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Does economic growth improve the wellbeing of the German society?

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Abstract

The question of whether wellbeing is connected to economic growth has arisen in recent years, on the one side of concerns whether growth can continue indefinitely and on the other side pointing out increasing negative side-effects.
The purpose of this study was to determine whether economic growth actually improves the wellbeing of the German society, and if possible to determine the inflexion point in which the impact of growth changed from positive to negative. To do so, wellbeing was defined in three dimensions (ecological, social and economic) using alternative indicators (based on the Enquete-Commission of the German Government) and compared to the real GDP over a period of 27 years (1990-2017), with the alternative measures all focussing on individual wellbeing and rather than business wellbeing. The quantitative research used primarily moving average and Pearson's normal and moving correlation coefficient, to analyse the relationship of economic growth to the other indicators.

The resulting relationships between economic growth and the indicators of ecological and social wellbeing of the society were very mixed – whilst some indicators showed positive reactions to real GDP growth, some possibly worsened due to economic growth. In the observed time frame however, the economic wellbeing of the society did not improve through economic growth of the society at all, but likely even worsened because of it between 1994 and 2011.

In conclusion, a singular point at which economic growth stopped adding value to society's overall wellbeing is not clearly determinable. Nevertheless, it has become prominent that economic growth over the past 27 years has had increasing negative side effects on the society's wellbeing, especially economically. This could mean that there is a need to continuously change regulations and policies to assure that every part of the ecological, social and economic wellbeing improves through economic growth. However, the question arises if the elimination of all negative effects is even possible in our current economic and societal system, or whether a departure from the growth paradigm, towards a more sustainable life model is needed.

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List of Abbreviations

BpB	Bundeszentrale für politische Bildung
BY	Base Year
CO2	Carbon Dioxide
e.g.	"exampli gratia" – for example
et al.	and others
GDP	Gross Domestic Product
GHG	Greenhouse Gas
i.e.	"id est" – that is to say
IMF	International Monetary Fund
Kg/ha	Kilogram per Hectare
MA	Moving Average
NWI	National Welfare Index
OECD	Organisation for Economic Cooperation and Development
p	"p-value"/ "critical value" is a key figure in statistical significance testing
P90/P10	Inequality index looking at the highest 90^{th} percentile and lowest 10^{th} percentile
r	"r" is the variable of correlation
SSE	Steady State Economy
W3	Indicator set published by the Enquete-Commission in 2013, as an alternative measurement for the wellbeing of the German society

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1 Introduction

Since the 2008 financial crisis, political and central bank policymakers are trying to stimulate the economy by a variety of means. The European central bank uses tools such as zero interest rates and quantitative easing which, at this point in time, appear to have exhausted the possibility of creating inflation of two percent as well as supporting the economies of its member states. Despite the vast efforts to stimulate growth, the rate of economic growth, measured in gross domestic product (GDP) terms, has hardly recovered to its historic goal of 2.5% growth in most countries. Instead, it has been on a constant decline since the 1970s.

At the same time, in which economic growth is harder and harder to achieve, a rising number of economists question the favourability of growth for the society in general, as positive effects on e.g. labour employment and innovation (Baumol et al., 2007) are more and more joined by negative effects, such as inequality and environmental damages (Meadows et al., 2004).

To counter the negative effects of economic growth, economists propose alternative approaches towards more sustainable societal models. The presumption being that economic growth itself has been the cause of negative societal impacts, as well as the fact that economic growth is not believed to be a sustainable mean to provide benefits to society. Alternative models proposed to date include minimum growth (Binswanger, 2009), no-growth (Daly, 2005), and degrowth (Latouche, 2010).

Other economists question the meaningfulness of GDP as a measure of wellbeing (of a society) in the first place, rather than questioning the impacts of economic growth, and demand a different method of measurement. By definition, GDP only measures the production activity of the national economy (Breuer et al. 2010) and does not include any measure of social or ecological development. As a result, an economy can grow without well-being gains if the negative effects of growth (at e.g. social or ecological) offset the positive gains. (Diefenbacher; Zieschank, 2011).

Considering the increasing difficulties of achieving growth and the rising doubts on the favourability of economic growth, in addition to the disbelief of GDP as an adequate measurement for wellbeing, there is an immediate need to understand the actual impact of economic growth on the wellbeing of the society.

This paper assesses the relationship between economic growth and the ecological, social and economic wellbeing of the German society. Focussing on the research question: *Does economic growth improve the wellbeing of the German society?*

The focus is on detecting relationships between economic growth and the wellbeing of the society and if possible, determine an inflexion point in which the impact of growth changed from positive to negative. To do so, wellbeing is defined using alternative indicators and compared to the economic growth over a period of 27 years (1990-2017), with the alternative measures all focussing on individual wellbeing and rather than business wellbeing. The alternative indicators are based on the Enquete Commission's report (Enquete-Commission, 2013), covering three measures for each ecological, social, and economic dimension of wellbeing. Economic growth is defined in terms of real GDP, measuring an economy's performance over a given period in constant prices. As the population in Germany's is almost constant, increasing by only 3.5% from 1990 to 2017, the change in population is not taken into account. (Federal Statistics Agency, 2018a)

Alternative indicators, as well as different ways (e.g. composite indicators) to measure wellbeing are available and could have been considered, however, for this paper, the selection of indicators was based on the Enquete-Commission's set, with some adjustments to take into account peculiarities specific to Germany.

Hereafter, we first explore existing literature, covering the pros and cons of economic growth, alternative economic models, and alternative measurements of wellbeing. After that, the methodology is explained, providing a detailed overview of the correlation analyses and visualisation of the results for each indicator's relationship with real GDP. Thereafter, we discuss the results and underlying implications in a broader macroeconomic picture, intending to give some explanation of the causality between the relationship of the indicators and real GDP. Finally, in the conclusion we revisit the research question and give an outlook for further research.

The broader societal impact of economic growth, beyond the covered indicators, as well as the causality between the economic growth and the indicators are beyond the scope of this paper.

2 Literature Review

The question of whether wellbeing is connected to economic growth has arisen in recent years as economists questioned whether growth can continue indefinitely and concerned increasing negative side-effects of growth. The debate, although topical, is not new and has been explored in literature since the mid-20th century with views pro and counter economic growth.

The narrative flow of the literature review is structured to give a sufficient context to objectively evaluate the results of this paper. Firstly, an overview of the positive and negative effects of economic growth are given, followed by a review of GDP as a measure of wellbeing of a society. Lastly, introducing alternative economic models, which are supposed to provide a more holistic view of economic growth, including the negative impacts of growth. The authors and papers were selected to present a view of the general opinion and key leaders for each topic, providing an overview of recent academic contributions.

2.1 Economic Growth

The first Club of Rome report *Limits to Growth* (Meadows et al. 1972) was one of the first and most prominent critiques of the current capitalistic growth model. The much-noticed report warned as early as 1972 that the limitations of natural resources and the consequences of emissions could halt the steady quality of life improvements that the world population experienced over the course of the 20th century. The researchers predicted an end to physical growth in the 21st century without more sparing use of natural resources, with the help of several mathematical simulations. Their model did not predict a collapse of the economy, however highlighted the need for technological, cultural and institutional change to continue prosperity - a broader focus of growth. Thirty years after this report, the authors further elaborated, iterating that the negative consequences of economic growth come after a phase of extended growth (Meadows et al. 2004). The apparent signs of such a phase were presented as: the civilisation's addiction for growth, exploding populations, and increasing pollution. They stated that, on a finite earth, an individual may increase its wealth through growth and progress, the foundation and resources on the other hand have inherent limits. (Meadows et al. 2004)

Following from Meadows et al.'s publications, views on the negative effects of economic growth have evolved and are often clustered into three categories: ecological, social, and economic.

2.1.1 Ecological effects of growth

From an ecological perspective, current literature consistently highlights an undeniable link between economic growth and ecological wellbeing. According to Meadows et al. in *Limits to Growth – the 30-Year Update* economic growth is still mainly achieved by the mining and introduction of new resources into the system. In economic terms, new resources or 'capital' is being used-up, instead of living from recycled resourced or 'interests'. Meadows et al. argued that this will lead to a bankruptcy in the ecological and economical system. (Meadows et al., 2004)

Miegel (2010), agrees with further points of Meadows et al. (2004): (1) that the overuse of renewable resources leads to increasing costs of production and lower returns (e.g. as cause of less arable land); (2) the inefficient use of non-renewable resources result in unsustainable supply (e.g. scarcities of "rare earths"); and (3) that increasing pollution and waste, damages the environment (e.g. resulting in polluted cities). Considering these consequences, both authors stressed that a growing economy ignores the inherent limits of the planet. (Miegel, 2010/ Meadows et al., 2004)

From an ecological perspective, although it is generally understood that growth negatively impacts ecology, reducing growth is not seen as the solution. It is more commonly argued that the problem is "cheap" pollution. Increasing costs through CO2 taxes, for example, would stimulate research into innovative and sustainable solutions that can be supported by economic growth with lower ecological impact. (Baumol et al. , 2007).

In addition, there are political barriers to solving ecological side effects. For instance, although industrialised nations are undoubtedly the biggest contributors to climate change, there is a significant increase in CO2 emissions in the emerging economies. These countries, however, can unlikely be convinced to slow down their growth. Solutions to limit the ecological effects are therefore more appropriate than stopping growth. (Paque, 2010)

The authors of *limits to growth* disapproved with Paque's view, who is preferring market self-regulation to political-intervention. The authors stated that the equilibrium of the market, which is argued to "self-regulate" ecological impacts through higher prices, is not sufficient as neither technology nor markets have more inherent wisdom or farsightedness or moderation or compassion than the human bureaucracies that created them. (Meadows et al. 2004)

2.1.2 Social effects of growth

Finally, from a social perspective, it is generally argued that economic growth is necessary for people to improve their lives. Academics and politicians often see economic growth as a precursor; only with more economic performance more people can achieve a more pleasant and satisfying life (Baumol et al. , 2007). Furthermore, rejection of economic growth carries the risk of creating a considerable gap in societal progress compared to other nations. In addition, Paque made the point that if economic growth is reduced or non-existent, societal improvements becomes a zero-sum game in which everyone can only improve at the expense of someone else (Paque, 2010). Decreasing or shrinking economic growth is therefore something most people would refuse, avoiding the diminishment of their standard of living or movement to the standard of living of the past. At a global level reducing economic growth is even more unlikely; less developed countries will not be prepared to stop their efforts to catch up. (Paque, 2010)

On the other side, Fred Hirsch, a british economist famous for his report *Social Limits to Growth* (1977), pointed out that in societies that become richer, additional goods and services are created for consumers to strive for, without the ability for all consumers to obtain them (positional goods). The consequence is that material wealth does not automatically correspond to a richer society. For Hirsch, this restriction represented an unsurpassable social limit to growth. (Hirsch, 1977). Meadows et al. concured with Hirsh, stating that not every individual gains equally from a prospering economy. The distribution of benefits favours the wealthier in a so called “success to successful” loop. The result is a growing gap between the rich and poor. (Meadows et al., 2004)

In the latest publication of the club of Rome, *Reinventing Prosperity* (2016), the authors claimed that the need for economic growth has led to a substantial deregulation of the economy and banks. The deregulation of the financial markets, the enormous pressure on the profit-margins of the real economy, automation, and the manufacturing in low-wage countries (whose products reach the markets without restriction thanks to free trade) have the effect of reducing jobs and wages of employees, but at the same time increase the profits of companies disproportionately. This concept boosts the economy, but profits only flow into the pockets of the wealthiest. In addition, the economy has been boosted by debt for decades (both state and private debt). Put simply, the poor borrow money from the wealthy in the system, whose prosperity further increases as a result. As this small class benefits disproportionately, there is no increase in prosperity among the general population leading to the gap between rich and poor that constantly widens - an effect that ultimately destabilises societies and states. As such, the report concluded

that, sooner rather than later, the society and economy will reach its limit and stop growing. (Randers; Maxton, 2016)

2.1.3 Economic effects of growth

On the one side, economically speaking, especially at a microeconomic scale but also on a macroeconomic scale, the global paradigm is focussed on growth. Companies can further boost their profits and sales through growth, which directly increases the available capital for investments in research and development of new technologies, which drives progress in our society but also further improves the quality of life and the environment. The richer societies are, the more resources they will have to maximize the overall well-being of a nation. (Baumol, et al. 2007)

On the other side, Tim Jackson has concerned himself with the inherent economic limitation of growth, and gained popularity by introducing an economic model that did not need growth to sustain, in his book *Prosperity without Growth* (Jackson, 2009). He stated that an economy whose progress depends on the constant increase of sales, will inevitably rely on monetary and debt expansion to sustain growth. In his view, the emergence of financial credit, a common economic method to stimulate growth, leads to unstable balance sheets. As a result of the over-reliance of such credit systems to stimulate growth, complex financial instruments were introduced and used to conceal unhealthy loans, increasing the risk of damaging the national product and the functioning of the economy itself. (Jackson, 2016)

Hans Binswanger, an economist popular for its non-Marxist growth critics, highlights that this paradigm is endorsed at the highest level of government and by regulators, whom are not willing to sacrifice growth as this badly reflects on their performance and could send a negative message to their voting population. Politicians therefore avoid taking on this risk (stopping or reducing economic growth) as it could negatively impact a national economy in the form of job losses, household deficits, and an eventual possibility of an economic collapse. (Binswanger, 2009)

Overall, from an economic perspective, the broad academic community agrees that as economic growth is so deeply embedded within society that it is hard, if not impossible, to move away from – for better or for worse.

Although the limits of economic growth are highlighted in academic literature, the pursuit of economic growth continues to be an unquestioned goal of economic trade (Alfredsson: Malmaeus 2017). In Adam Smith's work *Wealth of Nations* (1776), he already proposed the concept of improving the supply of goods to the population through long-term growth.

While it is only since the beginning of the 20th century that long-term economic growth has been considered a fundamental component of economic policies and theories.

In summary, proponents of economic growth defend the traditional importance of growth to advance as a nation or economy, whereas the opposition highlights the limitations and flaws in the current model such as the negative side effects in the social, ecological and economic wellbeing. Existing and represented literature thereby highlights a key question: has the wellbeing of the German society improved as a result of economic growth?

2.2 Measures of Growth

2.2.1 Proponents for GDP as a Measure of Growth

As a deeply embedded measure in the global political landscape, GDP as a measure of growth is generally accepted. Nevertheless, even its proponents maintain a healthy level of scepticism. For example, economist van Suntum accepted that GDP is not a perfect welfare measurement and should be expanded to include the missing social and environmental dimensions, but nevertheless remain as the basis and core of any wealth calculation and policy making. He stated that no other measure can match GDP in terms of data consistency, information content and objectivity. One reason for this is that GDP is based on market-driven costs and prices, which cannot be replaced by any other method, however sophisticated. Secondly, he argued that because the calculation of GDP is based on the methodology of double-entry or multiple-entry accounting it has an inner consistency that makes it conceptually superior to other wellbeing measures. (van Suntum, 2012)

2.2.2 Limitations of GDP as a Measure of Growth

On the other hand, several academics criticise GDP, regardless of its importance in society, and are looking at alternative or complimentary indicators. According to Breuer et al., the critique is not surprising as, although GDP is consistently used to measure a country's wellbeing, it was originally not conceived as a comprehensive measure of wellbeing (Breuer et al. 2010). The concept was only developed after the global economic crisis of the 1930s with the objective to measure the production activity of the national economy (Kuznets, 1934). Only in the aftermath has GDP increasingly been used as a measure of prosperity levels, both internationally and over time. At the same time, its limited expressiveness has occasionally been lost out of sight. After all, GDP describes the economic development of a country and covers all goods and services exchanged, allowing it to grow without wellbeing gains. Vice versa, even if the economy does not

grow, there may still be an improvement in overall wellbeing. Academics such as Diefenbacher and Zieschank have highlighted the costs and damage to nature and people, which are often left uncompensated (Diefenbacher; Zieschank, 2011).

From an ecological perspective, GDP is an indicator of a country's wellbeing, that almost completely ignores the environment. Environmental costs such as intangible damage to nature and landscape caused by the desertification of landscapes and habitats, the depletion of natural resources and, contrary to this, the costs of environmental restoration, are almost not taken into account at all. (Diefenbacher; Zieschank, 2011).

From a social perspective, GDP reflects very few social developments; it ignores the consequences of growing socio-economic injustices and the elements of good quality of life (e.g. life expectancy, school education, unemployment, etc.). If growth is concentrated only in one part of society, it does not contribute to improving national economic prosperity, since the social benefits of increased consumption by the rich are less positive than those of the entire community (Talberth et al., 2007).

From an economic perspective GDP also has limitations. Cambridge economics professor Diane Coyle stated that the gross domestic product is an analytical construct, involving a lot of judgement, therefore making it subject to inaccurate messages about the state of the economy and consequently wrongly informs policy decisions (Coyle, 2018). In addition, the collected data leaves out significant market activity, such as the digital industry, monetary transactions such as donations and moonlighting, as well as almost all non-monetary activities, such as childcare, volunteering, and domestic work, despite their important contribution to society (Ivkovic, 2016 / Coyle, 2018). Furthermore, many economic activities are included that do not seem to add value to the economy and yet appear in the GDP, such as illegal activity (e.g. drugs and prostitution) as well as non-value adding activities (e.g. financial intermediates betting on other transactions in the financial industry). (Coyle, 2018).

In summary of the above-mentioned authors, the gross domestic product does not and was not designed to measure and indicated the development of the wellbeing of a country. In addition to the therefore missing social and ecological indication, the economic interpretation also lacks in consistency. A new inclusive measurement of the development of a society's wellbeing, including social, economic and ecological dimensions is needed to illustrate and guide national prosperity development.

2.2.3 Alternative Measures of Growth

At the end of 2010, the German Bundestag set up a study commission ("Enquete Commission") with the task of developing a complementation to GDP with a view to measure growth, prosperity and quality of life. As an outcome, the commission has proposed, amongst others, to add nine indicators to measure wellbeing, in addition to GDP, covering aspects as diverse as income distribution, biodiversity, and life expectancy. These indicators, referred to as W3 indicators, can be divided into economic, ecological and social dimensions. (Enquete Commission, 2013)

Ecological	Social	Economic
• Greenhousegas Emissions	• Employment Quota	• Real GDP per Capita
• Nitrogen Surplus	• Education Quota	• Income Distribution
• Biodiversity	• Life Expectancy	• State Debt Quota
	• Democracy	

Table 1: Dimensions of Wellbeing according to W3 Indicators

Source: Enquete-Commissions, 2013; Own Illustration

Similarly, the National Welfare Index (NWI) was developed by the economic professors Hans Diefenbacher and Roland Zieschank, on behalf of the Federal Environment Agency, to incorporate social, ecological and economic factors into a single indicator. The NWI represents the sum of 20 monetary components. The largest item is private consumption weighted by income distribution (Gini index). In addition, other welfare-enhancing components such as housework, voluntary work and expenditure on education and health are positively integrated into the NWI. Finally, welfare-reducing activities are deducted, such as the costs of various environmental damage or damage to health. Although all-encompassing, this "composite-indicator" makes it hard to determine which improvement or deterioration contributes to a positive or negative change of the overall value. It therefore only represents the general welfare development of a nation, requiring deeper dives into the underlying indicators to understand social, ecological and economic development (Diefenbacher et al., 2016).

In summary, to measure non-business wellbeing of a society, two alternatives are suggested: an indicator set or a composite indicator. Although an improvement over GDP, neither proposal compares the development of these indicators (reflecting the society's wellbeing) to GDP (reflecting the economic/ business wellbeing); a gap this research paper is looking to close.

2.3 Alternative Models

The criticism against economic growth and the GDP as a measurement described so far did not in itself lead to alternative economic models. Many economists did indeed practice sound criticism against growth, but without the use of a formal and explicit model of a modern economy. They offered quantitative information to support and illustrate their arguments but did not build their own econometric models or made use of models built by others to make their case (Victor, 2008).

Although currently there is no dominant and binding macroeconomic concept that comprehensively reflects the functioning and social implications of a non-growing economy, various alternative approaches exist; covered below and arranged according to the degree of growth they still consider necessary: (1) minimum growth; (2) no-growth; (3) degrowth.

2.3.1 Minimum Growth as an Alternative Model

One alternative to maximising growth at the highest possible growth rate is maintaining a minimum global rate as too much growth increases the risk of crises (Binswanger, 2009). Binswanger argued that the most important driving force behind economic growth is the creation of the money economy. The effect of money creation (or lending) expands the economic cycle into an upward spiral. The increase in capital through bank lending and the reinvestment of part of the net profits justifies itself, that is, through the profits generated by the creation of credit and money. According to Binswanger, money creation must always be so high that the demand for products increases in proportion to the product range and the loss of money in the money creation process is compensated. According to his calculations, this results in a minimum growth of 1.8%. Only then would shareholders and banks be compensated by profits for risks taken and continue to provide sufficient capital. Below this level of growth, a downward spiral would begin and the economy shrinks (Binswanger, 2009)

2.3.2 No Growth as an Alternative Model

No economic growth, although hard to imagine in the current economic climate, is an alternative model underpinned by the Steady State Economy (SSE). SSE is a concept of the economy that stopped growing physically at an optimal level, and develops at a sustainable consumption level with a constant population. The underlying ideas were formulated about 150 years ago by classical economist John Stuart Mill (Kallis, 2012). More recently, Herman Daly (2008), economics professor at University of Maryland and

former economist at the Worldbank, described the concept of the steady state as desirable, as the quantitative spread of the economic system increases environmental and social costs more than production benefits, making us poorer and not richer, at least in developed countries. He therefore determined that a steady state economy could only be achieved in a country in which production is below the carrying capacity of the environment and social costs. Prior to the past two hundred years, people have always lived in such a system without exponential growth (Daly 2005).

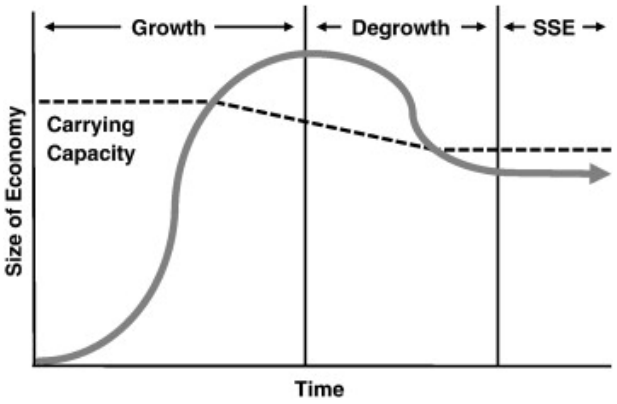

Figure 1: Transition from Growth to Steady State Economy
Source: O'Neill, 2012

2.3.3 Degrowth as an Alternative Model

Finally, a relatively new alternative model to growth is degrowth. A young and heterogeneous movement stands behind the concept of degrowth. This group, consisting of scientists, activists and politicians, advocate for a conscious departure from the economic model and society driven by growth, instead making a voluntary, smooth and equitable transition to a regime of lower production and consumption. The underlying driver is that economic growth is perceived as socially, ecologically and economically harmful (Kallis et al., 2012). According to Serge Latouche, former economics professor at the University of Paris XI and initiator of the degrowth movement, the current economic and social guiding principle is "higher", "faster", "further", leading to acceleration, excessive demands and exclusion. The degrowth process, which is focussed on sustainability, well-being, and the preservation of the ecological basis of life, enables human progress even without quantitative growth. This requires a fundamental change in our living environment and a comprehensive cultural change, with which the economy is to be shrunk back to a "healthy" level. Only in this way can a sustainable life be made possible for all (Latouche, 2010).

In summary, the existing research on alternative economic models, presupposes that economic growth has predominantly negative effects. This connection however, has yet to be analysed for the German society, to clarify the inherent need for a change in the national economic model.

2.4 Conclusion and Aims

Considering the existing research and literature on economic growth, there is a clear need to understand whether economic growth is positively or negatively impacting the wellbeing of the German society. This would provide a base for further evaluating the necessities to modify the current economic and societal model. Moreover, the possible lack of informative value of GDP on the society's wellbeing as well as the limited research on the individual prosperity are a clear gap in the current paradigm. In order to close this gap, this paper will attempt to answer the research question: *Does economic growth improve the wellbeing of the German society?*

To asses this, the research problem was divided into three hypotheses, clustering the wellbeing into different dimensions:

1. Economic growth does not improve the society's ecological wellbeing
2. Economic growth does not improve the society's social wellbeing
3. Economic growth does not improve the society's economic wellbeing

In other words, this paper looks to determine if economic growth (represented by GDP) still improves the wellbeing of the German society (represented by an alternative measure), focusing on the individual's rather than the business' wellbeing.

3 Methodology

The underlying assumption of this paper was that economic growth does not improve the wellbeing of the German society since 1990.

To prove the hypotheses, this paper assessed whether there is statistically relevant evidence of a relationship between economic growth and ecological, social, and economic wellbeing. Each dimension of wellbeing was represented by three indicators, based on the Enquete-Commission's report of the German government, and compared to economic growth, represented by real GDP.

The data for these indicators was collected using federal, European and international official institutions for a timeframe between 1990 to 2017. The quantitative research of this paper follows a traditional statistical assessment for time series data, starting with the data preparation including a basing and trend smoothing (moving average) for better comparability. Afterwards, Pearson's normal and moving correlation coefficient was used to analyse the relationship of economic growth and the other indicators, followed by a significance test to ensure statistical significance of the results.

3.1 Study Population and Sampling

3.1.1 Selection of an economic growth indicator

Firstly, a suitable reference value for economic growth had to be selected. In this paper, the real gross domestic product (GDP) was used as an indicator for growth as it measures an economy's economic performance over a given period (usually: one year). The definition of real GDP explains why it was a suitable indicator and why it was selected over nominal GDP.

In simple terms, GDP measures the value of all goods and services produced domestically at market prices (i.e. the total economic value added) (Freie Universität Berlin, 2018). The difference between nominal and real GDP is that nominal GDP does not take into account external factors such as exchange rate fluctuations (when converting GDP into US dollars for example). For this reason, nominal GDP is only of limited significance in an international comparison. In addition, nominal GDP does also not compensate for fluctuations in inflation, meaning that inflation would appear as economic growth, even if no additional goods or services were produced in real terms. Consequently, the significance of nominal GDP is also limited on a national level. (Freie Universität Berlin, 2018)

As a result, real GDP was selected as a measure for economic growth, incorporating external factors such as inflation and the price index. Real GDP provides more accurate information on a country's economic performance, or in other words, on the quantity of goods and services produced or sold in an economy. Real GDP considers the fact that both production can change from one period to the next, in addition to prices of traded products. In contrast to nominal GDP, real GDP is calculated by comparing the value of all goods sold at base year prices. This eliminates the distorting effect of price changes on GDP. Real GDP is therefore also called GDP at constant prices. (Freie Universität Berlin, 2018)

Henceforth in this paper, GDP will be used as a short form for real GDP (i.e. GDP refers to real GDP).

3.1.2 Selection of alternative measures

Secondly, we selected three indicators per wellbeing dimension (i.e. ecological, social and economic wellbeing) and attempted to use a broad set of non-controversial indicators (table 2). The indicator set used in this paper is based on the results of the Enquete-Commission of the German federal government form 2013, with some modifications (discussed in the next section).

To provide some background, the Enquete-commission was assigned to find a way for social prosperity, individual wellbeing and sustainable development to be adequately measured, given that the focus on gross domestic product (GDP) growth is no longer sufficient (Enquete-Commission, 2013). The resulting W3 indicator set is focused on societal and individual wellbeing rather than the wellbeing of business and industry. The indicator set covers:

- The material standard of living;
- Access to and quality of work;
- Social distribution of wealth;
- Social inclusion and cohesion;
- An intact environment;
- The availability of limited natural resources;
- Educational opportunities;
- Education levels;
- Health;
- Life expectancy;
- The quality of public services;
- Social security;
- Political participation;
- Quality of life and satisfaction.

The outcome of the report was a list of ten indicators, called W3, clustered into three sectors of wellbeing: social, ecological and economical (table 2). The indicators were selected and defined as follows:

- **Gross domestic product (GDP) per capita***:* For reasons of better international comparability, the Enquete Commission has decided to use primarily the per capita value of the gross domestic product. As a measure of the overall economic performance of an economy, it reflects a substantial part of individual material prosperity. In order to be able to make international level comparisons over time and to keep an eye on national developments, the rates of change in addition to the absolute values are of GDP also taken into account. In addition, the total real GDP is viewed in an international ranking.
- **Income distribution P80/P20***:* The income distribution is measured with the percentile view of net equalised income, specifically with the ratio of the high earning 80th and the low income 20th percentiles. The reasons given for the selection of this indicator and these percentiles were its intuitive comprehensibility and the relatively large distance of the percentiles from the respective extreme values above and below. This indicator shows how far the incomes of the "better-off" and the "low-income" differ.
- **State Debt Quota***:* The leading indicator is the ratio of gross State debt to GDP. It is both internationally established and compatible with the criteria of the European Union's Stability and Growth Pact.
- **Employment Quota***:* In contrast to the nationally more well-known unemployment rate, the employment quota is more difficult to influence by national legislation or labour market policy programmes. It is also easier to compare internationally. The employment rate is the percentage of the population aged 15-64 in employment. Employment is defined as those who have worked at least one hour for pay during the observed period.
- **Higher Education Quota***:* In order to measure the level of education in the population, the Enquete Commission uses the rate of all 20 to 24-year-olds with at least upper secondary education (vocational qualification, technical, subject-related or general higher education entrance qualification). Such a degree is regarded as a "minimum qualification for the developing knowledge society". The leading indicator thus has an early warning function.
- **Life expectancy at birth***:* Calculated using national mortality tables, this indicator represents the average life expectancy at birth. Other Indicators in this area - such as the number of potential years of life lost - are very complex in design and are also weak in their variance in highly developed societies.
- **Voice & Accountability***:* The World Bank indicator "Voice & Accountability" is an index of numerous individual stocks. It records how citizens of a country perceive

their participation in the selection of their government, as well as the prevailing degree of freedom of opinion, coalition and press. The individual values are exclusively secondary survey results - i.e. subjective data - from experts, citizens and companies. These data are aggregated and normalized on a scale from 0 to 100; the value 100 denotes the highest degree of "democracy".

- **Greenhouse gas emissions (national)***:* The leading environmental indicator is based on the requirements of the Kyoto Protocol and calculates five different substances in carbon dioxide equivalents and then adds them to CO2 emissions. The result is greenhouse gas emissions in tonnes per year.
- **Nitrogen surplus***:* The indicator represents the nitrogen supply minus nitrogen removal per square metre of agricultural land and represents a part of the environmental impact of human production.
- **Biodiversity (originally Bird Index)***:* The leading indicator shows the loss of biodiversity in Germany, compared to the base years 2030 and 1975. Since biodiversity is a complex phenomenon, the bird index is only an approximation. (Enquete-Commission, 2013)

For this research, three adaptations have been made relative to the W3 indicator list due to insufficient data availability from 1990-2017 and problems in comparability. To assure, that an equal amount of three indicators per sector remained, unsuitable ones were replaced by the best available alternative.

Firstly, the social indicators ‘Upper Secondary School Leaving Rate’ and ‘Voice and Accountability’ were replaced as these are relatively new indicators and did not have sufficient data available in the time frame. Nevertheless, unfortunately, a similar and consistent alternative was not available. Instead, the two indicators were replaced by the poverty risk quota. This indicator shows the share of the population that has an income below the poverty line or in other words, an income below 60 percent of the average household income. Although this does not perfectly replace the unsuitable W3 indicators, it adds valuable information on the social wellbeing in Germany.

Secondly, two economic indicators were replaced. The income distribution P80/P20 indicator was replaced by the P90/P10 indicator, due to lack of available and current data of the former indicator. This means that the new income distribution shows a ratio of the a higher (richer) percentile to a lower (poorer) percentile making it more “extreme” compared to the P80/P20. In addition, GDP per capita was replaced by the real net income, which shows the average nominal wage reduced by the rate of monetary devaluation (inflation) of an employee after deduction of taxes and social security contributions. This

indicator was replaced as the former indicator is derived directly from GDP, thereby limiting the comparability (to GDP itself) and the resulting insight. Both indicators attempt to represent the wealth development per person, with real net income seeming closer to reality and therefore a logical indicator to include in this analysis.

Dimension	W3 Indicator Set	Research Indicator Set	Data	Source
Base	-	Real GDP	1990-2017	IMF, 2018
Ecological	Greenhouse gas Emissions	Greenhouse gas Emissions	1990- 2016	Federal Environment Agency, 2018a
	Nitrogen Surplus	Nitrogen Surplus	1990-2015	Federal Environment Agency, 2018b
	Biodiversity	Biodiversity	1990-2014	Federal Environment Agency, 2018c
Social	Employment Quota	Employment Quota	1990-2016	Federal Statistics Agency, 2018b
	Life Expectancy at Birth	Life Expectancy at Birth	1990-2016	OECD, 2018a
	Higher Education Quota	Poverty Risk Quota	1991-2014	Federal Government, 2018a
	Voice & Accountability Index			
Economic	Real GDP per Capita	Real Net Income	1991-2016	Federal Government, 2018b
	Income Distribution P80/P20	Income Distribution P90/P10	1990-2016	OECD, 2018b
	State Debt Quota	State Debt Quota	1991-2017	Federal Central Bank, 2018

Table 2: Overview of Indicator changes and sources Source: Own Illustration

3.2 Data Analysis

3.2.1 Data Preparation

Following the collection of raw data for each indicator, an index was formed based on the first year data of all indicators was available, which means 1991 is the base year and represents 100% whereas subsequent years represent a percentage relative to the 1991 base. The creation of an index allows us to plot and compare trend lines of different indicators on a single chart, regardless of different units*.

Subsequently, the moving average was calculated as a method to smoothen time or data series. Smoothing refers to the elimination of significant outliers by replacing each data point by the arithmetic mean of the neighbouring points. In the simplest case, this is done by averaging three data points. (Wewel, 2014)

This paper used the 3-year and 5-year centered moving average, meaning they use one and two data point(s) prior and after the relevant year's data point respectively to calculate the arithmetic mean. Together with the raw data, this resulted in a picture of short (raw data), medium (3-year MA) and long-term (5-year MA) trends and developments.

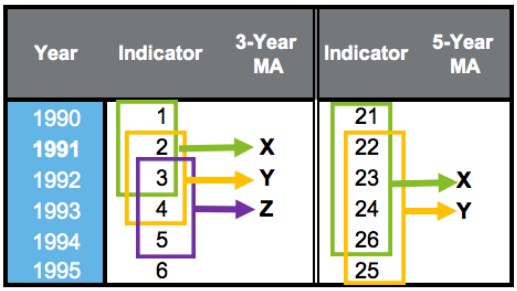

Figure 2: Methodology of Moving Averages
Source: Own Illustration

**All results calculated in this paper were double checked with a standardized data set, which has shown no difference in the results. This might be to the nature of Excel's functions, and was not further investigated. (See Appendix 2)*

3.2.2 Data Correlation

As the primary purpose of this paper was to determine the relationship between the economic growth and the individual indicators, we performed a correlation analysis to determine such a relationship; a popular statistical method to measure the strength of a linear relationship between two variables. In this paper the Bravais-Pearson method was used, which expresses the strength of the statistical correlation by a coefficient, which lies between -1 and +1. A +1 represents a strong positive/ concordant relationship, a -1 represents a strong negative/ inverse relationship. (Wewel, 2014)

The correlations were calculated between each indicator and GDP for the entire time frame (1990-2017) in their raw, 3-year and 5-year moving average versions. In practice this was calculated, using Excels' inbuild Pearson's function, which uses the formula as depicted in figure 3.

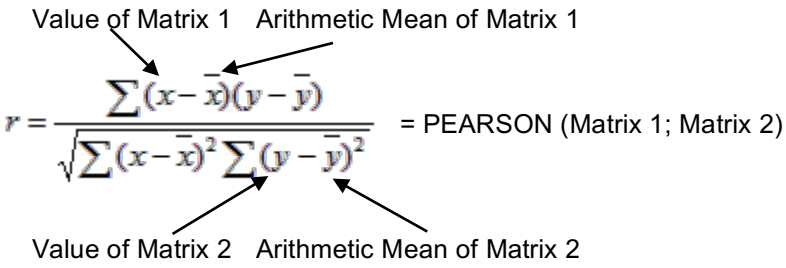

Figure 3: Formula and Function of Correlation Coefficient
Source: Microsoft 2018

As the correlations are always non-directional (i.e. they do not contain information about which variable causes another), both variables are equal and the correlations are an indication but not proof of causalities. Another limitation of correlation analysis is that only direct (inter-)dependencies are determined, but not time-delayed correlations. This would be particularly relevant as some variables may adapt to others with some delay and not react in parallel or are even influenced by a same, third variable. This problem was tried to address with the correlation of the moving averages, showing a longer-term development (Illowsky; Dean, 2017)

Subsequently, to gain further insight on the relationship between the economic growth and the indicators, the correlation between three year-periods was used (figure 4). This approach delivered a 3-year moving correlation factor of the relationship between GDP and the relevant indicator, which displayed valuable information of short-term developments, for example, changes in correlation or inflection points from positive to negative correlation. (Zivot; Wang, 2006) The latter, an inflection point, could indicate the year in which economic growth stopped adding value to the dimension of society's wellbeing.

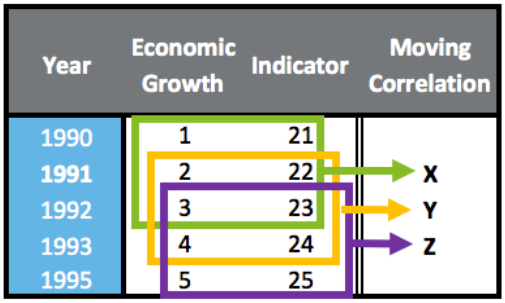

Figure 4: Methodology of Moving Correlations
Source: Own Illustration

3.2.3 Significance

Finally, significance was tested to determine the probability of a systematic relationship between the variables as it expresses whether a relationship between GDP and the indicator is purely coincidental or whether a causal relationship could exist. (Wewel, 2014)

The p-value, also referred to as the 'critical value', is the value that provides information about the significance and separates the acceptance area of a statistical test from its rejection area or critical area. The p-value value takes into account both the level of correlation and the size of the sample (figure 5). In our case, the sample is rather small, which is why the correlation must be larger to be significant. (Illowsky; Dean, 2017)

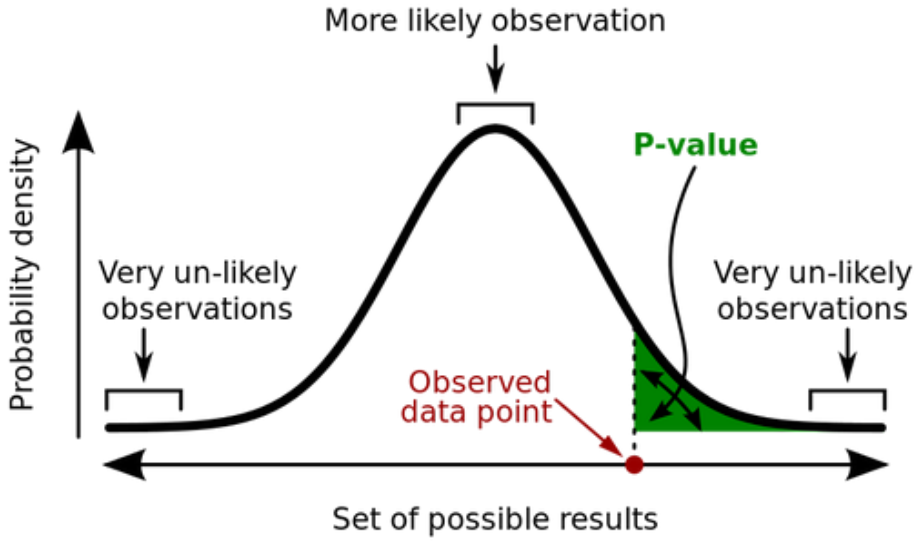

Figure 5: Methodology of Significance
Source: Liao, 2015

To determine whether the correlation between the variables is significant, the p-value is compared with the significance level. In this paper we adopt the common significance level α = 0.05. This means that the risk of concluding that there is a correlation between economic growth and an indicator, although there is no correlation, is 5 %. The p value indicates whether the correlation coefficient deviates significantly from 0. (Wewel, 2014)

The following rule-set was followed:

- **H0: p = 0 / H1: p ≠ 0**
- **p-value ≤ α:** The correlation is statistically significant. *If the p value is less than or equal to the significance level, it can be concluded that the correlation deviates from 0. Therefore, there is enough evidence to conclude that there is a significant linear relationship between economic growth and Y.*

- **p-value > α:** The correlation is not statistically significant. *If the p value is higher than the significance level, it can be concluded that the correlation does not deviate from 0. Therefore, there is not enough evidence to conclude that there is a significant linear relationship between economic growth and Y.*

(Illowsky; Dean, 2017)

In practice, the p-value was calculated using Excel's regression analysis, a function within the data analysis tools. The significance was determined for each correlation between economic growth and an indicator across raw, 3-year and 5-year moving average data-sets.

3.2.4 Visualisation

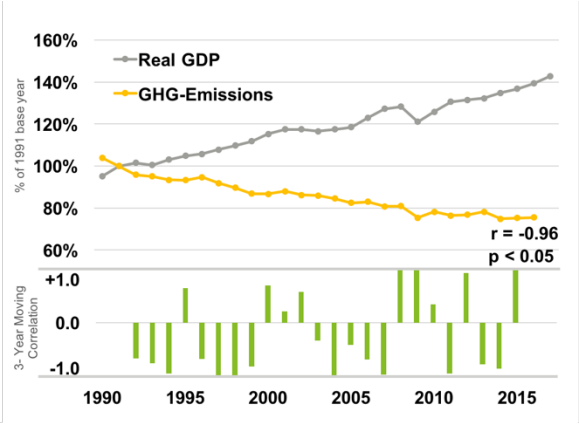

Figure 6: Example Result Chart
Source: Own Illustration

The results are visualised in three charts for the short-term trend (actuals), to the medium-term trend (3-year moving average) and the long-term trend (5 year moving average). The upper part of the charts describes the overall development of the data set, displaying the development of the grey real GDP and yellow Indicator from 1990 to 2017 (y-axis = years), using the base year 1991 for an easy visualisation (x-axis = percent of 1991 base year). On the right lower corner, the correlation coefficient of the entire time frame is stated (r=?) with its corresponding p-value (p=?).

The lower part of the combined charts displays bars of the moving correlation ranging from +1 to -1 (x-axis). The y-axis matches the above one ranging from 1990 to 2017, to guarantee the same year of moving correlation and as in the indicator development chart. In addition, each sector has a short overview at the beginning showing the development of the three corresponding indicators and the economic growth in percent of the base year 1991.

4 Results

4.1 General Observations

Prior to assessing the relationship between economic growth and the different indicators, we first assessed the GDP trend, the indicator of economic growth.

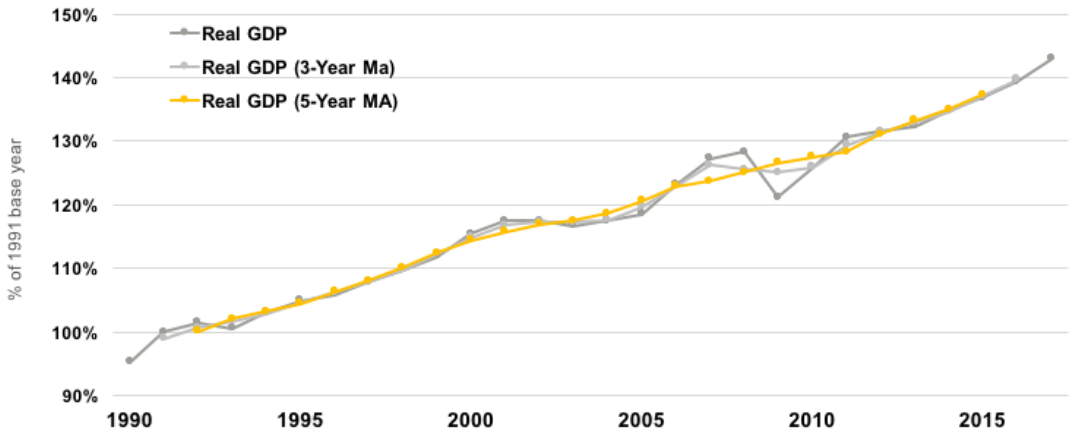

Figure 7: Real GDP Development from 1990 to 2017
Source: Own Illustration

Starting at the lowest point in 1990, the German economy produced 1.94 Billion € in goods and services. This number grew by 50.1%, or 1.5% annually to 2.9 Billion € by 2017 in constant 2010 €. Looking at the short-term data, the dominant growth trend is interrupted three times in 1993, 2001 and 2008. After further smoothening, the long-term trend of the economic growth shows a constant, yet attenuating increase.

Secondly, before reviewing individual relationships between indicators and GDP, we wanted to state two general observations on our results.

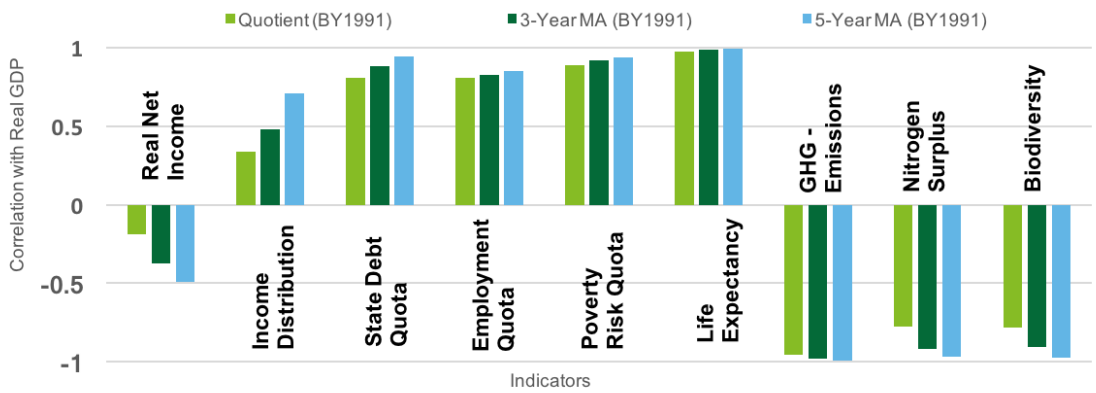

Figure 8: Correlation Development of all Indicators
Source: Own Illustration

The first general observation across all indicators was that when comparing the short-term, medium-term, and long-term correlations of indicators with GDP (figure 8), it can be seen that the correlation increases respectively. This implies that in the long-term the analysed indicators develop more similar/inverse to GDP. The reason for a greater correlation in the longer term could also be, as the growth of GDP may had delayed effects on the selected indicators, therefore requiring a longer-term adjusted trendline for trends to become prominent. For this analysis, the long-term data (5-year MA) was therefore the most relevant to draw conclusions from in a statistical perspective.

The second general observation was that in the analysed time frame most indicators have a strong positive or negative correlation (>0.6/<-0.6) with GDP (see figure 8), except for Real Net Income. In addition, Income Distribution is only strong correlated in the long-term. This could mean that most indicators had a strong relationship with the economic growth, partly concordant partly inverse with GDP.

4.2 Ecological Wellbeing

Ecological wellbeing of the German society was measured looking at GHG-emissions, nitrogen surplus and the biodiversity index. These were compared with GDP to determine if economic growth stopped adding value to the ecological wellbeing of the society. Whilst all ecological indicators declined, having had an inverse relationship to GDP growth, only one of the measures represented an unfavourable impact on Germany's ecological wellbeing.

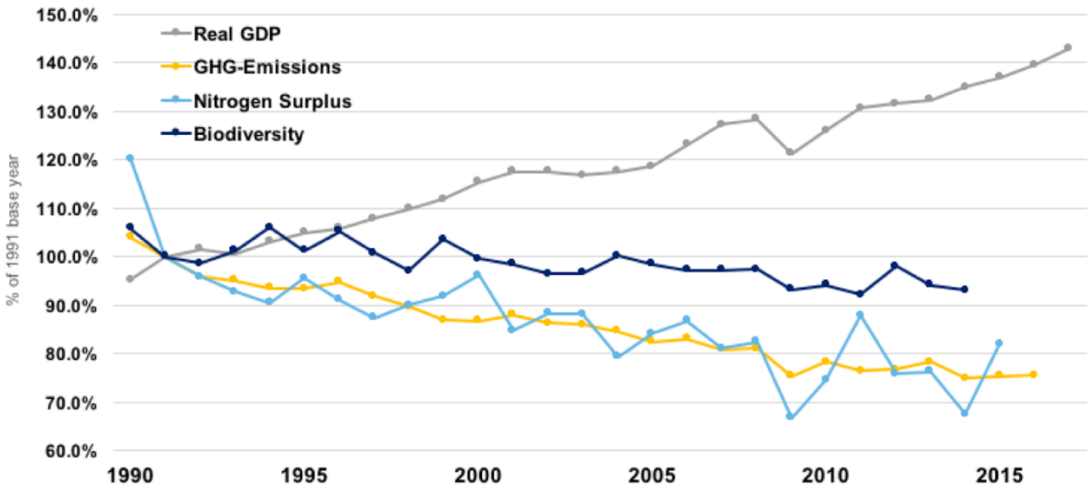

Figure 9: GDP & Ecological Indicators Development
Source: Own Illustration

GHG Emissions: From a growth perspective, the highest level of GHG emissions were observed in 1991, at 1,251 million tons of CO2 equivalent greenhouse gases. This number reduced at an annual rate of -1.2% resulting in 909 million tons CO2 equivalent in 2016, an overall reduction of 27.3%. In the long-term, GHG-Emissions and GDP have a noticeable inverse relationship, backed by the overall strong and significant negative correlation in the short (r=-0.96), medium (r=-0.97) and long-term trends (r=-0.99). In addition to the constant strong negative moving correlation in the long-term, this could imply that in the long-term greenhouse gas emission was reduce by economic growth.

Nitrogen Surplus: In 1990, an environment harming surplus of 149.7 kilograms of nitrogen per hectare arable land were emitted in Germany. This number annually decreased by -1.6% leading to 102.2 kg/ha in 2016, an overall reduction of 31.7%. In the long-term, the nitrogen surplus decreases as GDP increases. This inverse relationship is backed by a strong and significant negative correlation of -0.96 in the long-term. However, looking at shorter term views, the development of the nitrogen surplus seems to be more decoupled, backed by multiple moving correlation inflections. In the long-term, economic growth appears to have decreased harming to the environment in the form of nitrogen surplus, which based on the short-term trend is likely a coincidental correlation.

Biodiversity: In 1990, 76.5% of 1975's biodiversity was still living in Germany's nature. This number decreased by 12.2% leading to the lowest point of 67.2% of biodiversity in 2016, an annual reduction of -0.6%. In the long-term, the indicator decreased and developed inverse to the GDP increase, backed by a strong and significant negative correlation of -0.96. However, multiple inflections in moving correlation imply that the development of the ecological indicator was most-likely non-causal. Although it appeared that economic development might have a negative impact on the development of the diversity, based on the short-term trend this was likely a non-direct rather than a causal correlation.

The research of the relationships between GDP and GHG-emissions, nitrogen surplus and biodiversity, concluded in quite different results. Whereas there was likely a positive effect of economic growth on the nitrogen surplus and GHG-emissions, biodiversity worsened. Therefore, a clear point in which the economic growth stopped improving the society's ecological wellbeing is not clearly determinable.

4.2.1 GHG-Emissions

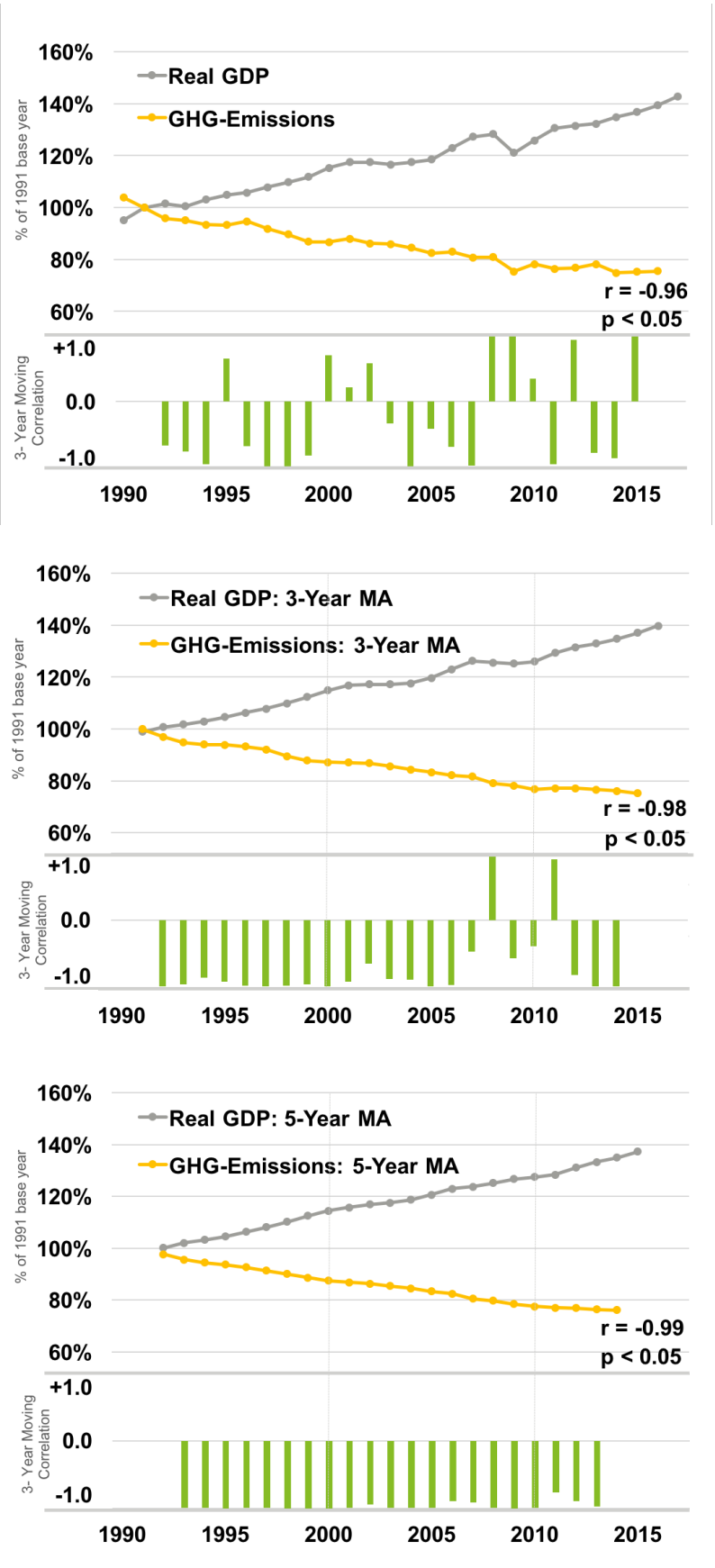

Figure 10: GHG-Emissions Analysis Results
Source: Own Illustration

The correlations between the GHG-Emissions and GDP development were overall significantly strong negative, ranging from -0.96 in the short-term, to -0.98 in medium-term, and -0.99 in the long-term trend. The short-term trend (top chart, figure 10), depicted GHG-Emissions developing predominantly inverse to GDP with many changes in moving correlation. In the medium-term trend (middle chart, figure 10) the moving correlation is negative, except for 2008 and 2011, where it changes to a strongly positive correlation. In the long-term trend (bottom chart, figure 10), a constant strongly negative moving correlation is observed, without any changes from inverse to concordant.

From a growth perspective, in 1990, the highest level of GHG emissions were emitted, being 1,251 million tons of CO2 equivalent greenhouse gases. This number reduced at an annual rate of -1.2% resulting in only 909 million tons CO2 equivalent in 2016, an overall reduction of 27.3%. The lowest observed point was in 2014 at 903 million tons CO2 equivalent per year.

The most prominent trend was the similar decrease in GDP and GHG emissions in 2009 as well as the overall significant strong negative correlation in the short, medium and long-term trends. This could indicate a causality between economic production and greenhouse gas emissions. In the long-term, GHG-Emissions and GDP have a noticeable inverse relationship, backed by the correlation of -0.99. This could imply that in the long-term greenhouse gas emission is reduced as the economy grows, therefore improving the ecological wellbeing of society.

Finally, to determine the point at which economic growth, measured by GDP, did not positively impact GHG-emissions (and therefore no longer added value to wellbeing), there was no sign of an inflection point, as changes from negative to positive were not long lasting.

4.2.2 Nitrogen Surplus

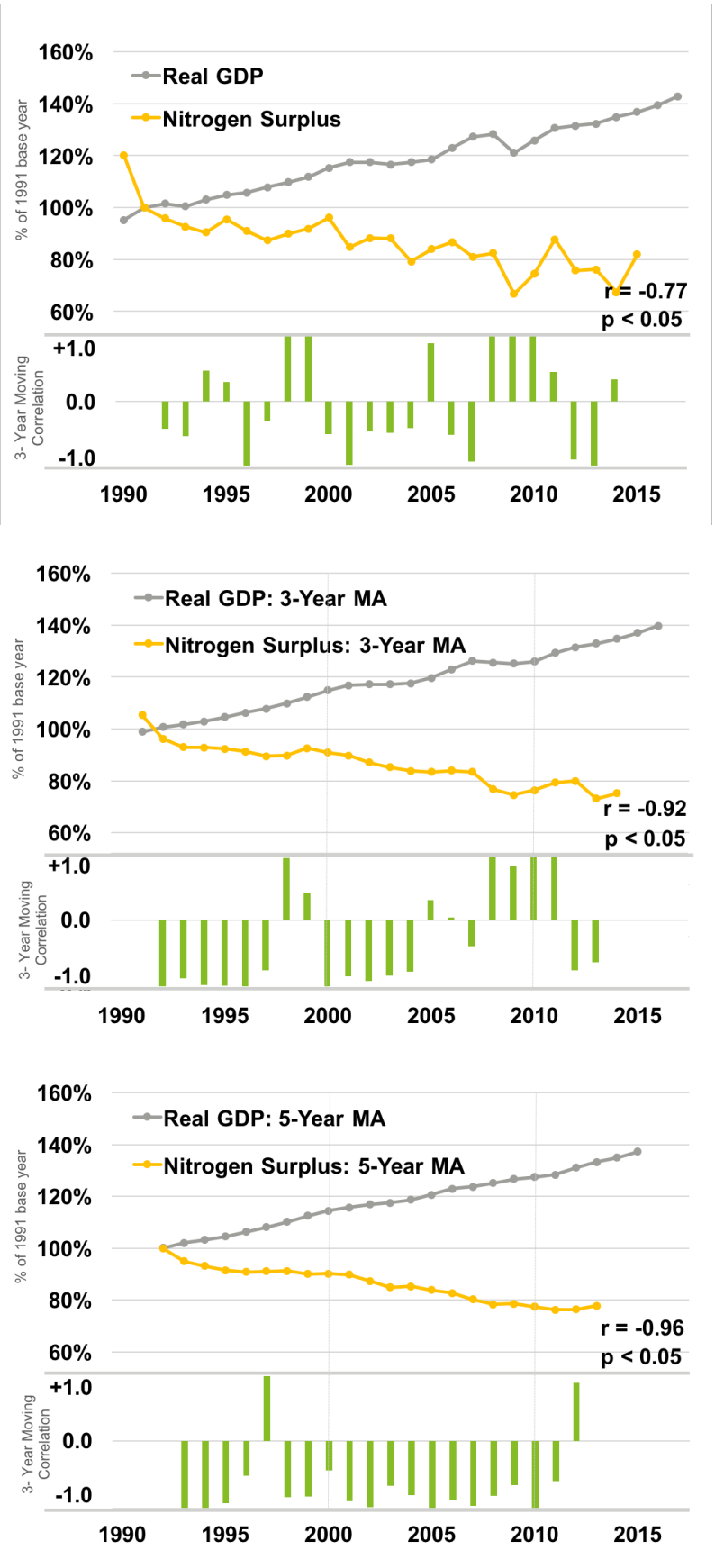

Figure 11: Nitrogen Surplus Analysis Results
Sources: Own Illustration

The correlations between the Nitrogen Surplus and GDP development were overall strongly negative, from -0.77 in the short-term trend (top chart, figure 11), to -0.92 in the medium-term trend (middle chart, figure 11) and -0.96 in the long-term trend (bottom chart, figure 11). In the short-term trend a high number of inflection points can be observed in the moving correlation. In 2008 to 2010 both lines shared a strong positive correlation, contrary to the overall correlation, as the ecological indicator decreased and increased in line with GDP. In the medium-term trend, the correlation is negative with two exceptions: from 1998-1999 and 2005-2011. In the long-term trend, the correlation (r=-0.96) demonstrated an overall negative relationship, with two inflections in 1997 and 2012.

From an absolute figure perspective, in 1990, the highest point in the data frame, an environment harming surplus of 149.7 kilograms of nitrogen per hectare arable land are emitted in Germany. This number annually decreased by -1.6% leading to 102.2 kg/ha in 2016, an overall reduction of 31.7%. The lowest point was in 2009 at 83.2 kilograms per hectare per year.

In the long-term trend, the nitrogen surplus decreased as GDP increased, backed by a strong negative correlation of -0.96. However, looking at the short-term trend, the development of the nitrogen surplus seems more decoupled, backed by multiple changes in the moving correlation. This could imply that the economic development had a positive impact on this ecological indicator, reducing the nitrogen surplus, however was more likely a non-causal relationship which should be explained by different means.

Finally, to determine the point at which economic growth, measured by GDP, did not positively impact nitrogen surplus anymore (and therefore no longer added value to well-being), no sustainable inflection point is observed in this direction. The Nitrogen Surplus and GDP had a mostly negative correlation, being an ecologically beneficial development for this indicator. An inflection point in the opposite direction (from negative to positive correlation) was observed in 1997 and 2012 in the long-term trend, however as the relationship was not long-lasting we will also dismiss this as a relevant finding in this report.

4.2.3 Biodiversity

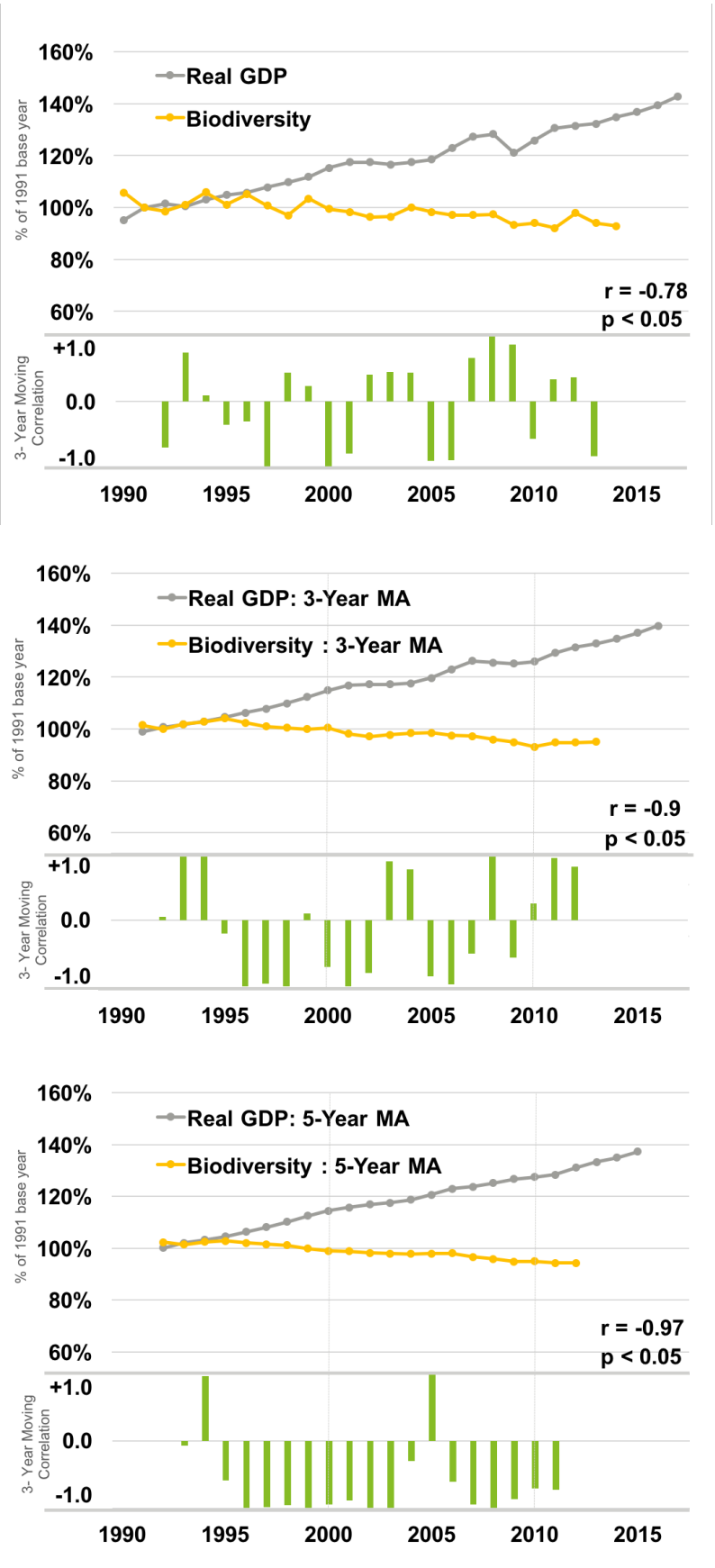

Figure 12: Biodiversity Analysis Results
Sources: Own Illustration

Overall, the correlation between GDP and the biodiversity index was significantly strong negative, showing a long-term inverse relationship. The short-term trend (top chart figure 12), showed a fluctuating biodiversity development with a high number of peaks and troughs, indicated by the multiple changes and low-correlation of moving correlation in several years. In the medium-term (middle chart, figure 12), the relationship between GDP and the index continued its fluctuating correlation, with 2-3-year periods of negative correlation followed by a short-term inflection of 1-2 years. In the long-term trend (bottom chart, figure 12), the negative correlation was (r=-0.97) – whilst moving correlation remained constantly negative with only two positive disruptions in 1994 and 2005.

From an absolute data perspective, in 1990, 76.6% of 1975's biodiversity was still living in Germany's nature. This number decreased by 12.2% leading to the lowest point of 67.2% of biodiversity in 2016, an annual reduction of -0.6%. The highest point was in 1994 at 76.6% of 1975's biodiversity.

In the long-term, the biodiversity in Germany decreased as GDP increased, backed by a significant strong negative correlation of -0.96. However, looking at the short-term trend, the development of the ecological indicator seemed to be decoupled, backed by multiple changes in the moving correlation. This could imply that economic growth had a negative impact on the development of the biodiversity, however was more likely a non-direct relationship which should be explained by different means.

Finally**,** to determine the point at which economic growth, measured by GDP, did not positively impact the biodiversity index anymore (and therefore no longer added value to ecological wellbeing), an inflection point can be observed in 1994 and 2005. However, these are not sustainable inflection points (i.e. the positive correlation is only 1 year). In addition, as the relationship between biodiversity and GDP is likely not causal we dismissed this finding in the report.

4.3 Social Wellbeing

This paper measured social wellbeing using employment and poverty risk quotas, as well as the life expectancy at birth. In the observed time frame, the conducted long-term trend analysis of the three measurements has shown that only one indicator worsened whilst two improved.

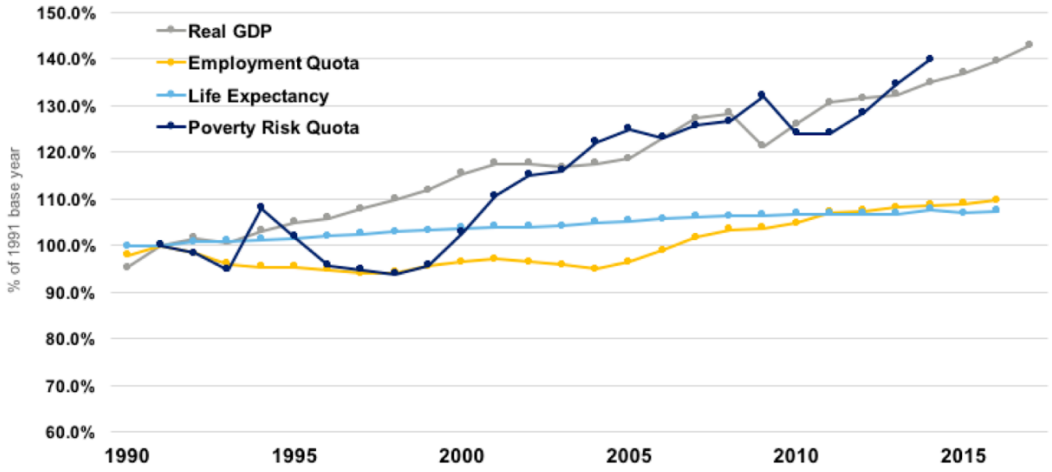

Figure 13: GDP & Social Indicators Development
Source: Own Illustration

Employment Quota: The employment quota increased by 12.2% or 0.4% annually over the observed timeframe. This means that at the beginning of the period, 66.3% of the population in Germany, aged between 15 and 65 were employed, increasing to 74.4% in 2016. In the long-term, GDP and employment quota have a significant strong positive correlation (r=0.85), this is backed from 1997 onwards by an almost constant positive moving correlation. In other words, when GDP, and therefore the economy grew, the share of employed people increased. This implies that economic growth could have had a positive effect on the employment quota after its inflection in 1996.

Poverty Risk Quota: Over the analysed period, the poverty risk quota decreased from 11.3% in 1991 to a 10.6% share of the population receiving an income below the poverty line in 1998, the lowest point in the data set, followed by an increase to 15.8% in 2014. This represents a total growth of 39.8% or an annual 1.7%. In the long-term, GDP and poverty risk quota have a significant strong positive correlation (r=0.94). Before 1997, the poverty quota developed inverse with GDP, with a strong negative moving correlation, meaning that after 1997, economic growth possibly stopped improving the poverty risk quota, and likely worsened it. 1997 is therefore found to be the inflection point.

Life Expectancy at Birth: This indicator had a constant growth of 0.3% annually, meaning that life expectancy at birth increased from the lowest point in 1990 at 75.3 years by 7.6% to 81 years in 2016. As the short-term trend did not share any peaks or troughs of GDP, seen at the constantly changing moving correlation, it is likely implied that there is no causality between the two indicators, rather being a coincidental correlation with both indicators having shared the same long-term growth trend. Despite the significant and strong positive long-term correlation of 0.99, no relevant conclusion can therefore be stated.

Overall, the analysed relationships between the GDP and social indicators varies. Whereas there was likely a positive and neutral effect of economic growth on the employment quota and life expectancy at birth, the poverty risk quota worsened. A clear point in which the economic growth stopped improving the society's social wellbeing was not clearly determinable, as employment quota and poverty risk quota both show inflection points between 1996/1997 changing from likely positive impact of growth to negative and vice versa.

4.3.1 Employment Quota

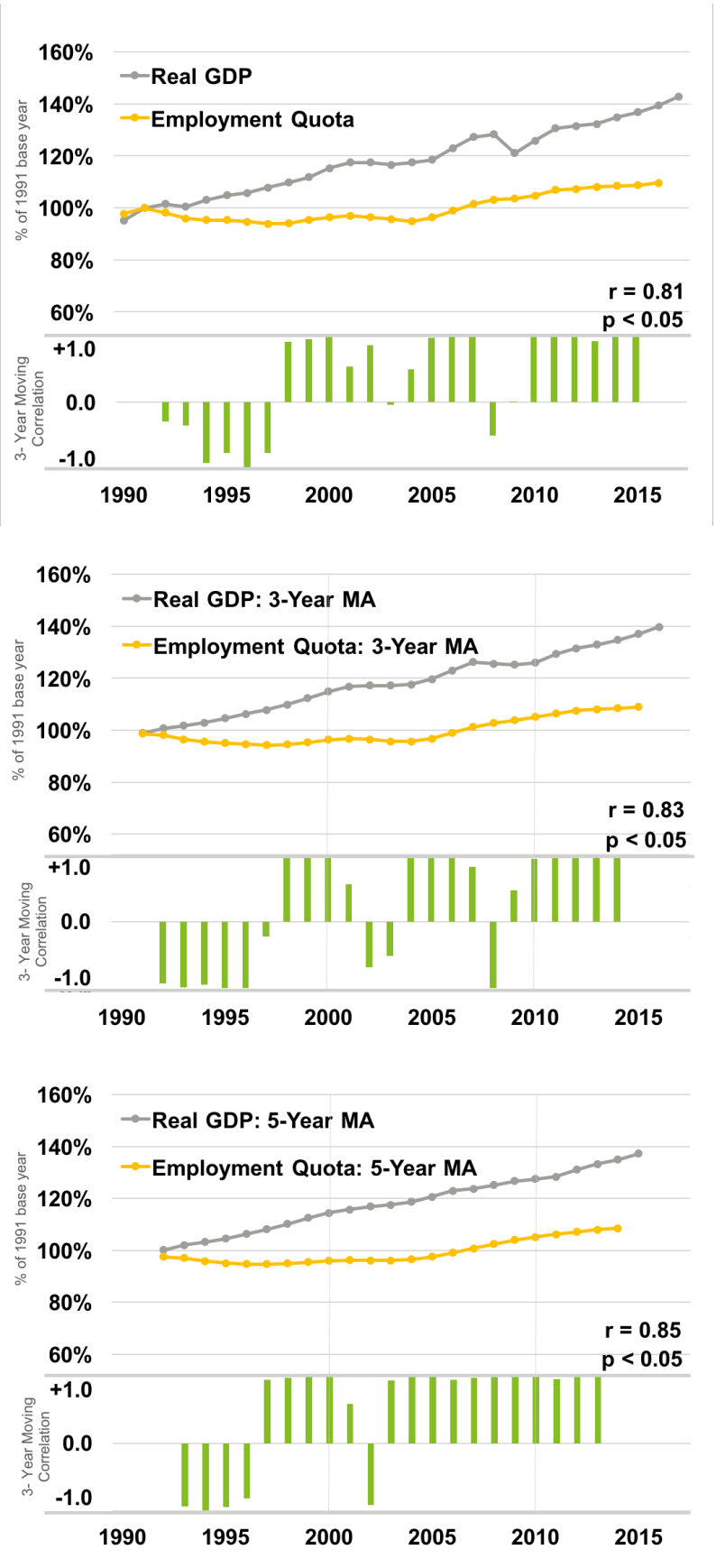

Figure 14: Employment Quota Analysis Results
Source: Own Illustration

The growth trend of the employment quota with GDP in the short (top chart figure 14**,** r=0.81), medium (middle chart figure 14, r=0.83) and long-term (bottom chart figure 14**,** r=0.85) was supported by significant strong correlations across all periods, particularly after 1997. Before that year, the employment quota developed inverse to GDP, backed by a strong negative moving correlation in the long-term. The only exception in the period after 1997 is in 2008, where GDP dipped while the employment quota remained relatively steady**.**

From a growth perspective in the analysed period, the employment quota increased by 12.2% or 0.4% annually. This means that at the beginning of the period, 66.3% of the population in Germany, aged between 15 and 65 were employed, increasing to 74.4% in 2016.

In the long-term trend, GDP and employment quota had a strong positive correlation (r=0.85). In other words, when GDP, and therefore the economy grew, the share of employed people aged between 15 and 65 increased. This could imply that economic growth had a positive effect on the employment quota after the inflection point in 1997, increasing the social wellbeing of society.

Finally**,** to determine the point at which economic growth, measured by GDP, did not positively impact the employment quota anymore (and therefore no longer added value to wellbeing), was not possible as we could not observe a persistent inflection point in this direction for the given period. We can, however, determine the opposite; the inflection point observed from strong negative correlation in 1996 (r=-0.82) to strong positive correlation in 1997 (r=0.95), which might represent the point at which economic growth, measured by GDP, started to positively impact the employment quota and increase the social wellbeing of the German society.

4.3.2 Poverty Risk Quota

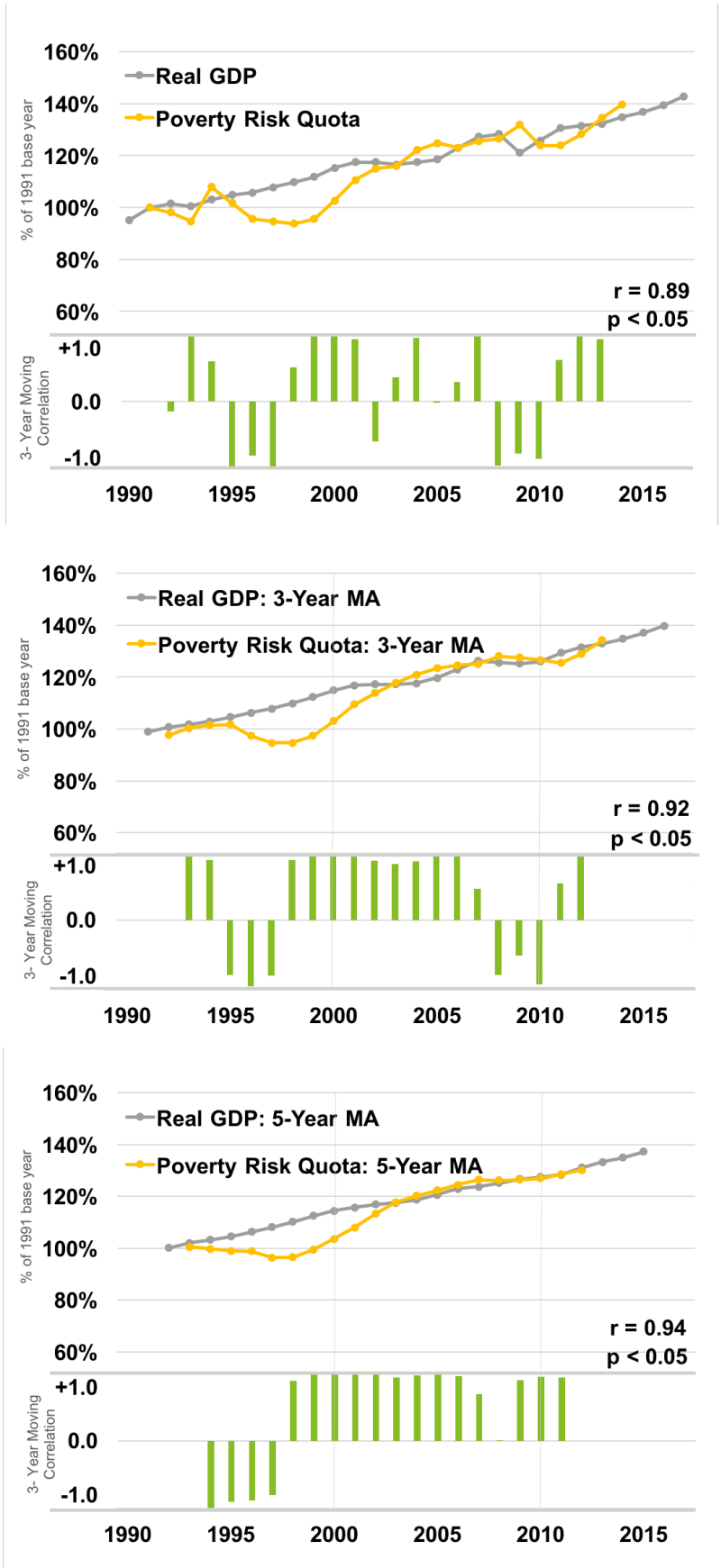

Figure 15: Poverty Risk Quota Analysis Results
Source: Own Illustration

The overall poverty risk quota and GDP correlation was significantly strong positive, ranging from 0.89 in short-term trend (top chart, figure 15) to 0.94 in the long-term trend (bottom chart, figure 15). In the long-term trend, the development of the indicator was inverse to GDP up to 1997, at which point it inflects from a strong negative to strong positive moving correlation. After this inflection, the poverty risk quota strongly correlated with GDP until 2007, after which, in the medium-term trend, it inversely developed with GDP for 3-years, followed by an inflection back to positive correlation.

From a growth perspective over the analysed period, in 1991, 11.3% of the population in Germany had an income below the poverty line, which declined to 10.6%, the lowest point in the data set in 1998, followed by an increase to 15.8% in 2014. This represents a growth of 39.8% or an annual 1.7% compound growth.

In the long-term trend, GDP and poverty risk quota have an inverse relationship up to 1997, meaning that the share of people having an income below the poverty line decreases while GDP increases. After the lowest point in 1998, the poverty risk quota develops in line with GDP, with a strong positive moving correlation, meaning that after 1997, economic growth could have stopped having a positive social wellbeing impact with an increasing share of the population receiving an income below the poverty line.

The point at which economic growth therefore stopped adding value to the poverty risk quota was observed in 1997; the point where we move from strongly negative moving correlation in 1997 (r=-0.80) to positive correlation in 1998 (r=0.90). Excluding a weak correlation of 0.004 correlation in 2008, which is not truly an inflection, this is the only change point to be considered and cloud therefore mean that after 1997 economic growth did not improve the wellbeing of the society anymore

4.3.3 Life Expectancy at Birth

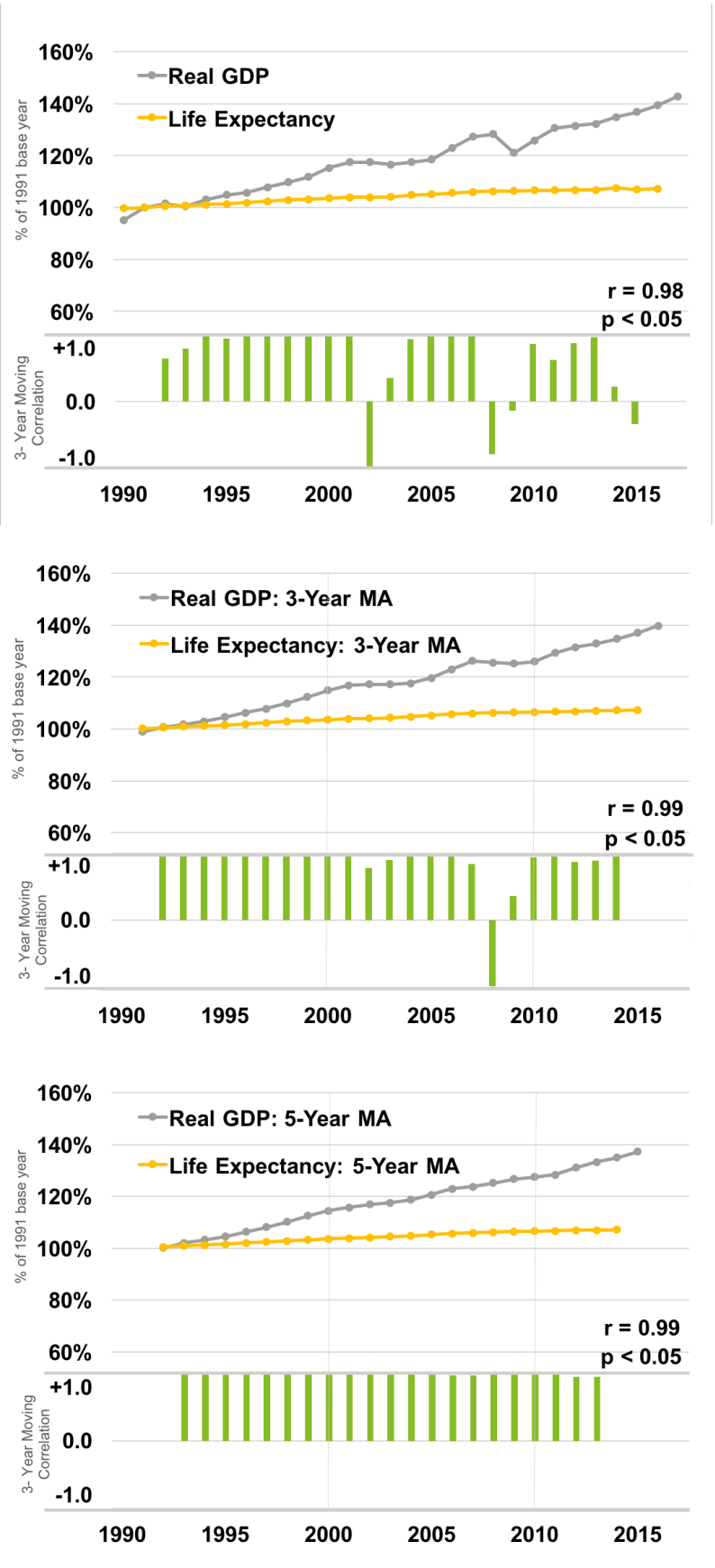

Figure 16: Life Expectancy at Birth Analysis Results
Source: Own Illustration

Life expectancy at birth strong positive correlated significantly with GDP development in the short (top chart, figure 16, r=0.98), medium (middle chart, figure 16, r=99) and long-term trend (bottom chart, figure 16, r=0.99). In the short-term, the moving correlation was strongly positive from 1991 to 2002. At that point GDP declined without affecting the growth of the life expectancy. After the trough, in 2004, the strong positive moving correlation returned, showing positive growth of both lines. At the next decrease of GDP in 2008, correlation was negative again, resuming once GDP growth resumes. In the medium-term trend, the only observed inflection point was in 2008, with all other peaks and troughs smoothened. In the long-term trend, GDP was further smoothened resulting in a constant positive moving correlation and strong significant positive moving correlation over the entire period.

From a growth perspective, life expectancy at birth increased from the lowest point in 1990 at 75.3 years to 81 in 2016. This represents a total growth of 7.6% or 0.3% annually. Over the entire period a steady growth rate was observed with the only exception of 2015, in which life expectancy decreased by 0.006% compared to the year before.

Interpreting the data, especially the fact that life expectancy at birth showed a very constant increase and did not share the ups and downs of the GDP development, could imply that there was no causality between the development of GDP and the life expectancy. Instead, coincidental correlation of growth was likely present.

In addition to the abundance of an inflection point, based on the above conclusion, it would be flawed to determine the point at which economic growth, measured by GDP, did not positively impact the life expectancy at birth anymore (and therefore no longer added value to wellbeing).

4.4 Economic Wellbeing

In this paper, the economic wellbeing of society was measured by real net income, income distribution, and the state debt quota. The analysis found that despite an economic growth of 50.1% (GDP increase between 1990-2016), most other economic indicators have not improved in the same extent, possibly linked to the increase of GDP.

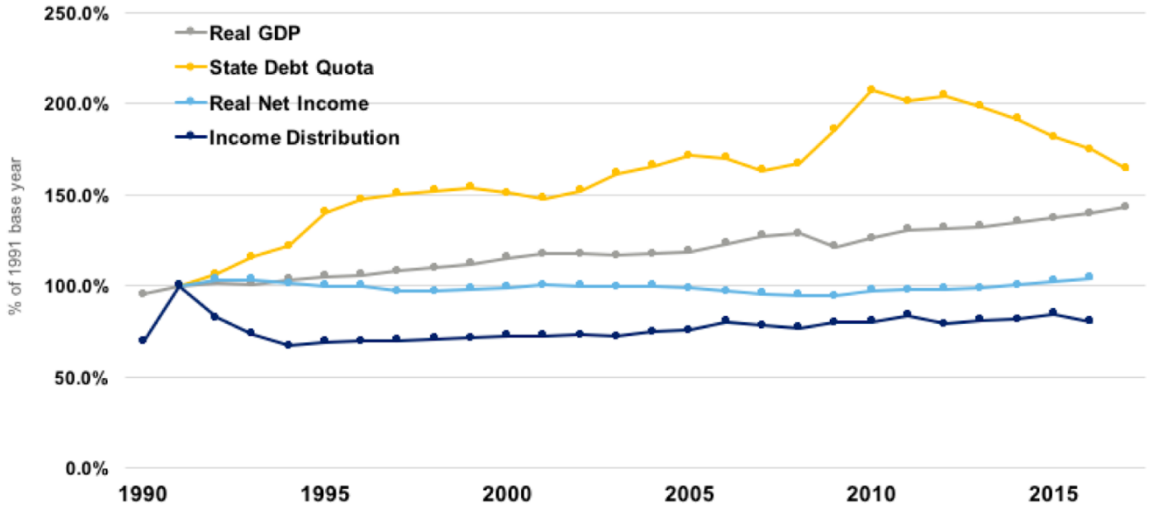

Figure 17: GDP & Economic Indicators Development
Source: Own Illustration

State Debt Quota: The indicator has increased by 63.9% in the time frame, meaning that in 1991 the German state debt represented 39.1% of GDP, increasing to 64.1% in 2016. We observed a strong positive moving correlation in the long-term between GDP and the State Debt Quota up to 2011. In addition to the significant strong positive correlation (0.94) of the long-term trend we found that economic growth could have negatively impacted the state debt quota, minimum until 2011.

Real Net Income: This economic indicator remained relatively stagnant from the beginning to the end of the time frame, meaning that the average employee earned almost the same in 2016 (20,637 €/ +826 €), as in 1991 (19,811 €). The long-term correlation between the real net income and GDP is significant weak negative at -0.49. In addition to a five year recurring pattern - switching from a strong positive moving correlation to strong negative one, it is likely that economic growth not only had no improving effect on the real net income, but possibly decreased the average employees salary at the beginning of each growth phase.

Income Distribution: This inequality indicator grew from 1990 to 2016 by 15.7%, or a 0.6% annually. In other words, in 1990 the 90th percentile had a 2.88 times higher income than the lower 10th percentile and until 2016 this number increased to 3.33 times.

The Indicator declined from 1991 to its lowest point in 1994, showing no relationship with GDP. After 1994 however, GDP and the indicator had a strong positive moving correlation, which could imply that economic growth had no improving affect, but possibly worsened the income inequality over time, backed by a significant positive long-term correlation of 0.71.

Overall, the conducted correlation and trend analysis between GDP and real net income, income distribution, state debt quota could imply that up to 1994, the economic growth had a neutral or slightly positive impact on the economic indicators. Within the inflection points in 1994 until 2011 however, economic growth possibly did not improve the society's economic wellbeing, or in the case of income distribution and state debt quota, likely worsened it.

4.4.1 State Debt Quota

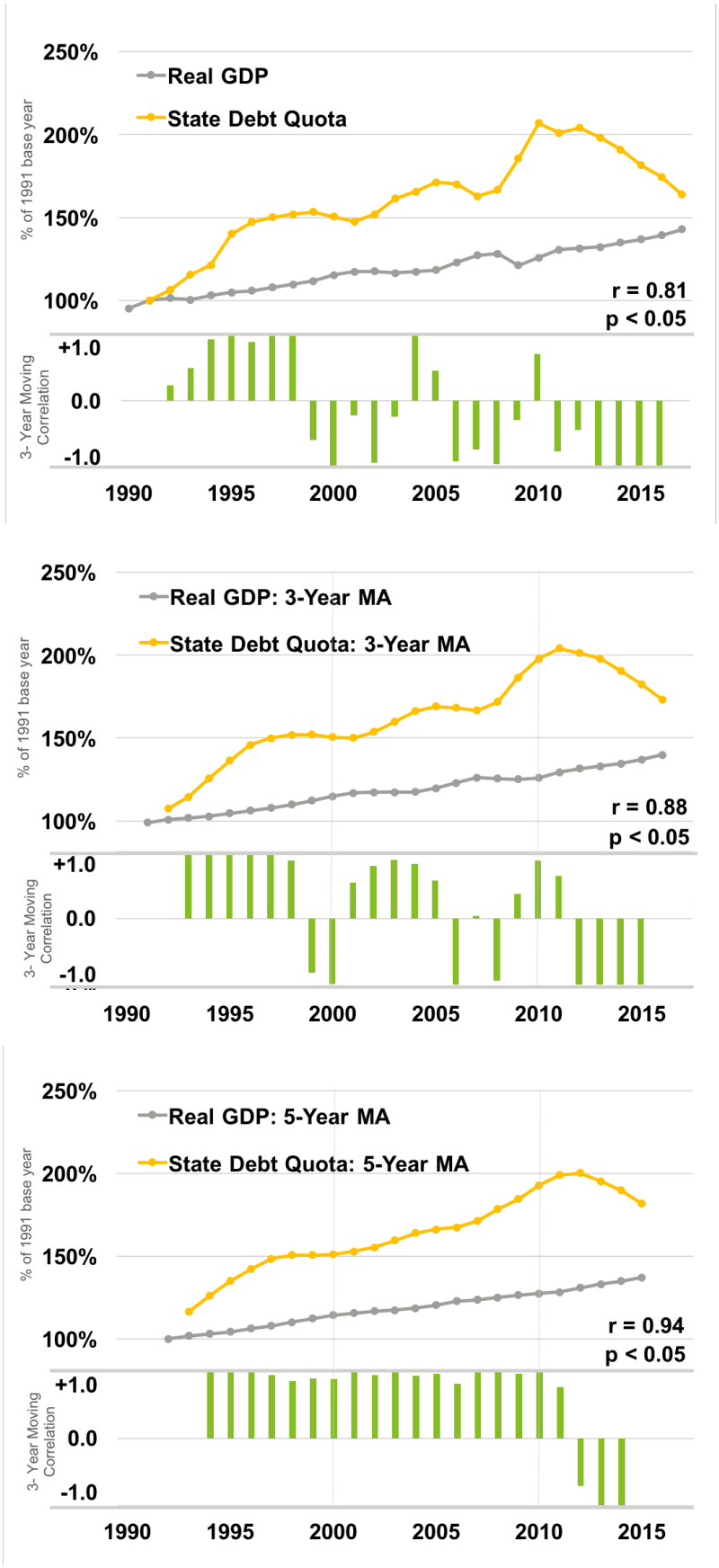

Figure 18: State Debt Quota Analysis Results
Source: Own Illustration

In the short-term trend (top chart, figure 18), the state debt quota and GDP showed a positive moving correlation up to 1998. After this period, the peaks of GDP seem to have matched the troughs of the state debt quota, and vice versa, as seen by the moving correlation. Nevertheless, the overall correlation is significant strong positive at 0.81. In the medium-term trend (middle chart, figure 18), the peaks and troughs were smoothened, thereby showing now a clearer encounter of the peaks of GDP and troughs of state debt quota in 2001 and 2007. This further increased the correlation to a significant strong positive 0.88. The long-term trend (bottom chart, figure 18), further smoothened the lines, hiding the peaks and troughs, and instead depicts a general positive moving correlation up to 2011. This resulted in a significant stronger positive correlation of 0.94.

In growth terms across the analysed period, the state debt quota grew by 63.9%, or 1.9% annually. This represented an increase of State Debt from 39.1% of GDP in 1990 to 64.1% in 2017. The lowest debt quota was at the beginning of the time frame in 1990, whereas the highest quota was observed in 2010 at 80.9% of German GDP.

Interpreting this trend, the long-term increasing development of the state debt quota and GDP, in addition to the strong positive correlation could ultimately mean that the economic growth came along with an overall increase in state debt (upto 2011). This can be partially explained by the fact that in the shorter-term trend line the post-peak level of state debt (e.g. 2008) never decreases fully to the level prior to the peak (e.g. 2004 levels for the 2008 pot-peak level). Furthermore, as the state debt quota is measures in % of the GDP and the debt increased together with economic growth, the nominal expansion of debt is even bigger.

Finally, a point at which economic growth, measured by GDP, stopped positively impacting state debt was not observed in the given period. We can, however, determine the opposite; the inflection point observed from strong positive moving correlation in 2011 (r=0.78) to strong negative one in 2012 (r=-0.70), which represents the point in which state debt started to decrease while the economy rose. Nevertheless, this should not overshadow the fact that, in the long-term, economic growth had a negative impact on state debt.

4.4.2 Real Net Income

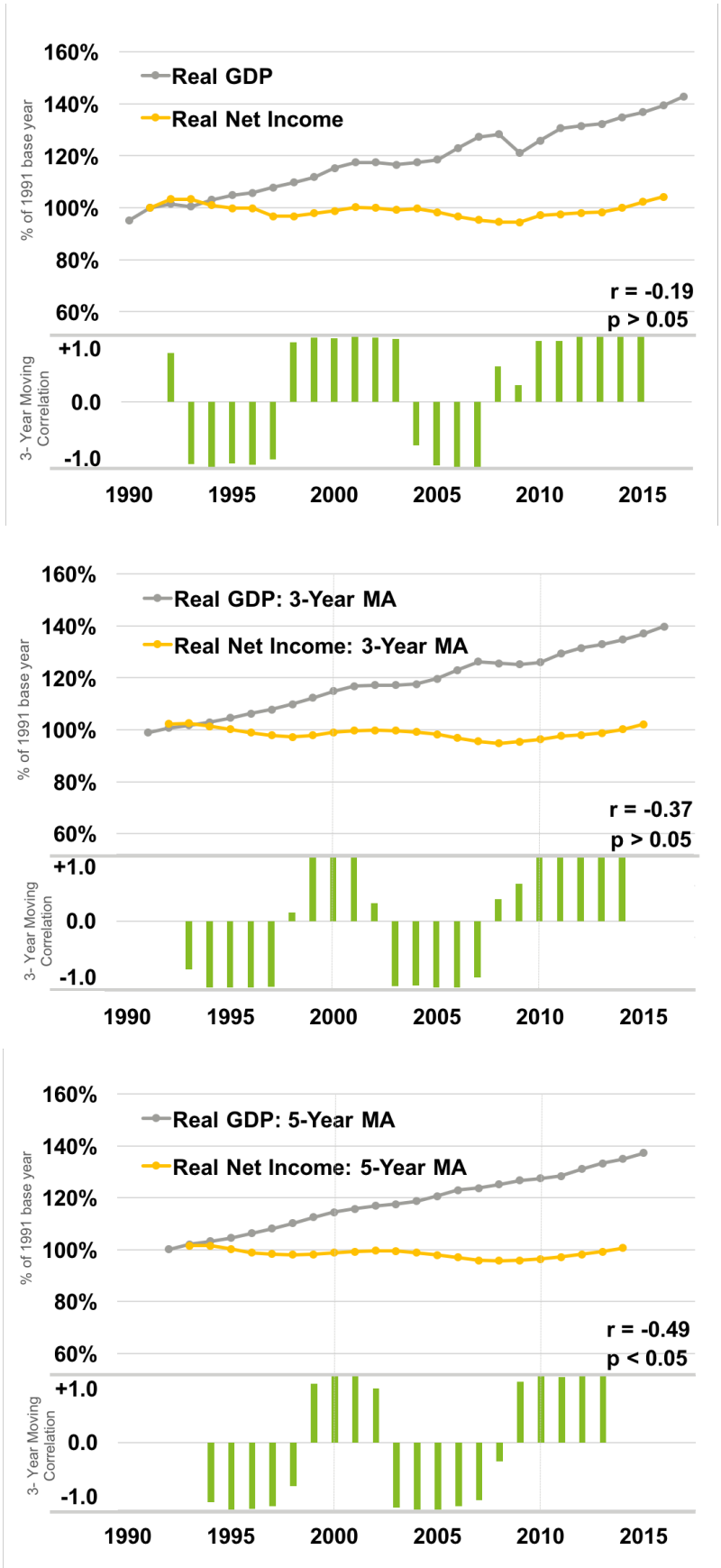

Figure 19: Real Net Income Analysis Results
Source: Own Illustration

When analysing the long-term moving correlations of the real net income and GDP in figure 19, a 5-year recurring pattern is observed; switching from a strong positive moving correlation to strong negative moving correlation approximately every 5 years. This movement resulted in an overall negative insignificant correlation of -0.19 in the short-term (top chart, figure 19); representing a mean of the inverse trend periods. However, in the medium-term (middle chart, figure 19) the correlation decreased to weakly negative -0.37, and further up to significant -0.49 in the long-term (bottom chart, figure 19). In addition, it can be observed that real net income never majorly surpassed its level from 1991.

From a growth perspective, at the beginning of the period, in 1991, an average employee earned 19,811€ in constant 2010 €. This income increased by 4.2% in total, or 0.2% annually, representing an average salary of 20,637€ in 2016 (+826 €). The last year represented also the highest income, whereas the lowest income of an average employee was in 2009 at 18,704€. In the same period, GDP increased by 39.4% in total.

Interpreting these results, two implications stand out. Firstly, the net income did almost not increase in 25 years (+4.2%) whereas GDP grew by 39.4% in the same period. In addition to the significant long-term correlation of -0.49, which could mean that as GDP grew, the average employee did not “really” benefit from economic improvements and phases of growth. Furthermore, the moving correlation of the recurring pattern could indicate that the first 5 years of a growth phase decreased the average income of employees, meaning they have not only not gained from economic growth but possibly “paid” for each increasing phase.

Finally, to determine the point at which economic growth, measured by GDP, stopped to positively impact real net income (and therefore no longer added value to wellbeing), we observed three years in which an inflection point (from positive to negative moving correlation) in the long-term is shown: 1998, 2002 and 2008. As no change was long-lasting, but part of a pattern, a clear moment in which economic growth stopped adding value is not visible.

4.4.3 Income Distribution P90/P10

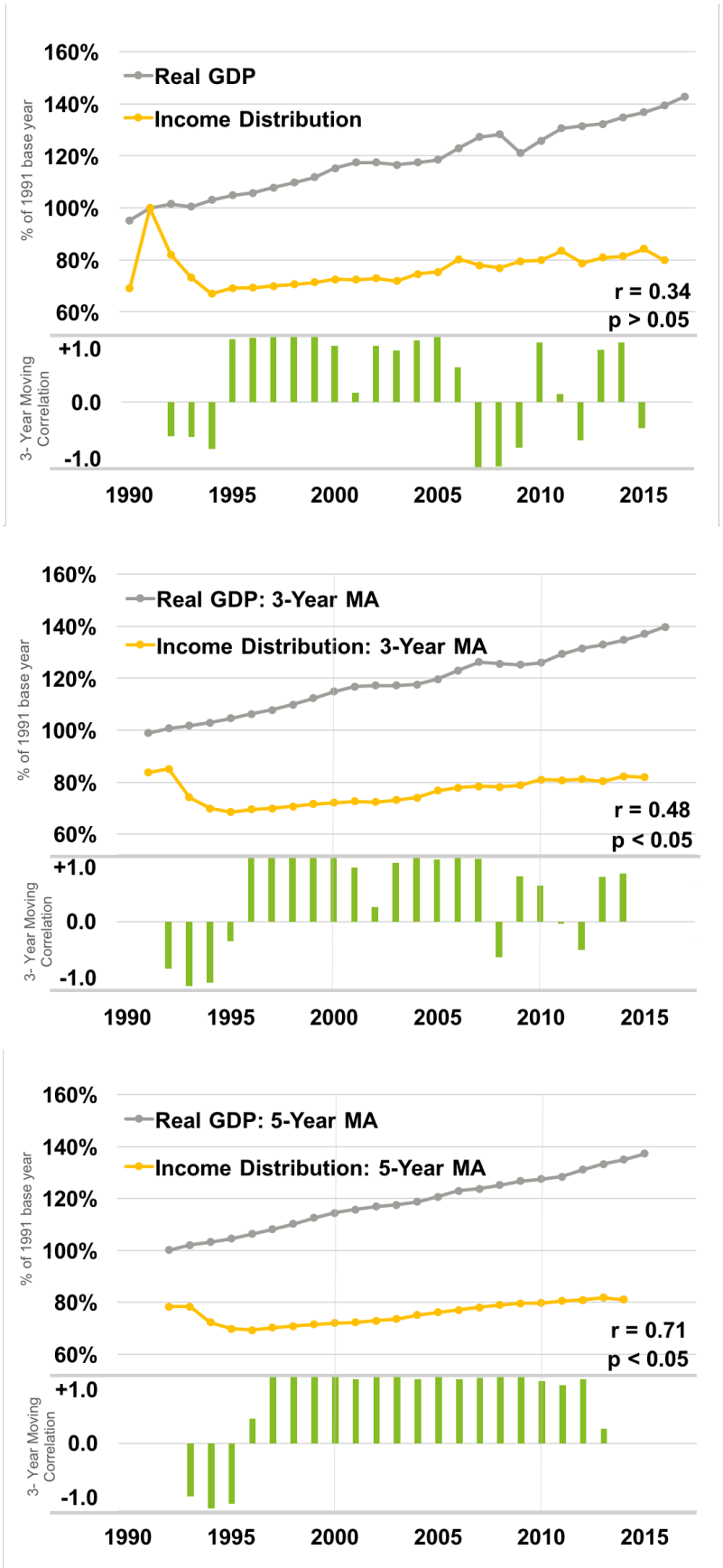

Figure 20: Income Distribution P90/P10 Analysis Results
Source: Own Illustration

In the short-term, GDP and income distribution showed a weak insignificant positive correlation (top chart, figure 20), whilst income distribution had an alone standing peak in 1991 followed by a three-year decrease. In the medium-term trend (middle chart, figure 20), the peak of the income distribution line smoothened and the correlation increased to significant weak positive 0.48. In the long-term trend (bottom chart, figure 20), the peak is further weakened whereas the recovery to the lowest point in 1994 remains. From that point onwards, the development of both, GDP and income distribution, showed a high similarity also displayed in the constantly positive moving correlation, as well as the significant strong positive correlation of 0.71 in the long-term.

In growth terms, the income distribution grew from 1990 to 2016 by 15.7%, or a 0.6% annually. In other words, in 1990 the 90^{th} percentile had a 2.88 times higher income than the lower 10^{th} percentile and until 2016 this number increased to 3.33 times.
The growth of this ratio represents a growing disparity between the high income 90^{th} percentile, and the lower income the 10^{th} percentile. This happened at the same time while GDP grew by 46.4%, which could mean that the high-income earner of the society gained more from economic growth, disproportionately to low income earners, having led to an increase in inequality.

Finally, to determine the point at which economic growth, measured by GDP, did not positively impact real net income anymore (and therefore no longer added value to well-being) we only observe one inflection point from strong negative moving correlation in 1995 (r=-0.89) to strong positive moving correlation in 1997 (r=0.99). This is the only persistent change and could therefore represent the moment economic growth became detrimental to income distribution.

5 Discussion

It is clear that the definition of wellbeing within society has changed over time. Since the beginning of industrialisation 150 years ago, the desire for improved material living conditions has been the primary focus; aiming to satisfy basic human needs such as sufficient food, housing and health. Since the turn of the 20th century, besides a continued focus on material prosperity, aspects of immaterial wellbeing such the improvement of social and ecological conditions have also been considered, however remain overshadowed by economic growth.

Bringing social, ecological and wider economic measures of growth to the forefront has two challenges. Firstly, the question as to which aspects of our wellbeing to include to ensure a collectively exhaustive view of society can be sketched. A fixed list of measures is hard to lock down due to changing political world views and changing subjective understanding of wellbeing. The 9 analysed indicators in this paper therefore represent a sub-set for consideration in an attempt to conclusively determine wealth and quality of life. The second challenge is agreeing on a coherent way to measure each indicator, keeping the measurements mutually exclusive. Data is not always widely available, often involves judgements, and tends to overlap across measures. Furthermore, data may not be comparable over time, especially if the set of indicators or definition is changed over time and indicators are being published by different institutions.

Putting these challenges aside, using the 9 indicators and respective measurements, this paper ambitiously aimed to determine whether economic growth, represented by real GDP, stopped improving our society and wellbeing, and if so, at which point in time economic growth stopped adding value. Although we found clear inflection points, at which some indicators and GDP inversed their trend, determining a clear moment (or number of points) has proven difficult due to the complex nature of macroeconomic trends.

Many events in the past 27 years led to outlying data points, which could not be excluded for obvious reasons, however challenged the identification of overarching trends and inflection points. Examples of such events include: the reunification of Germany in 1990, the dotcom (2001), financial (2008), and euro (2010) crises as well as several government and policy changes such as the European Central Bank's zero-interest rate and quantitative easing policies.

Nevertheless, the analysis of the 9 indicators gained valuable insight in the development of Germany's society in ecological, social, and economic dimensions challenging economic growth and the impacts it has on society.

Ecologically, the wellbeing of the society is developing mixed. The GHG-emissions, nitrogen surplus and biodiversity decrease, show a strong inverse relationship to economic growth. While this is positive for the first two indicators, it is not for the diversity in the nature which decreases constantly, agreeing with the research of Miegel (2010) and Meadows et al. (2004). The biodiversity mostly decreases, due to change in land use and natural habitats (e.g. traffic, straightening of rivers); climate change, resulting from the release of greenhouse gases (e.g. fossil fuels, industrial production and intensified agriculture); nutrient and pollutant contamination of terrestrial and aquatic ecosystems by agriculture; and overexploitation of natural resources. (Federal Environment Agency, 2018c). Therefore, only a partial influence between biodiversity and economic growth could exist.
The GHG-emissions and the nitrogen surplus on the other side are mainly caused by industrial activities, wherefore the economic growth should have an increasing effect on those indicators. Nevertheless, it turns out this is not the case, as environmental regulations are getting stricter, decreasing emissions (Federal Environment Agency, 2018a+c). As a result, those indicators may not have improved because of economic growth, but because of regulations and new technologies put in place to reduce environmental pollution. The greater the economic growth however, the more money can be invested in improving our society's ecological wellbeing, as stated by Baumol et al. (2007).

Socially, the wellbeing of the society is showing overall strong and significant relationships to economic growth, yet developing mixed too. While the economy grows, so does the share of employed people, but in the same time the poverty risk quota too (the share of the population who has an income below the poverty line). This means that more people have a job, yet a rising number of incomes are below the poverty line due to an increasing number of low salaries, lacking to secure a life out of poverty – showing similar results as Randers & Maxton's research in 2016. Resulting in economic growth likely worsening and improving parts of social wellbeing at the same time.
Regarding the life expectancy at birth, although there is a strong positive correlation, this research challenges an obvious relationship between the economic growth and the indicator, as many factors such as healthcare, medical innovation, and others were not considered (Kowitz, 2012). Yet, one could question whether economic degrowth would have had a negative effect on the life expectancy, meaning an indirect link could exist.

Economically, we found that the overall wellbeing of the society does not improve; it worsened since 1994 (until minimum 2011) – likely linked through a significant relationship to economic growth in the long-term. The rich are getting richer, as also seen in Hirsch (1977) and Meadows et al. (2004), and gaining disproportionately from the economic growth - increasing the inequality in Germany (income distribution P90/P10). Furthermore, the purchasing power has stagnated with the real net income remaining near the 1990's level, showing similar results as Randers & Maxton's research (2016). Finally, state debt rocketed to new heights up to 2010, only sustainable by the low interest rates of the European central bank's policies (Ettel; Zschäpitz, 2017). All measures therefore show that the economic growth is not economically improving everyone's life.

On the one side, inequality or, in capitalistic term, (1) accumulation, was observed in the form of increasing income distribution disparity; and (2) thrive for profits, seen in the increasing poverty risk and stagnating real net income: representing two essential columns of our economic (capitalistic) system. According to Karl Marx, accumulation has two sides: on the one hand more and more capital in the hands of the capitalists, on the other hand more and more misery of the workers. But this could precisely be what keeps capitalism going, according to Marx, as it forces the wage workers to sell their labour to the capitalists (possibly seen in the increasing employment quota), while corporations (capitalists) have to operate and make decisions more efficiently (possibly seen in the stagnating real net income) (BpB, 2018). Overall this results in the economy, especially corporations, to thrive while individual's wellbeing is stagnating or worsening (at least in relative economic terms).
On the other side, the increase in debt of state, as well as in businesses and households (Cünnen et al., 2018), implies that the economic development is strongly based and depended on monetary and debt expansion. In addition to the stagnating income and increasing poverty risk as a form of cost saving, this could indicate that organic ("natural") economic growth is difficult to maintain and that artificial market stimulation at the expense and risk of society is needed, backed by Jackson's research in 2009.

Now, if we were to aim for a sustainable and equal wellbeing for every member and dimension of the society instead, the resulting question seems to be: can we achieve that in a capitalistic system? The state or stronger unions, representing the interests of individuals against more powerful companies/capitalists, seems to be an appropriate counterbalance, creating a mutually-beneficial from economic growth.

How? Well, the state and unions advocate for: (1) more equal income distribution, decreasing salaries of the rich (e.g. income tax); (2) higher wages (e.g. setting a minimum

wage); (3) paying back the state debt (e.g. corporate taxes/ lower spending); and (4) as well as further tightening of environmental requirements (e.g. CO2 pollution taxes/limits)

Now if we hypothetically reached full equality and sustainability due to these counter-measures, would our societal and economic system still work or would it require our entire economic paradigm to shift to sustain equality for every member of the society? Currently, there is no dominant, binding macroeconomic concept that comprehensively reflects the functioning and social implications of a non-growing economy. The different approaches ranging from minimum, to no and de-growth are yet to deliver an all-embracing econometric model that addresses the negative effects of economic growth of the ecological, social and economic wellbeing of a society and is able to achieve a sustainable economic stability without consumption growth.

In the end, this research has shown that over the last 27 years of economic growth, certain indicators improved wellbeing while other worsened it, giving a mixed answer to our hypotheses. This could mean that economic growth itself is not negative, but in need for continuous changing in regulations and policies, to assure that every part of the social, ecological and economic wellbeing improves. However, the question arises if the elimination of all negative-effects is even possible in our current economic and social system, or whether a departure from growth towards a sustainable life model is needed. Nevertheless, the interim results clustered by hypothesis are:

1. **Economic growth does not improve the society's ecological wellbeing:** the research of the relationships between the real GDP and GHG-emissions, nitrogen surplus and biodiversity, concluded in overall strong significant negative correlations. As only biodiversity did possibly not improve due to economic growth, this hypothesis was rejected using data from the research and requires further analysis.
2. **Economic growth does not improve the society's social wellbeing**: the analysed relationships with social indicators showed overall strong significant positive correlations. Whereas this means a likely positive or neutral effect of economic growth on the employment quota and life expectancy at birth, only the poverty risk quota worsened - leading to the rejection of this hypothesis.
3. **Economic growth does not improve the society's economic wellbeing:** the conducted analysis between GDP and the economic indicators suggests that after 1994 (until minimum 2011) economic growth does likely not improve the overall economic wellbeing of the German society. The real net income stagnates - backed by a weak significant negative correlation – whilst income distribution and state debt quota, possibly worsens trough economic growth - backed by strong significant positive correlations. This hypothesis can therefore not be rejected using data from this thesis.

6 Conclusion

The macroeconomic environment is influenced by many different factors and complex relationships. Understanding the interplay and relationships amongst them was out of scope of this thesis, limiting this paper's ability to make a final and conclusive statement about the influence between economic growth and ecological, social and economic measures. Nevertheless, the results in this paper provide a first step in closing the literature gap at determining the point at which economic growth stopped adding value to the German society's wellbeing, further requiring to assess the causality between economic growth and the analysed indicators.

In conclusion, a singular point at which the economic growth stopped adding value to society's overall wellbeing is not clearly determinable. Therefore, it would be flawed to provide a definitive, black-and-white, answer to the research question: "*Does economic growth improve the wellbeing of the German society?"*
However, it has become prominent that the paradigm of economic growth over the past 27 years has had increasing negative side effects on the society's social and ecological wellbeing, whilst stopping to improve our economic wellbeing – requiring further research in whether our current economic and societal model can be adapted to eliminate negative effects like environmental damages and income inequality or whether a departure from growth towards a more sustainable life model is needed and possible.

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Appendices

Appendix 1: Raw Data Table of Indicators XI
Appendix 2: Calculations Output Table XII

Appendix 1: Raw Data Table of Indicators

Year	Real GDP	Real Net Income	Income Distribution	State Debt Quota	Employment Quota	Poverty Risk Quota	Life Expectancy	GHG-Emissions	Nitrogen Surplus	Biodiversity
1990	1943.27		2.88		66.30%		75.30	1251659.30	149.70	76.5%
1991	**2040.65**	**19811.00**	**4.17**	**39.10%**	**67.82%**	**11.3%**	**75.50**	**1204801.38**	**124.70**	**72.3%**
1992	2071.62	20458.00	3.42	41.60%	66.58%	11.1%	76.00	1154423.99	119.50	71.3%
1993	2051.21	20479.00	3.05	45.20%	65.10%	10.7%	76.10	1145280.91	115.60	73.1%
1994	2103.16	20000.00	2.80	47.50%	64.63%	12.2%	76.40	1126033.07	112.80	76.6%
1995	2141.13	19775.00	2.89	54.80%	64.62%	11.5%	76.60	1123367.14	119.00	73.1%
1996	2159.61	19793.00	2.89	57.60%	64.19%	10.8%	76.90	1141045.88	113.50	76.0%
1997	2200.87	19165.00	2.92	58.70%	63.69%	10.7%	77.30	1106096.28	108.90	72.8%
1998	2239.75	19179.00	2.94	59.40%	63.80%	10.6%	77.70	1080444.41	112.20	70.1%
1999	2281.19	19411.00	2.98	60.00%	64.78%	10.8%	77.90	1047044.00	114.50	74.8%
2000	2353.87	19576.00	3.03	58.90%	65.36%	11.6%	78.20	1044966.44	119.80	71.9%
2001	2396.87	19855.00	3.02	57.70%	65.84%	12.5%	78.50	1059907.74	105.70	71.1%
2002	2397.58	19808.00	3.04	59.40%	65.40%	13.0%	78.50	1038705.05	110.00	69.7%
2003	2380.33	19650.00	3.00	63.10%	64.90%	13.1%	78.60	1035329.25	109.90	69.8%
2004	2397.00	19756.00	3.11	64.80%	64.28%	13.8%	79.20	1018901.86	98.90	72.4%
2005	2418.03	19484.00	3.15	67.00%	65.39%	14.1%	79.40	993088.42	104.80	71.1%
2006	2511.70	19149.00	3.35	66.50%	67.08%	13.9%	79.80	1000322.75	108.20	70.2%
2007	2596.34	18898.00	3.25	63.70%	68.87%	14.2%	80.10	973427.10	101.00	70.2%
2008	2617.52	18741.00	3.21	65.20%	70.03%	14.3%	80.20	975279.38	102.80	70.4%
2009	2471.91	18704.00	3.32	72.60%	70.23%	14.9%	80.30	908182.48	83.20	67.4%
2010	2569.43	19240.00	3.33	80.90%	71.00%	14.0%	80.50	942782.58	92.90	68.0%
2011	2664.95	19323.00	3.48	78.60%	72.54%	14.0%	80.50	920304.53	109.40	66.6%
2012	2683.31	19416.00	3.28	79.80%	72.81%	14.5%	80.60	924627.73	94.50	70.8%
2013	2699.39	19483.00	3.38	77.50%	73.27%	15.2%	80.60	942004.15	95.00	68.0%
2014	2751.41	19816.00	3.40	74.70%	73.58%	15.8%	81.20	902675.91	84.10	67.2%
2015	2792.79	20258.00	3.52	71.00%	73.78%		80.70	906751.85	102.20	
2016	2844.60	20637.00	3.33	68.20%	74.37%		81.00	909404.50		
2017	2916.11			64.10%						
Unit	in billion €	in € per Employee per year	in P90/P10 Ratio	in % of total GDP	in% of total population between 15-65	in % of total population with a salary below Poverty border	in years	in kilo tons CO2 equivalent	in kg/ha agrable land	in % of Biodiversity 1975 and goal 2030
	(contstant prices BY 2010)									

Appendix 2: Calculations Output Table (excl. moving correlation)

	Real GDP	Real Net Income	Income Distribution	State Debt Quota	Employment Quota	Poverty Risk Quota	Life Expectancy	GHG-Emissions	Nitrogen Surplus	Biodiversity
Summary Data										
Min	1,943.27	18,704.00	2.80	39.1%	63.7%	10.6%	75.30	902,675.91	83.20	66.6%
Max	2,916.11	20,637.00	4.17	80.9%	74.4%	15.8%	81.20	1,251,659.30	149.70	76.6%
Average	2,417.70	19,610.19	3.19	62.9%	67.8%	12.9%	78.65	1,032,476.22	108.18	71.3%
Standard Deviation	265.10	495.19	0.28	0.11	0.04	0.02	1.83	97,419.54	13.25	0.03
Growth	50.1%	4.2%	15.7%	63.9%	12.2%	39.8%	7.6%	-27.3%	-31.7%	-12.2%
CAGR	1.5%	0.2%	0.6%	1.9%	0.4%	1.7%	0.3%	-1.2%	-1.6%	-0.6%
Correlations										
Raw	1	-0.185271484	0.33853022	0.80780077	0.81021035	0.88966042	0.975176967	-0.956420058	-0.7731734	-0.780326205
3-Year MA (Raw)	1	-0.374707821	0.47786559	0.88219396	0.82832964	0.91787793	0.98623669	-0.982130296	-0.91754596	-0.903315864
5-Year MA (Raw)	1	-0.491436433	0.70937018	0.94254024	0.85300627	0.93962263	0.991043912	-0.993279837	-0.96448191	-0.973630469
Quotient (BY1991)	1	-0.185271484	0.33853022	0.80780077	0.81021035	0.88966042	0.975176967	-0.956420058	-0.7731734	-0.780326205
3-Year MA (BY1991)	1	-0.374707821	0.47786559	0.88219396	0.82832964	0.91787793	0.98623669	-0.982130296	-0.91754596	-0.903315864
5-Year MA (BY1991)	1	-0.491436433	0.70937018	0.94254024	0.85300627	0.93962263	0.991043912	-0.993279837	-0.96448191	-0.973630469
Standardized	1	-0.185271484	0.33853022	0.80780077	0.81021035	0.88966042	0.975176967	-0.956420058	-0.7731734	-0.780326205
3-Year MA (STAND)	1	-0.374707821	0.47786559	0.88219396	0.82832964	0.91787793	0.98623669	-0.982130296	-0.91754596	-0.903315864
5-Year MA (STAND)	1	-0.491436433	0.70937018	0.94254024	0.85300627	0.93962263	0.991043912	-0.993279837	-0.96448191	-0.973630469
p-Value										
Quotient		0.364871682	0.08412509	3.5026E-07	3.0337E-07	6.056E-09	6.91003E-18	7.09335E-15	3.6454E-06	4.21415E-06
3-Year MA (BY1991)		0.071220092	0.01569311	5.5339E-09	3.1852E-07	1.7881E-09	1.75614E-19	3.46675E-18	2.8078E-10	3.6037E-09
5-Year MA (BY1991)		0.020191756	0.00015050	0.00000000	0.00000023	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000

Ehrenwörtliche Erklärung

Ich erkläre hiermit ehrenwörtlich:

1. dass ich meine Abschlussarbeit selbstständig und ohne fremde Hilfe angefertigt habe,
2. dass ich die Übernahme wörtlicher Zitate aus der Literatur sowie die Verwendung der Gedanken anderer Autoren an den entsprechenden Stellen inner-halb der Arbeit gekennzeichnet habe.

Ich bin mir im Weiteren darüber im Klaren, dass die Unrichtigkeit dieser Erklärung zur Folge haben kann, dass ich von der Ableistung weiterer Prüfungsleistungen nach §15 Abs. 3 SPO – AT Bachelor bzw. §14 Abs. 3 SPO – AT Master ausgeschlossen werden und dadurch die Zulassung zum Studiengang verlieren kann.

Ort, (Datum) (Unterschrift)