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THE ENVIRONMENTAL KUZNETS CURVE: A CRITICAL REVIEW

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Foreword

We would like to thank our supervisor Professor Thierry Bréchet for his useful comments and advice. This thesis would not have been possible without his valuable help.

We would also like to thank our friends and family for their support throughout this whole process.

Charlotte De Kort & Axelle Fache

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Acronyms & Abbreviations

EQ: Environmental Quality

EKC: Environmental Kuznets Curve

EF: Ecological Footprint

CO_2: Carbon Dioxide

SO_2: Sulfur Dioxide

DDT: Dichlorodiphenyltrichloroethane

OECD: Organization for Economic Co-operation and Development

GDP: Gross Domestic Product

WWF: World Wide fund for Nature

WAVES: Wealth Accounting and the Valuation of Ecosystem Services

NEF: New Economics Foundation

1 Introduction

Over the past few years, environmental quality has become an important topic all over the world. Many are becoming concerned about the issue and public concern has increased (Dinda, 2004). Because of this, efforts to better understand the reasons behind this environmental degradation are growing. The impact of a growing economy has been studied for a couple of years now, and one aspect in particular has captured many peoples attention: the link between environmental quality and economic growth. This is also the subject of our thesis.

We chose this topic because we both wanted to get deeper into this specific subject. We did not know much about environmental economics before this paper. In our past studies, the subject has had little attention in our courses. It had immediately captured our attention, not only because of the lack of knowledge we had about the topic, but also because it was something we both agreed on that was an interesting. It is a very 'hot' topic, because in the world we live in today, we are constantly reminded about the impact of different factors on the environment. But not so many years ago, this was completely different.

A few years ago, it has been suggested that the relationship between certain types of environmental pressure and income is characterized by an inverted U-shape. This curve is called the Environmental Kuznets Curve (EKC) (De Bruyn, van den Bergh & Opschoor, 1998). The EKC-hypothesis tells us that environmental pressure has the tendency to rise with income in the first stages of economic development. But after a certain point, the slope of this curve will go downwards and environmental pressure will decrease with income (De Bruyn, van den Berg & Opschoor, 1998). This idea about the relationship between economic growth and environmental quality has come to the attention of many researchers. Not all of them believe that this relationship will always show the same curve. This is what we will discuss in this paper as well. We will put together the different aspects of the EKC and discuss them based on the literature. We will look at it from the angle of (environmental) policy makers. If we can find some prove that the EKC is not valid, than we can maybe convince policy makers not to base their decisions on this curve. Because if the curve is fake, then all decisions based on this curve will be fake as well.

The research question that will be handled in this paper will thus be: "Is the Environmental Kuznets Curve useful to discuss economic growth in relation to pollution and is it the appropriate tool to use for policy making?"

The Environmental Kuznets Curve (EKC) has two axes: the axis for environmental quality and the axis for economic growth. Environmental quality, according to the OECD is: " a state of environmental conditions in environmental media, expressed in terms of indicators or indices related to environmental quality standards"[1]. When talking about environmental quality, it mostly means the state of the natural environment. When we measure environmental quality, the pollutants we look at are seen as indicators of environmental degradation. This is shown in the EKC. In this thesis, we will focus on two important indicators of environmental degradation: CO_2 and SO_2. The main difference between these two pollutants is that CO_2 is a global pollutant and SO_2 is a local pollutant. This difference here is important for the rest of the paper. Economic growth is seen as an increase in production and consumption of goods and services, with the population and per-capita consumption as important factors (Heilbroner & Thurow, 1987). To measure economic growth, GDP is used most of the time.

The concept of the EKC is explained earlier in this introduction. As said before, the goal of this paper was to give some discussion to the concept but also to make, if possible, some recommendations to improve it. The criticism on the EKC can be split into two categories, first there is the theoretical criticism and secondly, there is the econometric criticism. We have discussed the latter briefly, but this was not our main focus. We wanted to criticize the idea of the EKC and not the econometric set-up of it. Still it remains an important part, and so we gave a quick overview of this part. When it comes to the theoretic criticism, there is a lot of it. We tried to focus only on the ones that we think are important for our paper.

The rest of the thesis will go as followed: in Chapter 1, we will explain the different aspects of the EKC. We will look at environmental quality and at economic growth. After that, we will

[1] OECD. (2001, November 8). Glossary of Statistical Terms. Retrieved 2015, from OECD Web site: https://stats.oecd.org/glossary/detail.asp?ID=837

have a sufficient understanding of the different aspects to go on to the concept of the EKC in Chapter 2. In Chapter 3, we will start focussing on our research question. The validity of the EKC will be questioned be looking at different critiques. Once we know what are the flaws of this curve, we try to give some improvements or ideas for improvements. In Chapter 4, the conclusion is given.

CHAPTER 1: COMPONENTS OF EKC

Let us first look at the components of the Kuznets Curve. The EKC tries to capture the relationship between the environment and economic growth. When we want to say something about this relationship, we first need to define these concepts. We begin with the axe for Environmental Quality and then go on to the axe for Economic Growth. For each chapter, we will ask a few important questions about each factor that will lead us further into the discussion for improvements to the EKC.

2 Environmental Quality

The first important question to ask here is: "What is Environmental Quality and how is it measured?" The next step in our research is to ask the question: "What are important factors of Environmental Quality?" Afterwards we go deeper into these factors: "How do we measure these factors"' and "Does the choice of pollutant really matter for the EKC?" By asking these questions, and answering them, we will come to a better understanding of this part of the curve. Doing this makes it possible for us to be critical of the EKC.

Since the idea of sustainable growth, the preservation of the earth and its resources has become more important. For world leaders, this meant that they had to adopt new policies about pollutions and about preserving the quality of life (García-Sánchez & das Neves Almeida, 2015). This trend made it more important to measure the impact of humans on the environment and thus its quality.

2.1 What is Environmental Quality?

Before describing environmental quality, there should be a good understanding of what is meant by "environment". Thomas (1972) said that if the definition of "environment" is limited to only a certain pollutant in the air, environmental quality is not hard to understand. The more components are included in the definition of environment, the more difficult it will be to understand. Orubu & Omotor (2011) say the environment consists of: "the natural capital stock of an economy, comprising of all land and natural resources, water and related biodiversity, as well as the atmosphere, which envelopes the earth"[2].

The OECD describes natural capital as: "natural assets in their role of providing natural resource inputs and environmental services for economic production"[3]. This can be air, water, soils… basically all things we distract from the earth. These factors have an influence on the economy in a direct way, because they can be used as inputs, but they also have an indirect influence. This means that they can have an influence on other inputs of the production process.

2.1.1 Definition

But now, let us go back to Environmental Quality. According to Lawrence (2011) environmental quality is a complex notion that is nor static nor absolute. Chervinski (2014) has the same opinion as he states that the quality of an environment cannot be kept static because it is not meant to preserve and protect nature from all types of human impact. A lot of authors agree on the complex nature of EQ, saying it is a complex issue that involves a lot of different subjective perceptions, attitudes and values, that can all vary depending on different groups and individuals.

The OECD gives a definition of environmental quality: "Environmental quality is a state of environmental conditions in environmental media, expressed in terms of indicators or indices related to environmental quality standards"[4]. It is, according to the OECD, the immediate impact of the environment on people's well-being, because nature is important not only as a source of raw materials but also for the health of human beings. Khattab (1993) describes the impact of Environmental Quality through its different elements: "The immediate impact of Environmental Quality is the material aspects of the physical

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[2] Orubu, C., & Omotor, D. (2011). Environmental quality and economic growth: Searching for environmental Kuznets curves for air and water pollutants in Africa. *Energy Policy , 39*, 4178-4188.

[3] OECD. (2005, December 2). *Glossary of Statistical Terms*. Opgeroepen op 2015, van OECD Web Site: https://stats.oecd.org/glossary/detail.asp?ID=1730

[4] OECD. (2001, November 8). *Glossary of Statistical Terms*. Opgeroepen op 2015, van OECD : http://stats.oecd.org/glossary/detail.asp?ID=837

environment like air, water, pollution, depletion of resources, domestic and industrial pollution, consequences of overpopulation and noise, etc which have certain effects on people"[5].

An environmental quality standard according to the OECD is: "a limit for environmental disturbances, in particular, from ambient concentration of pollutants and wastes, that determines the maximum allowable degradation of environmental media"[6]. According to the IHCP an environmental quality standard means: "the concentration of a particular pollutant or group of pollutants in water, sediment (any material transported by water and settled to the bottom) or biota (all living organisms of an area) which should not be exceeded in order to protect human health and the environment"[7]. Kawamoto et al. (2011) say that: "Environmental quality standards (EQSs) have been established as desirable levels to be maintained for protection of human health and the conservation of the living environment by Basic Environment Law"[8].

When talking about environmental quality, it can mean the state of the natural environment but also the health of the people living in it. These are two different definitions of Environmental Quality. The focus can either be on the state of nature but also on humans. When we want to focus on humans, we see that because of its immediate impact, environmental quality can also have an impact on different social aspects such as happiness, population aging… There is an immediate link between primary elements of nature such as water, air & land and the quality of life (Banzhaf et al., 2014). Another note to make here is that there are several other variables that can have an important effect on environmental quality; degrees of political freedom, spatial intensity of population and economic activity, economic structure and price effects (Stern, 2004)

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[5] Khattab, O. (1993). An atempt to evaluate Government Housing Projects. *Environmental Quality Assessment , 2*.

[6] OECD. (2003, Maart 4). *Glossary of Statistical Terms*. Opgeroepen op 2015, van OECD Web Site: https://stats.oecd.org/glossary/detail.asp?ID=838

[7] Commission, E. (2015, May 8). *IHCP*. Opgeroepen op 2015, van European Commission IHCP: https://ihcp.jrc.ec.europa.eu/our_activities/health-env/eqs/eqs

[8] Kawatomo, T., Pham, T.-T.-P., Matsuda, T., Oyama, T., Tanaka, M., Yu, H.-S., et al. (2011). Historical review on development of environmental quality standards and guideline

When using the EKC, some use Environmental Quality, but others use Environmental Degradation, which is sort of the opposite. But more on that later, when we discuss the forms of the EKC.

2.2 How is Environmental Quality measured?

Now that we know what Environmental Quality is, we can take a deeper look into the way it is used. This section of the paper is important because the way the pollutant is measures and which pollutant you use, has an impact on the curve. It is thus necessary to make a distinction between different types of pollutants. When we measure EQ, the pollutants we look at can be seen as indicators of Environmental Degradation. This is important to know, since this is shown by the EKC. This means that the EKC can show the effect of numerous measurements of Environmental Quality & Environmental Degradation (Kaufmann et al., 1998).

Kaufmann (1998) says that, when measuring environmental degradation, the variables can fall under two general categories: emissions of pollutants or environmental concentrations of pollutants. The variables in these two categories are mostly used interchangeably although they measure different aspects. The emissions show how much pollution is generated by an economic activity with no regard to the size of the area into which the pollutants are emitted. They are linked to the level of economic activity today and so they also show the potential for damages to the environment. Concentrations measure the quantity of pollutants per unit area or volume, so here the size of the area does matter. However, none of these two measures the relationship with economic activity accurately, they both have shortcomings. For example, the use of atmospheric concentrations may not be correlated with the severity of environmental degradation because there is no direct relation between concentration and exposure. Important is thus to note this difference, which we will come back to later in this paper.

Cialani (2007) says there are a lot of possibilities we can use. There is no single criterion to measure Environmental Quality and so he suggests a number of indicators for environmental degradation like carbon dioxide, carbon monoxide, sulfur dioxide, nitrogen oxide, suspended particulate matter, lead, DDT, smog, chlorofluorocarbons, sewage, biological oxygen demand and other chemicals released directly into the atmosphere or rivers and oceans. Not all of these pollutants are important for the EKC, because for most of the indicators, and this is important to stress, there is little to no evidence that the EKC hypothesis even holds. Because we want to show the difference in the curve for different pollutants, we will focus on two very important factors of EQ, namely SO_2 & CO_2. These have been used the most in research papers as well because of the large availability of (time-series cross-sectional) data. For example for CO_2, there is data available from the 1950's on. We choose these different pollutants not only because of their importance but also to help us further investigate EKC. It makes us raise certain questions. "What is the difference between the two pollutants"? This question will be answered here.

It is important to know that the way a pollutant is measured, has great importance on policies as well, according to Khanna (2000). This is because, if a region is polluted and if it has a high pollution, then the resources devoted to the lowering of this pollution and to the efficacy of environmental regulation, will be much higher than if a region has none to less pollution. Still, measuring Environmental Quality is a complex task since it involves epidemiology, public health and economics. Khanna (2000) goes on explaining that, when measuring Environmental Quality, the impact of the pollutant should be translated into their impact on welfare and thus the impact on the human being.

2.2.1 CO_2

Before we go on, we need to have a clear view of what CO_2 actually is. According to the EPA-site, CO_2 is the short name for Carbon Dioxide. It is a gas that occurs at the earth's atmosphere. It is the primary greenhouse gas emitted trough human activities (76,7% of the total GHG) but it is also naturally present in the atmosphere because of the earth's carbon cycle. The fact that humans are adding more to this natural level is causing environmental problems all over the world. The main activity that causes the emission of CO_2 is the combustion of fossil fuels, which is used for energy and for transportation. Naturally, emissions and the removal of CO_2 in the air are being balanced, but since these human activities that add CO_2 in the air, the contribution of men to the level of CO_2 is significant, which has a direct link to global warming. This is also why we can see CO_2 as a global pollutant. The difficulty with a global pollutant is that it is not possible to internalize it within a single economy or region, because their impacts cannot be shown for a single region separately (EPA, 2015).

When using CO_2 emissions, a lot of possibilities are used when it comes to comparing the data. Some studies use time-series data (e.g. 1 country over time) but others use panel-data (e.g. multiple countries over time). The choice between these two can have a significant impact on the results that are seen in the EKC. Also, the choice of sample of CO_2 can be different. According to Sun (1999) there are three possibilities to choose from. The first is Energy-related CO_2 emissions data, which are calculated using the IEA energy balances, the default methods and emissions factors from the intergovernmental panel on climate change. The second sample is Man-made CO_2 emissions and is defined as data from fossil fuels and cement manufacture. The third one is called the UN CO_2 emissions data, and this shows more than 90% of CO_2 emissions resulting from fuel combustion. The first two samples are used the most in studies.

It is also important to note here that, when measuring the CO_2 for the usage of the EKC, there is no actual measurement of CO_2, they are simply calculated from energy statistics (Itkonen, 2012). Carbon Intensity, which measures how much carbon dioxide emissions one unit of energy produces, is an important factor here. From this they can derive Carbon Dioxide Emissions. Some problems that can arise here are that the parameters can be interpreted in a wrong way, which leads to a false conclusion.

2.2.2 SO_2

Just like for CO_2, we will begin with a short explanation of what SO_2 actually is. SO_2 stands for Sulfur Dioxide and, like CO_2, it is a gas. Human activity is the main cause of this pollutant in the air (99% of total), mainly industrial activities that work with materials that contain sulphur, according to Wikipedia (2015). Sulfur Dioxide can affect human health when it is breathed in. In the contrary to CO_2, SO_2 is not a global but a local pollutant. This means that the impact of this pollutant is local and it can be dealt with at a local level. So when EKC studies are done with SO_2 as a pollutant, they will focus more on cities or regions rather than countries (Lieb, 2002). The difference between local and global pollutants can be seen at the moment of the peak of the GDP. According to Stern (2004), the pollutant concentrations for cities peaked at lower levels of economic growth than for global pollutants. Here as well, the difference between panel-data and time-series data can be made as well.

Why is it feasible to use SO_2 as a pollutant to test the EKC? according to Arouri et al. (2012) First, they have an important effect on human health and are an important form of energy-related pollution. Second, the levels of SO_2 have been declining over the last decades, especially in industrialized countries. And finally, the EKC can reveal how MENA-countries are adapting to new technologies to filter SO_2.

The impact of all these different factors concerning different pollutants will be discussed during the part of the EKC's critique.

When measuring the pollutant that we want to link to income or economic growth, it is also important to bear in mind the fact whether you want to measure a stock or a flow pollutant. According to Lieb (2002) the difference between the two is very important when looking at the EKC, because both of them will give another kind of relation to income. For example: SO_2 is a stock pollutant, this means that the environment cannot absorb this pollutant. But even if it is a stock pollutant, it can still be seen as a flow pollutant from a long-run point of view, according to Lieb (2002). This is not the case for CO_2, which cannot be seen as a flow pollutant, only as a stock pollutant.

3 Economic growth

In this part of the thesis we want to address the following major question: "What drives growth?" We tackle this question by Starting off with a general definition of (economic) growth and discussing the main drivers of it. Later on we discuss how economic growth is commonly measured and we address some critical remarks about GDP as a measurement technique. Afterwards, we question the definition of growth itself and argue that economic growth is not an adequate concept when measuring wealth.

3.1 General definition

The second component of the EKC curve is economic growth. In order to discuss economic growth we start with a general definition from a traditional economic point of view. Heilbroner & Thurow (1987) define economic growth as the increase in production and consumption of goods and services, with the population and per-capita consumption as important factors. Another expression of the definition is made by Jouvet & Perthuis (2013) who define economic growth as the wealth created by economies and can be measured in terms of production, income and living standards. We remark that the increase in wealth of an economy described in the definition of economic growth puts an important focus on production as key to define economic growth. From this economic point of view, Jouvet & Perthuis (2013) argue that economic growth consists of two important drivers; namely human capital (generally expressed as labor) and productive capital (which includes machines, tools, infrastructure etc.). Now that we know what the drives economic growth we will discuss how to measure it.

3.1.1 Measuring economic growth

For measuring economic growth, the most well-known and commonly used indicator is GDP. In what follows we will discuss GDP a little further and focus on the shortcomings of it. We will come to the conclusion that GDP is not a good indicator for discussing living standards or well-being.

3.1.2 General definition GDP

There are three approaches to define GDP; the income approach, production approach and consumption approach. All of these approaches should give the same result. For the production approach the focus lies on measuring the value added of the production or domestic output of an economy. The income approach will look at the incomes, that households obtain trough their employment in the firm. The last approach will measure GDP by measuring purchasers' prices, which means that they will look at the consumption of products and services rather then production or income. In our thesis we will use the first approach namely the production approach, which is used by the OECD.

The OECD defined gross domestic product (GDP) as: "an aggregate measure of production equal to the sum of the gross values added of all resident, institutional units engaged in production (plus any taxes, and minus any subsidies, on products not included in the value of their outputs)" [9].

GDP in fact measures the value added by an industry or country. Value added is the value of an output minus the value of intermediary goods, whereby the value of this good is measured by multiplying the product quantities with the their prices (OECD). From this we can conclude that a good or service should have a price on the market to be included in the GDP definition of the OECD. This has some implications that we will discuss in what follows.

3.1.2.1 Implications when using GDP

According the New Economic Foundation (2013), a first implication is that GDP thus only captures those components that are sold on the market and consequently have a market price. NEF[10] (2013) implies that GDP does not measure those items that are not sold on the market, such as for instance natural assets. Notwithstanding items (such as natural assets), which do not have a market price, or are of major importance, should be included when trying to capture income of a country (or welfare as a whole).

Another implication, according to the New Economics Foundation (2013), of the fact that

[9] OECD. (sd). *glossary of statistical terms*. Opgeroepen op Mars 11, 2015, van OECD stats: http://stats.oecd.org/glossary/detail.asp?ID=1163

[10] NEF stands for the New Economics Foundation. This is a UK organisation that promotes social, economic and environmental justice.

GDP uses market prices to capture value, is that it indirectly assumes that the market correctly prices items (NEF, 2013). However, this is not always the case. For instance, for services provided by the government (such as busses and the army), this is not the case. The fact that GDP requires that the market can (correctly) price the items sold on the market is rather problematic because of the transformation to a new economical environment in developed countries. In the new economies, the public sector gains importance and offers a considerable amount of services (think of public transport for example). These government services are typically difficult to price. When a good or service does not have a market price, the cost of production will be used as an estimate of the market price (Wikipedia). However this leads to wrong estimations of GDP if the public service involves benefits above its costs for the consumers (Wikipedia). Otherwise said this estimation does not recognize a consumer surplus for efficient and effective public services (Wikipedia).

GDP is an aggregate figure and does not take into account the size of a country or nation. Therefore GDP per capita is introduced. With GDP per capita people try to measure the living standards in an economy. The argument here, according to Mankiw and Taylor (2011), is that an increase in economic production will be beneficial for all citizens of a country because it will lead to higher consumption opportunities (which will eventually lead to an increase in living standards). However we argue that GDP (per capita) is not a good indicator of standards of living nor well-being.

GDP does not include all factors that influence the wealth of a nation. Otherwise said, according to The New York Times (2008), GDP does not account for all externalities from the production of goods and services. According to the Natural Capital Committee of the UK, a major problem that can explain the fact that not all externalities are included is that GDP measures flows and not stocks. GDP typically does not look at sustainability and does not account for the lost natural capital due to over usage of these assets for production (Natural Capital Committee). These are naturally not the only factors that are not included in GDP but we chose to discuss these two because they are relevant for our thesis.

GDP does not look at sustainability, however, this is of importance when discussing standards of living and growth. GDP does not look at the long term, in other words it does not include sustainability questions. According to WAVES[11] (2010), GDP only looks at economic performance and expresses this in output. However, it is important to know what lies on the basis of this output, how this output is generated. WAVES (2010) argues that if the output is generated by using or (over) exploiting natural resources than this will have another impact on our wealth compared with when the output is created by more effective production techniques. In the first case, we could argue that wealth will decrease while in the later wealth is going to increase.

This is a rather important drawback of using GDP because in our thesis we try to capture the wealth of a nation and therefore accounting for sustainability is of major importance. According to the New Economic Foundation (2013), GDP does not measure natural assets, their scarcity nor their irreversibility. The definition of GDP from the OECD implies that more consumption is always better and that the more money spent, the higher the GDP will be. However this logic is fundamentally wrong. Expenditure is not always better for a country, for instance: if we spent a lot of money on cleaning installations when firms polluted the water. The New Economics Foundation (2013) argues that this should not be seen as an improvement in GDP because the pollution in the first place should have been avoided. Not accounting for sustainability is thus a major problem of the usage of GDP and is also a critic on the usage of the EKC curve, as we will see later (because it uses GDP for capturing growth).

In line with our first remark about sustainability, GDP does not look at natural capital when discussing standards of living. WAVES (2010) argues that GDP does not capture natural capital very well. This problem is inherent to national accounting, according to this organisation, were natural capital such as forests, wetlands, agricultural land etc. are rather difficult to capture in accounting books. According to Waves (2010) a good example is the forestry; where timber resources are taken into account but the forest carbon sequestration is overlooked. According to the New Economics Foundation (2013), if you consume more and more of natural assets faster than they can recuperate themselves, these assets will decrease and this decrease in natural assets can be irreversible for some of them. However,

[11] WAVES is the organisation for wealth accounting and the valuation of ecosystem services.

with the production definition of GDP form the OECD, we assume that if we consume more and more of these natural assets, GDP and thus income will increase and our welfare consequently would increase but actually our welfare is decreasing (NEF, 2013).

We suggest that we need to find a solution to either incorporate natural capital in GDP (and thus also in the national accounts of nations) or to find another indicator that is able to capture natural capital better and thus looks at sustainability.

3.2 History of Economic Growth Theory

Now that we know what economic growth is, what the drivers are and how it is commonly measured, we will critically review what we know so far. In this part we ask ourselves if economic growth is really what we are looking for or if there is a better way to measure wealth? The history of economic growth theory will be our starting point. In this part of the thesis we will conclude that economic growth is not a good indicator for measuring welfare.

According to Van Meerhaeghe (1980), the physiocrats were the first to introduce a theory about economic growth. Their theory argues that agriculture is the core of production (Cleveland, 1987). These people were the first ones that thought nature was a very important driver.

But after some technical and political developments, the classical economists (such as Adam Smith, David Ricardo, Thomas Malthus and John Stuart Mill) came to the playing field (Czech, 2000). They critiqued the physiocracy by arguing that manufacturing and labour are also important factors of economic growth (van Meerhaeghe, 1980).

According to Brenner (1966), after the industrial revolution another theory was developed called “the neoclassical theory of economic growth”. Important supporters of this theory defined by Brenner are: Alfred Marshall, Irving Fisher and Arthur Pigou. Their theory goes even further by introducing capital as a production factor (Czech, 2000). This theory sees human capital as one of the most important resources for a sustainable economic growth

(Simon, 1996) and that technological innovations make the production process even more efficient (Solow R. , 1988). These neo-classicists adopted a definition in line with the general definition that is regularly used today, where there is an important focus on production and the role of labour and infrastructure in it.

Researchers discovered that in 1990 a new theory got attention “the ecological economics”. These ecological economists argue that land, labour, capital, and natural capital are all factors of production (Cleveland, 1991) (Jansson, Hammer, Folke, & Costanza, 1994). It is clear that these people have a more complete view about economic growth and its drivers. We observe that they see labour and capital as important drivers, which is in agreement with the neo classical economists. However they also see nature (natural capital) as a driver, which is in line with the physiocrats. Daily (1997) and Repetto et all (1989) define natural capital as the sum of all natural resource stocks where some of them are potentially renewable and some of them are non-renewable and provide flows of goods and services.

From this overview of history, we can see that the drivers of economic growth changed over time. At first natural capital was the only driver but later on they forgot about it and human- and productive capital became the main drivers of economic growth. Recently more and more researchers, such as Daily (1997), are convinced that human capital and productive capital as well as natural capital are all three the main drivers of economic growth.

This shift in drivers leads us to the question if the general definition of growth (more precisely economic growth) is still an adequate definition, now that natural capital is becoming a well-discussed driver of growth. In what follows we argue that growth cannot be defined as economic growth any more. The question now is: “what would be a better definition of growth, including natural capital as a driver”?

3.3 Green growth

We already concluded, from the definition of economic growth, that it only discusses two drivers for growth namely: human capital and productive capital. From the history of growth theory we know that there is a third driver as well namely natural capital. This driver also needs to be taken into account when we discuss growth. In this section we discuss growth with the three drivers. Here we argue that a better way to capture growth is by defining growth as “green growth” rather than “economic growth”.

3.3.1 Definition

As already mentioned, the term green growth is nowadays a rather popular term and a lot of attention is paid on the environment. Green growth was first adopted by the ecological economists, who mentioned the importance of natural capital as a driver for growth.

However it really started to gain popularity in 2005 when the United Nations and social Commission for Asia and Pacific (UNESCAP) used natural capital to measure growth (ESCAP, 2005). According to ESCAP (2005), they focused on natural capital as well when measuring growth, in order to lower the usage of carbon in fast-developing Asian countries. Messner et all (2010) and Meadowcroft (2012) argued that calling this adoption of natural capital (as a third driver) “green growth” became a (popular) term in 2008 when the World Bank and the OECD became to use it too. From that point forward, Vazquez et all (2014) found that more and more supranational organizations became to define it as green growth, leading to green growth becoming a norm and the ultimate goal.

Over the years literature came up with a lot of different definitions of green growth. For our thesis we will use the definition from the OECD. The OECD defines green growth as: “the concept of stimulating economic growth and development in a manner that ensures the continuing provision of natural assets and resources, which are important for our well being”[12]. Green growth thus tries to achieve economic growth and development without creating irreversible damage to the environment and thus without exhausting the natural assets of nature (van der Ploeg & Withagen, 2013).

This means that companies and the economy as a whole need to adapt their operations so that they are within the ecological constraints of nature (Meadowcroft, 2013). This

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[12] OECD. (2011). *towards Green Growth.* OECD Publishing.

adaptation of production, consumption patters and lifestyles is important because nature has an intrinsic value, which we call" economical assets". An important characteristic of these economic assets is that they are exhaustible. Consequently when society always operates abroad the ecological borders, it will have an irreversible and major impact on the environment, which in turn will influence the economy and our lives (Meadowcroft, 2013).

According to Vazquez-Brust, Sarkis & Smith (2014), green growth implies that economic and ecological problems are linked together, meaning that when we think of growth and welfare we should always keep the environmental pressure in mind and thus we conclude that a better way to define growth is by green growth and not economic growth. We also conclude that the drivers of growth are not only human capital and productive capital but also natural capital.

3.4 Alternatives for GDP

There are three types of alternative measurements for GDP: adjustments to GDP, frameworks and indicator sets and composite indicators.

3.4.1 Adjustments to GDP

The adjustments to GDP are those indicators that use the GDP as the base of their indicator but they make some changes to account for the problems mentioned above. Some examples given by the New Economics Foundation (2013) of these indicators are the Genuine Savings Index and the Index of Sustainable Economic Welfare. The indicators are proven to be effective according to this organisation, for solving the problems with GDP. However, they are rather hard to interpret and use a lot of assumptions (because they need to find a way to price the extra components that normally do not have a market price).

3.4.2 Frameworks and indicator sets

According to the New Economics Foundation (2013), the second type of alternative indicators is the framework and indicator set. These large and comprehensive frameworks try to capture well-being and sustainable development. Examples of such frameworks are the one created by the OECD and the one created by Bartelmus.

Bartelmus (2013) allocates the different indicators in three main categories: Ecological sustainability, economic sustainability and sustainable development. According to him, an advantage of using common physical units such as area and weight will facilitate the aggregation of different impacts. A major problem with the ecological sustainability measures is that they are not appropriate for comparing economic outcomes and when measuring economic sustainability these indicators have measurement and valuation problems (Bartelmus, 2013).

The OECD has developed its own indicator framework for measuring green growth in OECD countries. This framework makes a distinction between three categories: production, consumption and environment, which lead to five measurement categories (which are interrelated) (OECD, towards Green Growth, 2011). As inclusive as these frameworks (they provide a large amount of information) are, they are very difficult to apply because of the large amount of info that you need to account for. Also, it is rather difficult to judge about the sustainable development and progress of a society.

3.4.3 Composite indicators

The last types of alternatives are the composite indicators, where the Human Development Index (HDI) is the most well known one. According to the New Economics Foundation (2013), these indicators are in direct relation with the individual indicators used in the frameworks. However, a problem with these indicators is that it is difficult to decide how much weight you will assign to an item.

From this overview we see that each approach has its advantages and disadvantages. Which one is the most appropriate to use, will depend on your goals and what you want to accomplish.

CHAPTER 2: THE ENVIRONMENTAL KUZNETS CURVE

The Kuznets curve is a rather largely discussed curve when discussing pollution in relation to economic growth. When we want to discuss this relationship we thus need to look into this curve and see if this can help us to better understand the relationship between economic growth and pollution. In this part we will explain the concept "Kuznets curve" and the inverted U-shape relationship. Later on we will discuss the major critics from other researchers about the Kuznets curve. These things are necessary to be able to make our own conclusion about the utility of the Kuznets curve, when discussing economic growth in relation to pollution.

4 The concept

Let us first begin by describing the curve. Now that both of the components of this curve are explained and reviewed, we can be more critical about this curve. Some questions answered in this part are "what is the EKC?" and "Why is the EKC important?"

The concept of the Kuznets Curve was created by Simon Kuznets, who argued that the income differences between countries (or more broadly defined as economic inequality) will increase at first, when the country is in its developing stage. Eventually, when the country is largely developed, the economic inequality will decline (Kuznets, 1995).

Later on Grossman and Krueger (1995) argued that this theory could also apply to the relationship between economic growth and environmental quality. This relationship does also follow an inverted U-shape. Later on this inverted U-shape relationship, between the environment and economic growth, was conceptualized as the Environmental Kuznets Curve (EKC).

4.1 The inverted U-shape relationship and the logic behind it

Grossman and Krueger believed that economic growth is good for the environment, after a country has reached a certain level of development (Arrow, et al., 1996). This statement can be justified because of the empirical relationship between per capita income and the environment, which has (as mentioned above) an inverted U-shape relation (Arrow, et al., 1996).

An explanation for this inverted U-shape is that when countries are still developing, they do not have enough money to diminish their pollution levels and are not very concerned about measures for environmental improvement. At this first stage the country sees increasing pollution levels as a necessary evil in order to become economic growth (Arrow, et al., 1996). Later on when the country is sufficiently developed and the living standard is high enough, there will be more concern about the environment and the government will set higher restrictions on environmental pollution (Arrow, et al., 1996). Krueger and Grossman found that the turning point (from increase in pollution to decrease) results from the demand for more or thus stricter environmental protection (Grossman & Krueger, 1995). Literature found out that the demand comes from the citizens themselves that ask for higher or stricter policies regarding environmental pollution and more attention for noneconomic aspects of living in general, when they reach a certain living standard (Grossman & Krueger, 1995). Grossman and Krueger (1995) argue that although this level would vary with the type of pollutant, in most cases the turning point is around 8000 dollar income per capita. This inverted U-shape relationship is certainty the case for air and waste quality (Grossman & Krueger, 1995).

According to literature, trade also has an explaining capacity for the inverted U-shape relationship. Some researchers argue that trade intensity and trade liberalization could explain the inverted U-shape relationship (Grossman & Krueger, 1993).

Grossman and Krueger (1993) argue that the trade intensity of a country can explain the decrease in pollution after a certain point is reached. They argue that the trade intensity has a positive impact on the environmental quality (and thus also on the pollution level) because, thanks to trade liberalization, countries get wealthier. If a country becomes wealthier it is more likely to implement stricter environmental policies (Grossman & Krueger, 1993).

A lot of researchers argue that there is a link between the trade liberalization and pollution levels (Anderson & Blackhurst, 1992) (Esty, 1994) (Chicilnisky, 1994) (Copeland & Taylor,

1994) (Cole, 2000). Because of greater competitive pressures, companies and countries become more efficient. Trade patterns are a part of the explanation for this inverted U-shape relationship (Cole, 2004). Trade openness helps countries to become more competitive and efficient in using resources, but possibly also by access of greener production technologies, which on there turn can lead to better environmental situations (Cole, 2004).

Grossman and Krueger (1991) came up with a systematic explanation of the relationship between trade and pollution levels. They argue that the impact on pollution is caused by three independent effects. The first one is the scale effect, which suggests that larger market access leads to more economic growth. Which in turn leads to more pollution up to a certain point (Grossman & Krueger, 1991). The second one is the technique effect, which is the decrease of pollution after a certain income level (Grossman & Krueger, 1991). The technique effect indicates that the production methods will also change due to the liberalization of the markets (greater environmental regulations that lead to greener technologies). The third one is the composition effect, which means that economies are changing their composition because of comparative advantages (Grossman & Krueger, 1991)

4.2 Support for the EKC

Grossman and Krueger are not the only authors that believe in the existence of an inverted U-shaped relationship between income and environment. Others that share this opinion are Selden and Song (1994), Holtz-Eakin and Selden (1992) and the World Bank (1992). The World Bank (1992) found that there is such a relationship for concentrations of sulfur dioxide in city air, in relation to income levels. It states that the turning point for this pollutant is even lower than the 8000 dollar mark (that was found by Krueger and Grossman). Shafik and Bandyopadhyay (1992) found this same relationship for total and annual deforestation, related to national income. Selden and Song (1994) at their turn found this kind of relation for estimated per capita national emissions of sulfur dioxide, particulates, oxides of nitrogen and carbon monoxide, in relation to income per capita. They argue that for those pollutants the turning point is higher than 8000 dollar (Selden & Song, 1994).

CHAPTER 3: THE EKC AS A POLICY TOOL

5 Questioning the validity of the EKC

In the following section, we want to show that the Environmental Kuznets Curve's validity can be questioned. We will critically review the concept and both axis of the curve to prove that, when policy makers rely on this curve, they are not making correct decisions. The EKC gives a policy tool; it justifies the decision of policy makers to just let the economy grow so that the level of pollution will lower. This means that to improve the environment, it is sufficient to become rich as an economy… There are a lot of questions that can be raised when we look at the EKC as a policy tool. "Is the EKC valid for all types of environmental pressure"? "Is it valid for both individual countries as for the world"? If this would all be true, the EKC would be relevant for policy makers. But if we can prove that the EKC has too many flaws and is actually not valid, we can show that policies should be different than from what the EKC proposes and that we should base policies on other curves or ideas.

The argument the EKC used; that economic growth eventually will be good for the environment is a controversial topic and has been criticized more than once. An overview of some critiques will be given here. We will focus on the more theoretical critiques than on the econometric ones, because we mainly want to question the ideas the EKC sets up rather than the econometric validity. In this section, we will start by giving some overall theoretical criticism and then move on to the econometric flaws of the curve, just to have an overview of some flaws it has in its econometrics. Next we go on to both axis and give an overall conclusion about the validity of the EKC.

5.1 Theoretical Criticism on EKC

To start this chapter, we will begin by giving some global theoretical mistakes of the EKC. The Environmental Kuznets Curve can be interpreted as: let the economy grow and pollution levels will lower. But the shape of this curve is a factor of multiple factors, actually. The fact that pollution levels would lower does not only depend on the fact that the economy grows. There are different factors that contribute to the shape and thus are of great importance as well for policy makers. Therefore, when the focus only lies on economic growth, wrong policies will arise. Dinda (2004) explains several of these factors, for example the income elasticity of environmental quality. This is the most common explanation for the shape of an EKC and it says that when a country achieves a sufficiently high standard of living, people will attach more value to the environment and are then willing to pay for a more clean way of living with a lower impact on the environment (Dinda, 2004). But this way of thinking is not true for all societies and can be influenced by multiple other factors… Also, if a developed economy becomes stronger, the pollution intensive industries will migrate from countries with stronger environmental policies to those with fewer regulations. This means that the lowering in the pollution levels can also be explained by the fact that those countries outsource their polluting activities. Environmental effects are thus not being reduced; they are being displaced (Dinda, 2004).

In the literature on the EKC, there are people who suggest that the inverted U-shape relationship only exists because of the so-called "pollution heaven hypothesis" (Grossman & Krueger, 1995). The criticism on the EKC is thus that it does not account for trade patterns (that can be a potential explanation for the inverted U-shape relationship) (Cole, 2004). When this pollution haven exists, than this is evidence for the claim that the inverted U-shape relation is only happening because of the change in manufacturing activity. This in turn implicates that the inverted U-shape relationship will not imply that growth would cure the environmental and-pollution problems (Cole, 2004). If this pollution heaven hypothesis is true, there might arise a problem when the developing countries will develop themselves and at a certain point in time this pass-on-mechanism will not work anymore (when every country has reached a certain development state) (Grossman & Krueger, 1995).

The poverty trap can also be a limit to the reasoning behind the EKC. A poverty trap means that there are a lot of plausible reinforcing mechanisms through which countries that start out poor, are very likely to remain poor (Kraay & Raddatz , 2007). These countries require a lot of help to get out of these poverty traps and sometimes this does not even work. But when linking the environment to poverty traps, we can look at it this way: economic poverty results from ecological poverty (Prieur, 2008). When people in poor countries do not have the incentive to stop polluting, their ecological debt will raise. Some of the damage done will be irreversible and therefore even when they grow, they will not be able to undo the damage done to the environment. This will lead to economic recession. Environmental degradation is thus not innocuous to growth but it can lead to poverty traps (Prieur, 2008).

Various other critiques according to Kaika & Zervas (2013) are that the assumption that world income is normally distributed and that all countries follow the same development pattern are false. The main issue according to this paper is that, when the EKC-concept is not longer valid, how will the income pollution relationship then evolve? Will it be the same as historically seen? This means that the indispensability of constructing structural models is a very important issue now. Another theoretical critique formed by Arrow et al. (1996) is that there is no feedback from environmental damage to economic production, because income is assumed to be an exogenous variable. There is thus an assumption that the economy is sustainable. With higher levels of economic activity, it is counterproductive to grow fast in the early stage of development.

To conclude this global criticism, we have to look at the EKC from an ethical point of view. It is possible to interpret the EKC as a curve that says you can pollute al you want because one day the economy will become rich enough to reverse it and to lower the pollution levels (Prieur, 2008). However, sometimes the damages done to the environment are irreversible…

5.2 Econometric Criticism on EKC

As we said earlier, we are going to give a global overview of some econometric critiques to the EKC. This is not the main focus of the paper, but it still is important as well to have some knowledge of this area. According to Stern (2004) the EKC is an empirical phenomenon that is econometrically weak. A lot of the critique formed on the EKC is about the econometrical validity. But before explaining this more, we can categorize the econometric critique on the EKC into four categories: heteroskedacity, simultaneity, omitted variable bias and co-integration issues (Stern, 2004).

When forming the EKC, little attention is paid to the statistical properties of the data that are used. There is also a low consideration to the possibility of omitted variable bias (Stern, 2004). Most of the time the assumption is made that when both coefficients are significant, that there is an EKC relation. Stern (2004) decided to re-examine this relationship and did diagnostic statistics and specification tests. After this, they found that actually the EKC relation does not exist. What they did found was a more realistic view of the effect of economic growth on environmental quality. They saw that most of the pollutants are rising with income. But income independently, they saw that time reduces the effect on the environment at all levels of income. He does however say that it is possible that there exists an inverted U-shape relation between certain pollutants and income. Though they need to be tested with more rigorous time-series or panel data methods. Perman & Stern (1999) state that when a study used data from the OECD will have an earlier turning point, at a lower income level, than other studies found. This means that the data that is used is of utter importance, because they can provide a too optimistic view of reality.

Stern (2004) is not the only one who is critical about the theoretical and empirical methods of the EKC, Copeland & Taylor state that: "Our review of both the theoretical and empirical work on the EKC leads us to be sceptical about the existence of a simple and predictable relationship between pollution and per capita income"[13].

The point of return in the EKC also depends on the functional form and the estimated model that is used to calculate it, not only on the data that is being used (Ekins 1997). Harbaugh et al. (2002) says that the results of the EKC are very sensitive to changes in nations, cities and years that are being sampled. Also additional covariates are important. All these studies suggest that the results shown in an EKC are very questionable and unreliable.

[13]Copeland, B., & Taylor, M. (2004). Trade, Growth, and the Environment. *Journal of Economic Literature*, *42* (1), 7-71.

5.3 Critical review of both axis

In the following part of this chapter we will look at both axes, look at their properties and see what impact they have on the shape of the EKC. We will critically revise every axis to look at its flaws. We will start by the axis of pollution and then go on to the growth axis

5.3.1 Pollution Axis

If we look at the EKC for CO_2 and SO_2, will we see the same curve? Can we interpret the curve in the same way? At this point, we would say that the EKC for both pollutants could not be the same, because they are too different in too many ways. The difference between the pollutants is just too big and too complex to have just one simple EKC. But let us take a look at some of the research that has been done on the relationship of both of the parameters and economic growth.

We will start by the most important thing when we look at the axis of pollution and that is that it is important to note that the EKC does not apply for all pollutants. As we have seen in the first section of this paper, there is a big difference between pollutants. They can be global, local, stock, flow… According to Dinda (2004), the EKC relationship will be more likely to be true for pollutants with more short-term and local impacts than for global pollutants. For example, the Kuznets Curve applies for pollutants such as sulfur dioxide in city air (World Bank, 1992) but this inverted U-shape relationship is not generally applicable to all pollutants. We can see in the table below, that for SO_2, almost every research has found an inverted U-shape relation, independent of the type of date and of which country or model they use. An inverted U-shaped relation will thus be easy to see for local pollutants like SO_2, NOx , CO etc.

But then what will we see for a global pollutant such as CO_2? Does it give the same outcome? For the CO_2 pollutant, the evidence for an inverted U-shaped curve is mixed, as you can see in the table below. Some research says that the inverted U-shape curve is clearly seen but others just see an up wards slope. Because this is a global pollutant, the impact of this pollutant on the environment cannot be internalized within one economy, because there is no specific region to show their impact (Miah MD et al, 2010). The fact that different researchers find different outcomes can also depend on the data that is used for the pollutant and the way that it is measured.

Evidence for CO_2 emissions: [14]

Overview different studies for CO_2

Authors	**Cities/Countries**	**Model Type**	**EKC Result**
Gangadharan & Velenzuela (2001)	51 countries	Not Found	Straight line, upward
Selden & Song (1994) for CO	22 OECD & 8 developing countries	Quadratic	Straight line, upward
Selden & Song (1994) for CO	22 OECD & 8 developing countries	Quadratic	Straight line, upward
Holtz-Eakin & Selden (1995)	A panel of 130 countries	Quadratic	Inverted U-shape
Agras & Chapman (1999)	34 countries	FE	Inverted U-shape
Shafik (1994)	47 cities in 31 coutnries	Linear, quadratic and cubic GDP	Relationship varied
Lindmark (2002)	Sweden	Dynamic structural model	Relationship varied
Hill & Magnani (2002)	In a panel of 156 countries	Generalized least squares	Straight line, upward
Friedl & Getzner (2003)	Austria	Linear, quadratic and cubic model	N-Shaped
Maradan & Vassiliev (2005)	76 developed & developing countries	Log linear	Inverted U-shape
Cole et al (1997)	11 OECD countries	Generalized least squares	Inverted U-shape
Shafik & Bandyaopadhyay (1992)	135 countries	Log linear	Straight line, upward

[14] Miah, M., MAsum, M., & Koike, M. (2010). Global observation of EKC hypothesis for CO2, SOx and NOx emission: A policy understanding for climate change mitigation in Bangladesh . *Energy Policy , 38*, 4643–4651 .

Evidence for SO_2 emissions: [15]

Overview different studies for SO_2

Authors	**Cities/Countries**	**Model Type**	**EKC Result**
Grossman & Krueger (1991)	52 cities of 32 countries	Cubic	Inverted U-shape
Shafik & Bandyopadhyay (1992)	47 cities in 31 countries	Quadric	Inverted U-shape
Torras & Boyce (1998)	18-52 cities in 19-42 countries	Ordinary least square	N-shape
Dinda et al. (2002)	39 cities in 26 countries	Ordinary least square	Inverted U-shape
Hill & Magnani (2002)	A panel of 156 countries	Generalized least square	Inverted U-shape
Shafik (1994)	47 cities in 31 countries	Quadratic	Inverted U-shape
Panayotou (1997)	30 developed and developing countries	Generalized least square	Inverted U-shape
Cole et al. (1997)	11 OECD Countries	Generalized and ordinary least square	Inverted U-shape
Selden and Song (1994)	22 OECD and 8 developing countries	Quadratic	Inverted U-shape
List and Gallet (1999)	US States	Quadratic and cubic	Inverted U-shape
Stern and Comon (2001)	73 developed and developing countries	Quadratic	Inverted U-shape

For Sulfur Emissions, several studies have been conducted. Globally, the turning point of the curve for the studies that use concentration as a base are lower than for the studies that use emissions, although there are some exceptions as well. The first note to make for these studies is that the EKC will not be the same when you use a different base. Secondly, we see that in more recent studies, that use more representative samples of data, there is a monotonic relation between the sulfur emissions and income. That is why the inverted-U shape is not to be seen in every study for $S0_2$. Stern (2004) points out that this makes it very difficult to make conclusions based on the EKC and that the only one that has been made is that concentrations of pollutants may decline from middle income levels while emissions

[15] Miah, M., MAsum, M., & Koike, M. (2010). Global observation of EKC hypothesis for CO2, SOx and NOx emission: A policy understanding for climate change mitigation in Bangladesh . *Energy Policy , 38*, 4643–4651 .

tend to be monotonic in income. According to Arouri et al. (2012), the difference between the results for a CO_2 EKC and a SO_2 EKC can be explained by the fact that CO_2 emissions are more linked to consumer behavior and that they are a non-source pollutant. While SO_2 emissions are more close to producers' behavior and are local pollutants.

The fact whether the pollutant is an emission or local concentrations pollutant or a regional or a trans-boundary pollutant is an important factor in the determination of the shape of the relationship that will be seen. This will help determine if an inverted-U shape relation will be found and if it is found, how it will be shaped. This answers the question whether all environmental indicators decline or increase with economic growth.

The way the pollutant is measured is also an important factor for the shape of the curve. Most empirical studies have used absolute measures of pollution like the amount of emission rather than a relative measure such as emissions per unit. If these kinds of measures are used, the relationship we observe can be different from the relationship when absolute measurements are used. Dinda (2004) also notes here that in this context, the effect of income on pollution intensity tends to be negative in open economies, but positive in closed ones.

To show another example of mixed evidence for the inverted U-shape relation for different types of pollutants, literature also found that this inverted U-shape relationship does not occur for some air pollutants, such as SPM (Harbaugh, Levinson, & Wilson, 2002), water and toxic pollutants (Lucas, Wheeler, & Hettige, 1992) (Hettige, Mani, & Wheeler, 2000). This means that the EKC mostly is affirmed for short-lived and local pollutants, as we have said before, while stock pollutants such as CO_2 are positively related to income. The EKC evidence for water pollution is mixed but there is evidence that an inverted U-shaped relation could occur for chemical oxygen demand and biological oxygen demand. Yandle, Vijayaraghavan & Bhattarai (2004) also agree with the statement that there is no single EKC relationship that fits every single pollutant for all places and times. This is important to bear in mind for policy makers as well. They cannot just assume that for every pollutant there will be an inverted U-shape relation, and that thus the best solution to lower pollutant levels is to let the economy grow. They need to look at each pollutant individually.

These different conclusions for different pollutants have implications on policies. The improvement of the environmental quality with the growth of income depends on policies and institutions. Good policies will flatten the underlying EKC and may move the turning point to an earlier time. Dinda (2004) states that it is very important for all authorities that are responsible for environmental policies to really comprehend how environmental quality will evolve. This is a very interesting path to go on. Is it possible for national policies to succeed when international ones (e.g. Kyoto Protocol) are failing? And does the EKC imply that environmental degradation is a problem that will go away on its own?

5.3.2 Economic Growth Axis

Economic growth

The EKC curve only discusses economic growth of countries and environmental pollution. This means that according to the EKC curve, environmental pollution will only depend on the economic growth level of a country. In the literature review of this thesis, we noted that according to Jouvet & Perthuis (2013) economic growth consists of two important drivers; namely human capital (generally expressed as labor) and productive capital (which includes machines, tools, infrastructure etc.). The question is: “Will environmental pollution only be based on human capital and productive capital of a country?” We think this is quite simplistic and naïf to think that there are no other factors involved in the levels of environmental pollution over time. We are not alone in this vision. Magnani (2001) mentioned in her paper as well that it is quite possible that other factors (besides economic growth) could explain the inverted-u shape of the EKC. We think for example of policies, which according to Grossman and Krueger (1995), form a strong link between economic growth and environmental pollution. But also welfare and natural capital stocks could, according to us, be involved in this relationship. We thus argue that the EKC curve is rather simplistic and could benefit form more indicators than only economic growth. We will discuss this further in the next chapter, where we will give some improvements to the EKC.

GDP

When the EKC curve is used, economic growth is almost always expressed by GDP. However, in our literature review we discussed some major drawbacks and inconveniences when using economic growth (represented by GDP). The most important drawback when using GDP is that it does not include or account for natural assets, their scarcity nor their irreversibility (New Economics Foundation 2013). However we saw that nowadays governments and all kinds of institutions (such as WAVES, OECD, etc.) are attaching more and more importance and attention to sustainable development and growth. The preservation of nature is becoming increasingly important for politicians and governments but also for individuals. Therefore, we argue that GDP and economic growth, in general, are not good enough anymore to anticipate on these sustainability concerns. In the next chapter we will propose another indicator to replace economic growth in the EKC graph.

Another drawback when using GDP mentioned in this thesis is according the New Economic Foundation (2013), that GDP thus only captures those components that are sold on the market and consequently have a market price. NEF[16] (2013) implies that GDP does not measure those items that are not sold on the market, such as for instance natural assets. Notwithstanding, items (such as natural assets) that do not have a market price, or are of major importance, should be included when trying to capture income of a country.

A last important drawback that we mentioned is that GDP represents the flow of goods and services but not the stock. This means that if the government wants to set a policy to control and limit water use or deforestation for example, basing themselves on GDP would be a bad idea. The reason here is that GDP does not say anything about the stock of water or the stock of forest for a country or economy on a specific moment in time. It is rather logical that if the government does not know exactly the current situation of the stocks of natural capital that the policy they would like to install will not be exact and could possibly be set less strict as they should be for a country. It could be perfectly possible that a country with a large GDP has a rather limited stock of one or more natural resources. If the government then sets policies based on GDP exhaustion of those natural resources (of which the stock is rather low) is very well possible and can form a treat for the welfare of that country. This because over exploitation of the natural resource could be possible.

[16] NEF stands for the New Economics Foundation. This is a UK organisation that promotes social, economic and environmental justice.

5.4 Conclusion on validity of EKC

In this section, we will try to give an answer to some of the important questions about the validity of the EKC as a policy tool by using the critiques we have seen on the theory of the EKC.

First of all, is the EKC valid for all types of environmental pressure? We have seen before that the inverted U-shaped curve is not seen for all types of pollutants. The EKC relationship is more likely to be seen for more local pollutants like SO_2 than global pollutants like CO_2. This means that the EKC relationship only applies to problems that are well documented and well known and thus are easier to solve (Dinda, 2004). Even though research shows mixed evidence for pollutants like CO_2, some of the research shows an inverted U-shaped relation but most of them just see a positive correlation between economic growth and the environmental indicator. The outcome that is seen in the research can depend on the type of data that is used and the way this data is measured. One of the problems is thus, as Arrow et al. (1996) already said, the EKC represents the patterns of flow pollutants, but actually environmental impact is often characterized as a stock problem. Dinda (2004) concludes that this means that the EKC does not necessarily reflect a sustainable time path of pollution.

Secondly, is the EKC a valid curve for only individual countries or also for the world? According to Dinda (2004), the EKC is estimated in a cross-section panel of countries, which does not mean that over time individual countries will move along the estimated relationship. As seen in the previous paragraph, there are a lot of factors that have an impact on the fact whether we will see an EKC relationship or not, and the country is one of them. "*Developed countries are at times associated with lower emission reductions but in developing countries, the environmental pressure increased over time.*"[17] Developing countries do not have the same income levels as developed countries and thus they are not high enough to be able to make a turning point. When we ask ourselves if the EKC is global, the answer is thus no.

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[17] Dinda, S. (2004). Environmental Kuznets Curve Hypothesis: A Survey. *Ecological Economics*, *49*, 431-455

Another important question to ask is whether the EKC curve is permanent? Some authors have questioned whether the observed decrease is a temporary phenomenon (Dinda, 2004). When we look at the curve of the EKC, we see that it implies that the increase in environmental pressure is temporary but that the decrease is not. There are not a lot of authors that have questioned whether the decrease is a temporary phenomenon due to technological limitation (Dinda et al., 2004). If the environmental pressure would increase again after the initial decrease, the curve would be N-shaped. This means that beyond a certain point or income, the relationship between environmental pressure and income becomes positive again. This means that the curve will start rising. There are different factors that could cause this shape, for example a country or region can have difficulties keeping up efficiency improvements while still continuing to grow (Dinda, 2004). Also, pollutants that have a costly end-of-pipe solution can have an N-shaped curve. There is no reason to believe that sustained growth is also sustainable (De Bruyn et al., 1998). According to them, it can be expected that developed economies in the past already have exhausted part of their assimilative capacities en thereby more easily expand carrying capacities than less developed economies. But they do say that the conclusions may critically be depended on the choice of parameters or proxies for environmental pressure.

6 Possible improvements to the EKC

In the previous sections of this paper, we discussed all aspects of the EKC and questioned its validity. Now that we know the EKC has a lot of flaws and that there is room for improvements, we will focus on this part in the following sections. We do not try to give a more perfect curve; instead we think about the flaws of the EKC and try to provide some small improvements to the theory. Our goal is not to provide a new EKC.

First of all, a big problem with the EKC is that it is difficult to generalize. As we have seen before in this paper, whether we see the typical inverted U-shape curve depends on a lot of things, like the type of pollutant, the data that is used etc. Therefore it is not possible for the EKC to hold for every type of relationship that is investigated. This is important for policy makers, because they cannot just assume that the EKC relationship will hold for every pollutant, they should check it first. It is important to have more time-series analysis, more follow-ups. In this way, policy makers have a more clear view of what the relationship really is and can then make a more grounded decision about policies. When they would just assume the relationship is an inverted U-curve, they would make the wrong decisions about policies. They would be urged to let the economy grow because this will eventually have a positive impact on the level of pollution but if the EKC relationship does not hold for that pollutant, things could just get worse. Therefore we argue that the generalization has to stop, and each pollutant, situation and time should be investigated individually, because the shape of the EKC curve is not well defined. The shape is different for each situation, depending on a lot of factors. The type of pollutant, the type of data that is used, the period that is investigated etc. The EKC is more an instrument that can be used to analyse a relationship, more than one that is used to make predictions upon.

To make the EKC more specific to every type of relationship and to improve the knowledge we get out of that relationship, it is possible to include country specific factors. It is important that when the policies are designed, the identification of factors behind the EKC gets priority. If these have been properly identified, only then can the course of the EKC make sense (Dinda, 2004). The choice of the structural model that is used for the EKC can have an impact on whether the mechanism behind the curve is found or not. We need to know all factors that can have an impact and include them into the relationship, only then we can be sure about its validity. It is important to improve these models, not only from an econometrical point of view.

When we look at the economic growth axe of the curve, we do have some remarks as well. As discussed in previous chapters of this paper, GDP does not include all the aspects that Green Growth does. Maybe, the EKC should use green growth as an indicator for growth of a country instead of economic growth (measured by GDP).

Economic growth vs. green growth

In the former chapter we discussed some drawbacks of using economic growth (measured by GDP) when used in the EKC, now we will propose some improvements.

Nowadays, governments and people in general are much more concerned about the environment, the sustainability and the preservation of nature. Therefore, we argue that there are other things that are involved in the relationship between income and pollution as well. We argue that it is quite necessary for governments to go beyond GDP when setting new policies (because of the former mentioned drawbacks from GDP and the increasing importance for sustainability). As an improvement for the EKC, we argue that economic growth should be replaced by green growth. In the literature review part of this thesis, we introduced the concept of green growth, which goes beyond economic growth. Green growth will account for natural resources, their scarcity and (possible) irreversibility. This is thus a much more complete concept, when discussing growth, than economic growth.

We saw that GDP contains two driving forces, namely: human capital and productive capital, while green growth contains three driving forces: human capital, productive capital and natural capital. It is not hard to see that if you use GDP as the base for setting a policy you will get different results than when you will set policies based on a green growth indicator (that includes natural capital). We will make our point by including some figures in the next section.

Table 1: The evolution of growth measured by different indicators. [18]

	1995	**2000**	**2005**
Wealth per capita In US dollars	469.275	521.329	562.363
Natural capital in US	3.539	7.584	4.933

[18] *Sources: The wealth per capita and the natural capital are retrieved from an excel file from World Bank website.*
The World Bank. (2015). The Changing Wealth of Nations. Opgeroepen op Mai 6, 2015, van The World Bank: http://data.worldbank.org/data-catalog/wealth-of-nations.
The GDP per capita is retreived from an excel file form the World Bank website. The World Bank. (2015). GDP per capita. Opgeroepen op Mai 6, 2015, van The World Bank: http://data.wroldbank.org/indicator/NY.GDP.PCAP.CD?page=1

dollars			
GDP (nominal) per capita in US dollars	28.522	23.151	36.927

This table is composed by using the Wealth of Nations dataset from the World Bank and the dataset of GDP per capita, also from the World Bank. In this table we listed the wealth per capita, the natural capital and the GDP per capita for Belgium for the years 1995, 2000 and 2005. All these figures are expressed in US dollars. Total wealth per capita is defined by the World Bank as: "it represents the value of future consumption that is sustainable, discounted at a rate of time preference of 1.5 per cent, over 25 years[19]". Natural capital contains according to the World Bank (2015): "the sum of Crop, Pasture Land, Timber, Non Timber Forest, Protected Areas, Oil, Natural Gas, Coal, and Minerals[20]". GDP per capita is calculated without including depreciation.

Wealth of nations represents a general inclusion of consumption, production but also looks at sustainability and natural capital. Therefore we argue that this could be a representation of green growth. From this table we can see that the wealth of Belgian citizens increased over time. However, when we compare this with GDP per capita for Belgium, which does not account for natural capital, we see that it decreased first and increased afterwards. It is thus clear that wealth of nations per capita has a different progress during time in regard to GDP per capita for Belgium. This is thus prove of what we already suspected; the figures when using one indicator or the other will be very different and will have consequences when using one or the other indicator for policy making. When we look at the natural capital in Belgium, we see that it firstly shrank and afterwards grew again. This could be explained for

[19] The World Bank. (2015). *The Changing Wealth of Nations*. Opgeroepen op Mai 6, 2015, van The World Bank: http://data.worldbank.org/data-catalog/wealth-of-nations

[20] The World Bank. (2015). *The Changing Wealth of Nations*. Opgeroepen op Mai 6, 2015, van The World Bank: http://data.worldbank.org/data-catalog/wealth-of-nations

example if in 1995 Belgian citizens exploited a lot of natural resources and maybe exhausted them but not that much so that they could restore again by 2000. The increase in natural capital could be explained for example if Belgian citizens got perhaps more concerned about sustainability and their (over) exploitation of natural assets and therefore decreased their usage of those natural assets.

The EKC curve, as said before, uses economic growth to base decisions on. From what we discussed before, we question if this is really the way to go and if it would not be better to use green growth in stead, especially in the light of the growing importance of sustainability nowadays. Unfortunately, just changing economic growth by green growth will not be very easy because of some difficulties.

A first difficulty we will face is the fact that green growth is a very broad concept and is still more of a theoretical concept. Green growth, in our opinion, is still most of all theoretical and something that people are striving towards to define and capture into real figures. It is broad because it tries to capture all of the natural resources, which is quite a challenge. We also argue that it is quite theoretical because a lot of papers are written about natural capital, what it is and what needs to be included in green growth. However, when we look at the actual indicators that are put forward to measure green growth, we see the actual problem.

Some frameworks (such as the one of Bartelmus or the OECD) are introduced as well as a lot of indicators (such as the ecological footprint, national savings etc.). It is clear that researchers know that we should, and need, to include natural resources into the calculations. However, they are not yet agreed on one particular indicator. On the contrary, for measuring economic growth there are also a lot of different ways and indicators to choose from but literature has found GDP the most convenient one and most researchers agreed on using GDP as the indicator measuring economic growth. We could say that GDP became the standard for measuring economic growth. As mentioned, this is not (yet) the case for green growth. This is thus the second difficulty to overcome when replacing economic growth by green growth; finding one inclusive indicator that would be the most appropriate to use and where most researchers agree on, that is the best indicator for measuring green growth.

Flow vs. stock

What we mentioned in the last chapter is that GDP represents the flow of goods and services but not the stock. This means that GDP does not say anything about the stock of water or the stock of forest for a country or economy on a specific moment in time. If the government does not know exactly the current situation of the stocks of natural capital, the policy they would like to install will not be exact and could possibly be set less strict as it should be for a country. Therefore, we suggest that when policy making is the purpose, GDP is not a good indicator to use as a basis when setting standards and limits to the exploitation of certain natural resources, or the usage of pollutants.

However, the question remains: “how could we correctly measure natural capital in order to set correct policies”? From what we already discussed, we can already say that we need to go beyond GDP and search for our answers elsewhere. Another conclusion we can make thus far is that we suggest using a stock indicator when setting policies. As mentioned above, a stock indicator will make it possible for governments to set accurate and precise limits to the usage of natural resources, better then when using GDP (World Wide Fund for Nature, 2010). A stock indicator will thus permit us to know the exact stock of a resource at a given point in time (World Wide Fund for Nature, 2010).

Now that we know that it would be better to use a stock indicator, we will go deeper into this and propose a useful indicator for policy making.

When investigating the stock indicators, the Word Wide Fund for Nature (2010) makes the distinction between two different types: physical indicators and monetary indicators. When we analyse the physical indicators, we can see that they will measure for example the m^2 forest or the m^3 clean water. Afterwards, these data will be used by a physical indicator that will give an indication of the natural capital or state of a certain natural asset. We argue that setting too strict or too lose policies when using physical indicators will be less common because the data needed for those indicators is tangible and quantifiable and therefore not very difficult to measure (World Wide Fund for Nature, 2010). As a consequence, less mistakes will be made than when we base indicators on estimations because of a lack of (quantifiable) data.

Another way to measure stocks instead of flows, according to the World Wide Fund for nature (2010), is by using monetary indicators. These ones will allocate a value for the natural resources based on market prices of the natural resources (World Wide Fund for Nature, 2010). An advantage of this approach according to the World Wide Fund (2010) is that these indicators will make a consolidation of different kinds of components possible. A well-known example of such a monetary indicator is the Genuine Savings Index. However, we will argue in what follows that these monetary indicators are not the best option and that they should not be trusted blindly. Our argument will be two folded.

A first reason why this approach is not very trustworthy is because you need to correctly value the (market) prices of the resources, which for natural resources, turns out to be rather difficult. The difficulty lies in the fact that there is a sustainability component attached to them, which makes correctly valuing them rather difficult. Sustainability means that natural resources are used in moderation so that they can recuperate and grow back for next generations to come. According to WAVES (2010), natural capital such as forests, wetlands, agricultural land etc. are sustainable (if they are not over exploited) and rather difficult to capture in accounting books because of this sustainability component. According to Waves (2010), a good example to describe the difficulty of measuring sustainability can be explained by using the forestry; where timber resources are taken into account but the forest carbon sequestration is overlooked. Therefore, the sustainability of the forestry is not (correctly) accounted for.

A second reason or problem we see with this approach, is the fact that market prices are very dependent on demand and supply (World Wide Fund for Nature, 2010). Some natural resources will vary a lot with demand and supply (think for example about agricultural products). The problem with this, rather large, dependency of demand and supply will be explained by the following example introduced by the World Wide Fund for Nature. When there is only a small amount of oil left, oil prices will know a steep increase in price. Therefore the value of the remaining oil will be high. However, this does not in any case mean that there is no exhaustion of the oil.

After reviewing the advantages and disadvantages of both indicators, we argue that physical (stock) indicators should get higher preference. An example of such an indicator is the ecological footprint (EF). Choong, Low, Usama and Abdul (2015), describe the ecological footprint as: "the ecological footprint captures the influence a country or nation has on the environment in terms of air, soil and water, and it is dependent of the country's income[21]". Whereby cited by Wachernagel (2008): "we actually want to know how much of the capacity of nature is used by human activities coming from individuals, countries, cities, etc. at a given moment in time[22]". The ecological footprint will in other words measure our consumption of natural assets such as forests, fishing places, sea products, natural energy resources, etc. All these things together, for one country at a certain point in time, will give us the ecological footprint of that country.

We mentioned earlier that monetary indicators have difficulties with setting (market) prices on natural resources because they have a sustainability component. We can ask ourselves the question: "how will the ecological footprint incorporate this"? The world Wide Fund for nature (2010) describes the ecological footprint as the demand for natural resources and the bio capacity is the supply, when setting supply equal to demand you can make some conclusions about sustainability according to them. For example if supply is smaller than demand, this could be an indication of over exploitation of natural resources, which can in worst circumstances lead to exhaustion, which will lead to sustainability weakening. A real life example given by the World Wide Fund of nature (2010), based on data of the Global Footprint Network for 2006, measured the bio capacity at 11,9 billion hectares whilst the (global) ecological footprint of that year was estimated 17,1 billion hectares. Supply is here

[21] Low, S.-T., Choong, W.-W., Usama, A.-m., & Abdul, H. M. (2015). Investigating the environmental Kuznets curve (EKC) hypothesis by utilizing the ecological footprint as an indicator of environmental degradation. *Ecological Indicators , 48*, 315-323.

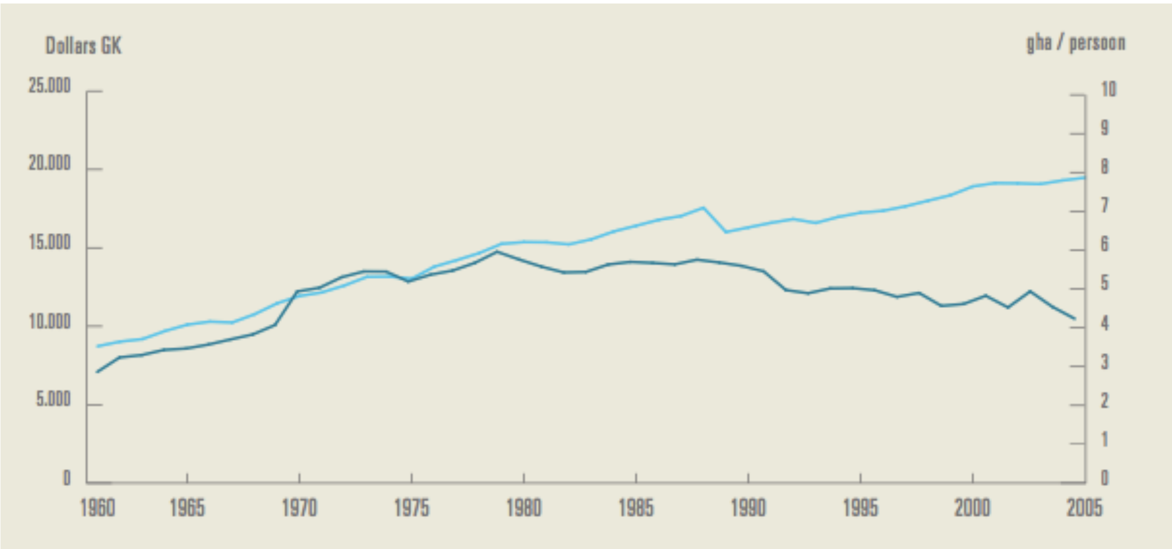
[22] Wachernagel, M. (2008). *Measuring Ecological Footprints.* Opgeroepen op february 11, 2015, van OECD library: http://dx.doi.org/10.1787/9789264044135-7-en

larger than demand, meaning that there was worldwide an over exploitation of natural resources in 2006, which could lead to exhaustion of some of the natural assets.

To conclude, we argued that GDP is not a good indicator for measuring growth because it does not account for natural capital and because GDP measures the flow and is not a stock indicator. We purposed to use a stock indicator, more precisely the ecological footprint. The change of indicator will naturally lead to some changes in results and also in changes of interpretations of results.

We have discussed that an increase in, for example, water pollution will lead sometimes to an increase in GDP thanks to the investment of capital to solve the water pollution. This thus means an increase in GDP and according to the definition of GDP, an increase in (economic) growth. However, when we use the ecological footprint as a measure of (green) growth, an increase in pollution will lead to an increase of the ecological footprint and will always be seen as bad for nature. Thus, green growth will not increase but rather decrease. We will make this even more clearly by showing the following figure.

Figure 4: The evolution of the ecological footprint and GDP per capita[23]:



[23] *Source: GFN and total economy database, the conference board and Groningen growth and development centre, 2006. From: World Wide Fund for Nature. (2010). België en zijn ecologische voetafdruk. WWF report 2010 .*

This figure is retrieved from the report of the World Wide Fund of nature (2010) and presents the ecological footprint per person and the GDP per capita in Germany for the period 1961 till 2005. On the X-axis you find the years and on the Y- axis you can find on the left side the GDP for Germany per capita (expressed in dollars) and on the right side, you find the ecological footprint per person (expressed as the global hectare per person). The global hectare is defined by Wikipedia (2015) as: " *A measurement unit of quantifying both the ecological footprint of people or activities as well as the bio capacity of the earth or its regions*[24]*".* The light blue line represents GDP per capita and the dark blue line represents the ecological footprint. From this figure we can see that there is an increase in GDP per capita as well as in ecological footprint per person for the period 1960 till 1970. From 1980 onwards it becomes particularly interesting for our discussion. Here we clearly see that the ecological footprint per person is decreased wile GDP per capita still increases. This graph is therefore proof of what we discussed earlier, that GDP and EF will give different results when we use one or the other as an indicator of growth.

In this part, we propose to use the ecological footprint as a measurement of growth instead of GDP when using the EKC. We saw that some advantages from using EF instead of GDP are: that EF implies interrelated resources, which are needed for sustainable development (van Vuuren & Smeets, 2000). Secondly it focuses on the consequences of a continuously increasing and exhausting consumption and what it does with nature's capital (van Vuuren & Smeets, 2000). Thirdly it is a stock indicator and not a flow indicator (such as GDP) and we can measure with the EF the stock of natural resources at given moment in time which for policy making is more optimal (because it will give a more precise indication of the exploitation of a resource).

However, as with any measurement tool there are some inconveniences as well. Firstly the World Wide Fund of nature (2010) mentions that the reliability of the results dependents on the quality of the data. Not all data (used as input for this physical indicator) is actualized with the same consistency and sometimes these data are not totally complete, which would

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[24] Wikipedia. (sd). *Global hectare*. Opgeroepen op Mai 5, 2015, van Wikipedia: http://en.wikipedia.org/wiki/Global_hectare

decrease the reliability of the EF as an indicator of growth (World Wide Fund for Nature, 2010). However, all indicators are dependent on the quality of the data they are based on and, as we saw earlier, for GDP there are some problems with the data too (such as for instance not adopting government services because they do not have a price on the market). A second difficulty according to the World Wide Fund of nature (2010) when using the EF is that the different bio productive surfaces are quite different in productivity and nature. Therefore, the comparability and joining them together will require an extra step (the standardisation of surfaces in global hectares)

CHAPTER 4: CONCLUSION

7 Conclusion

In this paper we have theoretically studied the EKC curve and critically analysed its usage, its shape and axes. This thesis began by discussing some general concepts related to the EKC such as environmental quality, economic growth and green growth. It was followed by the explanation of what the EKC actually is and what it represents. At the end of the paper, we finished with proposing some changes to improve the EKC, based on the critiques we collected on the concept of the EKC.

The overall purpose of our thesis was to critically analyse the EKC and especially its validity, to show that the EKC is not a correct tool to base policies on. More specifically, we tried to answer to the following research question: " Is the Kuznets curve useful to discuss economic growth in relation to pollution and is it the correct tool for policy making?" To answer this question we started by investigating some sub questions. There are some main findings coming out of our research that we will list below.

Firstly, we found that growth is driven by productive capital, human capital and natural capital. We also came to the conclusion that economic growth only recognizes the first two as drivers for growth but thanks to the growing importance of the environment and sustainability of it, we suggested that literature should move towards green growth instead of economic growth when discussing "growth" in general. A second finding was that EKC does not hold for all pollutants. There are several factors that contribute to the fact whether the relationship between the pollutant and economic growth will show an inverted U-shape or not. First of all, there is a big difference between global and local pollutants. As it is much easier to look at the impacts of a local pollutant, the EKC relationship will be seen more for local than for global pollutants. Sometimes the EKC relationship is found for global pollutants as well, but mostly a straight-line relationship is seen. Besides that, the way the pollutant is measured has an impact on the type of relationship. All these separate findings let us believe that the EKC is not quite a valid curve. In fact we could say that this curve is fake and the inverted U-shape relationship between pollution and economic growth does not hold for all pollutants nor does it hold for all income levels of countries. Said otherwise, there is no stable link between the x-axis and the y-axis. We also argued that there could be other factors that can explain the curve. One of these factors (in our opinion) are policies. Because the curve is fake and not valid, we argue that governments should not base policy making on the EKC and that policy making based on this curve could be dangerous. They could set wrong policies or limits, because the pollution levels will not always lower just because you let the economy grow.

Therefore we proposed some improvements to the EKC. A first suggestion was to use green growth on the x-axis instead of economic growth because it does meet better the needs of governments and individuals nowadays. It accounts for natural capital and looks at sustainability of the natural assets. A second suggestion was to use a stock indicator for measuring growth instead of a flow indicator. A stock indicator will permit us to know the exact stock of a resource at a given point in time (World Wide Fund for Nature, 2010). Therefore, a stock indicator will make it possible for governments to set more accurate and precise limits to the usage of natural resources better then when using GDP, which does not give any indication about the stock of a natural asset on a given point in time (World Wide Fund for Nature, 2010). After that, we pointed out that an EKC is not possible to generalize the relationship between economic growth and pollution. It is important that each relationship is looked at individually. This means that we need to investigate the effect that growth has on individual pollutants and especially make a separate investigation of the relationship between growth and local pollutants and growth in relation to global pollutants. For policy makers, that is an important fact to bear in mind, because they cannot just assume that the EKC relationship holds and that thus the solution is to let the economy grow.

With these outcomes we have some recommendations for governments and nations. A first recommendation is that governments should keep setting policies because the EKC curve does not provide us with a general and stable relationship between both axes (as differences occur between local and global pollutants for example). Therefore, it can thus not for sure be said that there will always occur an inverted U-shape relationship when looking at the relationship between economic growth and pollution. The environment and the natural resources are too important to take this risk. Therefore, we strongly suggest to keep intervening when it comes to pollution of the environment. A second recommendation is that governments should base policy making on green growth and for example using the ecological footprint instead of GDP, as we mentioned in the former chapter.

However, as with any research study we need to recognize some limitations concerning our investigation. A first limitation (and possibly the most important one) is that our thesis is a theoretical research paper and does not include empirical evidence of our findings. An empirical investigation of the relationship between economic growth and pollution and the link with policy making (based on different countries), would have given more power to our findings. Our findings are thus based on theory. However, often what is found in theory does not occur in practice or will occur in a different way. Because of our lack of experience in this field of study and the limited resources and tools publically available (and thus available for us), we were not able to do such a broad empirical study. Also, It would make our investigation far too complex. A second limitation about our research is that we cannot provide the reader with a "one way" answer about with relationships are involved in the EKC and if policies are influencing the relationship between economic growth and pollution. We can only provide some critics and suggestions but we cannot provide the reader with a fully straightforward approach of how they should make policy decisions. A third limitation of our research is that we propose small improvements to the existing EKC but we did not manage to come up with a new curve. This could be a limitation because we do not propose a direct solution for governments on how they need to set policies and if they need to set them. However, the proposition of a totally new curve goes beyond the scope of this thesis.

The aim of this thesis was to critically analyse the EKC curve and its relationship with policy making. Our work contributed to the existing literature because it sheds light on the usefulness and existence of the EKC and its inverted U-shape relationship. By giving general recommendations to the government and nations, we open the door for new research to go deeper in this line of thinking. We also recommend new studies to search for some empirical proof for these findings.

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