternal health knowledge) and access to and the availability of health infrastructures (Amouzou et al., 2012; Amouzou & Hill, 2004; Hobcraft et al., 1984; Omariba & Boyle, 2007). In addition to the deterministic factors that operate at a household (micro) level, there are several macro level indicators related to the Under Five Mortality Rate, including the quality of governance (Lin et al., 2014).

Governance can affect child mortality in a variety of ways; for example, through policy changes, governance can affect the availability of and accessibility to facilities and treatments (e.g., skilled health personnel and vaccinations). Some studies have considered the effect of governance in the delivery of health services; however, the role of governance on the Under Five Mortality Rate has not been sufficiently researched. The possible relationship between governance and the Under Five Mortality Rate requires more research to ensure that every possible effect has been considered. The majority of effects can be categorised as indirect; however, some are more specific than others.

The third chapter of this thesis considers the possible effects of governance and health aid (i.e., the financial aid allocated to health sectors) on child mortality. Two branches of the relevant literature are combined. The first branch relates to the effects of governance on the Under Five Mortality Rate (see, for example, the study Lin et al., 2014). The second branch is concerned with the effect of health aid on the Under Five Mortality Rate (see, for example, the studies of Mishra & Newhouse, 2007, 2009; Mukherjee and Kizhakethalackal, 2013; Yousuf, 2012). In Chapter 3, the effect of governance on child mortality and the effectiveness of health aid in reducing the Under Five Mortality Rate are considered.
1.3.2 Governance and Carbon Dioxide Emissions

The effect of CO$_2$ emissions on the environment is at the centre of environmental debates worldwide. More specifically, the role of developed and developing countries in reducing CO$_2$ emissions has been controversial; however, its inclusion as one of the MDGs changed the focus of researchers. Previous research considered only a single dimension of governance and its relationship with the environment. Only a few studies (e.g., Fredriksson et al., 2003; Pellegrini & Gerlagh 2006) considered two dimensions of governance; however, even these studies ignored the multi-dimensionality of governance and focused on the impact of governance on policy adoption rather than on real and practical variables.

Chapter 4 focuses on the role of several governance dimensions (including RL, CC and VA) on CO$_2$ emissions reduction. Previous research has focused upon indirect transmissions; however, studying the possible effects of dimensions of governance on CO$_2$ emissions provides clearer picture of direct links.
Chapter 2: A New Governance Indicator—An Application of the Extended Multiple Indicators Multiple Cause Methodology

2.1 Introduction

Economic development studies have used several measures and indicators to represent different aspects of governance. Some measures (e.g., the Bertelsmann Transformation Index) have been used to capture a wide definition of governance. Conversely, others measures (e.g., the CPI) have been used to measure specific dimensions of governance and capture a comparatively narrow definition of governance. Many researchers have acknowledged the importance of governance and its various dimensions. Kaufmann et al.’s (1999) WGIs measure governance using an econometric method called the Unobserved Component Method (UCM) that scores and ranks countries across six different aspects of governance. The ability of the WGIs to measure six (presumably) different aspects of governance, rank countries and report the values through a single data source has made it more popular than other indicators. Since their development, the WGIs have been used in a number of studies (e.g., Alence, 2004; Damania et al., 2004; Jong-Sung & Khagram, 2005; Licht et al., 2007; Tavits, 2007).

The importance of governance increased when the World Bank and developed countries named ‘better governance’ as a criterion for financial development aid (Bräutigam & Knack, 2004; Grindle, 2004; Hout, 2007; Knack, 2001; Neumayer, 2005; Santiso et al., 2001). Consequently, the importance of the WGIs also increased and,
since then, the WGIs have been used in many areas of research as a main measure of governance.

However, despite their popularity, the WGIs have been subject to criticism (Al-Marhubi, 2004; Langbein & Knack, 2010), as their specifications have been found to restrict their application in researches and have also affected the results of several studies (Langbein & Knack, 2010). The existence of lower and upper bands in the results makes cross-country or cross-aspect comparisons and panel data analysis challenging. Further, it appears that these bands could overlap across countries, thus making the identification of any improvements or declines in governance impossible. Kaufman et al. (1999) raised this very issue also, which can be clarified if the following two scenarios are considered:

1- Country X has indicator 3 with the upper band value 5 and a lower band value of 1.

2- Country Y has indicator 2 with upper band values of 5.5 and a lower band value of 1.5.

Any comparison between the above two cases is almost impossible, as the values for each case could vary between the upper and lower bands. Thus, the application of the WGIs is limited to a time series.

Langbein and Knack (2010) asserted that the WGIs have a number of conceptual and technical issues. In the following sections, criticisms of the WGIs and the implications of these criticisms are discussed. Langbein and Knack’s (2010) criticisms are the most significant, as they point out that the inadequacies of the WGIs from different perspectives.

The importance and benefit of having a single index that measures governance for the purposes of policy decisions and research projects was mentioned above. In this
study, a new methodology was proposed with the aim of constructing a governance indicator that accommodates the conceptual characteristics of governance. This new methodology was designed to addresses some of the criticisms directed at the WGIs. Additionally, it extended the existing Multiple Indicators Multiple Cause (MIMC) methodology.

In the next section, the methodology that Kaufmann et al. (1999) used to develop the WGIs is reviewed. Next, criticisms and limitations of the methodology are considered. Following this, a new methodology and model are proposed. An explanation is given of how this new methodology responds to criticisms directed at the WGIs and overcomes the limitations of the WGIs. The results are then set out and a new governance indicator is constructed to demonstrate how the new methodology can be applied. A robustness check is undertaken with the same ‘raw’ data used in the original set and the WGIs are reproduced to show the differences in results between the WGIs and the new methodology. The results of a simulation study are then presented. The results confirmed that the new methodology is more efficient than WGIs methodology. In the final section, the results of the methodology and possible applications of the proposed methodology are discussed.

2.1.1 The World Bank’s Methodology

As stated above, the ‘Good Governance’ concept identifies eight aspects of good governance; however, in developing the WGIs, Kaufmann et al. (1999) reduced these eight aspects to six. To create indicators, Kaufmann et al. (1999) considered groups of sub-indicators that represented six aspects of governance.\(^2\) For each group, they assumed that any individual data source provides an imperfect signal of some deeper underlying notion of governance that may be difficult to observe directly. Thus,

\(^2\) See Appendix 6.3, a part of this grouping is presented as an example.
Kaufmann et al. (1999) assumed that each of the existing sub-indicators followed an equation such as:

\[ y_{n,i} = \alpha_i + \beta_i(y^*_n + \varepsilon_{n,i}), \quad \varepsilon_{n,i} \sim N(0, \sigma_i^2) \]  

(2.1)

In which:

- \( \alpha_i \) and \( \beta_i \) are the parameters;
- \( y^*_n \) is the unobserved governance in country \( n \) and \( y^*_n \sim N(0,1) \);
- \( y_{n,i} \) is observed score of country \( n \) on indicator \( i \); and
- \( E[\varepsilon_{n,i}, \varepsilon_{n,j}] = 0 \) if \( i \neq j \)

Based on equation (2.1), the contribution to the log likelihood function by country \( n \) is:

\[ l(\alpha, \beta, \sigma^2) \propto \ln |\Omega| + (y_n - \alpha)'\Omega^{-1}(y_n - \alpha) \]  

(2.2)

In which:

- \( \Omega = \beta'\beta + B'SB \);
- \( y_n \) is a vector of \( I \times 1 \) indicators for country \( n \);
- \( \alpha = (\alpha_1, \ldots, \alpha_I), \beta = (\beta_1, \ldots, \beta_I), \sigma^2 = (\sigma_1^2, \ldots, \sigma_I^2) \); and
- \( B \) and \( \Sigma \) are diagonal matrices with \( \beta_i \) and \( \sigma_i^2 \) in the diagonal.

For each six group of WGI, Kaufmann et al. (1999) found Maximum Likelihood (ML) estimates of \( \alpha \) and \( \beta \), then calculated the conditional expected value and the conditional variance of governance aspect with the equations as follows:

\[ E[y_n|y_{n,1}, \ldots, y_{n,l}] = \sum_{i=1}^{I} w_i \frac{y_{n,i} - \alpha_i}{\beta_i^2} \]  

(2.3)

In which:

- \( w_i = \frac{\sigma_i^2}{1 + \sum_{l=1}^{I} \sigma_l^{-2}} \) is the weight that depends inversely on the variance of error term; and
- \( \frac{y_{n,i} - \alpha_i}{\beta_i^2} \) is the score of governance for each country.
The equation (2.3) is simply a weighted average of scores for each country. The conditional standard deviation of $y^*_n$, which indicates the precision of the estimated indicator, is:

$$S.D.\{y^*_n|y_{n,1},\ldots,y_{n,I}\} = \left(1 + \sum_{i=1}^{I} \sigma^2_i \right)^{-\frac{1}{2}}$$  \hspace{1cm} (2.4)

As stated above, Langbein and Knack (2010) have asserted that the widespread use of the WGIs might have significantly misled many policy makers and researchers. The criticisms made by Langbein and Knack (2010) relate to the:

1. Strong correlation among the WGIs: Langbein and Knack (2010) argue that the strong correlations between the six WGIs indicate that the WGIs measure one single concept rather than six different aspects of one concept.

2. Initial Grouping: Langbein and Knack (2010) state that there was no basis for the grouping of the indicators used to generate the WGIs. Further, they assert that Kaufmann et al. (1999) failed to provide any scientific support for the grouping of the sub-indicators and that in categorising the initial indicators a proven and cited hypothesis\(^4\) should have been used for the grouping, as it would have revealed how the sub-indicators were related.


\(^3\) Standard Deviation.

\(^4\) Langbein and Knack (2010) argued that the initial grouping should have been based on cited research and well-referenced, well-established literature.
In the following section, a new methodology is proposed. It is then explained how this new methodology addresses some of the aforementioned criticisms.

2.2 Methodology and Model

In this study, it was theorised that the issues related to the initial groupings and the strong correlations between the different indictors could be avoided by aggregating the existing indicators into one single indicator.

To address debates on the choice of an appropriate methodology, the advantages and disadvantages of some known aggregation methods were considered (see Appendix 6.4). The following section sets out why Goldberger’s (1972) methodology, known as the MIMC methodology, is a more appropriate measure of unobservable concepts such as governance. Three reasons support this choice:

1. The initial methodology proposed by Goldberger (1972) is fundamentally about an unobservable concept (similar to governance).
2. Compared to other discussed methodologies, the MIMC methodology allows the existence of error terms to be associated with each indicator.
3. In the MIMC methodology there is no specific requirement related to the indicators used in the model unlike in other methodologies such as PCA.

In the next section, the basis of the MIMC methodology is examined in greater detail and similarities to Kaufmann et al.’s (1999) UCM are noted. The foundations of the methodology used in this study are also explained.

2.2.1 Goldberger’s Methodology

To construct the new aggregate indicator, the methodology pioneered by Goldberger (1972) and further developed by Jöreskog and Goldberger (1975) was used. Goldberger (1972) assumed that $\gamma^*$ is an unobserved (latent) variable and that a vector
of some exogenous variables (X) has an equation such as that provided by equation (2.5). Goldberger (1972) also assumed that the vector of indicators Y, measures \( y^* \) imperfectly (see equation (2.6)). The vector of U in equation (2.6) includes the relative measurement or methodological errors.

\[
y^* = \alpha'X + \epsilon
\]  

\[
Y = \beta y^* + U
\]

In which:

- \( X = (x_1, \ldots, x_k)' \), \( Y = (y_1, \ldots, y_m)' \), \( U = (u_1, \ldots, u_m)' \);
- \( \alpha = (\alpha_1, \ldots, \alpha_k)' \), \( \beta = (\beta_1, \ldots, \beta_m)' \), \( \theta = (\theta_1, \ldots, \theta_m)' \);
- \( E[\epsilon U'] = 0 \), \( E[\epsilon^2] = \sigma^2 = 1 \), \( E(UU') = \Theta^2 \); and
- \( \Theta \) is an \( m \times m \) diagonal matrix with \( \Theta \) (i.e., the vector of standard deviation of the u’s) displayed on its diagonal.

Goldberger (1972) showed that parameters could be estimated using the Maximum Likelihood (ML). Goldberger (1972) named X as the vector of Multiple Causes and Y as the vector of Multiple Indicators. Thus, this methodology was named the MIMC methodology.
2.2.2 The World Governance Indicators Methodology versus the Goldberger Methodology

Comparing the methodology used by Kaufmann et al. (1999) with Goldberger’s (1972) methodology, two main differences can be identified. First, in Kaufmann et al.’s (1999) econometrical definition, governance is an unobservable stochastic variable. This assumption means equation (2.5) can be written as:  

\[ y^* = \varepsilon \]

Second, Kaufmann et al. (1999) introduced a vector of \( \mathbf{\alpha} \) to capture differences in scales. However, in Goldberger’s (1972) methodology there was an underlying assumption that the indicators had the same scales.

2.2.3 The Proposed Methodology

In the new methodology, similar to Kaufmann et al.’s (1999) methodology, it was assumed that each of the existing indicators gives a biased picture of unobserved governance. It was also assumed that the unobserved governance \( (y^*) \) is a random variable that follows a normal distribution with a mean of 0 and variance of 1. Given this definition, \( y^* \) can be written as:

\[ y^* = e \]

In which, \( y^* \) is scalar and is different for each of the observations (countries) at any given time\(^6\) and its variance is 1 (i.e., \( \sigma_{ee} = 1 \)). Equation (2.7) can also be written as:

\[ y^* \sim N(0,1) \]

---

\(^3\) Kaufman et al. (1999) did not set out the underlying assumptions of the definition or their reasons for not including a vector of \( X \) in the model. However, there may be a few reasons for the vector of \( X \) being omitted from their model of governance indicators. Ideally, the vector of \( X \) should include variables that may cause changes in governance \( (y^*) \), but as this branch of literature is still relatively young and there is no scientific consensus, generating indicators omitting the vector of \( X \) seems practical.

\(^6\) Where \( y^* \) is a random variable that is normally distributed across countries for any given year.
It was then assumed that each of the governance indicators for a country provides a biased picture of the unobserved $y^*$. Thus, the equivalent equation would be:

$$Y_{n,t} = \alpha_t + \beta_t y_{n}^* + u_{n,t}$$  \hspace{2cm} (2.9)

In which:

- $Y_{n,t}$ is the indicator $i$ for country $n$;
- $\alpha_t$ is the parameter that controls different scales in indicator $Y_i$;
- $\beta_t$ is the parameter that maps the unobserved $y^*$ into the observed $Y_{n,t}$; and
- $u_{n,t}$ represents any measurement or methodological error associated with the observed indicator ($Y_i$) and country $n$.

In Equation (2.9), similar to Kaufmann et al.’s (1999) methodology, $\alpha_t$ is introduced to cover the different scale in $Y_{n,i}$, as each of the observed indicators has its own measurement scale.

It should be noted that in Goldberger’s (1972) basic MIMC model, which included an assumption of an $I$ observed indicator for each country, there is no vector of $\alpha = (\alpha_i, ..., \alpha_I)$. A possible underlying assumption of the Goldberger (1972) model is that all the indicators measuring the unobserved concept have the same scales or could be normalised to have the same scales. Thus, if normalised indicators are considered in $Y_{n,i}$, the vector of $\alpha$ can be ignored and the equation (2.9) changed to:

$$Y_{n,i}^* = \beta_i^* y_{n}^* + u_{n,i}^*$$  \hspace{2cm} (2.10)

It is apparent that $Y_{n,i}^*$, $\beta_i^*$, $u_{n,i}^*$ are different to their counterparts in equation (2.9). However, the result (i.e., the estimation of $y^*$) would not be any different. In this study, to keep the model as generic as possible, the vector of $\alpha$ is also included to account for different scales of indicators in $Y_{I\times1}$.  

---

7 In further equations, the assumptions regarding $u_{n,i}$ are presented and explained.
As in equation (2.6), one of the fundamental assumptions of Kaufmann et al.’s (1999) model is that the $U$s are independent. Such an assumption implies that each of the observed indicators has their own unique measurement and methodological error that is not correlated with the error term of other indicators. This is an unrealistic assumption, as an error associated with one indicator that measures a specific aspect could be correlated with another indicator’s error term. Relaxing this assumption implies that:

$$E(u_i, u_j) \neq 0, \forall i, j.$$

It appears that the correlation between the results of the WGIs was partially caused by the fact that Kaufmann et al. (1999) failed to account for the high possible overlap between errors of individual indicators. Relaxing the assumption of independent error terms allows the variance-covariance matrix of $U$ (error terms) to have both diagonal and off-diagonal elements. It was tempting to consider an unstructured variance-covariance matrix and estimate all the elements in the matrix; however, this was not computationally possible. A problem arose because, after combing two equations and creating the reduced form, multiplication of parameters of $\beta$ appeared in all (i.e., both diagonal and off-diagonal) of the variance-covariance matrix alongside the $\sigma$s. This made the estimation impossible; thus, it was necessary to restrict variance-covariance matrix.\(^8\)

\[^8\] It should be noted that there were no problems of incidental parameters (as mentioned by Vinod (2008)). In this set-up, the number of observations (i.e., countries) was much larger than the number of unknown parameters (i.e., the length of $\beta$ or the number of observed indicators). However, a problem appeared in a reduced form when multiplication of out of interest parameters of different $\beta$s with various $\sigma$ (i.e., $\beta_i\beta_z\sigma_i\sigma_z$) equalled a single element of the variance-covariance matrix. Consequently, estimating the elements of the variance-covariance matrix when they consist of multiplication of the out of interest parameters is impossible. Goldberger (1972) also mentioned this issue. In this method, the multiplications of the parameters appear in all derivatives of MLE; thus, it is not possible to solve the function unless the parameters are restricted. Again, Goldberger (1975) mentioned this issue (and see the first footnote of Goldberger’s article). Further, no problem originates from the number of unknown parameters in this model, as the use of at least 100 countries and 11 indicators means that the unstructured variance covariance matrix would be 11 x 11 and would have at most 121 parameters (fully
However, restricting the covariance matrix required knowledge of possible relationships between error terms, which was also not possible, as the governance $y_i^*$ is unobservable as are the error terms associated with its measurement. As a solution to this problem, the indicators were clustered to reduce the number of parameters to be estimated in off-diagonal elements of the variance-covariance matrix. By clustering indicators, it is assumed that for each cluster any measurement error includes a random variable and noise that is unique to each indicator and has a normal distribution with a zero mean and variance of $\theta^2$.

\begin{equation}
    u_{in} = \xi_n + \mu_{in}
\end{equation}

\begin{equation}
    \xi_n \sim N(0, \gamma^2)
\end{equation}

\begin{equation}
    \mu_{in} \sim N(0, \theta_i^2)
\end{equation}

Combining equations (2.11) and (2.9), the main equation can be rewritten as:

\begin{equation}
    Y_{n,i} = \alpha_i + \beta_i y_{n,i}^* + \xi_j + \mu_{i,n}
\end{equation}

In equation (2.13), the $\xi_j$ is the random variable (effect) associated with cluster $j$.

The random variables were introduced based on the idea of random effects in panel data analysis. Given the fact that there might be several clusters in the dataset and considering the matrix of observed $I$ indicators for $n$ countries, the matrix representation of the equation (2.13) is derived as:

\begin{equation}
    \mathbf{Y}_{n \times I} = \eta_{n \times 1} \mathbf{a}_{1 \times I} + \mathbf{y}_{n \times 1} \mathbf{\beta}_{1 \times I} + \mathbf{\chi}_{n \times I} + \mathbf{E}_{n \times I}
\end{equation}

In which:

- $\eta_{n \times 1}$ is a vector of 1;

unconstructed case) and on the other side of the regression (equation) there are $100 \times 11 = 1,100$ elements. Thus, the number of equations is far larger than number of parameters.

It might be conceptually easier if equation (2.13) was viewed from a different perspective and as a model in the panel data. Then, the $\alpha_i$ could be viewed as a time effect and $\xi_n$ could be viewed as a random effect; these notations would make the model similar to a mixed model panel data.
\[
\chi_{n,i} = \chi_{n,i'} = \xi^j \text{ if } i \text{ and } i' \in j;
\]

- \(\xi^j \sim N(0, \gamma_j^2)\);
- \(E \sim N(0, \Theta^2)\); and
- \(\Theta^2\) is a diagonal matrix of \(\theta_i^2\) on its diagonal.

Based on equation (2.8), the conditional distribution of observed \(Y_n\) on \(y^*\) could be written as:

\[
Y_n | y^* \sim N(\alpha + y^* \beta', \Theta^2 + \Gamma^2)
\]  (2.15)

In which:
- \(\Gamma^2\) is the square matrix that has a number of partitions equal to the number of clusters;
- \(\Gamma_{ij}^2 = \begin{cases} \gamma_{ij}^2 & \text{if } i, j \in w; \\ 0 & \text{and} \end{cases}\)
- \(y^* \sim N(0, 1)\).

From equation (2.15), and following the specifications of normal distribution, the marginal distribution of \(Y_n\) is:

\[
Y_n \sim N(\alpha, \Omega^2)
\]  (2.16)

In which:

\[
\Omega^2 = \beta \beta' \sigma_{y^*} + \Theta^2 + \Gamma^2
\]  (2.17)

Further, based on (2.15), \(\sigma_{y^*} = 1\), equation (2.18) can be changed to:

\[
\Omega^2 = \beta \beta' + \Theta^2 + \Gamma^2
\]

For the purpose of finding an indicator for unobserved variables, \(y^*\), similar to Goldberger (1972) and Kaufmann et al. (1999), the expected value of the unobserved governance in condition to the observed vector of \(Y_n\) (i.e. \(E(y^* | Y_n)\)) could be used. To
find $E(y^* \mid Y_n)$ it is possible to use the properties of multivariate normal distribution.\(^\text{10}\)

Thus:

\[
E(y^* \mid Y_n) = \left(1 + \beta'(\Theta^2 + \Gamma^2)^{-1}\beta\right)^{-1}(\beta(Y_n - \alpha)) \tag{2.18}
\]

\[
V(y^* \mid Y_n) = \left(1 + \beta'(\Theta^2 + \Gamma^2)^{-1}\beta\right)^{-1} \tag{2.19}
\]

As stated above, for each country, governance was unobserved and in equation (2.18) the aim was to find the maximum expected value of $y^*$ as a condition of observing the vector of indicators $(Y_n)$ (i.e., the maximum of the conditional expected value of $y^*$). Thus, using the Expectation Maximisation (EM) algorithm the maximum conditional expected value of unobserved governance could be derived. Despite the fact the EM algorithm has been established for some period of time, it was more convenient to use common methods (e.g., the ML and Least Square (LS) methods). According to Chen (1981), the MLE of the parameters in equation (2.14) also makes equation (2.18) the maximum. Thus, the likelihood function was created based on Jöreskog and Goldberger’s (1975) model and the MLE of the parameters was derived by a likelihood function of:

\[
L(\alpha, \beta, \gamma^2, \sigma^2) \propto -0.5 \times \ln \Omega^2 + tr(\Omega^{-2}W) \tag{2.20}
\]

In which:

- $\Omega^2 = \beta\beta' + \Theta^2 + \Gamma^2$; and

- $W = \left(\frac{Y-\eta\alpha}{\sqrt{n}}\right)'\left(\frac{Y-\eta\alpha}{\sqrt{n}}\right)$.

### 2.3 Data

An important element of any proposed model is the input data. The estimates of the unknown parameters in this model relied heavily on the observed indicators (i.e.,

\(^\text{10}\) See Goldberger (1991) and Appendix 6.1.
the $Y$ matrix). In this model, 11 indicators measuring different aspects of governance were used. These indicators covered almost 116 countries for the period of 2012 to 2013 (see Table 2.1).

The same data used by Kaufmann et al. (1999) to construct the WGIs was accessed for this study. There were almost 30 indicators within this official source of data for the WGIs; however, not all of the indicators had good coverage across the countries. Thus, a culling of the indicators was inevitable. In this study, the indicators that covered a relatively large number of countries\(^{11}\) were selected. This restriction reduced the number of indicators used to 11. However, using the same data source as that used for the WGIs provided an important advantage; that is, it increased the comparability of the results of the two methods. The selected indicators from the WGI website had been normalised across all the countries;\(^ {12}\) thus, there was no need to consider vector $\mathbf{a}$ and the main equation used was (2.10).

One of the major differences between the proposed methodology and that used for the WGIs is the introduction of clusters in the covariance matrix. The introduction of clusters relaxed the assumption of the independent error terms. Thus, the number of clusters and the way they are created plays a crucial role in the estimation. However, it was recognised that clustering the variables based on any ad-hoc practice could create issues. Accordingly, in this study, the indicators and their error terms were clustered around the initial grouping used by Kaufmann et al. (1999) to create their six indicators. By way of example, Kaufmann et al. (1999) believed that the Freedom House Democracy Index (FRH) and Reporters without Borders Press Freedom Index (RSF) provided information on democratic aspects of governance; thus, these indexes were aggregated for VA and included as one cluster.

\(^{11}\) Any indicator that covered more than 85 per cent of the official World Bank list of countries was used. This selection made it possible to address an issue the basic method; that is, its high dependency on used data.

\(^{12}\) They all had an average of zero and a standard deviation close to 1, ranging from -2.5 to 2.5.
As stated above, Kaufman et al.’s (1999) initial groupings have been criticised. Thus, the use of this categorisation in clustering could create issues; however, the same grouping was maintained to ensure comparable results were produced. Further, while the initial groupings of indicators by Kaufman et al. (1999) has been the subject of debate, adopting the same grouping for error terms was reasonable, as there was a high probability that the error terms associated with the conceptually close indicators would be correlated. Further, before any ‘official’ indicator can be constructed, more research is required and more comprehensive and well-established categories are needed.

It was assumed that the measurement errors of indicators in one cluster would correlate with the same ratio, but be independent of, the error terms in other clusters. In Table 2.1, the indicators are presented along with their clusters.

**Table 2.1: Clusters of Indicators used in Creating the New GI**

<table>
<thead>
<tr>
<th>No</th>
<th>Indicator</th>
<th>Description</th>
<th>Clusters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FRH</td>
<td>Freedom House Democracy Index</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>RSF</td>
<td>Reporters Without Borders Press Freedom Index</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>HER</td>
<td>Heritage Foundation Index of Economic Freedom</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>TPR</td>
<td>US State Department Trafficking in People Report</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Ijt</td>
<td>iJET Country Security Risk Ratings</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>HUM</td>
<td>Cingranelli Richards Human Rights Database</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>IPD</td>
<td>Institutional Profiles Database</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>PRS</td>
<td>Political Risk Services International Country Risk Guide</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>WMO</td>
<td>Global Insight Business Condition and Risk Indicators</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>EIU</td>
<td>Economist Intelligence Unit-Index</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>GWP</td>
<td>Gallup World Poll</td>
<td></td>
</tr>
</tbody>
</table>
Adopting the clusters introduced in Table 2.1, it was possible to impose structure on the matrix of $\Gamma^2$. Thus, $\Gamma^2$ would be:

$$\Gamma^2_{i,i} = \begin{cases} 
\gamma_1^2 & \text{if } i,j \in \{1,2\} \\
\gamma_2^2 & \text{if } i,j \in \{3,4\} \\
\gamma_3^2 & \text{if } i,j = 5 \\
\gamma_4^2 & \text{if } i,j \in \{6,7,\ldots,11\} \\
0 & \text{Otherwise}
\end{cases}$$

2.4 Results

Using the estimated parameters in equation (2.13) the maximum value of $E(y^* \mid Y)$ (i.e., equation (2.19)) was found for each observation (in this case, each country) and taken as the ‘closest’ indicator possible to estimate $y^*$ (i.e., unobserved governance). Further, similar to Kaufmann et al. (1999), the conditional standard deviation ($S.D.(y^* \mid Y)$) was reported as a measure of precision of estimation for each observation.

Based on the estimated parameters and equation (2.20), the $V(y^* \mid Y)$ and $S.D.(y^* \mid Y)$ are 0.00179 and 0.04233, respectively. Comparing these values with their counterpart WGIs, the first point to be observed is the difference in standard deviations. It appears that the results of the proposed new methodology have a lower standard deviation and thus higher precision than the WGIs. Conversely, the New Governance Indicator (New GI) had 0.04233 deviation around its mean; however, the standard error variation of the WGIs ranged from a minimum of 0.10 to a maximum of 0.262. As stated above, the application of the WGIs has been limited by their relatively large variance. The lower variance in the results of the New GI, suggests that it has greater applicability and thus could be used in panel data analysis and cross sectional studies.

---

13 The average standard deviation of the six WGIs was 0.1712.
In Figures 2.1, 2.2 and 2.3, the New GI is presented against six WGI's. To save space, the comparison is presented for just three countries (i.e., New Zealand, Sudan and Serbia). According to the ranking based on the New GI, New Zealand is the country with the best governance (see Figure 2.1). In relation to New Zealand, the WGI's were shown as being positive; however, the New GI captured the overall effect of all the values. The indicators for mid-level countries were also quite interesting. These countries showed substantial variation in different aspects of governance; for example, Serbia had a relatively good level of RQ, but was significantly lacking in RL. In Figure 2.2, several governance aspects of this mid-level country are presented. The WGI's for Sudan, reported a negative value and the New GI was similarly negative, but had a lower variance.
In Figures 2.1 to 2.3, the New GI is presented against six different aspects of the WGI for three countries. In all the figures the dark bars represent the New GI and the arrows represent the standard deviation of each indicator. New Zealand is at the top of the list based on the New GI and Sudan is at the bottom of the list.

Figure 2.1 shows New Zealand (with a value of 1.8505) as the top country according to the New GI. Conversely, Sudan has the lowest value of -1.8334 (see Figure 2.3) and Serbia has a value of -0.197 (see Figure 2.2).
Figure 2.4: The New GI against the six WGI s

Figure 2.5: The New GI against the Maximum and Minimums of the WGI s
Further, the average of the WGI s and their minimums maximums were compared to the New GI (see Figures 2.4 and 2.5). In Figure 2.4, the bold line represents the New GI and the dashed lines represent the borders of the six WGI s for each country. The horizontal axis displays country rank and, at any point on the horizontal axis, there are six points within the dashed-band. The vertical axis displays the values of the indicators. In Figure 2.5, the same graph is presented again; however, to compare the New GI against the WGI s, the detailed trends were removed and replaced by a shaded band that shows the minimum and maximum range of the WGI s. Again, the bold line represents the New GI. As depicted in the graphs, the New GI indicator always stays within the range of the minimum and maximum values of the WGI s. In some instances, the New GI approaches the maximum value of the WGI s; however, in others, it remains close to the minimum value. Thus, the mean of the New GI differs to the WGI s.

2.4.1 A Reproduction of the World Governance Indicators

To test the robustness of the methodology of the New GI, the same input data was used to reproduce the WGI s; however, the new methodology was used. The results showed that the new methodology yielded a much smaller standard deviation than the methodology previously used to produce the WGI s. Further, a comparison between the re-produced and original WGI s showed that the WGI s understated the values for countries with good governance (i.e., the countries with higher values).

The introduction of clusters to the error terms of the covariance matrix relaxed the assumption that the error terms were independent. However, in reproducing the WGI s, it was assumed that there was only a single cluster within the data, as all the input indicators belonged to the same aspect. This assumption is similar to the consideration that there is one random effect between the error terms.
In Figures 2.6 to 2.11, reconstructed aspect was compared to original aspects of the WGI s. In general, it was found that the figures estimated by the New GI yielded a much smaller standard deviation than the figures yielded by the WGI s. Thus, it appears that the New GI is a better indicator of governance than the WGI s. Additionally, as compared to the WGI s, the reconstructed aspects had higher values for countries with better governance. In Figures 2.6 to 2.11, the dashed line represents the aspects of WGI s, the solid line represents the reproduction of that specific aspect using the new methodology and the bands around the lines represent the standard deviations. Figures 2.6 to 2.11 suggest that the assumption of independent error terms used by Kaufmann et al. (1999) generally resulted in a flatter trend. The gap between the WGI s and the reproduced aspect is comparatively wider in some dimensions (e.g., RL or VA); however, in others (e.g., PV) the gap appears to be narrower. This could be because the initial indicators measuring the PV aspect, for example, are more likely to be independent. Thus, by relaxing the assumption of independent error terms, the values did not change significantly.

Figure 2.6: New GI VA versus WGI VA
Figure 2.7: New GI CC versus WGI CC

Figure 2.8: New GI RL versus WGI RL
Figure 2.9: New GI PV versus WGI PV

Figure 2.10: New GI RQ versus WGI RQ
2.5 The Simulation Study

To validate the robustness of the results and findings, several simulations were run to compare the bias of estimation of the unobserved variable against the proposed methodology and the WGI methodology. In the simulations, the following processes were adopted:

1. In each repetition the $Y^*$ was generated based on the assumption of normality of the unobserved $Y^*$ across countries.
2. Based on the Data Generating Processes (DGP), which differed in the model specifications of equations (2.1) and (2.13) (due to the vectors of the parameters $\alpha$ and $\beta$), a matrix of $Y$ (i.e., the observed indicator) was created. The vectors of the parameters were fixed across all repetitions.
3. For each repetition, estimates of the parameters ($i.e., \alpha, \beta, y^2, \theta^2$) were derived using both methodologies.
4. Using the estimated parameters and based on equations (2.3), (2.4), (2.19) and (2.20), the indicator for \( y^* \) (i.e., \( E(y^* \mid Y_n) \)) and its standard deviations were estimated.

5. The squared bias between the estimated indicator and the generated unobserved governance (\( y^* \)) was then calculated.

6. Finally, for each of the four cases of simulations, a vector with the length of numbers of repetition was constructed (i.e., 1,000). Each row in this vector contained the countries’ averages of bias squared for a specific repetition.

Table 2.2 presents the column averages\(^{14}\) of this matrix. Figure illustrates the histogram of this vector that shows the extent to which each methodology was successful in retaining the generated value of the unobserved variable.

In all of the simulations, the simulation parameters were:

- \( n \) (sample size, number of countries) = 200
- \( I \) (number of indicators) = 15
- Simulation (Number of Simulations) = 1,000

In this simulation study, there were two main DGPs. In the first DGP, data was generated with the assumption that there was no correlation between the measurement errors (i.e., The World Bank methodology’s assumption). In the second DGP, the matrix of observed indicators was generated with the assumption that there were correlations between error terms in a form that was already known. Thus, the generated data was based on two scenarios: (1) independent error terms; and (2) the existence of a correlation.

It is possible that within the DGP, some of the draws (i.e., the samples) were quite different to others and yielded a significant bias that does not indicate a bias in the

\(^{14}\) The average across all repetitions.
methodology. Thus, when the squared bias in each repetition was limited to less than 2,000, almost 0.5 per cent of the simulations become 'unacceptable'. Table 2.2 and the histogram graphs in Figure 2.12 display the results of the simulations after limiting the bias to less than 2,000. A comparison of the results in Table 2.2, suggests that the new methodology is more robust and less biased across both DGPs.

Table 2.2: Average Squared of Bias < 2,000

<table>
<thead>
<tr>
<th></th>
<th>New DGP</th>
<th>WGI DGP</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Methodology</td>
<td>17.169</td>
<td>18.827</td>
</tr>
<tr>
<td>WGI Methodology</td>
<td>158.110</td>
<td>165.623</td>
</tr>
</tbody>
</table>

The value of the indicators for most of the latent variables, generally, and for governance, specifically, cannot be interpreted alone; however, a comparison of these values reveals some interesting points. Ranking is a typical method used to compare countries. Thus, to show how each of the competing methodologies succeeded in estimating the rank of a country in the simulations, the difference between two ranks was examined. In one, country was ranked based on a generated value and in the second, country was ranked based on the estimation of the value generated by the competing methodology. Mean differences were found across all simulations and a vector was created for each case. The statistics of these vectors (i.e., these cases) are presented in Table 2.3 and their histogram graphs are depicted in Figure 2.13.

---

15 Cases such as mean of rank bias between the new methodology and WGI methodology.
Figure 2.12: Simulation Results: Histogram of squared bias
Table 2.3: Statistics of Differences in Estimated Ranks

<table>
<thead>
<tr>
<th></th>
<th>New DGP</th>
<th>WGI DGP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>New Methodology</strong></td>
<td>Mean: -2.355×10^{-17}</td>
<td>Mean: -2.44×10^{-17}</td>
</tr>
<tr>
<td></td>
<td>S.D.: 15.155</td>
<td>S.D.: 23.504</td>
</tr>
<tr>
<td></td>
<td>Median: -0.566</td>
<td>Median: 0.008</td>
</tr>
<tr>
<td></td>
<td>Skewness: 0.277</td>
<td>Skewness: -0.226</td>
</tr>
<tr>
<td><strong>WGI Methodology</strong></td>
<td>Mean: -4.95×10^{-17}</td>
<td>Mean: -3.066×10^{-17}</td>
</tr>
<tr>
<td></td>
<td>S.D.: 23.319</td>
<td>S.D.: 18.945</td>
</tr>
<tr>
<td></td>
<td>Median: 2.015</td>
<td>Median: -0.942</td>
</tr>
<tr>
<td></td>
<td>Skewness: -0.280</td>
<td>Skewness: 0.289</td>
</tr>
</tbody>
</table>

The differences in the estimated rankings of the competing methodologies average approximately zero. An interpretation of the relative standard errors and medians reveals significant facts. The new methodology delivers relatively less variation in estimating the ranks of countries in both DGPs and the median is closer to zero indicating that the rank bias in the new methodology is approximately zero. Thus, it appears that the new methodology is better at estimating the ranks of countries ‘correctly’ than the WGI methodology.
2.6 Chapter Conclusion

The main goal of this chapter was to propose a new methodology to construct a new governance indicator (i.e., the New GI). The results suggest that this new methodology (and the New GI) have overcome some of the main criticisms levelled at the WGI and its methodology. Further, the new methodology has improved the methodology pioneered by Goldberger (1972). The New GI, constructed using the proposed new methodology, successfully captures all aspects of governance, while also controlling for possible correlations among error terms. This new methodology yielded a lower
standard error than Kaufmann et al.’s (1999) methodology even when the WGIs were reproduced. This was also confirmed by the simulation results. Less variance in the results implies a better indicator for unobserved variables. As stated above, earlier studies that used the MIMC methodology assumed that the error terms were not correlated; however, in the new methodology, this assumption was relaxed, as it seemed unrealistic. A consideration of the clusters between the error terms allowed for the delivery of better and more precise results. The extension of the MIMC methodology also broadens its application; for example, this extension enables researchers to measure and aggregate indicators of concepts such as social capital and social impact.
Chapter 3: The Effect of Governance and Health Aid on Child Mortality

3.1 Introduction

The high rate of child mortality observed in many developing countries is a key policy concern, globally. Estimates from the World Bank (2012) showed that the number of children dying before the age of five is still unacceptably high. The social science literature has identified several factors associated with the Under Five Mortality Rate, including micro and macro level indicators.

At the household level, numerous studies have identified several socioeconomic factors affecting child mortality. Early research (e.g., Hobcraft et al. 1984; Preston 1975) found that a household’s socioeconomic status significantly influences the mortality rate of children under the age of five. Additionally, the following socioeconomic status indicators have been identified as affecting the Under Five Mortality Rate: income per capita, parental education, urban/rural residence, parental work status and household assets.

Another branch of the literature explored the effect of biological factors on child mortality; for example, Pelletier et al. (1995) studied the effects of malnutrition on child mortality in developing countries and found that malnutrition has a far more powerful impact on child mortality than previously thought. However, Pelletier et al. (1995) also noted that merely screening for and reducing severe malnutrition would not sufficiently reduce child mortality rates. In another study, Kozuki and Walker (2013)

\[\text{\textsuperscript{16}}\text{For example, Amouzou et al., 2012, Amouzou & Hill, 2004 Hobcraft et al., 1984 and Omariba & Boyle, 2007.}\]
showed that intervals in birth between children influence the Under Five Mortality Rate. Using Demographic and Health Surveys (DHS), Kozuki and Walker (2013) found that shorter birth intervals were associated with higher child mortality rates; however, the negative effects of short birth intervals on child survival was only found in high parity births. In yet another study, Imdad et al. (2011) examined the effects of Vitamin A on child survival and found that Vitamin A supplements reduce diarrhoea related deaths for children under five-years-old. This branch of the literature focuses on the medical factors associated with higher Under Five Mortality Rates. Studies on the medical and physical condition of children in relation to mortality rates are important; however, this study focused on another important area related to child mortality; that is, the role of governance and its indirect influence on child mortality.

Despite numerous studies being conducted on this subject, the influence of macro level variables, including governance and health aid, on the Under Five Mortality Rate has been the subject of relatively little research. Thus, the possible impact of macro level indicators on the Under Five Mortality Rate needs to be further explored. The main focus of this study was to examine the role of governance and health aid on the Under Five Mortality Rate. This study addressed the question of whether the World Bank’s suggested strategies (including good governance reforms) have assisted countries in reducing child mortality (one of the targeted MDGs). The role of health aid alongside with governance was also explored, as changes in governance could potentially change health aid programmes and thus affect child mortality. Some research has been conducted on the effect of governance on the delivery of health services; however, the specific effect of governance on the Under Five Mortality Rate has not been adequately researched. Thus, the possible links between governance and the Under Five Mortality Rate have yet to be identified.
Allocations of financial aid, as well as the effectiveness of financial aid programmes, is one important way that governance could affect the Under Five Mortality Rate. The effectiveness of this type of aid is still a matter of debate, as the research has revealed conflicting results. This study used available data to explore the effects of both governance and health aid on the Under Five Mortality Rate.

3.1.1 Studies on Child Mortality: The Fourth Millennium Development Goal

The introduction of the MDGs (specifically, the fourth MDG to reduce child mortality rates) shifted the attention of researchers to possible strategies that could be implemented to achieve the MDGs. Amouzou and Hill (2004) examined the Under Five Mortality Rate in Sub-Saharan Africa from 1960 to 2000 and found that while there was some regional variations in the Under Five Mortality Rates in African regions before 1990, since then the trend has slowed. They also confirmed that in Sub-Saharan Africa, there was a consistent negative relationship between income per capita, literacy, urbanisation and the Under Five Mortality Rate.

Omariba and Boyle (2007) examined the possible impact of family structure on the Under Five Mortality Rate in Sub-Saharan Africa and found that children of polygamous unions were more likely to die than children with mothers in monogamous unions. They also acknowledged the positive effect of the socioeconomic status of households in reducing the Under Five Mortality Rate. The relationship between child mortality (as one of the MDGs) and socioeconomic factors has been explored from various points of view, across different regions and over different periods of time. In a cross-country analysis, Black et al. (2010) analysed the causes of child mortality in 193 countries and found that infectious diseases caused 68 per cent of deaths, but that 49 per cent of these deaths occurred in just five countries: India, Nigeria, Democratic Republic of the Congo, Pakistan and China.
As one of the targets of the MDGs, many studies have examined, suggested causes for and reported on the Under Five Mortality Rate (e.g., Amouzou et al. 2012, Bhutta et al. 2010; Lozano et al. 2011; Rajaratnam et al. 2010).

3.1.2 Financial Aid: the Eighth Millennium Development Goal

The eighth goal of the MDGs is to ‘Develop a Global Partnership for Development’. Consequently, there has been a flow of financial aid from both developed countries and the World Bank to under developed and least developed countries. Part of this financial aid has been allocated to the health sector and can lead to a number of positive outcomes, including reductions in the Under Five Mortality Rate. Within the literature, numerous studies have explored the effectiveness of health aid and how it differs across recipients and donors.

Some studies (e.g., Bourguignon & Leipziger, 2006; Bourguignon & Sundberg, 2007; Collier & Dollar, 2002; Rajan & Subramanian, 2005) have shown that financial aid has been effective in achieving set goals (e.g., triggering economic growth). Conversely, other studies (e.g., Bourguignon & Sundberg, 2007; Mukherjee and Kizhakethalackal, 2013) have focused on specific types of aid and argued of its effectiveness in relation to specific goals (e.g., reducing the Under Five Mortality Rate). Bourguignon and Sundberg (2007) have concluded that ambiguity still exists as to the effectiveness of financial aid on health outcomes, asserting that it is almost impossible to determine whether financial aid is effective, as the chains linking financial aid to health outcomes is complex and there is a lot of ‘noise’ along the links of the causal chains. Collier and Dollar (2002) identified a poverty-efficient allocation of aid and compared it with an actual pattern of aid allocation. They concluded that actual aid allocation differs significantly to that of poverty-efficient aid allocation and asserted that adopting their pattern of allocation would almost double the productivity of aid.
3.1.3 The Literature on Governance and Aid Allocations

Since Boeninger (1991) emphasised the importance of governance on economic performance, several other studies have attempted to explore the links between governance and economic development. Better governance (i.e., Good Governance) is one strategy that has been promoted by the World Bank to achieve the MDGs and economic development.

Despite debate on the effectiveness of aid, donors allocate significant amounts of money to underdeveloped countries each year. Since Boeninger’s (1991) study and the introduction of the WGI by Kaufmann et al. (1999), achieving higher WGI has been a critical criterion in the allocation of aid and studies have been conducted on how aid allocations are aligned with better governance (i.e., Good Governance). Carbone (2010) argued that when countries in the European Union (EU) agreed to act as a single entity, it became possible to apply one definition of Good Governance to aid allocation. Carbone (2010) opined that EU countries promote aid effectiveness to raise their profile in international politics and challenge the United State’s role. Berthélemy and Tichit (2002) approached aid allocation from an international trade perspective and concluded that by the end of the Cold War the disparity in aid allocation among countries was reduced in favour of trade partners. They also found that most donors pay close attention to political issues when deciding how to allocate aid to recipients and do not consider indicators of improved governance. Despite the various approaches adopted, almost all of the studies found that aid allocation was not directed at good governance reforms or achieving actual development outcomes (Epstein & Gang, 2009; Neumayer, 2002, 2005; Santiso et al., 2001; Thiele et al., 2007).

The majority of research has focused on the alignment of patterns of aid allocation with improvements in governance; however, a few studies have explored the inverse relationship between financial aid and governance. Bräutigam and Knack (2004) argued
that while financial aid can remove budget constraints for governments and enable them to invest in their legal systems and strengthen their domestic institutions, financial aid often creates obstacles that hinders the development of good governance. Further, Bräutigam and Knack (2004) found that there was a robust statistical relationship between high levels of aid and the deterioration of governance in Africa.

3.1.4 The Effectiveness of Aid on the Under Five Mortality Rate

A considerable amount of financial aid continues to flow into underdeveloped countries. Presumably, this aid should have a positive effect on a country’s development outcomes, including the reduction of the Under Five Mortality Rate. A number of studies, including Mishra and Newhouse (2007, 2009), Yousuf (2012), Mukherjee and Kizhakethalackal (2013), have considered the effect of health aid on child mortality. Mukherjee and Kizhakethalackal (2013) used semi-parametric regression and found that the overall effect of health aid on the Under Five Mortality Rate was insignificant; however, adult education (and awareness) was consistently found to lower the Under Five Mortality Rate in developing countries.

Conversely, Yousuf (2012) found a statistically significant effect between health aid and the reduction of the Under Five Mortality Rate. Yousuf (2012) estimated that doubling the amount of aid per capita could lead to a reduction of 709 deaths per 1 million live births per year. Similarly, Mishra and Newhouse (2007, 2009) concluded that health aid had a beneficial and significant effect on reducing the Under Five Mortality Rate and that by increasing health aid to 1.60US$ per capita per year, infant deaths could be reduced by 1.5 deaths per every one thousand births. Considering the small ratio of estimated effects, Mishra and Newhouse (2009) suggested that achieving MDG targets through additional health aid alone would require an approximately 15-fold increase in health aid levels. The effect of health aid on the Under Five Mortality
Rate is still under debate. Notably, the effectiveness of health aid in reducing the Under Five Mortality Rate appears to differ under various model specifications.

3.1.5 Contributions of this Study

Numerous studies in this area suggest that socioeconomic status has a significant effect on the Under Five Mortality Rate. One of the most important socioeconomic institutions in any country is its level of governance. In much of the literature, governance has been studied as criteria for health aid allocation. However, only a few studies (e.g., Lin et al. 2014) have examined governance as an independent effective factor on the Under Five Mortality Rate. Lin et al. (2014) found that good governance (along with other social determinants) has a positive effect in reducing the Under Five Mortality Rate. In addition to domestic factors (e.g., governance) foreign factors (e.g., financial aid) have also been linked to the Under Five Mortality Rate. Regardless of the motivation of financial aid, the effect of this aid on economic development (and specifically, on health outcomes) remains questionable.

This study sought to determine the effect of governance and health aid (i.e., the financial aid allocated to the health sector) on child mortality. Thus, similar to the studies of Mishra and Newhouse (2007, 2009) and Lin et al. (2014), this study can be categorised as macro level research. In this study, two branches of the relevant literature are combined\(^{17}\). Specifically, this study sought to examine whether health aid and governance can reduce the Under Five Mortality Rate.

The next section begins by introducing a model and explaining how each of the variables of choice can affect the Under Five Mortality Rate. Next, the methodology chosen to address this research question is explained. Following this, a snapshot of the

\(^{17}\) That is, both the effect of governance on the Under Five Mortality Rate (see Lin et al. 2014) and the effect of health aid on the Under Five Mortality Rate (see Mishra & Newhouse 2007, 2009; Mukherjee & Kizhakethalacakal 2013; Yousuf 2012) are investigated.
dataset is presented and an explanation is given on how each of the variables was measured. Finally, the results of the regression are reviewed and the robustness of the results checked using a different methodology.

3.2 The Model

In this study, the Under Five Mortality Ratio (i.e., the probability per 1,000 live births that a newborn baby will die before reaching the five years of age) was the main dependent variable used to examine the role of governance and health aid on child mortality. The two main independent variables were the level of governance and the amount of health aid per capita. To explore the true impact of governance and health aid on the Under Five Mortality Rate, the other characteristics of countries (e.g., education and population) had to be controlled.

The Under Five Mortality Rate is a household level indicator and has been typically studied at the micro level. However, it is also an important indicator of a country’s level of development. Thus, it has also been studied from a macro level and a developmental perspective (e.g., Amouzou et al. 2012; Mishra & Newhouse, 2007; Mukherjee & Kizhakethalackal, 2013). Possible macroeconomic factors that could affect the Under Five Mortality Rate include the status of a country’s health sector, governments’ budget allocations and foreign development aid allocations. In most cases, it is impossible to study these effects at a micro level; however, while the effect of a government’s expenditure in the health sector cannot be studied at a microeconomic level, available data can be used to examine the linkage in macro level analysis. Examining the impact of macroeconomic indicators on the Under Five Mortality Rate is possible, as child mortality rates, derived from household surveys, are nationally representative. Additionally, the Under Five Mortality Rate represents a probability and is a ratio that can be applied to macro analyses.
Thus, this study considered the role of governance and health aid allocation on the Under Five Mortality Rate at a macro level using macroeconomic indicators. Where the indicators and measures were derived from household surveys, all the indicators were nationally representative. To provide a clearer outline of the model and explain how countries’ different characteristics affect the Under Five Mortality Rate, each variable of choice related to the Under Five Mortality Rate is discussed. Additionally, consideration is given to how these variables can change the effectiveness of governance and health aid on the Under Five Mortality Rate.

3.2.1 Links between Health Aid and the Under Five Mortality Rate

The effectiveness of health aid on the Under Five Mortality Rate has been the subject of debate within the literature. Some studies (e.g., Mishra & Newhouse, 2007, 2009; Yousu, 2012) have focused on the positive influence of health aid, arguing that it can remove budget constraints and help countries to improve the wellbeing of adults and children. However, others studies (e.g., Mukherjee & Kizhakethalackal, 2013) have found no statistically significant link between health aid and the Under Five Mortality Rate and have argued that health aid has no effect on health outcomes such as the Under Five Mortality Rate.

Health aid is defined as any form of financial aid allocated to the health sector. Researchers examining the effect of health aid on health outcomes have struggled with the fact that it can be difficult to determine whether the aid allocated has been used for a specific purpose. This study had to contend with this very issue, as it was unclear whether health aid funds had been allocated to programmes directed at reducing the Under Five Mortality Rate. However, health aid funds allocated to different health programmes could also indirectly affect the Under Five Mortality Rate; for example, using health aid funds to equip medical centres, employ trained staff and improve the quality of nutrition could help to fight the causes associated with the Under Five Mortality Rate.
Mortality Rate. Further, given that the Under Five Mortality Rate is a targeted MDG, it is logical to assume that recipient countries are using a portion of their health aid funds to reduce the Under Five Mortality Rate.

This study evaluates the effectiveness of aid allocated to the health sector in the same year. Additionally, the effectiveness of last year’s allocated health aid is examined. The hypotheses of this chapter are similar to those of Mishra and Newhouse (2007).

3.2.2 Can Governance affect the Under Five Mortality Rate?

The other important explanatory variable in this study’s model is the level of governance. Governance has frequently been studied as a factor in health aid allocation; however, its influence on child mortality and health aid has not been fully explored. Theoretically, an increase in good governance could affect the Under Five Mortality Rate. First, it could change the effectiveness of foreign health aid (e.g., Good Governance could lead to health aid being allocated to the people most in need). Second, better governance could affect a country’s local and domestic health expenditure. Additionally, in well-governed countries, people can vote for policies directed at improving health and wellbeing, including polices aimed at lowering the Under Five Mortality Rate. Further, in countries with higher levels of governance, existing health budgets can be altered to work more effectively and efficiently.

3.2.3 Health Related Indicators and the Under Five Mortality Rate

The Under Five Mortality Rate is one of several highly interrelated health development issues (others include Human Immunodeficiency Virus (HIV), Acquired Immune Deficiency Syndrome (AIDS) and vaccinations). Black et al. (2010) found that almost 68 per cent of child mortality is caused by infectious disease. Thus, vaccinations against common childhood diseases could have a significant role in reducing the Under
Five Mortality Rate. In this model, the rates of immunisation against Diphtheria, Pertussis and Tetanus (DPT) were used to control for the effects of infectious disease. The other variable controlled for was the levels of HIV and AIDS in countries. Official figures for this indicator refer to the percentage of the population (aged between 15–49-years-old) infected with HIV/AIDS. HIV/AIDS is one of the most serious health issues in under developed countries, as if an individual with HIV/AIDS becomes ill with another (even a minor) infection, it could be fatal. Thus, in this model a control for HIV prevalence was also included.

Compared to developed countries, in under developed and (many) developing countries, a significant proportion of women give birth attended by un-trained people or without any assistance. The Under Five Mortality Rate refers to child mortality, not neonatal mortality; however, studies show that health care is important before, during and after pregnancy, as trained staff can educate mothers on the nutritional needs of their children and the possible risks that they may encounter. To control for the possibility that the number of trained staff present at births affect the Under Five Mortality Rate, the percentage of births attended by trained staff members was also included as a control variable.

Amouzou and Hill (2004), Amouzou et al. (2012) and Mishra and Newhouse (2007) specified access to sanitation facilities as another health related indicator that should be controlled. Poor sanitation and a lack of adequate sewage systems have been found to be the main method of transmission of infections and diseases. Additionally, the proportion of funds that governments allocate to the health sector is another factor that might affect the Under Five Mortality Rate as a health outcome. Thus, in this study, the total health expenditure of a country (as a percentage of the GDP) was used to control for the level of government health expenditure.
A number of studies (e.g., Amouzou & Hill, 2004, Amouzou et al., 2012, Bhutta et al., 2010, Lozano et al., 2011, Mishra & Newhouse, 2007, 2009, Rajaratnam et al., 2010, UNICEF, 2011 and Yousuf, 2012) have found that existing levels of health related factors (e.g., the share of health expenditure of the GDP, births attended by trained staff, immunisation rates, the prevalence of HIV/AIDS and access to sanitation facilities) can affect the Under Five Mortality Rate.

3.2.4 Socioeconomic Factors and the Under Five Mortality Rate

Studies have shown that socioeconomic factors are among the most important determinants of the Under Five Mortality Rate (Black et al., 2010; Hobcraft et al., 1984; Lozano et al., 2011). This study controlled for the effects of these factors by considering numerous other factors, including the female literacy rate, GDP per capita and population density. Hobcraft et al. (1984) considered the effects of maternal education and literacy on the Under Five Mortality Rate. In this model, the female literacy rate was used as a proxy for maternal education. Further, a significant number of studies (as mentioned in introduction) have suggested that income is another important factor affecting the Under Five Mortality Rate; accordingly, GDP per capita was also controlled for in the model.

3.2.5 The Main Model

Taking into account the above discussion and previous studies, an intuitive model was created in which the dependent variable was the logarithm of the Under Five Mortality Rate and the main independent variables were levels of governance and health aid per capita. The structure of the model is an intuitive combination of the models used in the studies of Lin et al. (2014) and Mishra and Newhouse (2007). On this basis, a naive equation (i.e., equation (3.1)) was derived that included control variables for the socioeconomic status and relative health related indicators of a country.
\[ \log(U5MR) = \beta_0 + \beta_1 H.AidPC + \beta_2 GG + \beta_3 X^H + \beta_4 X^{SE} + \epsilon \] (3.1)

In equation (3.1), \(U5MR\) refers to the mortality rate of children under five-years-old per 1,000 live births; \(GG\) is the proxy for governance\(^{18}\) and \(H.AidPC\) shows the health sectors allocated international development aid flow per capita. In addition to the main variables, control variables were also included to control for potentially effective health characteristics and health measures. This group of control variables is referred to as \(X^H\) and included: (a) immunisation against DPT (as a percentage of children aged between 12–23 months old); (b) health expenditure totals (as a percentage of the GDP); (c) births attended by trained health staff (as a percentage of the total births); (d) the prevalence of HIV (as a percentage of the population aged between 15–49 years of age); and (e) improved sanitation facilities (as a percentage of the population with access to sanitation facilities).

Variables were also included as a vector of socioeconomic control. These variables were noted as \(X^{SE}\) and included: (a) a logarithm for GDP per capita (i.e., PPP current international $); (b) an adult total for the female literacy rate (as a percentage of females aged 15 years and older); and (c) an error term \(\epsilon_{it}\).

In this model, the coefficients of \(\beta_1\) and \(\beta_2\) are points of interest. According to the literature (see Lin et al., 2014), a negative \(\beta_2\) implies a higher level of governance, a factor that could reduce child mortality. Additionally, \(\beta_1\) was expected to be negative, as studies (e.g., Kosack, 2003) have found that better governance can help the flow of aid and increase the quality of life of individuals in recipient countries.

\(^{18}\) This was constructed using PCA (see Appendix 6.4).
3.3 Data

In this study, the Under Five Mortality Rate (i.e., the dependent variable) was the probability of dying between birth and exactly five years of age (expressed per 1,000 live births). Birth and death data, derived from civil registration documents, censuses and/or household surveys (i.e., WHO, 1994), was used to construct nationally representative values. The Under Five Mortality Rate data is available through the World Development Indicator of the World Bank database. The Under Five Mortality Rate has a mean of 47.93 that varies from 2.2 to 266.4 and, as a trend, has been steadily decreasing since 1995 (see Figure 3.1).

![Figure 3.1: Trend of the Average Under Five Mortality Rate](image)

The indicator for the level of governance is one of the main explanatory variables in this study. Governance (and its various dimensions) has been in several studies; however, there is no known indicator for the concept of the level of governance as a whole. Thus, a proxy indicator for the level of governance was constructed using a PCA on Kaufmann et al.’s (1999) WGI.\(^\text{19}\)

\(^{19}\) In Appendix 6.4, the methodology is explained; specifically, it is shown how the methodology was used to create a proxy for governance.
The other important explanatory variable in this study was the amount of financial aid allocated to the health sector (expressed at a per capita rate). Financial aid data (available through the World Bank database ‘Aid Flows’) provided both aggregate and sector-specific data. For the purpose of this study, the per capita values of aid allocated to the health sector (from any donors to any recipient country) were used. Figures 3.2 and 3.3 show the average of the Under Five Mortality Rate and the average of health aid per capita for different geographical regions. The countries in Sub-Saharan Africa have the highest Under Five Mortality Rate; however, it should be noted that these countries do not receive significantly different amounts of health aid compared to other regions.

In Figure 3.5, the average levels of governance and the average of health aid per capita are presented for the five countries with the worst Under Five Mortality Rate. It is clear from the figures that these countries suffer from bad governance (as indicated by the negative values for the governance proxy).

Figure 3.2: Under Five Mortality Rate across Region

Figure 3.3: Health Aid per Capita across Region

Source: The World Bank Database, Development Indicators
Previously, it was suggested that a socioeconomic factor that might affect the Under Five Mortality Rate was maternal education. In this study, an adult female literacy rate was used as a proxy for maternal education. However, an issue in relation to the use of this variable arose, as there was a lack of sufficient data with desirable frequency. To overcome this problem it was assumed that the literacy rate would not change rapidly and that it would have a monotonous trend over time. Further, it was assumed that the literacy rate could be held constant for the years where no data was available.

3.3.1 The Variables and their Definitions

Table 3.1 presents the official definitions of the variables and their data sources. It should be noted that while most of the variables were exported from the World Bank database of World Development Indicators, the proxy for governance indicator was constructed using the PCA.
Table 3.1: Definitions of the Variables and their Data Source

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Source of Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Worldwide Governance Indicators (WGI)</td>
<td>These aggregate indicators combine the views of a large number of enterprises, citizens and expert survey respondents in industrial and developing countries. It includes aggregate and individual governance indicators for 215 countries and territories for the period of 1996–2012 for six dimensions of governance</td>
<td>Worldwide Governance Indicators database</td>
</tr>
<tr>
<td>Health Aid (Development Aid allocated to health sectors)</td>
<td>Development Aid refers to the financial aid given by governments and other agencies to support the economic, environmental, social and political development of developing countries. It can be distinguished from humanitarian aid because of its focus on alleviating poverty in the long term (i.e., it does not refer to aid given as a short term response)</td>
<td>The World Bank database of ‘Aid Flows’</td>
</tr>
<tr>
<td>Under Five Mortality Rate (per 1,000 live births)</td>
<td>The Under Five Mortality Rate is the probability per 1,000 live births that a newborn baby will die before reaching the age of five, if subject to current age-specific mortality rates</td>
<td>The World Development Indicators</td>
</tr>
<tr>
<td>Literacy Rate, adult female (percentage of females aged 15 years and above)</td>
<td>The literacy rate (in a percentage form) of female adults (aged 15 years and above) who can, with understanding, read and write a short, simple statement on their everyday life</td>
<td>The World Development Indicators</td>
</tr>
<tr>
<td>GDP per capita (current US$)</td>
<td>GDP per capita is gross domestic product divided by the mid year population. Data is in current US dollars</td>
<td>The World Development Indicators</td>
</tr>
<tr>
<td>Immunisation, DPT (percentage of children aged 12–23 months)</td>
<td>Child immunisation measures the percentage of children aged between 12–23 months who received vaccinations before 12 months of age or at any time before the survey</td>
<td>The World Development Indicators</td>
</tr>
<tr>
<td>Prevalence of HIV, total (percentage of the population aged between 15–49)</td>
<td>The prevalence of HIV refers to the percentage of people aged 15–49 who are infected with HIV</td>
<td>The World Development Indicators</td>
</tr>
<tr>
<td>Births attended by trained health staff (percentage of total)</td>
<td>Births attended by trained health staff refers to the percentage of deliveries attended by staff trained to give the necessary supervision, care and advice to women during pregnancy</td>
<td>The World Development Indicators</td>
</tr>
<tr>
<td>Improved sanitation facilities (percentage of population with access)</td>
<td>Access to improved sanitation facilities refers to the percentage of the population using improved sanitation facilities. The improved sanitation facilities include flush/pour systems (to piped sewer systems, septic tanks and pit latrines), ventilated improved pits (VIP) latrines, pit latrines with slabs and composting toilets</td>
<td>The World Development Indicators</td>
</tr>
<tr>
<td>Health expenditure, total (percentage of GDP)</td>
<td>The total health expenditure is the sum of public and private health expenditure. It covers the provision of health services (preventive and curative), family planning activities, nutrition activities and emergency aid designated for health, but does not include provision of water and sanitation</td>
<td>The Bank Development Indicators</td>
</tr>
</tbody>
</table>

3.3.2 Descriptive Statistics

Table 3.2 presents a summary of statistics for the variables used in the sample.

The sample size of this study comprised 534 observations covering 78 countries,
including 73 low and mid-level income countries of which almost 60 were located in Latin America and Sub-Saharan Africa. The mean of the Under Five Mortality Rate in the sample was approximately 83 deaths per 1,000 live births (see Table 3.2). Further, in the sample the constructed proxy for good governance varied from a maximum of 3.159 (with Chile having the best rate in 2002) to a minimum of -3.823 (with Haiti having the worst rate in 2004).

In addition to the main variables, the control variables were included in the dataset. The maximum scores for some of these variables were as expected; however, the minimums revealed shocking results. Specifically, the immunisation rate against DPT had a statistical minimum of 19. Thus, a significant number of countries require immunisation programmes. Additionally, the percentage of the population with ‘Access to Improved Sanitation’ was approximately 7.5 per cent, a shockingly low figure. As stated above, health expenditure as a proportion of the annual GDP was thought to be a factor that could affect the Under Five Mortality Rate. The dataset showed that across the sample this variable varied from 1.612 per cent (the minimum in Equatorial Guinea) to approximately 17 per cent (the maximum in Sierra Leone).
### Table 3.2: Summary Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs.</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality rate, Children Aged Under 5 (deaths per 1,000 live births)</td>
<td>534</td>
<td>82.081</td>
<td>48.410</td>
<td>6.3</td>
<td>219.4</td>
</tr>
<tr>
<td>Proxy Indicator for Good Governance</td>
<td>534</td>
<td>-1.061</td>
<td>1.356</td>
<td>-3.823</td>
<td>3.159</td>
</tr>
<tr>
<td>Health Aid Per Capita</td>
<td>534</td>
<td>3.653</td>
<td>4.208</td>
<td>0.002</td>
<td>33.31</td>
</tr>
<tr>
<td>Log of GDP Per Capita</td>
<td>534</td>
<td>6.959</td>
<td>1.117</td>
<td>4.682</td>
<td>9.645</td>
</tr>
<tr>
<td>Literacy Rate, Female Adults (percentage of females aged 15 and above)</td>
<td>534</td>
<td>61.241</td>
<td>26.059</td>
<td>8.057</td>
<td>99.79</td>
</tr>
<tr>
<td>Health Expenditure Total (percentage of GDP)</td>
<td>534</td>
<td>6.302</td>
<td>2.34</td>
<td>1.612</td>
<td>16.900</td>
</tr>
<tr>
<td>Immunisation, DPT (percentage of children aged 12–23 months)</td>
<td>534</td>
<td>80.88</td>
<td>16.16</td>
<td>19</td>
<td>99</td>
</tr>
<tr>
<td>HIV Prevalence</td>
<td>534</td>
<td>4.172</td>
<td>6.384</td>
<td>0.100</td>
<td>26.900</td>
</tr>
<tr>
<td>Access to Improved Sanitation</td>
<td>534</td>
<td>44.944</td>
<td>28.749</td>
<td>7.500</td>
<td>97.300</td>
</tr>
<tr>
<td>Births by Trained Staff</td>
<td>155</td>
<td>69.972</td>
<td>25.388</td>
<td>5.700</td>
<td>99.900</td>
</tr>
</tbody>
</table>

### 3.4 Methodology

As stated in previous sections, the dataset consists of both time series and cross sections. Thus, the main equation was constructed and estimated in panel data format. LS panel data is possibly the simplest econometric methodology for estimating the out of interest parameters in panel data format. This data provided insight into the general links between the main variables of this study; however, some methodological issues had to be addressed.

In normal panel data analysis, it is assumed that the error term is homoscedastic and is not correlated to any of the explanatory variables. However, in a practical sense,
in models with a significant number of cross sections and time series, the error term can be correlated within cross section and with times. Thus, to control for these correlations (known as time effects and fixed effects) researchers use panel data with fixed effects. Additionally, there could be a correlation between error terms across different times (this occurs in most time series analyses). However, according to Baltagi (2013), when the number of time periods is relatively small, as compared to the number of cross sections, robust standard errors can solve the autocorrelation problem. Thus, to overcome the heteroscedasticity and autocorrelation problems, the clustering option available in Stata® was used (as suggested by Wooldridge, 2010).

3.4.1 Methodological Concerns

A fixed effects method would have addressed the heterogeneity that occurs in normal Ordinary Least Squares (OLS) by controlling for country-specific individual effects; however, it could have also yielded a biased result for the model. Biases may occur for a number of reasons, including the correlations between lagged health aid variables and error terms20 (Mishra & Newhouse, 2009). A consideration of the health-specific control variables could have been beneficial in estimating the equation; however, these variables could also have caused an endogeneity problem, as an unknown factor could have affected both the Under Five Mortality Rate (i.e., the dependant variable) and any of the other health-specific control variables (e.g., the prevalence of HIV).

3.4.2 Generalised Method of Moments Dynamic Panel

Adopting the approach of Mishra and Newhouse (2009), the Generalised Method of Moments (GMM) Dynamic Panel Data were used to account for the potential

20 Thus, the unobserved effect (as captured by \( \epsilon \)) might carry information from the previous year’s health aid.
endogeneity issues that might be caused by variables of less interest to this study. The GMM was introduced by Arellano and Bond (1991) and further developed by Blundell and Bond (2000) and Bond (2002). Under the GMM, rather than the traditional application of instrumental variables, variables are lagged and used as instruments for their level or differences. In the GMM, there are two main equations (see the equations in (3.2)); the first is a level equation and the second, a differenced equation.

\[
\begin{align*}
\text{Log}U5MR_{i,t} &= \beta_0 + \beta_1 H.AidPC_{i,t} + \beta_2 G_{i,t} \\
+ \beta_3 X_{i,t}^H + \beta_4 X_{i,t}^{SE} + \epsilon_{i,t} \\
\Delta(\text{Log}U5MR_{i,t}) &= \beta_0 + \beta_1 \Delta(H.AidPC_{i,t}) + \beta_2 \Delta(G_{i,t}) \\
+ \beta_3 \Delta(X_{i,t}^H) + \beta_4 \Delta(X_{i,t}^{SE}) + \Delta\epsilon_{i,t}
\end{align*}
\] (3.2)

Lagged differences of variables (e.g., \(H.Aid_{i,t-1} - H.Aid_{i,t-2}\)) are used as instruments in the level equation and lagged variables (i.e., \(H.Aid_{i,t-1}\)) are used as instruments in the difference equation. The GMM panel data is used instead of the difference GMM for three main reasons. First, in the GMM, fixed effects are washed out in the equation after the difference is obtained. Second, the GMM provides results that are more plausible when the main variable is persistent (Blundell & Bond, 2000).\(^{21}\) Third, the GMM yields better results for panels with a small \(T\) (time), but a relatively large number \(N\) (Blundell & Bond, 2000), as was the case in this study.

Additionally, as mentioned above, the main focus of this study was to explore the effect of both governance and health aid upon the Under Five Mortality Rate. In equations (3.2), the level variable of health aid was considered and, in some specifications of the results section, one lagged period of this variable was included.

\(^{21}\)“When the series are near unit root process, the instruments used in the first-differenced equation become weak and thus System GMM would have better results”—Blundell and Bond, 2000. The Fisher-type unit root test was applied on the Under Five Mortality Rate and the results suggested a unit root process for the Under Five Mortality Rate.
An important step in applying the GMM is to identify the endogenous, exogenous and predetermined variables. Strictly exogenous variables refer to variables that do not correlate with the error term (i.e., $\epsilon_{i,t}$). Thus, if it is assumed that a variable such as $W$ is strictly exogenous, the definition implies $E[W_{i,s}, \epsilon_{i,t}] = 0$ for $s$ and $t$. Strictly exogenous variables enter into the instrument matrix independently. In this model, it was assumed that governance was strictly exogenous, as it would have been impossible for any shock in the Under Five Mortality Rate to change the level of governance. Another exogenous variable that was considered was population density. Similar to governance, any shock on the Under Five Mortality Rate would not have changed the levels of urbanisation or population density. Additionally, as suggested by Roodman (2009a) the time effects (i.e., the year dummies) were considered as another strictly exogenous variable.\(^{22}\)

The next step in the application of the GMM was the identification of predetermined variables. Predetermined variables are variables correlated with lagged error terms. If $W$ is taken as an example of a predetermined variable, the assumption yields $E[W_{i,s}, \epsilon_{i,t}] = 0$ if $s \leq t$ and $E[W_{i,s}, \epsilon_{i,t}] \neq 0$ if $s > t$. Predetermined variables might also be endogenous and may enter the instrument matrix with a minimum of two lags. Conversely, other predetermined variables, without endogeneity, enter the matrix with at least one lag. In the model, it was also assumed that the health sector-specific control variables were both predetermined and endogenous. They were considered to be predetermined variables, as any shock on the Under Five Mortality Rate would have changed the number of physicians or the share of GDP’s health budget in the next period (i.e., in the next year). Thus, health sector-specific variables were

---

\(^{22}\) ‘The autocorrelation test and the robust estimates of the coefficient standard errors assume no correlation across individuals in the idiosyncratic disturbances. Year dummies make this assumption more likely to hold’—Roodman, 2009.
considered to be predetermined and endogenous and entered into the instrument matrix with at least two lags.

To estimate the main equation with the above specifications, the Stata package implemented by Roodman (2009a) was utilised. One of the significant advantages of Roodman’s (2009a) package is that it reports all Sargan/Hansen J statistics and results in autocorrelation tests. It should be noted that it is possible that this model suffers from autocorrelation and heteroscedasticity. Accordingly, to control for autocorrelation and heteroscedasticity, the cluster and robust option in the Roodman (2009a) package was used to create HAC\textsuperscript{23} corrected standard errors in the estimation. Additionally, a two-step GMM procedure (also available by Roodman, 2009a) was used that included Windmeijer’s (2005) correction for finite sample bias.

### 3.5 Results

#### 3.5.1 Results of the Dynamic Panel Data

GMM Dynamic Panel data was used to estimate the parameters. The results are displayed in Table 3.3. In columns (1) to (6) one lagged period of health aid is considered; in columns (7) to (12) the value level of health aid (i.e., health aid without any lag) was used along with the control variables. As suggested by Roodman (2009a), and similar to the approach taken by Mishra and Newhouse (2009), in the regression results, the number of instruments used in the process of estimating the GMM was reported with other relevant criterion.

According to the results, governance has negative significant effect on the Under Five Mortality Rate across almost all specifications. These results aligned with the existing literature (e.g., the study of Lin et al., 2014). Further, the coefficients of health

\textsuperscript{23} The heteroscedasticity and autocorrelation.
aid per capita in all specifications (see columns (7) to (12)) were not statistically significant nor were the coefficients of the last year’s health aid per capita\textsuperscript{24}. Columns (6) and (12) show the interactive terms between governance and health aid per capita (or lagged health aid per capita). As shown in the table, the relative coefficients were not significant.

As mentioned above, in the GMM Dynamic Panel, lagged variables were used as instruments to estimate a system of equations. Thus, the numbers of instruments reported in the table actually represent the number of lagged variables used for the purpose of estimation. The number of instruments and the number of lagged variables are highly dependent on the width of the panel (i.e., the number of years included in regression). As stated by Roodman (2009b), a large number of instruments can be a practical issue, as, if the number of instruments becomes relatively too large, the regression may suffer from over identification and loss of degrees of freedom. Further, as Roodman (2009a) also mentioned, the GMM Dynamic Panels are efficient in datasets with a relatively small $T$ and large $N$.

It was assumed that the regression in this study did not suffer from an over identification problem or a large number of instruments. There are at least three reasons to support this assumption. First, the data used in the regressions covered approximately 80 countries over a maximum period of 11 years.\textsuperscript{25} Thus, the $N$ was relatively large in the data. Second, Roodman’s (2009b) strategy was adopted, whereby the problems related to having a large number of instruments was avoided by controlling the maximum number of lags in the variables used as instruments. In the results (see Table 3.3), a maximum three-year lag was considered. Third, as a consequence of there being a relatively large number of countries in the data, there was a sufficient degree of

\textsuperscript{24} The effect of births attended by trained staff was also tested; however, the coefficient was insignificant in all specifications and thus the results were not reported.

\textsuperscript{25} For a detailed list of the countries used in the sample, see Appendix 6.5.
freedom in the regressions. Conversely, as pointed out by Bazzi and Clemens (2013), in the GMM weak instruments could also cause significant differences in the estimation results in a macroeconomic analysis. The issue of weak instruments in other types of estimators and, specifically, in estimators using the GMM, has been the subject of various studies, tests and software packages (e.g., the Weakiv package by Finlay and Magnusson, 2009). In this study, the Weakiv package was used to show that the model did not suffer from weak instruments (see Table 3.3 for the relative test results). The results suggest that the model and specifications did not suffer from any weak instrument issues. Further, the stability of regressions in GMM Dynamic Panels is commonly suggested by two criteria: the Sargan test\textsuperscript{26} and Arellano and Bond (1991)’s autocorrelation test.

\textsuperscript{26} For more details, see Sargan (1988).
Table 3.3: System GMM Dynamic Panel Data

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)</th>
<th>(10)</th>
<th>(11)</th>
<th>(12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good Governance</td>
<td>-0.115**</td>
<td>-0.118***</td>
<td>-0.142***</td>
<td>-0.116***</td>
<td>-0.139***</td>
<td>-0.154***</td>
<td>-0.110**</td>
<td>-0.137***</td>
<td>-0.156***</td>
<td>-0.137***</td>
<td>-0.146***</td>
<td>-0.173***</td>
</tr>
<tr>
<td></td>
<td>(0.0488)</td>
<td>(0.0330)</td>
<td>(0.0447)</td>
<td>(0.0358)</td>
<td>(0.0503)</td>
<td>(0.0422)</td>
<td>(0.0463)</td>
<td>(0.0391)</td>
<td>(0.0510)</td>
<td>(0.0422)</td>
<td>(0.0495)</td>
<td>(0.0514)</td>
</tr>
<tr>
<td>Health Aid per capita</td>
<td>0.0196**</td>
<td>0.0123</td>
<td>-0.00148</td>
<td>0.0122</td>
<td>0.00156</td>
<td>0.00222</td>
<td>0.00829</td>
<td>0.00864</td>
<td>0.0103</td>
<td>0.0108</td>
<td>0.00906</td>
<td>0.0111</td>
</tr>
<tr>
<td>Lagged per capita Health Aid</td>
<td>0.0213**</td>
<td>0.0120</td>
<td>0.00134</td>
<td>0.0112**</td>
<td>0.00175</td>
<td>0.00560</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(One year lagged)</td>
<td>(0.00862)</td>
<td>(0.00797)</td>
<td>(0.00852)</td>
<td>(0.00822)</td>
<td>(0.00656)</td>
<td>(0.00710)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log of GDP per capita</td>
<td>-0.212***</td>
<td>-0.128*</td>
<td>-0.124**</td>
<td>-0.135*</td>
<td>-0.144**</td>
<td>-0.113*</td>
<td>-0.199***</td>
<td>-0.130*</td>
<td>-0.135**</td>
<td>-0.135*</td>
<td>-0.135*</td>
<td>-0.118*</td>
</tr>
<tr>
<td></td>
<td>(0.0725)</td>
<td>(0.0740)</td>
<td>(0.0539)</td>
<td>(0.0710)</td>
<td>(0.0609)</td>
<td>(0.0584)</td>
<td>(0.0591)</td>
<td>(0.0680)</td>
<td>(0.0526)</td>
<td>(0.0728)</td>
<td>(0.0587)</td>
<td>(0.0607)</td>
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<tr>
<td>Immunisation, DPT</td>
<td>-0.0113***</td>
<td>-0.00714**</td>
<td>-0.00593**</td>
<td>-0.00687**</td>
<td>-0.00618*</td>
<td>-0.00473*</td>
<td>-0.0125***</td>
<td>-0.00937***</td>
<td>-0.00848***</td>
<td>-0.00857***</td>
<td>-0.00801***</td>
<td>-0.00580***</td>
</tr>
<tr>
<td></td>
<td>(0.00355)</td>
<td>(0.00301)</td>
<td>(0.00256)</td>
<td>(0.00320)</td>
<td>(0.00356)</td>
<td>(0.00281)</td>
<td>(0.00368)</td>
<td>(0.00298)</td>
<td>(0.00251)</td>
<td>(0.00315)</td>
<td>(0.00275)</td>
<td>(0.00244)</td>
</tr>
<tr>
<td>Literacy Rate, adult female</td>
<td>-0.0113***</td>
<td>-0.00842***</td>
<td>-0.00644**</td>
<td>-0.00841***</td>
<td>-0.00586**</td>
<td>-0.00827**</td>
<td>-0.0115***</td>
<td>-0.00658**</td>
<td>-0.00478**</td>
<td>-0.00676**</td>
<td>-0.00519*</td>
<td>-0.00670**</td>
</tr>
<tr>
<td></td>
<td>(0.00310)</td>
<td>(0.00287)</td>
<td>(0.00255)</td>
<td>(0.00307)</td>
<td>(0.00264)</td>
<td>(0.00316)</td>
<td>(0.00309)</td>
<td>(0.00280)</td>
<td>(0.00313)</td>
<td>(0.00237)</td>
<td>(0.00338)</td>
<td>(0.00340)</td>
</tr>
<tr>
<td>Health Expenditure (percentage of GDP)</td>
<td>-0.0299</td>
<td>-0.0264</td>
<td>-0.00589</td>
<td>-0.0282</td>
<td>-0.00343</td>
<td>-0.00753</td>
<td>-0.0287</td>
<td>-0.0159</td>
<td>0.000543</td>
<td>-0.0168</td>
<td>-0.00299</td>
<td>-0.00126</td>
</tr>
<tr>
<td></td>
<td>(0.0262)</td>
<td>(0.0244)</td>
<td>(0.0225)</td>
<td>(0.0256)</td>
<td>(0.0241)</td>
<td>(0.0229)</td>
<td>(0.0265)</td>
<td>(0.0244)</td>
<td>(0.0253)</td>
<td>(0.0242)</td>
<td>(0.0265)</td>
<td>(0.0222)</td>
</tr>
<tr>
<td>Health Expenditure (percentage of GDP)</td>
<td>0.0552***</td>
<td>0.0451***</td>
<td>0.0326***</td>
<td>0.0458***</td>
<td>0.0301***</td>
<td>-0.00525</td>
<td>0.0556***</td>
<td>0.0460***</td>
<td>0.0274***</td>
<td>0.0451***</td>
<td>0.0321***</td>
<td>0.00328***</td>
</tr>
<tr>
<td></td>
<td>(0.00925)</td>
<td>(0.00640)</td>
<td>(0.00896)</td>
<td>(0.00632)</td>
<td>(0.00096)</td>
<td>(0.00378)</td>
<td>(0.000573)</td>
<td>(0.00850)</td>
<td>(0.0113)</td>
<td>(0.00099)</td>
<td>(0.00800)</td>
<td>(0.00078)</td>
</tr>
<tr>
<td>Access to Improved Sanitation</td>
<td>-0.00385**</td>
<td>-0.00375</td>
<td>-0.00826***</td>
<td>-0.00413</td>
<td>0.0392***</td>
<td>-0.00646**</td>
<td>-0.00943</td>
<td>-0.00711*</td>
<td>-0.00406</td>
<td>0.0289**</td>
<td>(0.00071)</td>
<td>(0.00304)</td>
</tr>
<tr>
<td></td>
<td>(0.000304)</td>
<td>(0.00381)</td>
<td>(0.0142)</td>
<td>(0.00286)</td>
<td>(0.00454)</td>
<td>(0.00376)</td>
<td>(0.00457)</td>
<td>(0.00113)</td>
<td>(0.00478)</td>
<td>(0.00357)</td>
<td>(0.0042)</td>
<td>(0.0037)</td>
</tr>
<tr>
<td>Log of Population Density</td>
<td>-0.00400</td>
<td>0.0392</td>
<td>0.0266</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0286)</td>
<td>(0.0311)</td>
<td>(0.0335)</td>
<td>(0.0314)</td>
<td>(0.0482)</td>
<td>(0.0357)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Lagged) Health Aid per capita</td>
<td>0.000392</td>
<td>0.000593</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.000425)</td>
<td>(0.000337)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The dependant variable was the logarithm of the Under Five Mortality Rate and the robust HAC corrected standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. A robust two-step GMM was used that included Windmejer’s (2005) correction for finite samples. Time fixed effects were considered in all regressions. A detailed list of countries is provided in Appendix 6.5.
As robust standard errors were reported, the Hansen test was performed rather than the Sargan test. The null hypothesis of both tests is that ‘the instruments as a group are exogenous’; however, a Hansen test is reported when a robust option is used. In relation to both the Hansen and Sargan tests, higher P-values are appreciated. Further, the Arellano and Bond (1991) autocorrelation test evaluates the hypothesis of ‘No autocorrelation with $X$ lag(s)’ and was applied to the differenced residuals. Thus, in Table 3.3 the P-value for the null hypothesis of ‘No Autocorrelation with two lags (or an AR (2) process)’ was reported. Based on the reported statistics, all of the specifications in Table 3.3 appear to be acceptable. As shown in Figure 3.3, health aid and the Under Five Mortality Rate vary across different regions. To control for these variations, regional dummies were included in the regressions. Regional dummies were also used where there were any geographical characteristics common across countries that could have affected the Under Five Mortality Rate of all the countries in a specific region.

The insignificant coefficients of health aid per capita and lagged health aid per capita aligned with previous research (e.g., Mukherjee & Kizhakethalackal, 2013). Additionally, the significant negative coefficient of the logarithm of GDP per capita was as expected and as found in previous studies. The negative effect of adult female literacy and the positive effect of HIV prevalence on the Under Five Mortality Rate were statistically significant across all specifications. Despite the results of other studies, in this study, no statistical evidence was found of health expenditure (as a proportion of the GDP) having an effect on the Under Five Mortality Rate. Similarly, there was no evidence suggesting that population density had an effect on the Under Five Mortality Rate and no consistent significant effect was found in relation to the rate of access to improved sanitation.
Overall, the results do not confirm the hypothesis that health aid (either in the level or lagged form) affected the Under Five Mortality Rate. However, the results do show that the role of governance has a statistically significant and negative effect on the Under Five Mortality Rate. According to estimations in this study, a one unit increase in the level of governance could decrease the Under Five Mortality Rate by approximately 0.1 per cent.

3.5.2 Robustness Check: Quantile Regression

The results presented in the previous section revealed that governance has a statistical significant negative impact on the Under Five Mortality Rate. The findings in relation to the insignificant role of health aid aligned with previous studies (e.g., Mukherjee & Kizhakethalackal, 2013); however, to check the robustness of the results for both governance and health aid, a cross section quantile regression was conducted.

As a robustness check, quantile regression was deemed suitable for two main reasons. First quantile regression would reveal whether the results and findings were consistent across all levels of the Under Five Mortality Rate. In the dataset, some countries had extreme Under Five Mortality Rates (e.g., Somalia had a rate of 400) whereas other situations were less severe and had lower values (e.g., Turkemenistan had a rate of 80). The quantile regression provided insight into the stability of the results. Second, quantile regression was used because previous studies (e.g., Mukherjee & Kizhakethalackal, 2013) have shown that the effect of health aid on the Under Five Mortality Rate could be different in semi-parametric estimations. Thus, there was a need to test the equivalent hypothesis for both governance and health aid using quantile regression as one of the non-parametric regression methods.  

Quantile regressions can be categorised as non-parametric models, as they relax any preliminary assumptions about the parametric distribution of the errors.
To run the quantile regression, the dataset was collapsed using the means of variables across time. Collapsing the dataset also allowed the stability of the results in the cross section models to be checked alongside the panel data. Thus, the main equation changed to:

\[ Q_{UMFR}(\delta \mid H.Aid, X^H, GG, X^{SE}) = \beta_{0,\delta} + \beta_{1,\delta} H.AidPC + \beta_{2,\delta} X^H + \beta_{3,\delta} GG + \beta_{4,\delta} X^{SE} + \epsilon \]  

(3.3)

Where \( \delta \) could be 0.25, 0.50 or 0.75 quantiles. The results of the quantile estimation are presented in Table 3.4. In columns (1) to (3), the results of the different specifications for the three quantiles were presented. The specifications varied across the columns; however, the overall results appeared to be consistent across almost all specifications and quantiles (i.e., the four statistically significant determinants of the Under Five Mortality Rate (HIV prevalence, female literacy and immunisation rates as measured against DPT and the Log of GDP per capita) were robust across models. No evidence was found of health expenditure in the GDP having any effect on the Under Five Mortality Rate. Similarly, the results showed that access to improved sanitation did not have any statistically significant effect on the Under Five Mortality Rate.
Table 3.4: Results of Quantile Regression

<table>
<thead>
<tr>
<th>Quantiles</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
</tr>
<tr>
<td>Good Governance</td>
<td>-0.851</td>
<td>-1.06*</td>
<td>-0.988</td>
</tr>
<tr>
<td></td>
<td>(0.0610)</td>
<td>(0.0630)</td>
<td>(0.0614)</td>
</tr>
<tr>
<td>Health Aid per capita</td>
<td>0.00354</td>
<td>-0.00727</td>
<td>-0.00706</td>
</tr>
<tr>
<td></td>
<td>(0.00736)</td>
<td>(0.00788)</td>
<td>(0.00639)</td>
</tr>
<tr>
<td>Log of GDP per capita</td>
<td>-0.407***</td>
<td>-0.239**</td>
<td>-0.204**</td>
</tr>
<tr>
<td></td>
<td>(0.155)</td>
<td>(0.106)</td>
<td>(0.102)</td>
</tr>
<tr>
<td>Immunisation, DPT</td>
<td>-0.00332</td>
<td>-0.00866</td>
<td>-0.0151***</td>
</tr>
<tr>
<td></td>
<td>(0.00767)</td>
<td>(0.00643)</td>
<td>(0.00657)</td>
</tr>
<tr>
<td>Literacy Rate, adult female</td>
<td>-0.00999</td>
<td>-0.00661</td>
<td>-0.00375</td>
</tr>
<tr>
<td></td>
<td>(0.00653)</td>
<td>(0.00443)</td>
<td>(0.00455)</td>
</tr>
<tr>
<td>Health Expenditure (percentage of GDP)</td>
<td>-0.0502</td>
<td>-0.0366</td>
<td>0.00182</td>
</tr>
<tr>
<td></td>
<td>(0.0419)</td>
<td>(0.0392)</td>
<td>(0.0326)</td>
</tr>
<tr>
<td>Access to Improved Sanitation</td>
<td>-0.00915</td>
<td>-0.00224</td>
<td>0.000955</td>
</tr>
<tr>
<td></td>
<td>(0.00585)</td>
<td>(0.00423)</td>
<td>(0.00374)</td>
</tr>
<tr>
<td>HIV Prevalence</td>
<td>0.0461***</td>
<td>0.0356***</td>
<td>0.0303***</td>
</tr>
<tr>
<td></td>
<td>(0.00960)</td>
<td>(0.00673)</td>
<td>(0.00872)</td>
</tr>
<tr>
<td>Births by Trained Staff</td>
<td>-0.00201</td>
<td>0.00114</td>
<td>0.000287</td>
</tr>
</tbody>
</table>

The dependent variable is the logged Under Five Mortality Rate. All the variables were averaged over time. *** p<0.01, ** p<0.05, * p<0.1. Bootstrap standard errors are in parentheses. Seven geographical regions’ dummies were included in the regressions.
Based on the results set out in Table 3.4, there was no evidence of health aid having any effect on the Under Five Mortality Rate. Conversely, in relation to governance a negative effect was found in the quantile regression. Importantly, the magnitude of the effect of governance on the Under Five Mortality Rate (see Table 3.4) is quite similar to that detailed in Table 3.3. These robust findings across different models suggest that governance has a solid negative effect on the Under Five Mortality Rate.

3.6 Chapter Conclusion

According to findings of this study, governance has negative significant effect on the Under Five Mortality Rate; however, there was no statistical evidence that health aid per capita had an effect on the Under Five Mortality Rate. Health aid per capita was insignificant in both parametric and semi-parametric models. However, the following three determinants were also found to have a robust effect on the Under Five Mortality Rate: adult female literacy rate, prevalence of HIV and immunisation against DPT.

The conclusions drawn in relation to the affect of health aid per capita align with the studies of Mukherjee and Kizhakethalackal (2013). However, a solid, consistent conclusion can be derived in relation to the effect of governance on the Under Five Mortality Rate; that is, there is a statistically significant negative effect. This conclusion was robust across parametric and non-parametric settings and it was also replicated in panel data analysis and quantile regression across cross sections. Conclusions on the magnitude of the effect of governance can also be drawn; a one unit change in governance appears to reduce the Under Five Mortality Rate by approximately 0.1 per cent.
Reducing child mortality rates is not only one of the targets of the MDGs, but is also an important target for all developing countries. As the eighth MDG, both developed countries and development organisations provide financial aid to under developed and less developed countries. The results of this study show the effectiveness of health aid in reducing the Under Five Mortality Rate is not conclusive. Further, the effect of health aid (i.e., the total amount of aid allocated to health sector) is not robust across different specifications. Thus, to reduce the Under Five Mortality Rate in countries, it appears that strategies other than health aid might prove more effective.
Chapter 4: Dimensions of Governance and Carbon Dioxide Emissions

4.1 Introduction

Environmental issues have been a major focus of studies related to sustainable economic development. Following the introduction of the MDGs, political and economic interest in environmental issues increased. The seventh MDG seeks to ‘Ensure Environmental Sustainability’. Shortly after its introduction, reducing CO₂ emissions per capita was announced as the official indicator of the seventh MDG. A considerable amount of research has been conducted on CO₂ emissions; however, the factors and consequences related to CO₂ emissions and the links between CO₂ emissions and institutions such as governance have not been sufficiently studied or quantified. This study aimed sought to examine whether there was any relationship between dimensions of good governance and CO₂ emissions per capita.

Considerable research (e.g., Pellegrini & Gerlagh, 2006) has been undertaken on the influence of certain dimensions of governance (e.g., corruption and democracy) and their effect on the environment; however, no previous study has considered this effect in relation to the concept of governance as a whole or in relation to other governance dimensions. This research sought to fill this gap and contribute to the literature by studying the effect of six different dimensions of governance on CO₂ emissions per capita.

This study extended the empirical analysis by using the panel data instead of cross section as in previous studies. Further, this study examined whether there was any non-linear effect between governance, its dimensions and CO₂ emissions per capita. Unlike other studies, this study considered the effect of governance in relation to a practical
environmental indicator (i.e., CO₂ emissions per capita) rather than in relation to policies. Additionally, as CO₂ emissions per capita are also a MDG environmental indicator, this examined the quantitative relationship between dimensions of governance and the environmental aspects of MDGs.

As shown in Figure 4.1, CO₂ emissions have slowly, but gradually, continued to increase over the past century. According to the World Bank database, CO₂ emissions increased from approximately 4.6 metric tonnes per capita in the year 2000 to 4.9 metric tonnes per capita in the year 2010. Despite the slow speed of the increase, the potential factors associated with the increase in CO₂ emissions have attracted the attention of researchers.

The recognition of emissions as an economic problem can be attributed to the influential work of Hardin (1968). Later studies, such as Beckerman (1992), Nordhaus (1991, 1993) and Selden and Song (1994), explored the effective factors and their relationship with various aspects of emissions. Nordhaus (1991) provided a framework for analysing the economic effects of a number of greenhouse gases, including CO₂.
Beckerman (1992) illustrated how environmental issues were related to economic development and explained why the environment was not a central issue in the economic policies of developing countries. Nordhaus (1993) also extended the literature by studying the effects of climate change and global warming on economics.

Other authors have extended the model specification to capture the non-monotonic relationship between emissions and their determinant factors; for example, Selden and Song (1994) confirmed the existence of an inverted U-shaped relationship between four important air pollutants and economic development. Shafik (1994) extended the conceptual coverage of air pollutants and calculated the elasticity of different air pollutants in relation to income per capita. In general, despite varied approaches and perspectives, the studies conducted from 1990 to 2000 concentrated on the link between economic factors and environmental issues and confirmed the existence of a relationship between economic factors (e.g., GDP) and environmental issues (e.g., CO₂ emissions).

4.1.1 Governance and Emissions

Since North’s (1990) work, a number of studies have examined the effects of economic institutions on countries’ economic performances. Good governance is one of the most important institutions in any country. Due to the poor environmental performance of the Soviet Union’s economy, a new branch of literature developed to explore the possible effects of democracy (one of the dimensions of governance) on the promotion of economic and environmental welfare.

Studies examining the links between dimensions of governance and pollution can be categorised into two main groups. The first group of studies have focused on the impact of institutions on practical environmental indicators such as CO₂ or sulphur dioxide emissions. Conversely, studies in the second group have concentrated on the
formation and implementation of policies rather than practical indicators. Torras and Boyce (1998) found that democracy has a positive effect on environmental quality. Selden and Song (1994), Shafik (1994), Suri and Chapman (1998) and Torras and Boyce (1998) confirmed the existence of an inverted U-shaped relationship between sulphur dioxide, smoke, heavy particles, dissolved oxygen, faecal coliform and income per capita. In another study, Harbaugh et al. (2002) similarly found a consistent negative relationship between sulphur dioxide and levels of democracy.

Studies in the first group have focused on the environmental variables; however, studies in the second group (e.g., Congleton, 1992; Neumayer, 2002) have explored the link between democracy and environmental policy. Congleton (1992) demonstrated the positive effect of democracy on the probability of signing a global convention for the reduction of emissions of ozone depleting substances. Neumayer (2002) presented statistical evidence showing the positive effect democracy had on the environmental commitment of countries. Generally, such studies have concluded that democracy (as an aspect of governance) is a significant positive determinant of environmental protection.

Studies in this branch of literature are not limited to the effects of democracy. Callister (1999) examined the effect of corruption on environmental variables and emphasised the significant impact of corruption on forest management and conservation. Similarly, Mitra et al. (2000) presented a game theory model in which a government has two alternatives: to be re-elected and consequently remain in power and receive direct transfers from lobby groups or to ignore lobby groups and adopt a strict policy. Mitra et al. (2000) showed that corruption could be an influential factor in the choice of government and found that environmental policy strictness has a negative relationship with corruption. However, governance is a multi-dimensional concept and democracy and corruption are just two of its dimensions (Boeninger, 1991).
In relation to the effects of governance on the environment, some studies have adopted wider definitions of democracy and corruption to explore the relationship. Fredriksson and Svensson (2003) presented a theoretical model where the main factor was political instability, which they interpreted as the replacement rate of a government’s administration power. They showed that environmental policy making is significantly influenced by political instability and corruption. Additionally, Pellegrini and Gerlagh (2006) considered the effects of democracy on the environment and found that by using democracy and corruption as simultaneous explanatory variables, the negative effect of democracy was replaced by the more significant (negative) effect of corruption.

CO\textsubscript{2} emissions have been at the centre of international debates on environmental issues. This study focused on the relationship between different dimensions of governance and CO\textsubscript{2} emissions per capita and explored the possible non-linear relationship between CO\textsubscript{2} emissions per capita and different dimensions of governance. In exploring the relationship between governance and CO\textsubscript{2} emissions, it was expected that an inverted U-shape relationship between these variables would be found. The majority of studies have consistently concluded that there is an inverted U-shaped relationship between emissions and income per capita. The inverted U-shape or the Environmental Kuznets Curve (EKC) implies that up to a certain level of income per capita, emissions increase, but thereafter they begin to decrease.\textsuperscript{28}

Studies such as Chong and Calderon (2000) and Kaufmann and Kraay (2002) have argued that levels of governance have a positive effect on economic growth and income per capita. However, the effect of governance on CO\textsubscript{2} emissions is not limited to income per capita; governance could have a direct impact on different types of

\textsuperscript{28} Conversely, researchers such as Moomaw and Unruh (1997) argue for the existence of an Environmental Kuznets Curve.
emissions, including CO$_2$ emissions. This impact could occur through changes in the formation of environmental policies or changes relating to the enforcement of these policies.

Different dimensions of governance could have fundamentally different effects on CO$_2$ emissions. Increasing democracy (i.e., VA) would likely lead to a reduction in emissions; however, such a direct effect may not occur in other dimensions of governance. For example, increasing the level of democracy could foster economic development via the indirect effect of increasing education or human capital (Baum & Lake, 2003), which could in turn lead to more diverse perspectives and allow for more environmentally protective approaches to be adopted in policy designs. However, the effects of CC are more ambiguous. Corruption is known to have a negative impact on economic growth (Mauro, 1995). Consequently, CC might increase emissions, as it could increase economic growth (which is known to increase the pollution) (Shafik, 1994). Conversely, less corruption might increase the effectiveness of environmental policies and thus lessen pollution. Presently, the dominating channel is unknown. The effects of RL and RQ on pollution appear to be similar to the CC effects. The relationship appears even more ambiguous if all factors are considered, as it is possible that the effect one factor could have a comparatively greater effect upon the reduction of CO$_2$ emissions. For example, an increase in GE might increase income per capita and economic growth; however, it might also simultaneously reduce emissions by increasing the effectiveness and efficiency of governments.

In the following sections, the model and main equation of interest are introduced and the relevance of the chosen variables is explained. Then, the dataset, the variables and their definition are reviewed and a summary of the statistics used in the sample is provided. Following this, the methodology used for estimating the main equation is explained. Next, the results are set out, including the results of the estimations and the
efficiency tests (e.g., the results for the autocorrelation and heteroscedasticity tests). Then, the main findings are tested in semi-parametric setting and the equivalent results presented. Finally, the conclusions are set out and some final points are discussed.

4.2 Model and Methodology

As stated above, this study aimed to explore the effects of dimensions of governance on CO$_2$ emissions in both linear and non-linear forms. The proposed model was based on models from previous related studies. In its foundations, the model used is similar to Pellegrini and Gerlagh (2006)’s model; however, different variables were used and the equation was estimated using a panel data analysis (rather than a cross section analysis). Pellegrini and Gerlagh (2006) considered the effects of both corruption and democracy on the environmental performances of countries. Their main dependent variable was an environmental performance index$^{29}$ and they used the Polity IV and the Corruption Perception Index to measure of democracy and corruption, respectively. In this study the effects of governance dimensions on CO$_2$ emissions was studied, as was deemed to be more practical to measure emissions than changes in environmental policies. Below, the possible effect of the chosen variables on CO$_2$ emissions per capita is discussed.

4.2.1 Gross Domestic Product Per Capita

Various studies (e.g., Selden & Song, 1994; Shafik, 1994) have suggested a generally positive effect between CO$_2$ emissions and GDP per capita. Additionally, these studies have argued that the effect of GDP per capita on CO$_2$ emissions is not monotonic, but has a non-linear relationship with CO$_2$ emissions. These studies argued that as GDP per capita increases, CO$_2$ emissions increase up to a specified level, before

\footnote{Developed by Esty et al. (2008)}
beginning to decrease (Selden & Song, 1994; Shafik, 1994). The model in this study introduced the logarithm of GDP per capita and \((\log GDP\ \text{per capita})^2\) to control for non-linearity.

4.2.2 Urbanisation

According to Pellegrini and Gerlagh (2006) and Fredriksson and Svensson (2003), the rate of urbanisation has a positive effect on CO\(_2\) emissions. Generally, pollution is higher in urban areas than rural areas. Higher CO\(_2\) emissions in more populated areas have been associated with several factors such as increased pollution caused by transportation and a lack of greenery. Thus, in this study, the model assumed that urbanisation was a significant factor in CO\(_2\) emissions.

4.2.3 Education and Literacy

As found by Pellegrini and Gerlagh (2006), education can influence CO\(_2\) emissions. This could be related to the effect of education on the implementation of policies. This study controlled for education to capture any indirect effects that changes in human capital might have on CO\(_2\) emissions.

4.2.4 Population

To control for the effect of population on CO\(_2\) emissions per capita, the population rate was considered by the model as one of the control variables. A consideration of the population also benefits the model, as it reduced the possibility of endogeneity between GDP per capita and CO\(_2\) emissions per capita.

4.2.5 Governance and its Dimensions

Theoretically, each aspect of governance could have individual and separate effects on CO\(_2\) emissions. The effect of some dimensions of governance (e.g., CC) on
CO₂ emissions might be meaningful to environmental policies; however, the possible impact of other dimensions of governance (e.g., VA) are more independent and changes in these dimensions could trigger policy changes or lead to the creation of a new policy. It should be noted that in this study, it was assumed that ‘no policy’ was a political direction or choice that could affect the dimensions of governance (e.g., VA).

VA can be viewed as being relatively close to democratic (or autocratic) dimensions of governance. In a fully autocratic setting, individuals in power look to maximise their own utility (or profit) and thus may ignore related negative effects on the environment. Conversely, democracy provides opportunities to accommodate more diversity and different ideas and, consequently, can result in the creation of political parties with specific visions and aims (e.g., ‘Green Parties’). Similarly, in countries with better VA, political parties try to obtain more votes; thus, their policies need to address aspects of their electorates’ lives, health, wellbeing and environment.

RQ is another dimension of governance that could affect CO₂ emissions. RQ measures the ability of the government to formulate and implement sound policies and regulations that permit and promote the development of the private sector. In the context of environmental policies, this dimension could measure the tendency of policies towards the private sector or refer to the strictness of the environmental policies that the private sector has to adopt. Clearly, policies that are easier for the private sector to adopt and implement will be more applicable. Thus, it was expected that any increase in RQ would result in a decrease in CO₂ emissions.

RQ and VA are directed at the design of policies. Conversely, other dimensions of governance (e.g., CC, RL and GE) are directed at the implementation and enforcement of policies and laws. Theoretically, it was expected that countries with higher/better CC would better enforce existing laws and have less deviations from the rules (e.g., environmental protection laws, including CO₂ emission permits). RL shows the extent...
to which designed laws are in place. It is possible that despite official rules, norms may be in place and people may follow a set of rules that are not aligned with any policies.

PV refers to the possibility that a government may be destabilised or overthrown by unconstitutional or violent means, including politically motivated violence and terrorism. In relation to CO₂ emissions, PV implies that anybody could design, implement and run policies, including environmental protection policies. Thus, theoretically, it was expected that an increase in the stability of a central government would reduce CO₂ emissions or at least keep emissions constant.

Given the above, in the general model, two equations were considered as the main equations (i.e., equations (4.1) and (4.2)).

\[
CO₂EPC_{it} = \alpha_0 + \alpha_1 GG_{it} + \alpha_2 \log GDPPC_{it} + \alpha_3 (\log GDPPC_{it})^2 \\
+ \alpha_4 Lit_{it} + \alpha_5 \log Pop Dens_{it} + \alpha_6 p_{it} + \epsilon_{it}
\]  

(4.1)

and

\[
CO₂EPC_{it} = \beta_0 + \beta_1 - \delta WGI_{it} + \beta_2 \log GDPPC_{it} + \beta_3 (\log GDPPC_{it})^2 \\
+ \beta_4 Lit_{it} + \beta_5 \log Pop Dens_{it} + \beta_6 Pop_{it} + \mu_{it}
\]  

(4.2)

In which:

- \(CO₂EPC\) is the CO₂ emissions metric tonnes per capita;
- \(WGI\)s refers to the six WGI\s;
- \(GG\) is the proxy for governance;\(^{30}\)
- \(GDPPC\) is the GDP per capita, PPP (current international $);
- \(Lit\) is the literacy rate, adult total (for a percentage of people aged 15 years and above);
- \(PopDens\) is Population Density (i.e., people per square kilometre);

\(^{30}\) These variables are explained in more detail in the data section.
- \( \text{Pop} \) is Population; and
- \( \mu_{it} \) and \( \epsilon_{it} \) are error terms.

The coefficients of \( \beta_1 \) to \( \beta_6 \) and the coefficient of \( \alpha_1 \) were included out of interest. Equations (4.1) and (4.2) provide a general framework for the estimations and regressions in linear form and the squared term of some variables were used to test the hypotheses on non-linearity.

To answer the main question of this study, a LS panel data with fixed effects was used. As expected, the individual characteristics of countries were important in the estimation. Equation (4.1) was estimated to explore the general link between governance and \( \text{CO}_2 \) emissions per capita. In equation (4.2), different dimensions of governance were added one by one to determine which of these dimensions had the greater deterministic impact on \( \text{CO}_2 \) emissions per capita. It should be noted that it was assumed that the indicators of the dimensions of governance constructed by Kaufman et al. (1999) were independent and measured different dimensions.

The model was tested for the existence of time effects and fixed effects against random effects and its stability was then examined by checking for the presence of heteroscedasticity and serial correlation. To control for presence of endogeneity originating from GDP per capita, the log of population was considered as an explanatory variable in the model. Further, to test the inverted U-shaped relationship between governance (and its dimensions) and \( \text{CO}_2 \) emissions per capita, the main equations were estimated in quadric form. Establishing the stability of the model, to examine the non-linearity effect further, the relationship was examined using a semi-parametric panel data analysis. In semi-parametric settings, it is assumed that the main function (that relates the out of interest variables to the LHS variable) is unknown.
As stated above, it was assumed that a ‘no policy’ approach was a policy choice that could be altered by governance dimensions. However, it was also considered desirable to check which countries had environmental policies. In doing this, two main sources were referred to: (1) The World Law Guide, which was also used in the studies of Campos and Nugent (2012) and Rowan (2009); and (2) the accreditation of ISO 14001 across countries. Data from both sources confirmed that all of the countries in this dataset had some kind of environmental policy. Thus, the effect of the dimensions of governance on CO₂ emissions became more interpretable.

4.3 Data

One aim of this study was to find a link between different dimensions of governance and CO₂ emissions per capita; thus, the latter became the dependent variable. CO₂ emissions are those that stem from the burning of fossil fuels and the manufacture of cement. They also include the CO₂ produced during the consumption of solid, liquid, gas fuels and gas flaring. CO₂ emissions per capita are measured by tonnes and reported as a ratio. In this study, data available through the World Bank database was used. Despite some variation across different countries, CO₂ emissions per capita have not fluctuated largely over time. In Figure 4.2, the average CO₂ emissions per capita for all countries are presented. Despite some slight fluctuations, CO₂ emissions per capita have increased since 1990.

---

31 Wikipedia states that the ‘ISO 14001 sets out the criteria for an Environmental Management System (EMS). It does not state requirements for environmental performance, but maps out a framework that a company or organisation can follow to set up an effective EMS. It can be used by any organisation that wants to improve resource efficiency, reduce waste, and drive down costs. Using ISO 14001 can provide assurance to company management and employees as well as external shareholders that environmental impact is being measured and improved. ISO 14001 can also be integrated with other management functions and assists companies in meeting their environmental and economic goals’.
This study set out to find the possible effects of governance and its dimensions on CO₂ emissions. The main explanatory variables included the indicator that measured the level of governance and the indicators that measured the different dimensions of governance. A proxy indicator was constructed for the level of governance using PCA. PCA was applied to the WGIs introduced and implemented by Kaufmann et al. (1999).³²

Using the available data, a scatter graph between governance and CO₂ emissions per capita was plotted (see Figure 4.3). Without controlling for other characteristics, the results suggested a modest positive link between governance and CO₂ emissions per capita (see Figure 4.3). Two key observations should be noted. First, there are several data points that have almost the same amount of CO₂ emissions, but very different values of governance. Second, the observed slight positive link could originate from other characteristics of countries besides governance. Thus, a regression analysis that controlled for some of these characterises was conducted to determine whether there was a clear correlation.

³² For more details on PCA and the WGIs see Appendix 6.4. Also, please see Section 1.2 where the reasons for not using the proposed methodology are explained.
In the sample, the mean of the CO$_2$ emissions was 4.76 tonnes per capita with a variation of approximately 0.012 tonnes (i.e., 12 Kg) to 61.62 tonnes per person. As the maximum and minimum suggest, the standard deviation was large (i.e., there was a standard deviation of 8.169). Table 4.1 presents the descriptive statistics of the data. Six dimensions of governance were included in the regression. Their averages were close; however, they had different minimums and maximums. CC had the highest maximum of 2.28 and RQ had the lowest minimum of -2.098. The constructed proxy for governance varied from -3.479 (the worst) to 3.789 (the best) and its mean was approximately -0.74. The rate of adult literacy had a maximum of approximately 100 per cent and a minimum just below 13 per cent. The average of 7.686 of log of GDP per capita implied that the countries included in sample had an average of 7.68 Log (GDP per capita). Additionally, the countries included in the sample had a maximum of 9.748 and 21.014 for the Log of population density and population, respectively.
Table 4.1: Summary Statistics of the Variables in the Sample

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs.</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO$_2$ Emissions (metric tonnes per capita)</td>
<td>283</td>
<td>4.038</td>
<td>8.169</td>
<td>0.0129</td>
<td>61.623</td>
</tr>
<tr>
<td>Proxy for Governance</td>
<td>283</td>
<td>-0.743</td>
<td>1.473</td>
<td>-3.479</td>
<td>3.789</td>
</tr>
<tr>
<td>Voice and Accountability (VA)</td>
<td>283</td>
<td>-0.358</td>
<td>0.729</td>
<td>-1.799</td>
<td>1.256</td>
</tr>
<tr>
<td>Government Effectiveness (GE)</td>
<td>283</td>
<td>-0.279</td>
<td>0.655</td>
<td>-1.768</td>
<td>2.255</td>
</tr>
<tr>
<td>Rule of Law (RL)</td>
<td>283</td>
<td>-0.371</td>
<td>0.688</td>
<td>-1.877</td>
<td>1.683</td>
</tr>
<tr>
<td>Regulatory Quality (RQ)</td>
<td>283</td>
<td>-0.215</td>
<td>0.694</td>
<td>-2.098</td>
<td>2.119</td>
</tr>
<tr>
<td>Control of Corruption (CC)</td>
<td>283</td>
<td>-0.301</td>
<td>0.682</td>
<td>-1.815</td>
<td>2.289</td>
</tr>
<tr>
<td>Political Stability and Absence of Violence (PV)</td>
<td>283</td>
<td>-0.425</td>
<td>0.875</td>
<td>-2.673</td>
<td>1.392</td>
</tr>
<tr>
<td>Adult Literacy (percentage)</td>
<td>283</td>
<td>78.164</td>
<td>21.241</td>
<td>12.848</td>
<td>99.79</td>
</tr>
<tr>
<td>Log of GDP per capita</td>
<td>283</td>
<td>7.686</td>
<td>1.425</td>
<td>4.870</td>
<td>11.348</td>
</tr>
<tr>
<td>Log of Population Density</td>
<td>283</td>
<td>4.100</td>
<td>1.340</td>
<td>0.433</td>
<td>9.748</td>
</tr>
<tr>
<td>Log of Population</td>
<td>283</td>
<td>16.317</td>
<td>1.723</td>
<td>11.335</td>
<td>21.014</td>
</tr>
</tbody>
</table>

In Table 4.2, the variables, their definitions and sources of data are presented. A detailed list of the countries considered by the sample can be seen in Appendix 6.6.
Table 4.2: Definitions of Variables and their Data Sources

<table>
<thead>
<tr>
<th>Variable laten in 4.2: Definitions of Variables and their Data Sources</th>
<th>Definition</th>
<th>Source of Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂ Emissions per capita (metric tonnes per capita)</td>
<td>CO₂ emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during the consumption of solid, liquid, gas fuels and gas flaring</td>
<td>Worldwide Governance Indicators database</td>
</tr>
<tr>
<td>Adult Literacy (percentage of population)</td>
<td>The adult (i.e., aged 15 years and above) literacy rate (as a percentage). The total is the percentage of the population aged 15 years and above who can, with understanding, read and write a short, simple statement on their everyday life</td>
<td>The World Development Indicators</td>
</tr>
<tr>
<td>GDP per capita (current US$)</td>
<td>GDP per capita is the gross domestic product divided by mid year population. Data is in current US dollars</td>
<td>The World Development Indicators</td>
</tr>
<tr>
<td>Population Density (people per sq. km of land area)</td>
<td>Population density is mid year population divided by land area in square kilometres. Land area is a country's total area, excluding the area under inland water bodies, national claims to continental shelves and exclusive economic zones</td>
<td>The World Development Indicators</td>
</tr>
<tr>
<td>Total Population</td>
<td>Total population is based on the de facto definition of population that counts all residents regardless of legal status or citizenship—except for refugees not permanently settled in the country of asylum and who are generally considered part of the population of their country of origin. The values shown are mid year estimates</td>
<td>The World Development Indicators</td>
</tr>
<tr>
<td>The Worldwide Governance Indicators (WGI)</td>
<td>These aggregate indicators combine the views of a large number of enterprises, citizens and expert survey respondents in industrial and developing countries. Aggregate and individual governance indicators for 215 countries and territories over the period 1996–2012 for six dimensions of governance</td>
<td>Worldwide Governance Indicators database</td>
</tr>
</tbody>
</table>

4.4 Results

In this section, the results of the estimating equations (4.1) and (4.2) are presented (see Table 4.3). The results suggest that there is a significant, negative relationship between the proxy for good governance and CO₂ emissions per capita (see column (1) in Table 4.3). Further, according to the results presented in columns (2)–(6) in Table 4.3, there is strong (statistically highly significant) negative relationship between CC and CO₂ emissions per capita. Table 4.3 shows a significant negative effect for political stability across all specifications (see columns (2)–(6)). However, the effect of RL and RQ appear to be insignificant across all specification models.
Interestingly, the sign of the significant coefficient for VA in column (3) of Table 4.3 was unexpected. A positive coefficient implies that an increase in VA would increase CO$_2$ emissions per capita. Another interesting result was the significant and positive coefficients of adult literacy; these results contradicted the findings of earlier studies. Notably, the highly significant positive effect of population density on CO$_2$ emissions per capita were expected and aligned with the literature.\textsuperscript{33} It should also be noted that the results shown in columns (1)–(5) of Table 4.3 display the results with fixed effects in the cross sections (i.e., one-way fixed effects).

Columns (2)–(6) in Table 4.3 suggest that a maximum of three dimensions of governance might have a statistically significant effect on CO$_2$ emissions per capita. The results in those columns were derived from a one-way fixed effect panel data regression. To check the existence of a two-way fixed effect, a regression containing three possibly significant dimensions was repeated with the year dummy variables to capture the time effects and equivalent results (see column (7)). By considering the time effects alongside the fixed effects, the significance of political stability disappeared.\textsuperscript{34}

Table 4.3 presented the fixed effects results, based on the assumption that each country would have its own environmental characteristics. The Hausman test results confirmed this assumption. According to the Hausman test results, the test’s null hypothesis that random effects are consistent was rejected.\textsuperscript{35} This implied that the model estimated using fixed effects was consistent. To test for serial correlation, the test suggested by Wooldridge (2002, ch 10) was used, where the calculated F-value of the test was 20.25 (i.e., $F (1,11) = 20.25$); its probability of 0.0009 suggested that the null

\textsuperscript{33} Pellegrini and Gerlagh’s (2006) main equation estimated the urban growth rate and schooling of adults who had completed secondary school; however, the overall results of this study did not align with the literature or the author’s expectations.

\textsuperscript{34} For more detailed results of the two-way fixed effect regression see Appendix 6.7.

\textsuperscript{35} See Hausman (1978) and Baum (2006). Note: Hausman’s test states: $\chi^2 (11) = 503.80$ & Prob $\geq \chi^2 = 0.000$. 

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hypothesis of no autocorrelation should be strongly rejected and that there was high autocorrelation in the estimations. Further, the model was also checked for heteroscedasticity. The results of the modified Wald statistic for group wise heteroscedasticity implemented by Baum (2000), suggested that the model also suffered from heteroscedasticity.
<table>
<thead>
<tr>
<th>Governance Proxy</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voice and</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accountability</td>
<td>0.771</td>
<td>1.126*</td>
<td>0.925</td>
<td>0.892</td>
<td>0.880</td>
<td>0.703</td>
<td></td>
</tr>
<tr>
<td>(VA)</td>
<td>(0.655)</td>
<td>(0.669)</td>
<td>(0.659)</td>
<td>(0.673)</td>
<td>(0.663)</td>
<td>(0.470)</td>
<td></td>
</tr>
<tr>
<td>Control of</td>
<td>-2.028*</td>
<td>-1.868*</td>
<td>-2.074*</td>
<td>-2.010*</td>
<td>-1.904*</td>
<td>-1.367*</td>
<td></td>
</tr>
<tr>
<td>Corruption (CC)</td>
<td>(1.062)</td>
<td>(1.018)</td>
<td>(1.053)</td>
<td>(1.112)</td>
<td>(0.992)</td>
<td>(0.764)</td>
<td></td>
</tr>
<tr>
<td>Political</td>
<td>-0.794**</td>
<td>-0.910**</td>
<td>-0.898**</td>
<td>-0.880**</td>
<td>-0.306</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stability (PV)</td>
<td>(0.337)</td>
<td>(0.348)</td>
<td>(0.358)</td>
<td>(0.344)</td>
<td>(0.285)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rule of Law (RL)</td>
<td>0.802</td>
<td>0.853</td>
<td>0.932</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.656)</td>
<td>(0.635)</td>
<td>(0.720)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulatory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality (RQ)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government</td>
<td>-0.335</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effectiveness (GE)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log of Population</td>
<td>164.9***</td>
<td>-166.9***</td>
<td>-158.1***</td>
<td>-162.9***</td>
<td>-164.7***</td>
<td>-164.1***</td>
<td>-190.5***</td>
</tr>
<tr>
<td>(26.61)</td>
<td>(23.60)</td>
<td>(23.26)</td>
<td>(23.03)</td>
<td>(25.97)</td>
<td>(27.02)</td>
<td>(19.55)</td>
<td></td>
</tr>
<tr>
<td>Log of Population</td>
<td>149.5***</td>
<td>152.6***</td>
<td>143.5***</td>
<td>148.0***</td>
<td>149.7***</td>
<td>149.0***</td>
<td>171.3***</td>
</tr>
<tr>
<td>Density</td>
<td>(31.71)</td>
<td>(27.49)</td>
<td>(27.00)</td>
<td>(26.50)</td>
<td>(29.38)</td>
<td>(30.63)</td>
<td>(20.12)</td>
</tr>
<tr>
<td>Adult Literacy</td>
<td>0.0735**</td>
<td>0.0414</td>
<td>0.0461*</td>
<td>0.0429*</td>
<td>0.0432*</td>
<td>0.0457*</td>
<td>0.0237</td>
</tr>
<tr>
<td>(0.0299)</td>
<td>(0.0258)</td>
<td>(0.0241)</td>
<td>(0.0232)</td>
<td>(0.0228)</td>
<td>(0.0249)</td>
<td>(0.0205)</td>
<td></td>
</tr>
<tr>
<td>Log of GDP per</td>
<td>7.364**</td>
<td>6.490**</td>
<td>6.921**</td>
<td>7.287***</td>
<td>7.317***</td>
<td>7.324***</td>
<td>3.631*</td>
</tr>
<tr>
<td>capita</td>
<td>(3.323)</td>
<td>(2.807)</td>
<td>(2.723)</td>
<td>(2.762)</td>
<td>(2.708)</td>
<td>(2.729)</td>
<td>(1.962)</td>
</tr>
<tr>
<td>(Log GDP per</td>
<td>-0.311*</td>
<td>-0.259</td>
<td>-0.287*</td>
<td>-0.311**</td>
<td>-0.312**</td>
<td>-0.312**</td>
<td>-0.179</td>
</tr>
<tr>
<td>capita)²</td>
<td>(0.177)</td>
<td>(0.157)</td>
<td>(0.154)</td>
<td>(0.156)</td>
<td>(0.154)</td>
<td>(0.155)</td>
<td>(0.131)</td>
</tr>
<tr>
<td>Year Dummy</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Constant</td>
<td>2.038***</td>
<td>2.064***</td>
<td>1.956***</td>
<td>2.015***</td>
<td>2.037***</td>
<td>2.030***</td>
<td>2.389***</td>
</tr>
<tr>
<td>(320.2)</td>
<td>(284.4)</td>
<td>(280.4)</td>
<td>(278.2)</td>
<td>(314.1)</td>
<td>(326.6)</td>
<td>(243.5)</td>
<td></td>
</tr>
<tr>
<td>R-squared</td>
<td>0.548</td>
<td>0.571</td>
<td>0.587</td>
<td>0.591</td>
<td>0.591</td>
<td>0.592</td>
<td>0.683</td>
</tr>
</tbody>
</table>

The dependant variable was CO₂, the PC and Robust standard errors are in parentheses. (HAC robust SE) - *** p<0.01, ** p<0.05, * p<0.1

In column (1), equation (4.1) was estimated including the proxy variable for good governance. In column (2), two dimensions of governance, namely Voice and Accountability (VA) and Control of Corruption (CC), were considered. In column (6), all six dimensions of governance as measured by the six WGIs were included in the regression. The number of observations was 283, across 125 countries. For a list of the countries included in the sample, see Appendix 6.6.
Following the suggestion of Wooldridge (2002) and Stock and Watson (2008), the cluster and robust options available in the software Stata® for fixed effect models were used to correct for heteroscedastic and autocorrelation. All the results reported in the Table 4.3 include robust standard errors. Further, to control for a potential endogeneity originating from the denominator of CO$_2$ emissions per capita and GDP per capita, log of population was considered as an explanatory variable.

Table 4.4 shows the results of regressions with robust standard errors corrected for autocorrelation and heteroscedasticity. As mentioned above, this study explored the possible non-linearity of relationships between dimensions of governance and CO$_2$ emissions per capita. Thus, in the results shown in Table 4.4, the squared value of VA, CC and PV were considered. In the results reported, the squared terms of these variables were considered (see column (10)) and it was shown that there was a non-linear link between the CC and CO$_2$ emissions per capita. Considering the significant negative of effect CC in both level and squared terms, it could be concluded that up to a specific level of CC, CO$_2$ emissions decrease with an increasing trend; however, after a certain point, CO$_2$ emissions decrease with a downward trend. From the results, it appeared that CC was an important determinant of CO$_2$ emissions with a presence of threshold effects.
Table 4.4: Non-Linear Relationship, HAC Robust SE

<table>
<thead>
<tr>
<th></th>
<th>(8)</th>
<th>(9)</th>
<th>(10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voice and Accountability (VA)</td>
<td>0.198</td>
<td>0.715</td>
<td>0.773</td>
</tr>
<tr>
<td></td>
<td>(0.667)</td>
<td>(0.659)</td>
<td>(0.662)</td>
</tr>
<tr>
<td>Control of Corruption (CC)</td>
<td>-1.333*</td>
<td>-2.429***</td>
<td>-2.335***</td>
</tr>
<tr>
<td></td>
<td>(0.738)</td>
<td>(0.781)</td>
<td>(0.765)</td>
</tr>
<tr>
<td>Political Stability (PV)</td>
<td>-0.316</td>
<td>-0.145</td>
<td>-0.779</td>
</tr>
<tr>
<td></td>
<td>(0.289)</td>
<td>(0.285)</td>
<td>(0.535)</td>
</tr>
<tr>
<td>(Voice and Accountability)^2</td>
<td>-0.487</td>
<td>0.427</td>
<td>0.480</td>
</tr>
<tr>
<td></td>
<td>(0.457)</td>
<td>(0.459)</td>
<td>(0.475)</td>
</tr>
<tr>
<td>(Control of Corruption)^2</td>
<td>-1.995***</td>
<td>-1.909***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.637)</td>
<td>(0.627)</td>
<td></td>
</tr>
<tr>
<td>(Political Stability)^2</td>
<td>-0.343</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.231)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log of Population</td>
<td>-194.9***</td>
<td>-223.1***</td>
<td>-211.1***</td>
</tr>
<tr>
<td></td>
<td>(19.21)</td>
<td>(20.85)</td>
<td>(17.66)</td>
</tr>
<tr>
<td>Log of Population Density</td>
<td>175.6***</td>
<td>208.6***</td>
<td>196.5***</td>
</tr>
<tr>
<td></td>
<td>(19.53)</td>
<td>(21.28)</td>
<td>(17.92)</td>
</tr>
<tr>
<td>Adult Literacy</td>
<td>0.0198</td>
<td>0.0340*</td>
<td>0.0296</td>
</tr>
<tr>
<td></td>
<td>(0.0212)</td>
<td>(0.0203)</td>
<td>(0.0186)</td>
</tr>
<tr>
<td>Log of GDP per capita</td>
<td>3.600*</td>
<td>2.119</td>
<td>2.948*</td>
</tr>
<tr>
<td></td>
<td>(1.926)</td>
<td>(1.905)</td>
<td>(1.623)</td>
</tr>
<tr>
<td>(Log of GDP per capita)^2</td>
<td>-0.164</td>
<td>-0.115</td>
<td>-0.170</td>
</tr>
<tr>
<td></td>
<td>(0.128)</td>
<td>(0.124)</td>
<td>(0.106)</td>
</tr>
<tr>
<td>Constant</td>
<td>2,443***</td>
<td>2,776***</td>
<td>2,627***</td>
</tr>
<tr>
<td></td>
<td>(239.8)</td>
<td>(258.9)</td>
<td>(219.5)</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.686</td>
<td>0.774</td>
<td>0.779</td>
</tr>
</tbody>
</table>

The dependent variable was CO2, the PC and robust standard errors are in parentheses. 
*** p<0.01, ** p<0.05, * p<0.1. 
Year dummies have been included in the regression, but for the purpose of saving space they 
were not reported. 
The number of observations was 283 across 125 countries. For a list of the countries included 
in the sample, see Appendix 6.6.
4.4.1 Semi-Parametric Panel Data

One of the major contributions of this study was its argument that there is a non-linear relationship between dimensions of governance and CO$_2$ emissions per capita. The results showed an inverted U-shaped relationship between CC and CO$_2$ emissions in the LS panel data with fixed effects. However, this non-linearity is based on a quadric form of the main equation and does not include other forms. To clear the ambiguity around the non-linearity effect, the parametric assumption of the main model was relaxed and the equation was estimated using a semi-parametric method. In this section, it was assumed that the function relating the variable of the CC to CO$_2$ emissions was unknown. With such an assumption, the main model changed to a partially linear model with the following equation (4.3):

\[
CO_2EPG_{it} = \gamma_0 + \gamma_jX_{it} + f(CC_{it}) + \omega_{it}
\]  

In which:

- $X_{it}$ is the vector of control variables, as previously mentioned in equation (4.2);
- $CC_{it}$ is Control of Corruption; and
- $\omega_{it}$ is the normally distributed error term.

Equation (4.3) was estimated using panel data with fixed effects following the semi parametric regression methodology introduced by Baltagi and Li (2002) and using the Stata® module of Verardi and Libois (2012). In Figure 4.4, the estimated function is presented using a semi-parametric equation.

The results in Figure 4.4 show the non-linearity of the relationship between CO$_2$ emissions and CC and that CO$_2$ emissions have an increasing trend up to a specific level of CC, but a decreasing trend thereafter. According to the results of this study, there was an inverted U-shaped relationship between CC and CO$_2$ emissions per capita. The
results from the LS panel data suggested a quadric form of equation relating CC to CO₂ emissions per capita; however, the existence of a non-linear link was also confirmed in the semi-parametric model.\textsuperscript{36}

\begin{figure}[h]
\centering
\includegraphics[width=0.7\textwidth]{figure02.png}
\caption{Predicted CO₂ Emissions per Capita versus Control of Corruption}
\end{figure}

4.5 Chapter Conclusions

As mentioned in previous sections, despite several studies on the deterministic factors of emissions, prior to Pellegrini and Gerlagh’s (2006) study, no research had considered democracy and corruption as two dimensions of governance in one model or considered their possible simultaneous effect on the environment. Pellegrini and Gerlagh (2006) studied the relationship in a cross sectional model. In this study, the research was extended to accommodate six different dimensions of good governance promoted by the World Bank in a panel data setting. Additionally, in this study CO₂ emissions per capita (one of the indicators of the seventh MDG) were studied as main dependent variable and at the same time as a practical (i.e., de facto) environmental

\textsuperscript{36}As according to the figure it was suspected that a few observations made the relationship nonlinear, those observations were omitted and model was re-estimated. The results did not differ.
variable. Thus, it was shown that various dimensions of governance could affect a real condition of the environment.

It was also found that three of the dimensions of governance (i.e., RQ, GE and RL) did not have any statistically significant effects on CO$_2$ emissions reduction. However, the negative effect of CC seems unquestionable in any form of the model. Additionally, the effect of VA disappeared when the variable of RL was considered in the model. However, the other aspect of governance, PV, was insignificant after controlling for serial correlation and heteroscedasticity with two-way fixed effects. Thus, it was shown that CC had a statistically significant negative role on CO$_2$ emissions per capita. It was also shown that there is a maximum level of CC contributing to CO$_2$ emissions reduction and, after a specific point, the negative effect of CC on CO$_2$ emissions decreases.

The findings in this study showed that CC has a significant role on CO$_2$ emission reduction. Given that almost no statistical evidence was found of the other dimensions of governance having an affect, it appears that the amount of CO$_2$ emissions is related more to operational aspects of governance than to decision-making processes (i.e., democratic or bureaucratic). Thus, in relation to CO$_2$ emissions, a country’s political system was not significant, as reductions in CO$_2$ emissions were more related to how existing regulations and laws worked and were enforced than to how these rules were created. Thus, in relation to the effects of governance on the practical measure of the environment, CC plays an important role and policy makers and strategists in countries should focus on reforms aimed at increasing the level of CC rather than other dimensions. These findings also suggest that rather than engaging in political debates to accommodate more ‘green’ political parties in decision-making systems, policy makers should concentrate on how existing regulations are executed and ruled.
Chapter 5: Conclusion

This study sought to find a relationship between the concept of good governance and economic development as measured by the targets of the MDGs. It found that governance has positive effects in countries’ achieving the MDGs. However, it was also found that good governance should accompany other effective economic elements such as GDP growth.

In examining the relationship between governance and economic development, one of the main challenges for researchers is selecting an indicator of governance. Governance is a multi-dimensional concept and researchers have studied these dimensions using different measures and indicators. In the absence of a single governance indicator, creating a proxy for governance via a known statistical method (such as PCA) is justifiable; however, the establishment of a single indicator that captures governance as a whole is vital. Thus, in Chapter 2, a new governance indicator was proposed. This new indicator was shown to capture a more accurate picture of governance. These results were further confirmed in the simulation study. Additionally, in Chapter 2, the application of the MIMC methodology, pioneered by Goldberger (1972) and Jöreskog and Goldberger (1975), was extended. To date, the majority of studies that have used the MIMC methodology have assumed that the error terms associated with the indicators were independent. However, in this study, a structure was imposed on a covariance of error terms and the assumption of the independent error terms were relaxed.

The proposed governance indicator followed the same definition of governance as the WGI; however, it adopted a better methodology. Thus, a more precise picture of governance was delivered. Using the same input data, the same dimensions of the WGI
were reproduced with the new methodology. The results showed that the WGIs understate the values of governance for countries with good governance and their general trend is significantly flatter. A simulation study was conducted in which a value of governance for each country was generated and the estimated indicators and rankings of countries were compared using competing methodologies. The simulation results confirmed the initial findings. However, before an ‘official’ governance indicator can be established, further studies are required that accommodate more indicators and cover longer periods of time and more dimensions.

In the literature on economic development, several measures and various indicators exist. However, since 2000, the targets and indicators of the MDGs have been used in different research contexts. Studying all the aspects of the MDGs is beyond the capacity of any one study. Thus, this project was limited to studying some of the specific goals of the MDGs. Specifically, this study focused on the effect of governance on child mortality as a health target and CO₂ emissions as an indicator of the environmental aspect of the MDGs. In general, good governance has a positive effect on the achievement of the MDGs.

The health aspect of the MDGs was the first dimension studied. Chapter 3, considered the effect of both health aid and governance on child mortality, one of the health indicators of the MDGs. Good governance can change the level of the Under Five Mortality Rate in two ways. First, by ensuring that countries adopt and implement appropriate policies and, second, by positively influencing the effectiveness of health aid. Thus, both health aid and governance were considered in this study. To date, no consensus has been reached on the effect of financial aid allocated to the health sector on child mortality. Some studies (e.g., Mishra & Newhouse, 2009, 2007; Yousuf, 2012) have found that health aid, in general, has a positive effect on reducing the mortality rate of children under five-years-old; however, other studies, conducted in more
technical settings, have argued against those results and suggested that there is no such relationship in semi-parametric models (e.g., Mukherjee & Kizhakethalackal, 2013). By simultaneously considering health aid and governance in one model, a significant effect of governance on child mortality was found that was also present in non-parametric settings such as quantile regression. However, a robust statistically significant effect of health aid on child mortality was not found. The findings in this study in relation to the effect of health aid on child mortality were aligned closely with previous research, including Mukherjee and Kizhakethalackal (2013).

Without doubt, a controversial dimension of economic development is the environmental aspect. As previously stated, the MDGs include environmental sustainability as one of their main goals. Indeed, the seventh MDG is specifically directed at environmental sustainability and reducing CO\textsubscript{2} emissions is one of its targets. Consequently, CO\textsubscript{2} emissions per capita is one of the official indicators of the MDGs. Exploring the determinant of CO\textsubscript{2} emissions and their relationship with governance and its dimensions provided a better understanding of the link between institutions and the practical measures of environmental sustainability.

In Chapter 4, the effects of the dimensions of governance on CO\textsubscript{2} emissions per capita were studied. It was found that CC is a dimension of governance that can reduce CO\textsubscript{2} emissions per capita. The results of a panel data analysis suggested a non-linear effect of CC on CO\textsubscript{2} emissions that was robust in a semi-parametric model. The analysis also found there to be a threshold level of CC that contributed to per capita CO\textsubscript{2} emission reductions; however, after a certain point, the negative effect of CC on CO\textsubscript{2} emissions decreased. Further, it was found that for the purpose of reducing CO\textsubscript{2} emissions, it was not important how policies were designed (i.e., by democratic or autocratic regimes); however, it was important how existing policies were enforced.
Governance is a multi-dimensional concept and its several dimensions need to be further explored. Using several indicators, the impact of those various dimensions can be studied from different perspectives. However, this does not alleviate the necessity of establishing a single indicator for the concept of governance as a whole. The proposed methodology in this second chapter of this project should be used in further research to construct an official indicator of governance.

The UN announced the MDGs in the year 2000. Since then, the MDGs have been researched from different perspectives; however, prior to this study, their relationship with the good governance framework had not been adequately explored. In focusing on child mortality as health indicator and CO$_2$ emissions per capita as an environmental indicator of the MDGs, a robust significant effect of governance was found and it appears that focusing on reforms towards better governance could be beneficial in achieving the MDGs.
Chapter 6: Appendix

6.1 Proof for $E(y^* | Y_n)$

According Goldberger (1991), if $n \times 1$ vector of $y$ is partitioned to two vectors of $n_1 \times 1, y_1$ and $n_2 \times 1, y_2$ with correspondingly partition $\mu$ and $\Sigma$:

$$y = \begin{pmatrix} y_1 \\ y_2 \end{pmatrix}, \quad \mu = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix}, \quad \Sigma = \begin{pmatrix} \Sigma_{11} & \Sigma_{12} \\ \Sigma_{21} & \Sigma_{22} \end{pmatrix}$$

Now if $y \sim N(\mu, \Sigma)$ then:

The marginal distribution of $y_1$ is multinormal:

$$y_1 \sim N(\mu_1, \Sigma_{11})$$

The conditional distribution of $y_2$ given $y_1$ is multinormal:

$$y_2 | y_1 \sim N(\mu_2^*, \Sigma_{22}^*)$$

Where:

$$\mu_2^* = E(y_2 | y_1) = \alpha + B'y_1$$

$$B = (\Sigma_{11})^{-1}\Sigma_{21}$$

$$\alpha = \mu_2 - B'\mu_1$$

$$\Sigma_{22}^* = V(y_2 | y_1) = \Sigma_{22} - B'\Sigma_{11}B$$

$$E[(y - E(y))(y^* - E(y^*))'] = E[(y - \alpha')(y^* - 0')] = E[(y - \alpha')y^*]$$

$$= E[yy^* - \alpha'y^*] = E[yy^*] = E[E(y | y^*)y^*]$$

$$= E[\alpha y^* + \beta(y^*)^2] = 0 + \beta \times E((y^*)^2)$$

As $Var(y^*) = E(y^{*2}) - (E(y^*))^2$ and $E(y^{*2}) = 1, E(y^*) = 0$

$$E[\alpha y^* + \beta(y^*)^2] = \beta = \Sigma_{12}$$

Also regarding the conditional variance. Then with the same rules if we assume $\Phi^2 = \Theta^2 + \Gamma^2$ then $E(y^* | Y) = 0 + \beta (\beta\beta' + \Phi^2)^{-1}(Y - \alpha)$

$$= [\beta \Phi^{-2} - \beta \Phi^{-2}(i + \beta\beta'\Phi^{-2})^{-1}\beta\beta'\Phi^{-2}](Y - \alpha)$$

$$= \beta \Phi^{-2}[i - i(i + \beta\beta'\Phi^{-2})^{-1}\beta\beta'\Phi^{-2}](Y - \alpha)$$

$$= \beta \Phi^{-2}[i + \beta\Phi^{-2}\beta]^{-1}(Y - \alpha)$$

$$= [i + \beta\Phi^{-2}\beta]^{-1}[\beta\Phi^{-2}(Y - \alpha)]$$
6.2 New GI Rank vs World Bank GI Ranks

The graphs in figures 6.1 to 6.6 show the percentile ranks of our new GI versus percentile rank different aspect of governance indicators, namely:

- CC: Control of Corruption
- GE: Government Effectiveness
- PV: Political Stability and Absence of violence
- RL: Rule of Law
- RQ: Regulatory Quality
- VA: Voice and Accountability

Figure 6.1: New GI rank VS WGI - CC aspect Rank
Figure 6.2: New GI rank VS WGI - GE aspect Rank

Figure 6.3: New GI rank VS WGI - PV aspect Rank
Figure 6.4: New GI rank VS WGI - RL aspect Rank

Figure 6.5: New GI rank VS WGI - RQ aspect Rank
Figure 6.6: New GI rank VS WGI - VA aspect Rank
6.3 WGI Initial Groupings

Figure 6.7: Initial Grouping of WGs – Example
6.4 Aggregation Methods

There are several methods of aggregation, from simple average, and weighted average, to comparatively more complex methods such as Principal Component Analysis (PCA). While each method has its own pros and cons, the choice of appropriate method to be compatible with the actual data is an important factor that needs to be considered. Compatibility of the method of aggregation with the data includes factors such as specification and requirements of initial variables to be aggregated or the fact that method of aggregation should be appropriate to the concept that aggregation is used for. Considering several aggregation methods, below, the advantages and disadvantages of each method based on Nardo et al. (2005) are presented.

**Principal Component Analysis (PCA)**

Principal Component Analysis (PCA) is a statistical method to reduce dimensionality. PCA is a procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of linearly uncorrelated variables called principal components. For the purpose of reducing dimensionality, the researcher can then ignore some of components and find the score of observations based on the component which explains the largest proportion of variance in the data. However, one of the fundamental assumptions of this method is a strong correlation among all the variables in the data set (the dimensions), therefore in some cases to create a measure of a multi-dimensional concept this assumption can be restrictive. The assumption requires finding highly correlated variables. In multi-aspect concepts such as governance, any indicator presents

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37 For example, simple average as an aggregation method would not be suitable for the variables that have overlap nor it would be compatible for the indicators which each carries a measurement error.
one aspect and assuming that they “should” be correlated is a restrictive assumption. Also, this method is highly sensitive to outliers in the data (Nardo et al., 2005).

**Cronbach Coefficient Alpha**

In statistics, the Cronbach Coefficient, largely noted as $\alpha$ (alpha), shows the internal consistency in a data set. This coefficient is broadly known to measure the degree to which several indicators measure single concept. While this coefficient might be useful to show whether the indicators measure the same concept, it has almost the same shortcomings of PCA.

**Benefit of Doubt (BoD)**

Benefit of Doubt (Bod) is a familiar, popular method of dimensionality reduction in social science, especially economics. This method is used to create the largely used Human Development Index (Mahlberg and Obersteiner, 2001). It is also the core method in the creation of the Sustainable Development index (Cherchye and Kuosmanen, 2004), Social Inclusion (Cherchye et al., 2007) and many others

The popularity of this method might be based on the fact that the benchmark as the core feature of this method is based upon theoretical bounds and a linear combination of observed best performances. Endogeneity of weights determined by observed values make this method more sensible in policy assessment framework. However, the benchmarks as a core feature of this method also brings a shortcoming to the results, which is that the derived weights are specific for each observation, whereas in the reality weights are different across observations (countries) and this limits its application in cross-country

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38 Such as Macro-economic performance evaluation (Melyn and Moesen, 1991; Cherchye, 2001), Unemployment (Storrie and Bjurek, 1999, 2000)

39 For example in the case of HDI, indicators related to education categorized in one group where each has a weight. To learn more about the method and its advantages see Mahlberg and Obersteiner (2001)
comparison. Also, because the derived weights are based on a “competition” like scoring, if during a specific period of time, the top country’s score improves, despite there being improvement in other countries, they are evaluated based on a higher delimiter and subsequently they might get lower, or at best, the same scores, which would fail to illustrate their improvement.

Analytic Hierarchy Process (AHP)

The other scoring method which is more common in the business world is the Analytic Hierarchy Process (AHP). This method is used in creation of the Index of Environmental Friendliness (Puolamaa et al., 1996). The advantages of this method are first that it can be used both for qualitative and quantitative data, and second, the transparency of the composition process is relatively higher than other methods. However, AHP is based on a number of pairwise comparisons and therefore this makes it practically costly and in some cases impossible. Also, it is highly dependent on the weight assigned by evaluators.

Unobserved Component Method (UCM)

This method is used in creation of World Governance Indicators (Kaufmann et al., 1999). In the following sections this method is reviewed in more depth, however, for purpose of comparison the advantages and disadvantages of this method are as follows:

- Advantages:
  - Weights do not depend on ad-hoc restrictions, (as they are in AHP or BoD)
  - It can be used even if component indicators are not correlated.
  - It is more useful in latent variables aggregation, as it accommodates the basic characteristics of latent variables, which is being un-observable.

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40 In the studies using HDI, ranks based on HDI are mostly used.
Disadvantages:

- Reliability and robustness of results depend on the availability of enough data.
- With highly correlated sub-indicators there could be identification problems.

Among the methods of aggregation and dimensionality reduction in statistics and econometrics, possibly the most convenient and popular is PCA. While, applying PCA on WGIs could be a convenient method to create a biased proxy of governance for purpose of some research projects, using this method as a fundamental method to create an ”official” governance indicator from existing measures causes at least three problems. First, as one of the preliminary assumptions of PCA, the variables should be strongly correlated, and it is a significantly restrictive assumption for indicators. This assumption implies that for the purpose of creating the governance indicator the data that used should be strongly correlated but using several indicators that measure various aspects of governance potentially contradicts this assumption. Second, in PCA, or any other similar method it is assumed that the variables are not biased or they do not carry any measurement or methodological error. Third, in the process of PCA (or FA\textsuperscript{41}), to reduce the dimensionality a part of the information provided by the data has to be ignored and a conscious bias has to be committed. After all, the dimensionality reduction methods such as PCA, are popular because of their ease of use and their applicability, however they are not econometrically suitable to use for construction of an ”official” new indicator.

\textsuperscript{41} Factor Analysis
6.5 PCA

Principal Component Analysis or PCA is a statistical method which by orthogonal transformation converts a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. The original data is evaluated in new coordinates which derived based on the variation within data. The number of new axis (coordinates, components) should be at most equal to the number of variables. Based on the derived components, a researcher can find how much each component contribute to the variation in the data. Higher correlation among variables, better explanation of component of variance in dataset.

PCA has many applications in statistical and econometrics such as principal component regression (PCR) or dimensionality reduction. Applying the PCA on data, extract the number of components equal to number of variables in dataset. For example if PCA has been applied on dataset with 8 variables, there will be eight component which will be ranked based on their eigen value (i.e., Their contribution to the explanation of variance in dataset). In some cases, one, or two components successed to explain the large proportion of dataset, A researchers can use those components as the new coordinates and find the values of each observation according to new coordinates.

In Table 6.1, we present the correlation matrix among the six different WGI's. Worldwide Governance Indicators (WGI) introduced and implemented by Kaufmann et al. (1999). The World Bank Governance Indicators or World Governance Indicators (WGI) consist of six aspects of good governance, namely:

- Voice and Accountability (VA)
- Political Stability and Absence of Violence (PV)
- Government Effectiveness (GE)
- Regulatory Quality (RQ)
- Rule of Law (RL)
- Control of Corruption (CC)

<table>
<thead>
<tr>
<th></th>
<th>VA</th>
<th>GE</th>
<th>RL</th>
<th>RQ</th>
<th>CC</th>
<th>PV</th>
</tr>
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<td>VA</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GE</td>
<td>0.887</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>RL</td>
<td>0.8262</td>
<td>0.9322</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RQ</td>
<td>0.8025</td>
<td>0.9335</td>
<td>0.8928</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CC</td>
<td>0.781</td>
<td>0.9331</td>
<td>0.9358</td>
<td>0.8689</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>PV</td>
<td>0.6867</td>
<td>0.6911</td>
<td>0.7872</td>
<td>0.5478</td>
<td>0.7331</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 6.8: Good Governance PCA Scores
To construct our proxy for governance we have applied the PCA on WGI\$s. Figure 8 shows the number of components in the horizontal axis and Eigen value in vertical axis, and according to the graph first component has the higher Eigen value and as it is shown in the Table 6.2 the first component can explain about 85% of variation in our data.

<table>
<thead>
<tr>
<th>Component</th>
<th>Eigenvalue</th>
<th>Difference</th>
<th>Proportion</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.097</td>
<td>4.679</td>
<td><strong>0.850</strong></td>
<td>0.850</td>
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<tr>
<td>2</td>
<td>0.418</td>
<td>0.151</td>
<td>0.0697</td>
<td>0.919</td>
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<td>3</td>
<td>0.268</td>
<td>0.149</td>
<td>0.0446</td>
<td>0.964</td>
</tr>
<tr>
<td>4</td>
<td>0.119</td>
<td>0.0653</td>
<td>0.0199</td>
<td>0.984</td>
</tr>
<tr>
<td>5</td>
<td>0.0539</td>
<td>0.0102</td>
<td>0.00900</td>
<td>0.993</td>
</tr>
<tr>
<td>6</td>
<td>0.0437</td>
<td>-</td>
<td>0.00730</td>
<td>1</td>
</tr>
</tbody>
</table>

Therefore, we can ignore other components (skipping almost 15% of our data) and find the new values of countries based on this component and use the scores as a proxy for governance. The main motivation behind this analysis is the assumption that governance is the factor which causes correlation among different aspects and with PCA we can extract this vector and use it as proxy for governance.
### 6.6 Countries in the Sample

Table 6.3: Countries in the Sample

<table>
<thead>
<tr>
<th>Country</th>
<th>Obs</th>
<th>Country</th>
<th>Obs</th>
<th>Country</th>
<th>Obs</th>
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<td>Guatemala</td>
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<td>4</td>
<td>Sao Tome and Principe</td>
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<td>Mauritius</td>
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<td>Trinidad and Tobago</td>
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<td>Mexico</td>
<td>6</td>
<td>Tunisia</td>
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<td>El Salvador</td>
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Total: 534
### Countries in the Sample

#### Table 6.4: Countries in the Sample

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### 6.8 Two-Way Fixed Effects Regression

Table 6.5: Two-Way Effects Regression

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<td>Log of Population Density</td>
<td>171.3***</td>
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<tr>
<td>Adult Literacy</td>
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<td>(0.0205)</td>
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<tr>
<td>Log of GDP per capita</td>
<td>3.631*</td>
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<tr>
<td>(log GDP per capita)$^2$</td>
<td>-0.179</td>
<td>(0.131)</td>
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<tr>
<td>Voice&amp; Accountability</td>
<td>0.703</td>
<td>(0.470)</td>
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<td>Control of Corruption</td>
<td>-1.367*</td>
<td>(0.764)</td>
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<td>Political Stability</td>
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<td>Dummy year 1996</td>
<td>-0.303</td>
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<td>Dummy year 2000</td>
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<td>Dummy year 2002</td>
<td>1.648**</td>
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<td>Dummy year 2003</td>
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<td>Constant</td>
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R-squared 0.678

Dependent variable is CO₂PC and Robust standard errors in parentheses. (HAC robust SE)

*** p<0.01, ** p<0.05, * p<0.1

Number of observation is 283, across 125 countries.
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