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Essays on Sustainable Development research: The contribution of latent variable modeling

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This thesis is dedicated to my nephew.

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Abstract

This Ph.D. dissertation focuses on the empirical application of Latent Variable Models (LVM) with special emphasis on Structural Equation Modeling (SEM), with six distinct studies. The broad area of sustainable development (SD) is used in cross-sectional applications to demonstrate how SEM can be applied in economics and management to research theoretical, underlying, constructs, while providing relevant policy insights. A better understanding of the hypothetical constructs that are ingrained in the sustainable development debate provides the indispensable foundation for the strategic success of businesses. It helps adjust for challenges that arise due to sustainable development concerns, identify and capitalize opportunities, and understand how the perceptions of managers and executives are formed. This dissertations contribution to the literature can be seen in three major ways. First, it tests and applies the SEM framework in an emerging area. Second, it contributes to the area of sustainable development by clarifying concepts at the macro and multi-level contexts. Third, highlighting the importance of sustainable development in the business context. The results of the six studies extend the current literature and pave the way for future research avenues in a substantive and methodological way, in the context of sources, data reliability, and statistical methods.

Latent Variable Model, Structural Equation Modeling, Sustainable Development, Perception Studies

JEL: Q01, C00

Resumo

Esta tese de doutoramento centra-se na aplicação empírica de Modelos com Variáveis Latentes (MVL), com especial enfoque na Modelação com Equações Estruturais (MEE), com seis estudos distintos. Estes são aplicados de forma transversal à área de desenvolvimento sustentável (DS), de modo a demonstrar como a MEE é útil em gestão e economia para investigação de construções teóricas, subjacentes, enquanto fornece relevantes informações para a compreensão de políticas. Uma melhor compreensão de construtos hipotéticos enraizados no debate sobre desenvolvimento sustentável fornece a base indispensável para o sucesso estratégico das empresas. Contribui para o ajustamento de desafios que se manifestam devido a preocupações de desenvolvimento sustentável, para a identificação e capitalização de oportunidades e de forma a entender como são elaboradas as perceções de gestores e executivos. A contribuição desta tese para a literatura deve ser enquadrado em três perspetivas principais. Em primeiro lugar, testa e aplica a estrutura MEE numa área emergente. Em segundo, contribui para a área de desenvolvimento sustentável, esclarecendo conceitos nos contextos macro e multinível. Em terceiro, destaca a importância do desenvolvimento sustentável em contexto empresarial. Os resultados dos seis estudos aprofundam o conhecimento nesta área e abrem caminho a investigação futura de cariz substantivo e metodológico, no que concerne fontes, fiabilidade de dados e métodos estatísticos.

Modelo com Variável Latente, Modelo com Equações Estruturais, Desenvolvimento Sustentável, Estudos da Perceção

JEL: Q01, C00

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Abbreviations

aBIC	Sample-size Adjusted BIC
AIC	Akaike Information Criterion
AVE	Average Variance Extracted
BIC	Bayesian Information Criterion
BRICS	Brazil, Russia, India, China and South Africa
CCS	CO_2 Capture and Storage
CER	Corporate Environmental Responsiveness
CETA	Comprehensive Economic and Trade Agreement
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CIP	Competitive Industrial Performance Index
CO2	Carbon Dioxide
Con	Controls
Cov	Covariance
CR	Composite Reliability
CSD	Commission on Sustainable Development
Dev	Developed
DoF	Degrees of Freedom
Eco	Economic
EER	Enforcement of Environmental Regulations
EFA	Explanatory Factor Analysis
EPI	Environmental Performance Index
ES	Environmental Sustainability
ESI	Environmental Sustainability Index
EU	European Union
EVI	Environmental Vulnerability Index
EY	Ernst & Young
FIML	Full Information Maximum Likelihood
GCI	Global Competitiveness Index
GDP	Gross Domestic Product
GNI	Gross National Income
HBM	Health Belief Model
HDI	Human Development Index
HIV	Human Immunodeficiency Virus
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IUCN	The International Union for Conservation of Nature
LISREL	LInear Structure RELations
LVM	Latent Variable Model
MDG	Millennium Development Goal
MIMIC	Multiple Indicators Multiple Causes
NAFTA	North American Free Trade Agreement
NPISHs	Non-profit Institutions Serving Households
OECD	Organisation for Economic Co-operation and Development

PCA	Principal Component Analysis
PhyVar	Physical Variables
PPP	Purchasing Power Parities
PS&V	Political Stability & Absence of Violence/ Terrorism
PwC	PricewaterhouseCoopers
R&D	Research & Development
RMSEA	Root Mean Square Error Approximation
SD	Sustainable Development
SDG	Sustainable Development Goal
SEM	Structural Equation Modeling
SER	Stringency of Environmental Regulations
SGCI	Sustainability-adjusted Global Competitiveness Index
SSI	Sustainability Society Index
STI	Sustainability of Travel and Tourism Industry Development
TLI	Tucker-Lewis index
UN	United Nations
UNIDO	United Nations Industrial Development Organization
WCED	World Commission on Environment and Development
WCY	World Competitiveness Yearbook
WEF	World Economic Forum
WGI	Worldwide Governance Indicators
YCELP	Yale Center for Environmental Law & Policy

Chapter 1

Introduction

"The many, as we say, are seen but not known, and the ideas are known but not seen" (Plato, 360 B.C.E.: Book VI)

This PhD dissertation contributes to the field of Latent Variable Models (LVM) with empirical research at the intersection of social sciences connecting psychology, management, and economics. It focuses mostly on structural equation and multilevel modeling applied to the vast area of sustainable development (SD). It shows how these modeling approaches can provide improved reliability and validity of measuring of theoretical concepts that are policy related for decisions making in management and economics.

This introduction presents the broad framework in which this dissertation is embedded. It starts with the analysis of the importance of sustainable development for businesses and explores the concept of SD itself. Then, follows a short overview of the methodological developments in latent variable modeling, in particular structural equation modeling and multilevel modeling, which the latter accounts for different levels of analysis. After the introduction of the main methodological developments, the affiliating three main contributions of this doctoral dissertation are discussed. In the sequence follow the six studies applying LVM. The thesis concludes with a summary of the main results, limitations and open issues for future research.

1.1 Sustainable development and its importance for management

"[D]evelopment that meets the needs of the present without compromising the ability of future generations to meet their own needs" is the standard definition of sustainable development according to the World Commission on Environment and Development (WCED) (1987, Chapter 2). This definition implicitly emphasizes the need of the three dimensions – economic, social, and environmental – to be balanced to achieve sustainable

development[1]. The underlying assumption is that the focus on only one or two dimensions will originate unbalances in development. For instance, a narrow focus on economics may lead to environmental degradation and social problems, such as increasing greenhouse gases and the rise in inequality, respectively. A pure focus on environmental aspects may lead to economic contraction and social instability as available funds are diverted to environmental protection. On the other hand, a concentration on exclusively social facets may lead to increasing economic and environmental problems. Thus, all three dimensions have to be kept in balance to avoid environmental degradation, economic crises, and social instability.

The Sustainable Development Goals (SDGs), adopted by the United Nations in 2015, set the agenda until 2030 to achieve a global path to sustainable development. The SDGs incorporate 17 quantifiable goals and 169 targets (United Nations, 2015e). Their main aim is to fight the increasing challenges of our current time in three key areas: social, economic, and environmental. Businesses are a central element to achieve these goals; not only through their role in the economic dimension such as 8 (decent work and economic growth) and 9 (industry, innovation, and infrastructure), but also their influence on many other aspects. For instance, Goal 17 focuses on the importance of partnerships with particular emphasis on the private sector (United Nations, 2015e).

Strategy guidelines around the world have been established to help firms align their corporate strategies and the SDGs. Examples abound from the SDG Compass (GRI, UN Global Compact and World Business Council for Sustainable Development, 2015) to the report from Gold Standard (2018). The big four auditing firms (Deloitte, Ernst & Young (EY), KPMG, and PricewaterhouseCoopers (PwC)) have also realized the big opportunity of sustainable development for firms and provide guidance for their clients to achieve the SDGs while profiting financially (Deloitte, 2017; Ernst and Young, 2019; KPMG, 2019; PricewaterhouseCoopers (PwC), 2016). A recent report shows that achieving the SDGs for instance in just four sectors (food and agriculture, cities, energy and materials, and health and wellbeing) will create market opportunities with a face value of $12 trillion until 2030 (Business and Sustainable Development Commission, 2017). The starting point for companies is, therefore, a better understanding of the concept of sustainable development to capitalize on these opportunities and neutralize threats (e.g., environmental).

The area of sustainable development is broad and very intricate. Most of the concepts are not directly measurable. Nevertheless, a better understanding of them is vital for the future

[1] In this dissertation, the words *sustainable development* and *sustainability* are used interchangeably.

success of tracking the achievement of goals. In this sense, LVM offers a methodological advantage that can answer research questions regarding constructs that are not directly observable.

1.2 Latent variable model

Plato's analogy from "Allegory of the cave" in The Republic (Book VII) (Plato, 360 B.C.E.) is a well-known comparison to explain the relationship between observed and latent variables (e.g., Byrne, 2002; Escobar, n.d.; Westland, 2015). In his classic text, Plato describes slaves that can only see a wall and the shadows on it. The shadows are manifestations of objects that are behind them and produced by the light of the fire.

In modern fast-changing and complex environment in which we interact, many underlying constructs that are essential to understand may only be seen as the *shadows* of those objects and cannot be measured directly. We can derive the original constructs from the observed data by using latent variable models. Latent means in this case that the variable is hidden and cannot be directly measured. An excellent example of a latent variable is climate change, as there is no direct or unique measure. Nevertheless, there are the *shadows* (indicators) such as rising sea levels, higher average temperature, and an increased number of extreme weather events that help infer the latent (underlying) variable, climate change.

Latent variable models are applied in almost all areas of empirical analysis to measure constructs that are not directly observable. Its immeasurable characteristic can be seen in the definition of latent variable “as a random variable whose realizations are hidden from us” (Skrondal and Rabe-Hesketh, 2004: Chapter 1.1). This distinctive attribute results in the application of latent variable to represent: theoretical constructs (Goldberger, 1972), unobserved heterogeneity (random effects) (Skrondal and Rabe-Hesketh, 2004), latent responses (Muthén and Satorra, 1995), missing data and counterfactuals (see Imbens and Rubin, 1997), and when variables are measured with error (Lord and Novick, 1968/2008). Latent variables are also used to generate flexible multivariate distributions (McLachlan and Peel, 2000) or combine information from different sources at the individual unit level (Morris, 1983).

The classical latent variable models include: Factor models, Item Response models, Latent Class Models, Models for longitudinal data, Multilevel (regression) Models, and Structural Equation Models (Skrondal and Rabe-Hesketh, 2004). The essays in this thesis are mostly focused on structural equation and multilevel modeling. [2]

1.3 Structural equation modeling

Structural equation modeling, also known as analysis of covariance structures, covariance structure modeling, or covariance structure analysis (Kline, 2016), combines confirmatory factor analysis and path analysis combining regression models with measurement error (Schumacker and Lomax, 2010). SEM is not one single statistical technique but entails a broad range of multivariate statistical techniques that are related procedures (Kline, 2016; Rosseel, 2012). This flexibility explains its widespread and increasing use and development in recent decades (see Figure 1-1). While its origins are in biology (Westland, 2015), nowadays its primarily use is in social sciences. In recent years, almost 50% of SEM research and applications were conducted in the social sciences (See Figure 1-1). Figure 1-1 is based on the keyword search *structural equation modeling* on Web of Science (August 28th, 2019) from 1991 - 2018. The red bar is the absolute number of publications within the Social Sciences area[3], the blue bar are the publications in all other categories (except Social Sciences), the light grey bar represent the percentage of Social Sciences publication in relation to all publications, and the dotted line connects the percentage of Social Sciences from year to year.

[2] Partial Least Squares (PLS) is another method that has been sparked recent interest. It is also being promoted as a SEM technique. However, we didn't use it as has received many critics for example, that it cannot handle the problem for which SEM are usually intended as it is „simply regression with scale scores" (Rönkkö et al., 2016). The editors of the journal of Operations Management even stated that they are likely to desk-reject any paper with the PLS technique (Guide and Ketokivi, 2015).

[3] We used for the Social Sciences areas all categories/classification that of Web of Science defined as Social Science (Web of Science, 2018) including the category Management.

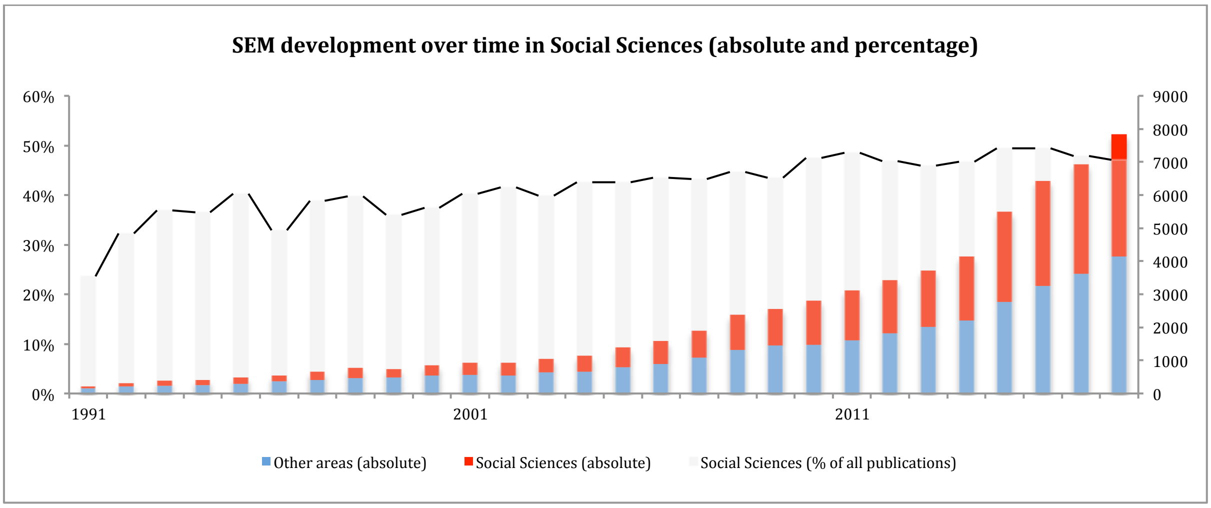


Figure 1-1: SEM development over time, within categories from 1991 to 2018 – based on Web of Science (August 28th, 2019)

The origins of SEM lie in path analysis, developed by Wright in 1918 (1920, 1921, 1934) (see Tarka, 2018). It was one of the first statistical methods that used a graphical model to analyze the genetic configuration of laboratory animals and their offspring. Later it was highlighted in sociology field, where the progressive experience of a group is measured or when a depended variable must be decomposed (Duncan, 1966). As path analysis is only one side of SEM, two further contributing traditions need to be highlighted: from the economic literature, simultaneous equation models (Haavelmo 1943; Koopmans 1945), and from the area of psychology, factor analysis (Anderson and Rubin, 1956; Lawley, 1940; Spearman, 1904).

With implications to the 70s, SEM emerged from these three different approaches and decisive contributions of different scholars should be highlighted: First, Jöreskog (1969) presented a general approach for a procedure to estimate a factor model with maximum likelihood and in 1970 introduced a general model to analyze covariance structures (Jöreskog, 1970). In the same year, Zellner (1970) developed a maximum likelihood estimator with the normality assumption by using a least-squares approach. In the following year, Hauser and Goldberger (1971) focused on models with over-identified unobservable variables and how to deal with it by using efficient estimation procedures. In 1972, Keesling (1972) wrote his doctoral thesis about “Maximum Likelihood Approaches to Causal Flow Analysis”. In 1973, Wiley (1973) focused on a framework for models with measurement error, unobserved variables, and measurement and structural components, and Jöreskog (1973) presented a general framework that contains two parts. First, the measurement model that connects the observations (measured variables) and the latent variable in a confirmatory factor model; second, the structural part that connects the latent variables by a simultaneous equations system (Jöreskog, 1973). In 1974, Browne (1974) proposed the analysis of covariance structure by a general least squares estimator. The main contributions for the current SEM approach, however, came from Jöreskog (1970, 1973), Keesling (1972), and Wiley (1973). They developed a framework that was also known as JWK model (Bentler, 1980), which was the first name for SEM.

Based on the JWK framework, Sörbom and Jöreskog developed a computer program with the name LISREL (Linear Structure RELations) at the beginning of the 70s (Kline, 2016). This software facilitated the use and application of this new field to a wide range of researchers and triggered a methodological revolution in the areas of behavioral and social sciences. Even after more than 40 years since its introduction, LISREL 10 is still one of the most widely used software packages in the area of SEM. Over the years the number of packages able to estimate covariance structures has increased (Westland, 2015). For instance, AMOS (IBM), CALIS (SAS), EQS (MSI), LISREL (SSI), Mplus (Muthén & Muthén), OpenMx/OpenSEM (Virginia), SEM (R), LAVAAN (R), TETRAD (CMU), and STATA (StataCorp LLC).

SEM models can model complex scenarios and powerful software is able to estimate them. Nevertheless, they have been used with caution. An SEM model may state that the data is consistent with the model, but a general statement is not possible (Kline, 2016). It is, a disconfirmatory procedure as models with poor model fit can be excluded. There may be a presence of a near-equivalent or equivalent model or, there is an error in the model specification, or a representation of false hypothesis. In line with the general framework in Jöreskog (1973), the specification of a structural equation model contains two components: the structural and the measurement model.

1.3.1 Measurement model

The measurement element comes originally from the factor analysis literature, which contains two broad categories: explanatory factor analysis (EFA) and confirmatory factor analysis (CFA) (Kline, 2016).

EFA can be used as an inductive research design to determine from a given set of indicators the dimensionality of the model and the indicators that measure each factor, based on the covariation between items (Mulaik, 1987). In the next step, a name for the factor is attributed based on the interpretation of the factor loadings and items contributing to each factor (Skrondal and Rabe-Hesketh, 2004). CFA, on the other hand, tests a theoretical model, where a latent variable (factor) is assumed to be measured by a set of predefined indicators. Given its nature, it is a hypothesis-driven approach, and the researcher needs to specify *a priori* a model based on theoretical grounding (Brown, 2015). The results of a CFA show whether the construct, represented by a latent variable, is measured well by its proposed indicators or not. In EFA, the number of factors and the indicators belonging to each factor is not *a priori* defined. Therefore, it can be said that EFA is an unrestricted measurement model, whereas CFA is a restricted measurement model. This is the main difference between the theory-driven CFA and the data-driven EFA. In the context of SEM, EFA plays a minor role and CFA is mainly used for the measurement model.

A standard measurement model, where the latent variable measures a true score with error, is (adapted from Lord and Novick, 1968/2008; Skrondal and Rabe-Hesketh, 2004):[4]

$$y_{ik} = f_i + \epsilon_{ik} \qquad (1\text{-}1)$$

where y_{ik} is the measurement of indicator k for country i, the factor f_i has a variance of ψ and is the true score of indicator k, and ϵ_{ik} have variance θ_k and represent the measurement errors. In general, it is assumed that the measurement errors (ϵ_{ik}) are independent, resulting in conditional independence of y_{ik} given f_i. The measurement errors are assumed to have an expected value of zero and are independent of the true score.

In the case of modeling a hypothetical construct in which the construct cannot be directly measured, the relationship is modeled by using a factor model (Skrondal and Rabe-Hesketh, 2004). It can be expressed as:

$$y_{ik} = \mu_k + \lambda_k f_i + \epsilon_{ik} \qquad (1\text{-}2)$$

where μ_k is the intercept of item (indicator) k, λ_k is the factor loading of the latent variable f_i, and ϵ_{ik} is the error term. The error term and the latent factor are independent. The variance of the error term ϵ_{ik} is σ_k.

Factor loadings indicate the strength of the relation between the latent and the observed variables (Schumacker and Lomax, 2010). Communality is the total variance that is common (shared) and is calculated by taking the square of the factor loading (Kline, 2016). For example, if $\lambda = 0.8$ then $\lambda^2 = 0.64$, meaning that 64% of the total variance of the indicator is

[4] Throughout the thesis we use the same notation.

explained by the common factor.[5] The remaining 36% of the variance is the unique variance of the indicator, including the random measurement error of the observed variable and unexplained variance, which may be caused due to specific indicator characteristics. The measurement error of the observed variable is the part (observed score of the variable) that measures something else then what is hypothesized for the latent variable to measure (Schumacker and Lomax, 2010). It is used to measure the variance of the error and therefore assess the reliability of the observed indicator. There are three possible explanations for the measurement error. First, it is an indication of unreliability of, e.g., the latent variable. Second, it indicates the need for a factor model with higher order. Third, the observed indicator (variable) measures another latent variable.

The characteristics of the variables also influence the statistical model. For example ordinal values, which may include responses about the level of perceived corruption (none, low, middle, and high) require a different approach than continuous variables (see Skrondal and Rabe-Hesketh, 2004).

1.3.2 Structural model

Before the measurement model is specified and indicators are selected and tested for reliability, the conceptual model (structural part) has to be defined. It characterizes the relation between latent variables (Schumacker and Lomax, 2010). A latent variable can be a dependent or independent variable in the structural part. The structural part of an SEM can be expressed as (adapted from Muthén, 1984; Skrondal and Rabe-Hesketh, 2004):

$$f_i{}^{(h)} = \mu + \beta_h f_i{}^{(h\prime)} + \varepsilon_i \qquad (1\text{-}3)$$

Where μ is the intercept, $f_i{}^{(h)}$ is the latent variable h, β_h is the slope of the latent variable for the latent variable $f_i{}^{(h\prime)}$, and ε_i is the normally distributed error term. With the specified structural model, the hypotheses about the relations between the latent variables can now be tested, i.e., check whether the data supports the conceptual model.

An SEM model can include, next to the indicators that measure the latent variable, observed indicators (called causes) that are regressed on the latent factor. In this case the model is

5 There are special cases where this does not hold. For example if you have 3 indicators for the same latent. In this case the model is completely identified.

called a Multiple Indicator Multiple Cause (MIMIC) (e.g., Skrondal and Rabe-Hesketh, 2004). A MIMIC model can be expressed in the following way:

$$E\left[f_i^{(h\prime)}\right] = \sum_k \beta_k^{(h\prime)} W_{ik} \tag{1-4}$$

where the $\beta_k^{(S)}$ is the slope of the control variable W_k.

For specific research questions, apart from an MIMIC framework, it may be necessary to add various levels of interaction and influences, resulting in multilevel modeling.

1.4 Multilevel modeling

Multilevel modeling provides a further extension to latent variable modeling as it allows the definition of latent variables for different data at different levels of the hierarchy (Schumacker and Lomax, 2010). Other names are random coefficient modeling or hierarchical linear modeling (Kline, 2016). For example a two-level structure could be pupils' popularity within their class with two characteristics at personal and class level (e.g. Hox, 2010).

Within the framework of multilevel modeling, it is possible to analyze the variation of the observed (dependent) data with a combined set of between- and within-group variables (Kline, 2016). For example, a data set contains information about students' popularity within their class, their gender, and extraversion (self-reported on a scale from 1 to 10), the size of the class and the mean years of experience of their teachers (e.g., Hox, 2010). The multilevel modeling can correct lower levels outcomes by controlling higher-level variables. For example, the student's popularity depends on the experience of the teachers, the size of the class, their gender, and their extraversion. A model including two levels, level 1 = i (e.g., students) and level 2 = j (e.g. classes), can be expressed in the following way:

The value of the indicator y_{ijk} measures the response of an individual (student) (i) from class (j) on the item (k). At the individual level the multilevel model is defined by:

$$y_{ijk} = \mu_{jk} + \lambda_k^W f_{ij}^W + v_{ij} \tag{1-5}$$

The random intercept of item k for class j is μ_{jk}. Thereby, we model the variation within class, where λ_k^W is the individual level loading for item k and f_{ij}^W is the score of the individual latent variable and v_{ij} is the residual random variable with a normal distribution N(0, σ_v^2).

Even though multilevel models are powerful tools, the traditional models have various limitations (Bauer, 2003; Curran, 2003, Kline, 2016). The difficulty to define a measurement model is based on the fact that: there is no direct way for a representation of latent variables as outcome or predictors; there is no direct way to represent measurement error (scores between and within predictors) as it needs to be assumed that they are reliable. The models that can be used to estimate the indirect effect are difficult to apply, and there is no global fit to test the whole model. The strengths of SEM models, can compensate for these relative weaknesses of traditional multilevel modeling (Kline, 2016), when both are combined in a multilevel SEM model. Measurement errors representation (for one or more indicators) is firmly easy to achieve with the measurement model specification and in a structural model, a latent variable can be either an outcome or predictor variable.

1.5 Contributions

This PhD dissertation contributes to the field of Latent Variable Models (LVM), a way to measure underlying constructs, with empirical research at the intersection of social sciences and bridges psychology and management methodologies with economic knowledge.

In the area of sustainable development, LVM, and in particular SEM, have been applied rarely. Currently, in economics simultaneously equation modeling and structural models that do not account for measurement error are dominant (see Greene, 2012; Wooldridge, 2010), but latent variable modeling is gaining ground slowly. A search on Web of Science on August 15th, 2019 resulted in 112 hits with the topic "structural equation modeling" & "latent variable" in the category economics, compared to 1081 hits with "simultaneous equation modeling" in the same category. The exception is for logit, probit, and tobit models that can be derived from a LVM specification (Wooldridge, 2012). Random-effect models can also be seen as LVM, although this variable is not a hypothetical construct but the sum of the variance of all unobserved variables without any further meaning (Skrondal and Rabe-Hesketh, 2004). If an SEM framework is applied in the area of economics and sustainable development, they are mainly used in a microeconomic context such as behavioral studies and individual preferences (e.g., Adongo et al., 2018; Chin et al., 2018; Contu et al., 2016; Ricci et al., 2018). This thesis builds on these developments and focuses on the macro- and multi-level of sustainability development with SEM models, within a cross-sectional setting, and its implications for businesses (perception of executives and managers).

This dissertation contributes to the SEM literature in three significant ways:

1. testing and applying the SEM framework in an emerging area;
2. contributing to the area of sustainable development by clarifying concepts at the macro and multi-level contexts;
3. highlighting the importance of sustainable development in the business context.

1.6 Structure of the thesis

In the sequence of this introduction (Chapter 1), this dissertation consists of six independent empirical studies that apply SEM in the broad area of sustainable development and its implications for businesses. The studies sequence is based on the contribution to the literature. Studies I, II, III, and IV are focused on the concept of sustainable development; whereas Studies V and VI focus on its implications at the business level.[6]

Study I (Chapter 2) establishes the methodological foundation of this thesis as it assesses the reliability (internal consistency) and external validity of the three dimensions of the Sustainable Society Index (SSI). This index has been used to measure sustainable development and its three dimensions (social, economic, and environmental). We analyze its internal consistency and present modified indices to assure construct reliability. We further assess its external validity by comparing the modified indices to well-known indices such as the Human Development Index (HDI) and the Environmental Performance Index (EPI).

Study II (Chapter 3) builds on the results of Study I and estimates the dimensions of SD with a new set of indicators in a reliable way. A starting pool of 68 indicators from widely accepted indices assures a solid basis for the estimation of each dimension for 138 countries. We further test whether SD is empirically better represented (model fit) by a three (social, economic, and environmental) or four-dimensional (the institutional dimension separated from the social one) representation. For a reduction of possible biases, a MIMIC model is applied, and control variables are added to the model.

[6] See Table A.1-1 for an overview of the different research questions, hypotheses, data, and applied methods.

Study III (Chapter 4) builds on Study II and uses a four-dimensional representation of SD, and tests the empirical relationship between competitiveness and the four dimensions of sustainability, for 138 developing and developed countries. Control variables (MIMIC model) are added to the model, to account for possible influences and to assure that the direct relationship between both constructs is measured.

Study IV (Chapter 5) analyses the relationship between institutions and sustainable development. The institutional dimension is hypothesized as an antecedent of the concept of SD (social, economic, and environmental dimension). We include different country-level control variables to assure that we measure the direct impact of institutions on SD.

In the next step, we focus on the perception of executives and managers in the broad area of sustainability.

Study V (Chapter 6) explores how executives' environmental sustainability perceptions are formed and how physical environmental indicators explain them. This is particularly important as their decisions impact society at the micro-level. A deeper understanding can help improve models that analyze the intersection between the perception of executives and its impact on society.

Study VI (Chapter 7) explores EU managers' perception of the level of corruption and how firm and country characteristics constitute their perception. This study helps understand the between- and within-country variability of managers' perceptions and the influencing factors at the firm- and country- levels. It uses a European sample of 7596 observations with ordinal and categorical data. A multilevel model uses micro-level data (firm level) and macro-level indicators (country level).

Finally, Chapter 8 concludes the thesis, presents the limitations, and provides insights for further research.

Chapter 2

The Sustainable Society Index: its reliability and validity [7]

Abstract

The Sustainable Society Index (SSI) is known as a comprehensive index that contains substantive aspects of all three dimensions of sustainable development (SD): social, environmental, and economic. This paper assesses the reliability (internal consistency) and external validity of the SSI for 154 developing and developed countries for the year 2016. Confirmatory factor analysis and standard measures of reliability are used to assess the internal consistency, and we use Kendall rank correlation coefficients to compare the country rankings of the social and economic dimension with the Human Development Index (HDI), and of the environmental dimension with the Environmental Performance Index (EPI). Our results clearly demonstrate that there are indicators within each dimension that need to be removed to achieve construct reliability. The three modified indices of the SSI show strong internal consistency. The external validity of the modified indices is supported as the country rankings are similar to those of the HDI and EPI and show a high correlation. In the current sustainable development debate, this study highlights the need for a detailed statistical analysis and adjustment of the indices that represent sustainable development to achieve a theoretical and statistically reliable representation of the concept.

2.1 Introduction

Social change is inevitable and has always been a part of the progress toward a more prosperous future. The accelerating change that has taken place in recent years has fostered social, environmental and economic achievements. Examples range from improvements in crucial areas such as access to electricity, the fight against child malnutrition and gender inequality to economic growth and more international actions to fight climate change. Global access to electricity increased from 78 to 87% and the least developed countries doubled their access from 2000 to 2016 (United Nations, 2018b). The percentage of stunted children under the age of 5 (chronic malnutrition results in children being too short for their age) declined

[7] The chapter is based on Witulski and Dias (2019c).

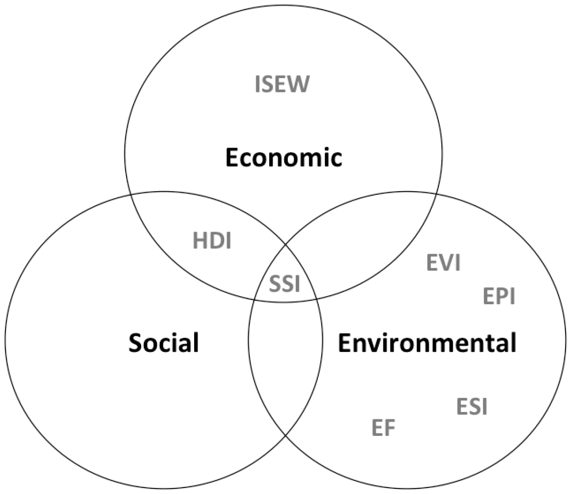
from 33% (2000) to 23% (2016) (United Nations, 2017a) and from 155 million children in 2017 to 151 million in 2018 (United Nations, 2018b). The global percentage of women in national parliament in lower or single houses rose to about 23% (2018) from 19% (2010) (United Nations, 2018e), and the ratio of young women aged between 20 and 24 who reported they had got married before the age of 18 fell from 1 in 3 to 1 in 4 from 2000 to 2015 (United Nations, 2017b). Climate change has been recognized as a pressing international issue: The Paris agreement was ratified by 175 parties (countries and organizations e.g. the European Commission) and there is steady progress toward the international goal to mobilize $100 billion per year by 2020 (from developed countries) to support developing countries in their actions to mitigate climate change (United Nations, 2018e). Furthermore, the fall in the global unemployment rate since the beginning of the century has been accompanied by a rise in labor productivity (United Nations, 2018e). This is also reflected in the average annual growth rate in real terms of GDP per capita for the whole world, which increased to 1.6% (2010-2015) from 0.9% (2005-2009) (United Nations, 2017c).

The improvements in the social, environmental, and economic dimensions are important and highlight progress toward a more balanced future, but further advancements are required in many areas. For example, it is necessary to achieve a minimum level of well-being, access to safe sanitation and water, and sufficient food. There are still too many people with unmet needs; indeed, the number of undernourished people increased by 0.4% (from 10.6% to 11.0%) from 2015 to 2016 to 815 million people (United Nations, 2018e). Even though the international community is paying more attention to environmental concerns, the levels of atmospheric carbon dioxide reached a new record high (400 parts per million) in 2016 and at the same time the global sea ice level went down to a record low of 4.14 million km^2 (United Nations, 2017d). Thus, this progress must be monitored and indices developed that not only accurately measure the current status of these three key dimensions (social, environmental, and economic) but also facilitate their communication. These three dimensions are the core of sustainable development (SD)[8] as defined by the Brundtland report in 1987 (World Commission on Environment and Development (WCED), 1987), which states that the social, environmental, and economic dimensions must be balanced to achieve sustainable development.

8 The terms *sustainable development* and *sustainability* are used interchangeably in this paper.

This comprehensive and multifaceted concept of SD imposes challenges of conceptualization, resulting in a wide range of SD indices that measure the whole concept or aspects of it[9]. For instance, the Ecological Footprint (EF) measures the number of natural resources required by a population (demand) and compares it with the available resources (supply) given its level of consumption (Global Footprint Network, 2018). It was calculated that 1.7 Earths would be required to absorb the waste and provide the natural resources for world consumption today. The Environmental Performance Index (EPI) ranks countries on their performance in high priority environmental issues. It covers 180 countries and includes 24 indicators in ten categories that are grouped into ecosystem health and ecosystem vitality (Wendling et al., 2018). The Human Development Index (HDI) incorporates the essential aspects of human development (education, long life, and income) and groups countries – based on their scores – into four categories: low, medium, high, and very high human development (United Nations Development Programme, 2018). Even though all indices are fundamental to measure a crucial aspect of sustainable development, one of the main weaknesses of these indices is that they cover only specific dimensions of sustainable development. Figure 2-1 represents the coverage of the SD dimensions by well-known indices. The Sustainable Society Index (SSI) includes the three dimensions of sustainable development and represents the broad concept of SD (van de Kerk and Manuel, 2008). The SSI is categorized into three well-being dimensions (human, environmental, and economic) and answers the question "how sustainable is your country?" (Sustainable Society Foundation, 2016a). It emphasizes the opportunity that humans have to develop themselves in freedom in a well-balanced society.

[9] See Gallego-Álvarez et al. (2015b) and Saisana and Philippas (2012) for an overview of SD indices.



SSI – Sustainable Society Index (Sustainable Society Foundation, 2016a)
HDI – Human Development Index (United Nations Development Programme, 2018)
ISEW – Index of Sustainable Economic Welfare (Daly and Cobb Jr., 1989)
EVI – Environmental Vulnerability Index (SPOCA, and United Nations Environment Program, 2005)
EPI – Environmental Performance Index (Wendling et al., 2018)
EF – Ecological Footprint (Global Footprint Network, 2018)
ESI – Environmental Sustainability Index (Yale Center for Environmental Law et al., 2005)

Figure 2-1: Overview of common sustainable development indices based on the dimension(s) they cover

In general, the combination of various indicators into a single index brings advantages in that it allows the analysis of complex concepts, supports decision making, permits easier public communication, and more straightforward interpretation (e.g., Nardo et al., 2005; OECD, 2008). Potential disadvantages of indices result from subjective decisions in the methodological process (e.g., handling of missing data, indicator weights, or indicator selection) (Nardo et al., 2005), resulting in an easy manipulation of indices. A composite index that does not include difficult-to-measure indicators may lead to an overly simplistic policy conclusion or inappropriate policy action (OECD, 2008). A strong substantive and methodological foundation is therefore essential.

The theoretical foundation of the SSI has been tested over the years by different authors and institutions. The selection of indicators to measure the SSI was addressed and critically reviewed by its own authors (van de Kerk and Manuel, 2008). In 2012 the Joint Research Centre (JRC) of the European Commission audited the SSI and confirmed that it is conceptually coherent and meets the requirements of the JRC. They concluded that the SSI is "suited to assess nations' development towards sustainability in its broad sense: Human, Environmental and Economic Wellbeing" (Saisana and Philippas, 2012: 6). In 2016 Strezov et al. (2016) confirmed that the SSI measures the broad concept of sustainability as it includes indicators for each of the three dimensions. Note that each dimension of the SSI is measured by distinct indicators, but the three wellbeing dimensions are not integrated into a single index. This non-consolidation into one index was recommended by the Joint Research Center (JRC) of the European Commission following the auditing of the SSI (Sustainable Society Foundation, 2016b).

From a methodological perspective, the weighting of indicators raises concerns as it has a crucial impact on the final score of each country. Van de Kerk and Manuel (2008) addressed these concerns and tested different weighting methods for the SSI. Another study used expert judgments to determine the weights of the indicators, categories, and clusters of the SSI (Seppälä et al., 2016). The emerging framework was tested and it was concluded that it is better to use different weights for each indicator than the same weights as in the SSI.

Other researchers have focused on applying and testing the SSI in a wide range of cross-sectional and longitudinal studies. For example, the level of income and its influences on a country's level of sustainable development (measured by the SSI) was tested by Rodríguez-Rosa et al. (2017), while Gallego-Álvarez et al. (2015a) tested the impact of geographic areas on countries' SSI scores by applying an HJ-biplot. From a longitudinal perspective, the correlations between the three dimensions were estimated for the period 2006-2012 (Kaivo-oja et al., 2014); Gallego-Âlvarez et al. (2015b) also analyzed the variation of the SSI over time, with a specific focus on geographic areas. Although van de Kerk and Manuel (2008) stated that the relevance of each indicator for each dimension should be further assessed, no empirical analysis of the reliability (internal and external consistency) of the SSI is reported in the literature.

This study contributes to closing this gap by providing a reliability and validity analysis of the three SSI dimensions for 154 developed and developing countries. The SSI has a solid theoretical foundation and was cited to represent the concept of sustainable development in a holistic way. We use confirmatory factor analysis (CFA) and propose modified dimensions to increase its statistical reliability. CFA is therefore adequate as it is used to determine whether a set of indicators has a common underlying construct (latent variable) (e.g., Brown, 2015). The external validity is analyzed by comparing the country rankings of each modified dimension with well acknowledged and widely used indices that focus on these specific dimensions (HDI and EPI) and by calculating Kendall rank correlation coefficients.

The next section describes the data selected and the methodology used to test the reliability and validity of the three dimensions of the SSI. The results are then presented. In the final section, we summarize, discuss, and provide insights into further research topics.

2.2 Data and research methods

2.2.1 Data

In this study we use the indicators of the Sustainable Society Index (Sustainable Society Foundation, 2016b), covering 154 developed and developing countries in 2016. The SSI includes 21 indicators that are grouped into seven categories (basic needs, personal development & health, well-balanced society, natural resources, climate & energy, transition, and economy) further aggregated into three wellbeing dimensions (social (human)[10], environmental, and economic) (see Table 2-1). Each indicator focuses on a different aspect; for example, sufficient food measures the percentage of people who are undernourished in a country, and greenhouse gases measures the emission of CO_2 per person and year. Each indicator is standardized (ranging between 0 and 10). The maximum score (10) corresponds to the complete fulfillment of a set target. For example, in the case of sufficient food, the target is 0% of undernourished people. All European countries receive the highest score of 10 as 0% of their population is undernourished. On the other hand, countries such as Haiti (53.4%), Central Africa Republic (47.7%), and Zambia (47.8%) show the highest percentage of undernourished people.

Table 2-2 shows the Pearson correlation of the indicators within each dimension. It is immediately visible that specific indicators do not seem to fit into their corresponding dimension as the correlation with the other indicators is either negative or very low. For example, gender equality (social dimension), income distribution (social dimension), biodiversity (environmental dimension), renewable water resources (environmental dimension), energy savings (environmental dimension), employment (economic dimension), and public debt (economic dimension) have (very) low and/or negative correlations with the other indicators in the same dimension.

We test the external validity of the SSI using the Human Development Index 2016 (United Nations Development Programme, 2016b) and the Environmental Performance Index (EPI)

10 Hereafter, the human dimension of the SSI is referred to as social as it combines the crucial aspects of the social dimension defined in the Brundtland report.

2016 (Hsu et al., 2016). The HDI includes three indices (life expectancy index, education index, and GNI index) that are measured by four indicators (life expectancy at birth, expected years of schooling, mean years of schooling, and GNI per capita (PPP $)) and are aggregated into the final HDI score. The EPI includes more than 20 indicators that are grouped into two dimensions (environmental health and ecosystem vitality) and nine subdimensions (health impact, air quality, water & sanitation, water resources, agriculture, forests, fisheries, biodiversity & habitat, and climate & energy). Each dimension has a weight of 50% in the final score. However, the subdimensions and the respective indicators within each dimension have different weights. For example, agriculture has a weight of 10% in the subdimension ecosystem vitality and is composed of two indicators: nitrogen use efficiency (weight within agriculture 75%) and nitrogen balance (25%) (Environmental Performance Index, 2016). As the HDI is a commonly agreed index to measure the economic and social development of a nation and the EPI covers the environmental perspective of development, we depicted the country scores for both indices. We further rank each country according to their score, based on the same countries that are included in the SSI.

Table 2-1: Indicators of Sustainable Society Index

Dimensions of the SSI	Category	Indicator	What it measures	Target*
Social	Basic Needs	Sufficient Food	Number of undernourished people in % of total population	0% undernourished people
		Sufficient to Drink	Number of people in % of total population, with sustainable access to an improved water source	100%
		Safe Sanitation	Number of people in % of total population, with sustainable access to improved sanitation	100%
	Personal Development & Health	Education	Gross enrolment ratio for primary, secondary, & tertiary education (combined)	100%
		Healthy Life	Life expectancy at birth in number of healthy life years	The actual maximum
		Gender Equality	Gender Gap Index of the World Economic Forum	1 on the scale of 0 to 1
	Well-balanced Society	Income Distribution	Ratio of income of the richest 10% to the poorest 10% people in a country	The actual maximum score, i.e. the lowest ratio.
		Population Growth	5-year change in total population size (% of total population)	No further increase of population.
		Good Governance	Sum of the six Worldwide Governance Indicators	The maximum score corresponds to 15, on the World Bank scale of -15 to +15
Environmental	Natural Resources	Biodiversity	10-year change in forest area & Size of protected land area (in % total land area)	Forest area: increase, at least no further decrease; Protected areas: 20%
		Renewable Water Resources	Annual water withdrawals (m3 per capita) as % of renewable water resources	No specific target has been formulated (Formula: F(X)=(100-X)/10 if 0≤X≤90; F(X)=0 if X>90)
		Consumption	Ecological Footprint minus Carbon Footprint	0.9 gha (global hectares)
	Climate & Energy	Energy Use	Energy use (tons of oil equivalent per capita)	No target specified (Formula: F(X)=-2*X+10 if X≤5; F(X)=0 if X>5)
		Energy Savings	Change in Energy use over 4 years (%)	No target specified (Formula: F(X)=25*X+5 if -0.2≤X≤0.2; F(X)=0 if X<-0.2; F(X)=10 if X>0.2)
		Greenhouse Gases	CO_2 emissions per person per year	≤ 2 ton CO_2 per capita per year
		Renewable Energy	Consumption of renewable energy as % of total energy consumption	100%
Economic	Transition	Organic Farming	Area for Organic Farming in % of total agricultural area of a country	20%
		Genuine Savings	Genuine Savings (Adjusted Net Savings) as % of Gross National Income (GNI)	Not specified (Formula: F(X)=10*ARCTAN(0.2*X)/π +5)
	Economy	GDP	Gross Domestic Product per capita, PPP, current international $	Not specified (Formula: F(X)=10*(1.01-EXP(-0.000065*X)) if 0≤X≤70000; F(X)=10 if X>70000)
		Employment	Number of unemployed people in % of total labor force	0%
		Public Debt	The level of Public Debt of a country in % of GDP	2.5 % of GDP

Note: Indicator Biodiversity is composed of two indicators: Biodiversity forest area and protected area; * The formula is only presented if no target is specified. The other formulas can be found at http://www.ssfindex.com/ssi2016/wp-content/uploads/pdf/calculation-formulas-2016.pdf
Source: Sustainable Society Foundation (2016a).

Table 2-2: Correlation coefficients with social, environmental, and economic dimensions

Panel A. Social dimension

	Sufficient Food	Sufficient to Drink	Safe Sanitation	Education	Healthy Life	Gender Equality	Income Distribution	Population Growth	Good Governance
Sufficient Food	1.00								
Sufficient to Drink	0.56	1.00							
Safe Sanitation	0.59	0.80	1.00						
Education	0.52	0.72	0.76	1.00					
Healthy Life	0.60	0.77	0.84	0.78	1.00				
Gender Equality	0.23	0.37	0.36	0.54	0.46	1.00			
Income Distribution	0.30	0.19	0.29	0.20	0.28	0.04	1.00		
Population Growth	0.42	0.62	0.63	0.63	0.64	0.41	0.21	1.00	
Good Governance	0.48	0.60	0.57	0.68	0.72	0.63	0.19	0.43	1.00

Panel B. Environmental dimension

	Biodi-versity	Renewable Water Resources	Con-sumption	Energy Use	Energy Savings	Green-house Gases	Renewable Energy
Biodiversity	1.00						
Renewable Water Resources	0.25	1.00					
Consump-tion	-0.26	-0.15	1.00				
Energy Use	-0.12	0.23	0.60	1.00			
Energy Savings	0.06	-0.06	-0.16	-0.32	1.00		
Greenhouse Gases	-0.09	0.30	0.53	0.94	-0.31	1.00	
Renewable Energy	-0.02	0.39	0.24	0.54	-0.16	0.69	1.00

Panel C. Economic dimension

	Organic Farming	Genuine Savings	GDP	Employ-ment	Public Debt
Organic Farming	1.00				
Genuine Savings	0.17	1.00			
GDP	0.55	0.26	1.00		
Employ-ment	-0.14	0.14	-0.11	1.00	
Public Debt	-0.16	0.19	-0.14	0.29	1.00

2.2.2 Statistical model and reliability indicators

We use confirmatory factor analysis (CFA) and standard reliability indicators to test the reliability of the three dimensions of the Sustainable Society Index. We apply a factor model (measurement model) for the social, environmental, and economic dimension as each dimension is a construct, which cannot be directly measured. However, the indicators within each dimension can be measured. This relationship can be expressed in the following way (Skrondal and Rabe-Hesketh, 2004):

$$Y_{ij}^{h} = \mu_{jh} + \lambda_{jh} f_i^{(h)} + \epsilon_{ij}^{(h)} \qquad \text{(2-1)}$$

where Y_{ij}^{h} is the measurement of the indicator j for dimension h in country i, μ_{jh} is the mean of the indicator j in dimension h, λ_{jh} is the factor loading of indicator j for the latent variable $f_i^{(h)}$, and $\epsilon_{ij}^{(h)}$ is the normally distributed error term. The variance of the error term $\epsilon_{ij}^{(h)}$ is σ_{jh}^{2}.

The overall model is summarized in Figure 2-2. The three dimensions of the SSI stand in relation to each other, as emphasized in the Brundtland report and each dimension consists of different indicators Y_j^h with $j = 1, \dots, J_{So}$, $j = 1, \dots, J_{En}$, and $j = 1, \dots, J_{Ec}$ for the social, environmental, and economic dimension, respectively. This illustration is also based on the recommendations of the JRC, which stressed that each dimension (of the SSI) should be separate and not combined into one final score.

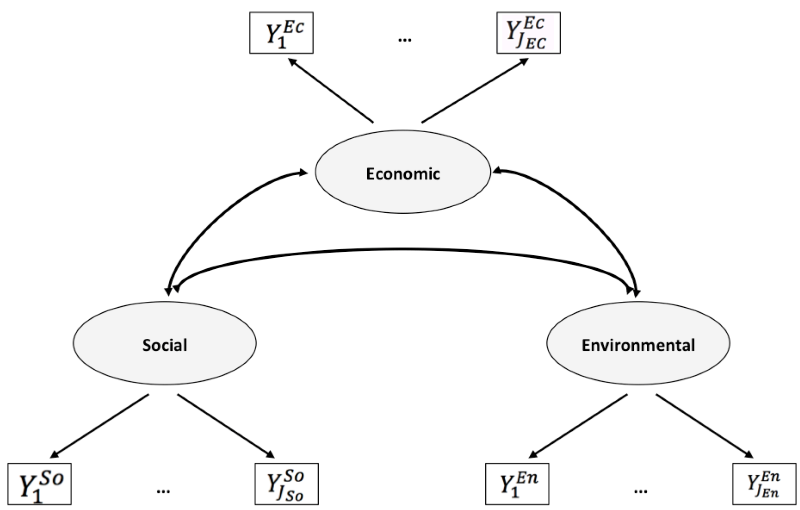


Figure 2-2: Overall model

To assess the model fit of each dimension, we apply the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), the Standardized Root Mean Square Residual (SRMR), and the Root Mean Square Error of Approximation (RMSEA).

To assess the internal consistency of the three dimensions, we use three standard measures (Hair et al., 2014): Cronbach's alpha, composite reliability, and average variance extraction. Cronbach's alpha should be ≥ 0.7 (Nunnally, 1978; Hair et al., 2014; Kline, 2016). For CR and AVE, the rule of thumb indicates a cut-off point of 0.7 (Fornell and Larcker, 1981) and 0.5 (Bagozzi and Yi, 1988), respectively. An AVE higher than 0.5 indicates that the variance explained by the indicators is on average higher than the unexplained variance.

Cronbach's alpha is estimated by using the raw data, whereas the CR and AVE are based on the results of the CFA. Cronbach's alpha is defined by:

$$\alpha_h = \frac{J_h \, \bar{r}_h}{1 + (J_h - 1)\, \bar{r}_h} \tag{2-2}$$

where $\bar{r}_h$ represents the inter-item average covariance and J_h is the number of items for dimension h. It varies between 0 and 1 for a medium correlation between 0 and 1 and has non-negative values.

The composite reliability (CR) is based on the standardized factor loadings (λ_{jh} of factor $f_i^{(h)}$ and indicator j in dimension h) of the CFA and is given by:

$$CR_h = \frac{\left(\sum_j \lambda_{jh}\right)^2}{\left(\sum_j \lambda_{jh}\right)^2 + \sum_j (1 - \lambda_{jh}^2)}, j = 1, \dots, J_h \tag{2-3}$$

The average variance extracted (AVE) is based on the standardized factor loadings (λ_{jh} of factor $f_i^{(h)}$ and indicator j) of the CFA and is given by:

$$AVE_h = \frac{\sum_j \lambda_{jh}^2}{\sum_j \lambda_{jh}^2 + \sum_j \left(1 - \lambda_{jh}^2\right)} = \frac{1}{J_h} \sum_j \lambda_{jh}^2, j = 1, \dots, J_h \tag{2-4}$$

After measuring the reliability, the validity of the measurement is analyzed by comparing the scores of the three dimensions with the HDI and EPI rankings of each country and by computing Kendall rank correlation coefficients. We used Mplus 6.12 and R Studio Version

1.1.456 with package lavaan (version 0.6-3 from September 23rd, 2018) and Maximum Likelihood method with robust standard error (Huber-White) to estimate the models. We further used the R package "PSYCH" version 1.8.12 for the estimation of Cronbach's alpha.

2.3 Results

2.3.1 Reliability analysis of the SSI

Before the overall model can be estimated, the first step was to assess the reliability of each dimension. Three factor models are estimated, one for each dimension (h): social, environmental, and economic. To ensure the reliability of the construct, only significant indicators ($p < 0.05$), with positive coefficients[11], and with standardized factor loadings $\geq$ 0.5[12] were kept. The results of the CFA confirm the first trends of the correlations (see Section 2.1) within each dimension. From a statistical point of view, specific indicators do not fit within the respective dimension, leading to the need to modify the SSI dimensions to ensure reliability.

The resulting model fits of the modified social and environmental dimensions are good, as the SRMRs and RMSEAs are below the recommended threshold of 0.1 (e.g. Kline, 2005) and the CFI and TLI values are higher than 0.9 (Hair et al., 2014) (see Table 2-3). The results highlight the fact that the indicators of the social and environmental dimensions have one underlying latent factor, namely the social and environmental factor, respectively.

The standard indicators of reliability further strengthen the internal consistency of the modified social and environmental dimensions (see Table 2-3). The social dimension has a Cronbach's alpha of 0.900, a CR of 0.699, and an AVE of 0.902; and the environmental dimension has a Cronbach's alpha of 0.870, a CR of 0.719, and an AVE of 0.880.

11 The indicators of the environmental dimension were transformed such that the highest value of each of the three dimensions indicates a maximum positive impact on the sustainable development.

12 A standardized factor loading of 0.5 means that 25% of the variance of the indicator is explained by the factor.

Table 2-3: Goodness of fit and indicators of reliability

	Social	Environmental	Economic
RMSEA	0.000	0.000	–
CFI	1.000	1.000	–
TLI	1.000	1.000	–
SRMR	0.006	0.000	–
Cronbach's alpha	0.900	0.870	0.710
CR	0.699	0.719	–
AVE	0.902	0.880	–

After the modification of the economic dimension to ensure construct reliability, only two indicators were retained (Organic farming and GDP). As such, the model fit cannot be calculated. Nevertheless, it can be integrated in the overall model from a statistical and substantive point of view. The two indictors have a correlation of 0.55 and a corresponding Cronbach's alpha of 0.710.

The indicators retained in each measurement model give a good representation of the substantive aspects of each specific dimension, namely social, environmental, and economic (see Table 2-4). The standardized coefficients are high and range between 0.579 and 1.000, meaning that 33.5% to 100% of the indicators are explained by the underlying latent factor.

Table 2-4: Standardized loadings (coefficients) of the modified social and environmental dimensions

Social	Coefficient	Environmental	Coefficient
Sufficient to Drink	0.848	Consumption	0.579
Education	0.856	Energy Use	1.000
Healthy Life	0.909	Greenhouse Gases	0.906
Population Growth	0.720		

2.3.2 Model estimates

The overall model (see Figure 2-2), which combines the modified social, environmental, and economic dimensions and models their relationships with each other, has a good fit with an SRMR of 0.053, CFI of 0.963, and TLI of 0.941[13]. The standardized estimates (correlations) between the three dimensions are high and range between 0.742 and 0.894, which is in line with the literature.

13 One additional covariance was added between Consumption and Greenhouse gases.

These results strengthen the internal consistency of the overall model (with each dimension combined into a single model) and highlight the strong interrelation (correlation) between dimensions (Table 2-5). In the next step we assess the external validity of the model.

Table 2-5: Correlation (standardized estimates) between the three modified dimensions

	Social	Environmental	Economic
Social	1.000		
Environmental	0.742	1.000	
Economic	0.885	0.894	1.000

2.3.3 External validity

For a holistic analysis of the reliability of the (modified) dimensions of the SSI, we compute the standardized factorial scores for each dimension and compare the country rankings with the HDI and EPI, and compute Kendall rank correlation coefficients.

World maps illustrate the factorial scores of the modified social, environmental, and economic dimensions (see Figures 2-3, 2-4, and 2-5). The factorial scores (normally distributed) were scaled to be between 0 and 1, i.e., using the transformation $(f_i^{(h)} - \min f_i^{(h)})/(\max f_i^{(h)} - \min f_i^{(h)})$. The lowest score (0) is represented by a darker color that becomes lighter as the score increases.

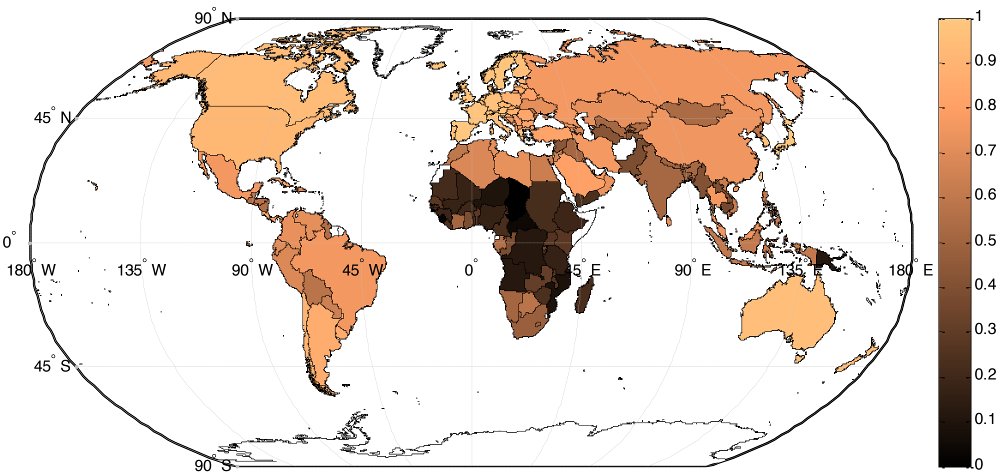


Figure 2-3: Modified SSI social dimension

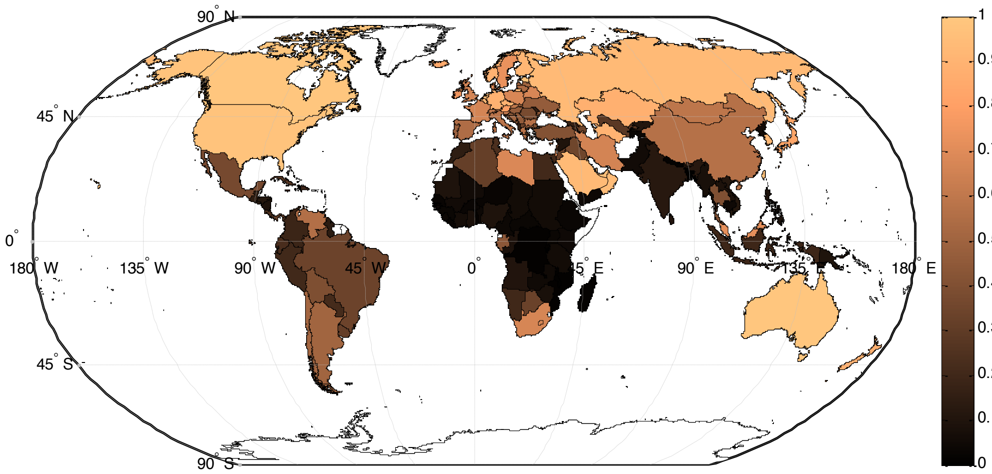


Figure 2-4: Modified SSI environmental dimension

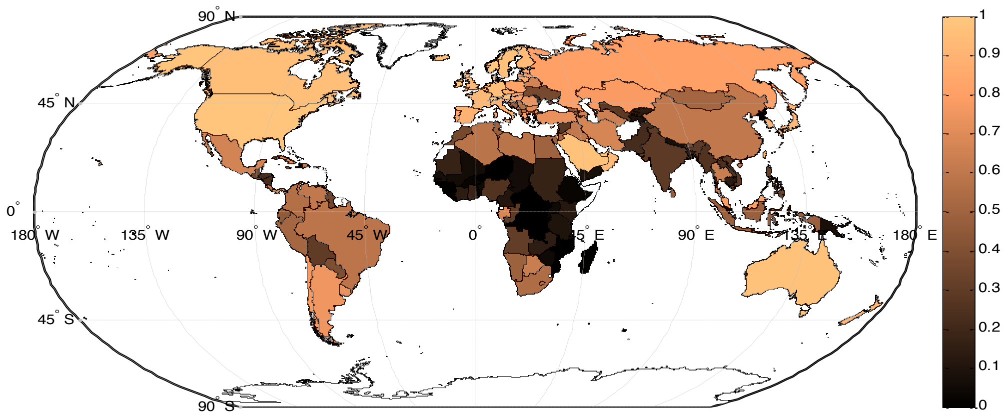


Figure 2-5: Modified SSI economic dimension

Overall, Australia, Canada, and USA have the highest scores throughout the social, environmental, and economic dimensions, whereas Central African countries have the lowest scores in each dimension. The other world regions demonstrate a very mixed picture. European countries have high scores in the social and economic dimensions but lower scores in the environmental dimension. In all three dimensions, Asia demonstrates a mixed picture with Northern Asian countries having higher scores (e.g., Russia and China) and countries in the southern part of Asia such as Pakistan, Bangladesh, and Nepal having low scores. Latin American countries have higher scores in the social dimension, followed by lower scores in environmental and economic dimensions.

These overall trends are supported by the country rankings of the HDI and EPI (see Table 2-6). Countries that have a high (low) ranking in the HDI also have a high (low) ranking in the social and economic dimension and countries with a low (high) score in the EPI have also a low (high) score in the environmental dimensions[14]. For example, in 2016 Norway was ranked first in both the HDI and the economic dimension, and in 14th place in the social dimension. Niger was in the 151st place of the HDI and also ranked 150 and 152 in the social and economic dimensions, respectively. Finland was in first place of the EPI and in 17th place of the environmental dimension and Australia occupied the 13th place of the EPI and second place in the environmental dimension. Mozambique was ranked 148 and 147 in the EPI and environmental dimension, respectively.

[14] We notice that all dimensions in the modified SSI are in agreement on the scale direction of the indicator, which does not apply to the original environmental dimension of the SSI. The Pearson correlation between the score of the EPI and the original Environmental score of the SSI in 2016 is -0.591; whereas the Pearson correlation between the EPI and the SSI modified environment index is 0.707.

Table 2-6: Country ranking of EPI, HDI, and the three modified dimensions of the SSI – based on the scores for each country

Country	HDI	EPI	Social	Environmental	Economic
Albania	60	60	51	93	82
Algeria	70	80	81	77	74
Angola	115	125	147	106	101
Argentina	42	43	38	54	48
Armenia	72	37	75	89	94
Australia	3	13	20	2	10
Austria	18	18	17	27	14
Azerbaijan	68	31	82	71	62
Bangladesh	111	149	111	153	118
Belarus	48	35	49	36	61
Belgium	15	41	21	12	20
Benin	130	142	123	132	135
Bhutan	109	100	94	95	93
Bolivia	95	73	95	66	102
Bosnia and Herzegovina	65	109	61	56	87
Botswana	84	76	96	74	65
Brazil	67	46	58	72	72
Bulgaria	45	33	46	48	56
Burkina Faso	146	141	141	140	140
Burma	117	132	115	117	109
Burundi	147	144	139	154	150
Cambodia	116	126	120	129	121
Cameroon	120	120	134	131	124
Canada	11	25	25	3	18
Central African Republic	150	136	152	137	154
Chad	149	151	154	121	132
Chile	39	52	30	53	47
China	74	99	63	47	69
Colombia	77	57	68	94	77
Congo	108	113	118	115	103
Costa Rica	54	42	41	83	67
Cote d'Ivoire	NA	112	106	119	120
Croatia	41	15	34	63	49
Cuba	62	45	44	81	55
Cyprus	30	40	31	41	33
Czech Republic	25	27	29	22	32
Democratic Republic of the Congo	141	147	148	150	151
Denmark	9	4	13	32	19
Dominican Republic	81	58	80	92	70
Ecuador	73	93	76	84	89
Egypt	92	94	87	87	83
El Salvador	97	89	84	100	95
Estonia	28	8	28	4	37
Ethiopia	138	140	142	139	138
Finland	14	1	22	17	21
France	22	10	9	39	23
Gabon	88	91	98	62	57
Gambia	139	123	128	148	142
Georgia	61	101	59	96	90
Germany	4	30	18	20	17
Ghana	112	115	117	116	115
Greece	29	21	10	46	43
Guatemala	103	83	101	99	98
Guinea	142	121	143	136	149
Guinea-Bissau	140	133	137	128	143
Guyana	102	72	99	101	99
Haiti	135	145	132	152	139
Honduras	107	84	97	104	114
Hungary	40	28	36	59	42
Iceland	6	2	5	25	16
India	106	122	105	102	104
Indonesia	94	97	89	91	86
Iran Islamic Republic of	53	95	56	40	59
Iraq	98	105	107	70	68
Ireland	5	19	8	28	8
Israel	20	49	26	30	31
Italy	26	29	19	45	29
Jamaica	82	54	77	85	91
Japan	17	39	1	26	25
Jordan	80	71	85	76	81
Kazakhstan	52	67	70	24	46
Kenya	114	110	125	127	123
Democratic People's Republic of Korea	NA	NA	93	120	141
Republic of Korea	21	77	15	16	26
Kuwait	49	102	64	14	5
Kyrgyzstan	99	68	102	105	122
Lao People's Democratic Republic	110	128	116	113	110
Latvia	38	22	35	55	45
Lebanon	71	87	83	61	58
Lesotho	128	135	140	130	125
Liberia	144	143	129	143	146
Libyan Arab Jamahiriya	93	108	72	33	73
Lithuania	33	23	37	52	38
Luxembourg	19	20	40	1	2
Madagascar	127	153	133	145	148
Malawi	136	131	127	151	145
Malaysia	51	62	62	31	41
Mali	145	150	144	124	133
Malta	27	9	32	51	28
Mauritania	129	137	138	110	116
Mauritius	55	74	48	75	54
Mexico	63	66	60	69	60
Mongolia	79	103	103	44	80
Montenegro	46	47	45	67	64
Morocco	100	63	91	98	97
Mozambique	143	148	151	147	153
Namibia	105	75	108	90	84
Nepal	118	129	109	146	130
Netherlands	10	36	7	9	12
New Zealand	16	11	24	23	27
Nicaragua	101	104	100	114	111
Niger	151	152	150	141	152
Nigeria	125	118	145	112	108
Norway	1	17	14	21	1
Oman	43	111	67	8	22
Pakistan	119	124	119	125	113
Panama	57	51	54	79	50
Papua New Guinea	121	134	149	108	129
Paraguay	87	79	86	86	92
Peru	75	70	79	88	79
Philippines	90	65	90	111	100
Poland	32	38	33	34	40
Portugal	37	7	11	57	39
Qatar	34	82	65	15	6
Republic of Moldova	89	55	92	97	112
Romania	47	34	43	68	52
Russia	44	32	55	10	44
Rwanda	126	127	121	149	137
Saudi Arabia	35	88	50	11	11
Senegal	133	106	124	142	131
Serbia	58	48	52	60	76
Sierra Leone	148	139	153	133	144
Singapore	8	14	2	13	3
Slovakia	36	24	42	42	36
Slovenia	23	5	23	35	35
South Africa	91	78	110	37	78
Spain	24	6	3	50	30
Sri Lanka	64	98	71	107	88
Sudan	134	146	136	122	117
Sweden	7	3	6	29	15
Switzerland	2	16	16	43	9
Syrian Arab Republic	122	92	112	109	107
Taiwan	NA	59	4	6	13
Tajikistan	104	69	114	135	127
Thailand	76	85	57	65	66
North Macedonia	69	50	66	73	75
Togo	132	138	135	144	147
Trinidad and Tobago	59	61	78	18	34
Tunisia	83	53	69	82	85
Turkey	56	90	47	64	53
Turkmenistan	85	81	113	19	63
Uganda	131	119	126	138	134
Ukraine	78	44	73	58	96
United Arab Emirates	31	86	53	7	4
United Kingdom	13	12	12	38	24
United Republic of Tanzania	123	117	146	123	126
United States	12	26	27	5	7
Uruguay	50	64	39	78	51
Uzbekistan	86	107	104	80	105
Venezuela	66	56	74	49	71
Viet Nam	96	116	88	103	106
Yemen	137	130	130	134	128
Zambia	113	96	122	126	119
Zimbabwe	124	114	131	118	136

The similarities in the rankings can be further confirmed by computing the correlations between the three dimensions and the EPI and HDI: the Kendall rank correlation coefficients between the Human Development Index and the social and economic dimensions are very high with 0.84 and 0.83, respectively. The Environmental Performance Index and the environmental dimensions also show a positive Kendall rank correlation coefficient of 0.58. All the correlations have improved with the modification. The Kendall rank correlation between original economic and social dimensions with HDI is 0.416 and 0.650, respectively. For the environmental dimension the Kendall rank correlation with the original environmental dimension is -0.338. Thus, the modified SSI improves the convergence with other well-known indices.

The overall results support the reliability (internal consistency) and external validity of the three modified dimensions of the SSI. Nevertheless, the analysis also shows the need to improve the measurement of economic and environmental dimensions by using more indicators; this is in part because the economic dimension contains only two reliable indicators.

2.4 Temporal stability

To further validate the reduced model, we measured the temporal stability of the results. We repeated the analysis for the 2014 data set. We conclude that the model stands as the internal fit is at the same magnitude as in 2016, with an SRMR of 0.055, CFI of 0.957, and TLI of 0.932. The standardized estimates (correlations) between the three dimensions are also high and range between 0.757 and 0.919.

Comparing the country rankings by the modified SSI dimensions with HDI and EPI, the Kendall correlations between the Human Development Index and the social and economic dimensions are very high with 0.836 and 0.856, respectively. Regarding the association between the Environmental Performance Index ranking and the modified environmental dimension, the Kendall correlation is 0.645. The Kendall rank correlations between original economic and social dimensions with HDI are 0.442 and 0.697, respectively. For the environmental dimension, the Kendall rank correlation with the original environmental dimension is -0.464. All the correlations improved with the modification of the SSI. Thus, results for 2014 confirm that the modified SSI dimensions improve the convergence with other well-known indices.

2.5 Discussion & conclusion

This study tested the reliability of the three dimensions of the Sustainable Society Index for 154 developing and developed countries. We applied confirmatory factor analysis and created modified dimensions to ensure construct reliability. The internal consistency of the dimensions is supported by the good model fit of the overall model (three dimensions of the SSI) and by the standard measure of reliability (for the social and environmental dimensions). The external validity is confirmed by comparing the country rankings of each dimension (based on their scores) with the HDI and the EPI rankings and Kendall rank correlation coefficients.

Saisana and Philippas (2012) show that the SSI categories of the social and economic dimensions are positively correlated with the other dimension respectively, i.e. social and economic, and economic and social. Furthermore, their results highlight the fact that two of the three SSI categories of the environmental dimension are negatively correlated with the social and economic dimensions. Possible explanations for the divergence of results are: first, the different years of analysis; second, we modified the original dimensions and removed non-significant indicators to ensure construct reliability within each dimension; third, correlations are jointly estimated in the overall model, in which specific indicators were transformed to ensure that their highest value corresponds to a positive "value" for sustainable development.

We further notice that the JRC analysis (Saisana and Philippas, 2012) used Principal Component Analysis (PCA) to measure how much of the variance is explained by the first factor of each dimension and Pearson correlation to analyze the correlations among the dimensions. Our study is distinct in three major ways: first, we do not apply exploratory but confirmatory factor analysis because we consider the indicators and dimensions as given; second, we estimate all three dimensions in one joint model while specifying the relationship among them; third, the external validity of the SSI dimensions is measured by comparing it with well-known international indices.

Contrary to the original three dimensions of the SSI, our results support Seppälä et al. (2016) and highlight different weights for different indicators (loadings). Our results further show that the internal consistency of the environmental and economic dimension can be improved if some variables that are negatively correlated are removed from the model. This approach resulted in one saturated model (environmental), with only three indicators per factor and one model with only two indicators (economic). Further research could extend this work and introduce additional indicators for the environmental and economic dimensions to represent each dimension theoretically and statistically, taking reliability and validity into account.

Chapter 3

Is there an autonomous institutional pillar in sustainable development? An empirical analysis [15]

Abstract

Sustainable development (SD) has recently been receiving increased attention at political, social, and business levels. Its underlying concept was introduced in the 1980s and includes different conceptualizations. The still most popular ones assume either three (economic, social, and environmental) or four equally relevant dimensions (adding institutions as the fourth pillar). This research analyses for the first time these alternative conceptualizations empirically. We hypothesize that four pillars, with the institutional dimension separate from the social pillar, provide a more holistic representation of the SD concept. Both definitions are tested using SD indicators from well-known indices (e.g., Environmental Performance Index, Human Development Index, and Sustainable Society Index) for 138 developing and developed countries. Results from structural equation models support the argument that the institutional dimension should be autonomized, i.e., a four-dimensional representation fits best even when other influences, such as world regions and being a developed country or not are controlled for. In the current discussion of how to achieve SD, this research strengthens the argumentation for a four-dimensional representation.

3.1 Introduction

Climate fluctuations that cause catastrophic events are becoming more and more frequent. The disastrous fires in the recent years in U.S. (California), Australia, Portugal and northern Spain killed more than a hundred people and destroyed thousands of hectares of forest (The Guardian, 2017b, 2018; The New York Times, 2017, 2018). The impact of these fires can to some extent be attributed to human-induced climate change, which has also increased the probability of heat waves in Europe by a factor of at least two (World Weather Attribution, 2017, 2018). The Intergovernmental Panel on Climate Change (IPCC) Special Report on *Global Warming of 1.5°C*, supports these results as they highlight that the consequences of

15 This chapter is based on Witulski, Dias and Roseta-Palma (2019b).

human-caused global warming can already be seen, as sea level rise and more weather and climate extremes occur (Intergovernmental Panel on Climate Change (IPCC), 2018). Contemporary sustainability problems are not limited, however, to environmental concerns; since social and economic instability are also becoming more prevalent. The yearly presented Global Risk Reports of the World Economic Forum (2019) ranks the global risk by impact and likelihood. The 2019 edition highlights environmental, economic, geopolitical, societal, and technological risks. As main driver of the risk landscape the Global Risk Perception Survey identified climate change and “increasing polarization of societies” (World Economic Forum, 2019: 13). These problems have to be tackled jointly as they are interrelated and can be achieved under the concept of sustainable development (SD).

The original definition that comes from the report *Our Common Future* defines sustainable development as having three balanced dimensions: social, economic, and environmental (World Commission on Environment and Development (WCED), 1987)[16]. Since then, this standard definition has been widely applied in almost all areas connected to SD at a business, regional, and national levels. The applications range from cross-section and longitudinal analyses (e.g., Gallego-Álvarez et al., 2015b; Moran et al., 2008) to development of composite indices such as the Sustainable Society Index (SSI) (Sustainable Society Foundation, 2016b), or to achieve international SD goals such as the Millennium Development Goals (MDGs) and their successor, the Sustainable Development Goals (SDGs) (United Nations, 2015d, 2017f). Nevertheless, researchers have extended this seminal definition by adding a fourth dimension (the institutional) next to the economic, social, and environmental pillars (e.g., Toumi et al., 2017; Valentin and Spangenberg, 2000). The institutional dimension is essential and inevitable to achieve SD. Hence, it should not be subsumed into the social dimension, but rather stand next to the social, economic, and environmental dimensions, leading to a four-dimensional definition of SD (e.g., Spangenberg, 2007; Waas et al., 2011).

Empirical research that conceptualizes SD based on four pillars is very scarce. Hosseini and Kaneko (2011) used the four-dimensional representation to test the longitudinal assessment of SD and the causality between the different pillars (Hosseini and Kaneko, 2012); while Toumi et al. (2017) assessed SD of Latin American countries. Our study analyzes empirically, for the first time, the two alternative definitions of sustainable development using structural equation models (SEMs) and thereby strengthening awareness of underlying concepts of SD. The

[16] The terms of sustainable development and sustainability are used interchangeably in this paper.

empirical results based on 138 developing and developed countries show that the selected indicators represent each of the four dimensions (measurement models) indicators well. The indicators in each dimension share the same underlying factor and cover the substantial aspects of each pillar. Furthermore, the estimated structural models reveal that the four-dimensional representation outperforms (goodness of fit and selection criteria-wise) the three-dimensional definition of SD, even when control variables are introduced.

The next section reviews the relevant literature on SD. This is followed by data description and the statistical methods. Section 4 presents and discusses the results. In the end we summarize, discuss limitations, and provide insights for future research.

3.2 Sustainable development – three and four dimensions

Living in a sustainable society is *per se* no contemporary idea. Indigenous traditions and religious beliefs provide insights into a harmonious existence between human society and nature (Mebratu, 1998) – a fundamental principle of SD. Some civilizations have managed to thrive sustainably over a long period (Cairns, 2001), while others suffered from a downfall caused by environmental problems (Diamond, 2003). A driving factor for the fall of the Roman Empire was considered to be lead pollution (Nriagu, 1983). The Babylonian Empire and other ancient societies eventually collapsed due to a degradation of the environment – as growing consensus between environmental archeologists shows (Mebratu, 1998). Various factors could have induced the Maya collapse such as demographic instability, deforestation, social upheaval, and overpopulation. The current discourse, however, focuses on climate change as a crucial factor (Marx et al., 2017), as the Mayas experienced an extended dry spell during their late period (Hodell et al., 1995). In the last decades, the unsustainable way of living in many countries has accentuated an increasing need for research and action toward a more sustainable path of development that avoids catastrophe.

Research over the last 40 years has shaped the concept of SD in crucial ways. Various milestones have added new perspectives, ideas, and definitions to the concept. Among the most vital milestones are: the report *Our Common Future*, also known as *The Brundtland Report,* in 1987 (World Commission on Environment and Development (WCED)) – which influenced all subsequent SD research, actions, and policies. The MDGs and their successor the SDGs have also played a vital role, as the targets to achieve the goals not only raise public awareness, but also increase actions, partnerships, and knowledge transfer to achieve a more prosperous future. This is crucial considering the 2014 Synthesis Report of the Intergovernmental Panel on Climate Change and the Special Report on *Global Warming of 1.5°C* (Intergovernmental Panel on Climate Change (IPCC), 2014, 2018), which shows the magnitude of climate change and the human causes of it. Other United Nations Reports have further contributed to successful evolution of SD. Such reports propose SD indicators (Commission on Sustainable Development, 2001), provide guidelines to develop country indicators by considering national priorities and conditions (United Nations, 2007), and inform on global sustainable development (United Nations, 2015d, 2016b).

In the literature the conceptualization of SD follows either a three- or four-dimensional representation (Ali-Toudert and Ji, 2017). The three pillars approach, containing the economic, social, and environmental dimensions, is often used as a basis to compare countries, create indices and dashboards, and set targets and goals of SD. For example, Santana et al. (2014) created efficiency rankings for BRICS countries to compare the SD of these nations with respect to the economic, social, and environmental dimensions. Sardain et al. (2016) developed a dashboard for SD indicators for Panama based on the three pillars to analyze past trends, current status, and (future) trajectories. Indices that measure SD have also focused on one or all of the three dimensions. For instance, Böhringer and Jochem (2007) presents and analyzes eleven SD indices that contain specific information on the three dimensions of SD. The three dimensions are also used to set international development goals and targets such as the SDGs (United Nations, 2017f).

The three-pillar definition, however, might not correctly conceptualize the concept of SD, leading to a four-dimensional representation, which adds to the existing three pillars the institutional dimension (Ali-Toudert and Ji, 2017).[17] The four pillars approach is used, for instance, by Valentin and Spangenberg (2000), which proposes a model to develop sustainability indicators at a local level; and by Hosseini and Kaneko (2011, 2012), which use a four-pillar definition of SD to analyze dimension dynamics and causalities. O'Connor (2006) highlights the importance of institutions (i.e., political sphere), for the other three dimensions, in the context of a system perspective on sustainability and presents a four-sphere model.[18]

Institutions are recognized as a necessary part of sustainable development (Spangenberg, 2007; Waas et al., 2011). The Brundtland Report includes, in addition to the environmental

[17] Ali-Toudert and Ji (2017) further mentions the cultural dimension as a fourth dimension.
[18] The system approach focuses on the independence of the different dimensions in the context of sustainable development.

and social-economic chapters, one that proposes institutional and legal changes (World Commission on Environment and Development (WCED), 1987). The UN Commission on Sustainable Development's (CSD) proposal for Sustainable Development Indicators (SDIs) contained a four-dimensional structure as well (Commission on Sustainable Development, 2001). The arguments for the separation of institutions as a fourth pillar range from the importance of institutions to implement targets (for other dimensions) to a reduction of complexity of the concept, to the identification and analyses of possible trade-offs or complementarities between pillars (see Spangenberg, 2007; Hosseini and Kaneko, 2011; Waas et al., 2011). This fourth pillar is commonly associated with "democracy" or "governance" (Meadowcroft, 2000). Thus, we hypothesize that *a four-pillar definition (institutional, social, economic, and environmental) measures sustainable development in a more thorough way than the three-pillar representation (social, economic, and environmental).*

The three or four dimensions should cover the complete spectrum of sustainable development, with all influences and impacts taken into account for a holistic picture. The achievements of the goals of the MDGs varied considerably from region to region.[19] While some areas achieved or surpassed their targets, others had poor progress or showed deterioration (United Nations, 2015b). The latest progress report of the United Nations supports these trends, for the successor of the MDGs, the SDGS, as it shows that the achievement of the SDGs varies strongly from region to region (United Nations Economic and Social Council, 2017). A common development of countries within regions could be due to sharing similar characteristics such as shared history (e.g., kingdoms, wars, and cross-country partnerships), cultural similarities (e.g., Christianity in the western hemisphere), or trade agreements (e.g., North American Free Trade Agreement and the European internal market). Whether a country is a developed country or a developing country further has implications on the possibility to strive for SD, as a developing country may not have the necessary resources (e.g., technological, financial, or institutions). As the level of development increases, it should therefore become more manageable for countries to strive for SD. To see the real effect and test the hypothesis, we should control for regions and for being a developed country or not.

Figure 3-1 depicts the two conceptual models (with three and four dimensions of SD) and control variables that need to be taken into account.

[19] The MDGs had a time horizon of 15 years (2000 – 2015).

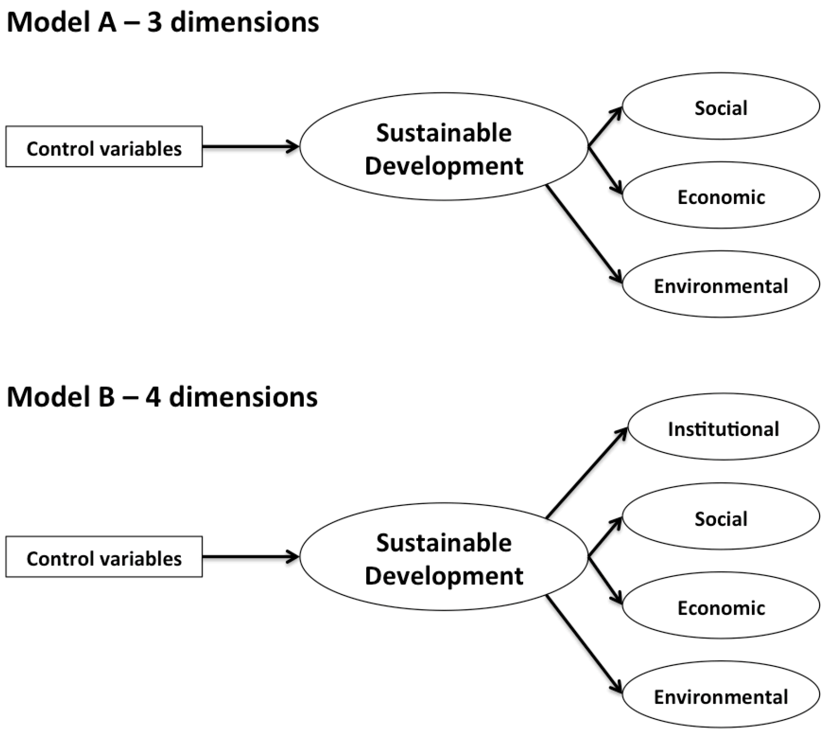


Figure 3-1: Conceptual models

3.3 Research method

3.3.1 Data

Parris and Kates (2003) illustrated that over 500 quantitative sustainable development indicators had already been introduced by 2003. Today the SDGs contains over 230 indicators (United Nations, 2017e) and the World Development Indicators of the World Bank cover 220 countries and more than 1,400 indicators (World Bank, 2017a). Considering the number of available indicators, we selected, for each of the four dimensions, frequently-used variables from the most popular sustainability indices (Gallego-Álvarez et al., 2015b; Moran et al., 2008; Saisana and Philippas, 2012): the Human Development Index (HDI), the Sustainability Society Index (SSI), and the Environmental Performance Index (EPI). The three indices were selected due to their importance, country coverage, broad reach, and the concepts they capture. Together they account for a comprehensive understanding of the three pillars of sustainability (Gallego-Álvarez et al., 2015b; Moran et al., 2008; Saisana and Philippas, 2012). We use from each index the indicators and not the aggregated dimensions, e.g., we do not use the HDI score but instead, the four raw indicators used to compute it. The same applies to the SSI and the EPI. For the institutional dimension we consider the indicators used by Hosseini and Kaneko (2011) and, to further enhance the economic dimension, additional indicators of the World Bank have been added; resulting in a total of 68 indicators for all four dimensions for 138 developing and developed countries.[20]

It should be noted that some indicators can be used to measure more than one dimension. In that case, the indicator is used in the dimension to which it is most closely associated. For instance, Renewable energy (consumption) could be included in the economic dimension given the important role of sustainable energy production. We selected it, nevertheless, for the environmental dimension because energy production is one of the main contributors to greenhouse gas emissions. Water resources could be included in the social pillar, due to the direct impact on people and their way of living, yet we included them in the environmental dimension given their importance to ecosystem vitality (one dimension of the EPI). Our choices coincide with the SSI and EPI classifications.

We included two sets of control variables in order to assess possible biases. First we used the region a country belongs to based on the World Bank (2019a) classifications; and second, a dummy variable for developing (Non-OECD) or developed (OECD) countries. Altogether, two variables lead to the following control variables: East Asia-Pacific, Middle East / North Africa, North America, Latin America / Caribbean, Sub-Saharan Africa, South Asia, and Developed; the reference categories were: Europe and Central Asia, and Developing.

3.3.2 Statistical model

Conceptual models can be tested by a variety of different statistical models depending on the exact characteristics of the model. Given a set of observed variables (indicators) a latent variable model (LVM) can measure distinct constructs and test a conceptual model. The latent variable can be seen as a construct or true value without measurement error. These models, also known as causal models, covariance structure models, and structural equation models are predominant in social sciences and are currently applied in different scientific fields. Common latent variables are measured by a factorial component from a set of indicators, as the concept of sustainable development (and its three or four dimensions) cannot be directly observed. The integration of factorial and regression models gives extreme flexibility to the LVM framework to conceptualize the relationships between variables when the measurement is performed under error (Kline, 2011; Skrondal and Rabe-Hesketh, 2004).

[20] See Table 3-2 for the final set of indicators (of each dimension) and their sources. We also analyzed the indicators regarding normality and symmetry with e.g. diagrams.

A set of indicators is used to measure each (first-order) latent variable. Let Y_{ij} represent the indicator j ($j = 1, \dots, J$) for country i. Now, assuming that a set of indicators measures a single dimension, they share a mutual latent factor (f_i). Thus, Institutional, Social, Economic, and Environmental are first-order factors that are measured directly by indicators:

$$Y_{ij} = \mu_j + \lambda_j f_i^{(h)} + \epsilon_{ij} \tag{3-1}$$

where μ_j is the mean of the indicator j, λ_j is the factor loading of indicator j for the latent ($f_i^{(h)}$), and ϵ_{ij} is the normal distributed error term. The variance of the error term ϵ_{ij} is σ_j^2.

Apart from the first-order latent factors $f_i^{(h)}$ that represent Institutional, Social, Economic, and Environmental (*h=Inst*, *Soc*, *Eco*, and *Env*), our conceptual model assumes a second-order factor called Sustainable Development that results from the four first-order dimensions and is represented by $f_i^{(SD)}$. The model is given by

$$f_i^{(SD)} \sim N\left(E[f_i^{(SD)}], \sigma_{(SD)}^2\right), \tag{3-2}$$

where the factor follows a normal distribution with $f_i^{(Inst)} = \gamma_{Inst} f_i^{(SD)} + \varepsilon_i^{(Inst)}$, $f_i^{(Soc)} = \gamma_{Soc} f_i^{(SD)} + \varepsilon_i^{(Soc)}$, $f_i^{(Eco)} = \gamma_{Eco} f_i^{(SD)} + \varepsilon_i^{(Eco)}$, and $f_i^{(Env)} = \gamma_{Env} f_i^{(SD)} + \varepsilon_i^{(Env)}$. The expected value of a high-order factor is measured by the indicators through the first-order factors (Koufteros et al. 2009).[21] Sustainable Development covers the four pillars defined by first-order factors. The error terms $\varepsilon_i^{(h)}$ are independent with null mean and constant variance.

The conceptual model (represented in Figure 3-1) includes control variables (W_k). Thus, the Multiple Indicators Multiple Causes (MIMIC) structure of the model is given by:

$$E\left[f_i^{(SD)}\right] = \sum_k \beta_k^{(SD)} W_{ik}. \tag{3-3}$$

Maximum likelihood was used to estimate the models. The model fit of the structural equation model (SEM) is tested with the chi-square test. Given its sensitivity to sample size, further indices were applied: the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI),

[21] The first-order latent factors are measured by the indicators for each factor. The higher order latent factor (e.g., second-order factor) is estimated by the first-order factors, which are measured by the indicators. This means in our case that the four first-order factors (Institutional, Social, Economic, and Environmental) are used to estimate a second-order factor, which represents the Sustainable Development dimension.

the Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Square Residual (SRMR).

A sequence of nested SEM is estimated to test the hypothesis. For the analysis, five measurement models and the structural models were estimated. The five measurement models represent the dimensions: Institutional, Social, Social2[22], Economic, and Environmental. The structural models are the second-order factor models (Sustainable Development with three and four pillars) without and with controls. The structural models are compared with information criteria: AIC – Akaike Information Criterion (Akaike, 1974) and the BIC – Bayesian Information Criterion (Schwarz, 1978).

Before model estimation another critical issue has to be dealt with: the sample size, as it is decisive for structural equation models. The rule of thumb suggests about 200-300 observations for SEM models. Whereas different authors refer to different minimum sample sizes, Boomsma (1982, 1985) suggests at least 100-200 and Bentler and Chou (1987) mentions 5-10 observations per estimated parameter. These general rules of thumb are often criticized because they do not take the specification of the model into account. MacCallum et al. (1999) show that there are specific characteristics such as sample size, level of factor determinacy, and level of commonality through the variables, which have an impact on the model fit and parameter estimation. Thus, it is questionable whether the rule of thumb should be applied. Wolf et al. (2013) and Sideridis et al. (2014) tested the minimum sample size for different structural equation models. Wolf et al. (2013) show that lower minimum sample size (as small as 30) can be applied, although it depends, e.g., on the number of indicators used, factor loadings, and amount of missing data. Sideridis et al. (2014) report that a sample size of 50 showed a satisfactory fit and 70-80 observations should be used to model relationships. Considering these studies, our sample size of 138 seems adequate, given the factor loadings, missing data, and the number of indicators. Mplus 6.12 was used to estimate all models.

[22] Social2 includes all eight indicators of the social and institutional dimensions to create a new dimension Social2, to compare three and four pillars of SD.

3.4 Results

3.4.1 Measurement models

3.4.1.1 Individual dimensions of sustainable development

Each of the three / four dimensions of SD requires, in addition to a comprehensive, substantial representation, also a good methodological foundation to measure SD. Hence, it is crucial to assess the contribution of each indicator for the reliability of its corresponding dimension[23]. First, we checked whether the indicators were significant ($p < 0.05$) and had a positive coefficient sign (standard rule for reliability, excludes negative coefficients). In the next step we deleted variables that are highly correlated or are overlapping (e.g., the institutional dimension includes indicators that are also aggregated, represented in one indicator of the sustainable society index – called governance). The remaining indicators can be used to measure each dimension in a reliable way.

A good model fit for structural equation models is characterized by the following: a Standardized Root Mean Square Residual (SRMR) and Root Mean Square Error of Approximation (RMSEA) below 0.1 (e.g., Brown, 2015; Harrington, 2008; Kline, 2005; Schumacker and Lomax, 2010; Whitley et al., 2013), and a Tucker-Lewis Index (TLI) and Comparative Fit Index (CFI) higher than 0.9 (e.g., Hu and Bentler, 1999).

Four of the five first-order measurement models (i.e., Institutional = Inst, Social = Soc, Economic = Eco, and Environmental = Env) show an excellent/very good model fit for the covariance structure of the indicators analyzed (see Table 3-1). The SRMR, RMSEA, CFI, and TLI are all within the thresholds for the Inst, Soc, Eco, and Env dimensions. Social2 (Soc2) has an SRMR below 0.1 and CFI and TLI values close to the threshold and its model fit is also acceptable. Given the model fit, it can be concluded that the indicators of each of the dimensions measure an underlying common factor: Institutional, Social, Social2, Economic, and Environmental.

[23] Some variables had to be transformed, see Table A.3-1 for the reasons and the description of the transformation.

Table 3-1: Goodness-of-fit measurement models

	Inst	Soc	Soc2	Eco	Env	SD3	SD4
Chi-Square	0.011	0.300	129.533	2.111	0.018	481.100	281.327
DoF (chi2_ms)	1	1	18	2	1	98	97
RMSEA	0.000	0.000	0.212	0.020	0.000	0.168	0.117
CFI	1.000	1.000	0.891	0.999	1.000	0.792	0.900
TLI	1.000	1.000	0.830	0.998	1.000	0.745	0.876
AIC	934.936	1433.570	2388.031	3120.920	1578.478	6892.022	6694.249
BIC	972.991	1470.947	2464.140	3156.047	1616.438	7050.094	6855.248
SRMR	0.000	0.004	0.094	0.020	0.002	0.147	0.088

The factors of the four first-order measurement models (Inst, Soc, Eco, and Env) are all measured by respectively four indicators – with significant standardizing loadings ranging from 0.487 to 0.983 (see Table 3-2), which indicate a very strong correlation between indicators and factors. To ensure the reliability of the construct, the factor loading (of each indicator) should ideally be ≥ 0.7, but ≥ 0.5 is also considered acceptable (e.g., Hair et al., 2014). Additionally, we added a direct association (covariance) between the indicators Voice and accountability and Political stability & absence of violence/terrorism (Institutional dimension), between Sufficient food and Sufficient to drink (Social dimension), and between Consumption and Renewable energy (Environmental dimension).

In summary, the substantive representation of each of the four dimensions is good. Its statistically significant indicators well represent the institutional pillar as they include Worldwide Governance Indicators (WGI) (World Bank, 2019d). For life in dignity (and an equal basis for welfare distribution) people need at least to have enough to eat, enough water, education, and overall healthy life (see United Nations, 2016a) – which is included in the social dimension. The economic pillar is well represented by its indicators as they are standard indicators of a country's economic health. These country-level indicators are the average national income per capita, the net lender or borrower to the rest of the world, how much of the GDP is exported, and how much the private households actually spend (or the counterpart: how much they save) (United Nations Development Programme, 2017; World Bank, 2017b). The environmental dimension includes indicators to account for the different facets of the environment, i.e., climate change, renewable energy, consumption, and water resources.

Table 3-2: First-order measurement models

Dimension	Indicators	Coefficient	Source (Data 2016)
Institutional	Voice and accountability	0.770	World Bank (2019d)
	Political stability and absence of violence/terrorism	0.764	World Bank (2019d)
	Rule of law	0.983	World Bank (2019d)
	Control of corruption	0.975	World Bank (2019d)
Social	Sufficient food	0.672	Sustainable Society Foundation (2016b)
	Sufficient to drink	0.824	Sustainable Society Foundation (2016b)
	Education	0.828	Sustainable Society Foundation (2016b)
	Healthy life	0.943	Sustainable Society Foundation (2016b)
Economic	Gross national income (GNI) per capita	0.753	United Nations Development Programme (2017)
	Current account balance (% of GDP)	0.483	World Bank (2019b)
	Households and NPISHs final consumption expenditure (% of GDP)	0.862	World Bank (2019b)
	Exports of goods and services (% of GDP)	0.605	World Bank (2019b)
Environmental	Adjusted savings: particulate emission damage (% of GNI)	0.867	World Bank (2019b)
	Water resources	0.781	Hsu et al. (2016)
	Consumption	0.511	Sustainable Society Foundation (2016b)
	Renewable energy	0.793	Sustainable Society Foundation (2016b)

3.4.1.2 Sustainable Development

For a representation of the whole concept of sustainable development, two second-order measurement models are estimated (SD3 and SD4). They include the three and four dimensions of sustainability respectively without controls. The goodness-of-fit of SD3, which contains Soc2, Eco, and Env, is poor, as all values are outside of the recommended thresholds (see Table 3-1), indicating that the data do not support the (three pillars) sustainability model. On the other hand, the model fit of SD4 is good, as the SRMR (0.088) is below the recommended limit, the CFI is 0.9 and the TLI close to 0.9. The standardized loadings between SD and the four dimensions range from 0.764 to 0.996, which shows a strong relationship between the first-order and second-order constructs (loadings between SD and Inst, Soc, Eco, and Env are respectively, 0.764, 0.996, 0.813, and 0.980). Thus, it can be concluded that the four dimensions (Inst, Soc, Eco, and Env) underlie a common factor, which we call Sustainable Development.

The AIC and BIC of both models (SD3 and SD4) highlight that SD4 is preferred (minimum AIC and BIC values), as it measures the concept better, which was also indicated by the poor model fit of SD3. These results support our hypothesis that four pillars rather than three represent sustainability better.

3.4.2 Structural models

3.4.2.1 Sustainable Development with controls (MIMIC – Model)

Two structural (MIMIC) models are estimated, that add control variables to the second-order factor models (SD3 and SD4) (see Table 3-3). The first MIMIC model (SD3 & Con) has an improved model fit regarding RMSEA and SRMR as their values are closer to the thresholds compared to SD3, but all goodness-of-fit indicators are still outside of the recommended threshold. The significant control variables are: South Asia, Sub-Saharan Africa, and Developed. The second structural model (SD4 & Con) shows an acceptable model fit with an SRMR of 0.093. The significant control variables are the same as for SD3 & Con (see Table 3-4).

Table 3-3: Goodness-of-fit - MIMIC models

	SD3 & Con	SD4 & Con
Chi-Square	927.905	676.696
DoF (chi2 test)	203	202
RMSEA	0.161	0.130
CFI	0.685	0.793
TLI	0.640	0.763
AIC	6785.258	6536.050
BIC	6963.821	6717.540
SRMR	0.120	0.096

Except for the poor model fit of SD3 & Con, the AIC and BIC also reveal that SD4 & Con is the best model and should, therefore, be picked. It supports the view that the institutional pillar should be autonomized from the social dimension, as it empirically fits the data better. This supports our hypothesis and the *four-pillar definition (institutional, social, economic, and environmental) measures sustainable development in a more thorough way than the three-pillar representation (social, economic, and environmental),* even when control variables are added.

Table 3-4: Sustainability with controls

Dimension	Indicators	Coefficient
	Institutional	0.739
	Social	1.0
	Economic	0.774
	Environmental	0.959
Institutional	Voice and accountability	0.768
	Political stability & absence of violence/terrorism	0.761
	Rule of law	0.990
	Control of corruption	0.967
Social	Sufficient Food	0.684
	Sufficient to Drink	0.805
	Education	0.849
	Healthy Life	0.928
Economic	Gross national income (GNI) per capita	0.816
	Households and NPISHs final consumption expenditure (% of GDP)	0.518
	Current account balance (% of GDP)	0.788
	Exports of goods and services (% of GDP)	0.585
Environmental	Adjusted savings: particulate emission damage (% of GNI)	0.875
	Water Resources	0.749
	Consumption	0.581
	Renewable Energy	0.765
Controls	East Asia & Pacific	-0.037
	Latin America & Caribbean	-0.101
	Middle East & North Africa	-0.010
	North America	-0.001
	South Asia	-0.166 **
	Sub-Saharan Africa	-0.692 ***
	Developed	0.364 ***

Note: *** p-value < 0.001; ** p-value < 0.01; * p-value < 0.05

3.4.2.2 Control variables

Countries in world regions such as South Asia and Sub-Saharan Africa struggle with essential aspects of human living conditions and improvements are inevitable. This may explain the negative slopes and the significance of these control variables. The Progress Report of the Sustainable Development Goals (United Nations Economic and Social Council, 2017) shows that in 2013, 42% of Sub-Saharan African population still lived in extreme poverty (less than 1.90$ per day) compared to a world average of 11%. The mortality rate of children under five years old was in Sub-Saharan Africa almost twice as high as the world average, with 43 deaths per 1,000 live births, in 2015. The HIV new infection rate was also five times higher than globally “with 1.5 new infections per 1,000 uninfected people in 2015” (United Nations Economic and Social Council, 2017: 5). Sub-Saharan Africa and South Asia account for the highest percentage of children under five years old with stunted growth[24]; together they account for 75% of all children under five that show stunted growth (2014) (United Nations Economic and Social Council, 2017). Countries in Sub-Saharan Africa not only show health problems, but also primary education is an ongoing problem; not even 50% of students have a minimum level of proficiency in mathematics at the end of primary education (United Nations Economic and Social Council, 2017). These vast problems that the countries in these regions face may explain why these regions have a significant negative coefficient in our model, and reduces the score of SD for example in Sub-Saharan Africa by 0.692 comparing to the reference region. Another controlling influences on the score of SD manifests the control variable developed. The significantly positive loading of developed implies that being one of these countries has a positive effect on sustainability and increases the score of SD by 0.364 compared to the reference category.

The results support our hypothesis and a four-dimensional representation is empirically better. Therefore, the institutional pillar should be autonomized from the social dimension. However, it is important to note that the concept of sustainability is challenging to define, and we do not claim that a four-pillar representation is the best and/or unique view of sustainable development. For a process such as sustainable development it is important to be open-minded and seek to include as many different opinions as possible. Robinson (2004: 375) states: "[w]hile intellectually frustrating from the point of view of science, this may be the appropriate approach in the messy world of the politics and policies of sustainable development. In other words, the lack of definitional precision of the term sustainable development may represent an important political opportunity."

3.5 Conclusion

This research empirically compares the most common concepts of sustainable development, the three- and four-dimensional representation. Multiple Indicator Multiple Cause models are applied on a dataset containing 138 developing and developed countries. The results show that each dimension of SD (institutional, social, economic, and environmental) is from a substantial and methodological perspective well represented. The structural models that combine the three and four dimensions to estimate the overall sustainable development concept reveal that the four-pillar concept outperforms the three-pillar concept (regarding

[24] The definition of stunting is that the height is not adequate for the age, it can be seen as a combined factor of infection and undernutrition (United Nations Economic and Social Council, 2017).

goodness-of-fit, AIC, and BIC). The results support the argument that the institutional dimension should, indeed, be rendered separately from the social pillar.

Given the nature of the concept of sustainable development and its operationalization, there are limitations of this study that must be considered. First, there is a possible indicator selection bias, in the original choice of indicators to be included in the dataset, as there are more than a thousand indicators available to measure aspects of SD. We minimized this bias by using indicators from widely known, tested, and applied indices. Second, the sample size could be considered an issue when thinking about the rule of thumb for these models, although Wolf et al. (2013) and Sideridis et al. (2014) showed that the sample size depends on the model itself and can be reduced to 30/50 observations. Given the strength of the factor loadings throughout all models and the number of indicators and lack of missing data, the sample size seems to be adequate in this research.

We acknowledge that there is also a broad discussion on whether culture could be seen as a fourth pillar and not institutions, since culture is omnipresent (especially in the social dimension) and has an influence on each of the dimensions. Further research could investigate the impact of culture on sustainable development in more detail and explore its role as the four dimensions of sustainability. Finally, we used cross-sectional data as we are interested in assessing and comparing the concepts at a certain point in time rather than determining how sustainable development changed over time. Further research could explore the difference between the three and four dimensions of sustainability over time and analyze their dynamics.

Chapter 4

Sustainable competitiveness of nations: An empirical country-level analysis [25]

Abstract

The concept of sustainable competitiveness emerged at the beginning of the 21st century and it highlights the interconnection of competitiveness and the four dimensions of sustainability. Although these topics have been well researched individually the relationship between them is still underexplored. This research provides the first empirical exploration of the relationship between competitiveness and the four dimensions of sustainability using structural equation modeling. The analysis reveals a significant positive association. The strongest association is between competitiveness and the institutional dimension, followed by the economic, social, and environmental dimensions. Our empirical evidence supports the notion that if a country focuses on its competitiveness, it will have positive spillover effects for sustainable development. The nation's sustainable development will be reinforced, resulting in more environmental and social stability that will, in turn, foster greater competitiveness, a virtuous cycle. However, the different stages of a country's development need to be considered and each country must address specific policy recommendations. For example, if a country is in Latin America & Caribbean, South Asia, and Sub-Saharan Africa, this has a negative impact on competitiveness.

4.1 Introduction

For most of human existence, the primary concern has been to ensure people's livelihoods, not an easy endeavor given the challenges posed by scarce resources, limited knowledge, and a zero-sum mentality of many civilizations. With the technological progress witnessed in the last 250 years, there have been great improvements in livelihoods almost everywhere, both quantitatively (more people) and qualitatively (better material conditions and better outcomes in health and longevity). The environmental crises of the 20th century issued the stark warning

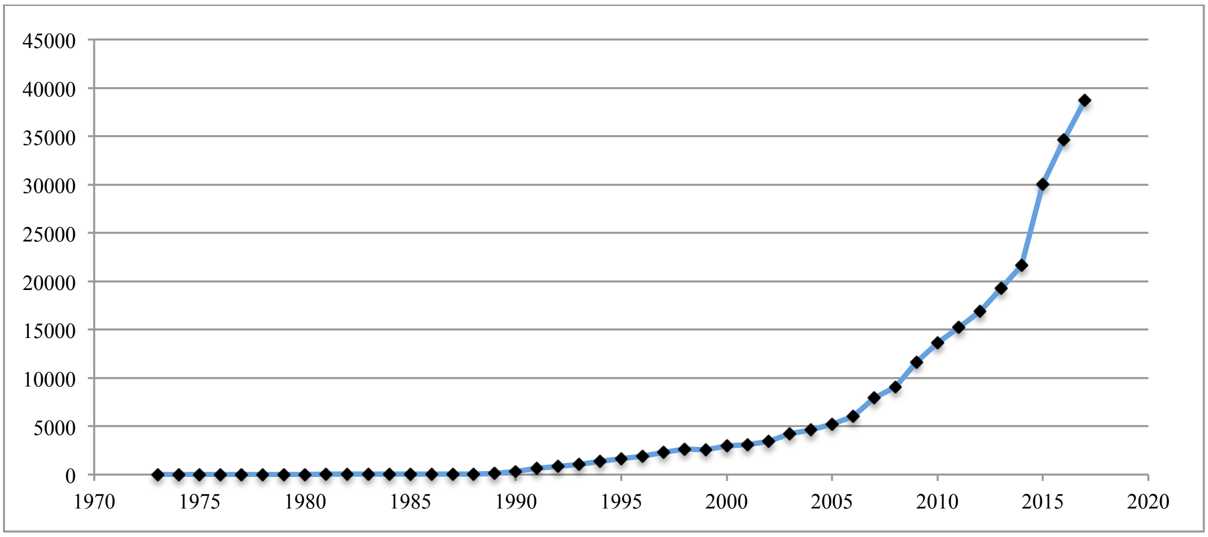
[25] This chapter is based on Witulski, Roseta-Palma, and Dias (2019).

that resources such as clean water and air, biodiversity, and climate regulation, had been critically jeopardized by human activities. Initial concerns focused on controlling pollution for a healthy environment (as in the 1972 United Nations' Stockholm Declaration) and there was growing international consensus to build a broader vision of sustainable development[26] (World Commission on Environment and Development (WCED), 1987); this was further developed in the 1992 Rio Earth Summit and in numerous subsequent international agreements. Climate change triggered by the rapid accumulation of human-originated greenhouse gas emissions that result in rising sea levels and stronger storms is one of the most significant challenges to humankind (United Nations Population Fund, 2016). The 2015 United Nations Climate Change Conference in Paris was a milestone in this debate. It defined the goal of a maximum 1.5 °C increase in the average global temperature and recognized that all nations must work to achieve this goal, albeit on a voluntary and asymmetric basis (United Nations, 2016c). The official United Nations milestones have led to a growing global awareness of sustainability and the increasing number of research publications.

The surge in published research in the area of sustainability in the early 1990s was followed by an exponential increase over the past two decades. From 1973 to 2018, there was an average annual growth rate of 24.2%[27] in the number of publications indexed on Web of Science (see Figure 4-1), which clearly indicates the scientific recognition of the need to encourage changes in the current lifestyle toward more sustainable standards and paths of development. More specifically, the growth rate was 26.5% between 1973 and 1987 (including the year of the Brundtland report) (due to the very low initial starting point), and 33.0% from 1987 to 2000 (including the year of the Millennium Development Goals (MDGs)). Thereafter, the absolute number of publications continued to rise sharply but the growth rate declined to 14.6% (2000-2018). This trend is further enriched by research efforts in related areas (Elsevier and Sci Dev Net, 2015).

[26] The terms sustainable development and sustainability are used interchangeably in this work.

[27] The growth rate is given by $(\ln(\#\, publications\ year_{t1}) - \ln(\#\, publications\ year_{t2}))(year_{t1} - year_{t2})^{-1}$.



Source: Web of Science on March 5th, 2019.

Figure 4-1: Published articles indexed by Web of Science – search for topic *sustainability* or *sustainable* from 1973 – 2018

The aspirations associated with improving human wealth and material well-being are still critical drivers for action at various levels. The concept of "competitiveness of nations" is particularly notable, although it has evolved since the 18th century and currently tends to be equated with the countries' productivity. Today, three major indices seek to measure the concept through a composite index: the Global Competitiveness Index (GCI), the Competitive Industrial Performance Index (CIP), and the IMD World Competitiveness Yearbook (WCY).

Although the concepts of competitiveness and sustainability have each been well explored, the links between them have not been thoroughly examined. Nonetheless, politicians and researchers around the world acknowledge that sustainable development and competitiveness are intertwined and a new concept has emerged in this context – *sustainable competitiveness* – as described in the following section. Despite all efforts, there is not as yet an empirical analysis of the relationship between competitiveness and sustainability at the country level. This paper provides such an exploration, explicitly considering the institutional, social, economic, and environmental dimensions that represent sustainability at a macro level, using latent variable models.

The next section reviews the main results achieved in this research field and provides the bases for the conceptual framework. The data and the estimation process are presented in the third section. The main results are then presented and discussed. The paper concludes with a summary of the main findings, limitations, and avenues for further research.

4.2 Sustainable competitiveness

The concept of the wealth of nations has evolved steadily since the classic political economist Adam Smith (Smith, 1776/1904) first mentioned it in 1776, when he related it to available inputs. Over time the discussion has shifted toward the concept of competitiveness of nations (Garelli, 2006). In the 1990s, Laura D'Andrea Tyson gave the most famous definition of competitiveness at that time: "competitiveness is our ability to produce goods and services that meet the best of international competition while our citizens enjoy a standard of living that is both rising and sustainable" (Krugman, 1994: 31). More recently, Rivkin (2015) notes that the competitiveness of a nation, specifically the United States of America (US), can be seen as having two main goals: to "win global marketplace" (in terms of real GDP and company profits) and to "lift the living standards of the average American". Over the centuries the reasons explaining why some countries prosper and others fall behind have always been at the heart of the discussion.

In 1776, Adam Smith specified four important input factors including natural resources, land, labor, and capital. In the 19th century David Ricardo (1817) enriched the discussion by providing the law of comparative advantage. Max Weber's (1905/1930) concept of the relationship between religion, values, economic performance, and beliefs of nations and Karl Marx's (1909) communist ideas, shaped ideas of the early 20th century, while in the middle of the century Joseph Schumpeter's (1942) notion of the entrepreneur as a competitiveness factor and Robert Solow's (1957) of know-how, education, and technological innovation for economic growth gained predominance. Table 4-1 provides a more detailed summary of the key contributions on the evolution of the concept of competitiveness.

Table 4-1: Overview of the most important contributions to the concept of competitiveness

Author	Contribution
Adam Smith	Four inputs: natural resources, land, labor, and capital (Smith, 1776/1904).
David Ricardo	Law of comparative advantage (Ricardo, 1817).
Alfred Marshall	"Industrial organization continued. The concentration of specialized industries in particular localities" Book IV, Chapter X (Marshall, 1920).
Max Weber	The relationship between religion, values, economic performance, and beliefs of nations (Weber, 1905/1930).
Karl Marx	Influence of sociopolitical environment on economic development: change in political context, namely toward a communist system, should precede economic performance (Marx, 1909).
Bertil Ohlin	Heckscher–Ohlin model: general equilibrium model for international trade (Ohlin, 1933)
Joseph Schumpeter	Highlighted the role of the entrepreneur as a factor of competitiveness, pushing technological improvement, and innovation (Schumpeter, 1942).
Robert Solow	Underlying factors for economic growth (US); highlighted the relevance of increased know-how, education, and technological innovation (Solow, 1957).
Alfred P. Sloan and Peter Drucker	Further development of the framework that management is a key input to competitiveness (Sloan, 1963; Drucker, 1969).
Michael Porter	Aggregation of ideas into one systematic framework: "The Competitive Advantage of Nations" (Porter, 1990).
Paul Krugman	"Increasing Returns and Economic Geography" (Krugman, 1991).
Paul Krugman	Productivity should be used instead of competitiveness for countries (Krugman, 1994).
Nicholas Negroponte and other modern economists	Refinement of knowledge as a concept that represents the most current factor of input for competitiveness (e.g., Negroponte, 1995).

The concept of competitiveness of nations has sparked controversy in recent decades (e.g., Fagerberg et al., 2007; Krugman, 1994; Lall, 2001). Indeed, there is no commonly agreed definition of competitiveness of nations (Despotovic et al., 2016). The term originates from the business literature and forms the basis for strategic analysis of companies that compete against each other over resources and markets (Lall, 2001). Relative profitability and market shares are analyzed to assess the competitiveness of companies and implement strategies to improve their performance. At the industry level, competitive performance can also be measured and compared. For instance, it can be stated that the United States is more (or less) competitive in manufacturing computers or textiles at the industry level than other countries. At the national level, however, the picture is different because it may be meaningless to argue that one country is more or less competitive than another. Krugman has forcefully argued against the use of the term "competitiveness of nations" (Krugman, 1994) because countries cannot go out of business as companies do and therefore the term competitiveness is misplaced and should be replaced with productivity. He recommended caution with regards competitiveness although he noted that the frequent use of the word in the business context makes it easily recognizable, thus helping explain its popularity within economics.

Hay (2011: 463) discusses why "Paul Krugman's now-famous warnings as to the 'dangerous obsession' of competitiveness have fallen on deaf ears". It was always unlikely that policymakers would understand the competitiveness of nations as similar to a fight for market shares, and even if they did, they would not inevitably translate this assumption into protectionist policies. Krugman's criticism seems too focused on the link between protectionism and competitiveness, and he therefore ignores other important factors. For instance, he overlooks the problem of cost competitiveness, while in fact "[i]t is cost competitiveness specifically, rather than competitiveness more generally, that is the dangerous obsession today" (Hay, 2011: 464). Price competitiveness is a less-needed condition for development and growth than capacity [28], technology, and demand competitiveness (Fagerberg et al., 2007). The debate on which is the most appropriate concept for nations – productivity or competitiveness – continues. Atkinson (2013) questions the equivalence between productivity and competitiveness. In his view, productivity growth can influence competitiveness if it takes place in tradable rather than non-tradable sectors (e.g., electric utilities, nursing homes, and grocery stores). Meanwhile, international organizations that focus on measuring and defining the competitiveness of nations put special emphasis on productivity.

The Global Competitiveness Index (GCI), published annually by the World Economic Forum (2017a), is among the most influential and widely used indices in the literature (Despotovic et al., 2016; Fonseca and Lima, 2015) [29]. Productivity is at the heart of the GCI. The World Economic Forum "define[s] competitiveness as the set of institutions, policies, and factors that determine the level of productivity of an economy, which in turn sets the level of prosperity that the country can achieve" (World Economic Forum, 2017a: 11). In the GCI, twelve pillars combine 114 indicators in three sub-indices ("basic requirements, efficiency enhancers, and innovation and sophistication factors") (World Economic Forum, 2017a: 11). Two further indices seek to measure the competitiveness of nations: the Competitive Industrial Performance Index (CIP) of the United Nations Industrial Development

[28] Capacity competitiveness was used by Fagerberg et al. (2007) as an addition to price and technology competitiveness to account for the remaining aspects except for demand competitiveness.

[29] For instance, a search of *World Competitiveness Report*, *Competitive Industrial Performance Index*, and *World Competitiveness Yearbook* on the Web of Science on January 4th, 2019 resulted in respectively 327, 74, and 42 articles.

Organization (2016), and the IMD World Competitiveness Yearbook (WCY) of the International Institute for Management Development (2016). Each index has a different emphasis: while the GCI focuses on the factors determining productivity (World Economic Forum, 2017a: 11), "[t]he WCY analyzes and ranks how nations and enterprises manage the totality of their competencies to achieve increased prosperity" (The International Institute for Management Development, 2016: 484); UNIDO, on the other hand, assesses and benchmarks the industrial competitiveness with the CIP by "building on a concept of competitiveness that emphasizes countries' manufacturing development, implying that industrial competitiveness is multidimensional" (United Nations Industrial Development Organization, 2016: 16).

Ever since the concept of competitiveness of nations was introduced, it has been clear that it must go beyond economic aspects. Not only is this explicit in Laura d'Andrea Tyson's definition (Krugman, 1994), but also in the two main goals described by Rivkin (2015). Sonntag (2000) stresses that social well-being is not ensured by competitiveness and expresses concerns about the unsustainable application of advanced manufacturing technologies due to the rise in the consumption of resources when market demand increases (Sonntag, 2000).

Initially, common perceptions of the link between competitiveness and sustainability assumed that the relationship would be positive. It was thought that introducing or tightening regulations to enhance sustainability would not inevitably harm competitiveness, but could rather be beneficial (Porter and van der Linde, 1995). Jaffe et al. (1995: 159) reviewed the literature on the impact of environmental regulations on competitiveness in the case of US manufacturers. A sizeable adverse effect of environmental regulations on the competitiveness of manufacturing companies is neither confirmed nor rejected, so the truth lies somewhere in between. The authors conclude that differences in international environmental stringency do not justify a significant reduction in US environmental regulation as there are insufficient threats to the industrial competitiveness of the US. Nevertheless, environmental (and social) regulations do tend to produce direct and indirect costs, and there is no proof that stricter regulations improve economic competitiveness.

In 1993 Weiss introduced the term *sustainable competitiveness* (Weiss, 1993). She merged the concepts of international competitiveness and sustainable development by focusing on economic growth and environmental protection to foster intergenerational equality. The terminology has been used over time in various different contexts and studies (e.g. Fonseca and Lima, 2015; Despotovic et al., 2016, Despotovic et al., 2019).

To contribute to this discussion, the World Economic Forum adapted its Global Competitiveness Index by developing the Sustainability-adjusted Global Competitiveness Index (SGCI) that describes "the set of institutions, policies, and factors that make a nation productive over the longer term while ensuring social and environmental sustainability" (World Economic Forum, 2014: 55). The SGCI was published in the Global Competitiveness Report until 2014-2015[30] and used in research (e.g., Thore and Tarverdyan, 2016). Two different aspects are expressed by the World Economic Forum (2014): i) productivity and competitiveness are interchangeable concepts, but the framework of sustainable competitiveness is much broader and includes crucial elements that go beyond economic facets to ensure high-quality growth;[31] ii) attaining medium- and long-term growth is vital for all nations. At the same time, the sustainability concept calls for an unceasing inquiry into whether we are creating the society in which we want to live. The SGCI combines economic, social, and environmental aspects, as emphasized by the Brundtland report, to represent sustainable development holistically. The SGCI methodology can still be questioned since it contradicts the underlying idea that all three pillars are equally important. In the SGCI, environmental and social components can influence the index by only ±20%.

Apart from the institutional approach by WEF, research has been conducted on specific features of the link between sustainability and competitiveness. The influence of single components of sustainability, such as a possible interaction between the economic and environmental dimension, is noted by Porter and van der Linde (1995). Berg and Ostry (2011) show that stable economic growth can be achieved by a more equitable distribution of income despite the countervailing effects of a wide redistributive policy within a country, and Fonseca and Lima (2015) find a strong correlation between innovation, sustainability, and competitiveness. As Fonseca and Lima (2015) use the SGCI as an indicator for the sustainability dimension and the IMD World Competitiveness Yearbook for the competitiveness dimension, their results can be questioned (i.e., the positive correlation may derive from the fact that the indices measure different facets of competitiveness). Other research on competitive sustainability tests the impact of the social and environmental dimensions on competitiveness (economic dimension). Despotovic et al. (2016) find that although the social dimension has a positive influence on competitiveness (economic

[30] Today the WEF produces a separate report, the goal of which is to measure inclusive growth. Regarding the environmental aspects, the WEF established partnerships with CIESIN and Yale that provide them with a ranking of the most environmentally sustainable countries. Therefore, they no longer include the SCGI in their report (personal communication with one of the authors via e-mail).

[31] The WEF mentions, for example, "[e]fficient use of natural resources", "[c]arbon reduction", and "[i]mproved health" (World Economic Forum, 2014).

dimension), it has a mixed impact (negative or positive) depending on the level of GDP for the case of European countries. On the other hand, dos Santos and Brandi (2014) examine the relationship between environmental indicators and competitiveness using canonical correlation analysis. They use the twelve pillars of the GCI as indicators of competitiveness and the seven indicators of EPI to measure the environmental dimension. Their results indicate a positive association between competitiveness and the environmental dimension, but still lack the full spectrum of four dimensions of sustainability (for a conclusive case for the association between sustainability and competitiveness).

Research on sustainability has conceptualized either a three or four-dimensional representation (Ali-Toudert and Ji, 2017). The four-dimensional representation adds the institutional dimension to the original (e.g. Brundtland report) three dimensions (social, economic, and environmental) and it is widely used by researchers (e.g. Hosseini and Kaneko, 2011, 2012; O'Connor, 2006; Valentin and Spangenberg, 2000). The four pillar concept provides a broader picture of sustainable development as it explicitly emphasizes institutions and their crucial role in sustainability, which has been highlighted over the years by many researchers (e.g., Spangenberg, 2007; Waas et al., 2011).

In summary, it is understood that if a country is sustainable, it should also have a better competitive position because (in the best case) it has well-functioning institutions, social aspects such as inequality and poverty are addressed, the economy is in a good shape, and there are relatively limited environmental pressures. To the best of our knowledge, there is not as yet empirical research on the relationship between competitiveness and the four dimensions of sustainability in one comprehensive model. This study fills that gap; we hypothesize that *there is a positive relationship between competitiveness and the four dimensions of sustainability.*

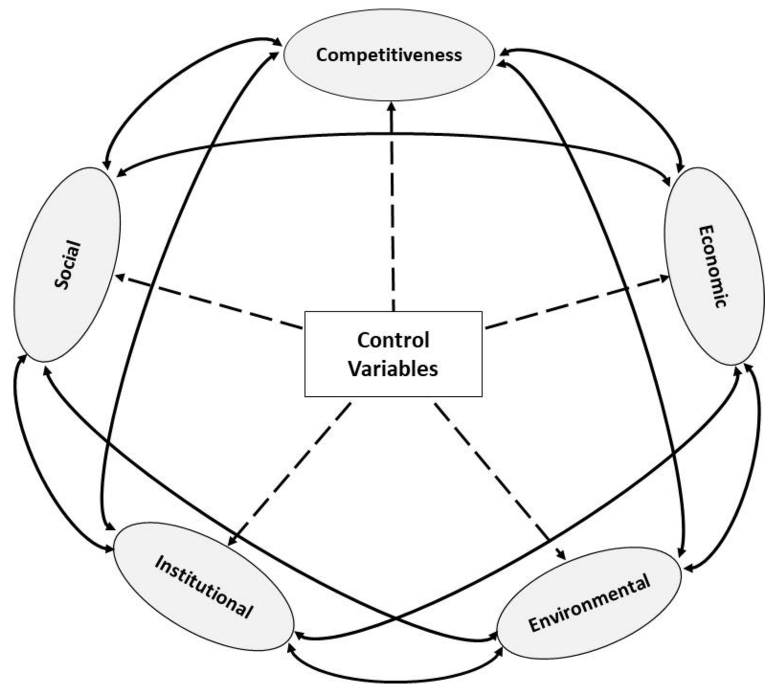


Figure 4-2: Conceptual model of sustainable competitiveness

Figure 4-2 depicts the conceptual model underpinning this study. The competitiveness dimension co-varies with the four sustainability dimensions: institutional, social, economic, and environmental. The four dimensions of sustainability are also interrelated. Control variables are added to remove other influences from the analysis.

4.3 Research method

4.3.1 Data

In this study we use indicators from well-known indices and sources to operationalize the concept of competitiveness and the four dimensions of sustainability. We use the indicators of the Human Development Index (HDI) (United Nations Development Program, 2017), the Sustainability Society Index (SSI) (Sustainable Society Foundation, 2016b), the Environmental Performance Index (EPI) (Hsu et al., 2016), and the World Bank (2019b, 2019d) (e.g. the indicators applied by Hosseini and Kaneko (2011)) to measure the institutional, social, economic, and environmental dimensions. The twelve pillars of the

Global Competitiveness Index (GCI) measure the competitiveness dimension (World Economic Forum, 2017a). Data pertain to the year 2016.[32]

The GCI includes over 100 indicators ranging from macroeconomic variables to executive opinion survey responses. A pre-selection of indicators is required to avoid a double counting problem: the estimated association between competitiveness and the four dimensions may be inflated as the same indicators are used to measure different concepts. This represents the primary challenge for indicator selection due to the number of macroeconomic indicators used in the GCI. To measure this effect, we compare the indicators we include in the four dimensions and the indicators that are used to estimate each of the twelve GCI pillars. Some indicators of the economic and social dimension are similar to those used in the GCI framework. For instance, Life expectancy (social dimension) and Exports of goods and services (% of GDP) (economic dimension) are both included in the GCI. Therefore, we selected GCI indicators that represent competitiveness and are not already included in the four dimensions of sustainability.

The context of the analysis of the association between the four dimensions of sustainability and competitiveness is taken into account by adding the world region to which the country belongs. It accounts for the fact that some areas share similar characteristics due to common history (e.g., wars, cross-country partnerships, common kingdoms), trade agreements (e.g., European Internal Market and North American Free Trade Agreement), and cultural similarities (e.g., the Western world – Christianity). This indicator is based on the World Bank classification (World Bank, 2019a). These variables gave rise to the following control variables: East Asia-Pacific, Middle East/North Africa, North America, Latin America/Caribbean, Sub-Saharan Africa, and South Asia – with reference categories: Europe and Central Asia.

4.3.2 Statistical analysis

Structural equation models (SEM) establish the methodological basis for this research and are widely applied in various disciplines, in which indicators measure a latent variable indirectly. A construct (latent variable) is measured using a set of indicators, which is adequate in this context as neither competitiveness nor the four dimensions of sustainability can be observed directly. Latent variable models combine factorial and regression models and thus provide a

[32] See Table 4-4 for the final set of indicators (of each dimension). We also analyzed the indicators regarding normality and symmetry with e.g. diagrams.

flexible statistical framework to conceptualize the association between variables when the indicators are prone to measurement error (Kline, 2011; Skrondal and Rabe-Hesketh, 2004). To operationalize the four dimensions of sustainability, we estimate four first-order models (one for each dimension, i.e. institutional, social, economic, and environmental), and, we include GCI indicators in a first-order factor model for a solid representation of the competitiveness dimension.

The measurement part of the model is given by:

$$Y_{ij} = \mu_j + \lambda_j f_i^{(h)} + \epsilon_{ij} \tag{4-1}$$

where Y_{ij} is the measurement for indicator j in country i, μ_j is the intercept of the indicator j, λ_j is the factor loading of $f_i^{(h)}$ for the five dimensions of the model indexed by h: competitiveness, economic, social, environmental, and institutional. ϵ_{ij} is the error term with variance σ_j^2.

The structural part of the model is given by the factors that are assumed to be normally distributed with $Var(f_i^{(h)}) = \sigma^2_{f^{(h)}}$ and $Cov(f_i^{(h)}, f_i^{(h')}) = \psi_{hh'}$. In the conceptual model (Figure 4-2), control variables (W_k) were added to test for other influences on factors $f_i^{(h)}$. Thus, the Multiple Indicators Multiple Causes (MIMIC) structure of the model is given by:

$$E[f_i^{(h)}] = \sum_k \beta_k^{(h)} W_k. \tag{4-2}$$

The goodness-of-fit of the SEM models is measured by the Root Mean Square Error of Approximation (RMSEA), the Standardized Root Mean Square Residual (SRMR), the Comparative Fit Index (CFI), and the Tucker-Lewis Index (TLI). The BIC – Bayesian Information Criterion (Schwarz, 1978) and AIC – Akaike Information Criterion (Akaike, 1974) are used to compare models. Mplus 6.12 and R Studio Version 1.1.456 with package "lavaan" (version 0.6-3 from September 23rd, 2018) was used to estimate all models.

4.4 Results and discussion

4.4.1 Measurement model

4.4.1.1 Competitiveness

The competitiveness dimension is well represented by four indicators of the World Competitiveness Index (GCI): Goods market efficiency, Financial market development, Business sophistication, and Innovation. The measurement model for competitiveness shows a very good model fit for their variance-covariance structure and it can be said that the indicators measure the underlying common factor (competitiveness) appropriately with an SRMR and RMSEA below 0.1 and CFI and TLI above 0.9 (see Table 4-2).[33]

Table 4-2: Goodness-of-fit measurement models

	Competitiveness	Institutional	Social	Economic	Environmental
Chi-Square	0.527	0.011	0.300	2.111	0.018
DoF (chi2_ms)	1	1	1	2	1
RMSEA	0.000	0.000	0.000	0.020	0.000
CFI	1.000	1.000	1.000	0.999	1.000
TLI	1.000	1.000	1.000	0.998	1.000
AIC	511.734	934.936	1433.570	3120.920	1578.478
BIC	548.912	972.991	1470.947	3156.047	1616.438
SRMR	0.003	0.000	0.004	0.020	0.002

The standardized loadings of the indicators that constitute the competitiveness dimension are high and range from 0.830 to 0.950 (Table 4-3). In general, the reliability of the construct is ensured by standardized loadings that are ideally ≥ 0.7, but ≥ 0.5 is acceptable (e.g., Hair et al., 2014). A low factor loading indicates that the common concept (latent variable) explains a smaller portion of the variance of the indicator. A standardized loading of 0.5 means that 25% of the variance of the indicator is explained by the factor, while a standardized coefficient of 0.7 means that 49% of the variance is explained by the factor. Financial market development has the lowest standardized loading (0.830), meaning that it is the indicator whose variance is (compared to the other indicators) the least explained by the factor (68.9% of its variance is explained by the factor). The financial market development may be an important aspect to consider for competitiveness, but the concept itself is much broader and other factors prevail. Innovation is the indicator with the second lowest standardized loading (0.885); this includes quality of scientific research institutions, company spending on R&D, availability of scientists

[33] We also added a covariance between *Business sophistication* and *Innovation*.

and engineers, and government procurement of advanced technology products, among others. The two indicators with the highest standardized loadings are Business sophistication (0.946) and Goods market efficiency (0.950). Business sophistication is a key driver for innovation-driven economies; it includes local supplier quantity and quality, state of cluster development, production process sophistication, and extent of marketing (World Economic Forum, 2017a), and Goods market efficiency highlights the importance of factors such as intensity of local competition, extent of market dominance, and effectiveness of anti-monopoly policy.

Table 4-3: Competitiveness standardized loadings

Indicators	Standardized loadings
Goods market efficiency	0.950
Financial market development	0.830
Business sophistication	0.946
Innovation	0.885

4.4.1.2 Four dimensions of sustainability

The sets of indicators representing each of the four dimensions of sustainability respectively (i.e., institutional, social, economic, and environmental) cover the concept well (Table 4-3). All substantial aspects of each dimension are accounted for and models show a good fit of the variance-covariance structure (Table 4-2). All four first-order measurement models have an excellent goodness-of-fit, with all values within the recommended range: SRMR ideally below 0.1 (Kline, 2005), CFI and TLI should be above 0.9 (Hu and Bentler, 1999), and RMSEA should be less than 0.1 (Harrington, 2008; Brown, 2015; Whitley et al., 2013; Schumacker and Lomax, 2010).

The standardized loadings of the indicators of each dimension are high and range from 0.483 to 0.983 (Table 4-4), which shows a strong correlation between indicators and the factor. The highest standardized loadings in each dimension, i.e. the indicators whose variance is best explained by their respective factors are: Rule of law (0.983, Institutional), Households and NPISHs final consumption expenditure (% of GDP) (0.862, Economic), Healthy life (0.943, Social), and Adjusted savings - particulate emission damage (% of GNI) (0.867, Environmental). Voice and accountability (0.770, Institutional), Current account balance (% of GDP) (0.483, Economic), Sufficient food (0.672), and Consumption (0.511, Environmental) have the lowest standardized loadings, demonstrating that they are important for their respective dimension but their variance is the least explained by the factor relative to the other indicators in each dimension.

Table 4-4: Indicators of the four dimensions of sustainability

Dimension	Indicator	Standardized loadings
Institutional	Voice & accountability	0.770
	Political stability & absence of violence/terrorism	0.764
	Rule of law	0.983
	Control of corruption	0.975
Economic	Gross national income (GNI) per capita	0.753
	Current account balance (% of GDP)	0.483
	Households and NPISHs final consumption expenditure (% of GDP)	0.862
	Exports of goods and services (% of GDP)	0.605
Social	Sufficient food	0.672
	Sufficient to drink	0.824
	Education	0.828
	Healthy life	0.943
Environmental	Adjusted savings: particulate emission damage (% of GNI)	0.867
	Water resources	0.781
	Consumption	0.511
	Renewable energy	0.793

4.4.2 Structural models

4.4.2.1 Association between competitiveness and the four dimensions of sustainability

The first structural model estimates the covariances between competitiveness and the four dimensions of sustainability without controls. The model has an acceptable model fit with an SRMR of 0.089 and a CFI of 0.906, and a RMSEA and TLI close to the threshold (Table 4-5).

Table 4-5: Goodness-of-fit of structural models

	Competitiveness and four dimensions: without controls	Competitiveness and four dimensions: with controls
Chi-Square	415.722	729.772
DoF (Chi-Square)	156	246
RMSEA	0.110	0.119
CFI	0.906	0.848
TLI	0.885	0.809
AIC	7007.139	6830.236
BIC	7223.756	7134.671
SRMR	0.089	0.087

The standardized covariances (correlations) between the competitiveness factor and the four dimensions of sustainability are high and range between 0.686 and 0.866 (Table 4-6), thereby supporting the discriminant validity of the constructs. These results indicate a positive and significant (p-value < 0.001) association between competitiveness and the four dimensions of sustainability without controls.

Table 4-6: Standardized covariance between competitiveness and the four dimensions of sustainability – without controls

	Social	Institutional	Economic	Environmental
Institutional	0.763			
Economic	0.767	0.826		
Environmental	0.984	0.680	0.788	
Competitiveness	0.724	0.866	0.816	0.686

Institutions are a crucial aspect for competitiveness as they establish the basis for conducting business in the long run, bringing, for example, the rule of law and control of corruption. This may explain why the highest association (correlation) is between competitiveness and the institutional factors (0.866). The weakest association can be found between competitiveness and the environmental dimension (0.686). Kozluk and Timiliotis (2016) study the effects of national environmental policies on exports. Overall, they do not find that stringent environmental policies have a negative impact on countries' competitiveness. Nevertheless, there is a significant loss of competitiveness in industries that are considered heavy polluters, while industries that are considered cleaner (less polluting) show a gain in competitiveness. This may explain the weaker association between competitiveness and the environmental dimension. The high correlation between the economic and competitiveness dimensions supports the view that the country's economic prosperity of the increases when it has a growing competitive advantage and vice versa. The strong association between the social and competitive factors (0.724) indicates that when a country increases its competitiveness, it may also have an effect on the social dimension, and vice versa.

Results support our initial hypothesis: we find a positive relationship between competitiveness and the four dimensions of sustainability. Previous research addressing aspects of sustainability (e.g., only the environmental dimension) and competitiveness is in line with our results as they point toward a positive association (e.g., Fonseca and Lima, 2015; dos Santos and Brandi, 2014; Weiss, 1993). The country focus on competitiveness creates positive spillover effects on the four dimensions of sustainable development. A reinforcement of the competitiveness of that country will result in more financial and social stability, which supports advances in sustainable development: a virtuous cycle.

4.4.2.2 Sustainability and competitiveness with controls

Table 4-7 shows the results when taking into account the impact of world regions on competitiveness and the four dimensions of sustainability (dashed lines in Figure 4-2). The model with control variables has better information criteria (lower AIC and BIC) than the models without the control variables (see Table 4-5) and should therefore be used.

Table 4-7: Standardized covariance between competitiveness and the four dimensions of sustainability – with controls

	Social	Institutional	Economic	Environmental
Institutional	0.829			
Economic	0.709	0.799		
Environmental	0.971	0.667	0.703	
Competitiveness	0.729	0.821	0.763	0.628

After controlling for world regions, the association between competitiveness and the four dimensions of sustainability is still high, increasing to 0.729 (social) or decreasing to 0.821 (institutional), 0.763 (economic), and 0.628 (environmental) (compared to the model without controls) (see Table 4-7).

As for the impact of world regions on competitiveness and dimensions of sustainability (see Table 4-8), Latin America & Caribbean, South Asia, and Sub-Saharan Africa have a negative coefficient throughout all five factors. Countries in these regions have lower scores relative to the reference group. For example, the social score of a country in South Asia is 0.246 lower than that of a country within the reference category. Countries in the Middle East & North Africa have lower scores for the social and institutional dimension and East Asia & Pacific countries have a lower score for the social dimension relative to the reference group. North America has a positive coefficient for the competitiveness factor, in which its score is 0.165 higher than the reference category. The distinct impacts of the world regions on competitiveness and the four dimensions of sustainability reflect the different stage of development within each dimension of each region. These results should be considered for policy recommendations as they show that the distinct features of regions and countries should be taken into account.

Table 4-8: Estimates of the slopes of control variables (world regions)

	Social	Institutional	Economic	Environmental	Competitiveness
East Asia & Pacific	-0.129 *	-0.076	-0.023	-0.099	0.060
Latin America & Caribbean	-0.241 ***	-0.418 ***	-0.353 ***	-0.184 **	-0.346 ***
Middle East & North Africa	-0.177 **	-0.231 **	0.020	-0.042	-0.126
North America	0.029	0.129	0.040	0.050	0.165 *
South Asia	-0.246 ***	-0.213 **	-0.278 ***	-0.329 ***	-0.175 *
Sub-Saharan Africa	-0.947 ***	-0.529 ***	-0.586 ***	-0.854 ***	-0.511 ***

Note: * (p-value < 0.05), ** (p-value < 0.01), and *** (p-value < 0.001).

4.5 Conclusion

Despite a vast literature on competitiveness and each of the four dimensions of sustainability, the interconnection between these concepts has not been well explored at the country level. This research contributes to this discussion by exploring the empirical relationship between competitiveness and the four dimensions of sustainability using data from 138 countries. Results of the structural equation models (SEM) strengthen the concept of sustainable competitiveness (positive association) and the idea of a virtuous cycle between competitiveness and the four dimensions of sustainable development.

Our empirical results show that competitiveness and the four dimensions of sustainability have a positive association, even when controlled for other influences. The strongest standardized covariance (correlation) is between competitiveness and the institutional dimension with a coefficient of 0.821, followed by the economic (0.763), social (0.729), and environmental (0.628) dimensions. World regions such as Latin America & Caribbean, South Asia, and Sub-Saharan Africa demonstrate a negative effect on competitiveness and the four dimensions of sustainability, while being a North American country has a positive effect.

Some limitations can be pointed out. First, the selection of indicators is always controversial given the wide range of available indicators for both competitiveness and the dimensions of sustainability. We selected indicators from well-known aggregate indices and sources to represent the pillars in a holistic view. Further research could validate our results with a different set of indicators. Second, the sample size could be considered small. For this kind of structural equation models (MIMIC models), the rule of thumb indicates at least 100-200 observations (e.g. Boomsma, 1982, 1985). Simplistic rules should be used cautiously, however, as they do not account for specific model characteristics. For instance, the number of indicators used, missing data, and factor loadings influence the sample size required to estimate SEM (e.g. Sideridis et al., 2014; Wolf et al., 2013). Thirty observations may be sufficient if specific model characteristics (e.g., high factor loadings and a low number of missing observations) are fulfilled (Wolf et al., 2013). Sideridis et al. (2014) report that a sample size of 50 showed a satisfactory fit. The sample size of 138 in this study seems adequate given the number of indicators and their factor loadings. Third, different results could arise from the recent leaning of the world economy toward more protectionism, especially with new tariffs by the US against China, Mexico, Japan, and the European Union, among others (Bloomberg, 2019; Office of the United States Trade Representative, 2018; The New York Times, 2019), which could lead to a trade war. Further research could focus on the effects of a trade war on sustainable competitiveness. Fourth, we decided against a second-order model in which four dimensions constitute sustainable development, as we sought to analyze the interplay between each of the four dimensions and competitiveness in order to understand the underlying strengths of the relationship. Finally, we used cross-sectional data and study competitiveness and sustainable development at a specific point in time. In the literature, some authors favor a dynamic process of competitiveness (Aiginger, 1998; Aiginger et al., 2013) and sustainability (Baumgartner, 2011). Further research could investigate the dynamics and check for differences and similarities across time.

Chapter 5

Institutions as antecedents of sustainable development [34]

Abstract

Institutions have been at the heart of sustainable development concerns at every major sustainability milestone, from the Brundtland Report in 1987 to the Sustainable Development Goals introduced in 2015. Institutions constitute the broad environment in which the three dimensions of sustainable development (social, economic, and environmental) interact, and should therefore be both a crucial part and antecedent of sustainable development. This study explores the role of institutions – as a necessary condition – for the sustainable development of nations by applying structural equation modeling (SEM) to a dataset containing 138 developing and developed countries. The empirical results support the concept that institutions are antecedents of sustainable development and that geographic areas influence institutions. Countries in the world's regions of Latin America & Caribbean, Middle East & North Africa, South Asia, and Sub-Saharan Africa have a lower institutional factor.

5.1 Introduction

Institutions play a major role in countries' wealth creation and economic growth (Drzeniek-Hanouz, 2015; Hausmann, 2014), as strong institutions can create a prosperous environment in which poverty is reduced, the growth of the private sector is facilitated, and citizens have more confidence in government. For example, studies have shown that institutions influence the economic development of a country (Acemoglu and Johnson, 2005; Rodrik at al., 2004), social aspects such as education and poverty (Branisa et al., 2013; Castells-Quintana et al., 2017), environmental facets such as climate change (Bhattacharya et al. 2017), and are essential for sustainable development (SD) (United Nations, 2015a).

Institutions have been defined in many ways: as systems that contain integrated and approved social rules to structure social interactions (Hodgson, 2006); as a means "to organize human

[34] This chapter is based on Witulski, Dias, and Roseta-Palma (2019b).

interactions that are structured and repetitive" (Ostrom, 2005: 3); and as "stable, valued, recurring patterns of behavior" (Huntington, 1968: 12). The most widely accepted definition of institutions was provided by North (1991), who defined them as: "the humanly devised constraints that structure political, economic and social interactions" divided into formal (e.g., property rights, constitutions, and laws) and informal (e.g. taboos, codes of conduct, traditions, customs, and sanctions) institutions (North, 1991: 97). This definition highlights that institutions establish the broad environment in which a country and its people are embedded and is used in this paper with a focus on formal institutions. The role of institutions as an antecedent of SD and its three pillars (social, economic, and environmental) is empirically analyzed in this research.

In recent decades the importance of institutions to the generation of economic growth and development has become clearer, underscoring their role in SD (OECD, 2014a; United Nations, 2016a)[35], which can be defined as "meet[ing] the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development (WCED), 1987). This standard definition of sustainability was one of the first milestones in the SD movement. It implies that to achieve SD, its three pillars – social, economic, and environmental – must be in balance. Since its introduction, this definition has often been applied and it is still the gold standard for SD research (see Böhringer and Jochem, 2007; Gallego-Álvarez et al., 2015b; Rodríguez-Rosa et al., 2017; Sustainable Society Foundation, 2016b; United Nations, 2016a). The Sustainable Development Goals, which have the aim of achieving a more prosperous future in which nobody will be left behind, further seek "to integrate and balance the three dimensions of sustainable development … in a comprehensive global vision" (United Nations, 2016a).

The United Nations Organization (UN) emphasizes the importance of institutions, particularly in the Resolution *Transforming our World: the 2030 Agenda for Sustainable Development* (United Nations, 2015a). They state that effective, accountable, inclusive, and transparent institutions are necessary to eradicate poverty and achieve sustainable development. The importance of institutions is further highlighted in subsequent reports focusing on specific regions. For instance, the *Annual report on regional progress and challenges in relation to the 2030 Agenda for Sustainable Development in Latin America and the Caribbean* draws attention to the importance of using existing, and establishing new, institutional mechanisms

[35] The terms *sustainable development* and *sustainability* are used interchangeably in this paper.

to achieve the 2030 Agenda for sustainable development (Economic Commission for Latin America and the Caribbean, 2017).

To the best of our knowledge, no study has empirically tested institutions as antecedents of SD. This study applies structural equation modeling (SEM) on a dataset containing 138 developing and developed countries. Our empirical results support a model in which institutions are antecedents of sustainable development, although there are differences that hinge on the world region to which a country belongs. World regions such as Latin America & Caribbean, Middle East & North Africa, South Asia, and Sub-Saharan Africa reduce the institutional factor, and the overall effect of institutions on sustainable development decreases by adding world regions to the model. The underlying motivation is that institutions establish the formal and informal boundaries within which individuals and companies operate and, therefore, are required (antecedents) for social, economic, and environmental goals to be achieved.

The remainder of the paper is structured as follows: Section 2 reviews the importance of institutions and their relationship with the three SD dimensions. Section 3 describes the data and methods. Section 4 presents and discusses the empirical results. The last section summarizes the main results and discusses limitations and potential implications for further research.

5.2 Literature review

Institutions are a necessary condition for economic prosperity. The current literature on the relationship between institutions, financial development, and economic growth shows that financial and macroeconomic policies, as well as property rights, influence the financial development of a country, which then fosters economic growth (Fernández and Tamayo, 2017). Property rights are essential and have a direct impact on long-term investment, financial development, and economic growth (Acemoglu and Johnson, 2005). Property rights and rule of law are also more important for the GDP per capita of a country than other well-known factors that influence the economy such as trade liberalization and geography (Rodrik et al., 2004). However, formal institutions have their limits and need to be embedded in well-functioning informal institutions; otherwise, they are so decisive that, without them, a country's economic development may be hampered (Williamson, 2009).[36]

The impact of institutions goes well beyond strictly economic dimensions since they also have a strategic role in fighting climate change and leading ecological development. The quality of institutions (e.g., represented by the economic freedom index) significantly influences the reduction of CO_2 emissions and economic growth (Bhattacharya et al., 2017); on the other hand, private and public (e.g., government agencies) institutions play a substantial role in facilitating climate change adaptation at the local level (Mubaya and Mafongoya, 2017)[37]. Even specific features of institutions are essential for ecological development; for example, the quality of democracy (e.g. percentage of the winning coalition in relation to the electorate) has a positive effect on air quality (Bernauer and Koubi, 2009). There is further evidence that democracies lead to a reduction of emissions or concentrations of pollution (Farzin and Bond, 2006).

The nature of institutions is also at the heart of a country's ability to achieve social goals. Social institutions play a crucial part in reducing poverty (Castells-Quintana et al. 2017; Henderson et al., 2007), inequality (Branisa et al., 2013), and gender disparities (OECD, 2014b). The impact of institutions is well documented in areas such as health systems (Swanson et al., 2015), corruption, the fertility rate, female education, and child mortality (Branisa et al., 2013; Djankov et al., 2002). For instance, pay-setting institutions play an important role in social dimensions (e.g., inequalities), as a recent analysis of 43 US industries from 1968 to 2012 demonstrates (Kristal and Cohen, 2017). The authors found that whereas about one-third of rising inequality was explained by technological change (e.g., computerization – investments in computer technology), institutions (e.g. pay setting) explain about half. Fighting inequalities is a major concern for political economists (Nolan and Pontusson, 2011) and some argue that institutions are part of the social structure (see e.g. Hodgson, 2006). Other researchers argue for a separation of the social and institutional dimensions (e.g., Hosseini and Kaneko, 2011, 2012; Spangenberg, 2002, 2007).

Since it is our goal to clarify on the impact of institutions not only on social outcomes, but also on economic and environmental goals, we separate these two dimensions in this work.

[36] The difference here between formal and informal institutions: the former are designed and can be enforced by the government; the latter cannot, as they represent culture, social norms, mental schemes, etc.

[37] Climate change adaptation refers to the policies and measures to reduce the risks that are associated with climate change; on the other hand, climate change mitigation refers to fighting the root causes of climate change (e.g. reducing greenhouse gases).

This separation is also implicit in the weight of institutions for SD at the national, regional, and global levels. Many countries have established specific institutions such as National Councils for Sustainable Development (NCSD) to seek a more sustainable country-level path of development (Osborn et al., 2014)[38]. Their primary goal is to increase society's participation in policy decision making. At the regional level each member state of the European Union is required to work toward the European 2020 strategy, which emphasizes "smart, sustainable and inclusive growth" (European Commission, 2010: 5). Formal and informal institutions are, therefore, required to meet the overall goals within each member state (Pasimeni and Pasimeni, 2016). At the international level, the focus since the Brundtland report has been on institutions and how they should change to facilitate global advancement toward SD (World Commission on Environment and Development (WCED), 1987). The report contains a chapter dedicated to institutions, and all subsequent events and reports include institutions as a crucial aspect. For example, Agenda 21, an action plan to achieve SD worldwide, provides a broader definition of formal and informal institutions (Spangenberg et al., 2002).

In 2015, the Sustainable Development Goals (SDGs) were introduced with the main objective of achieving a more sustainable path of development by focusing on 17 goals. Institutions play a key role as they are embedded in goal 16 "[p]romote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels" and target 17.14 "[e]nhance policy coherence for sustainable development" (United Nations, 2016a). Since institutions have been shown to be at the heart of SD, we hypothesize that,

> H1: *Institutions are antecedents of sustainable development and provide the necessary conditions for sustainable development.*

Geographic areas are important to the status of countries' SD levels, as can be seen in the 2018 "The Sustainable Development Goals Report" (United Nations, 2019d). Sub-Saharan Africa, for example, has the highest adolescent birth rate (101 births per 1,000 women aged 15 to 19) in the world. Sub-Saharan Africa (42%) and Western Asia and Northern Africa (52%) have the lowest participation rate in early childhood and primary education, well below the global average of 70%. Europe and Northern America have the highest proportion of people "using safely managed and basic drinking water, sanitation and hygiene services"

[38] Already in 2014 there were more than 100 NCSDs worldwide with different forms, functions, and responsibilities.

(United Nations, 2019d), while the areas of Latin America, South-Eastern Asia, and Sub-Saharan Africa show the greatest loss of forest in the world. Gallego-Àlvarez et al. (2015a) highlight that variables related to environmental or human well-being are often grouped within different geographic areas. The effect of geographic areas on the progress of countries is, however, mostly indirect. Rodrik et al. (2004) point out that institutions have a direct impact on the income levels of economies, and that geographic areas influence institutional quality and therefore have an indirect effect on country development. As institutions vary across world regions, their impact on SD achievements also varies. Hence, we hypothesize that:

H2: *The level of development of institutions varies across the world regions.*

Figure 5-1 presents the conceptual model underlying this research. Institutions are antecedents of SD and its three dimensions, while the level of development of institutions depends on the world region.

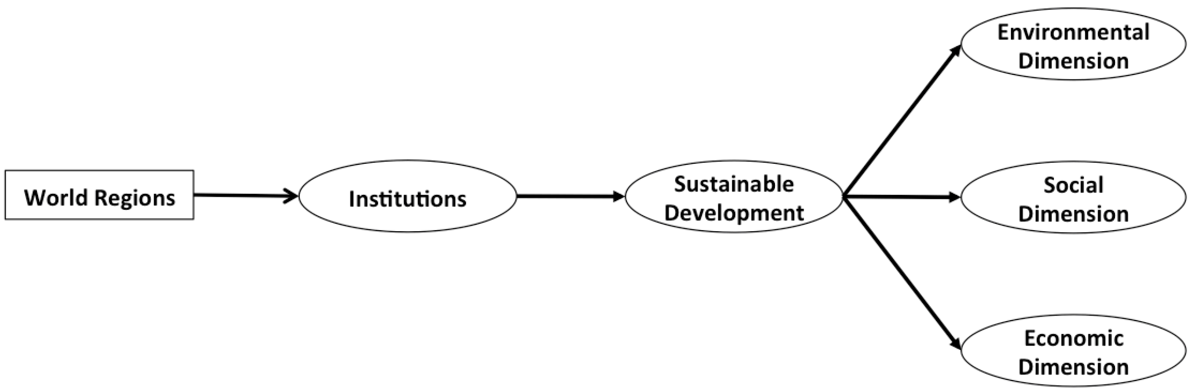


Figure 5-1: Conceptual model

5.3 Research methods

5.3.1 Indicators

The indicators used to measure the concepts underlying the model come from three widely used, tested, and applied indices: the Environmental Performance Index (EPI), the Human Development Index (HDI), and the Sustainable Society Index (SSI) (Gallego-Álvarez et al., 2015b; Moran et al., 2008; Saisana and Philippas, 2012). Together, they account for a broad understanding of the three pillars (social, economic, and environmental). Additionally, standard economic indicators – current account balance, exports of goods and services, and household final consumption – are included in the analysis to enrich the economic dimension. The indicators used by Hosseini and Kaneko (2011) are added to account for a wide set of indicators to represent the different dimensions of SD and also to measure institutions. These indicators cover 138 countries in 2016. The final list of indicators is selected using statistical procedures and substitutive considerations.[39]

The World Bank (2019a) classification is used to represent the different world regions. Based on this classification, six dummy variables are used: East Asia & Pacific, Latin America & Caribbean, Middle East & North Africa, North America, South Asia, and Sub-Saharan Africa. The reference category is Europe & Central Asia.

5.3.2 The statistical model

A structural equation model (SEM) is used to test our hypotheses. SEM is a latent variable model used to measure underlying concepts that cannot be directly observed (Westland, 2015). It tests whether indicators share a common dimension by using a confirmatory factor approach under an SEM.

An SEM contains a measurement and structural part. Each latent dimension ($f_i^{(h)}$) is measured by a set of indicators (measurement model). In this study four first-order measurement models are defined: institutions and the three dimensions of SD (social, economic, environmental) as well as one second-order measurement model (SD) that contains the three first-order measurement models (social, economic, and environmental). The measurement model for dimension $f_i^{(h)}$ (with $h =$ social dimension, economic dimension, environmental dimension, institutions) is given by:

$$Y_{ij} = \mu_j + \lambda_j f_i^{(h)} + \epsilon_{ij} \tag{5-1}$$

where Y_{ij} is the value for indicator j in country i, μ_j is the mean of the j indicator, λ_j is the factor loading of $f_i^{(h)}$ for indicator j, and ϵ_{ij} is the error term. The variance of the error term ϵ_{ij} is σ_j^2.

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39 See Table 5-1 for the final set of indicators (of each dimension) and their sources. We also analyzed the indicators regarding normality and symmetry with e.g. diagrams.

The second-order factor model is given by

$$f_i^{(h)} = \lambda_h f_i^{(SD)} + \epsilon_i^{(h)} \tag{5-2}$$

for the three dimensions of SD ($h =$ Eco, Soc, Env) and $\epsilon_i^{(h)}$ is the error term with variance σ_h^2.

The structural part estimates the impact of the latent variable institutions $f_i^{(Inst)}$ on the latent variable SD, $f_i^{(SD)}$. The following equation gives the structural model

$$f_i^{(SD)} = \beta_{Inst} f_i^{(Inst)} + \epsilon_i^{(SD)} \tag{5-3}$$

where $f_i^{(Inst)}$ is the factor institutions, $f_i^{(SD)}$ is the factor SD and β_{Inst} is the structural slope, and $\epsilon_i^{(SD)}$ is the error term with variance σ_{SD}^2.

A Multiple Indicator Multiple Cause (MIMIC) component adds K binary variables for world regions (W_k, $k = 1, \dots, K$) to the model (institutions). The MIMIC component is given by:

$$E\left[f_i^{(Inst)}\right] = \sum_k \beta_k \; W_{ik}, \tag{5-4}$$

$$\text{and } Var\left[f_i^{(Inst)}\right] = \sigma_{Inst}^2. \tag{5-5}$$

We applied goodness-of-fit measures to assess models. More specifically, we used the Root Mean Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI), the Tucker-Lewis index (TLI), and the Standardized Root Mean Square Residual (SRMR). We used the AIC – Akaike Information Criterion (Akaike, 1974) and the BIC – Bayesian Information Criterion (Schwarz, 1978) to compare the different models. The best model is indicated by the lowest values of AIC and BIC. Mplus 6.12 was used to estimate all models.

5.4 Empirical analysis and discussion

5.4.1 Measurement models

For a solid methodological representation of the set of indicators to measure institutions and the three dimensions of SD (i.e., social, economic, and environmental), we tested reliability in a stepwise procedure for each first-order factor. First, we deleted highly correlated indicators and ones that had more than 30 missing observations. Second, we excluded variables with low loadings or overlapping representativeness. Table 5-1 shows the final set of indicators for each dimension.[40] Finally, we estimated the first-order factor models and checked the goodness-of-fit.

Table 5-1: Indicators selection - final set of indicators used in the measurement models

Institutions	
Voice & accountability Political stability & absence of violence/terrorism Rule of law Control of corruption	World Bank (2019d)

Economic dimension	
Gross national income (GNI) per capita	United Nations Development Programme (2017)
Current account balance (% of GDP) Households and NPISHs final consumption expenditure (% of GDP) Exports of goods and services (% of GDP)	World Bank (2019b)

Social dimension	
Sufficient food Sufficient to drink Education Healthy life	Sustainable Society Foundation (2016b)

Environmental dimension	
Adjusted savings: particulate emission damage (% of GNI)	World Bank (2019b)
Water resources	Hsu et al. (2016)
Consumption Renewable energy	Sustainable Society Foundation (2016b)

[40] Some indicators had different measurement bases and needed to be transformed to reduce their variance. By doing so, we assured that a high value of each indicator (within one dimension) also measures the same direction of impacts. For example, in the environmental dimension, we assured that the highest value of each indicator corresponds to a value that is positive for the environment.

The first-order factor models: Institutions (Inst), Social (Soc), Economic (Eco), and Environmental (Env) have a good model fit (see Table 5-2)[41]. The CFIs and TLIs are above the recommended 0.9 (Hu and Bentler 1999), and the SRMR and RMSEA are below 0.1 (e.g., Brown, 2015; Harrington, 2008; Kline, 2005; Schumacker and Lomax, 2010; Whitley et al., 2013). Based on the model fit, we can conclude that each set of indicators has an underlying common factor.

Table 5-2: Goodness of fit of the models

	Inst	Soc	Eco	Env	SD	Structural1	Structural2
Chi-Square	0.011	0.300	2.111	0.018	76.514	281.327	681.984
DoF	1	1	2	1	49	97	172
RMSEA	0.000	0.000	0.020	0.000	0.064	0.117	0.147
CFI	1.000	1.000	0.999	1.000	0.973	0.900	0.770
TLI	1.000	1.000	0.998	1.000	0.963	0.876	0.732
AIC	934.936	1433.570	3120.920	1578.478	5860.322	6694.249	6654.965
BIC	972.991	1470.947	3156.047	1616.438	5980.340	6855.248	6830.600
SRMR	0.000	0.004	0.020	0.002	0.051	0.088	0.120

The second-order measurement model for SD contains the social, economic, and environmental dimensions as first-order models. It has a good model fit with an SRMR of 0.051, RMSEA of 0.064, CFI of 0.973, and a TLI of 0.963. Thus, the three latent variables (Sco, Eco, and Env) have a common underlying factor that is SD.

5.4.2 Structural models

5.4.2.1 Institutions and sustainable development

The first structural model tests whether institutions are, as hypothesized, an antecedent of SD. The model is specified so that the construct, institutions, (first-order measurement model) is regressed on the SD dimension (second-order measurement model). This first structural model (Structural1) is almost a representation of the conceptual model, but it excludes the control variables (see Figure 5-1). The model fit is conclusively acceptable, with an SRMR of 0.088 and a CFI of 0.9 (see Table 5-2).

[41] Additional covariances were added: a) in Inst between Voice & accountability and Political stability & absence of violence/terrorism; b) in Soc between Sufficient Food and Sufficient to Drink; and c) in Env between Consumption and Renewable Energy.

Table 5-3: Estimates of the structural coefficients (models with and without control variables)

		Structural1	Structural2
Inst → SD		0.841***	0.766 ***
World regions	East Asia & Pacific		-0.078
	Latin America & Caribbean		-0.414 ***
	Middle East & North Africa		-0.231 **
	North America		0.128
	South Asia		-0.215 **
	Sub-Saharan Africa		-0.535 ***

Note: *** p-value < 0.001; ** p-value < 0.01; * p-value < 0.05.

The resulting regression coefficient (from Inst to SD) is high with a standardized value of 0.841 (Table 5-3). The empirical data support our first hypothesis, i.e. *institutions are antecedents of sustainable development and provide the necessary conditions for sustainable development.*

5.4.2.2 World regions

The second structural model (Structural2) includes the binary control variables for the different world regions. The resulting MIMIC model includes the control variables' impacts on institutions. The model has an AIC of 6653.820 and a BIC of 6832.382, which are lower than the ones from the model without control variables (AIC 6694.249 and BIC 6855.248) (see Table 5-2). Therefore, the model with the control variables should be used, as indicated by the information criteria.

The impact of Latin America & Caribbean, Middle East & North Africa, South Asia, and Sub-Saharan Africa on institutions is significant and negative (see Table 5-3). A negative standardized coefficient means that the score of institutions for countries in each of these regions is lower than that of the reference group Europe & Central Asia. After adding the control variables, the standardized regression coefficient (between institutions and SD) is lower than before, with a value of 0.766. This may be explained by the fact that Europe includes mainly developed countries, whereas the other regions, except North America, include economies that are in transition (to being developed) or are considered developing (e.g. United Nations, 2019b).

It is generally recognized that although all countries must strive for SD, developed and developing countries may have different approaches. In particular, developing countries argue that developed countries should pay a larger share of the costs in global efforts such as climate change policy. This point of view is based on the different amounts and qualities of resources (e.g., human, finance, infrastructure, and education) available to countries. The unbalance also means that countries in each group have to tackle different challenges and this should be reflected in their institutional setting. A good example is the case of provincial government institutions in China. Wilson (2016) shows that when the initial level of development is low, economic growth does not depend on “high-quality formal governance structures” (Wilson, 2016: 147). He notes that in the pre-reform era in China when economic freedom was firmly restricted, the economy was deeply inefficient. Thus, fast economic expansion could be achieved with small changes leading to economic liberalization, even though no good governance institutions had been established. After some time had elapsed, the provincial governments took the opportunity to increase by increasing GDP and its positive effects to improve their local institutions. In doing so, they provided a stable basis for additional development. This work draws attention to the fact that a different set of institutions is required if the level of development changes. This is also implicitly reflected in our results as world regions other than Europe & Central Asia (except North America), which are mainly developing or transitional economies, have a reduced institutional factor score.

In summary, after controlling for the effect of world regions, institutions are still an antecedent of SD and provide the necessary conditions for sustainable development. Thus, this result supports our second hypothesis: *the level of development of institutions varies across the world regions.*

5.5 Conclusion

This research performed an empirical test of the explicit role of institutions for sustainable development. Institutions are hypothesized to be an antecedent of SD, whereas the world regions explain differences in terms of institutions. We used latent variables models and a sample of 138 countries. The empirical results support the model that institutions are antecedents of SD and the control variables for the world regions are significant. In particular, it shows that world regions that differ from Europe & Central Asia (except North America) have a lower institutional score. Possible policy recommendations to increase their institutional settings can be seen in the targets of SDG goal 16 (United Nations, 2019c). For example, the role of developing countries could be strengthened and broadened in the light of global governance or relevant national institutions, and international cooperation could be used “for building capacity at all levels, in particular in developing countries, to prevent violence and combat terrorism and crime” (United Nations, 2019c).

These insights for SD should be considered cautiously due to specific methodological limitations of this study. First, the selection of indicators for each dimension can be questioned due to its subjective nature as over 1,600 world development indicators are available (World Bank, 2019c). Hence, we induced a neutral selection by selecting internationally accepted indicators from indices that represent institutions and the three pillars of SD (social, economic, and environmental dimensions). Second, we decided to conduct a cross-sectional study in order to compare as many countries as possible for a given point in time. However, this does not allow us to provide insights on the dynamic patterns of development through time, arguably a more important endeavor in terms of policy implications. Given enough data, such an analysis might be conducted in the future. Third, the sample size might also be considered problematic as the rule of thumb indicates around 200 observations for this kind of study. We argue that our sample size is nevertheless acceptable within this study for two reasons: first, since we use country-level data, there are a limited number of countries worldwide supplying sufficient data; second, both Wolf et al. (2013) and Sideridis et al. (2014) used these models with smaller sample sizes. Given the dependency of the required number of observations on the model specifications, our sample size seems adequate (Wolf et al., 2013; Sideridis et al., 2014).

To conclude, rather than thinking of institutions as just one more important component of SD along with all the other components, our work emphasizes that institutions are a necessary pre-condition that have wide-ranging effects on all the other dimensions of sustainability. Concrete policy recommendations can be developed in further research to improve institutions and consequently the sustainable development of countries. The sustainable development debate would also benefit from enriching the quantitative analysis by means of qualitative indicators. This can be seen in the case of Weststrate et al. (2019) who propose using qualitative as well as quantitative indicators to measure the progress toward the Sustainable Development Goals.

Chapter 6

Antecedents of executives' perception towards environmental sustainability [42]

Abstract

Executives are key decision makers at the micro level and their decisions therefore have a broad impact on environmental sustainability. Their decisions are based on hard factors (e.g. internal firm capacities) and soft factors (e.g. executives' perception of the environment status). This research proposes a causal model that enhances the understanding of how executives' perception of environmental sustainability (policy, regulations, and industry development) is explained by physical environmental variables. Data from the *Travel & Tourism Competitiveness Index 2017* are modeled using structural equation models with independent variables (MIMIC – Multiple Indicators Multiple Causes). Results show that CO2 emissions and wastewater treatment are significant physical environmental indicators of the perception of environmental sustainability. Additionally, while political stability & absence of violence/ terrorism and geographic areas (Asia-Pacific, Sub-Saharan Africa) are significant control variables, the Human Development Index (HDI) is not.

6.1 Introduction

Environmental change has now become one of the main human challenges and the focus of intense debate. Severe impacts such as higher sea levels, changing weather patterns, and loss of biodiversity are already being felt, and will tend to intensify if no countermeasures are taken (World Wide Fund for Nature, 2016). The latest Planet Living Report and the UN climate conference in December 2015 (Paris) expressed the urgent need to adapt our current lifestyle towards more sustainable standards and paths for development. Hence, embracing environmental sustainability (ES) is crucial for the future of our society.

Stakeholder theories show that the debate is not only limited to politicians and economists,

[42] This chapter is based on Witulski and Dias (2019a).

but also involves executives who have a decisive role to play in the attempt to please different stakeholders (e.g. Donaldson and Preston, 1995; Steurer and Martinuzzi, 2005). More and more stakeholders acknowledge the importance of ES and thus force managerial decisions makers to adopt their policies. Houdet et al. (2012) show that, in specific business activities, stakeholders have recently increased the pressure to reduce the negative impact on ecosystems.

The first notion of sustainability dates back to the political economists, Thomas Malthus and John Stuart Mill. While the standard definition of sustainable development (SD) was provided by the Brundtland report in 1987 (World Commission on Environment and Development, 1987) and the contemporary discussions was further enriched by international meetings (e.g., United Nations Conference on Environment and Development in 1992, United Nations World Summit on Sustainable Development in 2002, and Rio+20 United Nations Conference on Sustainable Development in 2012 (United Nations, 2019a)), scientific research (e.g. Böhringer and Jochem, 2007; Saisana and Philippas, 2012), and policy reports (e.g. United Nations, 2016a). However, research on the topic has focused mostly on the physical variables or indicators of the environmental dimension. Table 6-1 exemplifies indicators that are commonly found in composite indices and frameworks.

Sustainable development can be influenced by decisions and activities at international, national, regional, company, and individual levels. This research focuses at the micro level and in particular on executives as they are responsible for company level decisions that affect the environment. Several reasons underlie the choice. First, firms must take increasing responsibility in the efforts towards SD due to the lack of actions at an international level. Nilsen and Ellingsen (2015), for example, show that climate change has not been successfully addressed internationally, thus placing greater responsibility on people, firms, and nations.[43] Second, company activities cause large scale damage to the environment, in particular, in areas such as fishery, forestry, oil and gas exploration, mining, utilities, and agriculture. As a result, "[p]rimary production and processing … cost the world economy $7.3 trillion a year in damage to the environment, health and other vital benefits for humankind" (United Nations, 2015c). Third, companies not only harm the environment but also foster biodiversity loss (Houdet et al., 2012). Fourth, environmental damage could be lessened if company introduced certain changes. Hörisch et al. (2015) presents evidence that the introduction of sustainable management tools (such as material flow analysis in the accounting area or sustainable supply

[43] The Paris climate agreement is a step in the right direction, but there is still the need for further commitment.

chain management in the product design area) can lead, for example, to a reduction in greenhouse gas emissions per unit of revenue (environmental impact).

Table 6-1: Examples of physical variables for common sustainable development indices

Framework	Physical variables (PhyVar) examples	Source
Sustainable Development Goals (SDG's)	PhyVar indicators used in the Goal 15 are e.g.: *15.1.1 Forest area as a proportion of total land area*, *15.3.1 Proportion of land that is degraded over total land area,* and *15.4.1 Coverage by protected areas of important sites for mountain biodiversity*.	United Nations (2016b).
The Sustainable development indicators of the European Union (EU)	Indicators for 'Climate change and clean energy' targets, include: *Greenhouse gas emissions by sector, Global surface average temperature* and *Greenhouse gas emissions intensity of energy consumption.*	Kurkowiak et al. (2015).
Sustainability Index of Hosseini & Kaneko (2011)	The environmental dimension of the index is composed of the following PhyVar on *Adjusted savings: carbon dioxide damage*, *energy depletion*, *mineral depletion*, *net forest depletion*, and *particulate emission damage*.	Hosseini & Kaneko (2011).
Sustainable Society Index (SSI)	The 'Environmental Wellbeing' perspective is covered by PhyVar. The indicator 'Biodiversity forest area' is measured by *the 10-year change of forest area,* whereas the indicator 'Biodiversity protected area' is measured by *the size of protected areas as % of the total land area of a country.*	Saisana & Philippas (2012).
Environmental Sustainability Index (ESI)	'Air Quality' is based on the following PhyVar: *Urban population weighted NO2 concentration*, *Urban population weighted SO2 concentration*, *Urban population weighted TSP concentration*, and *Indoor air pollution from solid fuel use.*	Yale Center for Environmental Law + Policy (2005).
Environmental Performance Index (EPI)	'Air Quality' is measured by the PhyVar: *exposure to net particulate matter, nitrogen dioxide,* and *the percentage of the population burning solid fuel indoors.*	Hsu et al. (2016).
The Travel & Tourism Competitiveness Index 2017	The ninth pillar 'Environmental Sustainability' is based on PhyVar. Examples are: *Baseline water stress, Threatened species, Forest cover change*, and *Wastewater treatment.*	World Economic Forum (2017b).

Corporate decisions that affect the environment result usually from a long process in which various hard factors (e.g. governmental regulation and company resources) and soft factors (e.g. cultural background and perceptions) play key roles. It is important to understand these soft factors because people's concerns can lead to changes in their behavior. Hershfield et al. (2014) show that the donations to an environmental organization increased as a result of a change in the environmental concerns of the participants of their study in the United States. Schacter et al. (2015: 133) defined perception as "[t]he organization, identification and interpretation of a sensation in order to form a mental representation". The Health Belief Model (HBM) and the Theory of Planned Behavior (Ajzen, 1991; Becker, 1974) are well-known examples of the conceptualization of the role of perceptions, attitudes, social norms as antecedents of behavior; they highlight the central role perceptions and their importance to on-going studies. Given that managers' perceptions and social judgments largely determine their environmental behavior (Rivera-Camino, 2012), this study focuses on soft factors generally and, in particular, on the understanding of executives' perceptions of environmental sustainability.

The influence of perceptions (on decisions and behavior) is widely acknowledged and extensive research has been conducted in this area, including perception studies about sustainable development (e.g. Etkin and Ho, 2007; Baffoe and Matsuda, 2018; Peterlin et al., 2005). Similarly, the general perceptions of executives are well explored (e.g. Calabrese et al., 2016; Papagiannakis and Lioukas, 2012). However, executives' perceptions of environmental sustainability in general and in the context of physical environmental indicators have received less attention.

The present study examines this under-researched field by explaining executives' perception of environmental sustainability (policy, regulations, and industry development) using physical (environmental) indicators. To the best of our knowledge, this is the first study to do so. We argue that individuals' perceptions are inherently affected by the signals captured from their environment, which constitutes their reality. Thus, the study proposes and tests a conceptual model that combines physical (environmental) variables of sustainable development and the perception of environmental sustainability held by executives. The current study differentiates itself from the literature in three ways. [44] First, it focuses on the perception of environmental sustainability; second, it is a cross-country study including 138 countries; third, a Multiple Indicators Multiple Causes (MIMIC) model is applied. It contributes to the literature in two major ways: first, it increases the understanding and shows the importance of real (physical environmental) data on the formation of executives' perceptions about SD, in that their decisions contribute greatly to the environmental degradation of our current world; second, it introduces a new conceptual model and methodology in the field of environmental sustainability studies.

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[44] Van der Linden (2015) presented ten major risk perception studies. Only three of them used a kind of physical indicator if 'ecological values' is counted as such. Otherwise, only one study used physical indicators.

The next section provides the literature review, the hypothesis under study, and the proposed conceptual framework. Followed by the data and method description, results are presented and discussed. The paper concludes with a summary, a description of limitations, and suggestions for further research.

6.2 Perceptions of environmental sustainability and important influences

Perception research is widely used in many different areas at the international (e.g. climate change risk perception), national (e.g. perception of corruption in politics), regional (e.g. perception of water quality of rivers/lakes), corporate (e.g. managers' perception of corporate social responsibility), and individual levels (e.g. health risk perception). Therefore, it reaches an extensive audience and addresses topics that range from personal to aggregate perceptions, and from methodological assessment to aspects such as misperception, risk perception, differences, or trends in perception. The subdomain of perception research, known as the perception of risk (e.g. climate change risk), has been explored in the context of climate change and environmental sustainability. It examines "the judgments people make when they are asked to characterize and evaluate hazardous activities and technologies" (Slovic, 1987: 280). McDaniels et al. (1997: 341) studied the "perception of ecological risk" linked to human activities that could impact the environment of water resources; Etkin and Ho (2007) highlighted the gap between the general public's awareness, perception, and understanding of climate change risks and those of the scientific community; and van der Linden (2015) introduced a social-psychological model of climate change risk perceptions that explains 70% of risk perception variance by integrating and connecting socio-cultural, cognitive, and experiential factors.

In the ongoing discussion about the coherence between reality and perception, most studies argue that reality and perceptions diverge (e.g. Dias, 2017; Grasmück and Scholz, 2005; Origo and Pagani, 2009). For example, van der Linden (2015) shows that studies exploring the gap between real facts (empirical evidence) and subjective knowledge (what individuals believe) tend to be inconsistent. Further, Dowd et al. (2014) analyzed knowledge about CO2 (e.g. properties and source) and its connection with the perception of energy technologies (such as the CO2 capture and storage (CCS)). They find there is a better understanding of CO2 in general than of its scientific dimensions (e.g. properties). They further show that objective dimension does not always correspond with the general understanding of CO2 and this is due to the technical nature of its definition, namely the capture and storage of CO2. On the other hand, Dogaru et al. (2009) show there is conformity between reality and perception in relation to the evaluation of water quality.

The potential gap between reality and perception can be explained by personal characteristics and experiences, as well as social and cultural norms. For instance, Ruddell et al. (2011) show that older people and anyone who has experienced heat-related illnesses at home are more likely to believe that the temperature in the city is rising steadily. Sulemana et al. (2016) illustrates that a person's perceived social class influences the willingness to spend money on environmental protection. The increase in perceived social class has a positive association with increased environmental concerns, except when the evaluation trades the protection of the environment off against job creation and economic growth. Leiserowitz (2006) claims that sociopolitical factors influence the risk perception of climate change. However, the study on terrorist attacks and natural disasters (actual exposure rate) by Gierlach et al. (2010) indicates that social exposure may in itself have less impact on risk perception than cultural factors. The personal characteristics are particularly relevant for perceptions when connected to the role of individuals in society.

The competitive environment, key company characteristics, expectations and personal perceptions influence executives' decisions. For instance, the findings of Sutcliff & Huber (1998) demonstrate that 40% of the variance in executives' perceptions of their company environment is explained by the company and the sector. In this line of reasoning, the corporate environmental responsiveness (CER) model, introduced by Papagiannakis and Lioukas (2012), shows that managers' attitudes and personal values, subjective norms, and managers' perceptions of how to deal with environmental issues seem to impact their responses. Rivera-Camino (2012) presents evidence that managers' perceptions and social judgment are the main drivers of their environmental behavior.

In light of the evidence in the literature, we argue that individuals' perceptions are inherently affected by the signals captured from their environment, which constitutes their reality. This implies that (physical) environmental sustainability indicators influence the country-level perception of executives (policy, regulations, and industry development). Thus, we hypothesize, that a country's physical environmental sustainability explains executives' perception of environmental sustainability.

The impact of physical indicators on the perceptions of executives cannot be measured appropriately without controlling for other factors. It is well-documented that public perceptions of climate change fluctuate over time and space (Capstick et al., 2015). This variation can be explained by the fact that people have a “finite pool of worry” (Weber, 2006: 115). In the study by Hansen et al. (2004), they showed that Argentinean farmers who worried more about political risk tended to worry less about climate risk. In the business area, research shows that there was less concern about environmental degradation and climate change when concerns about the implications of the last financial crisis increased (PewResearchCenter, 2009; Weber, 2006). This implies that a country’s current (e.g. political) situation also influences the perception of their inhabitants.

Factors like income level and human development also impact environmental sustainability. For example, the environmental Kuznets curve describes the relationship between a country’s environmental sustainability and its income level (inverted u-shaped curve) (e.g. Atkinson et al., 2007: 240). When there is economic growth, environmental sustainability (e.g. the pollution) in specific countries increases until it reaches a certain point and then it decreases. On the other hand, common cultural characteristics and current forces within a country influence the perception of people in general.

Figure 6-1 summarizes the conceptual model on how physical environmental sustainability influences perceived environmental sustainability. The perceived environmental sustainability is not directly observed but can be inferred from a set of indicators. Control variables are added to the model.

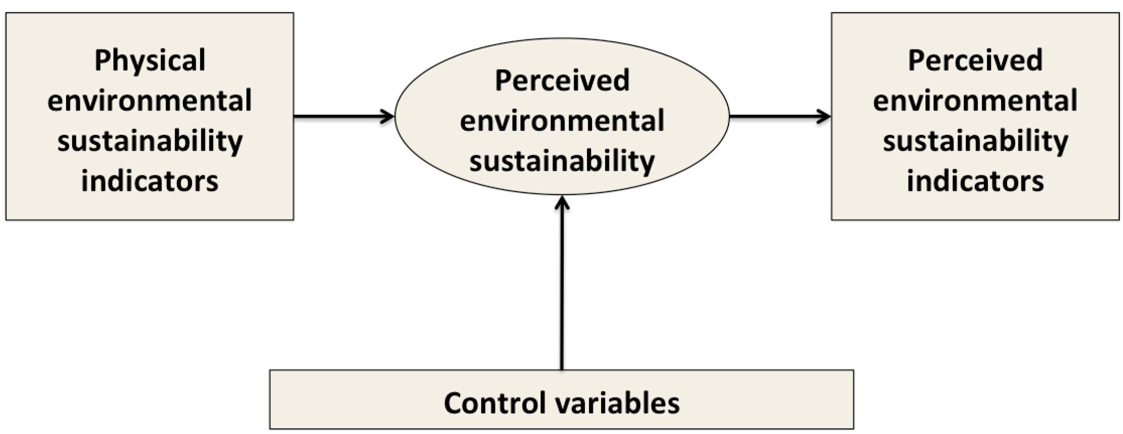

Figure 6-1: Conceptual model

6.3 Data

National and international policies and regulation are important tools to achieve a sustainable path of development. Important policies include unlock policies (such as price corrections, subsidies, and support for niche markets), a natural capital depreciation tax, or ecological tariffs (Atkinson et al., 2007: 72 ff.). The impact of these policies and regulation on the development (ecological and environmental) of industries is perceived by executives because they affect the kind of decisions they can make. Therefore, we use items of policy, regulation, and industry development to represent the perception of environmental sustainability in that country.

This study explores unique data from *The Travel & Tourism Competitiveness Index 2017*, namely from the Executive Opinion Survey that contains three items on the stringency of environmental regulations, enforcement of environmental regulation, and sustainability of the travel and tourism industry development (World Economic Forum, 2017b). These three indicators are used by the survey to measure the perception of environmental sustainability in relation to policy, regulations, and industry development.

Indices that seek to measure environmental sustainability, or an aspect of it, are usually categorized in different forms. For example, the Ecological Footprint is based on 15,000 data points, covering 200 territories since 1961 (Global Footprint Network, 2016). The Environmental Performance Index (EPI) includes 19 distinct indicators, which are ordered in two super categories and nine categories (Hsu et al., 2016), and the Environmental Vulnerability Index (EVI) contains 50 indicators in three sub-indices (SPOCA and United Nations Environment Program, 2005). In the present study, three recurrent areas in the literature are described: climate change, environmental impact on water & land, and international agreements. We select five physical indicators (which have also been used by other authors and institutions, see dos Santos and Brandi, 2014; Hsu et al., 2016; World Economic Forum, 2017b; World Bank, 2017c) to test the hypothesis and represent the three distinct areas: particulate matter (2.5) concentration, environmental treaty ratifications, wastewater treatment, CO2 emissions, industrial (kg per PPP $ of GDP), and fertilizer consumption (100 grams per hectare of arable land).

Finally, three dimensions are controlled in the model to test the real effects of physical sustainability on perception. Political stability and the absence of violence/terrorism is one of the world governance indicators (World Bank, 2017c) and is therefore used to control the political situation in the countries. The Human Development Index (HDI) is a widely used index for sustainable development (Holden, 2016); it provides a complementary perspective as it does not cover environmental sustainability (United Nations Development Programme, 2016a). Additionally, world regions are added as control variables.

Table 6-2: Indicators of the distinct components of the model

Model component	Indicators	Data source
Perceived environmental sustainability	Stringency of environmental regulations	World Economic Forum (2017b).
	Enforcement of environmental regulations	World Economic Forum (2017b).
	Sustainability of travel and tourism industry development	World Economic Forum (2017b).
Physical environmental sustainability	Particulate matter (2.5) concentration	Yale Center for Environmental Law & Policy (YCELP) + CIESIN at Columbia University (2016, data 2014).
	Environmental treaty ratifications	The International Union for Conservation of Nature (IUCN), Environmental Law Centre ELIS Treaty Database (2016).
	Wastewater treatment	Yale Center for Environmental Law & Policy (YCELP) + CIESIN at Columbia University (2016, data 2015).
	CO2 emissions, industrial (kg per PPP $ of GDP)	World Bank (2015).
	Original: Fertilizer consumption (100 grams per hectare of arable land); In analysis: log-transformed	World Bank (2015).
Control variables	Human Development Index (HDI)	United Nations Development Programme (2016a).
	Political stability & absence of violence/ terrorism	World Bank (2016).
	World regions	United Nations Statistic Division (2016).

Table 6-2 summarizes the indicators used to measure the distinct components of the conceptual model and data sources. A total of 138 developed and developing countries are covered in the analyses as a result of data scarcity for specific countries. Due to excessive skewness, the fertilizer consumption was log-transformed. The categorical variable World regions was transformed into a set of dummy variables: Asia-Pacific, Middle East/North Africa, South and Central America/Caribbean, and Sub-Saharan Africa. Europe plus North America is the reference group.

6.4 Methods

Structural equation modeling (SEM), also known as analysis of covariance structures, covariance structure modeling or covariance structure analysis, has been used extensively in scientific fields whenever concepts are not directly observed but can be inferred from indirect indicators that co-vary (Kline, 2011; Skrondal and Rabe-Hesketh, 2004). Examples abound of fields and constructs to which SEM has been applied (e.g. intelligence, consumer satisfaction). An SEM framework contains two components: a measurement component verifies whether indicators are reliable measures of the latent factors and the structural component tests the connection between factors.

The measurement model defines the latent variable as the cause of indicators. Let Y_{ij} represent the three indicators of perceived environmental sustainability, i.e., for country i, j varies from 1 to 3. Then, it is assumed they share a common latent factor (f_i) that is called perceived environmental sustainability. Assuming linearity, the measurement model is given by:

$$Y_{ij} = \mu_j + \lambda_j f_i + \epsilon_{ij} \tag{6-1}$$

where μ_j is the mean of the indicator j, λ_j is the factor loading for indicator j, f_i is the latent factor for country i, and ϵ_{ij} is the error term. The error error terms (ϵ_{ij}) are independent and normally distributed with null mean and variance σ_j^2.

The structural component defines the latent variable, perceived environmental sustainability, as a Multiple Indicators Multiple Causes (MIMIC) model, i.e., the latent variable is regressed on the independent variables, the physical variables. They are depicted by X_{il} (for country i and independent variable l) and their impact is corrected by control variables (W_{ik}, for country i and control variable k). Hence, the structural model is represented by the following equation:

$$E[f_i|X_{il}, W_{ik}] = \sum_l \beta_l X_{il} + \sum_k \gamma_k W_{ik}. \tag{6-2}$$

The intercept is fixed at zero to ensure model identifiability, i.e., if all betas and gammas are null, then the mean of the latent factor (f_i) is zero. The latent factor is assumed to be normally distributed with $Var[f_i|X_{il}, W_{ik}] = \sigma_f^2$.

Model estimation is performed by the full information maximum likelihood (FIML) procedure to handle missing data (Enders, 2001). The fit of the structural equation model is confirmed using the chi-square test. As it is sample-size sensitive, the following fit indices were also applied: the Comparative Fit Index (CFI), the Tucker-Lewis index (TLI), and the Root Mean Square Error Approximation (RMSEA).

To test the conceptual model (Figure 6-1), we estimate a sequence of three nested structural equation models. Three models are considered in the analysis. First, confirmatory factor analysis establishes the measurement model (Model 1) for perceived environmental sustainability using the three indicators from the Executive Survey of the World Economic Forum. Model 2 adds the MIMIC structure that accounts for the impact of the physical environmental sustainability indicator on its perceived factor. Finally, Model 3 adds control variables to the analysis. Models are compared using information criteria, namely the AIC – Akaike Information Criterion (Akaike, 1974) and the BIC – Bayesian Information Criterion (Schwarz, 1978). All analyses are performed using Mplus 6.12.

6.5 Results & discussion

6.5.1 Models for perceived environmental sustainability

Results show that the measurement model of perceived environmental sustainability has a very good fit for the variance and covariance structure of the analyzed indicators. Hu and Bentler (1999) recommend a CFI higher than 0.9 (good model fit), which is fulfilled with a CFI of 1.000. The Tucker-Lewis Index (TLI) (1.000) is also in the recommended area as it is above 0.9. The RMSEA (Root Mean Square Error of Approximation) value of 0.000 is below the recommended threshold of 0.1 (Brown, 2015; Harrington, 2008; Schumacker and Lomax, 2010). Therefore, all measures of goodness of fit (see Table 6-3) of the measurement model are in accordance with the literature, i.e., these three indicators underline a common factor, that can be called perceived environmental sustainability.

Table 6-3: Goodness of fit and information criteria

	Model 1	**Model 2**	**Model 3**
Chi-Square	0.815	38.724	71.745
Degrees of Freedom	4	13	25
RMSEA	0.000	0.128	0.124
CFI	1.000	0.955	0.928
TLI	1.000	0.938	0.896
AIC	538.929	451.154	403.364
BIC	553.266	481.907	450.893

The three indicators – stringency of environmental regulations (SER), enforcement of environmental regulations (EER), and sustainability of travel and tourism industry development (STI) – that measure perceived environmental sustainability have standardized loadings ranging from 0.825 to 1.000 (Table 6-4), which shows a very strong correlation between indicators and the factor.

Table 6-4: Perceived environmental sustainability (measurement model)

Indicators	Loadings	S.E.
Stringency of environmental regulations (SER)	0.975***	0.007
Enforcement of environmental regulations (EER)	1.000***	0.007
Sustainability of travel and tourism industry development (STI)	0.825***	0.024

Note: *** p-value < 0.01

Models 2 and 3 exclude and include control variables, respectively (see Table 6-5). The goodness of fit for Models 2 and 3 is good (see Table 6-3); CFI (Model 2: 0.955; Model 3: 0.928) and TLI (Model 2: 0.938; Model 3: 0.896) are both within the acceptable range. The RMSEA of Models 2 and 3 is slightly above the recommended threshold, which can be explained by the non-significant variables that are kept in the model. However, the Standardized Root Mean Square Residual (SRMR) of Models 2 and 3 is within the recommended threshold (below 0.1) as it is 0.041 and 0.023, respectively. Therefore, both models show adequate fit. Nevertheless, AIC and BIC provide relative evidence that Model 3 outperforms Model 2.

6.5.2 Antecedents of perceived environmental sustainability and control variables

Model 2 adds the physical sustainability variables that are hypothesized to explain perceived environmental sustainability. By adding the physical environmental sustainability indicators, the loadings of EER and STI decreased slightly, whereas SER increased marginally when compared to the measurement model (Model 1). All three standardized loadings range from 0.819 to 0.995 (see Table 6-5).

Wastewater treatment and CO_2 emissions are the significant physical environmental sustainability indicators (Model 2) that explain perceived environmental sustainability. Their regression slopes are 0.606 and -0.194, respectively, which implies that an increase in CO_2 emissions reduces the perceived environmental sustainability. On the other hand, an increase in wastewater treatment increases the perceived environmental sustainability. These results support the hypothesis that a country's physical environmental sustainability explains the executives' perceived environmental sustainability as CO_2 emissions and wastewater treatment are significant.

Table 6-5: Measurement and structural models

Dimensions	Variables	Model 2 Coefficient	Model 3 Coefficient
Perceived environmental sustainability	Stringency of environmental regulations (SER)	0.977***	0.981***
	Enforcement of environmental regulations (EER)	0.995***	0.991***
	Sustainability of travel and tourism industry development (STI)	0.819***	0.819***
Physical environmental sustainability	Particulate matter (2.5) concentration	-0.091	0.028
	Environmental treaty ratification	-0.026	-0.038
	Wastewater treatment	0.606***	0.469***
	CO2 emissions	-0.194***	-0.176***
	Log Fertilizer consumption	0.110	0.029
Control variables	Human Development Index		-0.024
	Asia-Pacific		0.170**
	Middle East / North Africa		0.033
	South and Central America / Caribbean		-0.003
	Sub-Saharan Africa		0.141*
	Political stability & absence of violence/ terrorism		0.557***

*** p-value <0.01; ** p-value <0.05; * p-value <0.1

Based on results for Model 3 (see Table 6-5), the variable political stability & absence of violence/ terrorism (PS&V) has a significant effect (estimate of beta is 0.557, implying that an increase in the PS&V score increases the perceived environmental sustainability). After controlling for PS&V and World regions, HDI is non-significant. That is, Human Development (variable HDI) does not influence the executives' perception of sustainability. One explanation is that world regions already take the HDI into account as regions have quite a similar development. Indeed, world regions tend to be homogeneous in terms of HDI scores. Figure 6-2 presents a boxplot of HDI scores by world regions. We conclude that for most regions the 50% of the HDI score is fairly coherent and there is not much divergence between the maximum and minimum except in Asia-Pacific and Sub-Sahara Africa. Thus, the agreement between world regions and HDI scores may lead to non-significant HDI after controlling for world regions.

After adding control variables (Model 3), the loadings of SER increased and EER decreased slightly, whereas STI has not changed when compared to Model 2. Wastewater treatment and CO2 emissions remain significant and explain perceived environmental sustainability. The correction effect of the control variables led to a decrease in the wastewater treatment from 0.606 to 0.469 and to an increase in CO2 emissions from -0.194 to -0.176.

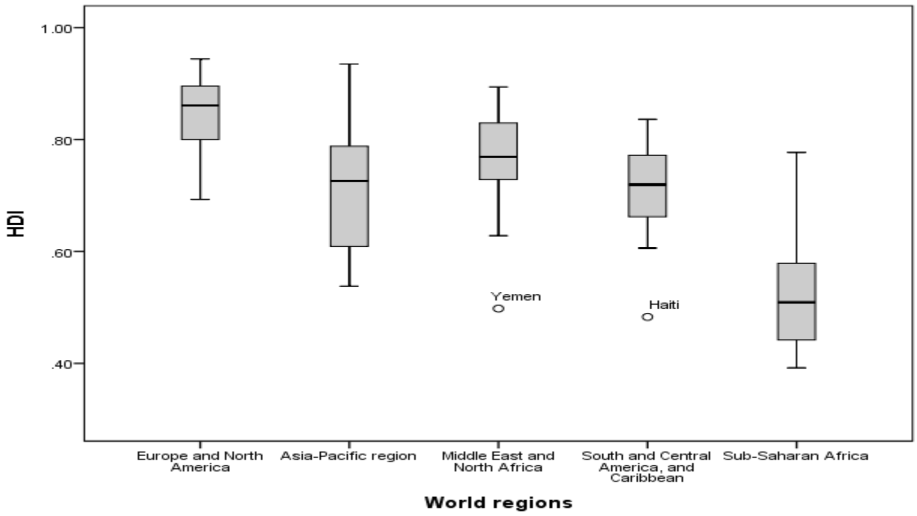

Figure 6-2: Boxplot HDI and world regions

There is currently increasing public awareness about wastewater treatment, which can be attributed primarily to the Millennium Development and Sustainable Development Goals. For example, one of the main targets of the Millennium Development Goals was the reduction "of the population without sustainable access to safe drinking water and basic sanitation" by 50% until 2015 (United Nations, 2015d). The successor – the Sustainable Development Goals (SDGs) – sought to increase water quality and wastewater treatment, and reduce water pollution (United Nations, 2016b). This may explain its significance and positive slope. Thus, an increase in wastewater treatment leads to an increase in the perception of environmental sustainability. Most authors state that wastewater treatment has positive benefits (e.g. Hanjra et al., 2012; UN-Water, 2015). However, at the company level, implementing a better wastewater treatment (preservation or even improvement of the current status) entails quantifying the cost-benefit relation of wastewater management (United Nations Environment Programme, 2015). Thus, wastewater treatment benefits are usually neglected either due to a lack of inclusion of controls/baselines in the calculation (Drechsel et al., 2015) or lack of the market determination of these values (United Nations Environment Programme, 2015). Nevertheless, our empirical results indicate that executives are aware of the benefits of wastewater treatment and it has a strong impact on their perception of environmental sustainability.

The variable for CO2 emissions is significant and has a negative loading sign. This implies that higher CO2 emissions reduce the perception of environmental sustainability. CO2 emissions are mainly associated with climate change as they are one of the main causes of "human induced climate change" (Sachs, 2015: 110). In their latest report, the

Intergovernmental Panel on Climate Change stated that "[c]umulative emissions of CO2 largely determine global mean surface warming by the late 21st century and beyond" (Intergovernmental Panel on Climate Change (IPCC), 2014: 8). Thus, these results demonstrate the current and future impact of CO2 emissions and the need to reduce them to limit the impacts of human-induced climate change. The relatively low slope of this indicator (compared to wastewater treatment) suggests that executives may think that CO2 reduction is important but that sufficient measures are already implemented for that purpose. For instance, the EU Emissions Trading System (ETS) carbon prices fell in September 2016 below 4€/EUA (European Emissions Allowances), which was the lowest value since 2013 (Sandbag, 2016).

On the other hand, particulate matter is non-significant, even though the World Health Organization (2003) showed that particulate matter is associated with respiratory, cardiovascular disease, and fatality (increase in hospital admissions) in many European cities and other parts of the world. The non-significance, however, could be explained by the fact that the international media (e.g. Financial Times, the Guardian, and BBC) usually focuses on greenhouse gases that induce climate change. Consequently, particulate matter does not receive as much attention as CO2 emissions and, as a result, it has no impact on the perception of environmental sustainability for executives.

Fertilizer consumption is a threat to the health of the ecosystem and humans (Longo and York, 2008; United Nations Environment Programme, 2012). The non-significance of the variable can indicate that executives are not aware of the danger of using fertilizer despite being, on average, more literate than the average citizen (the business management journal literature states that CEOs usually read 50+ books per year (e.g. Blinklist (2017) and Huffingtonpost (2016)). Consequently, fertilizer consumption has no influence on the perception of environmental sustainability for executives.

A possible justification for the non-significance of environmental treaty ratification may result from the perception of a lack of commitment by countries towards international environmental protection. For instance, Canada withdrew from the Kyoto Protocol in December 2011 (Government of Canada, 2011), the Russian Federation signed the Paris climate change agreement but has still not ratified it (United Nations Framework Convention on Climate Change, 2016), and Germany misses its climate goals (reduction of greenhouse gases by 40% by 2020, compared to baseline 1990 – currently they may not even achieve a reduction of 32%) (Tagesschau, 2018). On the other hand, Schulze (2014: 115) argues that the trend towards "internationalization of environmental politics" is a response to transboundary environmental problems, which results in an "increasing number of international environmental agreements" to tackle this problem. This trend seems to have no direct impact on executives' perceptions of environmental sustainability and that agreements are perceived to have little importance (non-significant indicator).

6.6 Conclusion

The main results showed that physical indicators explain executives' perceptions about environmental sustainability at the country level. In particular, wastewater treatment and CO2 emissions are significant independent variables of perceived environmental sustainability. Whereas the control variables of world regions (i.e. Asia-Pacific) and political stability & absence of political instability/terrorism are significant, that of Human Development Index is not.

This first attempt to model perceived environmental sustainability of executives presents specific limitations. By using secondary data available at the country level, analyses lose individual heterogeneity (Orcutt et al., 1968). On the other hand, non-aggregated country data that cover more than 130 countries are not available. Therefore, although this limitation is taken into account, it remained the best available dataset to answer our research question. The three indicators used to measure perceived environmental sustainability come from an executive opinion survey of the World Economic Forum (2017b). Although it has the unique ability to measure this concept for a wide range of countries, it may affect results due to halo effects, social desirable bias, and cross-cultural effects. However, these are well-known problems in surveys and the uniqueness of the dataset compensates for these possible limitations. In our study, control variables were picked to mitigate these differences.

As executives tend to have an above average level of education, it can be argued that their concern about the environment is greater than the average population. They may not be representative of the whole population in terms of their education and status levels. Although this means the results cannot be generalized to the whole population, executives are an important group to study in detail due to the scope and implications of their decisions. Our research aim was not to use a representative sample of the whole population, but rather to use a representative sample of executives, as they are responsible for micro-level decisions, and to understand how their perception are formed.

The study focused on understanding of how physical indicators at the country level feed executives' perceived environmental sustainability. Further research can collect executives and employee's data to recover and identify sources of individual heterogeneity regarding (environmental) sustainability perception. This will be crucial to understand as it shows in more detail which physical indicators drive the perception of individuals.

Chapter 7

European Union managers' perception of the level of corruption: a multilevel analysis [45]

Abstract

This study focuses on the under-researched area of business corruption in the European Union. The EU managers' perception of the level of corruption, which is decisive to the prevention and combating of corruption, is analyzed at the individual, firm, and country levels. A multilevel factor model (multiple indicators, multiple cause) is applied to a representative sample of 7596 managers of the European Union (EU28 excluding Cyprus) to study within- and between-country variability. Five items measure EU managers' perception of the level of corruption. We find that the sector, size, and performance of the firm are significant explanatory variables of managers' perception of the level of corruption. At the country level, between-country heterogeneity is explained by four dimensions of Hofstede's national culture framework, the economic and environmental dimension, and gender equality. Moreover, two clusters of countries are identified: southern and northern countries & central European countries. These findings show that EU managers' perception of the level of corruption is explained by both firm-level covariates and the country-level setting and that there are clusters within EU27. Policymakers, above all the European Commission, should focus on firm and national policies to combat and prevent corruption.

7.1 Introduction

Corruption is one of the biggest challenges facing our society and economy. It is manifested in many ways such as bribery and nepotism and its impact is both wide-ranging and serious (See Bardhan, 1997; Lambsdorff, 2006; Mauro, 1998a; Wei, 1999). Every year about 2% of global GDP ($1.5 to $2 trillion) is paid in bribes (IMF, 2016)[46], but this is just a fraction of the actual amount used for corrupt purposes. In the European Union (EU), the estimates of the

[45] This chapter is based on Witulski and Dias (2019b).

[46] The 2015 estimates are an extrapolation by Daniel Kaufman based on his estimate of $1.1 trillion in Kaufmann (2005).

direct and indirect cost of corruption range from €179bn to €990bn of GDP p.a., representing 1.2% - 6.7% of EU GDP[47] (European Parliamentary Research Service, 2016). However, the burden of corruption is unevenly distributed across EU countries; the world governnance indicators, Control of Corruption (World Bank, 2017c) and the Corruption Perception Index 2017 (CPI), which ranks the perceived level of corruption in countries worldwide (Transparency International, 2018), illustrate the wide discrepancy between EU countries. On one hand, Denmark is ranked by the CPI as having the second-lowest level of perceived corruption (Transparency International, 2018). This comes in stark contrast with countries such as Bulgaria (in seventy-first place) that are positioned at the opposite end of the spectrum.

The complexity and reach of corruption are demonstrated by recent corruption scandals that have hit different organizations, sectors, and countries. For example, in South Korea (ranked 45 in the CPI), the CEO and heir of Samsung was given a five-year prison sentence for embezzlement, concealing profits, perjury, hiding assets, and bribery (The Guardian, 2017c). He was accused of receiving political favors in exchange for donating large amounts of money to a foundation headed by a close friend of the former South Korean president (The Guardian, 2017c). In 2019, the President of a US labor union was arrested for demanding and accepting bribes (United States Department of Justice, 2019b); in exchange, he did not represent his labor union members appropriately, e.g. he refused "to file arbitration claims on behalf of Union member" (United States Department of Justice, 2019b). Other recent corruption scandals include Airbus (Independent, 2017), FIFA (The Guardian, 2017a), Nestlé (Friends of the Earth, 2018), and other labor unions (United States Department of Justice, 2019a). Corruption scandals can result from officials merely ignoring problems or from the intentional offer of bribes as in the case of Samsung and the union president. Bribery is sometimes explained as a means of "greasing the wheels", that is, speeding up bureaucratic procedures (Liu, 2016: 89 ff).

The difficulty in studying corruption starts with its definition as it is a complex concept without a single comprehensive definition (Kayes, 2006; Klitgaard, 1998; Levine, 2005; World Bank, 1997). Argandona (2003: 253) argues that in most cases corruption "involve[s] a private party (a citizen or a corporation) that pays, or promises to pay, money to a public party with the objective of obtaining an advantage or avoiding a disadvantage". A broad definition used by the World Bank (2018a) states that corruption is "the abuse of public office for

[47] Own calculation based on Eurostat (2017).

private gain" (Svensson, 2005). Other authors define corruption by focusing on distinct features: Shleifer & Vishny (1993) define it as "the sale by the government official of government property for personal gain"; Rose-Ackerman (2006: xvii) defines a corrupt transaction as: "[i]n the most common transaction, a private individual or firm makes a payment to a public official in return for a benefit"; and Jain (2001: 73) defines it as "acts in which the power of public office is used for personal gain in a manner that contravenes the rules of the game". All the different definitions of corruption have the misuse of public power in common.

Corruption causes governments to implement policies in areas where there is no need for action and removes resources from areas in particular need, such as safety and health regulation, environmental regulation, contract enforcement, macroeconomic stability, and social safety nets (World Bank, 2018a). At the country level, it deters capital imports (lower capital accumulation) (Lambsdorff, 2003), reduces both the level of growth (Mauro, 1995) and foreign direct investment (FDI) (Cuervo-Cazurra, 2006, 2008; Wei, 2000), and can lead to lower levels of exports (Lee and Weng, 2013). Even a country's health and education systems can be threatened as corruption may result in less investment in these areas (Mauro, 1998b). At the firm level, company growth is hampered as financial performance may be weakened by the direct and indirect costs associated with corruption (Vu et al., 2018).

The reduction of corruption therefore seems both desirable and inevitable; indeed, it is one of the core topics of the Sustainable Development Goals (SDGs) under Goal 16.5 "[s]ubstantially reduce corruption and bribery in all their forms" (United Nations, 2018c). For developing countries, the United Nations reports that "[c]orruption, bribery, theft and tax evasion cost some US $1.26 trillion for developing countries per year; this amount of money could be used to lift those who are living on less than $1.25 a day above $1.25 for at least six years" (United Nations, 2018a). At the EU level, policies have been put in place to fight corruption; these include a political mandate for the European Commission to develop anti-corruption policies and monitor the fight against corruption (European Council, 2010). The efforts of the European Commission range from legislation policies, monitoring corruption indicators, national level support for the exchange of knowledge (European Commission, 2019b).

In the context of EU countries, research has focused on many aspects of corruption such as determinants, the impact on voter turnout, the effect of corruption experience on the current perception, and tests of alternative perception-based indices (Bosco, 2016; Lee and Guven, 2013; Pellegata and Memoli, 2016; Sundström and Stockemer, 2015). Lee and Guven (2013) test the influence of risk preferences and gender roles on corruption and whether contagious effects could be found in a sample of over 20 EU countries (plus Iceland, Norway, Switzerland, Turkey, and Ukraine). They estimate the effect of past experience of corruption on the perception of bribery and the actual payment of bribes. Sundström and Stockemer (2015) study voter turnout in elections and the impact of perceived corruption in 170 regions of 18 EU countries and found that the quality of regional government has a positive impact on the regional turnout (on average, voter participation is higher if there is a lower level of perceived corruption). On the other hand, Bosco (2016) studies EU28 countries (plus Norway, Switzerland, and Turkey) and determinants affecting perceived corruption. He found that the perceived level of corruption was affected by public expenditure, religion and income[48]. In particular, he points out that privatization, the level of productive technology, and the perceived effectiveness of government activities, for example, are likely to reduce corruption (Bosco, 2016). Pellegata and Memoli (2016) analyze alternative perception-based indices of corruption and their effect on institutional confidence with a sample of 23,478 European Union citizens. They show that citizens' confidence in political institutions is negatively affected by perceived corruption.

Despite the broad literature at the individual, regional, and country-level of EU countries, there is a lack of empirical research on EU managers' perception of the level of corruption. On one hand, managers are also consumers, voters, and citizens in the EU and many studies have focused on the perception of the level of corruption and its effects (e.g., on voter turnout, confidence in institutions, or the determinants of corruption). On the other hand, they are decision-makers within their firms. Their decisions are not only influenced by their personal characteristics and organizational culture, but also by external factors such as firm size, current market situation (sector), growth potential, and the overall situation of the country (social, economic, and environmental aspects). These different aspects undoubtedly help shape the perception of managers and impact their decisions. The literature lacks a study that analyzes how EU managers' perception of the level of corruption is affected by firm and country factors. In other words, do firm characteristics explain the difference in the perception

[48] Religion is a crucial part of the national culture and it may have an effect on people's attitudes towards public officers and authority (Treisman, 2000). For example, societies embedded in a religion-oriented culture tend to be more hierarchical, which makes it more difficult for people to resist the authority (abuse) of a public officer (Bosco, 2016).

of corruption at the business level (within variability) after controlling for country characteristics (between variability)?

The present study fills this gap and analyzes the effects of firm and macro-level indicators on the EU managers' perception of the level of corruption. We use a unique representative European Union survey from 2017, covering the managers' perception of the level of corruption (managers' responses based on their perceived overall experiences) and characteristics of the firm for EU27 after excluding Cyprus (European Commission, 2017).[49] This data set provides specific insights into the topic of perceived corruption that typically uses aggregate indicators at the country level. The indicators, e.g. the Corruption Perception Index (CPI), are based on the perception not only of managers but also of analysts, business people, and experts. On the other hand, although the World Bank Enterprise surveys include over 135,000 companies in 139 countries (World Bank, 2018b), the timing of the observations range widely (from 2009 to 2017); moreover, the survey is not representative and focuses exclusively on bribery, which is only one aspect of corruption. Other data sets focus solely on specific features such as the supply-side of a United Nations oil-for-food program (Jeong and Weiner, 2012), or analyze firms in specific countries such as Uganda (Svensson, 2003). The data set used in this study not only covers a wide range of items regarding the EU managers' perception of the level of corruption but also represents the EU within a multilevel setting that includes firms' and countries' characteristics.

The remainder of this chapter is structured as follows: the next section presents the literature on the factors identified as affecting the perception of the level of corruption, which are summarized in the conceptual model. The methodology discusses the sample and statistical methods. The results are then set out and discussed before turning to some policy recommendations. The paper concludes by summarizing the main findings, limitations and suggested topics for further research.

7.2 Influences on Managers' Perception of the Level of Corruption

"Greasing the wheels" and "sand in the wheel" are two general notions that capture the positive and negative aspects of corruption respectively (Kaufmann, 1997; Liu, 2016: 89 ff.). It is argued that paying a bribe to "grease the wheel" facilitates business practices as it speeds

[49] This study excludes the sample from Cyprus as country-level covariates are not available for analysis. Hereafter, we use the acronym EU27.

up bureaucratic procedures (Huntington, 1968; Lui, 1985). Particularly in countries with extremely ineffective institutions (weak institutional framework), corruption is positively associated with increased efficiency (Méon and Weill, 2010). The opposing idea that corruption works more like "sand in the wheel" is supported by different studies. For example, corruption may prejudice investment within countries, resulting in lower growth rates (Ades and Di Tella, 1996), or change (complicate) the bureaucratic procedures so that corrupt politicians can receive more money in bribes (Liu, 2016).

From the micro perspective of firms, the "sand in the wheel" notion is further supported by research that focuses on the relationship of corruption with financial performance and firm growth. Businesses may increase their operational costs by paying a bribe as they expect a positive outcome, which may reduce their financial efficiency in the short run. However, this bribe does not guarantee that they receive the promised contract in the medium/long term, thus weakening the firm's financial position. Vu et al. (2018) show that bribing has mainly negative impacts on the financial performance of Vietnamese SME. They show, for example, that costs of bribes (to obtain permits and licenses) and informal payments to tax collectors reduce the financial performance of firms. Bribery further reduces firm growth as shown by Fisman and Svensson (2007) for 243 businesses in Uganda. Another adverse effect for firms is associated with the uncertainty of corruption. Rodriguez et al. (2005: 385) label this uncertainty as arbitrariness and defines it as "the inherent degree of ambiguity associated with corrupt transactions in a given nation or state". In particular, this high level of ambiguity is characterized by the uncertainty about the number of payments, their targets, and size required to receive approval from governmental officials (Rodriguez et al., 2005). Nevertheless, it is the managers who ultimately decide if a firm will be involved in or fight corruption, and their decisions are influenced by factors at the individual, firm, and country level.

An individual's personal values and beliefs generally mold their perceptions as these characteristics are inherent to each person and define their way of thinking (Melgar et al., 2010). In the specific area of managers' perception of corruption, it is further necessary to account for specific firm characteristics such as soft factors (organizational culture) and hard factors (size and sector). The organizational culture impacts employees' attitude towards corruption behavior and corruption may even become normalized within a firm. For example, Kapstein (2011) shows that the ethical culture of organizations is negatively correlated with observed unethical behavior; moreover, Ashforth and Anand's (2004) model explains the three decisive factors (institutionalization, rationalization, and socialization) underlying the normalization of corruption within organizations. Gorsira et al. (2019) show that factors such as "perceptions of whether their colleagues approve of and engage in corruption" are crucial for corruption-prone business employees and public officials. Hard factors such as firm size and sector have also been found to impact employees' actions and perceptions of corruption (OECD, 2014c; Stohs and Brannick, 1999). In addition, Chen et al. (2008) show that both firm characteristics and macro factors affect a specific form of corruption: bribery payouts.

It is therefore not enough to say that only individual and firm characteristics shape the perception of managers. A manager's national setting also plays a decisive molding role as it determines the broad environment in which managers interact. A country's cultural background establishes the general values and norms whereby citizens live and firms interact. This cultural background is also reflected in the way managers perceive corruption. For a holistic representation of country influences, it is essential to consider its current status of development alongside its cultural background. The economic, social, and environmental dimensions have been shown to be reliable proxies of country development as they are at the core of the Sustainable Development Goals (SDGs) (United Nations, 2018d). These three dimensions are complemented by specific country-level indicators that have been repeatedly found to reduce corruption activities and perceptions such as gender equality (representation of women in parliament) and the level of democracy (Dong and Torgler, 2013; Neudorfer, 2015). Thus, a multilevel framework that includes firm- and country-level covariates is the basis for this research.

7.2.1 Firm-level Factors

The sector of activity is a decisive firm characteristic as it can either increase or decrease the opportunities for corruption. Areas such as military and infrastructure have been shown to be more exposed to corruption practices (OECD, 2014c) as it is easier to pay bribes, use cheaper materials, and receive a kickback. Transparency International (2005: 1) reported that "[n]owhere is corruption more ingrained than in the construction sector". This comes as no surprise for the executive director of Transparency International (UK) as large projects in the construction sector are very complex, involving many different parties, and are large scale investments (Krishnan, 2009), thus providing the ideal environment for corrupt officials and policymakers. Government investment may be shifted from education and health to infrastructure and defense, where corrupt practices are easier to conceal (Shleifer and Vishny, 1993). This further aggravates the underinvestment in the health and education sector in corrupt regimes (see OECD, 2014c). Corruption in the construction sector therefore remains a problem as can be seen, for example, in recent studies in China (Shan et al., 2017; Yu et al., 2019), Indonesia (Wahyono et al., 2019), Italy (Locatelli et al., 2017), and Ghana (Ameyaw et al., 2017). Owusu et al. (2019b) conducted a systematic literature review of the causes of corruption in construction project management and concluded they are primarily: negative role models, poor professional ethical standards, inadequate sanctions, and close relationships.

Different measures have been implemented to fight corruption. Owusu et al. (2019a) studied "the anti-corruption measures" implemented to fight corruption in construction project management. They identified measures such as the mechanism of transparency, training and development initiatives, and ethical codes. However, the effectiveness of the different measures can be questioned. For example, in 2003, Ghana enacted the "Public Procurement Act 663" aimed at regulating and reforming public procurement and hence fighting corruption (Public Procurement Act, 2003). Nevertheless, Ameyaw et al. (2017) show that Ghana continues to have problems with corruption in the construction sector, raising doubts about the effectiveness of Act 663.

The need to combat corruption in the different sectors is omnipresent as the measures introduced have not proved as effective as anticipated. This should be reflected in the managers' perception of the level of corruption and the perceived corruption is expected to differ in line with the sector. Thus, we hypothesize that,

H1: Managers' perception of the level of corruption differs across sectors of activity.

The size of a firm also has a decisive impact on the corruption activities of managers. For example, as larger firms can afford to pay bribes over a more extended period and can handle increased costs better[50], they are more likely to be involved in bribery activities. Baucus and Near's (1991) longitudinal study reveals that larger firms were more likely to engage in illegal behavior that led to a conviction. In the specific case of corruption, Martin et al. (2007) cross-level analysis of firms and country characteristics found that bribery activities are explained by the numbers of employees and sales revenues. Wu (2009) notes that bribery activities within Asian firms are determined by firm factors such as growth rate, corporate governance, and firm size. Similarly, Rand and Tarp's (2012) study of Vietnamese firms concludes that formally registered and relatively large firms are more likely to pay bribes. On the other hand,

[50] For example, additional personal costs and time devoted by employees and managers to maintain corrupt relationships with government officials.

Wu (2016) states that in BRICS[51] the probability of bribing increases with certain firm characteristics such as less growth experience in the market, poor infrastructure, and a small number of employees. Therefore, the size of the firm is found to have an impact on the corruption activities of firms worldwide and will, in turn, influence the managers' perception of the level of corruption.

Beck at al. (2005) investigated the impact of perceived legal, financial, and corruption obstacles[52] on firm growth in 54 countries. They concluded that perceived corruption affects the growth of smaller firms and these firms are the most constrained. Thus, we hypothesize that:

H2: The firm's size influences its managers' perception of the level of corruption.

Firm performance also has a decisive impact on corruption activities. For example, Martin et al. (2007) show that the sales revenue variable is a significant covariate for bribery activities, while Wu (2009) show they are determined by the growth rate. As corruption activities are influenced by the firm performance, this will also be reflected in the managers' perception of corruption. Hence, we hypothesize that:

H3: Firm performance influences the manager's perception of the level of corruption.

Public procurement is cited as the most vulnerable area for corruption (OECD, 2016). A large proportion of national budgets is used for public procurement (European Commission, 2015; OECD, 2019). Indeed, 12% of GDP is spent on public procurement in OECD countries (OECD, 2019) and it is responsible for over €2 trillion of annual financial flows in the EU (European Commission, 2015). The EU increased its efforts to reduce corruption in public procurement with the "new EU Public Procurement Directive" (European Commission, 2015), which provides EU countries with more incentives and stronger tools to prevent corruption in this area. In the specific case of firms, this means that participation in a public procurement can have a significant impact on a manager's perception of corruption. Government officials can directly influence the procedure and use their power to receive, for example, money in return for a public offer (bribery) (e.g., Shleifer & Vishny,1993) or to give the contract to partisan allies (e.g., Dávid-Barrett and Fazekas, 2019). Dávid-Barrett and Fazekas (2019) identified three different stages in which government officials can influence the public procurement process: influencing the creation of procurement laws,

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51 BRICS stands for Brazil, Russia, India, China and South Africa.

52 They used data from The World Business Environment Survey (WBES) in which managers rated whether e.g. corruption presents obstacles for their business (Beck at al., 2005).

the direct (bureaucratic) implementation of the public tender, and disabling the control mechanism. As managers are directly involved in public tenders, we also expect this to be reflected in their perception of the level of corruption. Hence, we hypothesize:

H4: Managers' perceive corruption to be greater if their firms participated in public tenders.

7.2.2 Country-level Factors

The influence of culture on perceived corruption has been well documented over time (Husted, 1999; López and Santos, 2014; Mensah, 2014). Husted (1999) used the corruption perception index of Transparency International and regressed it on economic and cultural factors. His results showed that GNP per capita and Hofstede's three cultural dimensions (power distance index, uncertainty avoidance, and masculinity) impact the perception of corruption. Hofstede's model is often applied in studies that include the national culture as explanatory variables (Davis and Ruhe, 2003; López and Santos, 2014; Synal, 2005). For a more detailed analysis of Hofstede's dimensions, see Hofstede (2003, and 2015) and Hofstede et al .(1990, 2010)[53]. López and Santos (2014) show that social and cultural capital determines perceived corruption. They used the Transparency International Index as a dependent variable and social-political trust and cultural factors were significant independent variables (Hofstede's dimensions). Various other studies found the original four dimensions of Hofstede's framework to be statistically significant as independent variables explaining perceived corruption (Davis and Ruhe, 2003; Synal, 2005). The impact of culture on perceived corruption persists even after controlling for political and economic factors. Mensah (2014) shows that religion and cultural factors (from the Global Leadership and Organizational Behavior Effectiveness (GLOBE) study) have an independent impact on the perceived corruption in 62 countries after controlling for economic (GDP per capita), socio-economic (literacy), and political factors (measured by an index based on world governance indicators).

In the specific case of firms, previous studies have shown that perceived corruption activities such as bribery are driven by characteristics of the national culture. For example, Martin et al.'s (2007) study of 38 countries shows that bribery activities (measured by survey items of

[53] The national framework of Hofstede includes six cultural dimensions and was validated in more than 70 countries (Hofstede, 2015). It helps distinguish and compare countries. At first, Hofstede's model included four dimensions: power distance index, individualism vs collectivism, masculinity vs femininity, and uncertainty avoidance index. Later, on two new dimensions were included: long-term orientation vs short-term orientation and indulgence vs restraint.

the World Business Environment Survey) are driven by country-level factors such as cultural (measured by items from the GLOBE study) and social institutions. Chen et al. (2015) note that although manager-controlled firms (vis-a-vis shareholder-controlled firms)[54] are more likely to engage in bribery, this varies in line with the characteristics of the national culture. In particular, firms that are controlled by managers bribe more in countries with a high level of uncertainty avoidance (Hofstede dimension). As national culture influences the perception of the level of corruption in society as a whole, it also determines the perception of business activities. Thus, we hypothesize that:

H5: The different aspects of national culture influence managers' perception of the level of corruption.

Economic determinants have previously been shown to impact perceived corruption in various significant ways. The literature shows that perceived corruption is lower in more prosperous economies, measured by higher GDP (Goel and Nelson, 2010; Kolstad and Wiig, 2016). Husted (1999) concluded that GNP per capita is a significant independent variable in the explanation of perceived corruption. Goel and Nelson (2010) showed that countries with a higher GDP per capita are perceived to have a lower level of corruption (measured by the Transparency International Corruption Index). Kolstad and Wiig (2016) concluded that greater economic prosperity (log of GDP per capita) is associated with a reduction in the level of perceived corruption.

Other economic variables that decisively influence perceived corruption include imports, foreign direct investment (FDI), capital control, and the openness of the economy. More specifically, a country is perceived to be less corrupt if it has a high level of imports (Treisman, 2000). On the other hand a country that is perceived to be more corrupt has fewer capital controls in place, which reduces foreign investment and may foster future financial crises (Wei and Wu, 2001). In the context of FDI, Robertson and Watson (2004) analyzed the effects of changes in foreign direct investment levels on perceived corruption (measured by the Corruption Perception Index). Their findings show that there is a higher level of perceived corruption (measured by the Corruption Perception Index) if there is an accelerated change in the rate of FDI (a faster decrease or increase in the country's FDI leads to a higher level of perceived corruption). Brada et al. (2012) show that there is a negative relationship between

[54] According to their study, the manager is the ultimate decision maker in manager-controlled firm, whereas the final decision is with the board of directors in the shareholder-controlled firm. For more details, see Chen et al. (2015).

the perceived corruption of host countries and the probability of receiving FDI. There is an inverse U-shaped relationship between the perceived corruption of the home country and outward FDI. Countries with a low and high level of perceived corruption tend to have lower outward FDI. De Jong and Bogmans (2011) and Thede and Gustafson (2012) show that the level of international trade also influences perceived corruption. Ades and di Tella (1999) find that open economies and increased competition reduce the level of perceived corruption. Beets (2005) studied the demand-side of the perception of corruption (i.e., those who demand and accept corrupt payments) by analyzing economic variables (e.g., GNP per capita, Consumer Price Index, annual exports, annual imports, and annual private consumption expenditure per capita) and their relation with the perceived level of corruption. Beets (2005) grouped the 90 countries of his study into four categories for perceived corruption levels: low, mid-low, mid-high, and high. His findings show that economic variables differ significantly between the four groups of countries and that there is indeed an association between a country's wealth (economic indicators) and its perceived level of corruption. Thus, economic variables are expected to impact the perceived level of corruption and we hypothesize that:

H6: The higher the economic prosperity of a country, the lower the managers' perception of the level of corruption.

Inequality, poverty, and social capital are standard measures of the social dimension of a country. Li et al. (2008) studied the interactive effects of the three social institutions (i.e., the normative, the cognitive-cultural, and the regulative) on perceived corruption. They showed that government effectiveness reduces corruption perception. The risk of poverty also influences perceived corruption. Bosco (2016) studied 31 European countries and concluded that a higher risk of poverty, measured by the percentage of people at risk of poverty, is associated with a higher level of perceived corruption. That is, it increases the motivation and opportunity for wealthier people to be involved in corruption; on the other hand, people at the other end of the wealth spectrum are not only at greater risk of extortion, but are also less able to monitor corrupt behavior and hold the powerful and rich accountable for their actions (You and Khagram, 2005). López and Santos (2014) studied the sociocultural effects on perceived corruption. They concluded that social capital has both positive and negative effects on perceived corruption depending on whether social capital is constituted by a universalistic trust (e.g., trust in the general society) or by particularistic levels of trust (e.g., strong trust in specific networks and groups). Recent studies show that specific social indicators influence the perceived level of corruption (Ariely and Uslaner, 2017; Policardo and Carrera, 2018).

Ariely and Uslaner (2017) show that countries with low-income inequalities and a fair society are perceived to have less corruption and Policardo and Carrera (2018) found that an increase in income inequality is associated with an increase in perceived corruption. On the other hand, Husted (1999) found no relationship between perceived corruption and income inequality. As a relevant part of the literature indicates that specific social factors influence perceived corruption, we hypothesize that:

H7: The better the social dimension of a country (more equal and fair society), the lower the managers' perception of the level of corruption.

The unsustainable use of resources, environmental degradation, and climate change are closely connected with corruption activities and perceived corruption, especially in the case of governmental policies. For instance, Rahman (2018) notes that adaptation to climate change[55] is negatively influenced by corruption (extortion and bribery), which is rooted in the governmental system[56]. This might be explained by the potential risk of addressing climate change adaptation policies, such as water policies, as corruption may increase the costs of tackling the problems and simultaneously slow down the implementation of appropriate measures (Jacobsen and Tropp, 2010). Nevertheless, the introduction of adaptation policies for climate change entails both an increase in the necessary adaptation capacities, and a reduction in corruption in the governmental system in order to reverse climate change outcomes (Rahman, 2018).

In the context of the perception of corruption, Masron and Subramaniam (2018) show that countries with greater environmental degradation also have a higher level of perceived corruption. Thus, we hypothesize that:

H8: Managers have a higher level of perceived corruption in countries suffering from greater environmental degradation.

Democracies not only empower their citizens and improve their well-being, but also improve the perceived level of corruption within each country. Kolstad and Wiig (2016) found that democracy reduces the perceived level of corruption; moreover, Goel and Nelson (2010) find that democratic countries with a higher score on the Freedom House Civil liberties and

[55] There are two kinds of policies to address climate change: mitigation and adaptation policies. The first deals with the reduction of the impact (reduce severity) of climate change, while the latter deals with adaptation to climate change (environmental condition).

[56] The Bangladeshi governmental system was shaped over the last four decades by civil-governments that do not have broad support of the civil society, but were backed by the military (Rahman, 2018). As a result, corrupt practices have become embedded in the governmental system.

Political rights indices have a lower level of perceived corruption. Treisman (2000) shows that the duration of exposure to democracies further decreases the perceived level of corruption, i.e. countries that have long exposure to democratic regimes are perceived to be less corrupt[57]. Citizens even connect their perceived level of corruption to political institutions and leaders. Canache and Allison (2005) use the World Values Survey (WVS) and the CPI to analyze whether Latin American citizens are aware of the level of corruption and whether they can connect it to institutions and authority (accountability of corruption) in their countries. The findings suggest that people are aware of the level of corruption and connect it to political institutions and leaders. Counter-intuitively, Li et al. (2015), using samples from 50 countries, found that countries with higher democracy scores tend to perceive their government to be more corrupt in general. They measured the level of democracy by indicators of Polity IV and "Democracy and Dictators"[58].. However in their conditional model at the individual level, they show that people with strong democratic values (self-reported) and more developed democratic institutions (higher score in Polity IV and "Democracy and Dictators" indicators) are less likely to perceive their government as corrupt. Neudorfer (2015) presents empirical support for the notion that wealthy democratic countries are perceived to be less corrupt than wealthy autocratic countries and poor democratic countries are perceived to be more corrupt than wealthy democratic countries. The literature shows that being a democratic country has an overall positive effect on the perception of the level of corruption. Thus, we expect that:

H9: The higher the level of democracy, the lower the managers' perception of the level of corruption.

Gender equality (e.g., the percentage of women in parliament) has an effect on corruption attitudes and behavior and how corruption is perceived within a country. Women are generally less willing to accept a bribe or to be involved in corrupt activities as they may be more risk-averse and are more afraid of being caught (Paternoster and Simpson, 1996). For instance, Dong and Torgler (2013) show that a greater representation of women in the legislature reduces the actual number of registered cases of corruption. This is in line with Swamy et al. (2001) who found evidence that women are less likely to engage in bribery and forgive corrupt actions. They further show that a higher percentage of women in parliament and the workforce reduces the level of perceived corruption. Dollar et al. (2001) show that

57 The duration exposure was measured by two variables: the number of years a country has been a democratic regime and whether the country was a democracy as of 1995 (dummy variable) (Treisman, 2000).

58 For more information about the database of "Democracy and Dictators" see Przeworski et al. (2000).

people perceive countries as having less ingrained corruption if they have a higher proportion of women in parliament. Esarey and Schwindt-Bayer (2018: 10) supports this view as they hypothesize and show empirical evidence for "seventy-six democratic-leaning countries" in which the perceived level of corruption is lower when there is a higher percentage of women in the lower house (parliament) and this relationship is moderated by electoral accountability (punishment for corrupt officials by not being reselected). Hence, we hypothesize that

H10: The more gender-equal a country is, the lower the managers' perception of the level of corruption.

7.3 The Conceptual Model

In this study, we analyze the EU managers' perception of the level of corruption and the potential links with firm characteristics and country-level indicators (Figure 7-1). We assume two factors for the EU managers' perception of the level of corruption, both of which share the same basis of response items. The firm-level factor is regressed on firm characteristics to account for specific aspects of each firm such as size and sector. The country-level factor is regressed on country-level indicators to account for variability between EU countries.

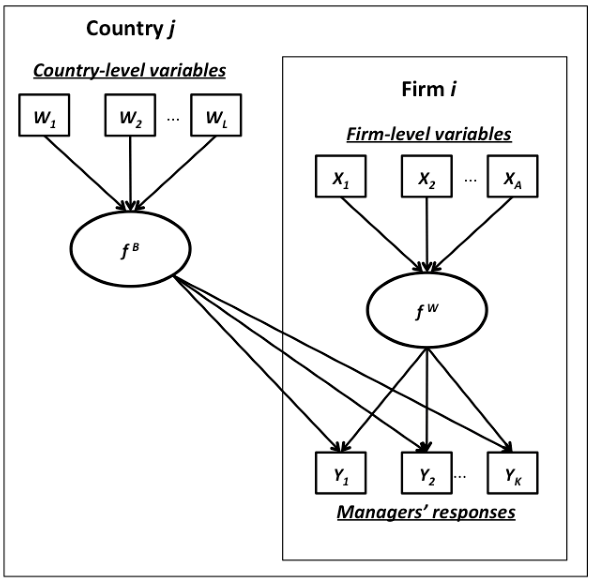

Figure 7-1: Conceptual model

We assume a multilevel model for the EU managers' perception of the level of corruption: the two latent variables f^B and f^W are the measures for the between and within EU managers' perception of the level of corruption. The two factors f^B and f^W are measured by a set of items $(Y_1, \dots, Y_K)$. The items represent the responses of the managers to different questions about their perception of the level of corruption. The macro variables $(W_1, \dots, W_L)$ explain the country background and firm variables $(X_1, \dots, X_A)$ are included to measure the impact of the firm on the perception of the level of corruption. The model assumes two levels of the perception of corruption that explain the observed items.

7.4 Methods

7.4.1 Sample

This research explores a unique data set on "Businesses' attitudes towards corruption in the EU", which is part of the Flash Eurobarometer data system (European Commission, 2017). It sheds light on business attitudes towards corruption using a representative sample of European Union companies (random sampling) and allows cross-country comparisons. It contains data on both the experience and perception of corruption of managers of firms with at least one employee and the characteristics of this specific firm including sector, size, turnover, and participation in public tenders. The survey covers 7746 businesses in the EU28 (European Commission, 2017). As noted previously, Cyprus was excluded from the analysis due to a lack of covariates at the country level[59]. The sample was reduced to 7596 observations and is referred to as EU27. The number of interviews is balanced across six sectors (see Table 7-1): Energy, mining, oil and gas, chemicals; Healthcare and pharmaceutical; Engineering and electronics, motor vehicles; Construction and building; Telecommunications and information technologies; and Financial services, banking, and investment. More than 50% of the companies in the sample have one to nine employees, 22% have 10 to 49 employees, 15% have 50 to 249 employees, and about 6% have more than 250 employees. Approximately 10% of the firms have been in business between one and four years, while over 38% have been in business for over 21 years. Almost half of the companies increased their turnover in the last two years, but 17% had a decrease in the annual turnover. The last year's turnover exceeded €500,000 in about 45% of the companies and more than 68% of the firms had not participated in a public tender in the last three years.

[59] The total GDP of Cyprus in 2018 represented about 0.15% of the total GDP of EU28 (Eurostat, 2019).

Table 7-1: Sample characteristics

	Frequency	Percent
Sector of activity		
Energy, mining, oil and gas, chemicals	1232	16.22
Healthcare and pharmaceutical	1210	15.93
Engineering and electronics, motor vehicles	1263	16.63
Construction and building	1292	17.01
Telecommunications and Information technologies	1301	17.13
Financial services, banking and investment	1298	17.09
Number of employees		
1 to 9 employees	4316	57.04
10 to 49 employees	1668	22.04
50 to 249 employees	1156	15.28
250 and greater	427	5.64
Firms's annual turnover over the last two years		
Increased	3547	48.68
Decreased	1250	17.15
Remained unchanged	2490	34.17
Firm took part in a public tender (last three years)?		
No	5104	68.95
Yes, once	513	6.93
Yes, more than once	1786	24.16

Note: unweighted sample; total 7596 observations; the total of each variable are not the same, due to missing data.

According to the responses, over 67% of the managers perceive corruption to be very or fairly widespread in their country, while only 0.43% says it does not exist (see Table 7-2). Almost 80% of the responders totally agree or tend to agree that too close links between business and politics lead to corruption. Roughly 62% totally agree or tend to agree that bribery and connections are the easiest way to obtain a public service, while almost 60% totally agree or tend to disagree that political connections are the only way to succeed in business. Finally, more than 70% totally agree or tend to agree that favoritism and corruption hamper business competition.

Table 7-2: Items on the corruption perception factors

	How widespread do you think the problem of corruption is in your country?			Too close links between business and politics in your country lead to corruption		Bribery and the use of connections is often the easiest way to obtain certain public services in your country		In your country, the only way to succeed in business is to have political connections		In your country favoritism and corruption hamper business competition	
	Freq.	**Percent**		**Freq.**	**Percent**	**Freq.**	**Percent**	**Freq.**	**Percent**	**Freq.**	**Percent**
Very widespread	2,301	31.93	Totally disagree	464	6.40	975	13.80	2,085	28.27	652	8.97
Fairly widespread	2,630	36.49	Tend to disagree	998	13.76	1,711	24.21	2,336	31.67	1,433	19.71
Fairly rare	1,646	22.84	Tend to agree	3,009	41.49	2,673	37.83	2,020	27.39	2,667	36.67
Very rare	599	8.31	Totally agree	2,781	38.35	1,707	24.16	935	12.68	2,520	34.65
Non-existent	31	0.43									

7.4.2 Latent Variable Indicators

Five items that cover the broad spectrum of corruption are used to measure the managers' perception of the level of corruption: how widespread do you think the problem of corruption is; too close links between business and politics in your country lead to corruption; bribery and the use of connections is often the easiest way to obtain certain public services in your country; in your country the only way to succeed in business is to have political connections; and in your country favoritism and corruption hamper business competition (see Table 7-2). By recoding specific items, all items measure the same direction of the perceived level corruption, i.e. the highest value of the response corresponds to either total agreement or a very widespread level of corruption. This means that a higher factorial score implies that managers perceive the level of corruption to be higher.

Firm- and Country-level Indicators

We used specific covariates to test each hypothesis. Firm-level covariates come from the Eurobarometer survey. For hypotheses 1 and 2, we included the sector and size (number of employees) of the firm, respectively. For hypotheses 3 and 4 we added the change in turnover in the past two years and participation in a public tender in the past three years. Dummy variables were created for the four firm characteristics: sector, the number of employees, change in turnover in the past two years, and participation in public tenders over the past three years. We selected as reference categories: Financial services, banking and investment (Sector), 1 to 9 (Number of employees), unchanged in the past two years (Turnover) and no (Participation in a public tender in the past three years).

At the country level, different data sources are used to test hypotheses. Hofstede's dimensions are applied to account for the cultural dimension (hypothesis 5), which is in line with research on the perception of the corruption level (Achim, 2016; Beets, 2005; Chen et al., 2008; Davis and Ruhe, 2003; Jeong and Weiner, 2012). All six dimensions of Hofstede are selected: power distance index, individualism vs collectivism, masculinity vs femininity, uncertainty avoidance index, long-term orientation vs short-term normative orientation, and indulgence vs restraint.[60] Hypotheses 6, 7, and 8 are tested using the three dimensions (environmental, human (social), and economic) of the Sustainable Society Index (SSI) respectively (Sustainable Society Foundation, 2016b). We use the Sustainable Society Index (SSI) and its

60 For a detailed description of the variables, see Hofstede (2015).

three dimensions as they not only cover the most crucial variables in each dimension but also focus on indicators for achieving a sustainable development path. The scores of the three SSI dimensions range from 0 to 10, with 10 indicating the most sustainable performance. For example, in the case of the environmental dimension, it indicates a country that is more environmentally friendly (e.g., has a lower level of CO2 and higher percentage of renewable drinking water resources). Hypotheses 9 and 10 are tested using data on the Press Score (Freedom House, 2018) to account for the level of democracy (H7) and the percentage of the seats held by women in national parliaments (Eurostat, 2018) to measure gender equality (H8). The Press Score is an aggregation of three dimensions – legal, political, and economic – and ranges from 0 to 100, with 0-30 representing a rating of free, 31-60 of partly free, and 61-100 of not free (Freedom House, 2018).[61]

7.4.3 Statistical model

A multilevel factor model is applied to measure EU managers' perception of the level of corruption by controlling for firm and country-level indicators. Managers from the same country share country characteristics; thus, the assumption of independence of responses cannot be guaranteed. The multilevel modeling takes this nested structure into account (Hox, 2002; da Costa and Dias, 2015).

The conceptual model (see Figure 7-1) is operationalized in two steps to distinguish the impact of firm covariates from country covariates. First, we define the baseline model (M0) and add firm-level covariates (M1). Then, we add the country-level covariates to the previous model (M2).

The value of the indicator y_{ijk} measures the response of the manager of firm i from country j on the item k. All indicators are measured on an ordinal scale, i.e., we assume that there is an underlying continuous latent variable (y^*_{ijk}). It measures the propensity of individual i in country j to choose category m and has a relation with the item k (ordinal scale) defined by thresholds

$$y_{ijk} = m, \qquad if\ \tau_{k,m-1} < y^*_{ijk} < \tau_{k,m} \tag{7-1}$$

[61] The correlation between the different country level indicators can be found in Table A.7-1.

The threshold ($\tau_{k,m}$) of item k defines categories m. Higher values of y^*_{ijk} result in higher observed (ordinal) categories. At the individual level, we define the multilevel model by:

$$y^*_{ijk} = \mu_{jk} + \lambda^W_k f^W_{ij} + v_{ij} \tag{7-2}$$

The random intercept of item k for country j is μ_{jk}. Thereby, we model the variation within the country, where λ^W_k is the individual level loading for item k and f^W_{ij} is the score of the individual latent variable and v_{ij} is the residual random variable with a normal distribution N(0, σ^2_v). The intercepts of the items are set to zero to identify the thresholds.

The following equation gives the structure of the random intercept to control for between-country variation

$$\mu_{jk} = \mu_k + \lambda^B_k f^B_j + u_j \tag{7-3}$$

in which λ^B_k represents the country-level loading for item k and f^B_j is the factor for country j. The distribution of the residual random variable u_j is normal with variance σ^2_u. We assume that v_{jk} and u_j are independent.

The model also allows an MIMIC (multiple indicators multiple cause) component, where the mean of the latent factor is regressed on a set of exogenous covariates. For the within-country variation, f^W_{ij} is regressed on the firm-level indicators ($X_a, a = 1, \dots, A$)

$$\gamma_1 X_{ij1} + \dots + \gamma_L X_{ijA} \tag{7-4}$$

whereas for the within-country variation, f^B_j is regressed on the country-level covariates ($W_l, l = 1, \dots, L$)

$$\gamma_1 W_{j1} + \dots + \gamma_L W_{jL} \tag{7-5}$$

The intraclass correlation coefficient (ICC) measures the ratio of the country level variance (σ^2_u) to the total variance (country level plus individual level (σ^2_v), ICC $= \sigma^2_u/(\sigma^2_v + \sigma^2_u)$.

To further examine the internal consistency of the indicators in measuring the construct, Cronbach's alpha, Average Variance Extraction (AVE), and Composite Reliability (CR) are computed (Kline, 2016).

Three information criteria are applied to compare models: the BIC – Bayesian Information Criterion (Schwarz, 1978), the aBIC – Sample-size adjusted BIC (Sclove, 1987), and the AIC – Akaike Information Criterion (Akaike, 1974). The lowest value of all indicators, indicate the best model. Statistical models were estimated using Mplus 6.12, Stata 13.0, and R Studio Version 1.1.456 with package "lavaan" (version 0.6-3 from September 23rd, 2018), and "PSYCH" version 1.8.12. We use maximum likelihood and robust standard errors for ordinal data (WLSMV estimator) and country-level weights.

7.5 Results

7.5.1 EU Managers' Perception of the Level of Corruption

The baseline model (M0) measures EU managers' perception of the level of corruption without firm- and country-level covariates. It contains two factors – the firm-level (f_{ij}^{W}) and the country-level (f_{j}^{B}) factors – which are measured by five items (responses)[62].

The model fit of M0 is good and the five items share a common factor that represents EU managers' perception of the level of corruption[63]. The internal consistency of the construct is supported by a Cronbach alpha of 0.82, a CR of 0.86, and an AVE of 0.56[64].

Table 7-3 presents the estimation of the loadings of the five items and variance estimates of the firm- and country-level factors[65]. Overall, the loadings of the items at the country level are lower than at the firm level. At the firm level, *Item 3: Bribery and connections* is the most affected by the latent variable perceived corruption, followed by *Item 5: Favoritism and corruption*, and *Item 2: Too close links*. The lowest impact of the latent variable is on *Item 4: Political connections*. At the country level, the item with the highest loading estimate is *Item*

[62] It corresponds to the conceptual model (Figure 7-1) after excluding firm- and country-level covariates. For more details, see subsection Latent Variable Indicators.

[63] The Root Mean Square Error of Approximation (RMSEA) is 0.04, below the recommend value of 0.1 (Brown, 2015; Harrington, 2008; Kline, 2005; Schumacker and Lomax, 2010; Whitley et al., 2013); and the Tucker-Lewis Index (TLI) and Comparative Fit Index (CFI) are higher than the threshold of 0.9 (Hu and Bentler, 1999) with respectively, 0.996 and 0.998.

[64] A construct is said to be consistent if the Cronbach alpha is above ≥ 0.7 (Hair et al., 2014; Kline, 2016, Nunnally, 1978); the CR above the cut-off point of 0.7 (Fornell and Larcker, 1981); and the AVE higher than the threshold of 0.5 (Bagozzi and Yi, 1988).

[65] The loading of *Item 1: How widespread* is set to 1 to retain the identification of the model.

5: Favoritism and corruption, followed by *Item 3: Bribery and connections*, *Item 2: Too close links*, and *Item 4: Political connections*.

Table 7-3: Estimates of the baseline models without covariates

	Firm level			Country level		
	Estimate	S.E.	p-value	Estimate	S.E.	p-value
Loadings						
Item 1: How widespread	1	-	-	1	-	-
Item 2: Too close links	1.295	0.089	0.000	0.687	0.070	0.000
Item 3: Bribery and connections	1.497	0.123	0.000	0.844	0.068	0.000
Item 4: Political connections	0.950	0.072	0.000	0.616	0.066	0.000
Item 5: Favoritism and corruption	1.481	0.095	0.000	0.883	0.089	0.000
Variance	1.492	0.138	0.000	1.831	0.271	0.000

Note: Item 1: How widespread (How widespread do you think the problem of corruption is in your country?); Item 2: Too close links (Too close links between business and politics in your country lead to corruption); Item 3: Bribery and connections (Bribery and the use of connections is often the easiest way to obtain certain public services in your country); Item 4: Political connections (In your country the only way to succeed in business is to have political connections); Item 5: Favoritism and corruption (In your country favoritism and corruption hamper business competition).

The results of the baseline model confirm the existence of between- and within-country variability. In particular, the variance at the firm level (1.492) is lower than at the country level (1.831) (see Table 7-3), which means there is more heterogeneity between countries than within countries. More specifically, the intraclass correlation coefficient (ICC) is 0.551, i.e. country heterogeneity accounts for 55.1% of the total variability in the model without covariates at both levels[66].

7.5.2 Firm- and Country-level Influences

The next models add first firm-level covariates to the baseline model (resulting in model M1) and then country-level covariates leading to our final model (M2) shown in Figure 7-1. M2 has the lowest values of information criteria (AIC and aBIC) from all three models (M0, M1, and M2), which indicates that the best fit when both levels of covariates are used (Table 7-4)[67]. It further highlights that country- and firm-level covariates contribute to the explanation of EU managers' perception of the level of corruption.

[66] Table A.7-2 in Appendix A reports the estimates of the thresholds of the ordinal questionnaire items. For example, managers with a score on *Item 1: How widespread* that is higher than 1.216 are likely to belong to the fourth category.

[67] According to BIC, M1 is the best model. However, it is well known that BIC tends to underestimate the complexity of the model (Arndt, 2001).

Table 7-4: Model fit M0, M1, and M2

Models	AIC	BIC	aBIC
M0	78286.99	78467.18	78384.56
M1	73475.02	73735.99	73615.24
M2	73433.31	73769.83	73614.12

Country- and firm-level covariates capture a part of the between and within-country variability, respectively. In fact, the country heterogeneity accounts for only 12.3% (ICC) of the total variability. As country-level indicators are added to the model, the variance of the country corruption factor decreases to 0.211 from 1.831 (M0 vs. M2), while the variance at the firm level increases from 1.492 to 1.510 (M0 vs. M2); this means that the country-level indicators account for a large proportion of the variability within the country factor and reduce its variance (Tables 7-5 & 7-6)[68].

Table 7-5: Firm-level covariates

	Model 1			Model 2		
	Estimate	S.E.	p-value	Estimate	S.E.	p-value
Sector of activity (ref: Financial services, banking and investment)						
Energy, mining, oil and gas, chemicals	0.131	0.089	0.143	0.120	0.088	0.174
Healthcare and pharmaceutical	0.410	0.091	0.000	0.403	0.091	0.000
Engineering and electronics, motor vehicles	0.214	0.075	0.004	0.204	0.074	0.005
Construction and building	0.417	0.075	0.000	0.411	0.075	0.000
Telecommunications and Information technologies	0.125	0.070	0.074	0.120	0.069	0.084
Number of employees (ref: 1 to 9 employees)						
10 to 49 employees	-0.215	0.081	0.008	-0.220	0.081	0.007
50 to 249 employees	-0.420	0.092	0.000	-0.431	0.092	0.000
250 and greater	-0.611	0.157	0.000	-0.608	0.156	0.000
Firms annual turnover over the last two years (ref: Remained unchanged)						
Increased	-0.098	0.052	0.058	-0.096	0.052	0.063
Decreased	0.277	0.087	0.002	0.276	0.087	0.001
Firm took part in a public tender or a…. (last three years) (ref: No)						
Yes, once	0.091	0.080	0.258	0.080	0.081	0.321
Yes, more than once	-0.099	0.077	0.202	-0.102	0.077	0.189
Variance	1.509	0.148	0.000	1.510	0.150	0.000

68 The intermediate model M1 (only firm-level covariates) allows the decomposition of the variances. It should be noted that the variance change also affects the denominator so it is not possible to compare it directly; however, it indicates the direction ICC changes. By adding the firm-level covariates, the variance of the firm- and country-level factors increased from 1.492 (M0) to 1.509 (M1) and 1.831 (M0) to 1.944 (M1), respectively. An ICC of 0.563 means that the country-level heterogeneity accounts for 56.3% of the total variability, when considering firm-level indicators.

Table 7-6: Country-level covariates

	Model 1			Model 2		
	Estimate	S.E.	p-value	Estimate	S.E.	p-value
Power distance index				0.008	0.004	0.027
Individualism vs collectivism				-0.012	0.006	0.052
Masculinity vs. femininity				0.003	0.004	0.429
Uncertainty avoidance index				0.014	0.004	0.001
Long-term orientation vs. short-term normative orientation				0.016	0.005	0.003
Indulgence vs. restraint				-0.026	0.006	0.000
Economic dimension				-0.284	0.085	0.001
Social dimension				0.269	0.258	0.297
Environmental dimension				0.566	0.128	0.000
Press Score				-0.016	0.010	0.112
Gender Equality				-0.027	0.013	0.041
Variance	1.944	0.291	0.000	0.211	0.053	0.000
ICC	0.563			0.123		

7.5.3 Firm-level Characteristics

The three sectors – Healthcare and pharmaceutical, Engineering and electronics, motor vehicles, and Construction and building – have a positive significant effect on managers' perceptions of corruption (p-value < 0.01) (Table 7-5)[69]. EU managers working in firms in these three sectors perceive corruption to be a more serious problem than managers in Financial services, banking and investment (reference category). The problem of corruption in the Healthcare and pharmaceutical sectors and Construction and building sectors has been highlighted in many studies (Locatelli et al., 2017; OECD, 2014c; Yu et al., 2019). Hence, our first hypothesis is supported: managers' perception of the level of corruption differs across sectors of activity.

The size of the firm is another influencing factor at the firm level. EU managers' perception of the level of corruption declines as the firm size increases (measured by the number of employees). The coefficient estimates for managers in firms with 50 to 249 employees and with more than 250 employees are -0.431 and -0.608, respectively. Hence, the EU managers' perception of the level of corruption working in firms with 50 or more employees is lower than that of managers working in micro firms (up to 9 employees). Our explanation is that bigger firms usually have stronger reporting requirements and codes of conduct in place. For example, in the EU all limited liable firms must report certain information (European

[69] In model M1 (M2 without country-level covariates), the significant covariates are the same as in the final model (M2). Thus, we focus our analysis on the latter model.

Commission, 2019c) and listed firms must disclose specific information to increase transparency for investors (European Commission, 2019d). The results support our second hypothesis: the firm's size influences its managers' perception of the level of corruption.

Hypothesis three (the firm performance influences the manager's perception of the level of corruption) is partially supported as a decrease in annual turnover is significant. This implies that the EU managers' perception of the level of corruption increases relative to the reference category (unchanged annual turnover) if they have a decrease in annual turnover. The results are partially in line with and extend the current literature as the firm growth rate influences both bribery activities and the perceived level of corruption. Using a linear regression model, Wu (2009) showed that the growth rate of the firm has a negative impact on bribery activities, i.e. the lower the growth rate, the higher the number of bribes they are required to pay. This is also reflected in the perceived level of corruption of EU managers as a decrease in annual turnover increases the perceived level of corruption.

Hypothesis four is not supported. The dummy variables that account for whether or not a firm competing in a public tender do not have a significant impact on the perception of the level of corruption. This means that even though managers are directly involved in an area that is cited as the most vulnerable to corruption (OECD, 2016), this is not reflected in managers' perceived level of corruption. About one third (on average) of the investment of public procurement within OECD is invested in health care spending (OECD, 2017). This may explain the non-significance of public procurement as our model already accounts for it by considering the sector of activity. For example, the healthcare and pharmaceutical sector is significant and has a decisive influence on the perceived level of corruption of EU managers.

7.5.4 Country-level Characteristics

Four significant dimensions of Hofstede's framework highlight the impact of national culture on EU managers' perception of the level of corruption (Table 7-6). Power distance index, Uncertainty avoidance index, and Long-term orientation vs short-term normative orientation have a positive impact, while Indulgence vs. restraint has a negative influence. EU managers who work in a country with a high score on the Power distance Index or a low score of Indulgence vs. restraint perceive corruption to be a more serious problem. These results are partially in line with Husted (1999) who also found that Power distance index and uncertainty avoidance index had a positive impact on the perception of corruption. Davis and Ruhe

(2003) also show that the Power distance index explains the perceived corruption. Contrary to our results, Davis and Ruhe's (2003) results highlight the importance of two further dimensions – Individualism vs. collectivism and Masculinity vs. femininity – that are not significant in the model. While not all dimensions of Hofstede's framework are significant, we can only partially confirm hypothesis five and there are different aspects of national culture that influence managers' perception of the level of corruption.

The economic dimension, measured by an index that is a function of the GDP, employment, and public debt, has a negative significant impact on the EU managers' perception of the level of corruption. The results for the specific group of EU managers are in line with the overall literature. Countries that have a better economic standing (higher GDP per capita) also have a lower level of perceived corruption (Goel and Nelson, 2010; Kolstad and Wiig, 2016). Our sixth hypothesis is supported: the higher the economic prosperity of a country, the lower managers' perception of the level of corruption.

The social dimension has no influence on managers' perception of the level of corruption and our seventh hypothesis is not supported. The non-significance of the social dimension stands in clear contrast to the main literature. Most studies on the influences of social indicators on the perception of the level of corruption suggest they are related (Ariely and Uslaner, 2017; Policardo and Carrera, 2018). Nevertheless, our results are in line with Husted (1999) who found no relationship between income inequality and the perception of the level of corruption. His explanation was that by considering the level of economic development, income inequality is already accounted for.

The environmental dimension is positive and significant, i.e., managers from countries with less environmental degradation perceive a higher level of corruption[70]. Figure 7-2 shows that managers from countries with an overall high country-level score of perceived corruption (perceive corruption to be a more serious problem) also have a high value in the environmental dimension (most sustainable performance). These results oppose our hypothesis eight and seem counter-intuitive. Countries such as Croatia and Romania have a high-country score for the perception of the level of corruption and also a high sustainable performance in the environmental dimension. On the other hand, countries such as Luxembourg, Estonia, and Belgium have a low score for the perception of the level of corruption and also a low score in the environmental dimension. The high scores in the environmental dimension of the SSI of Croatia and Romania might be explained by the

[70] A high score in the environmental dimension indicates the most sustainable performance in this area.

computing method. The environmental dimension focuses on facets related to CO2 emission such as Greenhouse Gases and Consumption (Ecological Footprint minus Carbon Footprint), in which countries such as Romania (47 rank[71]) and Croatia (54 rank) perform better than Luxemburg (141) or Belgium (139) (Sustainable Society Foundation, 2016b). Considering the weight of CO2 emission within the environmental dimension, our results are partially in line with Welsch (2004) who found that pollution increases monotonically with increasing perceived corruption (particularly strong for developing countries).

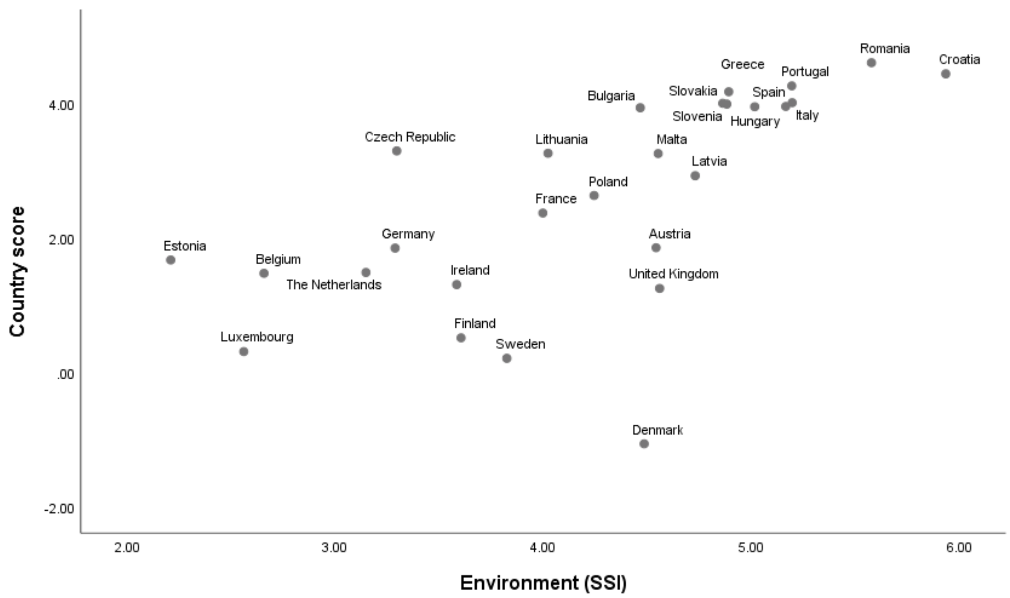

Figure 7-2: Country score of the perception of the level of corruption and the country score of the environmental dimension

The level of democracy has no influence on managers' perception of the level of corruption and our ninth hypothesis is not supported. These results challenge the current literature (see Goel and Nelson's, 2010; Kolstad and Wiig, 2016; Li et al., 2015). This might be explained by the fact that the level of democracy is already reflected within the national culture aspects and, therefore, the covariate is non-significant.

Gender equality (representation of women in national parliament) has a significant negative impact on EU managers' perception of the level of corruption. The higher percentage of women in national parliaments is associated with EU managers perceiving the level of

71 The ranks correspond to the countries' official positions in the environmental dimension of the SSI. The country with the highest rank has the most sustainable performance in the dimension (Sustainable Society Foundation, 2016b).

corruption to be lower. The result is in line with Esarey and Schwindt-Bayer (2018) who show that a higher percentage of women in national parliament (gender equality) has a negative effect on the perception of the level of corruption. Hence, hypothesis ten is supported: the more gender-equal a country is, the lower the managers' perception of the level of corruption.

7.5.5 Scores at the Individual- and Country-level

Table 7-7 depicts the factorial scores of each country based on the country level and averaging of firm-level scores. Figure 7-3 depicts the distribution of country-level scores of EU countries summarized by the mean and standard deviation. It shows that EU27 is heterogeneous. Northern and central EU27 countries have the lowest aggregated scores at the firm and country levels, while southern EU27 countries have the highest aggregated scores. A high mean score (averaged individual scores of respondents from the same country) means that the managers' perception of the level of corruption from a specific country is on average high. The perception of the level of corruption felt by managers in Denmark, Sweden, Luxemburg, and Finland is, on average, the lowest. At the other extreme, managers in Romania, Croatia, and Portugal have the highest perception of corruption levels in their countries. At the aggregated individual level, the highest scores are observed in Greece, Bulgaria, and Poland, while the lowest are in Austria, Sweden, and Denmark, i.e. the three middle/northern European countries have the lowest perception of the level of corruption at the aggregated individual level.

The results are also in line with the Corruption Perception Index (CPI), in which northern and central European countries have a better ranking, e.g. Denmark (2nd), Finland (3rd), Sweden (6th), Luxembourg (8th), and Austria (16th) (Transparency International, 2018). Countries in southern Europe are ranked lower in the CPI, e.g. Portugal (29th), Croatia (57th), Greece (59th), and Bulgaria (71st) (Transparency International, 2018). In summary, results highlight two main findings: 1) there is between- and within-country variability of EU managers' perception of the level of corruption; 2) this heterogeneity identifies two clusters: central and northern EU vs. southern EU countries.

Table 7-7: Factorial scores at the country and firm-level

Country	Country-level scores (estimate)	Firm-level scores (aggregate statistics)	
		Mean	Standard deviation
Austria	1.850	-0.133	1.078
Belgium	1.469	-0.080	1.066
Bulgaria	3.929	0.261	1.013
Croatia	4.433	0.023	1.049
Czech Republic	3.288	-0.043	1.022
Denmark	-1.064	-0.140	1.170
Estonia	1.667	0.175	1.050
Finland	0.511	-0.067	0.999
France	2.365	0.070	1.006
Germany	1.844	-0.048	1.060
Greece	4.167	0.316	0.956
Hungary	3.948	-0.047	1.157
Ireland	1.302	-0.026	1.249
Italy	4.004	0.067	0.924
Latvia	2.919	0.052	1.075
Lithuania	3.253	0.082	1.024
Luxembourg	0.306	-0.033	1.297
Malta	3.248	0.115	0.936
Poland	2.625	0.238	0.933
Portugal	4.254	0.094	1.055
Romania	4.598	0.096	1.033
Slovakia	3.995	0.078	1.068
Slovenia	3.983	0.009	1.086
Spain	3.944	0.134	1.103
Sweden	0.206	-0.233	1.058
The Netherlands	1.482	-0.056	1.047
United Kingdom	1.245	-0.008	1.009

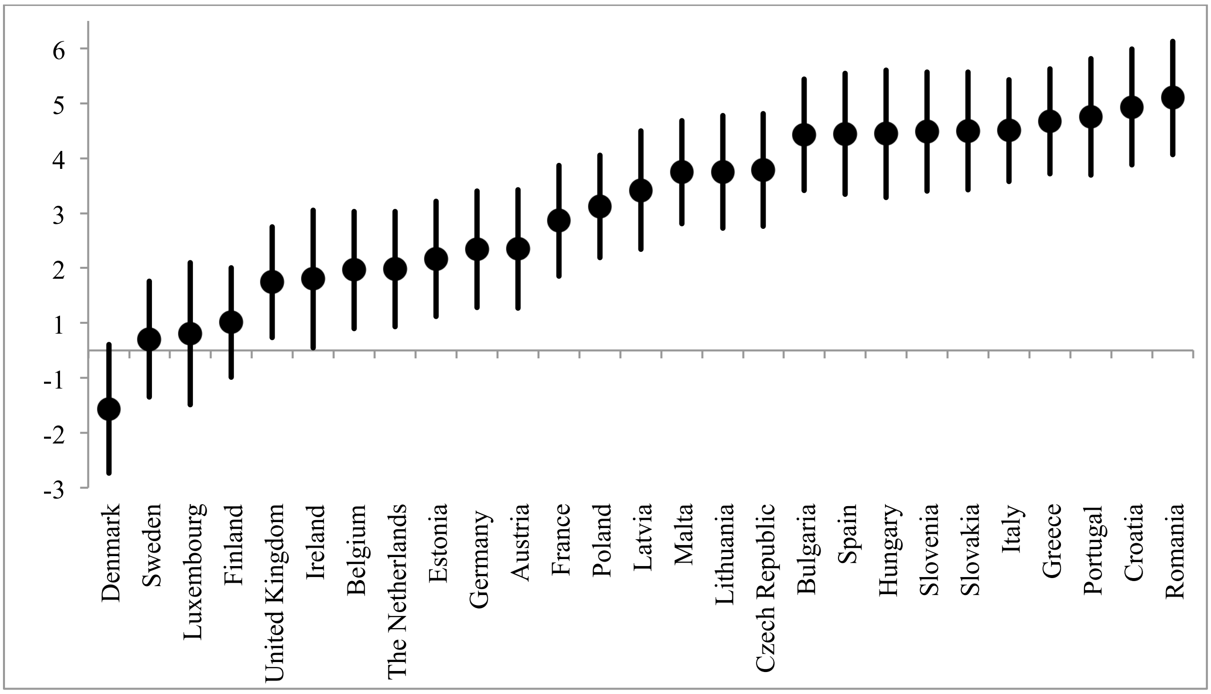

Figure 7-3: Distribution of EU countries

7.6 Policy Recommendations

Our policy recommendations are focused on how to target EU managers' perception of the level of corruption by introducing two paths of policy recommendations that fight observed corruption: a country-level strategy that targets all citizens and a tailored strategy specifically aimed at managers and firms.

At the national policy level, measures to fight observed corruption should be introduced that indirectly improve the perceived level of corruption at the society level. These may include the control and monitoring of the public bidding processes, specifically in the three main sectors where EU managers' perceived level of corruption is highest: Healthcare and pharmaceutical, Engineering and electronics, motor vehicles, and Construction and building. An effective policy should cover all three sectors and go further to impose the minimum requirements for public bidding procedure. It should set corruption-reporting rules, especially for small and medium-sized firms. The imposition of stricter rules on small firms can have a negative influence on their business performance (Fletcher, 2001); however, Kitching et al. (2015) show that these regulations have to be seen from a dynamic perspective as they can also have positive effects on SMEs' performance. Therefore, the policy should be well designed and provide support (financial or knowledge transfer) in the implementation phase.

The implementation of measures to tackle corruption in the sectors considered to be the most affected will reduce the EU managers' perception of corruption levels.

The second policy path is based on the assumption that the perceived level of corruption of EU managers will decrease if they participate more actively in fighting corruption. The policy includes three crucial elements: first, more severe punishments for managers that are involved in corrupt activities and for those who fail to report illegal demands/behaviors by government officials to the authorities; second, the setting up of an anonymous national call line where managers can report corruption activities and communicate suspicions of corrupt behavior; third, emphasis should be given to small and medium-sized firms operating in the Healthcare and pharmaceutical, Engineering and electronics, motor vehicle, and Construction and building sectors.

7.7 Conclusion

This research on EU managers' perception of the level of corruption uses a unique representative sample. The multilevel analysis took within- and between-country variability into account by adding firm- and country-level covariates, respectively. Results show that firm characteristics, namely sector, size, and firm performance, are statistically significant and explain EU managers' perception of corruption. At the country-level, national culture, the economic and environmental dimension, and gender equality are significant.

The policy recommendations to reduce the EU managers' perception of corruption levels are focused on fighting observed corruption in the Healthcare and pharmaceutical sector, Engineering and electronics, Motor vehicle, and Construction and building sectors and also in small and medium-sized companies. Further research could extend this study and explore the origins of managers' perceptions and how they are formed by focusing on personal characteristics such as education and experiences (personal and professional).

The results should be interpreted with caution due to possible data bias inherently embedded in the data. The Eurobarometer Surveys are used to survey the public opinion of EU citizens and are conducted on behalf of the European Commission (European Commission, 2019a) and, therefore, they are more policy-oriented, which explains the limited number of indicators on firm characteristics. Also the number of EU countries is limited (number of observations at the country level). Nevertheless, the drawbacks of this policy-oriented approach and the small number of country level observations are outweighed by the opportunity to use this unique and representative sample of EU managers and study the perception of the level of corruption of EU managers. Further, we want to mention that this study focused on the perception of the level of corruption. Future research could extend our results and explore the relationship and check for differences between the perceived level of corruption and the real corruption of EU managers'.

Chapter 8

Conclusion

This Ph.D. dissertation emphasizes the use of structural equations and multilevel modeling in the broad area of sustainable development (SD). SD establishes the foundation for the long-term prosperity of countries and simultaneously the strategic success of businesses. In particular, a broader understanding of the factors influencing SD help adjust for challenges that arise due to SD issues and support businesses to identify market opportunities/threats and capitalize/neutralize them.

Chapters 1 to 7 covered the introduction and the six independent studies that are part of this doctoral dissertation. In this conclusion, we present a short summary of each chapter, limitations, and avenues for further research.

8.1 Summaries of the chapters

Chapter 1 (Introduction) set out the basis of this dissertation by highlighting the importance of SD for businesses, presenting the statistical foundation, the three overall contributions of this thesis, and the substantive sequence of the six studies.

Chapter 2 (Study I) analyzed the statistical reliability (internal consistency) and external validity of the three dimensions (social, economic, and environmental) of the Sustainable Society Index (SSI). We applied confirmatory factor analysis and standard indicators of reliability, for the analysis of the internal consistency. The external validity was assessed by comparing the country rankings of the social and economic dimensions with the Human Development Index (HDI) and the environmental dimension with the Environmental Performance Index (EPI). The results present three modified indices, which are a result of achieving construct reliability of each dimension by removing statistically identified indicators. These three modified indices further show strong external validity.

This study highlighted that the use of SEM enables the assessment of the reliability (internal consistency) and external validity of an underlying construct of SD, an area in which these techniques are not common.

Chapter 3 (Study II) had two main aims: first, to measure the three/four dimensions of SD in a reliable way (statistical and substantive) based on 68 indicators; second, estimate and compare two different conceptualizations of SD. Four first-order measurement models were estimated (to represent each SD dimension). Then, they were combined into two second-order measurement models: one with the three traditional dimensions – social, economic, and environmental dimensions – and a second one that contains the three dimensions plus the institutional dimension. Our results show that a four-dimensional configuration outperforms (goodness-of-fit and information criteria) the three-dimensional representation, even after controlling for different influences as the level of development and geographic areas.

This study showed that SEM can be a useful tool in the SD debate to measure and compare different conceptualizations and provide the foundations for the selection of best empirical representations.

Chapter 4 (Study III) analyzed the interconnection between SD and competitiveness at the country level, and how both concepts are interrelated. One first-order factor (representing competitiveness) and four further first-order factors (representing SD) were estimated and control variables added. The analysis reveals a significant positive association between competitiveness and the four dimensions (institutional, social, economic, and environmental) of SD. The strongest association is between competitiveness and the institutional dimension, followed by the economic, social, and environmental dimensions.

This research highlights the application of SEM to estimate different constructs within one model and to assess their relation (covariation) after controlling for potential biases (control factors).

Chapter 5 (Study IV) explored the relationship between institutions and SD. We hypothesized that institutions are antecedents of SD and institutional development is at distinct levels in different regions of the world. Our results support that institutions are indeed antecedents of SD. Further, being a country in one of the world regions Latin America & Caribbean, Middle East & North Africa, South Asia, and Sub-Saharan Africa reduces the institutional score.

This study showed that SEM can be useful to test different hypothetical constructs and analyze the impact of one construct on others while considering control variables.

Chapter 6 (Study V) explored how environmental sustainability perceptions of executives are formed and how physical environmental indicators explain them. Results show that wastewater treatment and CO2 emissions are significant physical environmental indicators even after controlling other influences such as the Human Development Index.

This study highlighted that SEM can be applied in the estimation of an underlying construct (perceived environmental sustainability) and determine the influence of specific indicators on the perception of executives.

Chapter 7 (Study VI) explored EU managers' perception of the level of corruption in a multilevel setting (firm and country levels) taking between – and within-country variability into account. Results show that the firm characteristics sector and size are decisive factors EU for managers' perception of the level of corruption. At the country level, national culture, the economic and environmental dimension, and gender equality EU managers' perception of the level of corruption.

This study highlights the use of multilevel CFA to estimate hypothetical constructs while considering between and within-country variability.

8.2 Limitations and avenues for further research

The use of secondary data aims to show how the rich available data sets can be used to explore concepts and derive results. We acknowledge that in more substantive research, possible disadvantages of this option have to do with population representativeness, lack of items to test conceptual models, and overall lack of control on data quality. Nevertheless, the data sets in this dissertation are from official statistics and available in well-known archives. Thus, contributions in this thesis can be further replicated and updated in future researcher.

In line with the disadvantages of secondary data, we want to emphasize the issue of accuracy (reliability). International organizations are aware of the reliability issues and do their best to maximize the reliability of their reported indicators (e.g., Karr et al., 2006). Hence, it is known that the quality of the reported figures may vary from country to country. In particular, developing countries struggle to provide reliability indicators that make it difficult to assess several challenges ahead such as extreme poverty reduction, no safe water and sanitation, and insufficient school education coverage. This interconnects with the fact that weak institutions are also more common in developing countries, where official statics have less standardized procedures of data gathering and analysis to provide a good overview of the country's needs. Hence the data reliability can always be questioned by a sample that includes a wide range of countries. Moreover, there may also be problems with the data comparability as not all countries apply the same procedures.

During the analysis of the data, it became evident that some country-level data had missing values, heavy tails, and skewed distribution. Robust standard errors and transformation of variables to reduce skewness and heavy tails were used. Further research could develop a (statistical) open-source package for SEM (e.g., in R) that incorporates data that are skewed, with heavy tails, and longitudinal. This could lead to a wider application of SEM models in our applied fields.

This thesis focused on the understanding of constructs from a perspective of composite indicators and their implications for businesses in a cross-sectional framework. Future research could emphasize local relationships between well-defined variables, by parsing different dimensions of sustainable development, competitiveness, and institutions and looking at the causal impact of one of these on the others. A suggestion might be, to look at how the introduction of a given policy change in a specific country or group of countries (say the signing of the Kyoto protocol) might have led to different trends for businesses across times. This would mean moving away from cross-section data and look more into panel data. This analysis over time would further increase the sample sizes with more variability, not only throughout space but also throughout time. Possible techniques can be differences-in-differences, instrumental variables, regression discontinuity analysis methods, or longitudinal SEM analysis (e.g., Cameron and Trivedi, 2005; Greene, 2012; Kline, 2016).

It is imperative that SD research continues as it not only supports businesses to grow but also increases the well-being of Humanity.

"Businesses should focus on solving problems, putting the customer first, delivering value - not gimmicks - and growing in a sustainable manner." (Neil Blumenthal)

"A sustainable business is resource efficient, respects the environment and is a good neighbour" (Phil Harding)

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Appendice A

Table A.1-1: Overview research questions, hypotheses, data, and applied methods

	Research questions	Hypotheses	Data	Applied methods
Chapter II	Are the three dimensions of the SSI reliable (internal & external consistency)?	The SSI has a solid theoretical foundation and represents the concept of sustainable development in a holistic way.	• 154 countries • SSI, HDI, and EPI	• CFA • Cronbach's Alpha • Composite Reliability (CR) • Average Variance Extracted • Kendall rank corr. coefficients
Chapter III	What is the "better" empirical representation - SD 3 or SD 4?	A four-pillar definition measures sustainable development in a more thorough way than three.	• 138 countries • HDI, EPI, SSI, and World Bank	• CFA • MIMIC
Chapter IV	What is the relationship between SD (4 dimensions) and competitiveness?	There is a positive relationship between competitiveness and the four dimensions of SD.	• 138 countries • SSI, HDI, EPI and World Bank • GCI	• CFA • MIMIC
Chapter V	Are institutions antecedents of SD and do they vary across world regions?	H1: Institutions are antecedents of SD H2: Institutions vary across world regions	• 138 countries • SSI, HDI, EPI, and World Bank	• CFA • MIMIC
Chapter VI	Are executives' perception of environmental sustainability explained by physical environmental indicators?	Individuals' perceptions are inherently affected by the signals captured from their environment.	• 138 countries • WEF, UN, World Bank, HDI, YCELP + CIESIN, and IUCN	• CFA • MIMIC
Chapter VII	Are EU managers perception of the level of corruption explained by within and between country variability?	4 hypotheses at the firm level 6 hypotheses at the country level	• EU 27 (no Cyprus) • 7596 observations • Hofstedes dimension • SSI, Freedom House, Eurostat	• CFA • Multilevel modeling

Table A.3-1: Transformed variables

Variable	Transformation	Reason
Gross national income (GNI) per capita	$Y_1 = Y_0/1000$	Adjustment of the value to the other indicators.
Households and NPISHs final consumption expenditure (% of GDP)	$Y_1 = J – Y_0$	The inclusion of household final savings (% of GDP).
Exports of goods and services (% of GDP	$Y_1 = \log(Y_0)$	Adjustment (reduction) of the variance to the other indicators.
Adjusted savings: particulate emission damage (% of GNI)	$Y_1= J - Y_0$	A decrease in the value of Water Resources results in a positive effect on the environment. For Adjusted savings: particulate emission damage (% of GNI)it is the opposite, a high value is positive.
Water Resources	$Y_1 = \log (Y + 1)$	Adjustment (reduction) of the variance to the other indicators.
Consumption	$Y_1 = (J + 1) - Y_0$	A decrease in the value of Water Resources results in a positive effect on the environment. For Consumption it is the opposite, a high value is positive.
Renewable energy	$Y_1 = (J + 1) - Y_0$	A decrease in the value of Water Resources results in a positive effect on the environment. For Renewable energy it is the opposite, a high value is positive.

J = max value; Y_1 = new value; Y_0 = old value.

Table A.7-1: Correlation between the country-level variables

	Power distance index	Individualism vs collectivism	Masculinity vs. femininity	Uncertainty avoidance index	Long-term orientation vs. short-term normative orientation	Indulgence vs. restraint	Economic dimension	Social dimension	Environmental dimension	Press Score	Gender Equality
Power distance index	1										
Individualism vs collectivism	-0.5472	1									
Masculinity vs. femininity	0.2747	0.0705	1								
Uncertainty avoidance index	0.5431	-0.5787	0.1759	1							
Long-term orientation vs. short-term normative orientation	0.1182	0.1871	0.1204	-0.0286	1						
Indulgence vs. restraint	-0.5099	0.4114	-0.0937	-0.4155	-0.3836	1					
Economic dimension	-0.2528	0.2155	-0.3038	-0.5004	0.3242	-0.1299	1				
Social dimension	-0.3712	0.4148	-0.1676	-0.4614	-0.0474	0.5196	0.3210	1			
Environmental dimension	0.3712	-0.4332	0.1760	0.2761	-0.4175	-0.2136	-0.5057	-0.4524	1		
Press Score	0.4988	-0.4189	0.4004	0.5362	-0.0493	-0.5014	-0.4425	-0.6528	0.6730	1	
Gender Equality	-0.0558	-0.1228	-0.4894	-0.1694	-0.1016	0.3097	0.1294	0.3162	-0.0829	-0.3492	1

Table A.7-2: Thresholds baseline model

	Threshold 1		Threshold 2		Threshold 3		Threshold 4	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
Item 1: How widespread	-8.033	0.333	-3.856	0.170	-1.353	0.162	1.216	0.121
Item 2: Too close links	-4.208	0.191	-2.289	0.173	0.630	0.110		
Item 3: Bribery and connections	-3.291	0.174	-1.087	0.141	1.816	0.119		
Item 4: Political connections	-1.408	0.106	0.362	0.110	2.338	0.104		
Item 5: Favoritism and corruption	-4.078	0.225	-1.784	0.164	1.008	0.151		

Note: S.E. (standard error of the estimate); Item 1: How widespread (How widespread do you think the problem of corruption is in your country?); Item 2: Too close links (Too close links between business and politics in your country lead to corruption); Item 3: Bribery and connections (Bribery and the use of connections is often the easiest way to obtain certain public services in your country); Item 4: Political connections (In your country the only way to succeed in business is to have political connections); Item 5: Favoritism and corruption (In your country favoritism and corruption hamper business competition).