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Climate Change and Culture: An extended review with the Hofstede Model and a new cross-country analysis

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Contents

Abstract (in italiano)

L'elaborato inizia presentando il modello di Hofstede per la dimensione culturale dei Paesi del mondo, i suoi pregi e difetti, e prosegue discutendo le analisi di correlazione fra il modello e un ampio insieme di misure relative al cambiamento climatico investigate in letteratura. L'ultimo capitolo presenta una nuova analisi di correlazione fra il modello di Hofstede e lo sforzo di diversi Paesi nel combattere il cambiamento climatico, focalizzandosi su quanto i Paesi siano riusciti a ridurre le emissioni di anidride carbonica dalla firma degli Accordi di Parigi per il clima e degli obiettivi di sviluppo sostenibile ad oggi.

Introduction

This dissertation has been inspired by the following question: is it possible to say that some countries have a cultural bias towards protecting the environment and some others not? In 2015, two important agreements have been signed by almost all countries in the world: the Paris Agreement and the Sustainable Development Goals (SDGs). All the signatories recognized the importance of integrating climate change measures into national policies and strategies, with the aim of "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit such increase to 1.5°C" (UN, 2016). However, the documents do not include any specific provision for any country, so that free-riding in this fight is a natural consequence. Within this free-riding, culture might play a role besides other more important forces.

In the first chapter, I describe in detail the Hofstede Model for national culture, whose first edition appeared in G. Hofstede (1980). Up to now, this model is one of the most widely used proxies for culture in the academic world. I start by saying what culture is in Hofstede's mindset, and how it forms throughout the lifetime of an individual. Then, I describe the statistical procedure he used to derive the cultural dimensions, which is known as factor analysis. After that, I present a chronological perspective on the development of the model, without forgetting the important contributions of other researchers that occurred in the 1980s and in the 2000s. Then, I describe extensively the six dimensions, and I also present some correlations discovered by other scientists that support their meaningfulness from a logical point of view. Finally, I say which are the most important validations of the whole model and the most relevant criticisms that have been made to it, with a small note on how the score have been and are updated since Hofstede's retirement.

In the second chapter, I provide an extensive review of the literature that has already connected the Hofstede Model with different measures related to climate change at the level of countries. I start by specifying the processes through which culture is hypothesized to impact on climate change, and then I list some hypotheses that many researchers have already formulated about the impact of the Hofstede dimensions on it. After that, I provide a brief description for each of the article while focusing on the methodology and on the findings. A summary of the results can be found in the tables at the end of the chapter.

Finally, in the third chapter I present my own correlation analysis, which focuses on the degrowth in both production- and consumption-based CO_2 emissions of countries after 2015. The first section says in detail what are the provisions of the Paris Agreement and of the SDGs which allow for the free-riding hypothesis, so that culture may play a role. Then, I explain my research hypotheses based on the literature exposed in the second chapter. After that, I discuss how I have collected and manipulated the data, and then I present the results of my analysis. The last two sections submit my analysis to some robustness checks and discuss the findings, without forgetting to suggest directions for future research.

Chapter 1

Cultural Dimensions of Countries: The Hofstede Model

When it comes to talk about the culture of countries, it is impossible to avoid mentioning Geert Hofstede.[1] With an H-Index of 111 in Google Scholar up to November 7th 2023, he is one of the most cited social psychologist in the world and the most cited for what concerns national cultures. In this first chapter I am going to present his famous model in detail. In particular, the first two sections present Hofstede's mindset and the statistical technique at the basis of the model. These are followed by a section explaining how the model is born and a section discussing the six fundamental quantities in the model. Finally, the last section presents validations, criticisms and connections with other models.

1.1 Culture in Hofstede's Mindset

Hofstede's definition of culture can be found in G. Hofstede, G. J. Hofstede and Minkov (2010, p. 6):

Culture is the collective programming of the mind that distinguishes the members of one group or category of people from others

[1] Gerard Hendrik (Geert) Hofstede (1928-2020) was a Dutch mechanical engineer and social psychologist. He worked for ten years as an engineer at the IBM Corporation, where he developed his model. During that years, he also took a PhD in social psychology and later on he became Professor of Organizational Anthropology and International Management at the University of Maastricht and a fellow of the Center of Economic Research at Tilburg University. He was appointed Knight in the Order of Netherlands Lion, one of the most important among the awards that the Dutch government gives to eminent individuals in all walks of life, in 2011 (from Wikipedia contributors, 2023).

While this definition maintains that culture is always a group phenomenon rather than an individual one, it does not make specific reference to nations. Indeed, it can be applied to any type of group like ethnic groups, organizations, occupations, generations, genders and social classes. With "collective programming", Hofstede refers to the set of thoughts, feelings and potential actions learned through the entire course of one's life that makes her decide which strategies and actions to take in the face of a problem. This set is learned primarily during infancy, childhood and adolescence because these are the periods in which we face problems for the first time in our lives, we are yelled at if we do something wrong and rewarded if we do something correct, and there is shared consensus among social scientists that learning a thing for the first time is much easier than unlearning and learning again.

1.1.1 The Human Being in Social Science

Therefore, under Hofstede's definition, culture is learned. Social scientists distinguish three strata with fuzzy borders that define people as a whole (see G. Hofstede, G. J. Hofstede and Minkov, 2010, figure 1.1):

- *Human nature*, which consists in the set of characteristics completely devoted to our DNA. This stratum includes what all human beings have in common (for example, the human ability to feel emotions falls in this category);

- *Culture*, which is group specific, learned (at school, in family and in other social contexts), and refers to the mental processing already described above;

- *Personality*, which is individual specific (in the sense that each person has its own), is partially inherited and partially learned, and consists in how we express visually our emotions through the mediation of culture.

As a mean of an example, we can use these three strata as lens through which we examine a situation in which an individual feels fear. If she has an extrovert personality, she would usually react with aggression, while introverts would usually freeze. However, the degree of aggression actually expressed is determined by culture (at least up to some extent), because it makes it possible to discriminate when more aggression is appropriate.

1.1.2 Perceivable Expressions of Culture

Hofstede claims also something about how culture manifests (see G. Hofstede, G. J. Hofstede and Minkov, 2010, figure 1.2). In his opinion, the following four things are involved:

- *Symbols*, which are items, gestures and sentences that carry a specific meaning which is recognized only by people sharing a specific culture;
- *Heroes*, as real or imaginary characters that have all the features that are praised in that specific culture. Their function is to be models for behaviour;
- *Rituals*, i.e. collective actions that are fundamental (from a social point of view) in that specific culture, even if there is not a concrete goal to reach.
- *Values*, which consist in the tendency to prefer certain scenarios over others, are the most rooted in our mind among the four. In practice, this tendency is determined by feelings that arise unconsciously when facing a specific situation.

The following example gives a better explanation. In Italy (and especially in its Southern part), people tend to wear necklaces with a crucifix or the image of Christ (symbols), have the Pope as a model for their own behaviour (heroes), attend the Mass every Sunday (rituals) and usually show disappointment when they talk to people that explicitly claim their non-religiousness (values). The latter occurs because negative feelings ("dirtiness", "immorality") arise in them when non-religiousness is explicitly declared.

1.1.3 Other Properties of Culture

Furthermore, Hofstede assigns other properties to culture. First, he claims that no society is able to escape it. By taking the example of *The Lord of the Flies* by William Golding, he claims that if thirty people who come from completely different environments are collected and put to live in a remote island, they will produce a culture which collects all the elements that they share (a sort of "averaged" or "summarized" culture of them all).

Second, he claims that cultures are time-consistent, especially for what concerns values. This is due to a phenomenon that biologists call homeostasis: parents and teachers have been educated and trained in their youth

in a certain way that they tend to reproduce when it comes to raise their own children (and this is especially true for the values, which early learned early in life and rooted deeply in minds). In accordance with this theory, institutions and technology cannot determine a change in culture on their own, as society has to change first. Conversely, a change in societal culture can create the basis for a change in the institutions or in the way we use the new technologies.

Finally, he stresses the role of culture in determining social conflict (even though there are other factors that matter as well). In fact, it is a prerogative of human beings to classify new people as in-group or out-group members ("this is/is not like me"). Social scientists and also neurologists agree on the fact that we tend to classify as "in-group" only those people who share a noticeable trait with us (see for example Sapolsky, 2017). The others are usually classified as "out-group" and the interesting thing is that we impose, consciously and unconsciously, stricter rules and obligations and give less rights to the out-group members with respect to the in-group ones. So, people coming from societies that share a culture which imposes a priori narrower patterns on people's behaviour are at higher risk of social conflict when they come in contact with other cultures.

1.2 Factor Analysis

Factor analysis is a statistical technique created by psychologist Charles Spearman (see Spearman, 1904a). It is widely used in different fields of the academic world (psychology, biology, social sciences, physical sciences, marketing and politics), especially when meaningful information has to be extracted by surveys with self-reported answers. Hofstede used it extensively in his studies and this technique plays a very important role in the genesis of the model. The procedure is as follows and is described down below as it is in Rencher (2002).

1.2.1 General Setting and Assumptions

The goal of factor analysis is to represent (if possible) some random variables $Q_1, \ldots, Q_p$ of a predetermined dataset as a linear combination of other random variables $F_1, \ldots, F_m$ with $m < p$ called *factors* in order to reduce

the dimensionality of the model.[2] Variables are denoted with $Q_1, \ldots, Q_p$ because in Hofstede's setting they represent numerical answers to questions of a survey. The underlying idea of this setting is that if $Q_1, \ldots, Q_p$ are moderately or strongly correlated, then it is possible to predict them with high confidence by starting from the factors $F_1, \ldots, F_m$; and since the latter are fewer, the system is simpler than it was originally represented.

Let us assume a random sample $\boldsymbol{q}_1, \ldots, \boldsymbol{q}_n$, where $\boldsymbol{q}_i$ represents the vector of all normalized numerical answers to the survey for subject i (subjects are countries in the case of Hofstede). Given that normalization has already been computed, $\boldsymbol{Q} = (Q_1, \ldots, Q_p)$ has mean $\boldsymbol{\mu} = (0, \ldots, 0)$ and variance-covariance matrix $\boldsymbol{\Sigma}$ that coincides with the correlation matrix $\boldsymbol{P_\rho} = (\rho_{jk})$, where $\rho_{jk} = Corr(Q_j, Q_k)$ and $\rho_{jj} = 1 \quad \forall\ j \in \{1, \ldots, p\}$. Then, if a linear relationship is hypothesized, it is possible to write, for any observation vector $\boldsymbol{q}$,

$$\boldsymbol{q} = \boldsymbol{A}\boldsymbol{f} + \boldsymbol{\epsilon}, \tag{1.1}$$

where $\boldsymbol{f}$ is the vector of factor values for observation vector $\boldsymbol{q}$, $\boldsymbol{A} \in M(p \times m, \mathbb{R})$ is the matrix of *loading coefficients* and $\boldsymbol{\epsilon}$ is a vector of unobserved error terms. Each loading coefficient a_{jl} expresses how much F_l impacts Q_j.

Now, the problem is that both $\boldsymbol{A}$ and $\boldsymbol{f}$ are not observed and so they both have to be estimated. In order to do this, the following assumptions are required:

- **Assumption A1**:$E[\boldsymbol{f}] = \boldsymbol{0}$ and $Var[\boldsymbol{f}] = Corr[\boldsymbol{f}] = \boldsymbol{I_m}$, so to make factor values standardized and uncorrelated one another;
- **Assumption A2:** $E[\boldsymbol{\epsilon}] = \boldsymbol{0}$ and $Var[\boldsymbol{\epsilon}] = \boldsymbol{\Psi} = \boldsymbol{Diag}(\psi_1, \ldots, \psi_p)$. The first is a consequence of A1 and the fact that $E[\boldsymbol{q}] = \boldsymbol{0}$, the second is needed to make error terms uncorrelated each other;
- **Assumption A3:** $Cov(\boldsymbol{\epsilon}, \boldsymbol{f}) = \boldsymbol{O}$ (the null matrix), so to make factors totally uncorrelated with the unexplained part of $\boldsymbol{q}$.

Thanks to the assumptions, a simple expression for $\boldsymbol{P_\rho}$ can be derived. In fact, starting from equation (1.1), it is:

$$\begin{aligned} \boldsymbol{P_\rho} &= Var[\boldsymbol{q}] = Var[\boldsymbol{A}\boldsymbol{f} + \boldsymbol{\epsilon}] = Var[\boldsymbol{A}\boldsymbol{f}] + Var[\boldsymbol{\epsilon}] \\ &= \boldsymbol{A}Var[\boldsymbol{f}]\boldsymbol{A}' + Var[\boldsymbol{\epsilon}] = \boldsymbol{A}\boldsymbol{A}' + \boldsymbol{\Psi}, \end{aligned} \tag{1.2}$$

[2] Factor analysis requires the variables $Q_1, \ldots, Q_p$ to be commensurable in order to work properly. This is not always the case and in fact statistical softwares, like STATA, normalize them automatically before computing anything. In what follows, it is assumed that this normalization process has already taken place.

where in the third to last equality of the chain A3 was used and in the last equality the second part of A1 and A2 were used. An important thing to notice at this point is that $\rho_{jk} = Corr(Q_j, Q_k)$ is modelled only by factor loadings for $j \neq k$ because $\boldsymbol{\Psi}$ is diagonal. Prior to moving to the effective estimation of $\boldsymbol{A}$, an important result that will be used later on is presented.

Lemma 1.2.1. *Let equation (1.2) hold true and let $\boldsymbol{T}$ be an orthogonal matrix (i.e., a matrix such that $\boldsymbol{T}^{-1} = \boldsymbol{T}'$). Let $\tilde{\boldsymbol{A}} = \boldsymbol{AT}$. Then, $\boldsymbol{P_\rho} = \tilde{\boldsymbol{A}}\tilde{\boldsymbol{A}}' + \boldsymbol{\Psi}$. In words, the factor loadings that reproduce a given variance-covariance matrix are not unique.*

Proof. It is

$$\boldsymbol{P_\rho} = \boldsymbol{AA}' + \boldsymbol{\Psi} = \boldsymbol{ATT}'\boldsymbol{A}' + \boldsymbol{\Psi} = (\boldsymbol{AT})(\boldsymbol{AT}') + \boldsymbol{\Psi} = \tilde{\boldsymbol{A}}\tilde{\boldsymbol{A}}' + \boldsymbol{\Psi}. \quad (1.3)$$

□

1.2.2 The Principal Component Method

At this point, we can move to the effective estimation of matrices $\boldsymbol{A}$ and $\boldsymbol{\Psi}$. There are different techniques to achieve this goal; here the focus is on the so called *Principal Component Method*, which neglects the role of $\boldsymbol{\Psi}$ in the estimation. The random sample $\boldsymbol{q}_1, \ldots, \boldsymbol{q}_n$ is what is disposable and the first thing to do is normalizing the variables so that the numerical answers to survey questions are commensurable: the occurrence of this step is assumed in the discussion below. It is only possible to compute an estimation $\boldsymbol{R}$ of $\boldsymbol{P_\rho}$ based on this sample. The matrix $\boldsymbol{R}$ is symmetric, so the following result of linear algebra applies (the proof is omitted).

Theorem 1.2.1 (**Spectral**)**.** *Let $\boldsymbol{R}$ be a symmetric matrix. Then, $\boldsymbol{R} = \boldsymbol{MDM}'$, where $\boldsymbol{D} = \boldsymbol{Diag}(\lambda_1, \ldots, \lambda_p)$ has the eigenvalues of $\boldsymbol{R}$ on its main diagonal and $\boldsymbol{M}$ has the respective normalized eigenvectors as its columns.*

So, $\boldsymbol{R} = \boldsymbol{MDM}'$. Now, given that $\boldsymbol{R}$ is a variance-covariance matrix, it is positive semi-definite. This means that its eigenvalues are all positive or null and this implies that $\boldsymbol{D}$ can be factorized unambiguously as $\boldsymbol{D} = \boldsymbol{D}^{1/2}\boldsymbol{D}^{1/2}$, where $\boldsymbol{D}^{1/2} = \boldsymbol{Diag}(\sqrt{\lambda_1}, \ldots, \sqrt{\lambda_p})$. Then, it is

$$\boldsymbol{R} = \boldsymbol{MDM}' = \boldsymbol{M}\boldsymbol{D}^{1/2}\boldsymbol{D}^{1/2}\boldsymbol{M}' = (\boldsymbol{MD}^{1/2})(\boldsymbol{MD}^{1/2})'. \quad (1.4)$$

Matrix $\boldsymbol{R}$ in equation (1.4) is in an appropriate form. However, it is wrong to define $\hat{\boldsymbol{A}} = \boldsymbol{M}\boldsymbol{D}^{1/2}$ because the latter two are $p \times p$ matrices, and a $p \times m$ matrix is needed. In Principal Component Method, the procedure goes on as follows. The m biggest eigenvalues of $\boldsymbol{R}$ are renamed $\lambda_1 > \cdots > \lambda_m$, then the matrices are defined as $\boldsymbol{D_{red}} = \boldsymbol{Diag}(\lambda_1, \ldots, \lambda_m)$ and $\boldsymbol{M_{red}}$ as the matrix whose columns are the normalized eigenvectors that correspond to $\lambda_1, \ldots, \lambda_m$. Finally, $\hat{\boldsymbol{A}} = \boldsymbol{M_{red}}\boldsymbol{D_{red}}^{1/2}$.

The estimation of $\boldsymbol{\Psi}$ is then worked out from the equation $\boldsymbol{R} = \boldsymbol{A}\boldsymbol{A}' + \boldsymbol{\Psi}$. Indeed, since $\boldsymbol{\Psi} = \boldsymbol{Diag}(\psi_1, \ldots, \psi_p)$, it is enough to compute

$$\hat{\psi}_j = 1 - \sum_{h=1}^{m} \hat{a}_{jh}^2 \qquad \forall\, j \in \{1, \ldots, p\}. \tag{1.5}$$

1.2.3 Choosing the Number of Factors *m*

Up to now, I have assumed that the number of factors m to consider is predetermined. I now face the problem of choosing a suitable m in order to reduce the dimensionality of the model without neglecting too much information. Softwares usually compute factors for $m = p$, print some data like the eigenvalues (in descending order), the difference between an eigenvalue and the following one, and the absolute and cumulative percentage of total variance accounted to each factor (which is computed by λ_j/p, given that $tr(R) = \sum_{j=1}^{p} \lambda_j = \sum_{j=1}^{p} 1 = p$). The statistician must choose in accordance with this data. The three most used criteria in the literature are:

1. Take m equal to the number of factors whose cumulative variance is above a predetermined level (usually 80%);

2. (Kaiser, 1960) Take m equal to the number of factors that have the correspondent eigenvalue above the average eigenvalue of $\boldsymbol{R}$ (which is equal to 1). This is usually the default of statistical softwares;

3. (Cattell, 1966) Use the so called *scree test*: plot the eigenvalues of $\boldsymbol{R}$ in descending order and the line that connects each of them with the following. If the graph drops sharply at the beginning and then it becomes an almost horizontal line, choose m equal to the number of eigenvalues before the horizontal line begins;

None of these criteria is in principle better than the others, also because they are empirically based. However, all the methods almost always give the same value of m when the dataset is well-fitted by a factor analysis model (Rencher, 2002, p. 429). Thus, in the following it is assumed that m is equal to the one given by the Kaiser criterion, if not differently specified.

1.2.4 Orthogonal Rotation

I have already pointed out in Lemma 1.2.1 that the matrix of estimated factor loadings $\hat{\boldsymbol{A}}$ can be multiplied on the right by an orthogonal matrix T to obtain another estimate of the factor loadings $\hat{\tilde{\boldsymbol{A}}} = \hat{\boldsymbol{A}}\boldsymbol{T}$ without changing the goodness-of-fit of the model. In this subsection, I say how to use this property to improve the estimates of the factor loadings. In fact, from a geometrical point of view, the factors loadings in the i-th row of matrix $\hat{\boldsymbol{A}}$ represent the coordinates of $\boldsymbol{q}_i$ in the loading space. Then, it seems a good idea to find a m-dimensional rotation matrix $\boldsymbol{T}$ so to make the axes as close as possible to clusters of points in the loading space. The axes that result after the rotation represent the natural factors. This idea is known as orthogonal rotation and it makes the axes of the loading space remain perpendicular two by two, but it is possible to use also oblique rotation: see Rencher (2002, Section 13.5.3) for this.

Matrix $\boldsymbol{T}$ is usually computed through the *Varimax Technique*. This technique aims at selecting the rotation matrix $\boldsymbol{T}$ that maximizes the variance of the squared loadings in each column of $\hat{\boldsymbol{A}}\boldsymbol{T}$. In fact, if the loadings in a column are nearly equal one another, then the variance of the squared loadings is close to 0. But as they approach 0 and 1, the variance reaches a maximum. Thus, this method attempts to make the loadings either large or small. This may also make easier to interpret factors from a logical point of view. From now on, when speaking about factor analysis, it is assumed that orthogonal rotation has occurred.

1.2.5 Factor Scores

Finally, I discuss how to effectively compute the factor scores. The ordinary approach refers to Thomson (1948) and is based on a regression procedure. Indeed, since $E[\boldsymbol{f}] = \boldsymbol{0}$, it is possible to assume that $\boldsymbol{f}$ and $\boldsymbol{q}$ are related in accordance with the following regression model, where $\boldsymbol{B}$ is a $p \times m$ matrix:

$$\boldsymbol{f} = \boldsymbol{B}'\boldsymbol{q} + \boldsymbol{u}. \tag{1.6}$$

This is true in particular for any observation $i \in \{1, \ldots, n\}$ in the sample, so that it is possible to write:

$$\boldsymbol{f_i} = \boldsymbol{B}'\boldsymbol{q_i} + \boldsymbol{u_i}. \tag{1.7}$$

In transposed form, the previous equation becomes:

$$\boldsymbol{f_i}' = \boldsymbol{q_i}'\boldsymbol{B} + \boldsymbol{u_i}'. \tag{1.8}$$

Combining the n equations (which refer to the n observations) in a single model yields:

$$\boldsymbol{F} = \begin{pmatrix} \boldsymbol{f_1}' \\ \vdots \\ \boldsymbol{f_n}' \end{pmatrix} = \begin{pmatrix} \boldsymbol{q_1}'\boldsymbol{B} \\ \vdots \\ \boldsymbol{q_n}'\boldsymbol{B} \end{pmatrix} + \begin{pmatrix} \boldsymbol{u_1}' \\ \vdots \\ \boldsymbol{u_n}' \end{pmatrix} = \boldsymbol{Q}'\boldsymbol{B} + \boldsymbol{U}. \tag{1.9}$$

The ordinary least squares estimator $\hat{\boldsymbol{B}}$ of $\boldsymbol{B}$ is given by

$$\hat{\boldsymbol{B}} = (\boldsymbol{Q}'\boldsymbol{Q})^{-1}\boldsymbol{Q}'\boldsymbol{F}, \tag{1.10}$$

but $\boldsymbol{F}$ is not observed. Then, another strategy is needed. This consists in expressing $\hat{\boldsymbol{B}}$ in terms of variance-covariance matrices:

$$\hat{\boldsymbol{B}} = (\boldsymbol{S_{qq}})^{-1}\boldsymbol{S_{qf}}. \tag{1.11}$$

With all the assumptions of this section, $\boldsymbol{S_{qq}}$ coincides with the matrix that up to now I have called $\boldsymbol{R}$, while $\boldsymbol{S_{qf}}$ is given by the result claimed by the following lemma.

Lemma 1.2.2. *With all the assumptions considered up to now, it is*

$$Cov(\boldsymbol{q}, \boldsymbol{f}) = Corr(\boldsymbol{q}, \boldsymbol{f}) = \boldsymbol{A}. \tag{1.12}$$

Proof.

$$\begin{aligned} Cov(\boldsymbol{q}, \boldsymbol{f}) &= Cov(\boldsymbol{A}\boldsymbol{f} + \boldsymbol{\epsilon}, \boldsymbol{f}) = \boldsymbol{A}Cov(\boldsymbol{f}, \boldsymbol{f}) + Cov(\boldsymbol{\epsilon}, \boldsymbol{f}) \\ &= \boldsymbol{A}\boldsymbol{I_m} + \boldsymbol{O} = \boldsymbol{A}. \end{aligned} \tag{1.13}$$

□

Then, it is possible to write $\hat{\boldsymbol{B}} = \boldsymbol{R}^{-1}\hat{\tilde{\boldsymbol{A}}}$. Thus, equation (1.9) yields $\hat{\boldsymbol{F}} = \boldsymbol{Q}\boldsymbol{R}^{-1}\hat{\tilde{\boldsymbol{A}}}$, which is in a suitable form.

Finally, an important clarification. In order to obtain factor scores through this procedure, $\boldsymbol{R}$ must be non-singular. When this is not true, $(\boldsymbol{q}_1, \ldots, \boldsymbol{q}_p)$ have to be clustered into groups (i.e., factors) according to the loadings and a score for each factor can be found by averaging all the $\boldsymbol{q}_i$ associated with that factor.

1.2.6 Validity of Factor Analysis

Before moving to other topics, it is important to say that factor analysis is not a legitimate multivariate technique for a lot of statisticians. This occurs because of many reasons: the different ways to select m (none of which can be proven to be better than the others), the many methods to extract factors (of which I discussed only the Principal Component Method) and, above all, the actual existence of factors. In principle, the failure of methods described in Section 1.2.3 to detect m rather objectively is a signal for a matrix $\boldsymbol{R}$ unsuitable for factor analysis. Also, another important thing that professionals must do is hypothesize the existence of factors "a priori" by using strong theoretical arguments and use factor analysis just to check if their hypotheses found statistical support or not. In the next section, Hofstede's way of using factor analysis is presented.

1.3 The Genesis of the Model

1.3.1 Research prior to 1970

Hofstede has not been the first social scientist that has tried to distinguish societies in terms of cultural dimensions. A review of earlier attempts, either on the theoretical or on the empirical side, can be found in G. Hofstede (2001, pp. 29-33). As for theory-based studies, Hofstede says that all of them lack clarity because of the mixture between the individual and the group level of the analysis. Only the work of Alex Inkeles and Daniel Levinson (Inkeles and Levinson, 1969) has to be mentioned as an important reference, since Hofstede has found strong confirmation of what these two scientists wrote.

Inkeles and Levinson (1969) created an extended review of previously existing anthropological and sociological studies at the level of countries that had dealt with the "National Character". This expression refers to a representative human being of the national society in the sense that it has the psychological features found commonly in the adults of that nation and that the way in which adults cope with these features is of functional relevance for the social system. The two researchers found out that these characteristics are the following, so that they are the main determinants in distinguishing societies one another:

- The relation to public and private authority (so, not only the Head of the State and its elite but also the bosses of the private firm in which people are employed);

- The conception of self, both in terms of who between the individual and the society has to prevail on the other and which are the goals to fight for in life (career and money versus well-being and ease);
- The reaction to conflict, both in terms of social conflict (i.e., disagreement with other people) and in terms of facing contradictory information on some topics.

As for empirical based studies instead, Hofstede mentions Cattell (1949) as an important reference for his model. This is because Cattell (1949) had been the first to apply factor analysis both at the level of nations and in the development of psychological tests with self-reported answers. However, Cattell mixed a lot of different variables in his analysis at national level (they varied from geographic and demographic aspects to the number of Nobel Prizes with respect to the total population passing through economic, historical and medical aspects) and, except for a strong role for economic development, he found out that a very big number of factors (12, and difficult to interpret) had to be retained for the analysis to be significant.

1.3.2 The IBM Corporation and its Database

Hofstede was hired by International Business Machines (IBM) Corporation in 1965. At that time, IBM was already one of the largest multinationals in the world, with marketing-plus-service divisions in about 100 countries. In these divisions, offices were usually located in the capital city and they employed only citizens of that country in job positions like managers, supervisors, system and customer engineers, salespersons and administrative staff. The reasons for Hofstede's hiring have to be found in the policy of the corporation for what concerns marketing-plus-service divisions: since a lot of employees had to be directly in contact with customers, they believed that disgruntled employees would have made customers run away from IBM. So, they hired Hofstede and others to develop a survey that investigated on the satisfaction and the ambition of the employees to improve the organizational development.

The scientists began to work on already existing surveys of IBM. They summarized them in a 180-question survey that was administered to IBM employees starting from 1967. By the end of 1970, more than 60,000 employees from 53 countries in Western and Central Europe, North and South America and the Middle East from all IBM divisions (not only the marketing-plus-service one) had been interviewed and the results of this first stage were tracked. A second stage of administration (with a reduced

version of the questionnaire that included 60 questions of utmost importance and 66 "relevant" questions from the original 180) was carried out starting from 1971. By the end of 1973, more than 88,000 employees coming from 72 countries had provided with a response (see G. Hofstede, 2001, p.44). The entries in the dataset have been coded by country and job position.

It is at this point that Hofstede started to think that such a huge amount of data could be used to study cross-country cultural differences. In fact, he noticed that the questions of the survey could be grouped in four categories, in accordance with their content:

1. *Questions about satisfaction* asked the employees for an evaluation of some aspects of their work. They usually start with "How much do you like ..." or "How satisfied are you with ...";

2. *Questions about perceptions* asked the employees for a description of some aspects of their work. They usually start with "How often does it happen that..." (Examples: "How often does your manager expect a large amount of work from you?", "How often do you feel stressed?");

3. *Questions about personal goals and beliefs* asked the employees for some characteristics of their ideal job (regardless of the job they had at that moment) and about general issues in business. They usually start with "How important is it to you that..." (for personal goals) or are of the type "Fact A usually does more harm than good" (for beliefs), where Fact A is something like competition between employees or higher participation of employees (compared to managers) in the decision-making process.

4. *Questions about demography* asked the employees for their age, gender, years of education, years within IBM and so on.

Given that the interest lies in representing values (the most rooted mental programs in our mind) Hofstede understood that questions about personal goals and beliefs had to be his main source. This is because they reflected the contribution of the person much more than the contribution of the situation, to which questions about perceptions and satisfaction are devoted more. For this reason, he skimmed the questions even more: only 63 of them were selected, and among these a big role is played by those on personal goals and beliefs; which regarded job content, wages and other rewards, personal relations, and security and comfort in the company and in life in general.

1.3.3 Data Manipulation

The 63 questions just mentioned are all questions either whose answer ranged between 1 (= of utmost importance) and 5 (= of little or no importance) or whose answer had to be selected in a nominal scale, with the exception of questions about demography. For the latter to be turned into numbers, Hofstede computed percentages of respondents who chose each alternative. The scales are only ordinal, and not cardinal, so that differences in absolute values between them are meaningless. Hofstede retained only answers from the marketing-plus-service division at this point and paid attention to make the country where they came from clearly visible. When inspecting the dataset, he noticed that answers differed a lot one another when occupation was taken into account. This makes sense: occupation is correlated with a lot of factors (for example, gender, age and education) that may play an important role in determining the answers. Thus, he created the following 7 occupational categories:

1. Managers of the country head office;
2. Managers of the branch offices (including sales, system engineering and customer engineering);
3. System engineers;
4. Data processing sales representatives;
5. Data processing customer engineers;
6. Office products customer engineers;
7. Administrative personnel and staff.

He computed the averages of answers for these seven categories and then obtained the value of each country through an average of these averages, regardless of the effective number of respondents.[3] After controlling for occupation, he found no significant differences of gender, age or education in the data and decided to drop all the countries for which at least 4 of the previous 7 categories had less than 8 respondents. Because of that, he was left with 50 countries (combining the two waves of the survey) plus 3 geographical regions (Arabic speaking, East Africa and West Africa) for

[3] Since the scales for the answers cannot be interpreted as cardinal scales, the median should have been computed instead of the average. However, Hofstede found out that for all questions the mean and the median differed for at most 0.1, so he decided to use the means for a reason of simplicity in calculations.

a total number of 72,215 respondents. Even if the total number of respondents varied a lot among countries, there was no evidence that smaller size meant smaller reliability (see G. Hofstede, 1983).

Furthermore, he investigated on those countries who have been analysed in both the waves of the survey. He found out that 5 out of 63 questions showed inconsistency in the two waves (i.e., a significant difference in the country mean answers at aggregate level), so that he decided to drop them. He was left with the 58 questions that can be found in G. Hofstede (2001), Appendix 1, Parts A and B. In particular, questions A1, A2, A56 and A57 are demographic questions; questions A19-A32 plus A58 are about satisfaction; questions A37, A43, A48, A52, A55, B39, B44, B46, B47, B49 and B51 are about perceptions and finally questions A5-A18, A54, B9, B24, B25 and B52-B61 asked for personal goals and beliefs.

Finally, he noticed that that the questions on work goal importance (A5-A18 from above) suffered from *acquiescence*, which is the tendency to give a positive answer to all questions, regardless of their content. This phenomenon (also called "yes-manship") is particularly evident in less-educated and lower-status employee categories and this occurs for two main reasons: the will of lower-ranked employees to please their bosses (who designed and administered them the questionnaire) and the fact that they are not able to distinguish much clearly between the different goals. To get rid of this, Hofstede decided to standardize the answers by computing categories' means first (i.e., the mean answer to each question for each of the seven categories reported above) and by standardizing across goals then. This process was enough since there was no importance in the absolute score of a single goal: the only thing that mattered were comparisons, and standardization preserves both the standing and relative distances. The rest of the answers was instead kept in raw form.

1.3.4 The Derivation of Dimensions

With Inkeles and Levinson's idea stuck in his mind, Hofstede started to inspect more deeply the 58 questions mentioned above. From the very first peeks, it was clear that questions dealing with hierarchical relationships differed systematically across countries. In particular, the biggest differences were noted for question "How frequently, in your experience, are employees afraid to express disagreement with their managers?" (B46). Hofstede performed a correlation analysis with the other questions, and found out strong correlations with questions (A54) and (A55). These questions listed four different types of managers in descending order of author-

itarianism and asked the respondents for the perceived (at that time) and preferred type in their opinion. So, Hofstede hypothesized the existence of a dimension related to dealing with authority that was strongly dependent on these questions, and called it *Power Distance*.

As for reaction to conflict instead, Hofstede noted important differences across countries in question "How often do you fell nervous or tense at work?" (A37), and later discovered strong correlations of this question with questions "How long do you think you will continue working for this company?" (A43) and "To which extent do you personally agree or disagree with the fact that company rules should not be broken, even when the employee thinks it is in the company's best interest?" (B60). The latter questions express quite clearly the idea that "things have to go on as they have always gone on" and stress is also directly related to big changes in life. For this reason, Hofstede hypothesized the existence of another dimension, directly related to this three questions, and called it *Uncertainty Avoidance*.

Finally, as for the conception of self, Hofstede was not really able to identify any pattern in the remaining questions a priori. Nevertheless, he understood that much had to do with questions (A5)-(A18) about work goal beliefs. So, he tried to use factor analysis on these questions without any previous reasoning. He found out that the first two factors accounted evenly for 50% of total variance in the answers.

The first factor presented significantly positive loadings for questions:

- (A18): "How important is it to you to have a job which leaves you sufficient time for your personal or family life?"
- (A13): "How important is it to you to have considerable freedom to adopt your own approach to the job?"
- (A5): "How important is it to you to have challenging work to do - work from which you can get a personal sense of accomplishment?"

and significantly negative loadings for questions:

- (A9): "How important is it to you to have training opportunities (to improve your skills or to learn new skills?"
- (A12): "How important is it to you to have good physical working conditions (good ventilation and lighting, adequate work space, etc.)?"
- (A17): "How important is it to you to fully use your skills and abilities on the job?"

Hence, the first factor is directly dependent on goals stressing independence from the organization and inversely proportional to the importance that employees attribute to what the company does for them, so to suggest an *Individualism versus Collectivism* dimension.

The second factor instead presented significantly positive loadings for questions:

- (A16): "How important is it to you to have a good working relationship with your manager?"
- (A8): "How important is it to you to work with other people who cooperate well with one another?"
- (A6): "How important is it to you to live in an area desirable to you and your family?"

and significantly negative loadings for questions:

- (A7): "How important is it to you to have an opportunity for high earnings?"
- (A11): "How important is it to you to get the recognition you deserve when you do a good job?"
- (A15): "How important is it to you to have an opportunity for advancement to higher level jobs?"

Thus, the second factor is directly dependent on goals stressing interpersonal relations at work and well-being in general, and inversely proportional to ego-related goals like earnings and working career, so to suggest a *Social versus Ego* dimension.

1.3.5 Putting the Four Dimensions Together

In order to support even more the significance of the four dimensions so derived (two through reasoning, two through factor analysis), Hofstede decided to run another factor analysis. This time, he used all the elements of the survey and, after having trimmed down the demographic questions and adjusted some items (like questions A54 and A55, whose answers are percentages), the analysis produced the results summarized in Tables 1.1, 1.2 and 1.3 after orthogonal varimax rotation.

Table 1.1: Factor 1 (24% of total variance)

Loading	Question	Description
0.82	A18	Importance personal time
0.82	B53	Earnings better than interesting work
0.78	B52	Corporation not responsible for employees
-0.76	A55	Low percentage perceived manager 1 or 2
0.75	B46	Employees not afraid to disagree
0.74	A54	High percentage preferred manager 3
0.69	B59	Staying with one company not desirable
0.63	B56	Employees should not participate more
-0.62	A12	Low importance physical conditions
-0.61	A9	Low importance training
0.59	A13	Importance freedom
0.59	B55	Employees respect consultative managers
0.59	B24	Does not prefer foreign company
-0.58	A17	Low importance use of skills
0.41	A5	Importance challenging work
0.37	B58	Corporation not responsible for society
-0.35	A15	Low importance advancement

Factor 1 contains both the Power Distance dimension (questions A55, B46 and A54) and the Individualism/Collectivism dimension (questions A18, A12, A9, A13, A17, A5). Factor 2 instead contains the social/ego dimension (questions A16, A7, A8, A11, A6, A15). Finally, Factor 3 contains the Uncertainty Avoidance dimension (with reversed sign, questions B60, A37, A43). Thus, the existence of the four dimensions found support and consistency so that the model was established. However, I don't discuss here how indexes have been computed because the ways of doing that have been refined with time. In fact, Hofstede produced different versions of the original IBM survey: they are called *Values Survey Modules* (VSM) and they have been published in 1980, 1982, 1994, 2008 and 2013. In Hofstede's opinion, each version is an improvement of the previous, so that I am going to discuss in Section 1.4 only the most recent edition, the VSM 2013.

Table 1.2: Factor 2 (13% of total variance)

Loading	Question	Description
-0.71	A16	Low importance manager
0.68	A7	Importance earnings
-0.67	A8	Low importance cooperation
0.60	A11	Importance recognition
0.54	A5	Importance challenging work
-0.53	A6	Low importance desirable area
-0.51	A14	Low importance employment security
-0.46	A37	High stress
-0.45	B57	Individual decisions better
0.43	A17	Importance use of skills
0.39	A15	Importance advancement
-0.35	B52	Corporation responsible for employees
-0.35	B58	Corporation responsible for society

Table 1.3: Factor 3 (12% of total variance)

Loading	Question	Description
0.76	B60	Company rules may be broken
0.62	A37	Low stress
0.59	A43	Continue less than 5 years at IBM
0.56	B9	Prefers managerial to specialist career
-0.50	B57	Individual decisions better
0.49	A6	Does not prefer managers of own nationality
0.49	A58	Low overall satisfaction
0.46	A15	Importance advancement
-0.46	B55	Employees don't respect consultative managers
0.45	B54	Competition not harmful
-0.43	A9	Low importance training
-0.35	A10	Low importance benefits

1.3.6 Developments in the 1980s and the 2000s

The first version of the Hofstede Model, with the four dimensions mentioned before, was published extensively in G. Hofstede (1980). At that point, Hofstede was open to new developments in social sciences but also knew that if any new dimension had been added to the model, it would have had to be both conceptually and statistically independent from those already computed. The first challenge came thanks to the work of Michael Harris Bond, a Canadian scientist based at the University of Hong Kong. Bond wondered whether the IBM survey, which was developed entirely in Western countries, might have forgotten some important cultural traits that emerge elsewhere more clearly. Because of that, he told to some of his Chinese co-workers to develop a questionnaire similar to Hofstede's one. He expected them to create questions which take into account some aspects of life that have not been considered by Hofstede and his colleagues while they were analysing the IBM environment.

The questionnaire was developed during the early 1980s and then administered in Eastern and Western countries up to 1987 to samples of university students matched by age and gender. A complete overview of the answers with some comments can be found in Chinese Culture Connection (1987). The main result was the creation of a database called *Chinese Values Survey* (CVS), which showed the same number of dimensions of the Hofstede Model. In G. Hofstede and M. H. Bond (1988), the two scientists found that three of the four dimensions from the CVS were highly correlated[4] with three of the Hofstede's dimensions: no counterpart was found only for Uncertainty Avoidance. Instead, a new dimension emerged. It was named *Long-Term Orientation* because countries' scores on that correlate significantly with economic growth in the preceding 25 years.

This dimension is based on survey questions that remind of the philosophical school of thought known as Confucianism, because it counterposes the importance of persistence, perseverance and thrift with a widespread sense of shame in life to the importance of personal stability, respect for tradition and reciprocation of gifts, favours and greetings. These themes were absent in the IBM questionnaire because they were con-

[4] Hofstede worked out correlations between countries' scores for his dimensions and national-level data coming from other studies with either the usual Pearson coefficient (which measures linear correlations) or the Spearman rank coefficient (which measures monotonic correlations). Since this chapter has a descriptive function, I avoid reporting here the exact coefficients (which can be found in G. Hofstede, 2001, Appendix 6 and in the footnotes of G. Hofstede, G. J. Hofstede and Minkov, 2010) from now on, and I only say whether these significant correlations ($p < 0.05$) are strong or weak.

sidered unimportant by its designers. Unfortunately, only 23 countries were analyzed in the CVS (the majority belonging to South-East Asia) and further extensions to other countries were of doubtful consistence.

The situation came to a breakthrough only in recent years thanks to the Bulgarian linguist and polyglot Michael Minkov, based at Varna University of Management and International University College, Bulgaria (see Minkov, 2007). His exploration of the *World Values Survey* (WVS) is one of the most important for cross-cultural studies. The WVS is a dataset containing answers to questionnaires that cover more than 100 countries worldwide with 360 forced-choice items. They are usually delivered every ten years to national representative samples and ask them about ecology, economy, education, emotions, family, gender and sexuality, government and politics, happiness, health, leisure and friends, morality, religion, society and nation, and work. The entire dataset is available for free on the web at `https://www.worldvaluessurvey.org/wvs.jsp` and it had not been created yet when Hofstede started to investigate IBM.

At this point, there seems to be a problem: is it good to combine dimensions derived from IBM (i.e., from small matched samples with limited variability) with dimensions derived from the WVS (i.e., from large nationally-representative samples)? In Minkov (2012, Secc. 7.1, 8.1), he argues that this is not really an issue for more than one reason. First, it must be reminded that the aim is to compare countries, so that it is much more important that measurements occur in the same way across countries for each dimension. Second, Minkov cites a work that claims for the consistence between matched and representative samples. This is Straus (2009), who argues that the consistence is due to the *National Context Effect*: the idea that each national context influences the inhabitants of that country much more than any other demographic trait. Third, replications of Hofstede studies on larger samples had already been carried out from 1990s onward, and they did not show any relevant contradiction. Some of them will be described in Section 1.5.1.

In his analysis, Minkov found three dimensions. One was strongly correlated with Individualism versus Collectivism, another was negatively correlated with Long-Term Orientation as it is in Bond's CVS, and the last did not show any correlation with the previously existent dimensions. The second of these finds its roots in the positive correlation between being proud of the own national citizenship and strong religiousness, which holds in all continents. Pride is related to personal stability because it is a self-enhancing feeling and religiousness is related to respect for traditions because they both deal with the permanence of values and beliefs. Personal stability and respect for traditions collocate on the short-term side of

Bond's dimension from the CVS. Counterparts for thrift and the reciprocation of favours were also found since the WVS contained a question on how much thrift is a desirable trait for children and a question on how much important it is to make a service to a friend. Then, the scores of countries for the Long-Term Orientation dimension were updated and republished, with an important increase in the number of reliable measurements.

Finally, the last dimension was added to the Model with the name of *Indulgence versus Restraint*. This dimension deals with happiness (or subjective well-being, as academics prefer to call it) both in terms of how people evaluate their own life and how they describe their own feelings. The three main questions that determine differences among countries ask the respondents how much happy they are with their own life (evaluating all things together), how much freedom of choice and control they have over the course of their own life and how much important it is for them to have time for leisure. On one extreme point of this dimension there are those people who enjoy living, perceive a wide freedom in acting and believe that happenings are under their control; on the other extreme point there are those people who feel that actions are restrained by societal norms and believe that spending time in leisure is somehow wrong. In the next section, I describe the six dimensions more precisely.

1.4 The six Dimensions Explained

In this section, I report Hofstede's definitions of the six dimensions already mentioned, the most recent way that is used to compute indexes for them, and some interesting correlations involving the scores that have been found from the 1980s onwards. It is important to say that in formulas to compute indexes, the constants are not explicitly reported: Hofstede used them to make values range approximately between 0 and 100, but absolute values are meaningless so that another constant could have been used. I will refer totally to material in G. Hofstede (2011), G. Hofstede, G. J. Hofstede and Minkov (2010), and G. Hofstede and Minkov (2013a,b).

1.4.1 Power Distance

The definition of Power Distance can be found in G. Hofstede, G. J. Hofstede and Minkov (2010, p.61) and is given as follows. In the definition, the term "institutions" refers to the basic elements of society (family, school and community) while "organizations" refers to the places where people work:

Power Distance can be defined as the extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally.

Hofstede has not been the first to recognize the importance of relationships between bosses and subordinates in hierarchical contexts. Indeed, the creation of the term *Power Distance* is due to the Dutch psychologist Mauk Mulder (see Mulder, 1976, 1977). In particular, he was the first at discovering that the mere exercise of power gives satisfaction, so that more powerful individuals strive to maintain and increase their power with respect to less powerful people and vice versa.

In the Values Survey Module 2013, the Power Distance Index is computed with the following formula, where $\mu(q07)$ is the average score for question 07 and so on:

$PDI = 35 \times (\mu(q07) - \mu(q02)) + 25 \times (\mu(q20) - \mu(q23)) + C(PDI)$, where:

- (q07): "In choosing an ideal job, how important would it be to you to be consulted by your boss in decisions involving your work?" has answers ranging from 1 (= of utmost importance) to 5 (= of little or no importance);
- (q02): "In choosing an ideal job, how important would it be to you to have a boss (direct superior) you can respect?" has answers ranging from 1 (= of utmost importance) to 5 (= of little or no importance);
- (q20): "How often, in your experience, are subordinates afraid to contradict their boss (or students their teacher)?" has answers ranging from 1 (= never) to 5 (= always);
- (q23): "To what extent do you agree or disagree with the following statement: *An organization structure in which certain subordinates have two bosses should be avoided at all cost*" has answers ranging from 1 (= strongly agree) to 5 (= strongly disagree).

So, the PDI increases when the preference for a respectable direct superior, the preference for an organization where there is a unique boss and the perceived fear of contradicting the boss increase, and when the preference for a consultative boss decrease (and vice versa).

In Table 1.4 there are some differences between countries with small PDI and countries with high PDI. They refer to correlations performed after the first publication of Hofstede Model: some of them validate the dimension from a logical point of view too.

Table 1.4: Ten Differences between Small- and Large-PDI Countries

Small Power Distance	Large Power Distance
Use of power is rare and must be legitimated	Use of power is frequent and need not be legitimated
Children are equally treated by parents	Children are taught obedience by parents
No particular role for or feeling from older people	Respect for, fear from and obedience to older people
Student-centered education: students are expected to find their own intellectual path	Teacher-centered education: teachers are "guru" who convey mostly personal truths
Hierarchy in society reflects role inequalities	Hierarchy in society reflects existential inequalities
Subordinates expects to be consulted when important decisions have to be made	Subordinates expects to execute orders that come from the boss without questioning
Governments are pluralist and change with elections	Governments are autocratic and change with revolutions
Corruption is scarce and politicians cannot afford scandals	Corruption is frequent and politicians are immune to scandals
Rather even income distribution	Very skewed income distribution
Equality of believers in religions	Hierarchy of priests in religions

PDI values for 76 countries can be found in G. Hofstede, G. J. Hofstede and Minkov (2010, pp. 57-59): countries in South-East Asia, Central-East Europe and Central-South America display the highest values, while English-speaking and Germanic Western countries show the lowest ones.

1.4.2 Uncertainty Avoidance

The definition for Uncertainty Avoidance can be found in G. Hofstede, G. J. Hofstede and Minkov (2010, p. 191) and is given below.

Uncertainty Avoidance can be defined as the extent to which the members of a culture feel threatened by ambiguous or unknown situations.

Such a feeling manifests, at collective level, through stress and need for predictability (in terms of both written and unwritten rules). Also, it is important to say that Uncertainty Avoidance aims at reducing ambiguous situations, which are different from risky situations. This distinction is well-known to economists but probably not to the ordinary person: risky situations are those where there is a certain set of possible outcomes, each of which has a certain probability to occur. Instead, ambiguous situations are those were these probabilities are not known, and even the set of possible outcomes may be unknown. Quite interestingly, strongly uncertainty-avoiding cultures tend to engage in risky behaviours (possibly in order to avoid higher levels of ambiguity) more than uncertainty-accepting cultures. An example on maximum speed on motorways and traffic death rates can be found in G. Hofstede (2001, p. 199).

In the Values Survey Module 2013, the Uncertainty Avoidance Index is computed with the following formula, where $\mu(q18)$ is the average score for question 18 and so on:

$UAI = 40 \times (\mu(q18) - \mu(q15)) + 25 \times (\mu(q21) - \mu(q24)) + C(UAI),$ where:

- (q18): "All in all, how would you describe your state of health these days?" has answers ranging from 1 (= very good) to 5 (= very poor);
- (q15): "How often do you feel nervous or tense?" has answers ranging from 1 (= always) to 5 (= never);
- (q21): "To what extent do you agree or disagree with the following statement: *One can be a good manager without having a precise answer to every question that a subordinate may raise about his or her work*" has answers ranging from 1 (= strongly agree) to 5 (= strongly disagree);
- (q24): "To what extent do you agree or disagree with the following statement: *A company's or organization's rules should not be broken - not even when the employee thinks breaking the rule would be in the organization's best interest*" has answers ranging from 1 (= strongly agree) to 5 (= strongly disagree).

So, the UAI increases when tension, irritability and the preference for the respect of rules above all increase, and when the general health and the belief that good managers are only those who have a precise answer for everything decrease (and vice versa).

In Table 1.5 there are some differences between countries with small UAI and countries with high UAI. They refer to correlations performed after the first publication of Hofstede Model: some of them validate the dimension from a logical point of view too.

Table 1.5: Ten Differences between Weak- and Strong-UAI Countries

Weak Uncertainty Avoidance	Strong Uncertainty Avoidance
People accept inherent uncertainty in life and tend to take each day as it comes	People feel threatened by inherent uncertainty in life and tend to fight against it
People show higher ease, self-control and rationality	People show higher neuroticism, anxiety, stress and emotionality
Higher self-reported health and general well-being	Lower self-reported health and general well-being
People tolerate deviant ideas and persons and are curious about what they don't know	People don't tolerate deviant ideas and persons and fear what they don't know
Absence of structure or clarity is not a big deal	Need for structure and clarity is widespread
Bosses and teachers may be doubtful and unsure	Bosses and teachers are supposed to have all the answers
Resignations to change job position are quite common	Job positions are held for longer time, even if disliked
People tend to dislike rules, especially when too strict	People show emotional need for rules, no matter their respect
Citizens feel competent about politics and are seen so by politicians	Citizens feel incompetent about politics and are seen so by politicians
Empiricism and relativism dominate religion, philosophy and science	Grand Theories and Ultimate Truths dominate religion, philosophy and science

UAI values for 76 countries can be found in G. Hofstede, G. J. Hofstede and Minkov (2010, pp. 192-194): countries in South America and Mediterranean plus East Europe display the highest values, while Anglo-Saxon countries, Northern Europe and South-East Asia show the lowest ones.

1.4.3 Individualism versus Collectivism

The definition for Individualism and Collectivism can be found in G. Hofstede, G. J. Hofstede and Minkov (2010, p. 92) and is given below.

Individualism pertains to societies in which the ties between individuals are loose: everyone is expected to look after herself and her immediate family. Collectivism as its opposite pertains to societies in which people from birth onward are integrated into strong, cohesive in-groups, which throughout people's lifetime continue to protect them in exchange for unquestioning loyalty.

It is important to point out that, even if the definition is quite general, countries scores refer only to the Individualism/Collectivism dimension on the job. See Section 1.5.1 for extensions of Individualism/Collectivism outside work. Indeed, in the Values Survey Module 2013, the Individualism Index is computed with the following formula, where $\mu(q04)$ is the average score for question 04 and so on:

$$IDV = 35 \times (\mu(q04) - \mu(q01)) + 35 \times (\mu(q09) - \mu(q06)) + C(IDV),$$

where questions are of the form: "In choosing an ideal job, how important would it be to you to..."

- (q04): "... have security of employment?";
- (q01): "... have sufficient time for your personal or home life?";
- (q09): "... have a job respected by your family and friends?";
- (q06): "... do work that is interesting?"

The answers of all the previous questions range from 1 (= of utmost importance) to 5 (= of very little or no importance). Thus, IDV increases when the preferences for having enough free time and for having an interesting work increase, and when the preference for having a secure and socially-respectable job decreases (and vice versa).

In Table 1.6 there are some differences between individualist countries and collectivist countries. They refer to correlations performed after the first publication of Hofstede Model: some of them validate the dimension from a logical point of view too.

Table 1.6: Ten Differences between Individualist and Collectivist Countries

Strong Individualism	Strong Collectivism
People are expected to take care of themselves and their close relatives only	People spend their lives in extended families who protect them in exchange of loyalty
"I"-consciousness: people to spend time with are chosen according to personal preferences	"We"- consciousness: people to spend time with are not chosen but given by nature at birth
The right to privacy is claimed and recognized	In-group belonging is stressed and privacy comes after
Society thinks highly of people who say what they think	Everyone has to put effort in maintaining in-group harmony
Others categorized as individuals	Others classified as in-/out-group
Opinions and votes are personal and everybody has their own	Opinions and votes are predetermined in the in-group
People feel guilty when they don't respect norms	People feel ashamed when they don't respect norms
The word "I" is common and much used in language	The use of word "I" is avoided in language
Children are taught how to learn, so that they can be independent as soon as possible	Children are taught how to do, so that they can fulfil at best their preassigned role in society
Tasks prevail over relationships	Relationships prevail over tasks

IDV values for 76 countries can be found in G. Hofstede, G. J. Hofstede and Minkov (2010, pp. 95-97): Anglo-Saxon and Northern-Europe countries display the highest values while South-America and countries in the far east have the lowest values, with South and Central Europe and Arab countries in between. Notable differences are Italy, France and Hungary (which score high) and Pakistan (which scores very low).

1.4.4 Masculinity versus Femininity

The definition for Masculinity and Femininity can be found in G. Hofstede, G. J. Hofstede and Minkov (2010, p. 140) and is given as follows:

A society is called masculine when emotional gender roles are clearly distinct: men are supposed to be assertive, tough, and focused on material success, whereas women are supposed to be more modest, tender, and concerned with the quality of life. A society is called feminine when emotional gender roles overlap: both men and women are supposed to be modest, tender, and concerned with the quality of life.

The reason for the name of this dimension is that in Hofstede's first analysis on IBM employees this was the only dimension in which males and females respondents scored substantially different.[5] So, no stereotyping is involved in name assignation: in masculine countries, there exist males who behave in a feminine way, and in feminine countries there exist females who behave in a masculine way.

Once again, the definition is quite general, but countries scores refer only to the Masculinity/Femininity dimension on the job. Extensions of this dimension outside work are explored in Section 1.5.1. Indeed, in the Values Survey Module 2013, the Masculinity Index is computed with the following formula, where $\mu(q05)$ is the average score for question 05 and so on:

$$MAS = 35 \times (\mu(q05) - \mu(q03)) + 35 \times (\mu(q08) - \mu(q10)) + C(MAS),$$

where questions are of the form: "In choosing an ideal job, how important would it be to you to..."

- (q05): "... have pleasant people to work with?";
- (q03): "... get recognition for good performance?";
- (q08): "... live in a desirable area?";
- (q10): "... have chances for promotion?"

The answers of all the previous questions range from 1 (= of utmost importance) to 5 (= of very little or no importance). Thus, MAS increases when the preference for a job that recognizes effort with promotions increases, and when the preferences for having pleasant colleagues and a living environment decrease (and vice versa).

[5] This is actually true for the whole world except Scandinavia. Sweden, Norway, Denmark and Finland display four of the last nine values of MAS and no significant difference between the answers of male and female respondents emerges. Furthermore, the three Baltic Republics (Estonia, Lithuania and Latvia) are also very feminine countries, but with gender differences among the answers.

In Table 1.7 there are some differences between masculine countries and feminine countries. They refer to correlations performed after the first publication of Hofstede Model. As usual, some of them validate the dimension from a logical point of view too.

Table 1.7: Ten Differences between Masculine and Feminine Countries

Strong Masculinity	Strong Femininity
Emotional and social differentiation of genders is exasperated	Emotional and social differentiation of genders is limited
Men should take care of performance; women should be tender and take care of relationships	Men and women should both be tender and take care of both performance and relationships
Big and fast are beautiful and people admire the strong	Small and slow are beautiful and people sympathize with the weak
Work prevails on family and close relationships	There is balance between family / close relationships and work
People are ego-oriented: money and things are important	Both sexes deal with feelings and quality of life is important
Girls cry, boys don't; boys should fight back, girls shouldn't	Both boys and girls cry but neither should fight
Fathers decide how many children to have	Mothers decide how many children to have
Few women are managers or hold an elected political position	More women are managers or hold an elected political position
Emotional stability is secondary in people's health and lower norms protect it	Emotional stability is central in people's health and higher norms protect it
Sex is a way of performing, moralistic attitude towards it	Sex is a way of relating, practical attitude towards it

MAS values for 76 countries can be found in G. Hofstede, G. J. Hofstede and Minkov (2010, pp. 141-143). For the first time, there is not a clear role for geography in determining the standings, except for Scandinavia (whose situation has already been discussed) and the Muslim world (whose countries score around the mean). As for the rest, all continents are dispersed along the whole standings.

1.4.5 Long- versus Short-term Orientation

The definition for Long- and Short-term Orientation can be found in G. Hofstede, G. J. Hofstede and Minkov (2010, p. 239) and is given below:

Long-Term Orientation stands for the fostering of virtues oriented toward future rewards — in particular, perseverance and thrift. Its opposite pole, Short-Term Orientation, stands for the fostering of virtues related to the past and present — in particular, respect for tradition, preservation of "face" and fulfilling social obligations.

It has been already mentioned in Section 1.3.6 that Long-Term Orientation reflects the economic growth of countries in the recent past. Quite interestingly, G. Hofstede and M. H. Bond (1988) found that this dimension correlated even more with future economic growth (in the years 1985-1995), so that the existence of a causal arrow from the adoption of long-term oriented practices to economic growth in terms of GDP per capita was supposed (G. Hofstede, 2001, p. 367). This was not confirmed by Minkov's WVS analysis though: he focused on 1995-2005 data and did not find support for the causal effect at the global level (G. Hofstede, G. J. Hofstede and Minkov, 2010, fig. 7.1) but only when focusing on countries that were still poor in 1995. To summarize, the adoption of thrift and perseverance as guidelines of countries' policy seems a good idea to faster economic growth only in poor countries and not in countries that are already wealthy.

In the Values Survey Module 2013, the Long-Term Orientation Index is computed with the following formula, where $\mu(q13)$ is the average score for question 13 and so on:

$LTO = 40 \times (\mu(q13) - \mu(q14)) + 25 \times (\mu(q19) - \mu(q22)) + C(LTO)$, where:

- (q13): "In your private life, how important is it to you to do a service to a friend?" has answers ranging from 1 (= of utmost importance) to 5 (= of little or no importance);
- (q14): "In your private life, how important is thrift (not spending more than needed) to you?" has answers ranging from 1 (= of utmost importance) to 5 (= of little or no importance);
- (q19): "How proud are you to be a citizen of your country?" has answers ranging from 1 (= very proud) to 5 (= not proud at all);
- (q22): "To what extent do you agree or disagree with the following statement: *Persistent efforts are the surest way to results*" has answers ranging from 1 (= strongly agree) to 5 (= strongly disagree).

So, the LTO increases when the importance of persistence and being thrift increase, and when the importance of doing a service to friends and pride for own citizenship decrease (and vice versa).

In Table 1.8 there are some differences between long-term- and short-term-oriented countries. They refer to correlations performed after the integration of this dimension in the Hofstede model. As usual, some of them validate the dimension from a logical point of view too.

Table 1.8: Ten Differences between Long- and Short-Term-oriented Countries

Short-Term Orientation	Long-Term Orientation
Life is present-centred: important events are occurring	Life is future-centred: important events still have to occur
People believe that good persons are always the same and they emphasize stability	People believe that good persons adapt to the circumstances and they emphasize flexibility
Good and evil are concepts with neat borders and do not depend on the circumstances	Good and evil are concepts with fuzzy borders that depend on the circumstances
Traditions are sacrosanct and society evolves to preserve them	Traditions evolve in accordance with changes in society
Life is guided by imperatives	Life is guided by aspirations
People are very proud to be citizens of their country	People try to learn from citizens of other countries
Making services to others is considered very important	Perseverance and thrift are considered very important
Countries spend a lot in the social and their citizens consume a lot	Countries invest a lot and their citizens save a lot
Students believe that success and failure depend on luck	Students believe that success and failure depend on effort
Economies of poor countries grow slowly or don't grow	Economies of countries grow fast up till a prosperity level

LTO values for 93 countries can be found in G. Hofstede, G. J. Hofstede and Minkov (2010, pp. 255-258): the Far East and Eastern-Europe countries display the highest values while South-American, Anglo-Saxon and African countries have the lowest values.

1.4.6 Indulgence versus Restraint

The definition for indulgent and restrained societies can be found in G. Hofstede, G. J. Hofstede and Minkov (2010, p. 281) and is given below:

Indulgence stands for a tendency to allow relatively free gratification of basic and natural human desires related to enjoying life and having fun. Its opposite pole, restraint, reflects a conviction that such gratification needs to be curbed and regulated by strict social norms.

It has been already mentioned in Section 1.3.6 that this dimension deals with the subjective well-being of people. For many years, the academic world has expressed doubts on happiness measurement. As reported in Veenhoven et al. (1993, Sec. 4.2), it was believed that people have no idea about their appreciation of life, so that they report to be satisfied with it just to look good. This widespread thought reversed in the 1990s because it was proved that people actually ask themselves very often if they are happy with their life and no systematic overstatements of happiness were found. Nevertheless, caution in measurements is still needed. Comparisons with others, the past or other ways of life and summed life-aspect satisfactions have to be avoided. As E. Diener and M. Diener (1995) have shown, economic stability is a determinant of well-being in poor nations only, while family and friendship satisfaction matter in rich countries only.

In the Values Survey Module 2013, the Indulgence versus Restraint Index is computed with the following formula, where $\mu(q12)$ is the average score for question 12 and so on:

$IVR = 35 \times (\mu(q12) - \mu(q11)) + 40 \times (\mu(q17) - \mu(q16)) + C(IVR)$, where:

- (q12): "In your private life, how important is moderation (having few desires) to you?" has answers ranging from 1 (= of utmost importance) to 5 (= of little or no importance);
- (q11): "In your private life, how important is it to you to keep time free for fun?" has answers ranging from 1 (= of utmost importance) to 5 (= of little or no importance);
- (q17): "Do other people or circumstances ever prevent you from doing what you really want to?" has answers ranging from 1 (= yes, always) to 5 (= no, never);
- (q16): "Are you a happy person?" has answers ranging from 1 (= always) to 5 (= never).

So, the IVR increases when the importance of leisure and the frequency of happiness increase, and when the importance of moderation and the frequency of actions avoided due to others decrease (and vice versa).

In Table 1.9 there are some differences between indulgent and restrained countries. They refer to correlations performed after the integration of this dimension in the Hofstede model. As usual, some of them validate the dimension from a logical point of view too.

Table 1.9: Ten Differences between Indulgent and Restrained Countries

Indulgent	Restrained
High percentages of people self-report that they are very happy	Very few people self-report that they are very happy
People believe that what happens in their life depends for the majority on their own	People believe that what happens in their life usually does not depend on their will
Freedom of speech is considered very important	Freedom of speech is not a primary issue
Leisure is seen as vital	Leisure is not seen as vital
People remember positive emotions more frequently	People remember negative emotions more frequently
Countries with educated population exhibit high birthrates	Countries with educated population exhibit low birthrates
Countries with enough food have higher rates of obese people	Countries with enough food have lower rates of obese people
More people do physical activity more often	More people don't do physical activity very often
Wealthy countries promote tolerant sexual norms	Wealthy countries promote strict sexual norms
Low priority is given to maintaining order in the nation	Very high rates of police officers over the total population

IVR values for 93 countries can be found in G. Hofstede, G. J. Hofstede and Minkov (2010, pp. 282-284): South-America, North-Europe and Anglo-Saxon countries display the highest values while ex-soviet and Muslim countries have the lowest scores.

1.5 Relationships with other analyses

In this section, which closes the first chapter, I am going to discuss why the Hofstede model has found great support in the academic world through some papers that claim for the meaningfulness of the single dimensions as they have been defined in Section 1.4, and some others that have tested the model's whole structure on matched samples composed by people that were not IBM employees. Then, I present how the model relates to the analysis at individual level by explaining the Big Five Personality Test. Finally, I conclude by mentioning the most relevant criticisms that have been made to the model and how Hofstede replied to them.

1.5.1 Validations

The tables in Section 1.4, which report differences between countries at the extremes of each dimension, include some features that increase their meaningfulness because they resemble the dimensions in contexts that have nothing to do with the IBM setting.

For the Power Distance Index one of the most important is the way in which governments change (peacefully versus with riots), because this says whether people expect and try to get in contact with those who hold the power. An important reference can be found in Inglehart (1990), who discovered that, across 17 developed countries, the agreement with the sentence "The entire way our society is organized must be radically changed by revolutionary actions" for representative samples of the populations correlated positively and significantly with PDI. Another important feature is what children need to learn (in terms of independence versus obedience), because this shows if from a very young age people are trained to avoid questioning. This refers to Inglehart, Basanez and Moreno (1998), who discovered that, across 26 countries worldwide, parents' agreement with the sentence "Children should be taught obedience (resp. independence)" for representative samples of the populations correlated positively (resp. negatively) and significantly with PDI. Finally, there is the frequency and legitimacy of the use of power, for obvious reasons. In Van de Vliert et al. (1999), a Domestic Political Violence Index computed for 50 countries worldwide as the sum of the numbers of violent political riots and armed attacks correlated positively and significantly with PDI.

For the Uncertainty Avoidance Index, among the most important features there is the need for structure and clarity in procedures and companies, which is naturally linked to the fear for ambiguous contexts. A

study on that can be found in Laurent (1978). In this article, 635 people who declared to work as managers were tested across nine Western-European countries plus the USA on five sentences related to high effort in conflict elimination, high control over subordinates and strong respect for hierarchical line. Laurent found out that percentages of agreement with the facts just mentioned correlated positively and significantly with UAI. Second comes the spread of neuroticism as a symptom of stress in the population, which is directly linked to question q15 of the VSM 2013. In Lynn and Hampson (1975), the two scientists computed an index for neuroticism using already available national rates of divorce, illegitimacy, accident, murder, suicide, alcoholism, chronic psychosis, coronary heart disease, and the per capita consumption of calories, cigarettes and caffeine through a factor analysis for wealthy countries. They found out that the resulting scores correlated positively and significantly with UAI. Eventually there is the fear for what is somewhat deviant or different from the usual. This refers to Eurobarometer (1997), which is a study of the European Commission on racism and xenophobia in EU countries at that time. It shows that percentages of representative samples of populations who agree with sending immigrant, illegal and unemployed people back to their home country correlate positively and significantly with UAI.

For the Individualism Index, an important reference is Smith, Trompenaars and Dugan (1995). These scientists showed that for a sample of more than 8,000 workers of oil or hosiery industry that was balanced for job position across 35 countries, the percentage of respondents that stresses the importance of personal relationships over making plans and have them working out is negatively and significantly correlated with IDV, so to show that opposing the individual to the community is meaningful. Then, there is the respect and development of human rights, which can be found in Humana (1992). In this guide, 90 countries with more than one million inhabitants in all continents have been evaluated with a rating on the basis of 40 fundamental rights and freedoms. It appeared that the rating correlated positively and significantly with IDV scores for countries where the latter are available. This correlation was even stronger when only wealthy countries were considered. In the end, the use of words "I" and "we" in languages is also important because it reflects whether people have an "I" or a "We" consciousness. The main analysis on that is E. S. Kashima and Y. Kashima (1998), who have investigated on languages' allowance to omit the first-person singular pronoun from a sentence when speaking about themselves. They discovered that this allowance correlates negatively and significantly with IDV scores.

For the Masculinity Index, the preferences of salary over shorter working is of undoubtful importance, because it enhances the importance of money over leisure. A reference on this can be found in CCE (1978), which is a public opinion survey sponsored by the European Commission where about 9,000 representative respondents in the then nine EU countries were asked whether they preferred an increase in the salary for the same number of hours worked or a decrease in the number of hours worked for the same salary, if the economic situation of the country were to improve so that the standard of living were to raise. Preferences for an increase in the salary correlated positively and significantly with MAS values. Second, there is McGee (1977), who ran a public opinion survey on over 7,000 respondents in six EU countries. He asked them in what size enterprise they would prefer to work. The mean preferred size scores for the six countries were positively and significantly correlated with MAS, so to confirm the masculine preference for big and powerful. Finally, there is Schwartz (1992, 1994), who asked to elementary school teachers what they try achieve in their own lives and what they try to convey to their students. For a set of 23 countries, the percentage of teachers that stressed the importance of ambition, success and of the choice of personal goals correlated significantly and positively with MAS. So, the great importance of being motivated towards success in masculine societies is confirmed, also because even the children are trained to it.

For the other two dimensions (the most recent ones), fewer confirmatory studies are available, though some of them are important. For the Long-Term Orientation Index, an important feature is citizens' savings, because they tell us whether people give a higher importance to the future or to the present. In Read (1994) it is possible to see that the ratio between the change in real per-capita gross domestic savings and the sum of this with the change in consumption correlates positively and significantly with LTO scores for 15 Western countries. Furthermore, there is G. Hofstede, Van Deusen et al. (2002), who surveyed part-time students in Business Administration (Master level) in 17 countries about what the focus of countries' business leaders should be. They found that the percentage of respondents who claimed that profits in a 10-year time horizon have much more importance than the profits in this years correlated positively and significantly with LTO.

In the end, for the Indulgence versus Restraint Index, we have an analysis on the recalling of positive emotions (Kuppens et al., 2006), which is important because it says whether we are happy on a frequent basis and if the saliency of happiness is strong. From a survey of over 9,300 in 48 countries all around the world, they found out that people living in

indulgent countries are much more likely to remember positive emotions than people in restrained countries. Second, the number of police officers per 100,000 inhabitants is also important, because this reflects the importance that both the State and its citizens place onto restraint. Data for such feature can be found in UNODC (2000), and they correlate negatively and significantly with IVR scores. Finally, G. Hofstede, G. J. Hofstede and Minkov (2010, p.291) highlight the importance of friends in general because indulgence means enjoying life and friends provide fun and entertainment. In the WVS, the percentages of respondents who answered "very important" are positively and significantly correlated with IVR.

Last but not least, some researchers have tried to replicate the whole original model with four dimensions on matched samples outside the IBM or on representative samples, while up to date no replication with all the six dimensions seems available. As for replications with matched samples, G. Hofstede, G. J. Hofstede and Minkov (2010, pp. 34-35) present six groups of meaningful studies. They are following in chronological order:

- Hoppe (1990) and Hoppe (1998) interviewed the "elites" of 18 countries (parliamentarians, members of the government, labour and employers' leaders, academics and artists) and found confirmation for all the four dimensions;
- Shane (1995) and Shane and Venkataraman (1996) found confirmation for all the dimensions except Masculinity in employees of six international corporations (IBM was not among these) from 28 countries. Masculinity questions were not administered because they were considered politically incorrect;
- Helmreich and Merritt (1998) and Merritt (2000) confirmed all the four dimensions with a sample of commercial airline pilots from 19 countries;
- Søndergaard (2001) and Mouritzen and Svara (2002) found support for everything except Individualism by considering answers of top municipal civil servants from 14 countries;
- Nimwegen (2002) did not confirm Uncertainty Avoidance but found support for all the other three plus Long-Term Orientation among employees of an international bank from 19 countries;
- Mooij (2004) surveyed consumers from 15 European countries and replicated everything except Power Distance, possibly due to the fact that respondents were not selected on the basis of their job position.

Apart from these, minor replications involving smaller sets of countries can be found in Søndergaard (1994). For each study, it is unrealistic to expect confirmation of the IBM results, but a global review found statistical confirmation of the four dimensions.

As for replications with representative samples, we have already mentioned Minkov (2007)'s work which found confirmation for Individualism and Long-Term Orientation. Furthermore, Inglehart (1997), who has been the first at analysing the WVS for cultural research, found confirmation (on a previous version with respect to Minkov's one) for Power Distance, Individualism and Masculinity.

1.5.2 The Revised NEO Personality Inventory Test

As it was pointed out in Section 1.1, in Hofstede's mindset culture and personality are not completely independent. Despite this, the Hofstede model cannot be used for stereotyping individuals because the correlations among the answers to the IBM questionnaire at country level are not the same as the correlations at individual level within countries (G. Hofstede, 2001, p. 65). This is not paradoxical. For example, in countries with high UAI, there are a lot of stressed people and many who want to stay in IBM for a long time, but these are not the same people. Then, linking culture and personality has been difficult for many years, also because little data on them outside IBM was available.

The situation began to change more or less at the beginning of the new millennium. McCrae and Costa (2003) extensively describe the Revised NEO Personality Inventory Test (NEO-PI-R), which is now used worldwide to trace personality in adulthood. The test is available for free at `https://bigfive-test.com/` and it is composed of 120 multiple-choice questions of immediate comprehension about personal life with answers ranging from "strongly agree" to "strongly disagree". The results of this test are presented in the form of the so-called Big-Five Personality Dimensions, which are described below.

- *Openness to experience versus rigidity* (**O**) counterpoises eccentric people who make pindaric flights to inflexible and close-minded people;
- *Conscientiousness versus undependability* (**C**) counterpoises perfectionism and workaholism to irresponsibility and rashness;
- *Extraversion versus introversion* (**E**) counterpoises excitement and attention seeking to detached coldness and social withdrawal;

- *Agreeableness versus ill-temperedness* (**A**) counterpoises submissive and selfless people to manipulative and callous people;

- *Neuroticism versus emotional stability* (**N**) counterpoises depression and emotional lability to shamelessness and fearlessness.

In the same years, McCrae and Hofstede worked together to see whether it was possible to link the two models. The results are included in G. Hofstede and McCrae (2004) and refer to the first version of the Hofstede model. They analysed 33 countries of the IBM survey for which McCrae was able to derive samples corrected for age and gender from the analysis on personality. The results are summarized as follows.

- Power Distance correlates positively and with high significance with Conscientiousness and negatively with Extraversion. At the same time, it shows a negative and weak correlation with Openness to experience;

- Uncertainty Avoidance correlates strongly and positively with Neuroticism and negatively with Agreeableness;

- Individualism correlates only with Extraversion, but this correlation is the strongest among all;

- Masculinity correlates strongly and positively with Neuroticism, then weakly and positively with Openness to Experience and in the end weakly and negatively with Agreeableness.

Such correlations are not surprising, given the questions administered to IBM employees. In particular, the UAI was computed through self-evaluations of stress and neuroticism, IDV was higher where people tried to seek attention and gratification for their job, it seems logical that the PDI decreases where people are more prone to experiment new solutions and MAS is low where people are less selfish.

Data have been updated during the years and now they can be found in Allik et al. (2017, Appendix), where however they are very close to the one used in G. Hofstede and McCrae (2004). They give a quite strong statistical support to the hypothesis that culture and personality are interconnected, so that also Hofstede's mindset is supported.

1.5.3 Criticisms

The Hofstede model is the starting point of thousands of scientific studies in different fields of knowledge (for an extended review, see Kirkman, Lowe and Gibson, 2006) but is not free of criticisms. Hofstede himself expected criticisms and indeed provided comprehensive replies to his critics. Almost the totality of them can be classified in the lines of criticism described in the following paragraphs (see also G. Hofstede, 2001, p. 73 and Sent and Kroese, 2022).

First, there are those who claim the inappropriateness of Hofstede's methodology. Here we find those who claim that surveys are unsuitable to measure capital differences (McSweeney, 2002), those who maintain that nations are not the best units to study cultures (Baskerville, 2003) and those who affirm that one company is not enough to represent culture at country level (Triandis, 1982 and McSweeney, 2002). In his replies, G. Hofstede (2002, 2003) restates that surveys should not be the only source of data but finding other reliable sources is difficult and up to date nobody has engaged in that. At the same time, nation in surveys is most of the time the only unit available to make comparisons. However, Hofstede himself noticed from the very beginning that multilingual countries (Belgium, Switzerland and Yugoslavia) needed differentiation and computed scores for their parts (see G. Hofstede, 2001, p. 63). Finally, Hofstede claims that the IBM database is sufficient because what he wanted to extrapolate are differences in culture among countries and not scales that clearly says which country has which cultures. This first collection of criticisms do not exhibit empirical confirmation, so that more recent critics have rejected them as well (for example, Minkov and Kaasa, 2021).

Furthermore, there are those who reject some or all the dimensions of the model, either because of theoretical considerations (Trompenaars, 1993; Schwartz, 1994, 1999, the GLOBE project in House et al., 2004) or because of empirical findings from the World Values Survey (Inglehart, Basanez and Moreno, 1998; Minkov, 2017; Minkov and Kaasa, 2021). As for the firsts, Hofstede claims that Schwartz's reasoning delivers seven dimensions which are significantly correlated with his own (G. Hofstede, 2001, p. 511), so that he does not consider Schwartz's theory a valid disconfirmation. Also, Hofstede says that Trompenaars' studies have not been reviewed, so that it is not possible to understand what his database actually contains (G. Hofstede, G. J. Hofstede and Minkov, 2010, p. 43). Finally, for what concerns the GLOBE project, Hofstede replies by criticizing both the complexity of the questionnaire with respect to his own and the fact that questions do not trace the personal preferences of the respond-

ents (i.e., what they desire) but only how they perceive the society or, at most, what is desirable for the whole society (G. Hofstede, G. J. Hofstede and Minkov, 2010, p. 43).

Much more interesting are the criticisms that come from empirical analyses of the WVS. In particular, Inglehart, Basanez and Moreno (1998) finds strong support for Power Distance, Uncertainty Avoidance and Individualism but no support for the rest of the model. Instead, Minkov (2017) and Minkov and Kaasa (2021) find strong support for Individualism and Long-Term Orientation and no confirmation especially for Masculinity and Uncertainty Avoidance. More recently, Beugelsdijk and Welzel (2018) have found a way to integrate Hofstede's original four dimensions and data from the WVS. The synthesis was unsuccessful only for the Masculinity Dimension, which at this point seems clearly the most problematic. Taras, Steel and Kirkman (2012), who updated IBM database with more recent sets of meta-analytic cultural scores, even claim that Hofstede's scores for this dimension will not be connected any more to world's culture between 2020 and 2030 (p.337).

Possibly, the most important problem of Masculinity is that it is context-specific. For example, Merritt (2000), which is considered a validation of Masculinity, did not find it in the will to achieve promotions or a higher wage, because the interviewed pilots already had high income and social status. Instead, he found it in the lower importance attributed to the need of written procedures for all in-flight situations and their respect, so to suggest the existence of a "I can handle everything" arrogance. Nowadays, the academic world places a high importance on the so-called (Conservative) White Male Effect. This is described extensively in Finucane et al. (2000) and refers to the fact that white males have judgements of risks and worldviews that are completely different from those of the other people. This effect is logically linked to Masculinity, so that this dimension still has to be taken into account.

The work of Taras, Steel and Kirkman (2012) also poses the problem of temporal consistency of cultures, another common line of criticism to the Hofstede Model. This is a strong assumption of Hofstede on which there is contradictory evidence. While Kaasa, Vadi and Varblane (2014) and Beugelsdijk, Maseland and Van Hoorn (2015) claim the temporal consistency of Hofstede scores (though only relative positions in the standings are preserved), Inglehart and Baker (2000) and Taras, Steel and Kirkman (2012) suggest that time is slowly but constantly eroding Hofstede's scores up to the point that, if society continue to evolve at the rythm of today, they will not be meaningful any more in short time. This suggests strongly to integrate Hofstede's data with more recent one, whenever possible.

The most widely used source of updated scores is The Culture Factor Group, the operating brand of Hofstede Insights Ltd. This is a Finnish private company which provides strategy advisory to its customers, who need to understand local cultural subtleties and business environments. Updated scores can be found at https://www.hofstede-insights.com/country-comparison-tool. An update occurs any time either a new article on that topic is published on a scientific journal or a new study or commercial project involving their own research team and practitioners is ran. It is possible to see that, with respect to the latest version of the Hofstede scores, some new countries have been added to the dataset. Furthermore, IDV and LTO have been recomputed based on the analysis of the WVS of Minkov and Kaasa (2022). Thanks to that, the scores for IDV now differentiate societies besides what happens at work. In the end, Masculinity has been renamed "Motivation towards Achievement and Success" (with the same label MAS) so to stress the fact that this dimension is linked only to job preferences and to avoid treating gender as a binary concept. Such a change without any update in the scores has been motivated also by the Arab world: its countries are in the middle of the MAS standings even though it is obvious that they are the societies in which the social role differentiation of genders is the maximum in the world. I will use this new name for the MAS dimension in the next chapters and I will call "decisive" (resp. "consensus-oriented") the countries with high (resp. low) score on that, in accordance with the prescriptions of The Culture Factor Group.

Chapter 2

Review of the Literature on Climate Change and Culture

Climate Change (CC hereafter in the whole chapter) is one of the major issues in contemporary world. The 2023 version of the Global Risks Report, a yearly-updated document of the World Economic Forum on the major risks faced by humanity, claims that the four main threats to the world in 10 years are related to it: the failure to mitigate CC, the failure of CC adaptation, natural disasters and extreme weather events, biodiversity loss and ecosystem collapse (WEF, 2023, p. 6). The urgency to act is also highlighted by the Intergovernmental Panel on CC, which says that people are already affected by CC worldwide and that containing the increase in average temperatures on a global scale in 1.5°C within 2030 with respect to the pre-industrial era is the most important goal that humanity needs to achieve (IPCC, 2018). Unfortunately, all the efforts made until now are not enough to achieve the aforementioned goal (OECD, 2019).

In this context, little attention until the last two decades has been given to the cultural dimensions of countries. In this chapter, I am first going to say why culture has a role in determining CC-related choices; then, I am going to present the peer-reviewed literature that has already analysed how the cultural dimension of countries expressed in terms of the Hofstede scores is connected with different types of measures related to CC. The search for literature was conducted on Google Scholar by using as keywords "Hofstede", "climate change", and the names of the six dimensions presented in Section 1.4. In the whole chapter, correlations refer to significant correlations at a level of 0.05.

2.1 How Culture impacts on CC

First of all, while it may seem strange to affirm that the cultural values of societies determine at least partially the differences in the attention they pay to the problem of CC, there is enough evidence in favour of this claim.

The main contributors to CC are the emissions of carbon dioxide and methane due to combustion of fossil fuels (coal, oil, gas), deforestation, and livestock farming (IPCC, 2014). The United Nations claim that the biggest role belongs to carbon and methane emissions, because these account for over 75 per cent of global greenhouse gas (GHG) emissions (UN, 2024a). The pie chart reported in Figure 2.1, which is based on data from the Climate Watch open data platform (WRI, 2024), shows how global GHG emissions are composed. The chart assigns a role to different actors in contributions to CC. Individual households are responsible for the use of energy in residential buildings and for the majority of road transports through the use of private cars (see also EEA, 2022, Figg. 2.2, 3.1);

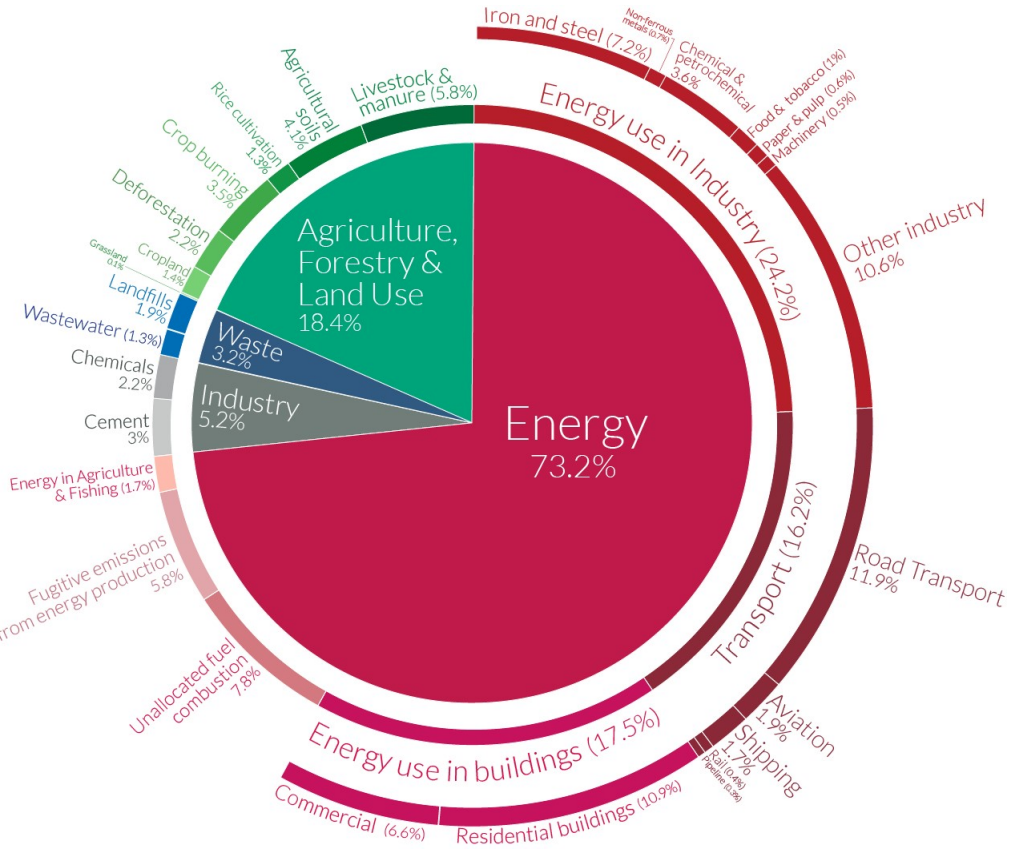

Figure 2.1: The Composition of global GHG emissions, Source: Ritchie (2020)

whereas corporations and firms are responsible for the use of energy in industry and for producing goods that require the use of natural resources or other pollutant goods. What the chart does not show is that corporations also play a big role in transferring environmentally friendly technology and in the education of employees (Shrivastava, 1995). Similarly, governments can influence the choices of individuals and societies through the school system, the implementation of environmental regulations and the promotion of sustainable development (OECD, 2001).

Nowadays, the majority of researchers agree on the fact that culture influences the choices of all these three "actors". In general terms, a review of the channels through which culture affects individual decisions can be found in Yates and De Oliveira (2016). This effect is true in particular when people must provide reasons for their decisions (Briley, Morris and Simonson, 2000). Focusing on CC, the importance of values in determining individual climate action is claimed in Steg (2023, Sec. "Values and Climate Actions"), primarily because values drive the focus and influence the perceived importance and evaluation of the consequences of one's choices. Moreover, Adger, Dessai et al. (2009) state that culture shapes public opinion about CC. This may result in higher levels of CC denial or in lower perceived costs of CC, which in turn hinder climate action. Eventually, Liobikienė, Mandravickaitė and Bernatonienė (2016) show that the green purchasing behaviour of consumers is driven by national culture.

As for corporations and their executives, the importance of national culture in determining strategic choices was first recognized by Tse et al. (1988). Then, it has been shown that culture also affects the success of technology transfer (Kedia and Bhagat, 1988; Kostova, 1999). Eventually, public policy choices of governments are significantly affected by national culture, both in terms of development and implementation (Vogel and Kun, 1987). As for CC, there is available evidence that forgetting to consider culture leads to the ineffectiveness of policies (Adger, Barnett et al., 2013; Nicholson-Cole and O'Riordan, 2009), so that both corporations and governments need to pay attention to the cultural dimensions of countries in which they work.

In the next section, the logical links between the Hofstede dimensions and CC-related behaviours are discussed in detail.

2.2 Hypotheses on the Hofstede Model and CC

Several researchers in a wide set of disciplines have discussed how the Hofstede dimensions might impact CC-related measures.

First, it has been hypothesized that Power Distance hinders the implementation of environmental programs because the bureaucrats in countries with high PDI advance professionally and in society more by the influence of sponsors rather than by job performance and technical competence, and such sponsors usually have little interest in the environment (Metz, 1991). Others underline the weak capacity for debating on environmental issues in such countries (Katz, Swanson and Nelson, 2001). Furthermore, corporations operating there tend to sacrifice environmental sustainability in favour of expediency (Blodgett et al., 2001; Swaidan and Hayes, 2005; Vitell, Paolillo and Thomas, 2003), and their stakeholders are less likely to expect environmental disclosure (Gray, 1988). Finally, people in power-distant societies generally exhibit low interest in the protection of Nature and high willingness-to-pay for environment-friendly goods (Dunlap, G. H. Gallup and A. M. Gallup, 1993). With the only exception of H. Wang, Guo and Tang (2021), who claim that a low level of Power Distance makes managers focus on power consolidation rather than social and environmental issues, it seems reasonable to say that *the Academic World generally expects PDI to be negatively associated to CC-related measures*.

Then comes Individualism, which is believed to help citizens to increase the pressure on those in power about environmental issues because the climate movement has emerged primarily thanks to the activity of widely dispersed interest groups rather than centralized associations (Dobson, 2007; Vogel and Kun, 1987). Such activity is also more widespread and diverse in countries with high IDV (Katz, Swanson and Nelson, 2001), and often results in effective changes in the societies (e.g., Ang, Fredriksson and Sharma, 2020 on the adoption of clean energy systems for home and transport purposes), though a minority argues that effective action may be hindered due to the belief that the others would not pursue any environmental interest (Lorenzoni, Nicholson-Cole and Whitmarsh, 2007). Furthermore, the high GDP per capita in countries with high IDV (G. Hofstede, 2001) makes researchers guess that such countries do not need to worry much about unemployment and poverty, so that they can invest more in the green transition. In business, Scholtens and Dam (2007) say that companies operating in individualistic countries often create and implement ethics systems, which are instead uncommon in collectivist societies (Swaidan and Hayes, 2005). Some other scientists however believe that collectivist countries are more sensitive to stakeholders' interest (Blodgett et al., 2001) and disclose them more environmental information (García-Sánchez, Cuadrado-Ballesteros and Frias-Aceituno, 2016). Then, even if in this case the counter arguments are relevant, *the Academic World generally expects IDV to be positively associated to CC-related measures*.

As for Motivation towards Achievement and Success, scientists even question the belief in the existence of CC in decisive countries, because the belief in conspiracy theories is high there (Adam-Troian et al., 2021). Furthermore, people in societies with low MAS scores exhibit more compassion and empathy toward the others (Pallab, Abhijit and Mukhopadhyay, 2006), and this makes researchers hypothesize that these people develop a sort of moral obligation for the purchase of environmentally-friendly products (see for example Barbarossa et al., 2015 for the adoption of private electric vehicles). In business, companies located in countries with high MAS are hypothesized to adopt costly environmental technology very slowly (Palmer, Oates and Portney, 1995), also because their stakeholders demand almost exclusively for financial reporting (Santema et al., 2005). Furthermore, board members of consensus-oriented countries are more sensitive to environmental issues and encourage discussion, information and participation to CC-related matters (Steensma, Marino and Weaver, 2000). With the only exception of Porter and Linde (1995), who claim that especially in emerging countries (Yan, Cui and Gil, 2016) environmental innovation requires ambition, competitiveness and success, followed by financial rewards (all features of countries motivated towards achievement and success), the listed hypotheses make it possible to say that *the Academic World generally expects MAS to be negatively associated to CC-related measures*.

The fourth dimension is Uncertainty Avoidance. On one hand, governments and companies in countries with high UAI are expected to be more concerned with CC, due to its unknown consequences, and such concern yields the implementation of stringent prevention and intervention policies (Jakučionytė-Skodienė and Liobikienė, 2021). Also, such firms and governments are supposed to act very well once some type of agreement for environmental targets has been signed, since the consequences of not complying with the targets are unsure (Parboteeah, Addae and Cullen, 2005). On the other hand, contexts who want to avoid uncertainty are thought of being less willing to accept innovations that overcome organizational inertia (Shane, 1993, 1995) and to promote changes to become more environmentally-friendly (Cordeiro and Sarkis, 1997). Some other researchers also argue that companies in societies with high UAI find it more difficult to implement sustainable development reporting due to the novel and challenging practices required (e.g., Schramade, 2017). Thus, the listed hypotheses clarify that *the Academic World has not yet reached consensus on whether UAI is positively or negatively associated to CC-related measures*.

Then there is Long-Term Orientation. It is hypothesized that short-term oriented countries have little care for the future because their focus is on the present (Laibson, 1997), so that they are little concerned with CC. Also, such countries are less pragmatic and more respective of traditions (Taras, Kirkman and Steel, 2010), which makes researchers guess that they are less likely to invest in CC adaptation (Bechtoldt et al., 2021). As for business, companies in countries with low LTO invest less in pollution prevention, recycling and waste reduction (Hackert et al., 2012). This might happen because they think that environmental investments are a waste of shareholders resources, since their payoffs take time to materialize (Cheng, Ioannou and Serafeim, 2014), so that they prefer to invest in the short period (Nakata and Sivakumar, 1996). With the only exception of G. Hofstede (2001), who says that high LTO is associated to high rates of economic growth (and this might be harmful for the environment especially in underdeveloped countries), the listed hypotheses make it possible to say that *the Academic World generally expects LTO to be positively associated to CC-related measures*.

Finally, there is Indulgence versus Restraint. On one hand, scientists believe that people have wasteful and extravagant lifestyles in indulgent societies, which are believed to be carbon-intensive (Disli, Ng and Askari, 2016). At the same time, such people are less likely to accept shifting behaviours if these do not satisfy immediate needs and feelings (as is the case of "green" ways of living, Lasarov et al., 2019). In business, Rosati and Faria (2019) also guess that in restrained countries there is greater likelihood of a freely demand that organizations address and publicly report on sustainability issues. On the other hand, it seems that environmental practices yields positive feelings and emotions (which are what indulgent societies look for; Steg, 2023), and that employees have more time and freedom to experiment and innovate in indulgent countries (Prim et al., 2017), with positive spillovers on pollution reduction since the environmental performance of companies depends on employees' ideas (Ramus, 2001). Thus, the listed hypotheses clarify that *the Academic World has not yet reached consensus on whether IVR is positively or negatively associated to CC-related measures*.

2.3 Data analyses with the Hofstede Model

Given the motivation exposed in Section 2.2, different cross-country analysis on the relationship between culture and CC have been carried out in the last two decades.

2.3.1 Articles that use National-level Indicators

The first study in chronological order is Husted (2005), who uses the Social and Institutional Capacity (SIC) as the measure for the environmental performance of countries. This is one of the main constituents of the Environmental Sustainability Index (ESI), an indicator developed by Yale and Columbia Universities in collaboration with the World Economic Forum and the European Commission. As described in YCELP and CIESIN (2005, Table 10), the SIC builds upon a set of 24 basic indicators regarding countries' environmental governance, energy eco-efficiency, private sector responsiveness to environmental issues and spread of science and technology. By using a classical multivariate OLS regression which contains also per-capita GNP and the population growth rate as controls, the author shows that for a set of 58 countries there exists a positive correlation between IDV and the ESI. At the same time, PDI and MAS are negatively correlated with the ESI. No role is found instead for UAI, while the other two dimensions, LTO and IVR, were not considered because reliable scores for them were not yet available (see Section 1.3.6). Husted (2005) finally points out that PDI has a much greater effect on SIC in rich countries, while MAS has it in poor countries.

The analysis of Husted is reproduced very closely in Peng and Lin (2009). With respect to Husted, they consider all the three points in time in which the ESI (and so the SIC) has been computed (2001, 2002 and 2005) and add a quadratic term for the population growth rate and the percentage of population enrolled in secondary or tertiary education in the set of control variables. In this way, they get a sample of more than 140 observations. Then, they perform OLS regressions, and their results confirm the findings of Husted (2005). In addition, they find a positive correlation between UAI and SIC.

Kumar, Giridhar and Sadarangani (2019) is another article that contains a similar analysis. These authors use the updated version of the ESI called Environmental Performance Index (EPI), which is computed through a weighted average of 24 indicators as described in Figure 2.2. They extend the number of countries with reliable measurements to 78 and use a Structural Equation Model instead of OLS (see Kumar, Giridhar and Sadarangani, 2019, Sec. Empirical Model and Bagozzi and Yi, 2012). They find that IDV correlates positively with EPI, while UAI correlates negatively with EPI. No other correlations emerge, so that their results are not consistent with those of Husted (2005), except for the one on IDV, but this inconsistency is not discussed further. Finally, they claim that IDV has a much higher impact in poor than in rich countries.

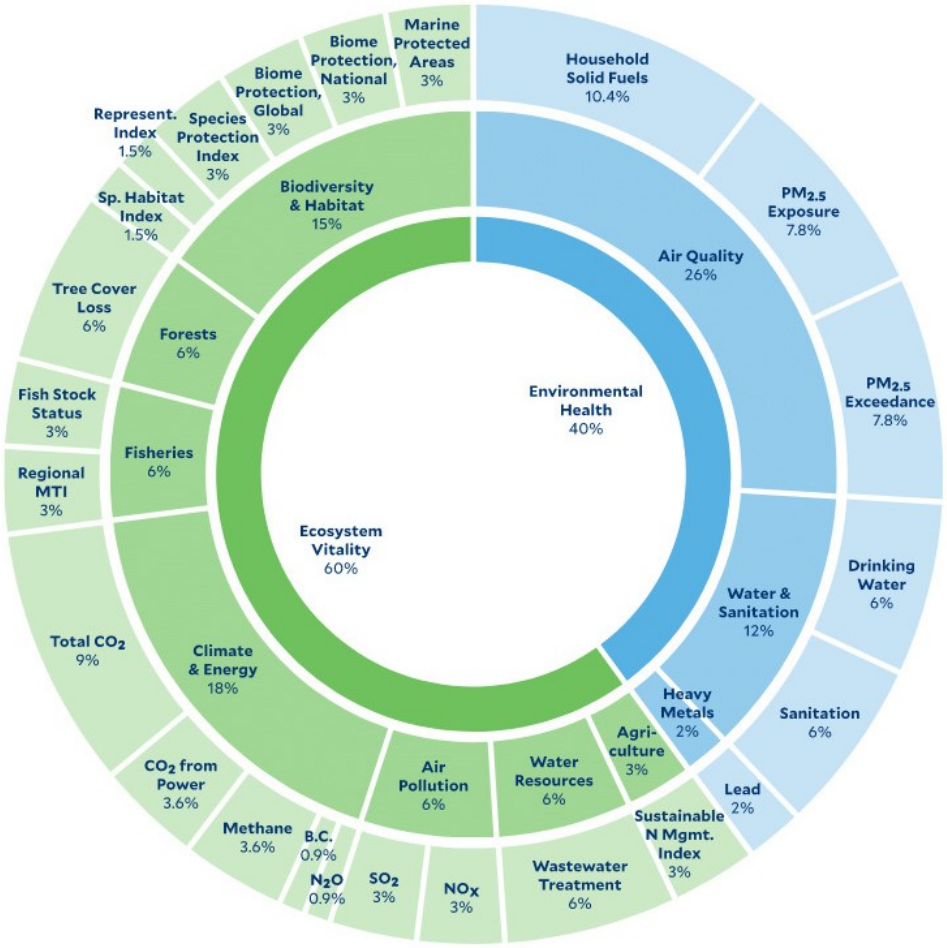

Figure 2.2: The composition of the EPI in 2018, Source: Wendling et al. (2018)

The most recent work that deals with the EPI is Dangelico, Fraccascia and Nastasi (2020), who use the 2020 version of the index. With respect to the 2018 version, eight new indicators are added, CC is given more weight, and air quality and water resource are given less weight in favour of water sanitation (see `https://epi.yale.edu/sites/default/files/images/Ring_20200522_v5(1).svg`). In this analysis, which is ran with OLS method and whose sample consists in a set of 62 countries, IDV, LTO and IVR are found to be positively correlated with the EPI, though the correlations disappear once population growth rate, education and income per capita are included in the controls (in accordance with Baron and Kenny, 1986, this means that the latter fully mediate the effect of cultural

dimensions on the EPI). Furthermore, two other analyses with the same control variables are proposed. One uses just the indicators that refer to the "Environmental Health" part of the EPI as the dependent variable, and IDV and IVR are found to be positively correlated with it (though, again, IDV's effect is fully mediated by the other control variables). The other, instead, uses just the indicators that refer to the "Ecosystem Vitality" section of the EPI as the dependent variable, and MAS, IDV and LTO are found to be positively correlated with it (with IDV's and LTO's effects fully mediated by the other controls).

Another important work is Alló and Loureiro (2014). This is a meta-analysis, i.e., a statistical analysis of a large number of results from individual studies. In particular, they collect willingness-to-pay (WTP) estimates for CC mitigation and adaptation policies from 342 studies carried out in 58 countries around the world: the majority of them took place in the USA and almost all focused on developed countries. They use many control variables in order to account for the different nature of the individual studies (see Alló and Loureiro, 2014, Table 2 for their list and description) and regress the Hofstede scores against the natural logarithm of WTP with OLS. The results show that only LTO is positively correlated with WTP and that only MAS is negatively correlated with WTP. No role for UAI and IVR appears, while PDI and IDV indexes are dropped due to collinearity problems (the two are highly correlated with the dummy variable "developing country" included in the controls). The article ends by specifying that the effect of MAS holds even after controlling for the political party in power at the moment in which the individual study was conducted.

The analysis of Disli, Ng and Askari (2016) is also very interesting, because they investigate the relationship between the Hofstede Model and the shape of countries' Environmental Kuznets Curve (EKC). The EKC within a country describes how CO_2 emissions vary in terms of income. In general, the curve is concave, which means that the strata of the population with the highest income have lower emissions per unit of income than those that locate in the medium-low strata (Berthe and Elie, 2015; Drupp et al., 2021), though some studies challenge its concavity at the very top of the income distribution (e.g., Baiocchi, Minx and Hubacek, 2010). Disli, Ng and Askari (2016) employ data for 69 countries over a time interval of nine years and use the Arellano-Bond estimator (see Arellano and S. Bond, 1991 for details) to carry out the regressions while controlling for GDP per capita and energy consumption. They find that increases in PDI, MAS and IVR are associated with upward shifts of the EKC throughout all income levels. At the same time, increases in IDV, UAI and LTO are positively associated with downward shifts of the EKC, though these relationships are not true for very high levels of income.

In the context of renewable energy consumption, a useful reference is the article of Pelau and Pop (2018), who investigate the relationship between culture and the share of renewable energy in gross final consumption in 30 European countries. By using data from the Eurostat Database for such dependent variable and the control variables (which are GDP per capita, participation rate at education of the adult population and rate of access to internet of all households), Pelau and Pop (2018) employ a random-effect regression model (whose details can be found in Wooldridge, 2016, Sec. 14.2) and find an important negative correlation between MAS and the dependent variable.

Then comes the paper of Lasarov et al. (2019). This has a different primary focus, in the sense that the cultural dimensions are not the main variables of interest, but still provides useful insights in the relationship between CC and culture. Indeed, the authors perform two statistical analyses in which the dependent variables are the environmentally-motivated consumption reduction (EMCR) and the frequency of counter-arguments (FC) provided to justify environment-unfriendly actions by individuals in the European Union (28 countries), while including the cultural dimensions of countries as controls. They use a hierarchical linear model to account for the two different levels of the variables (those who refer to individuals and those who refer to countries; see Lasarov et al., 2019, Sec. 3.4) and find positive correlations between EMCR and LTO, EMCR and IVR, FC and IDV whereas FC and PDI are negatively correlated.

The article of Chaikumbung, Doucouliagos and Scarborough (2019) is very intriguing because it analyses through a meta-regression the role for culture in the economic evaluation of wetlands. Indeed, wetlands are not among the first goods that come to our mind when we discuss environmental topics, but still they are very important for the survival of the human species (Barbier, Acreman and Knowler, 1997, Sec. 1.3). The authors focus on a set of 283 studies from 38 developing countries, for a total number of 1,041 observations that cover the time range 1995-2015. They regress the annual value of the wetlands per hectare per year in logarithmic form estimated by the previous studies against the cultural dimensions of Hofstede (together with some control variables listed in Chaikumbung, Doucouliagos and Scarborough, 2019, Table 1), and find that PDI and IVR are negatively correlated with such type of evaluation.

The work of Jakučionytė-Skodienė and Liobikienė (2021) is another cross-country analysis in the EU-28. With data collected from the Eurobarometer 91.3 survey performed in April 2019, the researchers analyse the relationship between CC concern, belief in personal responsibility for it, 13 actions whose aim is to mitigate CC and Hofstede's six cultural dimen-

sions taken from Hofstede Insights Ltd (see Jakučionytė-Skodienė and Liobikienė, 2021, Table 1 for details). By computing Spearman's rank correlation coefficients (which don't take into account the exact values of the variables but only their relative position in the standings, see Spearman, 1904b), they find out that CC concern is correlated only with UAI in a positive way. Instead, the belief in personal responsibility for CC and actions whose aim is to mitigate it are significantly more frequent in countries with low PDI, high IDV, low UAI and high IVR.

Finally, there is Ordonez-Ponce (2023). This article considers the Sustainable Development Goals (SDGs), a set of 17 goals that 195 countries around the world have subscribed in order to pursue a just, safe and sustainable future (further information is in UN, 2024c). A wide set of researchers led by the famous economist Jeffrey Sachs keeps track of the performance of the countries and publishes a report every year. In particular, the interest for this chapter lies in Goal 13 - Take urgent action to combat CC and its impacts. The index for this goal is computed as the average of the following three indicators, which range between 0 (the lowest value, attributed to the worst country in the world) and 100 (the highest value, attributed to the best country in the world): per-capita CO_2 emissions from fossil fuel combustion and cement production, per-capita CO_2 emissions embodied in imports, and per-capita CO_2 emissions embodied in fossil fuel exports. By using data from Sachs et al. (2020) and the Hofstede scores provided by Hofstede Insights Ltd, the author performs OLS regressions without any control variable and finds that IDV and UAI are negatively correlated with the index for Goal 13 at global level. Though, when restricting the sample to European countries, he finds only a negative correlation for IDV; while when restricting just to Eastern Europe, he finds a negative correlation for IVR.

A summary of the results of this section can be found in Table 2.1 at the end of this chapter.

2.3.2 Articles directly related to Business

The first study related to business is Ringov and Zollo (2007), who investigate the impact of culture on corporate social and environmental performance. The latter is measured through the Intangible Value Assessment (IVA) index provided by the InnoVest Group, one of the world's leading research firm specialized in the analysis of "non-traditional" issues (https://www.theinnovestgroup.com/). This IVA is a composite measure that builds up on more than 120 environmental, social and responsible

governance criteria, which can be found in Ringov and Zollo (2007, Appendix). The higher the IVA score of a firm, the lower its environmental or social risks and liabilities and the greater its ability to capitalize on environmentally or socially driven profit opportunities. The dataset at use is not publicly available, but the authors specify that it contains 463 firms in 28 developed countries with control variables specified in Ringov and Zollo (2007, Table 1). By running a classical OLS regression with standard errors robust to heteroskedasticity, the authors show that corporations based in countries with a high PDI or a high MAS exhibit a lower IVA score.

After that, there is Vachon (2010). He analyses what influence culture has on the degree of sustainable development practices by corporations in 55 countries around the world. This is measured using two proxies: a variable called "Green Corporatism" from the Global Competitiveness Report 2004-05 (see WEF, 2004) and a variable called "Environmental Innovation", which is nothing else than indicator number 63 from the ESI 2005 (see YCELP and CIESIN, 2005, Table 10). The first is a construct measured by seven questions on the behaviour of companies with respect to environmental issues (Vachon, 2010, Table 1). The answers come from business executives and entrepreneurs that work in companies with at least 50 employees, and the average of the items is computed for each country to form the variable. The second is based on business executives' answers to questions addressing environmental competitiveness, prevalence of environmental management systems, and cooperation with governments in the private sector. Both proxies are of the type "the higher, the better". While controlling for total population, population density and GDP per capita, the OLS regressions show that both the proxies are positively correlated with IDV and negatively correlated with UAI.

Then come Ho, H.-M. D. Wang and Vitell (2012). They update the analysis of Ringov and Zollo (2007) by using a larger set of companies (3,680 from 49 countries) and a different regression technique. Indeed, on the basis of what is declared in Garcia-Castro, Ariño and Canela (2010), they claim that Hofstede's cultural indexes suffer from endogeneity when regressed against the IVA index; so that they use a 2SLS regression where all of them are instrumented with the frequency of pronoun drop in languages (whose data come from E. S. Kashima and Y. Kashima, 1998). However, while Garcia-Castro, Ariño and Canela (2010) employ two different types of test for endogeneity in their data (Hausman, 1978; Mundlak, 1978), this research employ none of them, taking endogeneity for granted. Furthermore, Garcia-Castro, Ariño and Canela (2010) investigate culture but do not use Hofstede's dimensions. The researchers find that, while controlling for some features of the firms (Ho, H.-M. D. Wang and Vitell,

2012, Sec. Control Variables) PDI, MAS and UAI correlate positively with IVA; while IDV correlates negatively with IVA, so to disconfirm the results of Ringov and Zollo (2007). This inconsistency might be caused by the different methodology at use.

Another interesting analysis is the one of Gupta and McIver (2016), who focus on environmental attitudes among firms in the world. They build up an environmental index for each of the 23,914 firm-year observations in their sample (each firm has been surveyed in each year from 2002 to 2012; overall they are located in 45 countries) by using firms' answers to the 38 questions of the Thomson Reuters' Asset4 dataset (their list is in Gupta and McIver, 2016, Table 12.2, see also https://www.thomsonreuters.com/en.html). Since the questions require a yes-or-no answer, the authors computed the index for each firm in each year by taking the fraction of "yes" answers. Gupta and McIver (2016) implement then a regression model where they control for both the year and the industry (i.e., they add a dummy control variable for each industry and each year) as well as some features of the firms (Gupta and McIver, 2016, pp. 255-257) and conclude that PDI and MAS are negatively correlated with their environmental index, while IDV, UAI, Lto and IVR are positively correlated with it.

Another statistical model is employed by Gallego-Álvarez and Ortas (2017), who investigate on the practice of reporting environmental sustainability by corporations (CESR). These two researchers build up a CESR index by indicating how many of the 12 Global Reporting Initiative (GRI, https://www.globalreporting.org/) environmental core indicators are reported by each firm in the sample, which comprises 3,917 firms in 59 countries (see Gallego-Álvarez and Ortas, 2017, Table 4). As for the statistical model, they choose a quantile regression model, so to estimate different quantiles of the conditional distribution and not just its mean, which is what OLS does (Gallego-Álvarez and Ortas, 2017, Section 5). After controlling for firms features (Gallego-Álvarez and Ortas, 2017, Table 6), they find that PDI, MAS and IVR negatively affect the median and higher quantiles of the CESR distribution; while UAI and LTO positively affect them. Finally, IDV has no effect on any quantile and no dimension has any effect on the lowest quantiles of the CESR distribution.

Rosati and Faria (2019) instead want to discover whether the cultural factors might influence the practice of addressing the Sustainable Development Goals (SDGs; see UN, 2024b for a description of SDGs in business) in organizations' sustainability reports. For this reason, they scan the GRI database and consider only the organizations who have published a sustainability report in accordance with GRI standards which says whether the organization has addressed SDGs or not in 2016. In this way, the

authors get a sample of 2,413 organizations from 90 different countries. Then, they create a binary variable which denotes whether the organizations have addressed the SDGs in their reports or not, and test if the population of organizations whose such variable is equal to one differs from the one whose such variable is equal to zero with the Test of Mann-Whitney (Mann and Whitney, 1947). They find that organizations located in countries with lower PDI, higher IDV, lower LTO and higher IVR are more likely to address SDGs in their sustainability reports, after including a wide set of controls (Rosati and Faria, 2019, Table 1).

Pucheta-Martínez and Gallego-Álvarez (2020) instead focus on the practice of environmental disclosure. This refers to whether or not the firms report information on a set of 53 indicators that belong to three fields closely related to environmental impact: innovation, resource use and carbon emissions (Pucheta-Martínez and Gallego-Álvarez, 2020, Table 3). Data are collected from the Thomson Reuters Database for a total number of 12,759 firm-year observations covering the period 2004-2015. Such firms are located in 28 countries of the developed world. The dependent variable for each observation is the percentage of the 53 indicators mentioned above that have been reported in the database. By using the GMM estimator of Arellano and S. Bond (1991), the researchers run regressions by controlling for the year and for a wide set of features of firms and countries (Pucheta-Martínez and Gallego-Álvarez, 2020, Table 5). They find that IDV, MAS, LTO and IVR are negatively correlated with environmental disclosure, while UAI is positively correlated with it.

Then, there is H. Wang, Guo and Tang (2021), who are interested in the effect of national culture on Corporate Green Pro-activity. This expression refers generally to those actions taken actively by firms to reduce carbon emissions and promote the transition to a low-carbon business model. In particular, "a proactive firm is expected to be aware of carbon risk, provide transparent carbon disclosure, have advanced carbon governance mechanisms, and play a leadership role in corporate response to CC" (H. Wang, Guo and Tang, 2021, p. 141). The analyses are based on data from the CDP (the ex Carbon Disclosure Project), a not-for-profit organization who tracks the GHG emissions of firms through a questionnaire that is identical for all and whose results are then made publicly available (see `https://www.cdp.net/en/companies-discloser`). The dependent variable in the regression is "rank", a ranking provided by the CDP to the firms according to the information they have submitted through the questionnaire. It ranges between 1 and 8 and it is of the type "the higher, the better". By controlling for the year, the industrial sector and some other geographical and firms' characteristics (H. Wang, Guo and Tang, 2021,

Appendix A), regressions show that such ranking is lower for firms located in countries with high PDI, MAS and UAI. More precisely, PDI has a significant but weak quadratic effect in the sense that firms in countries with a very-high PDI score higher than those in middle-high PDI countries.

Finally, there is the analysis of Ullah et al. (2022), who focus on the relationship between culture and environmental innovation in 15 developing countries. The authors collect more than ten thousands year-firm observations covering the period 2015-2019 from the Thomson Reuters Eikon Database (https://eikon.refinitiv.com/), which contains a binary variable called Environmental Innovation that denotes whether each firm in each year sells a product that is explicitly designed and developed to be environment-friendly. The authors run multiple logistic regressions (i.e., they hypothesize that the dependent variable is the logistic function of a linear combination of the independent variables, see Wooldridge, 2016, Sec. 17.1 for details) and find that PDI, IDV, UAI and IVR are negatively correlated with Environmental Innovation, while MAS and LTO are positively correlated with it, when taken singularly. The correlations for PDI, MAS and IVR are significant also in a joint regression. The control variables that have been considered are listed in Ullah et al. (2022, Table 1).

2.3.3 Summary Tables

The Table 2.1 summarizes the findings of Section 2.3.1. With respect to what is written in Section 2.2, the analyses confirm the hypothesized negative relationships between PDI, MAS and CC-related measures (with the only exception of Dangelico, Fraccascia and Nastasi, 2020 for the latter) as well as the positive ones for IDV and LTO (with the only exception of Ordonez-Ponce, 2023 for the first). The mixed evidence for UAI is also consistent with the hypotheses, while for IVR the data analyses point towards a positive relationship that was not evident in the hypotheses (with the exceptions of Disli, Ng and Askari, 2016 and Chaikumbung, Doucouliagos and Scarborough, 2019).

The Table 2.2 summarizes instead the findings of Section 2.3.2. Once again, statistical analyses generally confirm the theoretical framework described in Section 2.2 for PDI and MAS (with the exceptions of Ho, H.-M. D. Wang and Vitell, 2012 for both and Ullah et al., 2022 for the latter). Instead, mixed evidence is found for both IDV and LTO, which is not consistent with what is generally hypothesized. Finally, the mixed evidence for UAI and IVR confirms the hypotheses that these two dimensions affect CC-related measures through different competing channels.

Table 2.1: Summary of correlations in studies of Section 2.3.1

Article	Y-variable	PDI	IDV	MAS	UAI	LTO	IVR
Husted (2005)	SIC[a]	-	+	-			
Peng (2009)	SIC[a]	-	+	-	+		
Kumar (2019)	EPI		+		-		
Dangelico (2020)	EPI		+			+	+
	EH[b]		+				+
	EV[c]		+	+		+	
Allò (2014)	WTP			-		+	
Disli (2016)	EKC	-	+	-	+	+	-
Pelau (2018)	REC[d]			-			
Lasarov (2019)	EMCR[e]					+	+
	FC[f]	-	+				
Chaikumbung (2019)	WE[g]	-					-
Jakučionytė-Skodienė (2021)	CCC[h]				+		
	PRCC[i]	-	+		-		+
	FCA[j]	-	+		-		+
Ordonez-Ponce (2023)	SDG-13[k]		-		-		

[a] SIC = Social and Institutional Capacity
[b] EH = Environmental Health
[c] EV = Ecosystem Vitality
[d] REC = Renewable Energy Consumption
[e] EMCR = Environmentally-Motivated Consumption Reduction
[f] FC = Frequency of Counter-arguments
[g] WE = Wetlands Evaluation
[h] CCC = CC Concern
[i] PRCC = Personal Responsibility for CC
[j] FCA = Frequency of Climate-friendly Actions
[k] SDG-13 = Sustainable Development Goal 13 - Climate Action

Table 2.2: Summary of correlations in studies of Section 2.3.2

Article	Y-variable	PDI	IDV	MAS	UAI	LTO	IVR
Ringov (2007)	IVA[a]	-		-			
Vachon (2010)	GRC[b]		+		-		
	EIN[c]		+		-		
Ho (2012)	IVA[a]	+	-	+	+		
Gupta (2016)	EI[d]	-	+	-	+	+	+
Gallego-Álvarez (2017)	CESR[e]	-		-	+	+	-
Rosati (2019)	SDGR:Y/N[f]	-	+			-	+
Pucheta-Martínez (2020)	ED[g]		-	-	+	-	-
Wang (2021)	CDP-rank[h]	-		-	-		
Ullah (2022)	FSGP:Y/N[i]	-	-	+	-	+	-

[a] IVA = Intangible Value Assessment by InnoVest
[b] GRC = Green Corporatism
[c] EIN = Environmental Innovation
[d] EI = Environmental Index from Thomson Reuters' Asset4 dataset
[e] CESR = Corporate Environmental Sustainability Reporting
[f] SDGA:Y/N = SDGs Addressing in sustainability reports: Yes or No
[g] ED = Environmental Disclosure
[h] CDP-rank = Ranking according to the CDP
[i] FSGP:Y/N = Firm Sells "Green" Product: Yes or No

Chapter 3

Commitment to Climate Action: cross-country evidence on the role of culture

There has been a year of utmost importance in recent history of CC. In 2015, 196 countries around the world have negotiated the *Paris Agreement* on CC (UN, 2016), whose main goals are:

- Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit such increase to 1.5°C;
- Increasing the adaptation to the adverse impacts of climate change and fostering low GHG emissions development, in a manner that does not threaten food production;
- Making finance flows consistent with a pathway towards low GHG emissions and climate-resilient development.

In the same year, all United Nations members have adopted the *2030 Agenda of Sustainable Development*, which consists in the already mentioned 17 SDGs (UN, 2024c). Goal 13 is called "Climate Action", and it commits countries to:

- Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters;
- Integrate climate change measures into national policies, strategies and planning;

- Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.

Given such declaration of commitment and broad participation, one may wonder how the situation has changed following the agreement and if there is a role for culture in determining the countries' actual commitment to the green transition. In this chapter, I present my own correlation analysis, which is also the new contribution of this dissertation to the research world. More precisely, I focus on CC mitigation by analysing how CO_2 emissions of countries have changed from 2015 to 2021, so that this work is closely related to the ones presented in Section 2.3.1. This focus is justified primarily by the fact that CO_2 emissions are the main drivers of CC, as already discussed in Section 2.1.

In detail, the first section discusses briefly why the Paris Agreement and the SDGs allow each country to decide for itself, so that other forces (such as culture) play a role in shaping climate action beyond the prescriptions of the two documents. The second section presents the research hypotheses, in terms of how each of the Hofstede cultural dimensions may affect the change in the levels of CO_2 emissions. Then, the third section says how data have been collected and manipulated. After that, the fourth and the fifth section display the results of the analyses. The fourth refers to production-based (PB thereafter) emissions, while the fifth refers to consumption-based (CB thereafter) emissions: the two are investigated under different sets of hypotheses. In the sixth section, it is checked whether the results are robust to alternative choices for the dependent variables and to influential data points. Finally, the seventh section discusses the results and their implications, and provide directions for future research.

3.1 The structure of the Paris Agreement and of the SDGs

The scientific community claims that fighting CC, which comprises the goals of the Paris Agreement and SD Goal 13 listed before, requires deep changes in the functioning of societies (especially economically-developed ones) to be effective (IPCC, 2018). Then, I believe that it is a good idea to look more precisely at what the two documents prescribe in order to achieve the goals.

First, the Paris Agreement consists in a mix of top-down and bottom-up norms. It ties countries to the submission and consequent respect of the nationally-determined contributions (NDCs, commitments that the countries make to reduce their GHG emissions) every five years, but it leaves them free to set at which level to cut down emissions (Bang, Hovi and Skodvin, 2016; Dimitrov et al., 2019). Such mixture has been implemented in order to account for the broadest possible participation, which has been achieved, but has also resulted in a first cycle of NDCs submissions that is not consistent with the 2°C target for year 2100. Multiple sources have indeed estimated that warming is going to curb somewhere between 2.7°C and 3°C with such NDCs (e.g., Höhne et al., 2017; Millar et al., 2017; Rogelj et al., 2016), even if there are important differences among countries. Reviewers also indicate that the Paris Agreement suffers from the lack of enforcement mechanisms (Bang, Hovi and Skodvin, 2016; Dimitrov et al., 2019), in the sense that the only one prescribed (a committee of experts, Article 15.1) must function in a manner that is non-adversarial and non-punitive (Article 15.2), so that compliance with commitments relies primarily on the pressure of interest groups and politicians (which some years ago has proven to be insufficient for the Kyoto Protocol; Bang, Hovi and Skodvin, 2016) and on mutual confidence among countries (about which, the temporary withdrawn of the USA from 2020 under Trump's presidency to 2021 under Biden's presidency has been a bad signal).

As for the SDGs instead, it is possible to say that they are a novelty in international legislation because they have been negotiated with the approach known as "Governance through Goals" (Biermann, Kanie and Kim, 2017). This approach favours once again broad participation through the use of qualitative instead of quantitative global goals (which are in any case vague; Persson, Weitz and Nilsson, 2016), and by providing no obligation for governments to formally transfer the SDGs into their national legal systems, even if the SDGs are grounded in international law. This means also that if a country decides to make the SDGs part of its national legal system, it is free to determine its own ambition in their implementation. Furthermore, this approach provides for weak institutional arrangements at the intergovernmental level (Biermann, Kanie and Kim, 2017), especially for what concerns monitoring and reviewing of the targets and of the actions undertaken to achieve them. Indeed, no peer or independent agency is legally expected to monitor the progresses of countries up to date (Persson, Weitz and Nilsson, 2016).

Even if such features of the two documents are not necessarily negative for commitment and compliance (see Weiss, 1998 for a set of myths about compliance with previous international environmental agreements),

I argue that they imply a higher degree of "free-riding" by countries, so that their national characteristics (among which there is culture) might exert an important influence on the actual levels of commitment and compliance. This is consistent for example with Jacobson and Weiss (1995, Fig. 2), who pose national culture as one of the fundamental factors that contribute to decrease or increase national compliance with such type of agreements. The importance of the national context is highlighted also by Dimitrov et al. (2019) for the Paris Agreement, because they place emphasis on national policies (especially, on how they interact with the provisions of the agreement) and on national institutions, which are required to function well and to have administrative capacity. The same is claimed by Biermann, Kanie and Kim (2017) for the SDGs, who also add that public-private and private-private partnerships are crucial because the big amount of resources and the technology transfers that are needed for target achievement can be mobilized only by involving the private world, and there is evidence to believe that private sector responsiveness to environmental topics is influenced by culture (Section 2.3.2).

Thus, in my analysis there may be a space for culture as well. In the next section I describe how the Hofstede dimensions might impact on the reductions of CO_2 emissions that the countries have reached up to now.

3.2 Research hypotheses

The two dependent variables of my analysis are the percentage decreases in the per-capita levels of PB and CB CO_2 emissions of countries. Given that the first seems to me more logically related to the decisions of governments and companies while the second seems more related to the choices of individual citizens, the two are investigated under different hypotheses.

3.2.1 The control variables

I have decided to avoid regressing the two dependent variables against only the cultural scores of the Hofstede Model because I suppose that their behaviour is primarily driven by other forces. First, I have decided to control for the per-capita GDP of countries, which is one of the controls that appear more frequently in the analysis reported in Section 2.3.1. I believe that the companies located in countries with high per-capita GDP have a more adequate amount of resources to invest in the decarbonization of their production processes, which is usually a costly achievement.

This might occur also because the governments of such countries, which have more money to spend for the green transition, may give some of it to the companies as an incentive. Furthermore, the governments of rich countries can invest more in public transports, which contribute as well to decarbonization. Finally, I believe that the citizens of wealthy countries can afford a higher amount of environment-friendly products, which usually have higher prices. For these reasons, I claim the two hypotheses reported below:

- *Hypothesis A1. Per-capita GDP is positively associated with decreases in production-based CO_2 emissions;*
- *Hypothesis B1. Per-capita GDP is positively associated with decreases in consumption-based CO_2 emissions.*

Another control variable that is widely used in the papers of Section 2.3.1 is education. More precisely, I decided to control for tertiary education, because I believe that students become able to deal with the great complexity that characterizes our world only at university. In particular, CC-related themes belong to this complexity and they are usually not treated (if not in a marginal way) at school. In my opinion, countries with a higher share of the population with tertiary education have a higher amount of minds that are able to take into account environmental issues in governments and companies. In the same way, I believe that citizens of such countries are more aware of the environmental consequences of their own choices. Thus, the following two correlations are hypothesized:

- *Hypothesis A2. Education is positively associated with decreases in production-based CO_2 emissions;*
- *Hypothesis B2. Education is positively associated with decreases in consumption-based CO_2 emissions.*

I have also added a dummy variable called "Industry" in order to be consistent with the Environmental Kuznets Curve (EKC) Hypothesis, which has been first introduced independently by Grossman and Krueger (1991), Shafik and Bandyopadhyay (1992) and Panayotou (1993). This hypothesis posits that in the history of a country the highest amount of pollutant agents is emitted when its economy transitions from a rural-based one to an industrial-based one (see figure 3.1). Indeed, in the first stages of industrialization, high priority is given to increase material output, and people are more interested in income than clean environment. Thus, the economic

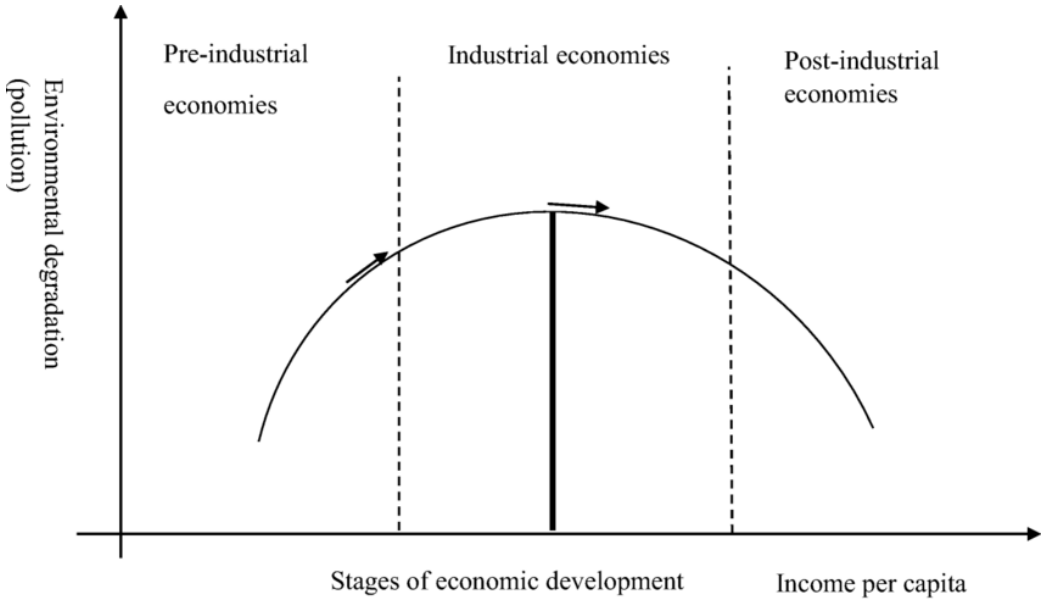

Figure 3.1: The Environmental Kuznets Curve Hypothesis, Source: Panayotou (1993)

growth that is achieved results in greater use of natural resources and emission of pollutants. Instead, in later stages of industrialization, people value the environment more, regulatory institutions become more effective and cleaner technology becomes available and affordable, so that pollution level declines (Dasgupta et al., 2002; Dinda, 2004).

In line with that, I have decided to trace with the variable "Industry" the countries whose share of total employment in the industrial sector has increased during the time period that I have considered (more details on this variable will be given in Section 3.3). This captures an important source of pollution that is however compensated in social terms by poverty alleviation. I expect a negative impact of this variable on both PB (for obvious reasons) and CB emissions (because the increase in their income allow citizens to increase their consumption levels).

- *Hypothesis A3. Industry is negatively associated with decreases in production-based CO_2 emissions;*
- *Hypothesis B3. Industry is negatively associated with decreases in consumption-based CO_2 emissions.*

Finally, I have added a dummy based on the estimates of Gore and IEEP (2021, Fig. 1), who report that the world needs to reduce the level of CO_2 emissions to below 2.3 tons per-capita in order to be consistent with the goal of the Paris Agreement that aims at limiting the increase in the global average temperature to 1.5°C. I have created a variable called "Below _ 3t" that denotes the countries whose emissions levels were below 3 tons per-capita in 2015, because these countries do not need to lower their emission levels, and not considering this would yield biased results. I have decided to opt for 3 tons per-capita instead of 2.3 because I believe that some countries whose emissions levels range between 2.3 and 3 tons per-capita internalize the fact that some other countries in the world (especially many of those in Sub-Saharan Africa) will remain well below the 2.3 tons per-capita level within the short-term. Thus, they have less incentive to reduce their emissions too, given that the major responsibility for the per-capita data at the global level belongs to big emitters. I expect this variable to have a negative impact especially on PB emissions.

- *Hypothesis A4. Below _ 3t is negatively associated with decreases in production-based CO_2 emissions;*
- *Hypothesis B4. Below _ 3t is negatively associated with decreases in consumption-based CO_2 emissions.*

3.2.2 Hofstede's cultural dimensions

I believe that the four variables mentioned up to now are the main drivers of the behaviour of the dependent variables. Besides them, there might be a role for culture in terms described in the paragraphs that follow.

First, given the hypothesis of Section 2.2, I believe that it is natural to hypothesize a negative relationship between Power Distance and the decrease in CO_2 emissions. The empirical evidence summarized in Tables 2.1 and 2.2 points towards this direction as well. In particular for my purposes, governments in countries with high PDI have been found to have lower social and institutional capacity to commit to environmental issues (Husted, 2005; Peng and Lin, 2009), while companies tend to report environmental sustainability with lower frequency (Gallego-Álvarez and Ortas, 2017; Rosati and Faria, 2019) and to sell a lower quantity of "green" products in developing countries (Ullah et al., 2022). Furthermore, the citizens of countries with high PDI tend not to believe that they are personally responsible for CC and make fewer climate-friendly actions (Jakučionytė-Skodienė and Liobikienė, 2021). Thus, the hypotheses are the following.

- *Hypothesis A5. PDI is negatively associated with decreases in production-based CO_2 emissions;*
- *Hypothesis B5. PDI is negatively associated with decreases in consumption-based CO_2 emissions.*

As for Individualism instead, the hypotheses of Section 2.2 make me guess a positive relationship between IDV and the decrease in CO_2 emissions. The empirical evidence of Tables 2.1 and 2.2 is consistent with that. In particular, governments of countries with high IDV have better social and institutional capacity to deal with the green transition (Husted, 2005; Peng and Lin, 2009) and a higher EPI (Kumar, Giridhar and Sadarangani, 2019); while firms of such countries exhibit greater environmental innovation (Vachon, 2010) and address the SDGs with higher frequency in their sustainability reports (Rosati and Faria, 2019). Moreover, citizens of individualistic countries believe that CC is also their own responsibility and tend to make climate-friendly actions more often (Jakučionytė-Skodienė and Liobikienė, 2021). Thus, the hypotheses are the following.

- *Hypothesis A6. IDV is positively associated with decreases in production-based CO_2 emissions;*
- *Hypothesis B6. IDV is positively associated with decreases in consumption-based CO_2 emissions.*

Then comes Motivation towards Achievement and Success, for which the hypotheses of Section 2.2 claim a negative relationship with CC-related measures. This negative correlation has been confirmed by empirical studies reported in tables 2.1 and 2.2. In particular, governments of countries with high MAS have once again a lower social and institutional capacity to deal with CC (Husted, 2005; Peng and Lin, 2009), while firms of such countries tend to disclose environmental information with less frequency (Gallego-Álvarez and Ortas, 2017; Pucheta-Martínez and Gallego-Álvarez, 2020). Also, the citizens of decisive countries exhibit a lower willingness to pay for CC mitigation and adaptation policies (Alló and Loureiro, 2014) and, in Europe, use a lower percentage of renewable energies with respect to the total energy consumption (Pelau and Pop, 2018). Hence, I guess a negative correlation in my analysis as well.

- *Hypothesis A7. MAS is negatively associated with decreases in production-based CO_2 emissions;*
- *Hypothesis B7. MAS is negatively associated with decreases in consumption-based CO_2 emissions.*

Fourth comes Uncertainty Avoidance. The theoretical reasoning of Section 2.2 do not indicate a clear direction for the correlation between UAI and CC-related measures, and the analyses I have reviewed in tables 2.1 and 2.2 are consistent with that. As for my own analysis, I guess that the more important factors to consider are the better social and institutional capacity of governments in countries with high UAI (Peng and Lin, 2009) together with the fact that such countries have a better EKC (Disli, Ng and Askari, 2016), the higher degree of environmental sustainability reporting by firms in such countries (Gallego-Álvarez and Ortas, 2017; Pucheta-Martínez and Gallego-Álvarez, 2020), and the fact that their citizens tend not to feel personally responsible for CC and make less climate-friendly actions (Jakučionytė-Skodienė and Liobikienė, 2021). So, I hypothesize what follows.

- *Hypothesis A8. UAI is positively associated with decreases in production-based CO_2 emissions;*
- *Hypothesis B8. UAI is negatively associated with decreases in consumption-based CO_2 emissions.*

Next comes Long-term Orientation, for which the hypotheses of Section 2.2 maintain a positive relationship with CC-related measures. However, the empirical evidence summarized in tables 2.1 and 2.2 does not always support that. Governments of countries with high LTO have a higher EPI (Dangelico, Fraccascia and Nastasi, 2020), but firms operating in these countries are found to report sustainability more often in only one study (Gallego-Álvarez and Ortas, 2017), while opposite findings appear in other papers (Pucheta-Martínez and Gallego-Álvarez, 2020; Rosati and Faria, 2019). In any case, I adopt the perspective of a positive correlation between LTO and decreases in PB emissions. Instead, citizens of countries with high LTO exhibit a higher willingness to pay for CC mitigation and adaptation policies (Alló and Loureiro, 2014) and a higher environmentally-motivated consumption reduction in the European Union (Lasarov et al., 2019). To sum up, my hypotheses are the following.

- *Hypothesis A9. LTO is positively associated with decreases in production-based CO_2 emissions;*
- *Hypothesis B9. LTO is positively associated with decreases in consumption-based CO_2 emissions.*

Finally, there is Indulgence versus Restraint. As for this dimension, the hypotheses reported in Section 2.2 make me say that the Academic World has not yet established whether it relates positively or negatively with CC-related measures. The empirical evidence collected in tables 2.1 and 2.2 seems to confirm that. Indeed, indulgent countries have a higher EPI (Dangelico, Fraccascia and Nastasi, 2020) but tend to evaluate less an important source of biodiversity, which is the wetlands (Chaikumbung, Doucouliagos and Scarborough, 2019). Also, firms of restrained countries seems to disclose more environmental information in their reporting (Gallego-Álvarez and Ortas, 2017; Pucheta-Martínez and Gallego-Álvarez, 2020), though some researches find the opposite (Rosati and Faria, 2019). In any case, I adopt the perspective of a negative correlation between IVR and decreases in PB emissions. Instead, citizens of indulgent countries show a higher degree of environmentally-motivated consumption reduction in the European Union (Lasarov et al., 2019) and tend to believe more that climate action is also their own responsibility, so that they make climate-friendly actions more often (Jakučionytė-Skodienė and Liobikienė, 2021). In brief, the hypotheses I propose are the following.

- *Hypothesis A10. IVR is negatively associated with decreases in production-based CO_2 emissions;*
- *Hypothesis B10. IVR is positively associated with decreases in consumption-based CO_2 emissions.*

3.3 Data collection and manipulation

In this section I describe chronologically and in detail how I have collected and manipulated the data for my regressions. When the data comes from the website Our World in Data (`https://ourworldindata.org/`, OWID), I report also the primary source that the reviewers of OWID have used.

3.3.1 Independent variables

First of all, I have collected the data for the Hofstede Model. I have decided to use the updated data provided by The Culture Factor Group at `https://www.hofstede-insights.com/country-comparison-tool` because such data allows for a broader set of countries with reliable measurements with respect to what happens for the majority of articles that I have reviewed in Sections 2.3.1 and 2.3.2. Data is available for a set of

119 countries in all the continents, though 10 of them still lack the score for LTO and 21 of them still lack the score for IVR. The scores for each dimension range between 0 and 100, and higher scores mean more adherence with that dimension. Together with the six dimensions, I have collected the name of the countries and their ISO3 code, which allow for easy matching with data coming from different sources.

Then I have collected data for the per-capita GDP of countries from the database of the World Bank. This variable refers to purchasing-power-parity (PPP) per-capita GDP in current international dollars and can be found at https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD?name_desc=true. With respect to the 119 countries for which the cultural scores are available, the database for GDP lacks data for Syria, Venezuela and Taiwan. I have decided to drop Syria and Venezuela from the sample due to the particular situations that have occurred in these countries in the last decade (Syria is in civil war since 2011 while Venezuela has experienced a heavy impoverishment of its population since 2014 under Maduro's presidency). Instead, I have decided to keep Taiwan, for which I have used the estimation of the same unit provided by the International Monetary Fund, which can be found at https://www.imf.org/external/datamapper/PPPPC@WEO/OEMDC/ADVEC/WEOWORLD. More precisely, for all the countries I have imported the data from 2015 to 2021 and I have computed the average value over this time window. Since values range from the 1,334.21 $ of Mozambique to the 117,646.77 $ of Luxembourg, I have decided to compute the natural logarithm of such averaged quantity and I have obtained the variable "Log _ GDP".

Second, I have obtained the variable "Industry" from OWID. At *this link*, it is possible to find for a wide set of countries the percentage of their labour force that is employed in each of the three main economic sectors (agriculture, industry and services). Data are based on estimates provided by the International Labour Organization (https://www.ilo.org/) via the World Bank. I have decided to denote with this variable all the countries whose share of employment in industry has risen by at least one percentage point from 2015 to 2019 (due to unavailability of more recent data), with two exceptions: Saudi Arabia's and Jamaica's PB emissions are consistent with the increase in the share of employment in industry up to 2019, but not after that year. Thus, I have assigned them a value of 0 for Industry, since I use data that refers to 2021 for the CO_2 emissions. I have avoided using the entire standings because decreases in the percentage of the labour force employed in industry might not imply deindustrialization (and so, a decrease in the emissions) due to the fact that workers might be replaced by machines (and technology in general).

Then I have collected the data for tertiary education. I have decided to use the estimates provided by the OWID website (Ritchie, Samborska et al., 2023), which are based on the results of Barro and J.-W. Lee (2015) and J.-W. Lee and H. Lee (2016). This data account at the country level for the percentage of the population aged 25 to 65 years who have either completed or partially completed tertiary education. The reported values are estimations based on the educational attainment of people in 2010, from which projections every five years over the following three decades have been constructed, using estimates of school enrolment and population structure (for further details, see Barro and J.-W. Lee, 2015, Chap. 3). I have taken the values for each country for 2015 and 2020, and I have averaged the two to obtain my variable "Educ".

Unfortunately, data are not available for 16 countries of my sample. Since I did not want to lose all of them, I have proxied their value for this variable with data from the World Bank about the percentage of population that has obtained at least a Bachelor's degree or equivalent (`https://data.worldbank.org/indicator/SE.TER.CUAT.BA.ZS`). Indeed, such data are consistent with the data in OWID because the correlation coefficient between the two variables is equal to 0.8979 in 2015 for the 55 countries that are covered by both estimates and to 0.8475 in 2020 for 42 countries. However, a linear regression of the OWID data against the World Bank data shows that the regression coefficient for 2015 data is significantly greater than 1: I have then multiplied the values that come from the World Bank by 1.3, which is the point estimation for the 2015 regression and the upper bound of the 95% confidence interval for the 2020 regression. In the end, since I have not found a suitable proxy for tertiary education in Lebanon, I have decided to drop it from the sample. Values for "Educ" then range from 0.2% in Guatemala to 68.85% in Russia.

The last independent variable is the one I have called "Below _ 3t". I have created one version of this variable for PB emissions and one for CB emissions, by assigning it a value of 1 if the country has a value of per-capita PB/CB CO_2 smaller than 3 tons in 2015, and 0 otherwise. Further details are given in the next subsection.

3.3.2 Dependent variables

The data for the two dependent variables have been collected once again from the website Our World In Data. More precisely, data for production-based emissions have been collected from Ritchie, Rosado and Roser (2023a). They account for the quantity of carbon dioxide emitted from the

burning of fossil fuels (coal, oil, gas and flaring), and directly from industrial processes such as cement and steel production. Instead, they do not account for land use change, deforestation or soil pollution, for emissions embedded in traded goods and for emissions that derive from international aviation and shipping.

On the other hand, I have collected the data for consumption-based emissions from Ritchie, Rosado and Roser (2023b). They are the previous type of emissions after trade adjustments. More precisely, they are computed as PB emissions minus the emissions generated in the production of goods and services that are exported to other countries or regions, plus emissions from the production of goods and services that are imported from other countries or regions. If the CB emissions of a country are higher (resp. lower) than its PB ones, then it is said to be a net importer (resp. exporter) of carbon dioxide. Once again, data do not account for emissions from land use change, deforestation or soil pollution nor for emissions from international aviation and shipping. For the detailed process of collection and computation of data for both types of emissions, the references are Peters et al. (2011), Andrew and Peters (2023) and Friedlingstein (2023).

In my analysis, I have imported data for both types of emissions for the years from 2015 to 2021 and I have calculated the average yearly degrowth rates in this time window for each country to form the variables "PB _ CO2" and "CB _ CO2" (i.e., negative values for the variables reflect increases in the emissions). The year 2021 has been chosen because it is the most recent one with available data for both types of emissions. Indeed, CB emissions always lag PB ones by one year because an adequate resolution of trade data becomes available only one year later. At this point, one may question whether using data for 2021 emissions might result in biased estimates due to the lockdowns determined by the Covid-19 pandemic. This is the reason why some of the robustness checks that I have considered use data that refers to year 2019 instead of year 2021. Details are given in Section 3.6.1.

Data for PB emissions are available in OWID for all the 116 countries of my sample except Puerto Rico, which was then dropped from it. Instead, 16 countries lack data for CB emissions. OWID researchers claim that this depends on the low quality of their trade data. There is no hope to find a suitable proxy for such countries, so the two analyses on the two types of emissions will differ in the sample size. Nevertheless, the significance of the analysis on CB emissions is not altered because the countries that are excluded belong mostly to the Third World, while major economies and big emitters are all included.

3.3.3 The regression models

All the analyses have been carried out through the statistical software STATA, version 18.0. I have used standard OLS regression models with "robust" option, which allow for heteroskedasticity correction. In accordance with STATA (2024, p. 3), this means that if n is the sample size, k is the number of regressors and e_i is the calculated residual for country $i \in \{1, \dots, n\}$, then the variance-covariance matrix at use is

$$V = diag(\hat{\sigma_1}, \dots, \hat{\sigma_n}), \text{ where } \hat{\sigma_i} = \frac{n}{n-k} e_i^2, \tag{3.1}$$

instead of the usual homoskedastic matrix, which is

$$V = \hat{\sigma}^2 I_n, \text{ where } \hat{\sigma}^2 = \sum_i^n \frac{e_i^2}{n-k}. \tag{3.2}$$

I have first tested the following two regression models, where the cultural dimensions of Hofstede are absent:

$$\begin{aligned} PB\_CO2_i = \alpha + \beta_{GDP} Log\_GDP_i + \beta_{EDUC} Educ_i + \\ + \beta_{IND} Industry_i + \beta_{B3T} PB\_Below\_3t_i + \epsilon_i; \end{aligned} \tag{3.3}$$

$$\begin{aligned} CB\_CO2_i = \alpha + \beta_{GDP} Log\_GDP_i + \beta_{EDUC} Educ_i + \\ + \beta_{IND} Industry_i + \beta_{B3T} CB\_Below\_3t_i + \epsilon_i. \end{aligned} \tag{3.4}$$

After that, for each of the two types of emissions, I have added the cultural variables one at a time. Then, I have got six more models with the following equations:

$$\begin{aligned} PB\_CO2_i = \alpha + \beta_{GDP} Log\_GDP_i + \beta_{EDUC} Educ_i + \beta_{IND} Industry_i + \\ + \beta_{B3T} PB\_Below\_3t_i + \beta_{Cult} Cult_i + \epsilon_i, \end{aligned} \tag{3.5}$$

$$\begin{aligned} CB\_CO2_i = \alpha + \beta_{GDP} Log\_GDP_i + \beta_{EDUC} Educ_i + \beta_{IND} Industry_i + \\ + \beta_{B3T} CB\_Below\_3t_i + \beta_{Cult} Cult_i + \epsilon_i; \end{aligned} \tag{3.6}$$

$$\text{where } Cult \in \{PDI, IDV, MAS, UAI, LTO, IVR\}.$$

I have avoided estimating a model with the six cultural variables all together because such a model would not satisfy the rule of thumb that claims that a powerful regression requires at least 10 observations for each independent variable (Pardoe, Simon and Young, 2023, Sec. 12.9).

To sum up, the table 3.1 summarizes my research hypotheses in terms of the sign of the regression coefficients.

Table 3.1: Research Hypotheses

Coefficient	PB Emissions (Type A Hypotheses)	CB Emissions (Type B Hypotheses)
H1: β_{GDP}	Positive	Positive
H2: β_{EDUC}	Positive	Positive
H3: β_{IND}	Negative	Negative
H4: β_{B3T}	Negative	Negative
H5: β_{PDI}	Negative	Negative
H6: β_{IDV}	Positive	Positive
H7: β_{MAS}	Negative	Negative
H8: β_{UAI}	Positive	Negative
H9: β_{LTO}	Positive	Positive
H10: β_{IVR}	Negative	Positive

3.4 Analysis of production-based emissions

First, I have investigated PB emissions. Since the dependent variable is the average yearly percentage decrease in PB emissions per capita from 2015 to 2021, small absolute variations in the emissions of countries that have very low emissions will be captured as high percentage variations. This is going to affect the results of my regressions, so that I have decided to drop from the sample some countries whose emission levels in 2015 are very low. Figure 3.2 shows the countries that have PB emissions below 1 ton per capita in 2015. Since from 0.8 tons per capita to 0.6 tons per capita there are only two countries (São Tomé and Príncipe and Senegal), what has seemed to me a good choice for the cutoff is 0.7 tons per capita. Such a rapid decline in the variable occurs also from 0.6 tons per capita to 0.4 tons per capita, so that 0.5 tons per capita seems another good choice for the cutoff that will be tested in Section 3.6.2.

Then, I have checked for the absence of abnormal values at the two tails of the distribution of the dependent variable. These could be reflected by very high average yearly growth or degrowth rates. The top 10 growth rates are reported in Figure 3.3. Instead, the top 10 degrowth rates are reported in Figure 3.4. They suggest to check what has happened in Angola in recent years, since this is the only country with an average yearly

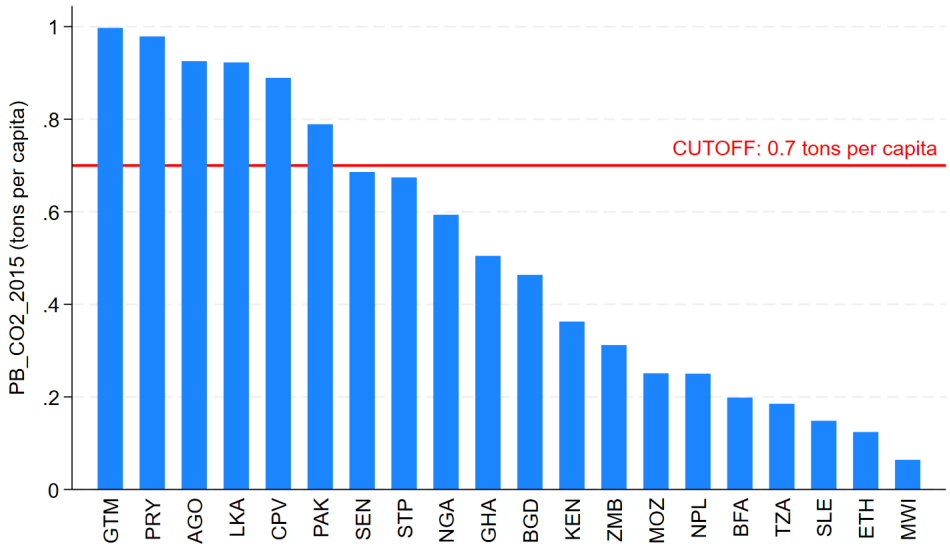

Figure 3.2: Countries with lowest PB emissions per capita in 2015

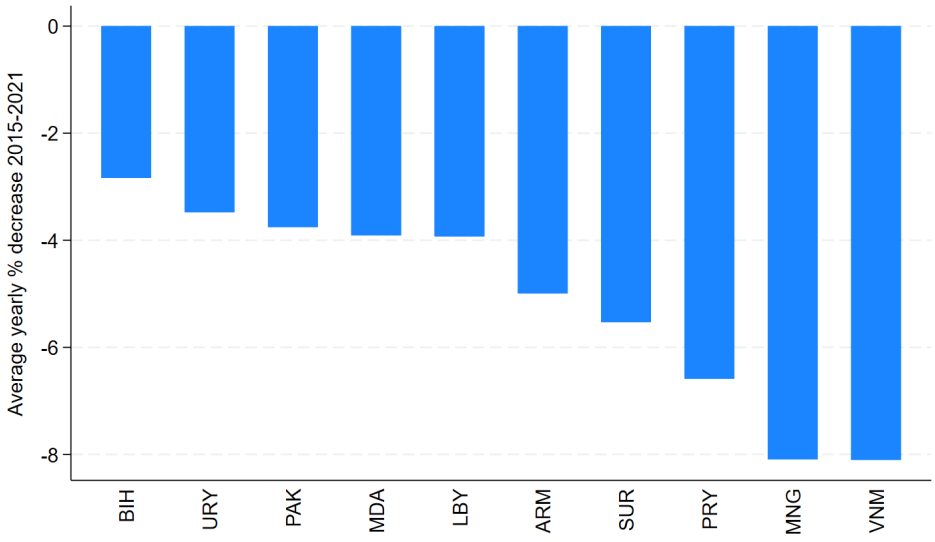

Figure 3.3: Top 10 average yearly % increases in PB Emissions

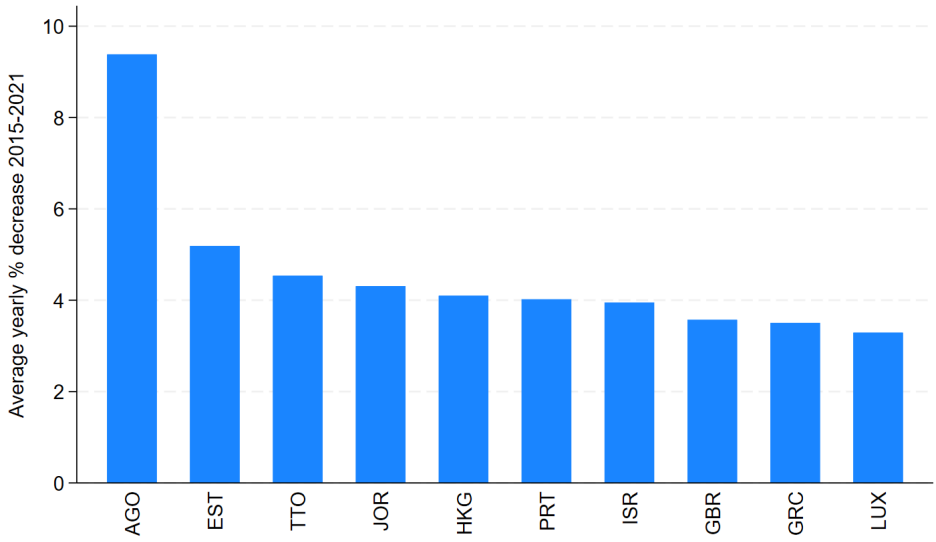

Figure 3.4: Top 10 average yearly % decreases in PB Emissions

degrowth rate well above 8 %. Angola's PB emissions in the last 25 years are reported in Figure 3.5. This figure does not show any sudden jump in the trend from one year to the following, which would suggest some sort of temporal inconsistency in the data. Thus, there is no reason to drop Angola from the sample.

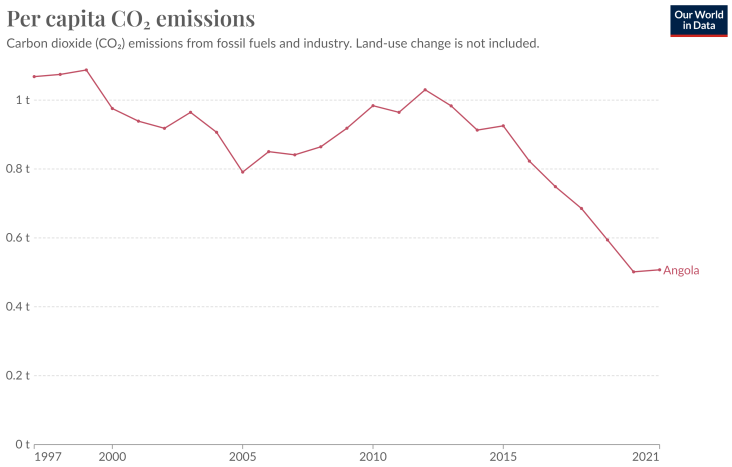

Figure 3.5: Angola's PB Emissions in the last 25 years

At this point, I have carried out the regressions. The results are reported in Table 3.2, where standard errors are in parentheses.

Model (1) is the one without culture, and it shows that Log _ GDP is positively correlated with the degrowth in PB emissions, while Industry is negatively correlated with it. No role is found, instead, for education and for having 2015 emissions below 3 tons per capita.

Models (2) and (3) show respectively that PDI is negatively correlated with the dependent variable while IDV is positively correlated with it. In both models however, Log _ GDP loses its significance: this suggests that Power Distance and Individualism are partially correlated with GDP. The correlation coefficient between IDV and Log _ GDP is 0.7043, and the increase in the R-squared when IDV is added to the regression is below 3%. These two things reveal that IDV and Log _ GDP are not really different variables, so that Individualism by itself does not have a great influence on the emissions besides the influence it has through GDP. Instead, the correlation coefficient between PDI and Log _ GDP is -0.5086, and the increase in the R-squared that occurs when PDI is added to the regression is above 6 %. Thus, Power Distance has an influence by itself on the dependent variable besides the one it has through GDP. Its scatterplot versus the average yearly % decreases in PB emissions is reported in Figure 3.6.

Finally, models (4), (5), (6) and (7) show that the other Hofstede cultural dimensions are not correlated with the dependent variable.

Figure 3.6: Power Distance and decreases in PB emissions

Table 3.2: Analysis of PB Emissions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log_GDP	1.1261*	0.4852	0.6714	1.1122*	1.0764*	1.1417*	1.2372*
	(0.4840)	(0.4889)	(0.5203)	(0.4780)	(0.5057)	(0.5207)	(0.5776)
Industry	-2.6607***	-2.1623**	-2.5570***	-2.6873***	-2.6084***	-2.6478***	-2.3421**
	(0.6424)	(0.6795)	(0.6509)	(0.6511)	(0.6982)	(0.6490)	(0.6918)
Educ	0.0004	-0.0037	-0.0037	0.0008	0.0004	-0.0074	-0.0168
	(0.0181)	(0.0157)	(0.0174)	(0.0185)	(0.0180)	(0.0173)	(0.0170)
PB_Below_3t	-0.0308	-0.3688	0.2524	-0.0325	-0.1202	-0.3439	-0.5455
	(0.7309)	(0.6883)	(0.7551)	(0.7297)	(0.7568)	(0.7766)	(0.8985)
PDI		-0.0378***					
		(0.0101)					
IDV			0.0295*				
			(0.0135)				
MAS				0.0039			
				(0.0120)			
UAI					-0.0073		
					(0.0133)		
LTO						0.0012	
						(0.0127)	
IVR							0.0183
							(0.0150)
Intercept	-10.7622*	-1.7086	-7.4892	-10.8050*	-9.7455	-10.6824*	-12.1681*
	(5.0285)	(5.4302)	(5.1677)	(5.0922)	(5.5853)	(5.2731)	(5.5437)
R-squared	0.2644	0.3252	0.2918	0.2651	0.2677	0.2989	0.3452
Observations	101	101	101	101	101	94	86

*** p<0.001, ** p<0.01, * p<0.05

3.5 Analysis of consumption-based emissions

Second, I have analysed CB emissions. For the same reasons as before, I have decided to drop from the sample some countries whose emission levels in 2015 are very low. Figure 3.7 shows the countries that have CB emissions below 1 ton per capita in 2015. Since from 0.8 tons per capita to 0.6 tons per capita there are only two countries (Ghana, very close to 0.8 tons per capita, and Nigeria, very close to 0.6 tons per capita), once again a good choice for the cutoff is 0.7 tons per capita.

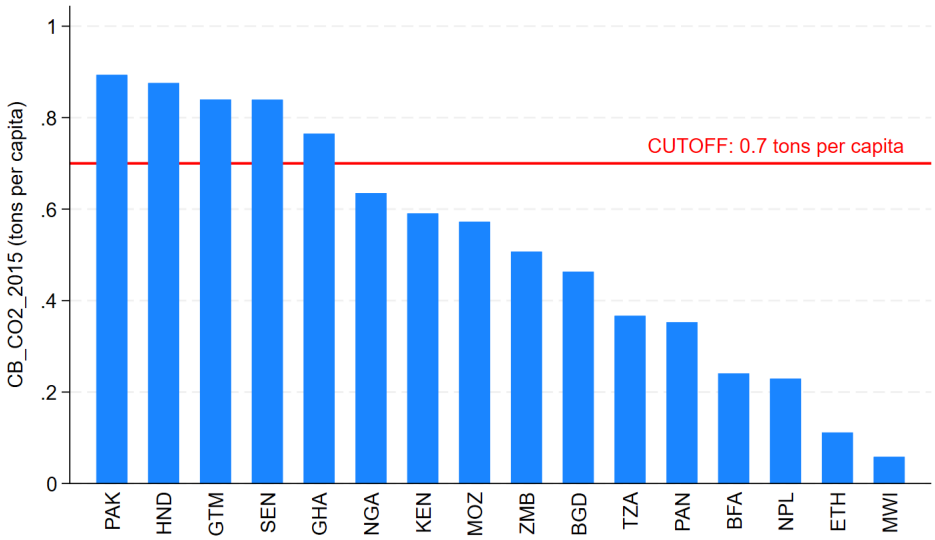

Figure 3.7: Countries with lowest CB emissions per capita in 2015

In line with what I have done for PB emissions, I have then checked for the absence of abnormal values at the two tails of the distribution of the dependent variable. The top 10 growth rates are reported in Figure 3.8, while the top 10 degrowth rates are reported in Figure 3.9. These two charts suggest to check what has happened in Guatemala in recent years, since this is the only country with an average yearly growth rate well above 8 %. Guatemala's CB emissions in the last 25 years are reported in Figure 3.10. This figure shows a sudden jump in the trend from 2017 to 2018, which points towards some sort of temporal inconsistency in the data. For this reason, I have decided to drop Guatemala from the sample, because not doing that might yield biased results in the regressions.

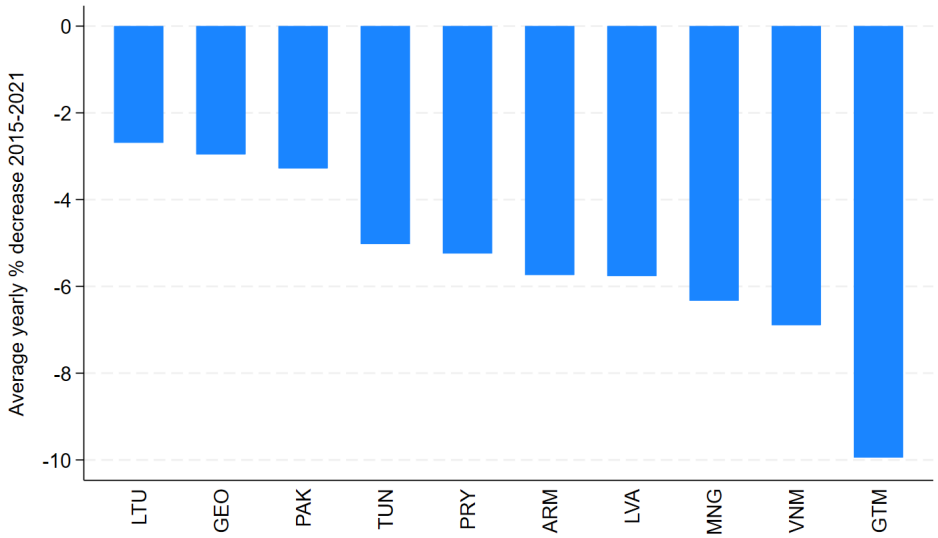

Figure 3.8: Top 10 average yearly % increases in CB Emissions

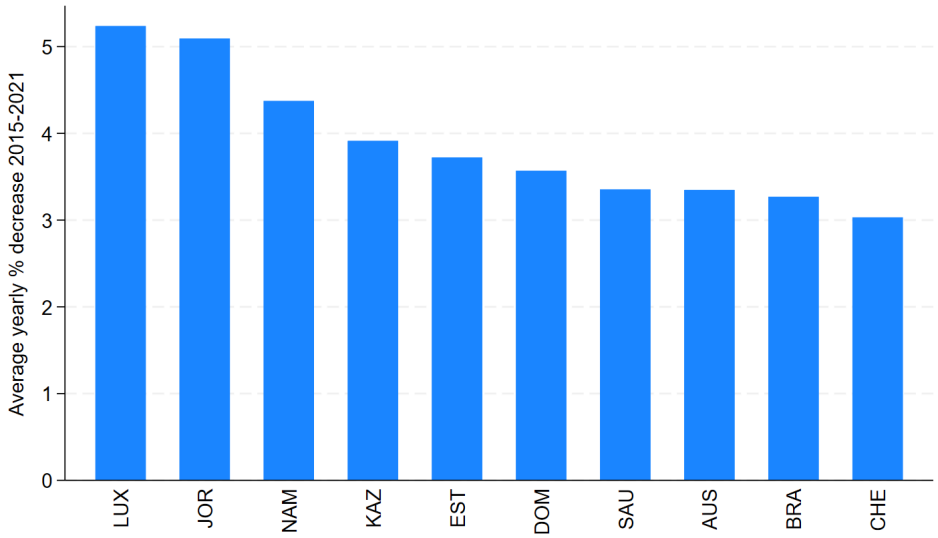

Figure 3.9: Top 10 average yearly % decreases in CB Emissions

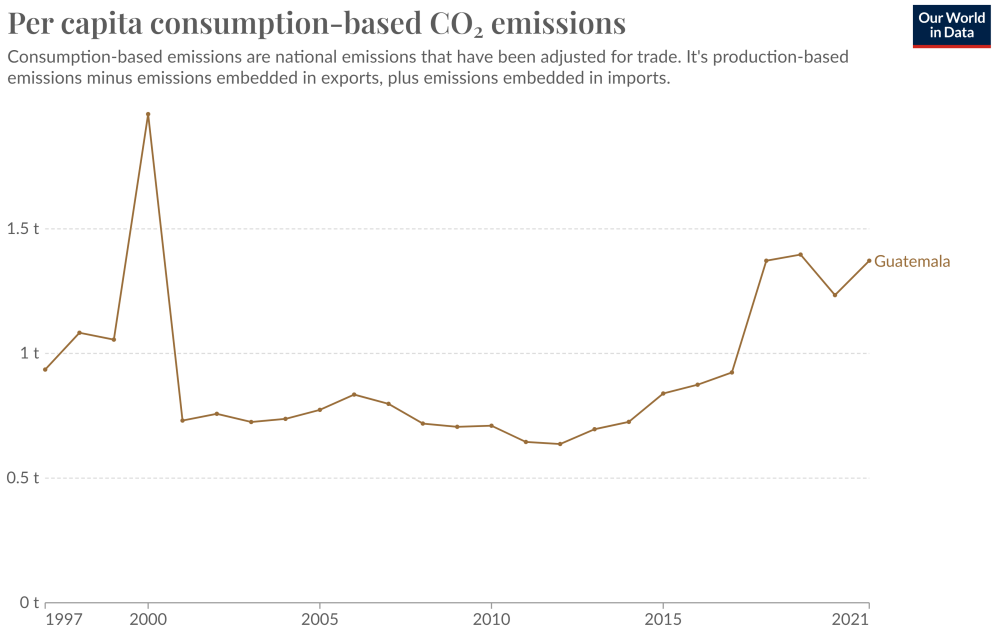

Figure 3.10: Guatemala's CB Emissions in the last 25 years

Without this abnormal value, I have been ready to run the regressions. The results are reported in Table 3.3, where standard errors are in parentheses.

Model (1) is the one without culture, and it shows that only the variable Industry is significantly correlated in a negative way with the degrowth in CB emissions. All the other three hypothesized main drivers (GDP, education and having 2015 emission levels below 3 tons per capita) are instead non significant.

Model (4) shows that MAS is significantly correlated with the dependent variable in a positive way. Motivation towards Achievement and Success contributes to the regression without lowering the significance of the variable Industry and by increasing the R-squared of the model by more than 4%. Thus, even if such a type of finding was not expected (see Section 3.7 for further discussion on the role for MAS), this dimension has some effect on the behaviour of consumption-based emissions. The scatterplot for MAS versus the average yearly % decreases in CB emissions is reported in Figure 3.11. The correlation is not evident there, but it must be remembered that the result in Table 3.3 comes after controlling for GDP and Industry.

Finally, models (2), (3), (5), (6) and (7) show that the other Hofstede cultural dimensions are not correlated with the dependent variable.

Table 3.3: Analysis of CB Emissions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log_GDP	0.7642	0.5544	0.8828	0.6870	0.7406	0.8793	0.8775
	(0.5149)	(0.5306)	(0.5462)	(0.5094)	(0.5345)	(0.5343)	(0.6115)
Industry	-2.4984***	-2.3024**	-2.5090***	-2.6325***	-2.4784***	-2.4543***	-2.1937**
	(0.6869)	(0.6953)	(0.6860)	(0.6519)	(0.7116)	(0.6872)	(0.7071)
Educ	-0.0168	-0.0178	-0.0154	-0.0136	-0.0165	-0.0024	-0.0122
	(0.0139)	(0.0134)	(0.0143)	(0.0133)	(0.0137)	(0.0163)	(0.0134)
CB_Below_3t	-0.8005	-0.9047	-0.8796	-0.8390	-0.8469	-1.0391	-0.3848
	(0.9737)	(0.9755)	(0.9793)	(0.9444)	(1.0198)	(1.0219)	(1.1104)
PDI		-0.0160					
		(0.0089)					
IDV			-0.0079				
			(0.0126)				
MAS				0.0276*			
				(0.0124)			
UAI					-0.0053		
					(0.0098)		
LTO						-0.0249	
						(0.0148)	
IVR							0.0230
							(0.0124)
Intercept	-6.8040	-3.6647	-7.6607	-7.3834	-6.2108	-7.1871	-9.2416
	(5.4685)	(5.8579)	(5.6083)	(5.4269)	(5.9940)	(5.6008)	(6.2305)
R-squared	0.2850	0.2987	0.2874	0.3277	0.2871	0.3123	0.3388
Observations	87	87	87	87	87	84	76

*** p<0.001, ** p<0.01, * p<0.05

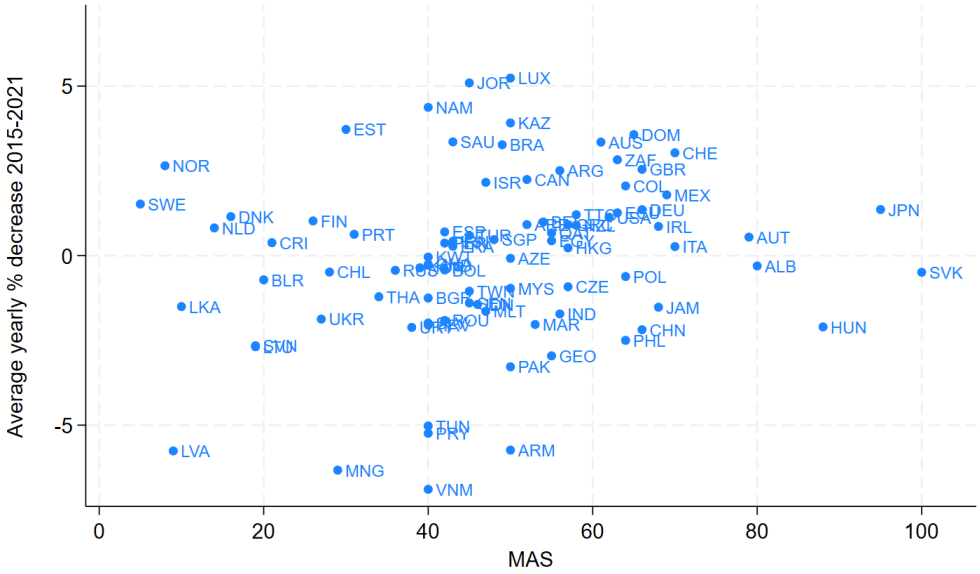

Figure 3.11: MAS and decreases in CB emissions

3.6 Robustness checks

The results obtained in the previous two sections may be partially dependent on either some of the choices that I have made in the manipulation of data or on the existence of countries that play the role of outliers in the regressions (i.e., dropping them from the sample yield a completely different estimation of the regression coefficient). In the following to subsections, I present the robustness tests that I have performed.

3.6.1 Alternatives for the dependent variable

The first objection that can be moved to my analysis is that it uses data that refer to year 2021, when many countries of the developed world were still experimenting lockdowns to limit the spread of the Covid-19 pandemic. The lockdowns might have determined an involuntary decrease in the emissions of CO_2, in the sense that they are not caused by the choices of governments, citizens and companies. For this reason, I have reran the regressions by considering only the time window that goes from 2015 to 2019. In this new time window, the variables have been computed in the same way as before, except for the fact that in this case the temporal horizon ends in 2019. The variable Educ has remained unchanged because it is available only for the years 2015 and 2020. Instead, the variable In-

dustry has value equal to 1 in this new time window also for Saudi Arabia and Jamaica, given that now their PB emissions are consistent with the increase in the share of workers employed in industry.

The second Achilles' heel of my analysis is the use of the average yearly degrowth rate as the dependent variable. This choice gives more weight to the countries that have lower absolute levels of CO_2 emissions and less weight to big emitters. For this reason, I have rerun the regressions (for both 2021 and 2019 data) with the average absolute decrease in the emissions. This means that the dependent variable is now the 2021 (resp. 2019) value for the emissions minus the 2015 value divided by 6 (resp. 4).

The results of the analyses with this new set of choices are summarized in Table 3.4, which shows that the findings of my first set of regressions (Tables 3.2 and 3.3) are confirmed.

As for what concerns the primary drivers, GDP and Industry are respectively positively and negatively correlated with both PB and CB emissions almost always. In CB emissions, Industry has a bigger role when percentage degrowth is considered, while GDP has a bigger role when absolute degrowth is the dependent variable. Education and having emissions below 3 tons per capita in 2015 are always non significant.

As for the cultural dimensions instead, Power Distance is the only one significantly correlated in a negative way with PB emissions. PDI always reduces the significance of the coefficient of Log _ GDP, except when 2019 data and absolute variations are considered (its importance is null in this case). Instead, IDV is not significant in all the alternative models that I have considered. Furthermore, Motivation towards Achievement and Success is always positively correlated with decreases in CB emissions and it never lowers the significance of the other significant variables.

3.6.2 Alternative cutoff

Another criticism that can be moved to my first analysis is that I have selected a too high cutoff. Table 3.5 presents the results of the regressions with a cutoff of 0.5 tons per capita for both PB and CB emissions in 2015 (i.e., this new set of analysis has bigger sample sizes). It can be seen that the roles of the variables Log _ GDP, Industry, PDI (for PB emissions) and MAS (for CB emissions) is confirmed throughout all the alternatives, with the only exception of PDI when 2019 data and absolute decreases are used.

Table 3.4: Summary of the robustness checks

Time window	Type of decrease	Emissions	Significant coefficients	Comments
2015-2021	Percentage	PB	GDP (+), Industry (-), PDI (-), IDV (+)	These are the results of Table 3.2
2015-2021	Percentage	CB	Industry (-), MAS (+)	These are the results of Table 3.3
2015-2019	Percentage	PB	GDP (+), Industry (-)	PDI (-) is the cultural dimension with the lowest p-value (0.1107)
2015-2019	Percentage	CB	Industry (-), MAS (+)	
2015-2021	Absolute	PB	GDP (+), Industry (-), PDI (-)	
2015-2021	Absolute	CB	GDP (+), Industry (-)	MAS (+) is the cultural dimension with the lowest p-value (0.0508)
2015-2019	Absolute	PB	GDP (+), Industry (-)	No cultural dimension has a low p-value (i.e., $p < 0.15$)
2015-2019	Absolute	CB	GDP (+), MAS (+)	

Table 3.5: Summary of the robustness checks with alternative cutoff

Time window	Type of decrease	Emissions	Significant coefficients	Comments
2015-2021	Percentage	PB	GDP (+), Industry (-), PDI (-), IDV (+)	
2015-2021	Percentage	CB	Industry (-), PDI (-), MAS (+), IVR (+)	
2015-2019	Percentage	PB	GDP (+), Industry (-)	PDI (-) is the cultural dimension with the lowest p-value (0.0704)
2015-2019	Percentage	CB	Industry (-), MAS (+)	Also IVR (+) has a low p-values (0.1112)
2015-2021	Absolute	PB	GDP (+), Industry (-), PDI (-)	
2015-2021	Absolute	CB	GDP (+), Industry (-)	MAS (+) is the cultural dimension with the lowest p-value (0.0534)
2015-2019	Absolute	PB	GDP (+), Industry (-)	No cultural dimension has a low p-value (i.e., $p < 0.15$)
2015-2019	Absolute	CB	GDP (+), MAS (+)	

3.6.3 Influential data points

Finally, the results of the analyses might be subject to the influence of some data points, especially because of the limited sample size. These data points are said to have leverage, which means that they have the ability to move the regression line towards themselves. Identifying outliers is always important because regressions are not robust to influential points (as all averages are not). The procedure that I have used to detect such points is the one I have learnt in Raggi (2023), with STATA code that can be found in Canette (2014).

I have tested the robustness to outliers for the two most important results that have emerged from previous analysis: the negative correlation of Power Distance with PB emissions and the positive one of Motivation towards Achievement and Success with CB emissions. This is done as follows. The equation at use for PB emissions and PDI is the following version of the already reported Equation 3.5:

$$PB\_CO2_i = \alpha + \beta_{GDP} Log\_GDP_i + \beta_{EDUC} Educ_i + \beta_{IND} Industry_i + \\ + \beta_{B3T} PB\_Below\_3t_i + \beta_{PDI} PDI_i + \epsilon_i, \tag{3.7}$$

Let $\boldsymbol{\beta} = (\alpha, \beta_{GDP}, \beta_{EDUC}, \beta_{IND}, \beta_{B3T}, \beta_{PDI})'$ denote the vector of true regression coefficients, and let $\boldsymbol{b} = (a, b_{GDP}, b_{EDUC}, b_{IND}, b_{B3T}, b_{PDI})'$ be the set of regression coefficients provided by the OLS method robust to heteroskedasticity with full sample (i.e., all 115 countries except those that have emissions below 0.7 tons per capita in 2015). Furthermore, let $\boldsymbol{b}_{(i)} = (a_{(i)}, b_{GDP(i)}, b_{EDUC(i)}, b_{IND(i)}, b_{B3T(i)}, b_{PDI(i)})'$ be the set of the regression coefficients provided by the OLS method robust to heteroskedasticity when observation i is dropped from the sample. The idea is to compute the norm of $\boldsymbol{b} - \boldsymbol{b}_{(i)} \; \forall \; i \in \{1, \ldots, n\}$ and rerun the regression without the countries for which such norm is greater than 1 (rule of thumb; Raggi, 2023).

In STATA, this procedure can be done using the command "jackknife" (Canette, 2014). This yields for PDI and PB emissions the values reported in Figure 3.12. Following the rule of thumb, I have reran the regression without the seven countries that are above the cutoff. The results are reported in Figure 3.13. They show that the role for PDI is confirmed, and in particular it is confirmed besides the role played by GDP. Indeed, in this new regression the standard error for GDP reduces with respect to Model (2) in Table 3.2 (0.3497 versus 0.4889), so that Log _ GDP is much more significant than it was there (p-value is 0.064 versus 0.3482). So, the influence of the outliers is not such that it alters the results of the first regression.

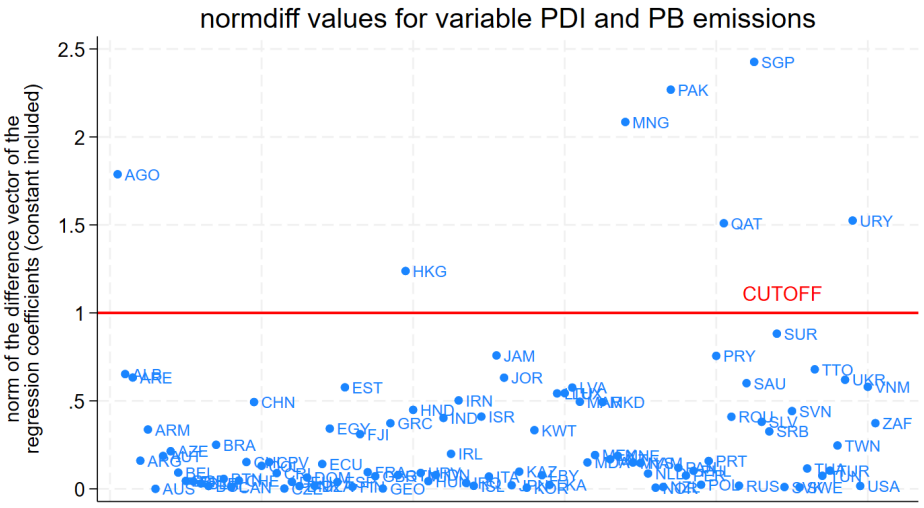

Figure 3.12: Values of $||\boldsymbol{b} - \boldsymbol{b}_{(i)}||$ for PDI and PB emissions

```
Linear regression                               Number of obs     =         94
                                                F(5, 88)          =      17.94
                                                Prob > F          =     0.0000
                                                R-squared         =     0.4192
                                                Root MSE          =     1.9101

------------------------------------------------------------------------------
             |               Robust
      PB_CO2 | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
         PDI |  -.0358042   .0097338    -3.68   0.000     -.055148   -.0164603
     Log_GDP |   .6556144    .349716     1.87   0.064    -.0393726    1.350601
    Industry |  -1.789558   .5914296    -3.03   0.003      -2.9649   -.6142159
        Educ |    .004064   .0142853     0.28   0.777    -.0243251    .0324531
 PB_Below_3t |  -.3535997   .5831661    -0.61   0.546     -1.51252    .8053203
       _cons |  -3.754858   3.978556    -0.94   0.348     -11.6614    4.151686
------------------------------------------------------------------------------
```

Figure 3.13: Regression for PDI and PB emissions without the outliers

The same procedure was adopted for the relationship between MAS and CB emissions, whose outliers are identified in Figure 3.14. The results of the regression without the five outliers are instead reported in Figure 3.15. Once again, the primary results that I have obtained (i.e., Model (4) in Table 3.3) are not altered by the absence of the outliers.

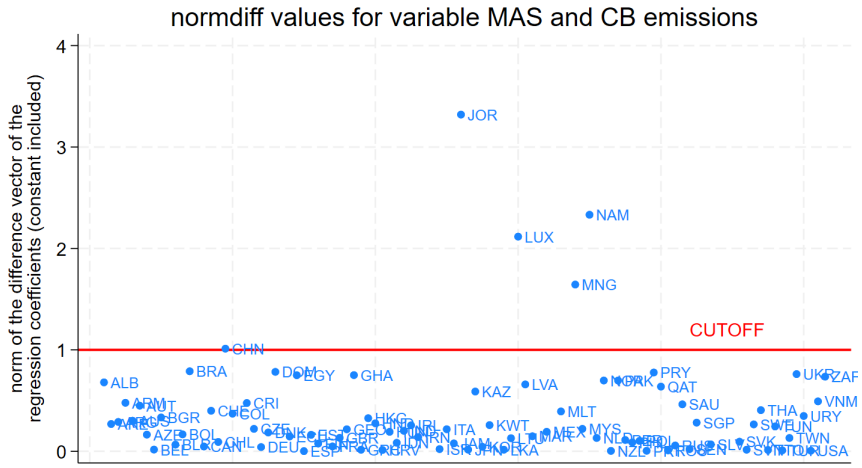

Figure 3.14: Values of $||\boldsymbol{b} - \boldsymbol{b}_{(i)}||$ for MAS and CB emissions

```
Linear regression                               Number of obs     =         82
                                                F(5, 76)          =       7.06
                                                Prob > F          =     0.0000
                                                R-squared         =     0.3339
                                                Root MSE          =     1.8844

------------------------------------------------------------------------------
             |               Robust
      CB_CO2 | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
         MAS |   .0280751   .0121397     2.31   0.023     .0038967    .0522535
     Log_GDP |   .7738038   .3699512     2.09   0.040     .0369822    1.510625
    Industry |  -2.215522   .6265491    -3.54   0.001    -3.463403   -.9676412
        Educ |  -.0078235   .0117826    -0.66   0.509    -.0312905    .0156436
  CB_Below_3t |   -.590797   .8070941    -0.73   0.466    -2.198264     1.01667
       _cons |  -8.637864   3.887597    -2.22   0.029    -16.38069   -.8950431
------------------------------------------------------------------------------
```

Figure 3.15: Regression for MAS and CB emissions without the outliers

3.7 Discussion and further research

As for the control variables, I conclude that two of the hypotheses in Table 3.1 find support, while two do not. The regressions I have ran support H1 and H3 for both PB and CB emissions: GDP is positively correlated with a degrowth in the emissions, while the variable Industry is negatively correlated with it. Instead, the regressions do not find a significant effect for the percentage of population with tertiary education (H2) and for having 2015 emission levels below 3 tons per capita (H4). Possibly, tertiary education is not the most suitable proxy for education when the analysis deals with climate change. For example, the article of Lawson et al. (2019) shows that teaching CC to middle school-aged children yields a higher level of concern in their parents. Even if there is no proof in the article that such concern then transforms into a concrete action, it is possible to use a variable that tracks whether the national school system at all levels provides courses on environmental sustainability instead of my variable. As for having emission levels below 3 tons per capita in 2015, I believe that its non-significance reveals just the fact that some countries have not been able to achieve economic development yet.

As for the cultural dimensions of Hofstede instead, I conclude that two main results emerge from the analysis. The first is the fact that after 2015 the production-based emissions of CO_2 have reduced more in countries with low Power Distance, besides the role played by the control variables. This finding supports H5 for PB emissions and is perfectly in line with many of the results reported in Table 2.1. Thus, it may be interesting to analyse power distant societies at the individual level to discover the causes of such a correlation. The already available literature claims that governments and companies in countries with high PDI undertake less climate action either because the bureaucrats who implement environmental programs advance there professionally more by the influence of sponsors that have little interest in the environment rather than job performance and technical competence (Metz, 1991); because the governments of such countries have a weak capacity to debate and respond to social issues (Katz, Swanson and Nelson, 2001); or because the companies of such countries tend to sacrifice ethics and sustainability in favour of expediency (Blodgett et al., 2001; Swaidan and Hayes, 2005; Vitell, Paolillo and Thomas, 2003). Nevertheless, no article among those that have been cited has tried to disentangle causality.

The second result is instead the fact that after 2015 the consumption-based emissions of CO_2 have reduced more in countries with high Motivation towards Achievement and Success. This finding is in opposition with hypothesis H7 for CB emissions and also with the analyses reported in Table 2.1 (except Dangelico, Fraccascia and Nastasi, 2020, whose focus is not on the emissions of CO_2 anyway). Moreover, in the available literature it is not possible to find hypotheses that support it. Indeed, the one reported in Ullah et al. (2022) and based on the thoughts of Porter and Linde (1995) and Yan, Cui and Gil (2016), who claim that environmental innovation requires entrepreneurship, ambition and competitiveness, which are features of decisive countries, refers only to poor countries and targets the business world rather the choices of citizens, which are instead the main drivers of CB emissions. Thus, the causes that might have determined these results have to be hypothesized without previous references.

I provide here two possible paths. First, it is possible that the citizens of countries with low MAS (who look for quality of life rather than material wealth in their existences; G. Hofstede, 2001) have started to reduce their emissions in everyday life before 2015 because they have begun to care about climate change as soon as the first evidence in favour of its existence became available. Instead, in the time window after 2015, the citizens of decisive countries might have provided high reductions because they have undertaken in this period the steps undertaken before 2015 by the citizens of consensus-oriented countries, which instead might have slowed down their green transition in recent years due to the limited advancements in the available technology and/or the high costs it involves. Second, given that people living in societies with high MAS tend to consider money as very important (G. Hofstede, 2001), it may be that the environment-friendly technology that has become available after 2015 has become cheap up to the point that its purchase has made people better-off than going on with the old technology, while this was not the case before 2015 (e.g., buying solar panels is cheaper than continuing to purchase natural gas to produce heat with the boiler; buying an electric car is cheaper than buying a traditional one, given the costs of the petrol in the long run). This effect might have been helped in very recent years by the fact that some examples of green products specifically designed for people who consider showing status very important, which is another peculiarity of countries with high MAS, have appeared (e.g., big and powerful cars with electric engine).

Conclusions

This dissertation has presented first the Hofstede Model for national culture, with all his positive and negative features, and an extended review of the literature that has linked it to a wide set of indicators related to climate change. A clear pattern has emerged for some of the six dimensions of the model, while mixed evidence has been found for the others. As for country-level indicators, the articles that I have analysed show that they are worse in countries with high Power Distance, low Individualism, high Motivation towards Achievement and Success, low Long-term Orientation and low Indulgence. No clear direction has been found instead for Uncertainty Avoidance. As for studies directly related to the world of business (i.e., their focus is on the environmental sustainability indexes of firms and corporations), they are worse in countries with high Power Distance and high Motivation towards Achievement and Success, while no clear evidence has been found for the other dimensions.

Second, I have presented my own correlation analysis. This has focused on the decreases in both production-based and consumption-based per-capita CO_2 emissions of countries after 2015, which is the year in which the whole world has recognized the importance of climate action through the signing of the Paris Agreement and the Sustainable Development Goals. The trend in the emissions, both PB and CB, has been analysed up to the most recent year for which there are reliable data (i.e., 2021) and also by limiting to year 2019 to avoid biases that might have been caused by the Covid-19 pandemic. My models have shown that production-based emissions have reduced more in countries with low Power Distance, while consumption-based emissions have reduced more in countries with high Motivation towards Achievement and Success. These results have also passed a variety of robustness checks.

The result on Power Distance is perfectly in line with the evidence that has emerged from the literature review and pertains to a dimension of the Hofstede Model that is not problematic. Besides all the validations of the model listed in the first chapter, PDI has been found to emerge also from recent representative surveys of national population (the reference is Minkov, 2017, though in this analysis it has emerged as a logical facet of Individualism rather than as an independent dimension). This finding suggests that further research should focus on countries with high PDI to see if their worse performance is due to their governments (since these have a low capacity to respond to social issues and their bureaucrats advance professionally and in the society thanks to sponsors that have little interest in the environment) or to their firms (since these tend to sacrifice environmental sustainability).

Instead, the result on Motivation towards Achievement and Success is a complete novelty in the literature, and it is inconsistent with what the academic world has always hypothesized. This means that further analysis should clarify why such a type of correlation has emerged. I suggest to check whether the green transition has started before 2015 and has slowed down after this year in countries with low MAS; and if the environment-friendly technology that has become available after 2015 has become cheap up to the point that its purchase makes citizens invest in it, while this was not the case before this year. Also, it must not be forgotten that MAS is one of the two most problematic dimensions of the Hofstede Model (together with Uncertainty Avoidance), because none of the experiment that have been carried out in recent years has been able to find traces of it in wide samples of national population (see Minkov, 2017 and Minkov and Kaasa, 2021 for further reference on that). Thus, further evidence on the temporal invariance of this dimension (or disconfirmation of that) must also be provided.

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