Happiness and the Environment: Finding out a relationship

By

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Biographical Note

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Before completing the degree, in October 2008, she began working first as an internal auditor and then as a project analyst at IAPMEI (*Instituto de Apoio às Pequenas e Médias Empresas*). A year after left the company to join the *INOV Contacto* Program, an internship in the Portuguese Trade and Investment Office in New York, USA. Upon her return, she worked at *Parques de Sintra – Monte da Lua* in management and planning, in the financial and administrative department.

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Abstract

Pollution is a serious issue that has been raising concern for decades. It negatively influences human lives in a wide variety of ways, much of these leading to decreases in overall well-being. GDP is the most broadly used measure of welfare, even though it was not built with that intent. It is discussed that there are better ways to evaluate well-being, such as self-reported levels of happiness and life satisfaction. Furthermore, the economics of happiness is a blooming area in contemporary economic research.

This dissertation examines a group of 65 countries to try explaining divergences in self-reported levels of life satisfaction by reference to, among other indicators, air pollutants and environmental amenities, while controlling for economical, social, demographic, and cultural influences. This is done through the interpretations of the results of a constructed econometrical model. The regression analysis is done for the year 2000 and 2010.

It is concluded that the variables most impacting life satisfaction on both years are GDP per capita, the percentage of Muslims and Buddhists, and the percentage of people over 65 years. From 2000 to 2010, environmental variables, such as CO_2 and other greenhouse gases emissions per capita, the percentage of marine and terrestrial protected areas and the percentage of fossil fuel in total energy consumption became significant in explaining life satisfaction. This points to a positive shift in the relationship between well-being and the environment.

It is also compared the situation in Portugal, a country going through a severe social crisis, with Denmark, where economically and socially all is stable, for the period between 1990 and 2010. While in the first, the improvement in environmental indicators was not enough to prevent life satisfaction from decreasing, in Denmark, with all social indicators stable, life satisfaction rose in this country with a better environment.

Resumo

O tema da poluição tem, há décadas, levantado sérias preocupações por todo o mundo. Esta tem uma influência nefasta na vida do ser humano, resultando em diminuições de bem-estar. O PIB é a medida de bem-estar mais usada a nível mundial, apesar de não ter sido construído com esse intuito. Na presente dissertação é discutido que existem formas mais adequadas de avaliar o bem-estar, como a felicidade e a satisfação com a vida. Ademais, a economia da felicidade é uma área em significante crescimento na economia contemporânea.

Esta dissertação examina um grupo de 65 países como o objectivo de explicar divergências nos níveis de satisfação com a vida. Para tal, recorre-se a indicadores de poluição aérea e de amenidades ambientais, controlando influencias económicas, sociais, demográficas e culturais. Isto é conseguido através da interpretação dos resultados de análises de regressão com base num modelo econométrico construído, para os anos de 2000 e 2010.

Conclui-se que as variáveis com impacto mais significativo em ambos os anos foram o PIB per capita, a percentagem de muçulmanos e budistas e a percentagem de população acima dos 65 anos. De 2000 para 2010, algumas variáveis ambientais, como as emissões de CO_2 e outros gases de efeito de estufa per capita, a percentagem de áreas marítimas e terrestres protegidas e a percentagem de combustíveis fósseis no total de energia consumida, tornaram-se significativas na explicação da satisfação com a vida. Isto indica uma mudança positiva na relação entre bem-estar e o ambiente.

Para o período de 1990 a 2010, é também comparada a situação de Portugal, três um país que se encontra no meio de uma grave crise social, com a Dinamarca, que passa por um período de estabilidade económica e social. Enquanto para o primeiro as melhorias a nível ambiental não foram suficientes para prevenir uma queda na satisfação com a vida, na Dinamarca, a estabilidade dos indicadores sociais, permitiu que a satisfação com a vida subisse com as melhorias ambientais.

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List of Abbreviations

BOD	Biological Oxygen Demand
CDIAC	Carbon Dioxide Information Analysis Center
CIA	Central Intelligence Agency
CL	Civil Liberties
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DAS	Detroit Area Study
EEA	Environmental European Agency
EPA	Environmental Protection Agency
ESS	European Social Surveys
FISH	Fordham Index of Social Health
GCAC	Global Community Assessment Centre
GDP	Gross Domestic Product
GESDI	Gross Environmental Sustainable Development Index
GNH	Gross National Happiness
GNP	Gross National Product
GPI	Genuine Progress Indicator
GS	Genuine Savings
GSDP	Gross Sustainable Development Product
HDI	Human Development Index
HFC	Hydrofluorocarbons
HPI	Happy Planet Index
HPI	Human Poverty Index
IISP	Institute for Innovation in Social Policy
INSEE	Indian Society for Ecological Economics
MEW	Measure of Economic Welfare
NEF	New Economics Foundation
NO_2	Nitrogen Dioxide
NOx	Nitrogen
OECD	Organisation for Economic Co-operation and Development

Pb	Lead
PFC	Perfluorocarbons
PM	Particulate Matter
SF6	Sulphur hexafluoride
SO_2	Sulphur Dioxide
SPI	Social Progress Indicator
SS	Suspended Solids
USA	United States of America
USD	United States Dollars
UK	United Kingdom
VOC	Volatile Organic Compounds
WHO	World Health Organization

1. Introduction

Pollution is a serious issue that has been raising concern for decades. It negatively influences human lives in a wide variety of ways, much of these leading to decreases in overall well-being. Through health problems and effects of climate change, pollution has been diminishing the quality of life of most individuals throughout the world. In opposition, environmental amenities, such as lakes, forests, or parks, and the proximity to them and ability to enjoy them have a positive effect on individual happiness. Shockingly, in many countries, especially in the less privileged ones, this topic is still not fully addressed. The laws are not strict enough and not well enforced. And the way our economy is shaped does not encourage environmental protection.

While the foundation of neoclassical economics is the maximization of utility, many studies have shown that utility should not simply be considered spending. There are many other variables that influence one's well-being that are not accounted for in GDP, the main measure of welfare nowadays. Employment, sense of freedom, job amenities, social relations, physical health, social status, healthy environment, and government activity are just a few examples. Studies have been made to try to isolate genetics from other influences in determining subjective well-being. It has been shown that 50% is genetics and 50% is attributed to what has been previously discussed. This still gives plenty of room for governments to influence individual's well-being with policies focused more on happiness than solely on economic growth.

The study of happiness can thus be a great tool for economists all over the world. It can also act as an impeller to decrease pollution, through tighten environmental laws and inspection, and environmental awareness, as governments get to see how pollution reduces happiness for present and future generations.

This dissertation proposes to examine a group of 65 countries to try explaining divergences in self-reported levels of life satisfaction by reference to, among other indicators, environmental pollutants and amenities. Control variables (cultural, economical, social, and demographic) are included in the analysis. This is done through the construction of an econometric model where the results of the regression analysis are interpreted for the years of 2000 and 2010.

It is as well a purpose of this dissertation to make a comparison between a country going through a severe social crisis, Portugal, with Denmark, a nation economically and socially very stable. This is done for the period of 1990 to 2010.

The dissertation is organized as follows. Section 2 begins with a literature review divided in three parts. Firstly, there is a critique to GDP, particularly for its use as a measure of welfare, for which several alternatives are presented. Secondly, a review on numerous studies relating happiness and economics, and the determinants of well-being. Thirdly, a compilation of the most well-known, harmful, and studied pollutants, and their effects on well-being, and a review on environmental amenities. In section 3, the methodology, data and econometric model used are explained. In section 4, the results of the regression analysis are exhibited and discussed. And a comparison of the economical, social and environmental situation in Portugal and Denmark is presented. Section 5 concludes.

2. Literature Review

2.1 GDP's criticism

2.1.1 Advantages and Drawbacks

"Gross domestic product (GDP) is the monetary, market value of all final goods and services produced in a country over a period of a year. The real GDP per capita (corrected for inflation) is generally used as the core indicator in judging the position of the economy of a country over time or relative to that of other countries. The GDP is thus implicitly, and often even explicitly, identified with social welfare – witness the common substituting phrase 'standard of living'. This approach does not follow from any theory about GDP as a measure of social welfare, but has grown to become like this in the course of time." (Bergh, 2009, pp. 117-118)

GDP has suffered great criticism as a measure of welfare as early as the 1950s but more strongly since the gap between the quality of life and GDP began to expand, in the 1970s (Stockhammer *et al.*, 1997). The indicator fails to include non-market activities and measures of well-being (e.g. leisure, quality of social relations, economic security, personal safety, health and longevity) while it ignores both the positive and the negative externalities (e.g. environmental), income distribution, and quality changes (Fleurbaey, 2009; Stiglitz *et al.*, 2009; Kula *et al.*, 2010; Muller *et al.*, 2011).

Governments are a central part in current economies. They provide crucial services of a collective nature, as security, health services, and education. The quantity and quality of these vary tremendously across nations and have evolved quite differently over time and countries. These services tend to be positively valued by individuals, as it raises their well-being, and the more close to being a part of a welfare state they are the more of a safety net and sense of security individuals tend to feel. However, all these government provided services tend to be poorly measured and are not accurately included in the GPD. And it is even worse when it comes to adjust for quality, which is fundamental to properly estimate not only the value of these services but also real income and real consumption (Stiglitz *et al.*, 2009).

GDP does not take into account the unequal distribution of income throughout a country. It fails to capture the difference between a rise of income in a poorer family

and a richer family (distinctive due to diminishing marginal utility of income). It also neglects to differentiate expenses on basic versus luxury goods. Truthfully, the latter have a comparatively higher weight given their higher prices (Bergh, 2009).

This indicator doesn't cover the informal economy, which might explain why GDP per capita for the developing countries is so low. Thus for, informal activities are repressed by public policy which, in turn, can create risks for social welfare. In many cases, local social contracts, the foundation of a happy stable life, are much sturdier and frequent in informal developing economies. Putting these in jeopardy will conflict with positive aspects, which are not reflected on GDP, of what constitutes a society (Bergh, 2009).

One of the most criticized points is that GDP doesn't incorporate negative environmental externalities. No damage derived from pollution (air, water, soil, etc.) is accounted in GDP (Bergh, 2009; Muller *et al.*, 2011). However, there is an increase in GDP if pollution is being fought, for example through increasing costs caused by pollution in building maintenance or repairs, in water treatment, healthcare, accidents (oil spills), and loss of productivity and natural resources (Bergh, 2009). This is one of the main critics to the GDP, some actions give the wrong signal, increasing GDP when it should decrease and vice-versa. This holds for the fight against pollution but also happens when an individual acquires something health damaging (GDP raises in the short run but utility lowers in the long run).

Even though the size of GDP has an impact on the environment, what is really decisive is the output structure; production of, for instance, steel and chemicals is far more damaging then child care or education. For the past decades, the input-output structure of the GDP has been changing, as many countries have been experiencing a shift to services from agriculture and industry. Nonetheless, even though these two sectors have been losing share in relative terms they have been growing in absolute terms. Additionally, the third sector also puts its strains on the environment. For example, in this sector the use of computers is constant, yet its technology continuously becomes obsolete, requiring new equipment. Also, transports, part of the service sector,

are extremely energy-intensive. Therefore, changing the output structure might in some cases minimize environmental damages but it cannot offset them[1] (Røpke, 1997).

GDP also doesn't account for the natural capital, like fish stocks, forests, biodiversity, fossil energy, or metals, and its depreciation. There would have to be a sustainable use of this capital for a null effect on the economy (Bergh, 2009).

From this framework was born the idea of green accounting, which is a wider take on national accounts that aims to include not only marketed natural resources but also non-marketed as well to incorporate the environment in economic discussion. There are several environmental effects already indirectly included in the system of national accounts, for example, losses in income from tourism due to pollution. However, even though these are accounted for, most are not directly recognizable, only public resources being exploited show up via royalty schemes. There is the need to integrate the use of the environment and natural resources on national accounts and reflect them in the measures of income and product (Hamilton, 1994).

Well-being is also highly correlated with leisure. This is again not taken into account by GDP. As a matter of fact, it is entirely the opposite, as there is an opportunity cost for not being productive (Bergh, 2009).

There are many unaccounted factors that weight in individual happiness or well-being. For example, having a job, a stable family, health, freedom, friends, or being part of a community. Within this framework, it is safe to say that individual income does not capture individual happiness; so it is highly unlikely that GDP would offer an accurate measure of social welfare at a macro level, especially when aggregated information continuously leads to losses (Bergh, 2009).

If the economic agents and society as a whole credit GDP for influencing the economy and if this belief prompts pessimistic and optimistic reactions to fluctuations in GDP growth, then they become reality. Governments, banks, and international organizations reinforce this pro-cyclic phenomenon of GDP. Nevertheless, this creates the reverse effect of trust and economic stability when GDP grows. GDP, the most commonly used measure of economic activity, presents some other economical

[1] From a global perspective, there is no point in altering the output structure for a less damaging one if the country will import environmentally harmful products from other countries. To the planet it does not matter where the harm occurs (Røpke, 1997).

advantages. This indicator has also proven quite valuable in providing a rough estimate to future tax revenues, which in turn is fundamental to ascertain fair financial contributions of member states and to evaluate the possibility of international loans. For developing countries in particular, there is a more direct link between economic growth and welfare, meaning that GDP is more relevant. Ultimately, GDP provides a clear economic comparison between countries, guarantying data homogeneity; even not being an accurate measure for welfare it certainly has some advantages (Bergh, 2009).

Individuals' necessities can be broadly divided into two categories: lower and higher needs. The first, for example satisfying hunger and thirst, ought to be fulfilled prior to the second. In addition, there are certain goods and services in which the individuals' needs are limited. Given this frame of reference, it is not coherent to assume that income and consumption growth are a good proxy to the satisfaction of elementary needs. Therefore, the increases in GDP may not reflect the same changes in welfare. Furthermore, there are several studies that suggest that since the mid 20th century, in most OECD countries, while GDP has grown, welfare hasn't. There are empirical evidences that point to a split in GDP and welfare growth curve; after a period of growing at the same pace, the quality of life begins to deteriorate (Max-Neef, 1995 in Bergh, 2009).

Individual well-being has several dimensions. According to Stiglitz *et al.* (2009), the basic ones are: "material living standards, health, education, personal activities including work, political voice and governance, social connections and relationships, environment (present and future conditions), and insecurity, of an economic as well as physical nature)" (Stiglitz *et al.*, 2009, pp. 15). When trying to raise people's level of well-being, efforts should be directed at these eight topics, and this should be a government's concern when designing policies. These can be measured through surveys where individuals self-report their own levels of well-being.

Therefore, Stiglitz *et al.* (2009) defend the necessity of creating a system of measurement that focuses on people's well-being, in terms of sustainability, rather than economic production. This without totally disregarding GDP, as it is still valuable to monitor economic activity. These measures can and should complement each other to provide more and better information. The authors also recommend that instead of production the focus should be on income and consumption, and including non-market

activities and leisure. A recommendation made by the authors is that in the short-run, while the indicators cannot be adjusted, governments ought to try focusing more on net instead of gross measures of economic activity. This would include depreciation (and not forgetting environmental depreciation) that can account for differences in the structure of production, even though it is usually hard to calculate.

However, the question of sustainability comes as a complement to the topic of well-being, and even tough they go together they should be analysed separately. Sustainability is about predicting the future to try guarantying at least the same level of well-being for the next generations (Stiglitz *et al.*, 2009).

2.1.2 Sustainability

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). Since this first notion of sustainable development was published, the concept has stretched to incorporate all scopes of present and future economic, social, and environmental well-being (Stiglitz *et al.*, 2009).

In the Brutland report, it was also stated that economic growth is fundamental to improving the conditions of life in developing countries and to fight environmental problems in all nations. This is due to the fact that the higher the GDP the easiest it is to make people more aware of the environmental problems, to make resource use more efficient, to find ways of substituting the use of scarce resources, and to develop new cleaner technologies[2] (Røpke, 1997). Goodland (1995), on the other hand, argues that environmental sustainability does not allow economic growth, as it implies sustainable levels of production and consumption.

Environmental sustainability emphasises the role natural resources, which provide renewable (forests) and exhaustible (minerals) physical inputs, incorporating them into the production process. In environmental sustainability models, the

[2] This is in line with the theory behind the Environmental Kuznets Curve. There tends to be environmental degradation with economic growth but only until a certain point. Afterwards, economic growth continues rising and the environment begins improving.

production process is also incremented with the disregarded life-support systems, such as atmosphere, water, and soil. Social sustainability deals with the preservation of life-support systems that come before environmental quality, such as poverty reduction. These two concepts are obviously highly correlated[3] (Goodland, 1995).

The key rules for maintaining the environment sustainable are to guaranty that (1) the rate of use is equal or lower than the natural regeneration rate when using renewable resources; and (2) the waste flows to the environment do not go over the capacity of the environment to assimilate them. These rates can easily change through population growth, technological progress, increased efficiency and catastrophes (Pearce, Turner, 1990).

When speaking about environmental sustainability there is a need to point out that some actions have irreversible consequences. The extinction of a species cannot be changed, the species cannot be brought back. Tropical forests cannot be recreated. It is quite difficult to take any advantage of desertified land (Pearce, Turner, 1990).

The concept of sustainability can be applied to well-being as the well-being of the next generations will depend on the quantity and quality of the resources passed to them by the current generation. These resources are not only in terms of natural capital but also physical, such as machines and buildings, and human, through education and research. And there is a present need to evaluate the durability of the current ways, i.e. to understand whether perpetuation of present trends can be maintained (Stiglitz *et al.*, 2009).

One conclusion from happiness research is that quality is more important than quantity; in neo-classic economic theory, the current economic theory, *ceteris paribus*, more is always better. With relation to the environment, one of the main implications of this research is that aligns with sustainable development. Sustainability tells us that there is a need to consume less and happiness research concludes that individuals need not to maintain or increase their levels of consumption to be happy. Environmental quality makes individuals happy (MacKerron, Mourato, 2009).

[3] For instance, a society that does not over explore its resources has less chances of having a war (Goodland, 1995).

2.1.3 Alternative Indicators to GDP

Over time, several indicators were created in an attempt to substitute, improve, or complement GDP. As an example a non-comprehensive list of the most relevant indexes for this dissertation is developed. It is organized as follows: firstly, the most well-know indexes, with a focus on social components but not regarding the environment or happiness; secondly, indexes weighting the environment as well as well-being; lastly, two indexes that correlate happiness and the environment.

a) Human Development Index (HDI)

HDI, developed by the United Nations for the first time in 1990, is a composite index comprising the geometric means of education, life expectancy and income statistics. It aims to depict human well-being more directly and effectively than simple measures of consumption. (Kula *et al.*, 2010). This indicator does not generate a monetary value and it presents an alternative to GDP to show that development is more than increasing national income. It is commonly used, mainly due to its transparency and simplicity, in media and policy as it allows comparisons between nations on the human development level. This is a socio-economic indicator and it does not comprise environmental measures (O'Neill, 2011).

Reversely, HDI neglects the distribution of human development inside nations. Likewise, it does not account for other dimensions of welfare, such as human rights, security and political participation (Harttgen, Klasen, 2012).

b) Human Poverty Indices (HPI)

As the previous, these indices were formulated by the UNDP. HPI calculates deficiencies in the same three dimensions of human development as HDI. HPI-1 was created for developing economies and HPI-2 for developed countries. The latter also captures social exclusion. However, unlike in HDI, the distribution of individual well-being is taken into account. In the three dimensions, indicators of deprivation have been included (Kula *et al.*, 2010).

c) Fordham Index of Social Health (FISH)

FISH reports well-being during different periods of life, with a total of 16 social indicators that put together provide an ample view of the social health of a nation. For children, it conveys infant mortality, child abuse, and poverty. For youth, it registers teenage suicides, drug use, and high-school dropout rate. For adults, it accounts for unemployment, average weekly earnings, health insurance coverage among those under age 65, poverty for those over 65, and out-of-pocket health-care costs for over 65. For people of all ages, it reports homicides, alcohol-related highway deaths, food stamp coverage, access to affordable housing, and income inequality (IISP, 2013).

The indicators chosen are social in the sense that they are connected to all stages of life and to social institutions such as the labour market, social welfare programs, school, and family. As other indices did, FISH showed a similar growth pattern to GDP until late 1970s. From then on, it has decreased while GDP has increased (data for the USA) (IISP, 2013).

d) Measure of Economic Welfare (MEW)

MEW was created by Nordhaus and Tobin (1972) as a comprehensive quantification of the annual real consumption of households and public consumption, valued at market prices or at their equivalent in opportunity costs. It is based on GDP with alterations to allow the quantification of all market and non-marketed goods and services, like the excluded items leisure or the quality of the environment. MEW equals the sum of the value of GDP, leisure time, and unpaid work, minus the value of environmental damage (Kula *et al.*, 2010).

e) Index of Sustainable Economic Welfare (ISEW)

ISEW is an advance on MEW, as it further adjusts GDP not only by adding a broader spectrum of harmful effects caused by economic growth but also through the exclusion of public spending on defence. Daly and Cobb created this indicator in 1989 for the USA. In this country and in most of the subsequence countries that have run ISEW, there is one common trade to be found. ISEW and GDP have parallel growth rate until the 1970s, from then on the former starts to decline while the latter continues rising (Castaneda, 1999).

ISEW equals the sum of personal expenditure, public expenditure and value of unpaid work, minus public defence and the value of environmental damage (Bergh, 2009). The general thinking behind ISEW is to remove from personal consumption the expenses that do not contribute to an increase in welfare (defensive expenditures) and to include those that might (non-defensive expenditures), referring to adjustments not contemplated in traditional accounts (Castaneda, 1999).

f) Genuine Progress Indicator (GPI)

GPI is very similar to the ISEW but includes further specific items: voluntary work, criminality, divorce, leisure time, unemployment and damage to the ozone layer (Bergh, 2009). This indicator proposes to quantify the impacts of economic growth on sustainable welfare through monetary valuation. GPI is the sum of personal consumption expenditures adjusted for income inequality, non-defensive government expenditures, and non-market contributions to welfare, minus defensive private expenditures, costs of environmental degradation, and depreciation of the natural capital base (Posner, Costanza, 2011).

g) Genuine Savings (GS)

The World Bank has embraced GS, also known as Adjusted Net Savings, as one of their central indicators (Bergh, 2009). GS is based on the concept of green national accounts that is calculated by adding net investment in produced capital to investment in human capital minus the net depreciation of natural capital (Dietz, Neumayer, 2004). This indicator is based on traditional net savings to which are deducted estimates of capital consumption of produced assets, then added expenditures on education (as a proxy for value of investments in human capital), then deducted estimates of the depletion of a variety of natural resources, and at last pollution damages (including economic and health effects) are subtracted (The World Bank, 1997).

h) Gross Sustainable Development Product (GSDP)

GSDP measures the total value of production within a region over time and it is calculated resorting the market prices for goods and services of transactions in the

economy. This indicator was developed by the Global Community Assessment Centre as a substitute for GDP (GCAC, 2004).

GSDP measures the economic impacts of environmental and health degradation or improvement; resource depletion, depreciation or appreciation or finding new resources; the impact of people activity on the environment; the impact of people activity on availability of resources and on economic development; the quality of the environment, people, resources and development and impact of changes in these on the national income and wealth; the impact of global concerns on the economy; welfare, quality of life and economic development of future generations; expenditures on pollution, health, floods, and car accidents; the resource stocks and productive capabilities of exploited people and ecosystems; the impact of economic growth on biological diversity; and the impacts of social costs and health costs on future generations and the nation's income (GCAC, 2004).

i) Gross Environmental Sustainable Development Index (GESDI)

GESDI proposes to measure the quality of growth and development with more than 200 indicators of non-market values. These are structured around physical, biological, health, social and cultural components that influence a society. They are mainly divided in four areas: people (includes dimensions of social, economic, psychological, physical and spiritual indicators as well as literacy, rights, justice, diversity, community, peace and conflict, legal and political, etc.); available resources; environment; and economic development (GCAC, 2004).

j) Social Progress Index (SPI)

SPI, developed by Michael Porter, evaluates the provision of social and environmental needs to the people in each country. The index is constituted by 52 indicators, which are divided through three areas (equally weighted) of basic human needs, foundations of well-being, and opportunity. The index concludes that economic development is a necessary condition but not a sufficient one for social progress, and that a country’s overall degree of development disguises social and environmental forces and challenges (The Social Progress Imperative, 2013).

k) Gross National Happiness (GNH)

The King of Bhutan, whose country ranked low on GDP, first expressed the idea of GNH in the 1980s. This indicator, developed in this country, aims to account for all values relevant to life on earth. This is in alignment with the concept of mixed economy, which states that markets cannot regulate themselves on all aspects needing some government intervention (Tideman, 2011). GNH measures the extent to which a population approaches a sufficient level in an array of dimensions instead of simply aggregating happiness or using its average. There are nine equally weighted dimensions of well-being to GNH, which are: psychological well-being, use of time, community vitality, culture, health, education, environment, living standards, and governance (Ura, 2008 in Bates, 2009).

It has the drawback of being hard to compare satisfaction and happiness among populations and the possibility of being more focused on well-being rather than living and social conditions (Fleurbaey, 2009).

l) Happy Planet Index (HPI)

HPI is a measure of sustainable well-being, comprising data on life expectancy, experienced well-being and ecological footprint. The results rank countries on how many long and happy lives they produce per unit of environmental input. This indicator, contrary to many others that emphasize economic activity, focuses on current and future well-being demonstrating that the western model of development is not sustainable. HPI equals experienced well-being, multiplied by life expectancy and divided by ecological footprint (NEF, 2013).

2.1.4 The Problem of Overpopulation

Economic growth on its own represents numerous social costs. Our planet does not offer unlimited resources and with exponential economic and population growth only starvation, diseases and conflicts can level food supply and population (Malthus, 1798).

Several authors defend that the world is or will rapidly be overpopulated, that there will be too many of us in the near future for our life style to be maintained. The most well known of these being Thomas Malthus, known as the father of demographics. In 1798 he wrote *An Essay on the Principle of Population* where it is defended that while population grows in a geometrical way, food supply only grows arithmetically. According to Malthus, if, for example, a country starts at place where the means of subsistence are just the necessary to support its people, the population will grow quicker than the food supply. This means that there will be a decrease in the real value of labour whilst the value of provisions will rise. Workers will then have to work more just to earn the same. During this period, there is a likelihood of naturally appearing restraints to population (there are incentives to have fewer children), the employers will be able to hire more people (as labour is cheaper) and ultimately the ratio of people to food will stabilize. This exercise for a fictitious country, which can easily be extrapolated to the whole world, leads to a vicious cycle as after a period of equilibrium the tendency is for the cycle to repeat itself (Malthus, 1798).

Another way for this cycle to play out would be if instead of a check in population growth conflicts arose. This has a higher probability of happening if there is a sudden rapid increase of people.

This discussion has been put aside for the past decades for some reasons. On the one hand, fertility levels have been falling considerably, particularly in the developed world. On the other hand, in the past century the world has experienced a technological growth like no other ever seen before, therefore technological progress has been contradicting the Malthusian theory and pushing this discussion away from the economists' eyes. Also, religious and political views have influenced this discussion, as this is a very controversial topic that goes against the ideological foundations of many individuals (Brander, 2007).

These arguments only reinforce the idea that GDP, especially by itself, as a measure of social welfare is not enough and it does not accurately represent the needs of society. It was Simon Kuznets himself, the creator of GDP, who said that a measure of national income was not a measure of national welfare. Moreover, there is a necessity of overcoming a consumerist perspective, as consumption does not necessarily lead to well-being. The fact that trends in GDP and social indicators were once aligned but

have, roughly from the mid 1970s, diverged only backs up this notion. Economic growth alone does not necessarily improve the quality of life and this needs to be taken into account by the governments when drawing public policies. Furthermore, if a country is more stable and more at peace, then it is clearly a better place to do business, which means that well-being also produces economic growth and not just the other way around.

2.2 Happiness in Economics

2.2.1 Happiness, life satisfaction and subjective well-being

"Happiness is defined, as the overall appreciation of one's life-as-a-whole, in short, how much one likes the life one lives. […] Thus defined, happiness is a state of mind and can therefore be measured using questioning techniques, among which single, direct questions." (Veenhoven, 2006, pp. 450-451)

The concept of happiness is usually used interchangeably with life satisfaction. These two ideas fall under the notion of subjective well-being. They are all associated to choice (Diener *et al.*, 1985; Peterson *et al.*, 2005; Veenhoven, 2006; Costanza *et al.*, 2007; Ferrer-i-Carbonell, Gowdy, 2007; van Praag, 2007; Mota, Pereira, 2008; Rehdanz, Maddison, 2008; Mackerron, Mourato, 2009; Welsch, 2009; Frey, Stutzer, 2010; Stutzer, Frey, 2012; Easterlin, 2013; Ferrer-i-Carbonell, 2013; Frey, Stutzer, 2013). A survey addressing questions of subjective well-being can contain questions both on happiness and life satisfaction, as do the European Social Survey and the World Value Surveys (Welsch, 2009).

Diener *et al.* (2009) states that the satisfaction of needs will result in happiness, which allows using self-reported life satisfaction and happiness data interchangeably.

Measures of subjective well-being usually have a satisfactory degree of internal consistency, validity, reliability, and an elevated degree of stability across time (Diener *et al.*, 1999 in Costanza *et al.*, 2007 and in Welsch, 2009).

Data on self-reported well-being can be employed in estimating the monetary value of non-marketed goods, such as air quality and environmental amenities (Ferreira, Moro, 2010).

Blanchflower and Oswald (2004) compare well-being evolution in the USA and Britain over time. To do so they resort to a question consistently asked in surveys in both countries. While in the USA the authors use the responses from a question on happiness, in Britain's case they resort to the replies to a question on life satisfaction. The authors consider the results similar enough to allow comparison.

Di Tella *et al.* (2001) found a correlation of 0,56 between self-reported happiness and life satisfaction for the period of 1975-86, using data from the Euro-Barometer Survey Series, concluding that due to their correlation a focus on one of them is sufficient.

2.2.2 Factors Influencing Happiness

The economics of happiness, which has arisen as one of the most blooming areas in contemporary economic research, deals mainly with investigating the determinants of subjective well-being. Even though science tells us that happiness is highly correlated with one's personality (about 50% is heritability of subjective well-being (Sheldon, Lyubomirsky, 2009)), which means that genetics play a central role, there are also many evidences to life circumstances being of huge importance (Ferrer-i-Carbonell, 2013). Among those, economic development has over time been directly linked with happiness, which explains the use of GDP as a measure of welfare. However, several other explanatory factors have to be taken into account when estimating people's well-being, for example, income, inequality, employment, inflation, job amenities, government activity, political institutions, sense of freedom, being part of a tolerant community, culture, democracy, religion, commuting time, age, social relations, marital status, social status, physical health, healthy environment (Oswald, 1997; MacKerron, Mourato, 2009; Stiglitz *et al.*, 2009; Welsch, 2009).

The Easterlin Paradox was the first to establish the relationship between real GDP per capita and happiness. It ascertains that individuals with higher income are on

average happier within countries. However, comparing people in rich and poor countries did not allow concluding that the former are happier than the latter (Kula *et al.*, 2010). Blanchflower and Oswald (2004) found this theory consistent with their study well-being for Britain and USA. This can be extrapolated to an individual level. Often people don't regard the value of their income on its own, but by comparison with their peers (Blanchflower, Oswald, 2004; Costanza *et al.*, 2007; Clark *et al.*, 2008 in Welsch, 2009; Caporale *et al.*, 2009; Luttmer, 2005 in Stutzer, Frey, 2012) and also the variance between working more to collect a higher income and simply coming across with gains is not captured (Stutzer, Frey, 2012). Another theory relating individual happiness to income states that the comparison of income with peers happens because it allows people to draw expectations about future income (Ferrer-i-Carbonell, 2013). Also, not all increases in GDP translate into an augment in welfare, for example, public expenditures for reconstruction after a catastrophe (Stutzer, Frey, 2012). These findings allowed deducing that it is necessary to shift the targets of public policy from the sole maximization of the economy to reducing the gap in income as the more equal people are the happier they will be. This could be achieved through taxes directed at a more even distribution of income (Caporale *et al.*, 2009; Kula *et al.*, 2010).

Economic growth is more related to well-being in developing countries, as any income increase will provide a high return in aspects related to survival, such as food, clothes, or health care (Oswald, 1997; Inglehart, 1997 in Inglehart *et al.*, 2008). In these countries only a slight improvement, such as replacing dirt floors with cement floor, can go a long way in improving health, particularly of children, and welfare (Cattaneo *et al.*, 2009). Conversely, in develop countries, these needs are well taken care of, and a rise in revenue won't be directed to primary necessities. There will be a point at which an economic growth won't directly and equally be translated in a rise in welfare. Here, governments should focus more on policies that increase the quality of life (Oswald, 1997; Inglehart, 1997 in Inglehart *et al.*, 2008).

The conditions regarding the impact of employment on happiness have been extensively studied throughout literature. What creates the greater difference in people's well-being is the difference between being employed or unemployed, not only due to loss in income but particularly in social capital. The conditions of the workplace, the job amenities, the distinction between being self-employed or an employee, or being part of

a society with high unemployment rates also seem to affect happiness (Clark, Oswald, 1994; Oswald, 1997; Di Tella *et al.*, 2001; Blanchflower, Oswald, 2004; Helliwell, Putnam, 2004; Mota, Pereira, 2008; Welsch, 2009; Stutzer, Frey, 2010; Stutzer, Frey, 2012). As an example, a person being a part of a high unemployment society is subjected to higher crime rates, stress on public finances, wider income gap, higher probability of facing a job loss in the future, less prospects of a promotion, scarcer chances of changing jobs, and possible changes in working hours and earnings (Frey, Stutzer, 2002 and Frey, 2008 in Frey, Stutzer, 2013). Also, Frank (1999, in Frey, Stutzer, 2013) advocates that people quickly get used to an income increase, which suggests that the added utility is only momentarily. This is called the adaptation effect. Furthermore, researchers in Germany concluded that people working in the private sector were more disturbed by economic shocks than people in the public sector, due to the higher job security in the latter (Frey, Stutzer, 2013). Inflation has been shown to also have a negative impact on happiness (Di Tella *et al.*, 2001; Mota, Pereira, 2008; Welsch, 2009; Stutzer, Frey, 2010; Ferrer-i-Carbonell, 2013).

Well-being is influenced by the level of (dis)satisfaction with government activity. A negative relationship may result in tax evasion (Torgler, 2007 in Frey, Stutzer, 2010), lead to an increase in parallel economy (Enste, Schneider, 2002 in Frey, Stutzer, 2010) or instigate migration (Devereux, Weisbrod, 2006 in Frey, Stutzer, 2010). The fairness of institutions has been shown to be positively related to happiness (Mota, Pereira, 2008).

Another factor that impacts happiness is free choice and the sense of controlling your own life. This tends to have a higher influence with greater economic safety (Johnson, Krueger, 2006 in Inglehart *et al.*, 2008). Also, being part of a tolerant community, which supports gender equality, accepts outgroups, and is democratic, has been proven to be positively linked to happiness (Inglehart, Welzel, 2005 in Inglehart *et al.*, 2008). Religion has as well shown this positive relationship, as it offers a safety feeling, particularly in times of economic uncertainty (Inglehart, 1997). Commuting time has a negative correlation with well-being, even after controlled for earnings (Stutzer, Frey, 2004 in Ferrer-i-Carbonell, 2013).

Age shows a U-shape correlation with happiness, the down point being at 40 years of age (Blanchflower, Oswald, 2004; Ferrer-i-Carbonell, 2013). Ferrer-i-

Carbonell (2013) argues that at the beginning of adulthood, individuals have higher life expectations; at midlife, the expectations are revised downwards; and, later on, they rise again when people grow accustomed to the idea that not all hopes and dreams are achievable.

One factor that impacts happiness is social capital, the better and more social relations the higher happiness is (Blanchflower, Oswald, 2004; Helliwell, Putnam, 2004; Mota, Pereira, 2008; Stutzer, Frey, 2012). Moreover, volunteer work, for its rewarding characteristics, also raises happiness (Meier, Stutzer, 2008 in Stutzer, Frey, 2012).

Last but not least, health very much impacts happiness. Veenhoven (2006) concludes that happier people tend to have longer lives, as not only do they have the tendency to take better care of themselves but also because happiness protects physical health. Pollution is therefore a cause of diminishing well-being as it may cause many adverse health effects, such as insomnia, stress, hearing problems, high blood pressure, heart diseases, lower immune system, birth defects, and respiratory diseases (Helliwell, Putnam, 2004; Passchier-Vermeer, Passchier, 2000 and Gouveia, Maisonet, 2005 in MacKerron, Mourato, 2013).

Inglehart *et al.* (2008) have concluded that while Latin American countries presented higher levels of subjective well-being, life satisfaction and happiness, nearly all of former communist countries had the lower ranks in these categories. The reason presented by the authors for these low results have to do with the breakdown of the political, economic, and belief systems that the collapse of communism produced. On the other hand, the high results in South American nations are attributed to a strong belief in God.

Easterlin (2013) analyses GDP growth rate and life satisfaction surveys across seventeen developed countries, nine less developed nations, eleven countries in transition, seventeen countries from South America and China concluding that economic growth alone does not increase happiness. The author claims that any opposing conclusions arise from mixing the short-term relationship between happiness and GDP (positive) with the long-term (null) or from lack of data in some countries experiencing economic transitions.

There are however some authors that criticise indicators of national happiness because its aggregation method. For once, it does not consider the distribution of happiness throughout a country. However, an equally weighted function would give the same ponder to each individual, which is contrary to the GNP, fundamentally determined by people with high purchasing power while people with no earnings are marginalized (Frey, Stutzer, 2010). Also, if the population ought to increase tremendously, so would the sum of total happiness, without having any correlation to the welfare of the people (Parfit, 1984 in Bates, 2009). Another critique has to do with the aptitude for adaption of different persons, for example, a judge would have to give different compensation for disability for two distinctive people that suffered the same type of accident when one adapts easily and quickly to its new reality (Frey, Stutzer, 2007 in Bates, 2009).

Nevertheless, the study of happiness, whether at an individual level or at a macro level, has the potential to be put in good use by governments. For example, there has been an increase in demand for cost-benefit analysis related to the evaluation and provision of public goods. These are quite hard to measure, as they are non-marketed goods and services. A suggestion would be an approach based on the well-being variation subject to a change in public goods (Frey, Stutzer, 2013).

Easterlin (2013) advocates that what has the most positive impact on happiness, and should therefore be pursued by governments, is full employment and safety net policies. He compares empirical findings from European countries that have the same GDP per capita and diverse socio-economic policies. For this purpose, the author groups Denmark, Sweden, and Finland in what he calls the "ultra-welfare states" and France, Germany, Austria, and the United Kingdom as the "semi-welfare states". Among each group, GDP per capita, the inflation rate, and the unemployment rate are almost equal. However, the social policies are quite different, they are much more substantial and ample in the first set of countries, in areas like health, pension, and unemployment benefits, education, and care of children and the elderly, which leads to superior confidence in the political system. In the "ultra-welfare states", through reports of life satisfaction, it is observed that overall well-being is on average higher than in the second group. Easterlin (2013) also compares what he defines as transition countries (countries where there were policies of full employment and safety nets and were

afterwards abandoned) and China. In both, there was a severe rise in unemployment and most benefits were lost. China's overall life satisfaction has seen no increase in the last two decades, in spite of much higher incomes on average, which allows again conjecturing that the job and benefits losses had a much greater effect on happiness than a rise in earnings. Much like China is the example of East Germany, a transition country. Comparing the periods before and after the changes, it is possible to see that following the transition there was a substantial increase in satisfaction with the environment and availability of goods. However, in health, work, and childcare, the variation was vastly negative. The outcomes of these comparisons tell us yet again that countries welfare cannot be judge solely on GDP per capita nor should government policies be focused on that alone. There are many other factors, some with much higher effect that impact overall and individual life satisfaction, which need to be taken into account when drawing policies.

2.2.3 How to Measure Happiness

Over the past few years, many more researchers have become interested in the study of happiness, mainly in self-reports of happiness. Data on this subject is usually gathered through surveys where the respondent is asked a general question about his own level of happiness (Di Tella, MacCulloch, 2006; Welsch, 2009).

"There are a number of different measurement techniques available to capture subjective well-being [...]. These can be distinguished along two dimensions: cognition, the evaluative or judgmental component of well-being (usually assessed with questions asking about satisfaction with life overall); and affect, the pleasure-pain component of well-being (Diener, 1984). With regard to the latter, it is common to distinguish further between positive affect (e.g., happiness, joy) and negative affect (e.g., anger, sadness), treating them as independent." (Frey, Stutzer, 2013, pp. 434)

The most common method to measure happiness is a straightforward individual questionnaire with questions related to income, job, health, and overall satisfaction. Their answers can be either in discrete terms with verbal categories (bad/good) or numerical categories (1-10) (Oswald, 1997; van Praag, 2007; Welsch, 2009; Stutzer,

Frey, 2010). People are considered to be suitable reviewers of their own overall life quality, therefore this kind of measure can provide valuable information (Stutzer, Frey, 2010).

There are other approaches to measure happiness, for example the Experience Sampling Method, where information is collected on the actual experiences of individuals in real time in their natural environments; the Day Reconstruction Method, where people are asked on how satisfied they felt at several times throughout the day; the U ("unpleasant")-Index, where it is described the portion of time that an individual passes in an unpleasant state each day; Brain Imaging, where magnetic resonance imaging is used to scan individual brain activity for association of positive and negative affect; and the Life Satisfaction Approach, where "the marginal utility of public goods or the disutility of public bads is estimated by correlating the amount of public goods or public bads with individuals' reported subjective well-being" (Frey, Stutzer, 2013, pp. 441).

2.2.4 Happiness and Classical Utility

"Utility is a term used in economics to measure the relative satisfaction from, or desirability of pursuing one course of action rather than another." (Frey, Stutzer, 2013, 431)

In the prevailing economic theory, utility is captured through consumption and choices between alternatives; economists are taught to infer preferences from observed choices, see what people do instead of hearing what they say (Di Tella, MacCulloch, 2006; Frey, Stutzer, 2010). However, many authors defend the study of happiness in economics as a more appropriate proxy for utility, instead of the now in use GDP, as people are often biased when selecting amongst alternatives (Welsh, 2009; Frey, Stutzer, 2010; Frey, Stutzer, 2013). For example, it is appealing for individuals to eat candy, and this in fact raises their utility in the short run, nonetheless, afterwards they realize that it would have been better not to not have done it (Stutzer, 2009 in Frey, Stutzer, 2013). In standard economic theory, this act would have increased utility when in fact it does the opposite. Basing utility on revealed preferences doesn't account for

consumers not always making the best choices for themselves. This is one of the main critics to the GDP, some actions give the wrong signal, increasing GDP when it should decrease and vice-versa. The study of happiness allows correcting these biases (Frey, Stutzer, 2013).

The study of individual happiness is, therefore, based on subjective views that people have on their own lives. And, while some argue that people often don't proper estimate their own utility levels, which can be pointed as a criticism for using self-reported happiness as a measure of well-being. For example, it frequently happens to overestimate the effect of particular events in one's life and the capacity of adaptation to them (Stutzer, Frey, 2012). Others defend the exact opposite. For instance, Ferrer-i-Carbonell (2013) states that there has been empirical proof over the past years validating the predictive ability of the happiness reports and their link with individuals' behaviour.

2.3 The Environment and Happiness

2.3.1 Pollutants: a short overview

The USA Environmental Protection Agency (EPA, 2010) defines pollution as "the presence of a substance in the environment that because of its chemical composition or quantity prevents the functioning of natural processes and produces undesirable environmental and health effects". According to the European Environmental Agency, there are two distinct kinds of pollution harming the environment: point source pollution, produced by a "stationary location or fixed facility from which pollutants are discharged" (EEA, 2013); and non-point source pollution, caused from diffuse sources.

The atmosphere is mostly composed by compounds containing sulphur, nitrogen, carbon, and halogen. Air pollution occurs when concentrations of these compounds are sufficiently elevated, exceeding regular levels, to produce a measurable effect on humans, animals, vegetation, or materials. Methane, ethane, propane, and butane are composed of carbon atoms (Seinfeld, Pandis, 2006). According to the EPA,

the six most common pollutants are ground-level ozone, particulate matter, carbon monoxide, nitrogen oxides, sulphur dioxide, and lead (EPA, 2012d). Ozone develops "through chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC) in the presence of sunlight. Emissions from industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapors, and chemical solvents are some of the major sources of NOx and VOC" (EPA, 2012b). Particulate matter (PM) is a composite combination of very tiny particles and liquid droplets, consisting of components such as acids (nitrates and sulfates), organic chemicals, metals, and soil or dust particles (EPA, 2013b). Carbon monoxide (CO) is a gas resulting from combustion process that is presented with no odour or colour (EPA, 2012a). Nitrogen dioxides (NO2) are extremely reactive gasses rapidly created through vehicle, power plants, and off-road equipment emissions. NO2 leads to the creation of ground-level ozone, particle pollution, and negative effects on the respiratory system (EPA, 2013a). Sulfur dioxides (SO2) are extremely reactive gases created through "fossil fuel combustion at power plants (73%) and other industrial facilities (20%)" (EPA, 2013c). Lead (Pb) is a metal that can be located in nature and in manufactured products. Nowadays, leaded aviation gasoline is the primary source for lead emissions (EPA, 2012c).

Water is fundamental for existence, just as air. However, drinkable water is a limited resource in our planet and maintaining its quality is vital (WHO, 2013b). There are seven types of water pollution: surface water pollution, ground water pollution, oxygen depleting, nutrients, microbiological, suspended matter and chemical. These can be caused by sewage and wastewater, marine dumping, industrial waste, radioactive waste, oil pollution, underground storage leaks, atmospheric deposition, global warming, and eutrophication. All are harmful for humans and animals, especially after long-term exposure (EPA, 2013d).

The main water pollutants are biological oxygen demand (BOD) and suspended solids (SS). "Organic water pollutants are oxidized by naturally-occurring micro-organisms. This 'biological oxygen demand' removes dissolved oxygen from the water and can seriously damage some fish species which have adapted to the previous dissolved oxygen level. Low levels of dissolved oxygen may enable disease causing pathogens to survive longer in water. Organic water pollutants can also accelerate the growth of algae, which will crowd out other plant species. The eventual death and

decomposition of the algae is another source of oxygen depletion as well as noxious smells and unsightly scum. The most common measure for BOD is the amount of oxygen used by micro-organisms to oxidize the organic waste in a standard sample of pollutant during a five-day period" (Hettige *et al.*, 1995, pp. 37). Suspended solids are "small particles of non-organic, non-toxic solids suspended in waste water [that] will settle as sludge blankets in calm-water areas of streams and lakes. This can smother plant life and purifying micro-organisms, causing serious damage to aquatic ecosystems. The loss of purifying micro-organisms enables pathogens to live longer, raising the risk of disease. When organic solids are part of the sludge, their progressive decomposition will also deplete oxygen in the water and generate noxious gases" (Hettige *et al.*, 1995, 37).

2.3.2 Amenities

"Environmental amenities are defined as all those natural assets including green spaces that are aesthetic, ecological, and economic in nature, as well as those that have a physical or psychological effect on human health, such as pollution control, noise abatement, and the provision of recreational opportunities." (Tyrväinen, Miettinen, 2000 in Gupta *et al.*, 2009)

Environmental amenities are associated to the quality and quantity of the natural resources of one's community, such as lakes, rivers, forests, croplands, pastureland, under water bodies, shoreline, climate, light, and parks, and to the quality and quantity of the air, water, noise, and waste present in the environment (Marans, 2003; Poudyal *et al.*, 2008; Wu, 2006). They are also directly linked with physical health (Marans, 2003; Poudyal *et al.*, 2008).

Financial investments can go a long way to increase, improve, and encourage the use of natural amenities by improving areas of open space, restoring rundown properties, constructing outdoor facilities, improving street cleanliness, improving public areas, and creating cycling and walking paths (Poudyal *et al.*, 2008). These investments create economical return as they make surrounding areas more attractive to

investors (house developing, businesses, services), increase migration to the region, and raise property value (Tajibaeva *et al.*, 2008).

Environmental amenities are mostly non-excludable, which means that it is hard to exclude non-payers from enjoying its benefits and in turn disincentives individual investment. Therefore, many researchers defend that the investment in natural amenities should come from the government (Haddock, 2004).

Nonetheless, individuals prize environmental amenities. These are usually valuated through proximity. For example, there is a positive effect of being close to coast that weakens with increasing distancing. The exact opposite occurs with proximity to waste facilities. Therefore, geography has a significant impact on well-being (Brereton *et al.*, 2008).

2.3.3 The tragedy of the commons

Each individual is constantly using available goods, space, and resources that belong to the entire population. The individual benefit captured is obvious and the impact caused seems harmless. The rational individual rapidly concludes that the benefits outweigh his losses, which results in the tragedy of the commons, a concept popularized by Garrett Hardin in the 1960s. The main point defended by Hardin, an extrapolation from the prisoner's dilemma, states that what is common to the individuals will be exploited until exhaustion (Hardin, 1968). A common good is a finite resource whose use will lead to extinction.

The author resorts to a very clarifying example. He conceives a pasture for cattle shared by a community. Not having any type of control or limits to its use, each individual will try to make the most use of the field without worrying with its sustainability in the long run. This will lead to the pasture's exhaustion and consequent extinction of the resource as it is impossible to maximize two variables, either one has more animals or a sustainable pasture (Hardin, 1968). Nature has the capacity of self-regeneration but not if resources are over-exploited, as the example describes and as it is being experienced nowadays (Dasgupta, Ehrlich, 2013).

Hardin assumes that the individual is rational (as described by Adam Smith), therefore his goal is to maximize his own gains. Thus, there will always be an incentive to place one more animal on the pasture as each one brings an individual gain whilst the loss is distributed among all. In this context, it is necessary to re-evaluate individual freedom because maximizing one's gains does not correspond to the society's optimal point (contradicting Adam Smith's theory). Also, it is assumed that the pasture is limited; that it won't hold an infinite number of cattle (Hardin, 1968).

This tragedy is what affects the environment, a common, nowadays. This happens not only due to an excessive use of resources but also through pollution. For the rational individual, the cost of not treating sewage, chemicals, radioactive material, or not producing dangerous and harmful fumes is smaller than if he would. There is no incentive to interiorize the externalities. If all the population is composed by rational individuals, then everyone will act in this way leading to a tragedy of the commons, as the water and air that surround us are accessible to all (Hardin, 1968). This is only made harder by the mobility of the pollutants, through river flows, animals, and wind (Dasgupta, Ehrlich, 2013).

In a reverse way, environmental amenities, as parks or beautiful landscapes, can be analysed in the same way. They are highly valued by individuals but its optimal is challenging to estimate. Given that they are common goods, one cannot be excluded from its enjoyment. This in turn creates an incentive to understate the real demand for environmental amenities, due to free riders (Eagle, 2004).

History has shown us that with continuous rise in population common goods are disappearing due to over-exploitation. Since the creation of private properties, fishing areas, and hunting laws, there is a pattern of privatization or restriction to the common good as its demand increases. It is also what has been happening in the environmental area. There are laws regarding water treatment, residues, garbage, countries that enforce recycling, incentives to the development of renewable energies, the Kyoto protocol (for example, the carbon credit market), and tight laws for activities or products with higher environmental impact, as factories, insecticides, or fertilizers. The goal is to internalize the cost of polluting or destroying natural resources, as externalities are mostly not self-correcting, and avoid the tragedy of the commons in the environment (Hardin, 1968).

These externalities are a result of the choices made by each individual.

Consumption is known to bring about these consequences, for present and future generations. Modern practices of consumerism incentivize constant new purchases and money spending just for the sake of it (Dasgupta, Ehrlich, 2013). Neo-classical theory states that, all things the same, more is always better. This is quite problematic, as all other things never always remain the same. This view that promotes more production and consumption imposes severe consequences on all other things (MacKerron, Mourato, 2009). But consumption is driven not only through competition but also for the desire of fitting in. This is more observable and of especially concern in developed societies, as the environmental consequences are steep. For example, individuals tend to have a car if people in their circle also have them, together with the discovered evidence that the choice of make and model of the vehicle is driven by competition with peers. This only leads to more cars and more used up oil. This is just one of many examples where today's consumption social conventions are environmentally damaging. On top of these rich countries issues, there is happening a resource-intensive increase in the consumption of goods and services in developing nations (Dasgupta, Ehrlich, 2013).

Technological progress has been pointed out by many as the miracle solution for nearly all environmental issues. However, there has to be incentives for the creation of new technologies. And as so many are not sensible or downplay the importance of the environmental challenges that the world is facing it is unrealistic to expected big technological improvements in the near future. Furthermore, history has revealed the extinction of many societies due to over-use of their natural resources and degradation of local environment (Dasgupta, Ehrlich, 2013).

2.3.4 Pollution and Well-Being

Pollution is affecting climate in an array of ways, for example increasing global average temperature, abrupt changes in regional weather patterns, melting glaciers, decreasing crop yields, escalating intensity of storms, forest fires, droughts, flooding and heat waves, rising of sea level, and reducing biodiversity. Furthermore, all these impacts are much more likely to affect the poorest nations that have less capacity to adapt and fight these consequences and in turn widens the gap between richer and

poorer countries (Stern, 2008). The economic results of climate change, according to several studies, are usually reflected on variations in productivity in areas such as agriculture, energy, and tourism. These changes can have either positive or negative consequences subject to time and place (Rehdanz, Maddison, 2005).

Particularly in the developing countries, water and air pollution have become topics that raise serious concerns. Since there is hardly any waste treatment and pollutant controls (such as for fertilizers or industrial chemicals), many severe health issues have been arising. The World Health Organization (WHO) estimates 2 million deaths a year due to water contamination alone, many more if air pollution is accounted for (highly driven by megacities and their heavy fog) (Biswas *et al.*, 2012). And WHO also estimates that environmental factors represent about 24% of the total burden of disease (data for 2008), with increasing chronic conditions. Children are the most burdened, as they have higher concentrations of pollutants due to having less body weight than adults; the elderly and the poor are also higher risk groups (Stiglitz *et al.*, 2009).

Air quality, in addition to health and property, influences individual's reported well-being, the higher the pollution the more negative is the effect. Luechinger (2009, in Oswald, 2012) shows that German people's happiness is affected by the quantity of SO2 in the air. Levinson (2012) calculates the monetary value that people seem to be predisposed to spend, about $35 for an enhancement of one standard deviation in air quality for one day, in the USA.

Ferrer-i-Carbonell and Gowdy (2007) study the relationship between concern for ozone pollution and threat to biodiversity, and individual's well-being in the United Kingdom. The authors find a statistically significant negative correlation concerning environmental degradation and well-being (around 81% of the individuals demonstrate concern for the ozone layer) and a statistically significant positive connection between caring for animal extinction and well-being (about 85% of the individuals revealed concern for the extinction of species), the latter being coherent with other findings, which show that individuals care about biodiversity (Nunes, van den Bergh, 2001, in Ferrer-i-Carbonell, Gowdy, 2007). Even after controlling for psychological traits, the preceding conclusions are not challenged (Ferrer-i-Carbonell, Gowdy, 2007).

Another factor associated with increasing pollution is the shadow economy. It is been known to comprise many pollution intensive activities, "such as leather tanning, brick making, metal working, resource extraction, urban transportation with old and inefficient vehicles, and production in small scale or family-based factories" (Biswas *et al.*, 2012, pp. 114), all of which do not tend to follow environmental standards. Biswas *et al.*, using a panel data from 1999-2005 for over 100 countries, established that an increase in the underground economy increases pollution (results hold when controlling for additional causes of pollution). Still, controlling corruption can restrain this effect.

Noise pollution has been identified in literature as an influence on well-being, particularly associated with roads and airports (Rehdanz, Maddison, 2008; Weinhold, 2008). Chronic airport noise exposure has a negative impact at an economical, physical, and psychological level, affecting not only life satisfaction but also house satisfaction (Weinhold, 2008). It is an issue that seems to disturb different people in different ways, as some are more sensible to noise than others (Walters, 1975 in Weinhold, 2008). Weinhold (2008) found that respondents to happiness surveys that ticked the higher boxes of complaint with noise were significantly unhappier than the rest, as a highly significant level. As the urbanization increases, so will noise pollution, as people level in areas of increasing high density and housing prices. The negative effect can be minimized by better acoustic insulation of dwellings, an area left wide open for governments to legislate.

Pollution can cause insomnia, stress, hearing problems, high blood pressure, heart diseases, lower immune system, birth defects, and respiratory diseases (Passchier-Vermeer, Passchier, 2000 and Gouveia, Maisonet, 2005 in MacKerron, Mourato, 2013). A polluted environment seems to have a negative effect on individual's well-being. Welsch (2006, in Ferrer-i-Carbonell, 2013) found an inverse correlation between self-reported satisfaction with life and lead and nitrogen.

Natural environments have long been positively correlated to better health, well-being and happiness. Authors MacKerron and Mourato (2013) have conducted an experiment that allowed them to conclude, at a highly statistically significant level, this exact correlation. They propose three explanations. On the one hand, science has shown that experiences in nature tend to reduce stress in the nervous system. On the other hand, natural environments are associated with lower pollution, which causes mental

and health degradation negatively impacting happiness. Also, a deeper interaction with nature tends to encourage physical exercise, leisure activities, and social interaction; actions associated with higher levels of happiness (Barton, Pretty, 2010, Morris, 2003 in MacKerron, Mourato, 2013). Rangel (2003, in Ferrer-i-Carbonell, Gowdy, 2007) discovered a positive correlation between economic security and concern for preserving environmental quality for future generations.

3. Methodology

The aim of this dissertation is to analyse the impact of environmental variables on well-being, measured through self-reported levels of life satisfaction. To this end an econometrical model will be constructed were life satisfaction is the independent variable and environmental, economical, social and demographical indicators will be the explanatory variables.

To estimate the model, the method of ordinary least squares was used, for a cross-section model. The Newey-West method was also used, as it corrects standard errors for autocorrelation and heteroscedasticity (Gujarati, 2004). This was done for the year 2000 and 2010 to allow comparison between two different statistical periods.

The model used in Rehdanz and Maddison (2005) was particularly interesting and some inspiration was drawn from it to construct the empirical model. However, since the study of these two authors was quite different some adaptions had to be done. First, pollutants and environmental amenities variables replaced the climate variables, as the impact of the environment is in study and not the impact of the climate. Second, it was used data on life satisfaction as a proxy for happiness and well-being. This is due to the fact that data on life satisfaction is more widely available and complete and that there are empirical evidences showing that self-ratings of happiness reflect short-term mood, while self-reported life satisfaction correlates with longer-term assessments, even though they both generate consistent findings (Helliwell, Putnam, 2004). Nonetheless, data on self-reported life satisfaction was not complete for 2000 and 2010 for all 65 countries. It was considered that data from a three-year spam around the year in question was a good approximation for the value needed.

"Studies employing aggregate country data, both on happiness and environmental quality, suffer from three important limitations. First, they cannot control for individual characteristics (both observed and unobserved personal traits); second, they impose interpersonal comparisons at the cardinal level; and finally, they assume that aggregate country pollution measures properly capture the air quality of every single location (for example, that pollution is fairly evenly distributed across the whole country)" (Ferrer-i-Carbonell, 2013, pp. 48).

3.1 Variables

3.1.1 Dependent variable

The availability of data on life satisfaction is much higher than on happiness. Many authors argue that one is a proxy for the other and that both equally represent well-being (Diener *et al.*, 1985; Peterson *et al.*, 2005; Veenhoven, 2006; Costanza *et al.*, 2007; Ferrer-i-Carbonell, Gowdy, 2007; van Praag, 2007; Mota, Pereira, 2008; Rehdanz, Maddison, 2008; Mackerron, Mourato, 2009; Welsch, 2009; Frey, Stutzer, 2010; Stutzer, Frey, 2012; Easterlin, 2013; Ferrer-i-Carbonell, 2013; Frey, Stutzer, 2013). Furthermore, there are empirical evidences showing that self-ratings of happiness reflect short-term mood, while self-reported life satisfaction correlates with longer-term assessments, even though they both generate consistent findings (Helliwell, Putnam, 2004). Therefore, in this dissertation, life satisfaction data will be employed and the terms happiness, life satisfaction and well-being will be used interchangeably.

The World Database of Happiness provides data on self-reported levels of life satisfaction and happiness. For the purpose of this dissertation, only the data on life satisfaction will be used. This database comprises information on the average level of well-being for 155 countries throughout several years. This information is attained through surveys where the respondents are questioned about their own levels of life satisfaction (Veenhoven, 2013).

The database for life satisfaction on the World Database of Happiness has data on five different scales: 1-3, 1-4, 1-5, 1-10, and 0-10, where the lowest reply is always the option for the least satisfied with life. In this dissertation, the chosen scale is 1-4; as there is far more data on this scale than in any of the others.

To complement data on life satisfaction, input from World Value Surveys (WVS, 2011) is used. As in the World Database of Happiness, individuals self-report their levels of life satisfaction. WVS surveys address 97 countries, comprising almost 90% of the world's population on an extensive array of topics. The replies are ranked from 1 to 10 as follows: "dissatisfied"=1, "satisfied"=10 (WVS, 2011). To allow comparison with data from the World Database of Happiness, a simple proportion was applied to transform the scale from 1-10 in 1-4.

Supplementary data are also taken from European Social Surveys (ESS, 2012).

The ESS covers 30 countries and has been administered every two years since 2002. The questionnaire addresses many topics in addition to happiness and life satisfaction. The scale for the life satisfaction question is 0 (dissatisfied) to 10 (satisfied). To allow comparison with data from the World Database of Happiness, a proportion was applied to transform an 11-item scale into a 4-item scale.

For the purpose of this dissertation, the dataset[1] used in the empirical model includes 130 observations obtained in 65 different countries[2] for 2000 and 2010 (unless otherwise stated). Considering the dataset being used for 2000, the most satisfied country was Denmark (3,58) while on the bottom of the table was Peru (1,72). In 2010, the most satisfied nation was again Denmark (3,67) and the lowest scoring was Iraq (1,78).

From 2000 to 2010, the highest positive variation was in Ecuador, with an increase of +1,28 on overall self-reported life satisfaction of the country. The most significant negative change was observed in Morocco that experienced a decrease of -0,32 in ten years.

When reading the results of the regression analysis, it is important to have in mind that the conclusions are conditioned to the above-mentioned assumptions. Due to lack of data, it is assumed that different databases and scales are comparable and that the data collection among different countries is equal. It is also assumed that life satisfaction has a small variation and, therefore, data from a three-year spam is considered valid for the necessary year when data on that year is not available.

[1] For the complete dataset and references on life satisfaction for 2000 and 2010, please refer to appendix I, table I.1.
[2] For a full list of the countries please to refer to appendix I.

3.1.2 Independent variables

To estimate the impact of pollution and environmental amenities on life satisfaction, several indices are taken into account. Foremost, CO_2 emissions per capita[3] are used, as they are a well-known cause of global warming. Particulate matter[4] is also a common air pollutant and its average concentration levels are included in the model. This pollutant is particularly health damaging. Methane emissions, nitrous oxide emissions, and other greenhouse gas emissions per capita are also included[5]. According to Han and Naecher (2006), SO_2 and Pb are not as preoccupying as other pollutants; therefore they are not incorporated in the model. Also according to Han and Naecher (2006), ozone is considered a secondary pollutant, thus it is excluded. To include amenities, the percentage of forest area and terrestrial and marine protect areas are taken into account.

To explain the variations in life satisfaction, several economic, social and demographic indicators are included as variables in the model. Firstly, the empirical model incorporates GDP per capita in constant 2005 USD[6]. As it has been previously argued, even though GDP shouldn't be considered as a measured of welfare on its own, it certainly contributes to fluctuations in life satisfaction, which justifies its inclusion in the model. Additional economic variables, such as the annual GDP growth, the total unemployment as a percentage of the total labour force, and the annual inflation rate, were included[7] (Rehdanz, Maddison, 2005).

In 2010, the country with the highest GDP per capita, on this sample, was Luxembourg (81.385 USD), followed by Norway (64.590 USD) and Switzerland (54.685 USD). The country with the lowest GDP per capita was Vietnam (854 USD).

[3] CO_2 emissions data were taken from The World Bank (2013) for 2000 and from CDIAC (2013) for 2010. To convert into CO_2 per capita, data on the total population per country were taken from The World Bank (2013).
[4] Concentrations of particulate matter data were taken from The World Bank (2013).
[5] Methane, nitrous oxide and other greenhouse gases emissions data were taken from The World Bank (2013). To convert into methane, nitrous oxide and other greenhouse gases per capita, data on the total population per country were taken from The World Bank (2013).
[6] GDP per capita in constant 2005 USD data were taken from The World Bank (2013).
[7] GDP growth, unemployment rate and inflation rate data for were taken from The World Bank (2013). With the exception of unemployment rate 2000 for Brazil and Honduras, data taken from Index Mundi (2013); Jordan, data taken from EconStats (2012); Iraq, data for 2003. For 2010 unemployment rate, Brazil, Bolivia and Iraq, data were taken from Index Mundi (2013); and Vietnam from EconStats (2012). Data on inflation for 2000 for Chile and Venezuela were taken from Index Mundi (2013).

The countries with the higher GDP growth were Paraguay (13,09%), India (10,55%), and China (10,40%). Venezuela had by far the highest inflation rate (28,19%). And Macedonia had the highest unemployment rate (32%).

To account for cultural diversity, it is included an index of freedom measured through civil liberty (Rehdanz, Maddison, 2005). This index has an inverted scale of 1-7, where the latter is the lowest level of freedom[8] (Freedom House, 2013). Also, the weight of the major religions is integrated: Buddhist, Hindu, Muslim, and Christian[9] (Rehdanz, Maddison, 2005).

As measures of demographic variables, also employed by other researchers while trying to understand what influences well-being, are included life expectancy (for health), literacy rates[10] (for education), population density, proportion of the population over 65 and under 14 years of age, and proportion of the population living in urban areas (Rehdanz, Maddison, 2005)[11]. Studies show that urbanization has diverse environmental impacts, both positive and negative. For once it increases the burning of fossil fuels, due to intensive usage of public and private transportation (Panayotou, 1997 in Biswas *et al.*, 2012). However, it also increases environmental awareness and facilitates actions against heavily polluting industries (Biswas *et al.*, 2012).

[8] The only country scoring 7 (the least freedom) was Iraq in 2000. It was followed by China with 6 on both years.
[9] Data on religions were taken from Pew Research Center (2012). Data is for 2010 and is used both for 2000 and 2010.
[10] For further information on data and references for literacy rate, please refer to appendix I, table I.2..
[11] Life expectancy, population density, proportion of the population over 65 and under 15 years and proportion of urban population data were taken from The World Bank (2013)

3.2 Model

To estimate the impact of environmental pollutants and amenities on life satisfaction, the following model is constructed using the variables described in table 1 for two separate years, 2000 and 2010[12]:

$$LSatisf_{it} = \alpha + \beta_1 GDPcap_{it} + \beta_2 GDPcap_{it}^2 + \beta_3 Inf_{it} + Unemp_{it} + \cdots + \varepsilon_{it} \quad \text{Equation 1}$$

The GDP per capita variable is included both in its level, as the other variables, and as a quadratic variable (Rehdanz, Maddison, 2005).

Table 1 – Definition of variables

Variable	Definition
LSatisf	Average score of self-reported life satisfaction
GDP cap	GDP per capita in 2005 USD converted using market exchange rates
Inf	Annual inflation rate (%) - consumer prices
Unemp	Annual rate of unemployment
GDP growth	Annual GDP growth rate (%)
CO2 cap	Annual emissions of CO_2 (metric tons per capita)
PM	Concentrations of PM10 (micrograms per cubic meter)
Methane cap	Annual emissions of Methane (metric tons per capita)
Nitrous cap	Annual emissions of Nitrous oxide (metric tons per capita)
Other gases cap	Annual emissions of other greenhouse gases (metric tons per capita)
Forest area	Percentage of forest area
Protected areas	Percentage of terrestrial and marine protected areas
Fossil Fuels	Percentage of fossil fuel energy consumption
Popdens	Population density in persons per square kilometre
Urbpop	Percentage of the population living in urban areas
Age 0-14	Proportion of the population under 15 years
Age >65	Proportion of the population over 65 years
Lit	Percentage of the population age 15 and above who can, with understanding, read and write a short, simple statement on their everyday life

[12] *i* – countries; *t* – periods of time

Freed CL	Index of personal freedom - Civil liberties
Christian	Proportion of the population who are Christian
Muslim	Proportion of the population who are Muslim
Hindu	Proportion of the population who are Hindu
Buddhist	Proportion of the population who are Buddhist
Life exp	Life expectancy in years

4. Results

In table 2 are displayed the range of the variables, their means and standard deviations.

Table 2 – Summary of the data

	2000				2010				Growth rate between 2000-2010 (average values)
	Average	**Standard deviation**	**Minimum**	**Maximum**	**Average**	**Standard deviation**	**Minimum**	**Maximum**	
Lstatisf	2,67	0,43	1,72	3,58	2,93	0,43	1,78	3,67	9,74%
GDP cap	15655,70	17448,14	474,63	72394,19	17855,34	18756,53	854,32	81385,29	14,05%
Inf	8,33	14,75	-1,71	96,09	3,80	4,08	-1,09	28,19	-54,38%
Unemp	9,14	6,20	1,40	32,20	9,14	5,09	3,50	32,00	0,00%
GDP growth	4,17	2,49	-4,30	10,00	3,50	3,32	-4,94	13,09	-16,07%
CO2 cap	6,10	4,70	0,68	20,25	6,22	4,51	0,78	21,36	1,97%
PM	43,38	33,14	11,54	168,92	28,72	20,09	9,26	112,01	-33,79%
Methane cap	1,46	1,15	0,29	6,67	1,38	1,06	0,32	5,68	-5,48%
Nitrous cap	0,73	0,59	0,13	3,95	0,62	0,45	0,10	2,36	-15,07%
Other gases cap	0,13	0,21	0,00	1,28	0,20	0,22	0,00	1,13	53,85%
Forest area	32,90	18,97	0,06	73,74	32,96	18,40	0,07	72,91	0,18%
Protected areas	11,49	9,88	0,05	50,18	13,19	10,24	0,05	50,19	14,80%
Fossil Fuels	74,82	18,35	25,62	99,70	74,02	18,24	17,51	97,45	-1,07%
Popdens	108,52	109,41	2,49	476,13	116,85	117,38	2,87	508,86	7,68%

	2000				2010				Growth rate between 2000-2010 (average values)
	Average	**Standard deviation**	**Minimum**	**Maximum**	**Average**	**Standard deviation**	**Minimum**	**Maximum**	
UrbPop	67,09	15,69	24,37	97,12	69,99	15,10	30,39	97,46	4,32%
Age 0-14	24,95	8,71	14,32	44,06	21,85	7,89	13,29	41,52	-12,42%
Age >65	10,56	4,94	3,13	18,26	11,86	5,44	3,37	22,96	12,31%
Lit	92,80	9,94	52,31	100,00	94,47	8,15	62,75	100,00	1,80%
Free CL	2,62	1,42	1,00	7,00	2,25	1,45	1,00	6,00	-14,12%
Christian	66,63	32,63	0,10	99,00	66,63	32,63	0,10	99,00	0,00%
Muslim	11,70	27,71	0,10	99,00	11,70	27,71	0,10	99,00	0,00%
Hindu	1,45	9,84	0,00	79,50	1,45	9,84	0,00	79,50	0,00%
Buddhist	1,69	5,95	0,00	36,20	1,69	5,95	0,00	36,20	0,00%
Life exp	73,38	5,07	54,78	81,08	75,83	5,32	52,08	82,84	3,34%

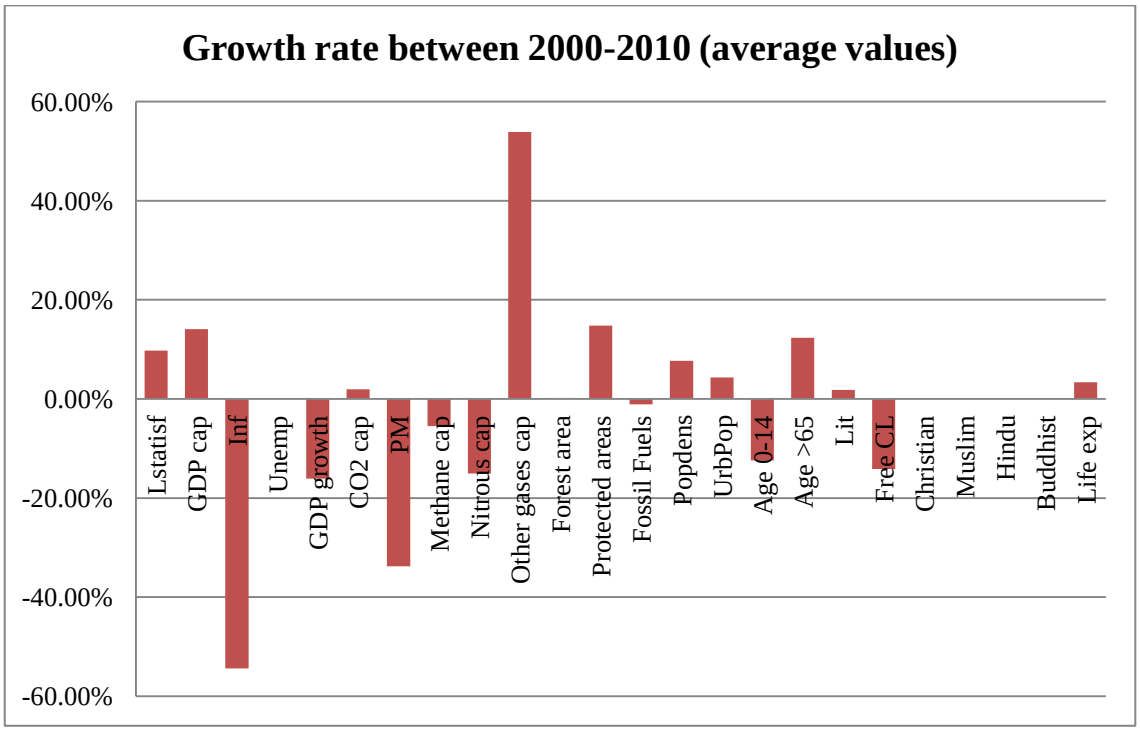

Figure 1– Growth rate between 2000 and 2010 for all variables (average values)

From 2000 to 2010, considering the country sample, there was a +9,74% increase in average self-reported life satisfaction. GDP per capita also increased on average, +14,05%. The average of the inflation rate decreased more than half, -54,38%. Average unemployment level was maintained. The emissions of CO_2 (+1,97%) per capita increased slightly and the emissions of methane and nitrous oxide per capita decreased slightly. The average concentration of particulate matter had a significant decrease (-33,79%). The average percentage of forest area showed no significant change, much as the percentage of fossil fuel in total energy consumption. But the percentage of protected area increased +14,80%. The percentage of the population under 15 years decreased on average and the opposite was verified for the percentage of people over 65 years.

4.1 Results for 2000

There were estimated two regressions for the year 2000[1]; one with all the variables and a second one were the not statistically relevant ones were removed. The results of the first one are presented in Table 4. This regression has a R^2 of 82,62%, which is regarded as elevated. However, there are many variables with a high p-value that need to be excluded from the regression, as they have no statistical significance. Variables are considered significant at 5% significance level.

Table 3 – Regression results 2000 – All variables

Dependent Variable: LSATISF
Method: Least Squares

Sample: 1 65
Included observations: 65
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.073380	0.941892	4.324678	0.0001
GDP_CAP	4.54E-05	6.75E-06	6.721656	0.0000
GDP_CAP^2	-4.16E-10	8.68E-11	-4.788952	0.0000
INF	-0.007863	0.001285	-6.120308	0.0000
UNEMP	-0.014831	0.006620	-2.240525	0.0307
GDP_GROWTH	-0.002633	0.021894	-0.120246	0.9049
CO2_CAP	-0.005558	0.010522	-0.528224	0.6003
PM	-0.000919	0.001144	-0.803511	0.4264
METHANE_CAP	0.018526	0.081959	0.226040	0.8223
NITROUS_CAP	0.022545	0.131444	0.171519	0.8647
OTHER_GAS_CAP	-0.006655	0.155002	-0.042938	0.9660
FOREST_AREA	0.001338	0.002759	0.485091	0.6303
PROTECTED_AREAS	0.002688	0.005735	0.468774	0.6418
FOSSIL_FUEL	0.000881	0.002983	0.295531	0.7691
POPDENS	-0.000212	0.000313	-0.679586	0.5007
URBPOP	-0.003331	0.003384	-0.984338	0.3309
AGE_0_14	-0.010051	0.013732	-0.731943	0.4685
AGE___65	-0.031953	0.020670	-1.545849	0.1300
LIT	0.006434	0.005045	1.275236	0.2096
FREE_CL	0.037712	0.049024	0.769250	0.4463
CHRISTIAN	-0.003188	0.001505	-2.118706	0.0404
MUSLIM	-0.002788	0.003076	-0.906462	0.3701
HINDU	-0.007636	0.002390	-3.195427	0.0027
BUDDHIST	-0.020219	0.007956	-2.541458	0.0150
LIFE_EXP	-0.018445	0.009667	-1.908015	0.0636

R-squared	0.826210	Mean dependent var	2.672308
Adjusted R-squared	0.721936	S.D. dependent var	0.433282
S.E. of regression	0.228477	Akaike info criterion	0.168965
Sum squared resid	2.088078	Schwarz criterion	1.005268
Log likelihood	19.50865	Hannan-Quinn criter.	0.498940
F-statistic	7.923454	Durbin-Watson stat	1.980508
Prob(F-statistic)	0.000000	Wald F-statistic	98.38302
Prob(Wald F-statistic)	0.000000		

[1] The software used for all regressions was EViews 8.

The following variables were considered not significant in explaining life satisfaction: GDP growth, CO_2, methane, nitrous oxide, and other greenhouse gases emissions per capita, concentration of particulate matter, percentage of forest area and protected areas, percentage of fossil fuel in total energy consumption, literacy rate, the index of freedom, population density, and percentage of the population living in urban areas.

Therefore, a new regression for the same year is estimated without them. The results are presented in table 6.

Table 4 – Regression results 2000 – Significant variables

Dependent Variable: LSATISF
Method: Least Squares

Sample: 1 65
Included observations: 65
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.841156	0.667754	7.249905	0.0000
GDP_CAP	3.98E-05	5.36E-06	7.410442	0.0000
GDP_CAP^2	-3.61E-10	5.92E-11	-6.105006	0.0000
INF	-0.006419	0.001160	-5.533545	0.0000
UNEMP	-0.015152	0.004648	-3.260100	0.0019
AGE_0_14	-0.015524	0.008940	-1.736451	0.0883
AGE___65	-0.037261	0.016407	-2.271022	0.0272
CHRISTIAN	-0.002834	0.001534	-1.847785	0.0702
MUSLIM	-0.003565	0.001571	-2.269218	0.0274
HINDU	-0.010184	0.001719	-5.923733	0.0000
BUDDHIST	-0.019659	0.004177	-4.706273	0.0000
LIFE_EXP	-0.018305	0.008308	-2.203424	0.0319

R-squared	0.799138	Mean dependent var	2.672308
Adjusted R-squared	0.757450	S.D. dependent var	0.433282
S.E. of regression	0.213389	Akaike info criterion	-0.086265
Sum squared resid	2.413347	Schwarz criterion	0.315160
Log likelihood	14.80361	Hannan-Quinn criter.	0.072123
F-statistic	19.16935	Durbin-Watson stat	2.047523
Prob(F-statistic)	0.000000	Wald F-statistic	128.8574
Prob(Wald F-statistic)	0.000000		

This regression has a R^2 of 79,91%, slightly lower than the previous one, which was expected as there are less independent variables. In this regression, GDP per capita and its quadratic function are the most statistically significant explanatory variables. The former has a positive coefficient sign, which means that it is expected for a country with a higher GDP per capita to have a higher life satisfaction. This is in agreement with the literature previously discussed.

Unemployment is also highly significant in explaining life satisfaction. Its negative coefficient sign translates into the expectations of a country with a higher unemployment rate having a lower life satisfaction value. The same is verified for inflation.

In 2000, no environmental variable was considered statistically significant.

The percentage of people over 65 years impacts negatively life satisfaction. The percentage of Muslims, Hindus and Buddhists impact negatively life satisfaction, at a 5% significance level. The higher the percentage of religious people of these three religions the lower was life satisfaction.

Life expectancy had a negative statistically significant impact on life satisfaction. This result was contrary to the expected and defended in the literature.

4.2 Results for 2010

As for the year 2000, there were estimated two regressions for 2010; one with all the variables and a second one were the not statistically relevant ones were removed. The results of the first one are presented in Table 6. This regression has a R^2 of 84,24%, which is high especially considering that there are 65 observations. However, there are some variables with a high p-value that need to be excluded from the regression, as they have no statistical significance. Variables are considered significant at 5% significance level.

Table 5 – Regression results 2010 – All variables

Dependent Variable: LSATISF
Method: Least Squares

Sample: 1 65
Included observations: 65
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.469339	1.121079	1.310647	0.1975
GDP_CAP	2.93E-05	6.49E-06	4.525300	0.0001
GDP_CAP^2	-2.12E-10	6.27E-11	-3.383437	0.0016
INF	-0.000164	0.009494	-0.017270	0.9863
UNEMP	-0.002754	0.006878	-0.400325	0.6910
GDP_GROWTH	0.001007	0.009719	0.103633	0.9180
CO2_CAP	-0.024331	0.011280	-2.156969	0.0371
PM	-0.000880	0.002484	-0.354464	0.7249
METHANE_CAP	-0.014341	0.054201	-0.264593	0.7927
NITROUS_CAP	0.125977	0.129067	0.976059	0.3349
OTHER_GAS_CAP	-0.209923	0.120777	-1.738103	0.0899
FOREST_AREA	0.002833	0.001562	1.813826	0.0772
PROTECTED_AREAS	0.007906	0.004058	1.948165	0.0584
FOSSIL_FUEL	-0.002372	0.002028	-1.169459	0.2491
POPDENS	7.02E-05	0.000404	0.173706	0.8630
URBPOP	0.002783	0.002070	1.344202	0.1865
AGE_0_14	0.012202	0.012216	0.998884	0.3239
AGE__65	-0.052876	0.015896	-3.326365	0.0019
LIT	0.015442	0.007075	2.182778	0.0350
FREE_CL	-0.022304	0.042836	-0.520678	0.6055
CHRISTIAN	-0.004491	0.001519	-2.955535	0.0052
MUSLIM	-0.007268	0.002052	-3.541405	0.0010
HINDU	-0.004617	0.004606	-1.002389	0.3222
BUDDHIST	-0.018484	0.008831	-2.093026	0.0427
LIFE_EXP	0.005366	0.008124	0.660510	0.5127

R-squared	0.842412	Mean dependent var	2.927692
Adjusted R-squared	0.747859	S.D. dependent var	0.429523
S.E. of regression	0.215679	Akaike info criterion	0.053672
Sum squared resid	1.860697	Schwarz criterion	0.889974
Log likelihood	23.25567	Hannan-Quinn criter.	0.383647
F-statistic	8.909438	Durbin-Watson stat	2.151091
Prob(F-statistic)	0.000000	Wald F-statistic	209.5523
Prob(Wald F-statistic)	0.000000		

The following variables were considered not significant to explain life satisfaction: unemployment rate, inflation rate, GDP growth, nitrous oxide and methane emissions per capita, concentration of particulate matter, population density, the index of freedom, life expectancy and the percentage of people under 15 years.

Therefore, a new regression for the same year is estimated without them. The results are presented in table 7.

Table 6 – Regression results 2010 – Significant variables

Dependent Variable: LSATISF
Method: Least Squares

Sample: 1 65
Included observations: 65
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.472986	0.560398	4.412910	0.0001
GDP_CAP	3.63E-05	5.06E-06	7.167948	0.0000
GDP_CAP^2	-2.79E-10	6.25E-11	-4.468628	0.0000
CO2_CAP	-0.024465	0.008765	-2.791135	0.0074
OTHER_GAS_CAP	-0.270327	0.108372	-2.494446	0.0160
FOREST_AREA	0.002743	0.001434	1.913219	0.0615
PROTECTED_AREAS	0.007778	0.002823	2.755077	0.0082
FOSSIL_FUEL	-0.003509	0.001468	-2.389817	0.0207
URBPOP	0.004625	0.001844	2.507775	0.0154
AGE__65	-0.065706	0.006597	-9.959475	0.0000
LIT	0.012458	0.005579	2.233178	0.0300
CHRISTIAN	-0.004759	0.001442	-3.300922	0.0018
MUSLIM	-0.008222	0.001893	-4.342897	0.0001
HINDU	-0.005395	0.002846	-1.895886	0.0638
BUDDHIST	-0.021140	0.008746	-2.417134	0.0193

R-squared	0.828036	Mean dependent var	2.927692
Adjusted R-squared	0.779887	S.D. dependent var	0.429523
S.E. of regression	0.201516	Akaike info criterion	-0.166722
Sum squared resid	2.030434	Schwarz criterion	0.335060
Log likelihood	20.41847	Hannan-Quinn criter.	0.031263
F-statistic	17.19710	Durbin-Watson stat	2.169545
Prob(F-statistic)	0.000000	Wald F-statistic	177.4897
Prob(Wald F-statistic)	0.000000		

This regression has a R^2 of 82,80%, slightly lower than the previous one, which was expected as there are less independent variables. In this regression, the emissions of CO_2 and other greenhouse gases per capita are statistically significant. The coefficient signs are negative, which may mean that individuals value their health as they associate pollution with poorer health. The percentage of fossil fuel in total energy consumption impacts life satisfaction negatively. The environmental amenities percentage of marine

and terrestrial protected areas has a positive statistically significant impact on overall life satisfaction.

GDP per capita is highly significant to explain life satisfaction, as is its quadratic function. The former has a positive coefficient sign; therefore a country with a higher GDP should have a higher life satisfaction.

The variable proportion of the population over 65 years is also highly statistically significant to explaining life satisfaction. The sign of the coefficient is negative, which means that population with a high weight of people over 65 in the composition of the population tend to have lower levels of life satisfaction. People often associate retired people with a burden on social security, on the government, and indirectly as a possible tax increase.

The variables percentage of Christians, Muslims and Buddhists present in a society are statistically significant in explaining life satisfaction. Their coefficient sign is negative, which might mean that higher concentration of believers of any of these religions on a country results in lower life satisfaction.

The literacy rate is positively statistically significant in overall well-being, and its positive coefficient sign translates into people valuing belonging to a literate society.

4.3 Correlation matrixes

Table 8 – Correlation of variables, 2000

	GDP cap	Inf	Unemp	GDP growth	CO2 cap	PM	Methane cap	Nitrous cap	Other gases cap	Forest area	Protected areas	Fossil Fuels	Pop dens	Urb Pop	Age 0-14	Age >65	Lit	Free CL	Christian	Muslim	Hindu	Buddhist	Life exp
GDP cap	1,00	-0,26	-0,40	0,12	0,70	-0,44	0,26	0,37	0,67	-0,07	0,05	-0,03	0,19	0,52	-0,54	0,61	0,47	-0,66	0,13	-0,23	-0,10	0,04	0,70
Inf		1,00	0,02	-0,10	-0,19	-0,09	-0,03	-0,12	-0,17	0,02	0,19	0,14	-0,16	-0,14	0,12	-0,17	0,00	0,20	0,16	0,05	-0,04	-0,15	-0,20
Unemp			1,00	-0,24	-0,12	0,11	-0,09	-0,20	-0,30	-0,11	-0,08	0,28	-0,28	0,00	0,05	-0,09	-0,06	0,24	-0,04	0,27	-0,10	-0,22	-0,31
GDP growth				1,00	0,34	-0,36	-0,09	-0,10	0,13	0,14	0,05	0,16	0,14	0,04	-0,27	0,15	0,23	0,02	-0,18	-0,11	-0,01	0,16	0,01
CO2 cap					1,00	-0,48	0,38	0,44	0,56	-0,05	0,05	0,37	0,13	0,53	-0,61	0,57	0,54	-0,53	0,01	-0,23	-0,12	0,06	0,49
PM						1,00	0,00	-0,12	-0,30	-0,22	-0,30	-0,02	-0,01	-0,31	0,51	-0,46	-0,47	0,52	-0,42	0,48	0,18	0,06	-0,34
Methane cap							1,00	0,86	0,32	-0,03	-0,03	-0,01	-0,36	0,33	-0,14	0,16	0,27	-0,30	0,24	-0,25	-0,09	-0,14	0,13
Nitrous cap								1,00	0,25	-0,07	-0,05	-0,09	-0,28	0,35	-0,17	0,21	0,26	-0,45	0,27	-0,27	-0,10	-0,14	0,26
Other gases cap									1,00	-0,04	-0,07	-0,03	0,09	0,36	-0,38	0,39	0,35	-0,41	0,03	-0,16	-0,06	0,15	0,47
Forest area										1,00	0,34	-0,33	-0,11	-0,01	-0,07	0,03	0,18	-0,10	0,23	-0,36	-0,08	0,24	0,05
Protected areas											1,00	-0,05	-0,04	0,11	0,09	-0,07	0,07	-0,03	0,25	-0,31	-0,09	-0,08	0,10
Fossil Fuels												1,00	0,15	0,11	-0,23	0,12	0,09	0,14	-0,26	0,29	-0,07	0,01	0,00
Popdens													1,00	-0,04	-0,19	0,16	0,02	-0,06	-0,38	-0,07	0,28	0,47	0,18
UrbPop														1,00	-0,34	0,38	0,51	-0,46	0,15	-0,16	-0,31	-0,08	0,57
Age 0-14															1,00	-0,94	-0,74	0,56	-0,13	0,35	0,13	-0,11	-0,54
Age >65																1,00	0,69	-0,59	0,18	-0,35	-0,16	0,02	0,61
Lit																	1,00	-0,50	0,33	-0,49	-0,40	0,07	0,57
Free CL																		1,00	-0,42	0,50	0,03	0,13	-0,54
Christian																			1,00	-0,42	0,50	0,03	0,13
Muslim																				1,00	-0,66	-0,25	-0,43
Hindu																					1,00	0,02	-0,10
Buddhist																						1,00	-0,02
Life exp																							1,00

Table 9 – Correlation of variables, 2010

	GDP cap	Inf	Unemp	GDP growth	CO2 cap	PM	Methane cap	Nitrous cap	Other gases cap	Forest area	Protected areas	Fossil Fuels	Pop dens	Urb Pop	Age 0-14	Age >65	Lit	Free CL	Christian	Muslim	Hindu	Buddhist	Life exp
GDP cap	1,00	-0,35	-0,22	-0,36	0,70	-0,43	0,21	0,29	0,63	-0,02	0,09	-0,08	0,18	0,52	-0,47	0,57	0,46	-0,62	0,13	-0,24	-0,10	0,05	0,68
Inf		1,00	-0,09	0,09	-0,20	0,17	0,07	-0,06	-0,29	-0,08	0,21	0,09	-0,08	-0,12	0,28	-0,38	-0,25	0,45	-0,07	0,13	0,25	-0,07	-0,33
Unemp			1,00	-0,25	-0,03	-0,17	-0,11	-0,04	-0,03	-0,07	-0,19	0,19	-0,27	-0,12	-0,11	0,06	0,12	-0,01	-0,01	0,18	-0,14	-0,19	-0,28
GDP growth				1,00	-0,28	0,55	0,03	-0,04	-0,32	0,11	-0,16	-0,04	0,10	-0,18	0,34	-0,44	-0,31	0,31	-0,35	0,18	0,27	0,22	-0,31
CO2 cap					1,00	-0,46	0,37	0,30	0,64	0,03	0,06	0,33	0,12	0,46	-0,53	0,51	0,51	-0,45	-0,04	-0,21	-0,12	0,11	0,41
PM						1,00	0,09	0,06	-0,41	-0,21	-0,30	-0,05	0,01	-0,28	0,50	-0,45	-0,44	0,43	-0,33	0,35	0,14	0,10	-0,32
Methane cap							1,00	0,82	0,21	0,00	-0,07	-0,02	-0,39	0,29	-0,13	0,10	0,29	-0,19	0,20	-0,23	-0,09	-0,12	0,07
Nitrous cap								1,00	0,27	-0,05	-0,04	-0,20	-0,33	0,35	-0,15	0,17	0,31	-0,41	0,26	-0,28	-0,11	-0,15	0,21
Other gases cap									1,00	0,05	0,05	-0,03	0,01	0,40	-0,48	0,51	0,43	-0,45	0,01	-0,22	-0,09	0,13	0,47
Forest area										1,00	0,30	-0,28	-0,10	0,02	-0,18	0,16	0,23	-0,11	0,20	-0,36	-0,07	0,28	0,14
Protected areas											1,00	-0,10	-0,05	0,15	0,05	0,01	0,06	-0,03	0,30	-0,34	-0,11	-0,11	0,15
Fossil Fuels												1,00	0,18	-0,01	-0,13	0,02	0,05	0,19	-0,34	0,31	-0,01	0,10	-0,09
Popdens													1,00	-0,03	-0,14	0,16	-0,07	-0,07	-0,40	-0,04	0,31	0,45	0,20
UrbPop														1,00	-0,21	0,32	0,50	-0,42	0,12	-0,17	-0,32	0,01	0,50
Age 0-14															1,00	-0,90	-0,72	0,62	-0,13	0,38	0,13	-0,16	-0,51
Age >65																1,00	0,66	-0,68	0,16	-0,38	-0,16	0,12	0,59
Lit																	1,00	-0,59	0,35	-0,47	-0,49	0,07	0,49
Free CL																		1,00	-0,38	0,47	0,06	0,16	-0,54
Christian																			1,00	-0,66	-0,25	-0,43	0,08
Muslim																				1,00	0,02	-0,10	-0,25
Hindu																					1,00	-0,02	-0,25
Buddhist																						1,00	0,16
Life exp																							1,00

GDP per capita correlates highly and positively with the percentage of urban population, the percentage of people over 65 years. It correlates highly and negatively with the index of freedom (low values represent higher freedom). The countries with the higher GDP per capita are developed nations with high urban populations and aging population, which explains the correlation between these variables. In 2000, it also has a high negative correlation with the percentage of people under 15 years, the countries with higher young population are the developing countries with low GDP per capita. In both years, GDP per capita correlates highly with life expectancy; developed countries tend to have higher life expectancy than developing ones.

CO_2, methane, nitrous oxide, and other greenhouse gas emissions per capita correlate high and positive among themselves. CO_2 emissions per capita also have a high correlation with the age structure of the population and the literacy rates, most likely for the same reasons that these variables correlate with GDP per capita.

The variables percentage of people under 15 and percentage of people over 65 have a high negative correlation, as a country that has a high percentage of one tends to not have a high percentage of the other. There are also high correlations among the socio-demographic variables literacy rate, freedom, life expectancy, and percentage of people under 15 and over 65.

The percentage of Muslims and Christians has a negative correlation, as they tend to not coexist in the same society.

4.4 Comparing 2000 and 2010

In both years, the most significant variables in explaining life satisfaction were GDP per capita, its quadratic function, the percentage of Muslims and Buddhists, and the percentage of people over 65 years. The first has a positive coefficient sign for both years, which is in line with the literature that states than even though GDP is not the only factor influencing life satisfaction it certainly gives a major contribution. Being part of a society with an aging population is associated with lower life satisfaction, showed by the negative coefficient sign of this variable. Being a part of a Muslim or Buddhist society is also associated with lower life satisfaction, due to the negative coefficient sign.

In the year 2010, the emissions of CO_2 per capita were statistically significant, with a negative coefficient sign, i.e. it is expected for societies with higher CO_2 emissions per capita to have lower levels of life satisfaction. The same happens for the emissions of other greenhouse gases per capita. It may indicate that people associate CO_2 with environmental issues and health problems more than economic growth. The fact that this variable was not statistically significant in 2000 but is in 2010 may suggest a change in individual's mentality.

Inflation rate and unemployment rate only weighted in well-being in 2000. For both the coefficient sign was negative, meaning that a country higher unemployment and/or inflation is expected to have a lower life satisfaction. This is in alignment with the literature, which particularly for unemployment stated that it is extremely damaging for overall well-being. The average inflation rate diminished more than half in this decade, which can explain the variable being statistically significant only in 2000.

In the year 2010, the percentage of fossil fuel in total energy consumption had a statistically significant negative impact on life satisfaction, which may translates into people being concerned with the environment and preferring renewable energy sources. Also in this year, people valued positively the existence of protected areas, which might reflect that people are starting to value environmental amenities correlating them to their own well-being.

Considering this dataset, it is possible to infer that environmental variables have gained significant weight on overall life satisfaction, their impact increased significantly

from 2000 to 2010. The fact that there isn't a more strong relationship can be related to a disassociation between environmental problems and health issues and the fact that these are usually only manifested at a latter age (e.g. concentration of particulate matter, emissions of methane and nitrous oxide per capita). Weitzman states, "at low levels of income and economic activity, environmental concerns typically represent a relatively low priority" (Weitzman, 1994, pp. 200). The author also argues that higher levels of economic activity produce a disproportional significant environmental destruction. And that environmental amenities are perceived as a luxury good, which might be on a changing path as the percentage of marine and terrestrial protected areas became positively significant in 2010.

4.5 The case of Portugal and Denmark

In Portugal, overall self-reported life satisfaction has shown a decreasing tendency between 1990 and 2010. During these years, GDP per capita increased, inflation dropped, and the literacy rate increased, as did life expectancy. When comparing these three realities to a country such as Denmark, a pioneer country in environmental laws (Jänicke, 2005), the picture is quite different. Over the 20 years between 1990 and 2010, life satisfaction increased in this nation, as did GDP per capita.

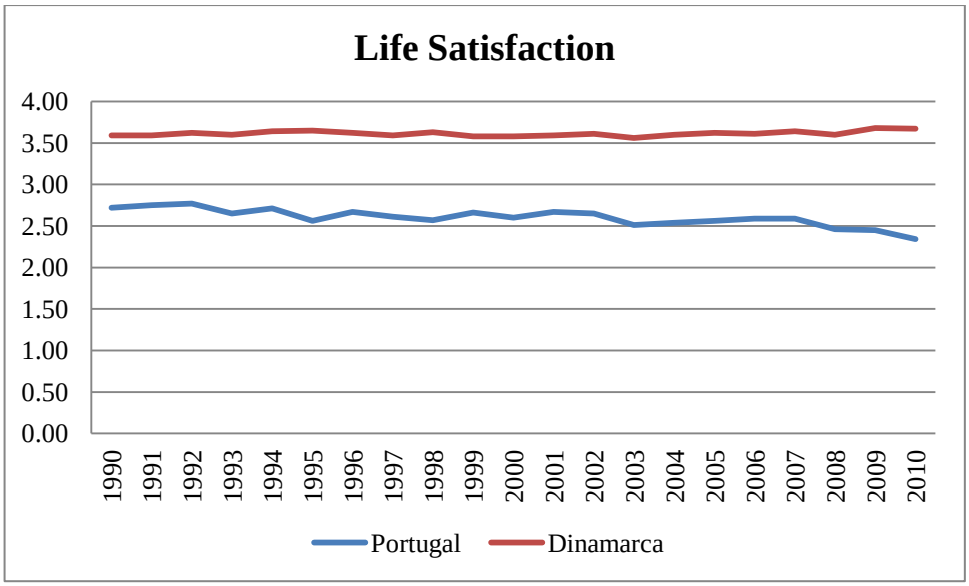

Figure 2 – Life satisfaction evolution for Portugal and Denmark between 1990 and 2010

Environmentally, Portugal was not in 2010 worse off than in 1990, the emissions of CO_2, methane, nitrous oxide, and other greenhouse gases per capita barely increased and the concentration of particulate matter decrease more than 50%. In Denmark, during the period between 1990 and 2010, the per capita emissions of CO_2, methane, nitrous oxide, and other greenhouse gases diminished. The concentration of particulate matter decreased by nearly half in twenty years.

The level of CO_2 per capita is higher in Denmark than in Portugal, however in former the decrease has been more significant than in the latter.

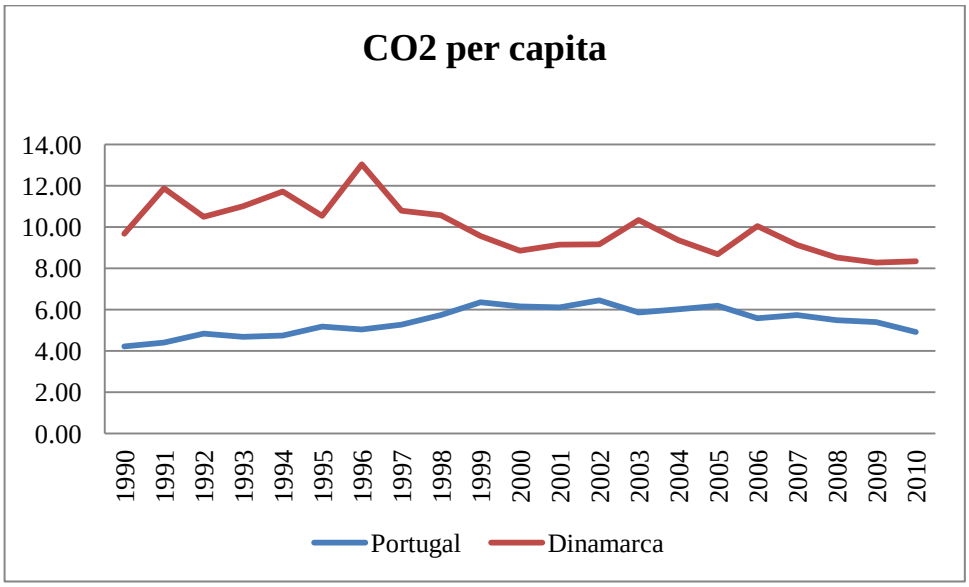

Figure 3 – CO_2 emissions per capita evolution for Portugal and Denmark between 1990 and 2010

There were in Portugal in 2010 more forests and protected areas than in 1990. The same happened in Denmark. Nonetheless, Portugal has a higher growth rate of percentage of marine and terrestrial protected areas than Denmark.

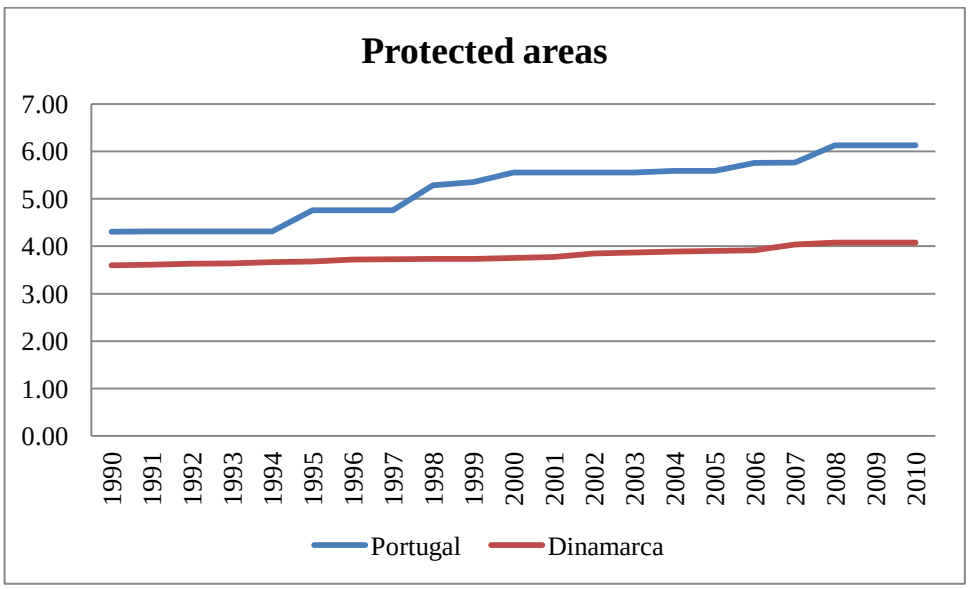

Figure 4 – Percentage of marine and terrestrial protected areas evolution for Portugal and Denmark between 1990 and 2010

The percentage of fossil fuels as a total of energy consumption diminished 5% in twenty years in Portugal. In Denmark, there was a decrease of more than 10% in this variable, most likely due to many investments made in renewable energy sources.

However, even with all these progresses, average well-being still decreased in Portugal and increased in Denmark.

In these twenty years, Portugal lost 5% of people under 15 years and gained the same in people over 65 years. At the same time, unemployment raised 6% (from 5% in 2000 to 11% in 2010). This created a social crisis stronger than any economical or environmental improvements could ever over turn. There is no financial security with unemployment rising. Also, the relative increase of population over 65 years and the relative decrease of population under 15 years raise concerns with the short and long term sustainability of social security. It creates added pressure on the working class as taxes increase to counterbalance this new reality. When a country is going through times of social uncertainty, the environmental reality takes a back seat in people and government's priorities.

In Denmark, the inflation rate and the unemployment rate were much unaltered during this period, as were the percentages of people under 15 years and over 65 years. Here is a society still not much going to the aging process other countries are (e.g. Portugal) and without an unemployment crisis. The social stability lived in the country allows people to have other priorities and value different scenarios. Danish people, free of social crisis, can thus for give importance to the environmental quality of their surroundings. As so many improvements happened in the environmental field in Denmark, the average life satisfaction of the country increased.

Even though these conclusions hold for individuals, the same should not be applied to the government. They have the obligation to put environmental concerns in the same degree of importance as social and economical issues. For once, it is the government's role to protect its citizens from harm and potential diseases that pollutants can cause (Stern *et al.*, 1985). They also have the responsibility of guarantying the preservation of the environment for future generations, given equal importance to all dimensions of sustainable development, economical, social, and environmental (Stiglitz *et al.*, 2009).

5. Conclusion

This dissertation's purpose was to determine if there was an impact supported by statistical evidence of the environment on subjective well-being. To achieve this aim a sample of 65 countries were chosen and data were collected for the years 2000 and 2010 in order to make an evolutionary comparison between the two years.

The dependent variable chosen was self-reported life satisfaction measured through surveys administered to individuals across time and countries. As explanatory variables to account for pollution and environmental amenities, the following were chosen: emissions of CO_2, methane, nitrous oxide and other greenhouse gases per capita, concentration of particulate matter, percentage of forest area, percentage of marine and terrestrial protected areas, and percentage of fossil fuel of total energy consumption. These comprise some of the most harmful air pollutants and important environmental amenities. To fully understand what influences happiness, it were included in model economical, social and demographical variables: GDP per capita, inflation rate, unemployment rate, GDP growth, population density, percentage of urban population, percentage of people under 15 years, percentage of people over 65 years, literacy rate (as a proxy for education), the weight of major religions and life expectancy (as a proxy for health).

An econometric model was constructed with the variables above-mentioned and regressions analyses were run, one with all the variables and another with the statistically significant ones for each year.

For both years, one of the most significant variables in explaining life satisfaction was GDP per capita, with a positive impact. As it has been previously argued, even though this is not the only factor influencing well-being it certainly has its importance. The percentage of people over 65 years impacts negatively life satisfaction, both in 2000 and in 2010, as people associate being part of an aging society with a load on social security and potential taxes increases.

There are no significant environmental variables in 2000. However, what is interesting to notice is that several environmental variables that were non-significant in 2000 became significant in explaining life satisfaction in 2010. This happened with the emissions of CO_2 and other greenhouse gases per capita, the percentage of fossil fuel in

total energy consumption and the percentage of protected areas. For all these variables, the coefficient sign was the expected. These results suggest that people are becoming more aware of environmental issues and valuing more environmental amenities, correlating them to their own well-being.

Some reasons are pointed out to explain the lack of a stronger relationship between environmental variables and life satisfaction. On one hand, there is a disassociation between environmental problems and health issues, which usually only manifest at a latter age. On the other hand, pollution is still much associated with economic growth, which only shows a need to pursue less polluting ways of production and consumption.

To complement the econometrical analysis, a statistical comparison was made between Portugal, a country going through a severe social crisis, and Denmark, a socially stable nation, for the period comprised between 1990 and 2010, on an early average. It was possible to verify that with increasing unemployment rates there is not enough room for individuals to value environmental improvements, Portugal had diminishing life satisfaction ratings with increasing unemployment rates. However, with unchanging unemployment rates, as happened in Denmark, and all other social variables stagnated, individuals were able to enjoy environmental progressions. Life satisfaction rose in this county between 1990 and 2010.

It is crucial to have in mind that pollution affects people in an extensive variety of ways, mainly through health problems and consequences of climate change. And there is a governmental obligation to mitigate these effects, not only through tighter environmental laws and inspections but also through raising environmental awareness. It is also of importance to notice that GDP, the main economical and welfare indicator used in the world, does not account pollution, environmental degradation, stock depletion, species extinctions, or the benefits of environmental amenities. Therefore, there is the space to complement GDP with other indicators, through direct adjustments or in combination with several other measurements. Subjective well-being, through data on self-reported happiness or life satisfaction, can be a great complementary tool for governments throughout the world. It will impel them to stop prioritizing economic growth and start focusing more on what really makes people happy and better off.

Given that the economics of happiness has been growing in the last decades and that it is starting to have an important role in contemporary economics, in the next few years it will be possible to redo this work with more data, countries and years wise. This analysis could in the future be extended to include further environmental variables, such as water pollutants that to date do not have significant available data to be incorporated in the model. Many pollutants and environmental amenities vary immensely not just among countries, but also within countries. It would be interesting to apply this study to a region level. The adaptation effect has also not been included in the model. All this is deferred to future research.

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Appendix I

Table I.1 – Life Satisfaction data

	For 2000			For 2010		
Country name	**Lsatisf**	**Year**	**Reference**	**Lsatisf**	**Year**	**Reference**
Australia	3,06	2000	Veenhoven (2013)	3,07	2010	Veenhoven (2013)
Austria	3,11	2002	ESS (2013)	3,10	2006	ESS (2013)
Belgium	3,08	2000	Veenhoven (2013)	3,16	2010	Veenhoven (2013)
Bolivia	2,95	2000	Veenhoven (2013)	3,09	2010	Veenhoven (2013)
Brazil	2,61	2000	Veenhoven (2013)	3,45	2010	Veenhoven (2013)
Bulgaria	2,08	2001	Veenhoven (2013)	2,20	2010	Veenhoven (2013)
Canada	3,36	2000	Veenhoven (2013)	3,11	2010	Veenhoven (2013)
Chile	2,28	2000	Veenhoven (2013)	3,12	2010	Veenhoven (2013)
China	2,75	1999	Veenhoven (2013)	2,71	2007	WVS (2011)
Colombia	2,40	2000	Veenhoven (2013)	3,46	2010	Veenhoven (2013)
Costa Rica	2,64	2000	Veenhoven (2013)	3,44	2010	Veenhoven (2013)
Croatia	2,79	2004	Veenhoven (2013)	2,78	2010	Veenhoven (2013)
Czech Republic	2,84	2001	Veenhoven (2013)	2,90	2010	Veenhoven (2013)
Denmark	3,58	2000	Veenhoven (2013)	3,67	2010	Veenhoven (2013)
Ecuador	1,86	2000	Veenhoven (2013)	3,14	2010	Veenhoven (2013)
Egypt	2,14	2000	WVS (2011)	2,31	2008	WVS (2011)
El Salvador	2,34	2000	Veenhoven (2013)	3,07	2010	Veenhoven (2013)
Estonia	2,44	2001	Veenhoven (2013)	2,77	2010	Veenhoven (2013)
Finland	3,10	2000	Veenhoven (2013)	3,33	2010	Veenhoven (2013)
France	2,94	2000	Veenhoven (2013)	2,99	2010	Veenhoven (2013)
Germany	2,96	2000	Veenhoven (2013)	3,08	2010	Veenhoven (2013)
Greece	2,61	2000	Veenhoven (2013)	2,36	2010	Veenhoven (2013)
Guatemala	2,64	2000	Veenhoven (2013)	3,31	2010	Veenhoven (2013)
Honduras	2,63	2000	Veenhoven (2013)	3,32	2010	Veenhoven (2013)
Hungary	2,54	2001	Veenhoven (2013)	2,42	2010	Veenhoven (2013)
Iceland	3,44	2004	ESS (2013)	3,62	2010	Veenhoven (2013)
India	2,06	2001	WVS (2011)	2,32	2006	WVS (2011)
Indonesia	2,78	2001	WVS (2011)	2,76	2006	WVS (2011)
Iraq	2,09	2004	WVS (2011)	1,78	2006	WVS (2011)
Ireland	3,21	2000	Veenhoven (2013)	3,24	2010	Veenhoven (2013)
Israel	2,81	2001	WVS (2013)	3,22	2010	Veenhoven (2013)
Italy	2,88	2000	Veenhoven (2013)	2,76	2010	Veenhoven (2013)
Japan	2,59	2000	WVS (2011)	2,64	2010	Veenhoven (2013)
Jordan	2,24	2001	WVS (2011)	2,88	2007	WVS (2011)
Latvia	2,54	2001	Veenhoven (2013)	2,60	2010	Veenhoven (2013)
Lithuania	2,29	2001	Veenhoven (2013)	2,55	2010	Veenhoven (2013)
Luxembourg	3,27	2000	Veenhoven (2013)	3,34	2010	Veenhoven (2013)
Macedonia	2,05	2001	WVS (2011)	2,51	2010	Veenhoven (2013)

	For 2000			For 2010		
Country name	**Lsatisf**	**Year**	**Reference**	**Lsatisf**	**Year**	**Reference**
Mexico	2,71	2000	Veenhoven (2013)	3,27	2010	Veenhoven (2013)
Moldova	2,28	2001	WVS (2011)	2,18	2006	WVS (2011)
Morocco	2,42	2001	WVS (2011)	2,10	2007	WVS (2011)
Netherlands	3,38	2000	Veenhoven (2013)	3,48	2010	Veenhoven (2013)
Nicaragua	2,16	2000	Veenhoven (2013)	3,21	2010	Veenhoven (2013)
Norway	3,19	2002	ESS (2013)	3,25	2010	ESS (2013)
Panama	2,78	2000	Veenhoven (2013)	3,41	2010	Veenhoven (2013)
Paraguay	2,14	2000	Veenhoven (2013)	3,15	2010	Veenhoven (2013)
Peru	1,72	2000	Veenhoven (2013)	2,97	2010	Veenhoven (2013)
Poland	2,65	2001	Veenhoven (2013)	2,92	2010	Veenhoven (2013)
Portugal	2,60	2000	Veenhoven (2013)	2,34	2010	Veenhoven (2013)
Romania	2,00	2000	Veenhoven (2013)	2,33	2010	Veenhoven (2013)
Russia	2,68	2000	Veenhoven (2013)	2,40	2010	ESS (2013)
Slovakia	2,48	2001	Veenhoven (2013)	2,88	2010	Veenhoven (2013)
Slovenia	3,04	2001	Veenhoven (2013)	3,04	2010	Veenhoven (2013)
South Africa	2,53	2001	WVS (2011)	2,88	2007	WVS (2011)
South Korea	2,49	2001	WVS (2011)	2,56	2005	WVS (2011)
Spain	2,98	2000	Veenhoven (2013)	2,88	2010	Veenhoven (2013)
Sweden	3,34	2000	Veenhoven (2013)	3,46	2010	Veenhoven (2013)
Switzerland	3,26	2002	ESS (2013)	3,32	2010	ESS (2013)
Turkey	2,26	2001	Veenhoven (2013)	2,75	2010	Veenhoven (2013)
Ukraine	2,26	2001	Veenhoven (2013)	2,06	2010	ESS (2013)
United Kingdom	3,20	2000	Veenhoven (2013)	3,31	2010	Veenhoven (2013)
United States	3,38	2001	Veenhoven (2013)	3,06	2010	Veenhoven (2013)
Uruguay	2,36	2000	Veenhoven (2013)	3,24	2010	Veenhoven (2013)
Venezuela	2,82	2000	Veenhoven (2013)	3,43	2010	Veenhoven (2013)
Vietnam	2,61	2001	WVS (2011)	2,84	2006	WVS (2011)

Table I.2 – Literacy rate data

	For 2000			For 2010		
Country Name	**Lit**	**Year**	**Reference**	**Lit**	**Year**	**Reference**
Australia	99,00	2003	CIA (2013)	99,00	2003	CIA (2013)
Austria	98,00		CIA (2013)	98,00		CIA (2013)
Belgium	99,00	2003	CIA (2013)	99,00	2003	CIA (2013)
Bolivia	86,72	2001	The World Bank (2013)	91,17	2009	The World Bank (2013)
Brazil	86,37	2000	The World Bank (2013)	90,38	2010	UNESCO (2012)
Bulgaria	98,20	2001	The World Bank (2013)	98,35	2011	The World Bank (2013)
Canada	99,00	2003	CIA (2013)	99,00	2003	CIA (2013)
Chile	95,72	2002	The World Bank (2013)	98,55	2009	The World Bank (2013)
China	90,92	2000	The World Bank (2013)	94,27	2010	The World Bank (2013)
Colombia	92,80	2004	The World Bank (2013)	93,37	2010	The World Bank (2013)
Costa Rica	94,87	2000	The World Bank (2013)	96,16	2010	The World Bank (2013)
Croatia	98,15	2001	The World Bank (2013)	98,83	2010	The World Bank (2013)
Czech Republic	99,00	2011	CIA (2013)	99,00	2011	CIA (2013)
Denmark	99,00	2003	CIA (2013)	99,00	2003	CIA (2013)
Ecuador	90,98	2001	The World Bank (2013)	91,85	2010	The World Bank (2013)
Egypt	71,41	2005	The World Bank (2013)	72,05	2010	The World Bank (2013)
El Salvador	79,83	2004	The World Bank (2013)	84,49	2010	The World Bank (2013)
Estonia	99,77	2000	The World Bank (2013)	99,80	2010	The World Bank (2013)
Finland	100,00	2000	CIA (2013)	100,00	2000	CIA (2013)
France	99,00	2003	CIA (2013)	99,00	2003	CIA (2013)
Germany	99,00	2003	CIA (2013)	99,00	2003	CIA (2013)
Greece	95,99	2001	The World Bank (2013)	97,19	2010	The World Bank (2013)
Guatemala	69,10	2002	The World Bank (2013)	75,18	2010	The World Bank (2013)
Honduras	80,01	2001	The World Bank (2013)	84,76	2010	The World Bank (2013)
Hungary	99,03	2004	The World Bank (2013)	99,05	2010	The World Bank (2013)
Iceland	99,00	2003	CIA (2013)	99,00	2003	CIA (2013)
India	61,01	2001	The World Bank (2013)	62,75	2006	UNESCO (2012)
Indonesia	90,38	2004	The World Bank (2013)	92,81	2010	UNESCO (2012)
Iraq	74,05	2000	The World Bank (2013)	78,17	2010	The World Bank (2013)
Ireland	99,00	2003	CIA (2013)	99,00	2003	CIA (2013)
Israel	97,10	2004	CIA (2013)	97,10	2004	CIA (2013)
Italy	98,42	2001	The World Bank (2013)	98,93	2010	The World Bank (2013)
Japan	99,00	2002	CIA (2013)	99,00	2002	CIA (2013)
Jordan	89,89	2003	The World Bank (2013)	92,55	2010	The World Bank (2013)
Latvia	99,75	2000	The World Bank (2013)	99,78	2010	The World Bank (2013)
Lithuania	99,65	2001	The World Bank (2013)	99,70	2010	The World Bank (2013)
Luxembourg	100,00	2000	CIA (2013)	100,00	2000	CIA (2013)
Macedonia	96,13	2002	The World Bank (2013)	97,27	2010	The World Bank (2013)
Mexico	90,54	2000	The World Bank (2013)	93,07	2010	The World Bank (2013)
Moldova	96,65	2000	The World Bank (2013)	98,52	2010	The World Bank (2013)
Morocco	52,31	2004	The World Bank (2013)	67,08	2011	UNESCO (2012)
Netherlands	99,00	2003	CIA (2013)	99,00	2003	CIA (2013)

	For 2000			For 2010		
Country Name	**Lit**	**Year**	**Reference**	**Lit**	**Year**	**Reference**
Nicaragua	76,68	2001	The World Bank (2013)	78,00	2005	The World Bank (2013)
Norway	100,00		CIA (2013)	100,00		CIA (2013)
Panama	91,90	2000	The World Bank (2013)	94,09	2010	The World Bank (2013)
Paraguay	90,27	1992	The World Bank (2013)	93,87	2010	The World Bank (2013)
Peru	87,67	2004	The World Bank (2013)	89,59	2007	The World Bank (2013)
Poland	99,41	2004	The World Bank (2013)	99,52	2010	The World Bank (2013)
Portugal	87,95	1991	The World Bank (2013)	95,18	2010	The World Bank (2013)
Romania	97,30	2002	The World Bank (2013)	97,68	2010	The World Bank (2013)
Russia	99,44	2002	The World Bank (2013)	99,58	2010	The World Bank (2013)
Slovakia	99,60	2004	CIA (2013)	99,60	2004	CIA (2013)
Slovenia	99,65	2004	The World Bank (2013)	99,69	2010	The World Bank (2013)
South Africa	82,40	1996	The World Bank (2013)	92,98	2011	UNESCO (2012)
South Korea	97,90	2002	CIA (2013)	97,90	2002	CIA (2013)
Spain	96,49	1991	The World Bank (2013)	97,75	2010	The World Bank (2013)
Sweden	99,00	2003	CIA (2013)	99,00	2003	CIA (2013)
Switzerland	99,00	2003	CIA (2013)	99,00	2003	CIA (2013)
Turkey	87,37	2004	The World Bank (2013)	92,66	2010	UNESCO (2012)
Ukraine	99,43	2011	The World Bank (2013)	99,71	2010	The World Bank (2013)
United Kingdom	99,00	2003	CIA (2013)	99,00	2003	CIA (2013)
United States	99,00	2003	CIA (2013)	99,00	2003	CIA (2013)
Uruguay	96,78	1996	The World Bank (2013)	98,07	2010	The World Bank (2013)
Venezuela	92,98	2001	The World Bank (2013)	95,51	2009	The World Bank (2013)
Vietnam	90,16	2000	The World Bank (2013)	93,18	2010	The World Bank (2013)