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# The Roots of Economic Growth: Geography and Institutions

Bachelorthesis

presented by

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# List of Abbreviations

| | |
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| **PPP** | purchasing power parity |
| **NTL** | Night Time Light |
| **NTLGDP** | Night Time LightGross Domestic Product (GDP)Estimate |
| **GDP** | Gross Domestic Product |
| **GNP** | Gross National Product |

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# 1 Introduction

Historically, research into economic development has shown a general consensus that a cross-national economic divergence exists. This inequality is expressed mainly through low-income hotspots in Latin America, Africa, Asia and Oceania and high-income hotspots in Europe and the neo-Europes. According to the growth theory, *proximate determinants* (physical capital, human capital and technology) affect directly economic growth. However, there is no general agreement on which *fundamental determinants* explain cross-country income differences based on proximate determinants. The main hypothesis with regard to the *fundamental* determinants of growth are: (1) the geography hypothesis, (2) the culture hypothesis, (3) the luck hypothesis, and (4) the institutions hypothesis (Acemoglu 2009; Henrich 2015; Nunn and Wantchekon 2009). Proponents of the geography hypothesis emphasise the relevance of local geography, ecology and climate to explain economic divergence. In contrast, proponents of the institutions hypothesis emphasise the influence and diversity of political and economic institutions. Despite the extensive research, a major issue is the high dependence of growth on the interaction of geographic and institutional factors. Despite this interest, no one to the best of my knowledge has studied the interdependence between Night Time Light (NTL) data, as an indicator for economic growth, and the *fundamental* determinants. This paper gives an short overview over the *geography hypothesis* and the *institutions hypothesis* considered both individually and in interaction with each other, followed by an empirical analysis using both NTL data and GDP, as well as geographic and institutional data. For reasons of space, the *culture* hypothesis and the *luck* hypothesis are not considered in this paper.

The paper proceeds as follows: Section 2 provides an overview of global economic divergence over time and discusses spatial economic divergence in the current period. Section 3 explains both the geography and the institutional hypothesis and emphasises their relevance for economic growth. Section 4 discusses the reversal of fortune based on the individual hypotheses and based on their interaction with each other. Section 5 summarises the main findings and draws a conclusion.

# 2 Economic Growth: Overview

## 2.1 The Big Picture

Global income distribution has been highly unequal in the past and remains so today. Henderson (2000: 1) highlights that 15 per cent of the world's population earns almost 50 per cent of the world's GDP. Additionally, 54 per cent of the world's GDP is produced by countries that account for only 10 per cent of the world's surface area and the poorest half of the world's population earns just under 14 per cent of the world's GDP. An examination of the per capita income (PPP) in 2010 and the percentages of the world's population that receive at most a certain per capita income illustrates this income inequality further. Firstly, fig. 1 illustrates the average GDP per capita distribution in 2010, in purchasing power parity (PPP) current international dollars, henceforth only called "GDP per capita" as nonPPP GDP will not be used. The interquartile range lies between 1604 and 19,960 GDP per capita (PPP). Furthermore, the median income is 5642 GDP per capita. The higher limit lies at 47488 GDP p.c. (PPP) and the lower limit lies at 234 GDP p.c. (PPP). Values that do not lie within this interval are outliers. Additionally, fig. 2 illustrates the maximum GDP per capita (PPP) earned by a certain share of the global population. Further, the horizontal line indicates the average GDP p.c. (PPP). The graphic shows that approximately 84.63% of the population earns a maximum of 15830 GDP per capita, which highlights the unequal per capita income distribution. This observation is further clarified by Weil (2016: 1), who argues that approximately 60% of the global income is earned by 20% of the global population. An historical and intertemporal observation of growth rates by Acemoglu (2012: 5) points to the uneven cross-country growth. The ratio between the moderate rich (75th percentile) and the moderate poor (25th percentile), as well as the ratio between the very rich (90th percentile) and the very poor (10th percentile) has increased, the latter implying an increase in the ratio since 1900 from approximately 8 to more than 30. Weighting by the population the ratio between the 75th and 25th percentile decreased but the ratio between the 90th and 10th percentile increased from six in 1900 to approximately 20 in 2008. Therefore, even though the middle-income countries converge, the extremes, the very rich and very poor countries, drift further apart.

## 2.2 The Geography of Economic Divergence

Geographically, inequality is characterised by low-income hotspots in the Global South (broadly defined: Latin America, Asia, Africa, and Oceania) and high-income hotspots in the Global North (broadly defined: The neo-Europes (Canada, United States and Australia) and Europe). Based on the neoclassical growth theory, this inequality may be partly due to a lack of proximate determinants of growth, i.e., a lack of human capital, physical capital and technology. Figure 3 illustrates the geographical divergence in GDP per capita in 2020 using the data provided by the World Bank Group. It can be observed that geographic regions in between the Tropic of Cancer and the Tropic of Capricorn and therefore close to the equator are linked to lower middle-income or low-income, whereby European and neo-European countries are characterised by a high-income. Furthermore, socialist economies in Asia are associated with a middle-income and some countries with high resource reserves, for example in oil, have an upper middle-income to high income (e.g., Saudi Arabia and Libya). In order to understand the divergence of national economies today, it is essential to look at the *fundamental* drivers of economic growth, especially on exogenous geographic factors, and on the persistence and change of the growth path determined by institutions. These will be discussed in the next section.

# 3 Fundamental Determinants of Economic Growth

There is a considerable amount of literature on historical and contemporary reasons for the current economic bifurcation of nations. Even though differences in physical capital, human capital and technology are *proximate* causes of cross-national differences in economic growth, it is imperative to discuss the *fundamental* determinants which attempt to explain the cross-national heterogeneity in *proximate* determinants and therefore different economic outcomes. In recent decades and centuries there has been considerable interest in the effect of geographically specific conditions on economic outcomes, reaching back to Michiavelli (1519), Montesquieu (1748), Toynbee (1934-1961), Marshall (1890), Myrdal (1968), and more recently Diamond (1999) and Sachs (2000, 2001). Furthermore, a growing body of literature has examined the effect of institutions on economic development (North 1981, 1988, 1990, 1991a,b, 1993, 2000b, Acemoglu and Robinson 2013).

## 3.1 The Geography Hypothesis

The geography hypothesis states that the geography, ecology and climate determine the global differences in economic prosperity. The relevance of the geography for economic growth is emphasised by the fact that most poor countries are located in tropical regions (Af, Am, Aw) in between the Tropic of Cancer and the Tropic of Capricorn, as shown by a comparison of fig. 3 and fig. 6 (Sachs and Malaney 2002: 682, Rodrik 2003: 1, and Beck et al. 2018). In contrast, the majority of rich countries are located in temperate zones (Csa, Csb, Cwa, Cwb, Cfa, Cfb). Moreover, table 2 shows that economies with a high share of land in a tropical (A) and arid (B) climate are associated with a lower GDP and NTLGDP per capita. Therefore, this section describes the mechanisms through which geography has had and continues to have an influence, directly or indirectly, on historical and contemporary economic growth, thus being an exogenous determinant of economic growth (McArthur and Sachs 2001: 14).

### 3.1.1 The Direct Effects of Geography on Economic Growth

The direct effects highlighted by the existing literature on the geography hypothesis are the effects of geography, ecology and climate on (1) agricultural productivity, (2) the burden of disease, also known as the disease environment, and health, and (3) energy resources (Sachs 2001). These effects in turn depend on the geography of an economy, which is determined by the climatic conditions (temperature, humidity, rainfall), the biogeography (plague, pest, diseases) and the geology (soil quality, erosion, topography) (Sachs 2001, McArthur and Sachs 2001, Spolaore and Wacziarg 2013: 327, Masters and McMillan 2001, and Myrdal 1968).

**Hypothesis 1** *The agricultural productivity directly affects economic development and growth.*

The agricultural productivity is directly determined by geographic conditions, such as, the temperature, humidity and precipitation, and by biogeographical factors, such as the prevalence of pests. These factors affect (1) the soil formation and erosion, (2) regional pests and parasites, (3) the plant respiration and net photosynthesis and (4) the water availability and control (Sachs 2001: 13-15).

Firstly, the *soil formation and erosion* are negatively affected by the absence of winter frosts. The absence of winter frosts in tropical regions cause a short-circuited

nutrient cycle, due to the high conversion rate of nutrients into biomass. In addition, high temperatures and precipitation rates reduce the cation exchange capacity of soils by promoting soil depletion through mineralisation and deposition of organic components, which in turn reduces the effectiveness of fertilisers. In consequence, tropical climatic conditions cause a low agricultural productivity in the tropics (Sachs 2001: 13-15, Masters and Wiebe 2000, and Masters and McMillan 2001: 173,178,182). Secondly, the prevalence of *pests and parasites*, promoted by high temperatures and the absence of winter frost affect negatively the viability of production through agricultural monoculture and domestication of livestock (Sachs 2001: 13-15). Last but not least, high temperatures hinder the *plant respiration and net photosynthesis* and therefore reduce the agricultural yields (Sachs 2001: 13-15). Finally, high temperatures negatively affect the *water availability and control* of plants by increasing the evaporation of surface water and evapo-transpiration. For example, (1) non-temperate humid-dry climates experience droughts and large fluctuations in annual precipitation and (2) non-temperate humid tropics are characterized by a high precipitation, which hampers water regulation and cause soil leaching, waterlogging of forests and impediments to grain drying and storage (Sachs 2001: 13-15). In consequence, the agricultural productivity of the major staple crops (rice, maize and wheat) and therefore the agricultural yield is lower in non-temperate zones (humid-dry and humid tropics) than in temperate zones (Sachs 2001: 13-15). Consistent with the theory, Sachs (2001: 12) states that the productivity per hectare of grain cultivation in temperate climate zones was on average 51% higher than in non-temperate climate zones.

**Hypothesis 2** *The disease environment and health status directly affect economic development and growth.*

The *biogeography* and *geography* determine the disease environment of an economy, which in turn has an effect on the health status in an economy (Sachs 2001: 15). Therefore, a high disease burden affects economic growth directly by reducing the labour productivity based on lost workdays and by diminishing the physical and cognitive abilities due to acute and chronic illness (see also Spolaore and Wacziarg 2013: 327, Bloom and Canning 2005). Furthermore, it affects economic growth *intertemporally* by affecting human capital formation (Mayer-Foulkes 2005). Moreover, it affects economic outcomes *indirectly* due to its effect on (1) fertility rates, (2) the population

age structure and (3) overall population growth rates (Sachs 2001: 15).

The disease burden itself is directly determined by an interplay of the ecology, on the one hand, and the economic situation, social aspects and genetic factors, on the other hand (Sachs 2001: 15-17, Bonds et al. 2010: 1185, Hamoudi and Sachs 1999). The geography (e.g., temperature and humidity) influences the transmission conditions of infectious diseases, hence affecting local *ecological* conditions. Regions with high temperatures and humidity experience a higher transmission rate of pathogens. The ability to counteract the adverse disease environment depends on the private and public *economic situation*, which determines the ability to finance medical treatment, to promote and support public health, and to prevent malnutrition, which has an immunosuppressive effect and increases the susceptibility of an individual to diseases (Jian 1996: 2037; Sachs 2001: 16). The distribution and the type and effectiveness of "healthcare" in turn depends on *social aspects*, such as, the status of women, and social beliefs. Furthermore, the susceptibility to diseases depends on *genetic conditions*, which developed through a process of natural selection (Sachs 2001: 16-17). For example, in temperate zones the confrontation with diseases and epidemics during the early urbanisation led to an increase in population immunities to some directly between humans transmittable diseases and to diseases transmitted via intermediate hosts, which caused a decrease in morbidity and mortality (Sachs 2001: 17-18; Bloom et al. 1998). Furthermore, the sickle cell trait, which is most prominent in West Africa and developed through a process of natural selection, causes heterozygous carriers to be protected from falciparum malaria, whereby homozygous carriers will get the sickle cell disease (Sachs 2001: 16; Sachs and Malaney 2002: 680).

With regard to the tropical physical ecology, which supports high levels of infectious disease transmission causing low income, the poor nutrition resulting from low productivity of food production and low financial resources, and the multiple negative feedbacks through poverty (illiteracy, lack of access to health care, lack of access to sanitation etc.), the disease burden is not only a cause, but also a consequence of poverty (Sachs 2001: 16, Bonds et al. 2010: 1185, and Bloom et al. 1998). This vicious cycle is represented by a positive feedback cycle between low income and low productivity due to the disability from diseases, which is illustrated by the negative non-linear correlation of income and infectious diseases (Bonds et al. 2010: 1189;

Hamoudi and Sachs 1999: 21). Additionally, a comparison of the spatial prevalence of malaria (fig. 7, fig. 8, fig. 9 and fig. 10) and the spatial distribution of income p.c. (fig. 3) illustrates the importance of considering the disease environment. In temperate zones, especially in southern and central Europe, where malaria was prevalent during the Middle Ages, attempts to eliminate the prevalence of malaria have been successful due to the available medical treatment and comparatively better transmission-inhibiting geographic conditions. In addition, they experienced relative higher improvements in the nutrition, an adaption to different prevalent diseases, better public hygiene and medical advancements, and the introduction of effective vaccinations (Sachs 2001: 18). *Tropical* zones were and still are characterised by (1) individual and public poverty which hinder improvements in nutrition, hygiene and medical innovations, and (2) less effective investments in sanitation and clean water relative to those in temperate zones (Sachs 2001: 18). In addition, despite attempts to eliminate the malaria parasite, the disease burden has increased due to population movements to malaria-infested regions, changes in agricultural practices (e.g., construction of dams and irrigation schemes), deforestation, weakening of public health services in some poor countries, long-term climate change (El Niño cycles and global warming), and parasites which developed a resistance to drugs and insecticides (Sachs and Malaney 2002: 680).

The relevance of the morbidity and mortality is illustrated by the fact that Africa alone accounts for 90% of the mortality in tropical regions, reflecting the relevance of malaria in the context of African economic development (Sachs and Malaney 2002: 680; Gallup, Sachs, and Mellinger 1999: 203). Bloom et al. (1998) further argue that if malaria had been defeated in 1950, malaria experiencing countries would be twice as rich today. Simultaneously, an increase in one standard deviation in infant mortality rates as a health measure can be linked to a decrease in the Gross National Product (GNP) p.c. by 50% (McArthur and Sachs 2001: 11). This is a crucial finding as the disease burden, which has a negative impact on life expectancy and infant mortality, is higher in the tropics compared to the temperate zones. Thus, the 52% lower infant mortality rate and the 8% higher life expectancy in temperate zones in comparison to non-temperate zones can partly explain the relatively lower tropical income (Sachs 2001: 15). Consistent with these results, table 3 shows that an increase in the average malaria incidence of *Plasmodium falciparum*, respectively *Plasmodium vivax*, can be attributed to a decrease in GDP (NTLGDP) p.c. by 4.49% (5.10%), respectively

24.77% (27.50%). In conclusion the disease environment is an important factor which contributes to the explanation of global income differences.

**Hypothesis 3** *The energy resource endowment directly affects economic development and growth.*

The level of industrial development in the 19th century in the temperate zones depended on the spatial proximity to coal deposits promoted the speed of industrialisation. Thereby, approximately 90.3% of the coal deposits were in 1998 located in 10 temperate zone countries, which accounted together for 87.3% of global production. In the case of India, a tropical country, the share of coal reserves as well as the share of global production was 7.6% in 1998. The access to oil and gas in the 20th century, and the access to hydroelectric power, especially in northern Europe in comparison to Southern Europe, further promoted economic growth. With respect to the hydrocarbons oil and gas, production in countries with a majority of the population in temperate climates was about 173 quadrillion BTUs (82.5%) and in those with a majority of the population in tropical zones about 37 quadrillion BTUs (17.5%). With 43% of the world's population living in tropical zones and 57% in temperate zones, the p.c. hydrocarbon production in tropical countries was only 28% of non-tropical countries. However, many low-carbon economies such as Switzerland and Japan were economically successful, while the growth of high-carbon economies declined. According to this hypothesis, the geographic endowment of resources relevant for energy production may have accelerated and intensified the industrialisation process and the ensuing expansion. Even though its relevance for growth has decreased it still remains positive (Sachs 2001: 18-19).

### 3.1.2 The Indirect Effects of Geography on Economic Growth

Over time geography has been a relatively exogenous variable influencing partly-endogenous factors, which are relevant for economic growth, such as (1) the technological change, diffusion and transmission, (2) the demography, (3) the political and military power, and (4) the economic integration, openness and trade (Sachs 2001). In addition, the spatial distribution of human characteristics, affected by historical effects of initial geographic endowments, influenced human characteristics, such as, institutions, human capital, social capital and cultural traits. These indirect mechanisms

influence per capita income, productivity and the economic environment in the long run and determine economic growth rates in the contemporary world (Spolaore and Wacziarg 2013: 326). In other words, the indirect mechanism of geography on the economy acts as an amplifier of the direct effects (Sachs 2001).

**Hypothesis 4** *The geography indirectly affects economic development and growth through its effect on technological change, diffusion and transmission.*

Technology is a *proximate* determinant of economic growth due to its influence on the productivity in an economy. However, geographical differences affect the spatial transmission pattern of technologies. Beginning in the *Neolithic Age* at the north of the Tropic of Cancer, prehistoric geographic conditions and biological conditions affected the long-term comparative development. According to Diamond (1999), prehistoric geography and biological conditions had an effect on the diffusion of productivity-enhancing innovations between populations by influencing the onset and spread of agriculture and domestication (Diamond 1999; Hibbs and Olsson 2005, cited by Spolaore and Wacziarg 2013: 327-328). The main factors fostering economic development in Eurasia were (1) the larger continental size of Eurasia, (2) the East-West orientation of the continent, which promoted the diffusion of agricultural innovations due to the same climate zone and (3) the initial biological conditions, such as, the diversity of animals and plants suitable for domestication and cultivation in prehistoric times (Diamond 1999; Hibbs and Olsson 2005, cited by Spolaore and Wacziarg 2013: 327-328). These environmental advantages enabled populations in Eurasia in 10,000 BC to make a transition from hunter-gatherer economies to agricultural and pastoral production, called the "Neolithic Revolution". In consequence the population growth rate altered and the acceleration of technological innovation began relatively earlier in Eurasia. In addition, it caused the populations to experience the impact of "old-world diseases" and therefore to develop a genetic immunity relatively early (Diamond 1999, cited by Spolaore and Wacziarg 2013: 328-329). In consequence, Eurasia was relatively more successful in economic and politic terms and was later on able to exercise its domination over other regions (Spolaore and Wacziarg 2013: 328-329).

Taking into account the relevant factors emphasised by Diamond (1999) (absolute latitude, share land in tropical areas, landlockedness, island dummy, wild grasses and domesticable animals) and excluding both neo-European countries (economically suc-

cessful countries today due to colonisation) and countries whose income is based on the extraction of resources, geographical factors have an explanatory power of 55% in relation to the logarithmic p.c. income in 2005 (Hibbs and Olsson 2005 and Hibbs and Olsson 2004, cited by Spolaore and Wacziarg 2013: 329). Furthermore, geographic and biological variables are individually significant, and geographic variables and biological factors explain jointly 51.6% of the variation in log GDP, whereby the geographic conditions are of higher relevance for contemporary economic outcomes. In addition, the biological conditions had a higher importance in the Old World than in the New World, which supports the hypothesis of Diamond (1999) (Hibbs and Olsson 2005 and Hibbs and Olsson 2004, cited by Spolaore and Wacziarg 2013: 329). In addition, the geographic conditions can explain 70% of the variation in the timing of the adaption of agriculture and 44% of the variation in population density in 1500. Even though the biogeographical conditions are jointly correlated with the population density, they were only relevant for the timing of the Neolithic Transition (Ashraf and Galor 2011, cited by Spolaore and Wacziarg 2013: 330-331).

Furthermore, a heterogeneous geography and biogeography did also affect the diffusion of technologies negatively in the *Post-Neolithic* period, especially in the 19th and 20th century (Sachs 2001). According to Sachs (2001: 20-22), higher invention rates in larger markets and the scale dependence of technological innovations lead to increasing returns to scale in economic growth (see also Mellinger, Sachs, and Gallup 1999: 12-13). The costs of an innovation (R&D costs) have to get paid once and are unproblematically amortised through repeated use of the innovation if economies of scale are exploited in a large market. Therefore, innovation activity should grow disproportionately with the size of a market. Since the market is larger in temperate zones due to the long horizontal axis of Eurasia and due to additional industries in the neo-Europes, temperate innovation rates and economic growth are higher relative to those of the tropics. In addition, the sectors most affected in the 19th and 20th century were health care, agriculture, energy use, construction, environmental management and new materials. In consequence, the combination of (1) a high rate of innovation and technology diffusion between temperate regions, (2) a low rate of innovation in tropical zones and (3) a low rate of technology diffusion from the temperate zone to the tropics increased the technological divergence between the temperate and tropical zones, and caused a worsening of the temperate-tropical technology gap, resulting in an economic

divergence (see also Mellinger, Sachs, and Gallup 1999: 13). Additionally, with respect to the technological diffusion, spatial proximity is relevant, as the technological diffusion rate and spillover between neighbouring countries is higher than between distant countries and countries characterised by environmental barriers, such as a different climate zone. For example, the tropics account for 35.7% of the world's population and 17.1% of GDP, but use only 1.9% of the U.S. patents and thus the technologies related to it. The tropical zones themselves continue to lag behind the temperate zones in both absolute R&D spending and R&D spending relative to GDP (Sachs 2001: 20-22).

**Hypothesis 5** *The geography indirectly affects economic development and growth through its effect on the demographic transition.*

The *demographic transition* is a societal transition from high fertility and high mortality to low fertility and low mortality. The demographic transition (1) causes higher investments per child due to lower fertility (quantity-quality trade-off), (2) leads the population growth rate to become zero or negative, thus increasing the proportion of the working age population, (3) reduces the load on fixed resources (arable land, mineral deposits, soils), and (4) the absolute reduction in the working age population reduces the savings necessary for capital widening while promoting capital deepening. In the East Asian example, the demographic transition was essential for the increase in GDP per capita (Sachs 2001: 23).

In the tropics the geography influences the demographic transition through its effect on health, fertility and agricultural productivity. A lower agricultural productivity reduces the rate of urbanisation and thus increases the proportion of rural population. In consequence, the tropical urbanisation rate is by 9.25% lower than in the temperate zones. Furthermore, fertility rates are higher in rural regions due to the lower opportunity costs of maternal time and the positive contribution of children to household production, which lead to higher net economic benefits in farming households. In addition, rural households raise their total fertility rate due to a higher rural disease burden in order to counteract the relatively higher rural infant mortality rate. If rural households are risk averse, the total fertility rate can exceed the infant mortality rate, thus causing a high overall tropical population growth rate (Sachs 2001: 23-25). In consequence, these countries might end in a Malthusian trap. For example, an economy located in the temperate zone has for a given GDP per capita an average total

fertility rate equal to 52% of the average total fertility rate of a non-moderate climate zone economy. In consequence, high fertility rates and rural population lead to low per capita income and possibly to a Malthusian trap (Sachs 2001: 15,23-25).

**Hypothesis 6** *The geography indirectly affects economic development and growth through its effect on the economic integration, openness and trade.*

The *landlockedness* affects both the access to the sea and maritime trade. Mellinger, Sachs, and Gallup (1999: 12) highlight the negative effect of an increase in the distance to the sea, which causes higher transportation costs. Henderson (2005: 1558-1560) underlines the persistent effect of urbanisation close to the sea, which in turn has an positive effect through agglomeration factors (e.g., localized information and knowledge spillovers) promoting economic growth. Thus, the proximity of less than 100km to the coast is linked to a 7.4% higher urbanisation rate in these coastal regions (Sachs 2001: 23-25). Especially with respect to Sub-Saharan Africa, where approximately 78% of the population lives in landlocked and non-temperate regions, geography might be a factor hindering growth. Therefore, the higher the distance to the sea, the higher the productivity disadvantage (Rappaport and Sachs 2003: 36). Consistent with the mentioned above, table 4 highlights that being landlocked is linked to a decrease in income by approximately one percent.

In consequence, different geographical conditions affect the economy individually and jointly. For example, the coastal population share, the transport cost margin, the prevalence of malaria and the endowment of hydrocarbons jointly explain 69% of the cross-country variation of GDP p.c. in 1995 (Gallup, Sachs, and Mellinger 1999: 199-200). In conclusion, heterogeneous geographical conditions are linked to the cross-country heterogeneity of economic growth. The interaction of climate, geography and ecology in the tropics reduces the agricultural productivity and worsens the health status, hence decreases economic growth and increases the fertility. Moreover, it hampered the industrialization in the past and reduces economic growth in the present partly due to the absence of energy resources. In addition, it caused a low north-south technology diffusion rate and still hinders the economic integration and trade of landlocked regions. However, “geography is not destiny”; for example (1) Australia, which has big share of tropical land characterised by deserts, drylands, a low and variable pre-

cipitation, a low soil productivity, (2) Botswana, which is a landlocked country, and (3) Mauritius which is a tropical country with a high dependency on commodity exports, are all economically successful despite their adverse geography (Rodrik 2003: 13; see also: Zafar 2011, Frankel 2014, Soderbom 2003, Durbarry 2004, Acemoglu, Johnson, and Robinson 2001a, Fosu 2013). Additionally, I argue that the closeness to economic centres matters. Even though a high latitude, in other words a more northern location, is significantly positively correlated with a high GDP and NTLGDP, it includes indirectly other factors, such as, the climate and distance to the world market. The "outcloseness" represents the distance to each node in the World Trade Network. The higher the closeness, the higher the GDP and NTLGDP (see table 4).

## 3.2 The Institutions Hypothesis

In contrast to the geography hypothesis, the institutions hypothesis argues that endogenous economic and political institutions determine the observable global differences and the intertemporal discontinuity in prosperity. However, the definition of "good institutions" is influenced by the social, economic and political environment and changes over the course of time (Acemoglu 2009: 143). Henceforth, the term "institutions" refers to the interpretation by Douglass North, who defines institutions as follows:

**Definition 1** *"Institutions are the humanly devised constraints that structure political, economic and social interaction. They consist of both informal constraints (sanctions, taboos, customs, traditions, and codes of conduct), and formal rules (constitutions, laws, property rights)." North (1991a: 1)*

**Definition 2** *"Institutions are the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction. In consequence they structure incentives in human exchange, whether political, social, or economic." North (1991b: 3)*

According to the previous definitions, institutions are *humanly devised* and embody *formal rules* which "structure incentives" of human interaction and economic behaviour in a political, social and economic context, hence affecting economic outcomes (Acemoglu 2009: 132-133,142-143). Probably the most prominent case in favour of the institutions hypothesis is the case of North and South Korea. When Korea was divided after the Korean War along the thirty-eighth degree of latitude into North and

South, both countries had the same culture, the same history and the same geography. Whereby South Korea became part of the Economic Miracle of Asia, North Korea experienced an economic recession (Henderson, Storeygard, and Weil 2012). In consequence, differences in institutions might explain the cross-national divergence in income.

**Political and Economic Institutions** Institutions can be of *political* or *economic* nature. Political institutions are rules which affect the political decision process by shaping political incentives and the distribution of political power. Economic institutions, which coexist with and in general arise through political institutions, are economic agreements, which shape economic incentives, contracting possibilities and the distribution of resources (Acemoglu and Robinson 2013; North 2000a; Acemoglu 2009: 926,1008)

**Extractive and Inclusive Institutions** Institutions can be categorized into inclusive and extractive institutions (Acemoglu and Robinson 2013: 6). Broadly spoken, the main factors of *inclusive* institutions is the enforcement of property rights, a functioning judicial (legal) system, the absence of corruption, relatively open markets and free entry, constraints to the economic and politic power of political elites and politicians, an equal distribution of political power (e.g. democracy vs. dictatorship or autarchy), and electoral rules in democracy (Acemoglu 2009; Acemoglu and Robinson 2013; North 2000a; Acemoglu, Laibson, and List 2016: 210-211, Sokoloff and Engerman 2000: 218, and Acemoglu, Laibson, and List 2016: 210). Institutions, which do not guarantee these elements, but are characterised by negative characteristics, such as, expropriation, arbitrariness and bureaucracy, are considered *extractive* institutions and inhibit economic activity (Acemoglu and Robinson 2013: 6, Acemoglu, Laibson, and List 2016: 211, and Sokoloff and Engerman 2000: 218). In summary, the main elements of institutions, or more precisely *institutions of private property*, are (1) the enforcement of property rights, (2) constraints on powerful groups, such as, elites and politicians; and (3) equal opportunity, which interact with each other and create an relatively certain political and economic environment (Acemoglu 2009).

**Hypothesis 7** *Private property rights promote economic growth.*

Property rights incentivise investments into physical capital, human capital and technologies and foster the adaption of more efficient technologies (Acemoglu 2009: 143; Acemoglu, Johnson, and Robinson 2006: 20). Acemoglu (2009: 147) figured out that a positive correlation between economic prosperity, measured in per capita GDP, and security of property rights (low expropriation risk) exists. Thus, property rights are essential for long-run investments.

**Hypothesis 8** *Constraints to powerful groups promote economic growth.*

Institutions are actively and directly or indirectly chosen by a society or powerful groups. Thus, if the political power is not evenly distributed throughout society, the existence of inherent conflicts of interests within the society, or the existence of multiple institutional equilibria due to the deficient ability of the society to coordinate on and maintain a good equilibrium from which all members of a society benefit, can lead to *extractive* institutions (Acemoglu 2009: 144). Constraints to powerful groups (upper class, or rather, the "rulers") undermine an unevenly distributed political power (extractive political institutions) which would lead to the implementation of inefficient policies by the elite in order to maintain their power and privileges. These inefficient policies would enable the creation of an unequal economic framework, thus inefficient economic institutions. In consequence, without constraints to powerful groups, an economy would be characterised by the expropriation of incomes and investments of other members of the society by the elite. Moreover, it would enable the extraction of resources and revenue at the expense of the rest of society, the manipulation of factor prices and a political consolidation (Acemoglu 2006: 515, Acemoglu, Laibson, and List 2016: 211, and Acemoglu 2009: 132-133,142-143,926,1008).

**Hypothesis 9** *Equal opportunity promotes economic growth.*

Equal opportunity promotes investments (e.g., in human capital) and the productive economic participation (Acemoglu, Johnson, and Robinson 2006: 20; Acemoglu, Laibson, and List 2016: 210-211). Human capital in turn increases the productivity and the technology adoption. The absence of the equality of opportunity in societies, which protects the elite and the already-privileged, creates distortions and does not allow the rest of the society to accumulate human capital, hence hindering economic growth. In addition, for Schumpeterian creative destruction to work, it is necessary to

have a functioning competitive market that allows entrants to outperform incumbents and thus gain a larger market share. Therefore, the equality of opportunity, guaranteed by institutions, is essential for the technological progress (Acemoglu 2009: 143-144). Moreover, as Acemoglu and James A. Robinson (2000: 128-129) highlight, the political system and institutions have an influence on the adoption of technologies. As the introduction on a new technology might enable groups with lower political power to gain influence by being economically more successful than the elite, especially in the context of the industrialization, powerful groups block the introduction of new technologies. Therefore, political power might be of higher relevance as a reason for blocking new innovations and the technological diffusion than a heterogeneous geography.

In conclusion, differences in institutions have an effect on investments in the accumulation of physical capital and human capital, and on investments in research and development, hence affecting technological and organizational change and innovation (Acemoglu and Robinson 2013; Acemoglu 2009: 143). *Inclusive* institutions foster the productive usage of talents and ideas and the productive economic participation of the population. Furthermore, they ensure the efficient allocation of resources to most efficient uses and determine the distribution of profits, revenues and residual rights of control (Acemoglu 2009: 143). Additionally, on the one hand, they promote risk-taking and investments, and on the other hand, they increase the saving ratio and reduce the time preference of consumption. Furthermore, they govern the collective action and provide public goods (Acemoglu and Robinson 2013: 6, Acemoglu 2009: 143, and Acemoglu 2009: 143, Acemoglu, Laibson, and List 2016: 210-211). McArthur and Sachs (2001: 11) highlight that a one standard deviation decrease in the risk of confiscation and forced nationalization of property can be associated with an increase in GNP p.c. of 80-90%. Furthermore, Acemoglu et al. (2007: 34) highlights that even though political concentration has a long and medium-term negative effect on economic outcomes (e.g., in Africa and Latin America), a degree of inequality between the powerful members in a society has a positive effect on economic growth.

The following regressions give an overview over the significant link between institutions and economic outcomes, whereby a reverse causality is highly probable. Using

the government indicators provided by the World Bank Group, a significant correlation between inclusive institutions and income per capita can be observed. Furthermore, fig. 11, fig. 12, table 5, and table 6 illustrate the correlation of the government indicators with the GDP per capita (PPP) and NTLGDP per capita in 2010. According to the results, the control of corruption (CC.EST), the government effectiveness (GE.EST), the political stability and absence of violence and terrorism (PV.EST), the regulatory quality (RQ.EST), the rule of law (RL.EST) and the voice and accountability (VA.EST), which imply inclusive politic and economic institutions, affect the income. These are individually significant positively linked to a high GDP (NTLGDP) p.c. (PPP) and explain between 20 (30) and 56 (63) percent of the cross-country variation in GDP per capita (NTLGDP adjusted $R^2$ in brackets). Thereby, Rule of Law and Government Effectiveness seem to have the highest influence on GDP and NTLGDP.

Furthermore, the indices of the Heritage Foundation illustrated in fig. 13 and fig. 14 provide further information. The "Rule of Law" indices (Property Rights, Judicial Effectiveness, Government Integrity) have a relatively high explanatory power concerning the global variation in GDP (NTLGDP) per capita with an adjusted $R^2$ between 30.9% (39.0%) and 46.0% (70.2%) (fig. 15 and fig. 16). Thus, an economic environment orientated at secure property rights, which are provided by political institutions, are linked to economic activity, which is consistent with the theory. Additionally the "Government Size" indicators, Government Spending, and Fiscal Health, are all significantly negatively linked to per capita income, their adjusted $R^2$ of 2.5% (4.5%) to 12.8% (27.2%) is relatively low. The Tax Burden is insignificant using GDP but significant using NTLGDP, however its adjusted $R^2$ is close to zero (table 7 and table 8). Hence, countries with a high government spending and bad fiscal health have a lower income. However, the effect might be endogenous as a high government spending deteriorates the fiscal health and requires high taxes, which in turn has a negative effect on economic activity. Last but not least, the "Regulatory Efficiency" indices, Business Freedom, Labor Freedom, and Monetary Freedom, are also positively and significantly linked to GDP (NTLGDP) per capita income, whereby the business freedom has with an adjusted $R^2$ of 29.2% (40%) the highest explanatory power (fig. 17 and fig. 18). This addresses inclusive institutions which guarantee *equal opportunity* and promote competition between enterprises and on the labour market, in support of the institutions hypothesis. Finally, the "Market Openness" indices (Trade Freedom, Investment

Freedom, Financial Freedom) explain between 15.3% (31.2%) and 32.7% (39.4%) of the global variation in GDP (NTLGDP) per capita, which is consistent with the theory (fig. 19 and fig. 20). However, Rodrik (2003: 12-13) states that although successful countries benefit from trade and foreign investment, policies that seek international economic integration or disintegration are not strongly correlated with economic performance across time. For example, Australia experienced a recession before its disintegration through higher tariffs, import licences and limiting Asian immigration. The example of Mauritius shows that economic growth can also occur under protectionism. Therefore, Rodrik (2003: 12-13) states that an internal change in institutions and policies seems to have a greater impact on economic growth than integration into the world trade.

Despite the institutions hypothesis characterises important relatively endogenous factors of a successful economy, it cannot fully explain the development of some countries that experienced an economic miracle. Additionally, institutions that are generally judged to be of good quality do not necessarily have positive influences on developing countries and may even be detrimental to economic growth (Rodrik 2003: 15). China, for example, implemented transitional institutions, which were and still are different from the "best practice" institutions generally sought in developing countries. These transitional institutions were better adapted to local economic conditions for reasons of political feasibility and economic efficiency. Important aspects of these transitional institutions were that (1) the state adopted a two-track reform, which implied liberalisation of prices at the national borders but maintained the planned economy; (2) the state allowed community and village enterprises, thus enabling an intermediate form between private and state ownership; (3) there was Chinese-style federalism, which left considerable autonomy to the regions and created healthy economic competition between them; and (4) there was anonymous banking, which allowed financial development while limiting the state's ability to expropriate large depositors (Rodrik 2003: 14-15). Furthermore, the *forms and systems of government* do not always matter. Glaeser et al. (2004a: 2-3) highlight that the causal direction between democracy (inclusive political institutions) and investments in human and physical capital is not clear. On the one hand, according to the institutions hypothesis, investments are promoted by inclusive institutions. On the other hand, the development view states that a dictatorship can

also guarantee secure property rights, which lead to economic growth and later on to inclusive political institutions. For example, South Korea's economy experienced economic growth after the economic and political division from 1950 to 1980, but before the implementation of democracy in South Korea. Based on their research, Glaeser et al. (2004a: 1) claim that human capital is a more fundamental source of growth than institutions are. Moreover, poor countries escape poverty through good policies implemented by dictators. As a result, political institutions are improved. Therefore, human capital and physical capital, which can also be fostered by a dictatorship that guarantees property rights, can lead to democracy and *inclusive* institutions. Thus, the institutional hypothesis can by no means fully explain the "path to economic success", but represents an extreme of an economic system that can also be realised gradually and can already induce economic success unfinished and modified (Rodrik 2003: 17).

In conclusion, with respect to table 9, both the geography hypothesis and the institutional hypothesis highlight factors that go hand-in-hand. Model (1) illustrates the main geographical factors, which are all significantly linked to the income measures. Model (2) shows the importance of institutional factors, while keeping the mean VIF under 5. However, GE_EST and RQ_EST are highly correlated, which might explain the lower significance of RQ_EST and might inflate the adjusted $R^2$. Nevertheless, all variables are significant. Interestingly, VA_EST has a negative effect on the GDP and NTLGDP. This might be due to the fact that, as earlier mentioned, even a dictatorship can guarantee a high political stability and absence of violence, government effectiveness, and regulatory quality. Another possible explanation is that the average GDP and NTLGDP per capita do not represent the heterogeneous effects of democracy, as (Acemoglu et al. 2013) states. Thus, democracy benefits in certain contexts the powerful elite, which causes an ambiguous effect of the ability to participate politically. These approaches need to be further explored in future research. Model (3) keeps the AIC and BIC relatively low, while implementing both hypothesis in the model. According to the adjusted $R^2$ the model explains 71% of the variation in GDP per capita and 76% of the variation in NTLGDP per capita while almost all variables remain significant. In conclusion, both the institutional and geographical variables are of high importance.

# 4 Discussion: The Reversal of Economic Fortune

Even though the Aztecs and Incas in the Americas and the Mughals in India were among the richest civilisations in 1500, the regions where these civilisations once flourished are now part of the Global South. In comparison, regions where once relatively undeveloped civilisations lived are nowadays part the Global North. This section discusses possible explanations for this observation (Acemoglu and Robinson 2013: 152, Sokoloff and Engerman 2000: 219, Acemoglu, Simon Johnson, and James A. Robinson 2002: 1231, Acemoglu, Johnson, and Robinson 2006: 24).

Pre-industrial time civilizations were only able to support a high population density and large urban centres due to a high agricultural productivity and a developed transportation and commerce network, which implies economic prosperity (Acemoglu, Simon Johnson, and James A. Robinson 2002; Acemoglu, Johnson, and Robinson 2006: 25). Also at present, per capita income is still positively correlated with the degree of urbanisation (Acemoglu, Johnson, and Robinson 2006; Acemoglu, Simon Johnson, and James A. Robinson 2002). However, as the pre-industrial population density, as a measure for urbanisation, is positively correlated with economic prosperity in 1500, but is negatively linked to the contemporary income, the world history has witnessed a *reversal of economic fortune* (Acemoglu and Robinson 2013: 152-153, Acemoglu, Simon Johnson, and James A. Robinson 2002: 1232, Acemoglu, Johnson, and Robinson 2002, and Acemoglu, Johnson, and Robinson 2006: 24-29).

## 4.1 Change in Geography: Temperate Drift Hypothesis

The geography hypothesis emphasises the geography as an exogenous, time-invariant factor, which influences economic development. Hence, according to the *simple geography hypothesis*, regions which were rich in 1500 should be rich in the present too (Acemoglu, Simon Johnson, and James A. Robinson 2002: 1233, Acemoglu, Johnson, and Robinson 2006: 25-27). The *sophisticated geography hypothesis* in turn stresses the reversal of the effect of certain geographical characteristics on productivity and development and the interaction of geography and technology. Therefore, climate, ecology, and disease environments may have time-varying effects.

First, the *temperate drift hypothesis*, also know as the *latitude specific technology hypothesis*, highlights the shift of the centre of economic gravity away from the equa-

tor. Even though the tropics had a comparative advantage over temperate zones in 1500 due to the lower calorie intake required in warm climates, promoting the tropical population density, the technological change turned the tide. In the subsequent period after 1500 agricultural innovations (e.g. heavy plough, crop rotation systems, domesticated animals s.a. cattle and sheep, and high-yield crops s.a. wheat and barley) could be used relatively more effective in temperate zones, increasing temperate productivity relative to the tropical zones (Acemoglu, Simon Johnson, and James A. Robinson 2002: 1233,1261, Acemoglu, Johnson, and Robinson 2006: 25-27, Spolaore and Wacziarg 2013: 332; Engerman and Sokoloff 1994, cited by Spolaore and Wacziarg 2013: 333-335). The reason for the lower effectiveness and the lower cross-ecological zone diffusion of agricultural technologies and innovations in the health sector in the tropics is based on the homogeneity of biogeographical and geographical conditions (Diamond 1999). Even though the *temperate drift hypothesis* seems to explain the reversal of fortune, Acemoglu, Simon Johnson, and James A. Robinson (2002: 1233-1234) argue that if the hypothesis is correct, the reversal should have set in during the colonial era, which caused a diffusion of European agricultural technologies between the 16th to 18th century. However, the reversal did not set in in North America with the start of the colonization, but at the beginning of the 19th century with the industrialisation, during which the divergence between Europe, the neo-Europes and the rest of the world began (Acemoglu, Simon Johnson, and James A. Robinson 2002: 1233-1234; Sokoloff and Engerman 2000: 218).

Second, the timing and extend of industrialization might have been promoted by other geographic characteristics, such as, the coal reserves and the access to the sea and world trade (Acemoglu, Simon Johnson, and James A. Robinson 2002: 1233). As trade fosters specialization in industry, increasing the potential of Economies of Scale, and is promoted by low transportation costs, regions with sea access should experience economic growth. However, countries with natural ports (e.g. in Central America, India, or Indonesia) and islands (e.g. Caribbean) did not industrialize at the same time as Europe and the neo-Europeans (Acemoglu, Simon Johnson, and James A. Robinson 2002: 1261).

Another hypothesis highlights the lower work effort in warm climates, especially in the industrial sector, thus linking low economic income to warm climates which have a comparative disadvantage (Acemoglu, Simon Johnson, and James A. Robinson

2002: 1261-1262). Additionally, another view claims that regions which experienced a higher immigration of Europeans (e.g. USA, Canada, Australia, New Zealand) were affected directly by European values, which promoted development or by better trade relations to Europe and higher productivity of Europeans. However, Acemoglu, Simon Johnson, and James A. Robinson (2002) reject these hypothesis and highlight the relevance of the colonial era.

## 4.2 Change in Institutions: Colonialism Hypothesis

Much of the literature highlights the *colonialism hypothesis*, which links the colonial era to the reversal of fortune. The hypothesis argues that the heterogeneous settlement and institutional implementation patterns during the colonial era persisted in the long-run, which affected the economic growth and income inequality in the post-colonial period (Sokoloff and Engerman 2000: 220).

European colonizers applied different colonization strategies, implementing extractive (Congo, Gold Cost) or inclusive institutions (United States, Australia, New Zealand) which affected negatively or positively the investment in physical capital, human capital and technologies, hence affecting the economic progress (Acemoglu, Johnson, and Robinson 2001b: 1395). Inclusive institutions focused on the implementation of rule of law and promoting investments, but exclusive institutions focused on policies, which promote the resource extraction (Acemoglu, Johnson, and Robinson 2001b: 1395). The relevance of colonialism, as argued by Sokoloff and Engerman (2000: 218-219) and Acemoglu, Johnson, and Robinson (2002), is demonstrated by the observation that the economic leadership of North America (United States and Canada) did not emerge until several centuries after the Europeans arrived and began establishing colonies. In fact, until 1700 the per capita income in Mexico and the British colonies was approximately identical and the most prosperous economies were located in the Caribbean. Hence, Central and South America were economically relatively more prosperous than North American economies. This section addresses the characteristics and consequences of colonialism in the Americas.

A possible confirmation of this hypothesis is the observation of a negative relationship between the log population density in 1500 and log income per capita in 2005 in regions of former European colonies. More precisely, a positive change in the popu-

lation density in 1500 by 1% is related ceteris paribus to a change in the income by –47.88%. Restricting the set to regions where at most 50% of the population is today indigenous, a positive change in the population density in 1500 by 1% is related c.p. to a change in the income by –32.81%. Combining both restrictions, a change in the population density in 1500 by 1% is related c.p. to a change in the income by –51.69% (Acemoglu, Simon Johnson, and James A. Robinson 2002, cited by Spolaore and Wacziarg 2013: 332-333; Acemoglu and Robinson 2013: 152-153). This relationship gets stronger the higher the share of the indigenous population in the total population (Spolaore and Wacziarg 2013: 335). Therefore, the lower the settlement rate of Europeans in a specific region of the New World, the greater the negative effect of an colonial experience on national economic growth. The positive relationship between the contemporary population density and the contemporary per capita income, as mentioned by Acemoglu and Robinson (2013: 152-153), and the positive (negative) relationship between current income and population density of 1500 in non-former (former) European colonies (Spolaore and Wacziarg 2013: 335), highlight the relevance of colonial rule for economic outcomes in the New World.

### 4.2.1 Geographical Roots of Colonial Institutions

Colonialism was promoted by the European long-term effort to exploit the economic opportunities in underpopulated or underdefended territories around the world (Sokoloff and Engerman 2000: 220). For example, the weak tropical economies were characterised by a geopolitical and military weakness relative to temperate zone economies. Therefore, the vulnerability to the colonizers was high (Sachs 2001: 25). In consequence, European colonists were able to enforce their profit interests at the expense of the tropical native population (Sokoloff and Engerman 2000: 220). However, the geography of a region determined the profit potential and the viability of settlement, and therefore whether extractive or inclusive institutions were implemented (Acemoglu 2009: 157). Extractive institutions were implemented in regions whose initial factor endowments promised high returns and which were not suitable for the settlement of European settlers (Sokoloff and Engerman 2000: 220). Therefore, whether extractive or inclusive institutions were implemented in the New World and whether conflicting interests of the population in one region have existed depend on different factors: (1) the population density (2) the agricultural productivity of cash crop cultivation, (3) the

disease environment and (4) the topography.

**Agricultural Productivity** Firstly, whether extractive or inclusive institutions were implemented depended on the *agricultural productivity* of a region. On the one hand, *extractive institutions* were implemented especially in regions that were suitable for growing cash crops (sugar, coffee, rice, tobacco and other crops with high market value) and enabled economies of scale. These institutions led to slave economies that were managed by the social elite and maintained by them through appropriate policies and institutions. The result was a great inequality and low incentives for investment and innovation (Engerman and Sokoloff 1994, cited by Spolaore and Wacziarg 2013: 333-335). On the other hand, *inclusive institutions* were implemented in regions that could not take advantage of the high prices of cash crops and economies of scale, but were only suitable for small-scale crops (grain and livestock). This led to a relatively equal distribution of land, wealth and political power, which had a positive impact on long-term economic performance (Engerman and Sokoloff 1994, cited by Spolaore and Wacziarg 2013: 333-335).

**Disease Environment** Acemoglu, Simon Johnson, and James A. Robinson (2001: 1370) argue that the settlement patterns were also affected by the feasibility of regions determined by the disease environment, which is a biogeographical indirect channel. In regions with a low mortality rate, European settlers implemented good, productivity-enhancing institutions. In contrast, poor, productivity-inhibiting institutions were implemented in biogeographically survival-hostile regions (Acemoglu, Johnson, and Robinson 2001b and Acemoglu, Johnson, and Robinson 2002, cited by Spolaore and Wacziarg 2013: 333). Hence, regions, which were not suitable for "neo-Europes", had a higher probability of experiencing the implementation of extractive institutions (Acemoglu, Simon Johnson, and James A. Robinson 2001: 1370). Additionally, the higher *population density* further aggravated the *disease environment*. Formerly relatively rich and densely populated regions, which were characterised by malaria and yellow fever, acquired extractive institutions in the course of colonisation. In contrast, sparsely populated, poor and economically unattractive regions, which had an low disease burden, experienced a high migration of Europeans and good, inclusive institutions (Acemoglu 2009: 157).

**Labour Endowment** Whether extractive or inclusive institutions were implemented depended on the *population density* of a region. South American regions were more attractive to Native Americans, hence the population density in these regions was greater than in North America (Spolaore and Wacziarg 2013: 333-335). Furthermore, inclusive institutions that promote investment were implemented in regions that had a low population density and low urbanisation rates (Acemoglu, Johnson, and Robinson 2001b and Acemoglu, Johnson, and Robinson 2002, cited by Spolaore and Wacziarg 2013: 333).

**Ruggedness and Landlockedness (Topography)** The *topography* influenced the viability and profitability of a region for the colonisers. Nunn and Puga (2012: 32-34) argue that terrain ruggedness has in Non-African countries a negative direct, but in African countries a positive effect on income. The reason for this observation can be partly explained by the negative effect of ruggedness on agriculture, construction and trade, but also by positive historical effect exclusively within Africa because the regional ruggedness provided protection from slave traders. They find that the historical (indirect) positive effect is twice as large as the negative (direct) contemporary effect in the African context.

**Identity of the Colonial Power** In addition, a hypothesis states that whether extractive or inclusive institutions were implemented depends on the *nationality of the colonizer*, called the national heritage, which represents an exogenous factor. North (2000b) attributed the relative success of the USA and Canada to British institutions being more conducive to growth than those of Spain and other European colonizers (Sokoloff and Engerman 2000: 218). Additionally, Sokoloff and Engerman (2000: 218-219) state, that the former British colonies (Canada, USA, Australia) are relatively rich in comparison to former colonies with a different colonial heritage (e.g, Spanish and French). However, Sokoloff and Engerman (2000: 218-219) add that regardless of the nationality of the coloniser, Caribbean colonial economies were similarly successful during the colonial era. In addition, the Industrialisation started late not only in former non-British colonies, but also in former British colonies. Even though having a French colonial heritage is associated significantly to a lower GDP, illustrated in table 10, this effect becomes insignificant when controlling for the malaria incidence

and climate in table 11. Thus, other factors than the national heritage might be more relevant for economic growth.

### 4.2.2 The Contemporary Effect of the Colonial Heritage

Colonial rule hindered economic growth in the colonies in the past due to (1) the relative neglect of essential public goods (esp. primary education and basic health care for the indigenous population), (2) the suppression of higher education among the colonised population, (3) the creation of repressive political mechanisms (e.g. forced labour and poll taxes) to extract resources from the local population, and (4) the active suppression of local industry in favour of cash crops and extractive industry (Sachs 2001: 25). Additionally, the heterogeneous settlement pattern during the colonization implied a factor movement of labour from Europe to North and South America. Therefore, a homogenous transfer of not only institutions but also human capital occurred (Glaeser et al. 2004b: 274, cited by Spolaore and Wacziarg 2013: 274). In consequence, as the colonists settled mostly in North America and Australia, these regions received an increase in their human capital stock, hence affecting research and development outcomes and technological diffusion rates, leading to an earlier industrialisation.

To examine the GDP per capita in 1995 as a function of the duration of colonial rule, Sachs (2001: 25-26) uses (1) the proportion of the population living near the coast, (2) the proportion of the population living in a tropical climate, (3) the proportion of years with open trade policies during 1965-90, (4) hydrocarbon production per capita, and (5) a dummy variable equal to 1 if the country became independent after 1945. The effect of the dummy is highly significant and negative. New states that emerged or gained independence after 1945 had a GDP per capita of 59 per cent relative to the GDP per capita of the old states, i.e., those that were not colonised. This implies that the colonial period had a negative effect on the tropical development and thus increased the divergence, affecting contemporary outcomes. In consequence, tropical climates have a GDP per capita of 44 per cent relative to non-tropical zones. Furthermore, Gallup, Sachs, and Mellinger (1999: 200-201) regress a combination of political and economic institutional (socialism, the time under colonial rule, openness, government quality) and geographical variables (coastal population, spatial distance to New York, Rotterdam or Tokyo; malaria dummy; and the endowment of hydrocarbons p.c.) on

the GDP p.c. in 1995, accounting for 88% of the variation in p.c. income. The model predicts a negative effect of socialism, being a new state and the presence of malaria, and a positive effect of all other variables. In addition, the exclusion of the malaria variable increases the New state variable, suggesting an increase in the vulnerability of tropical zones to colonization. Moreover, I argue that the increase in the significance of the dummy may also be due to the fact that the settlement of colonists displaced the Native population in areas that were not suitable for settlements. Accordingly, it may be that an increased incidence of malaria in the New World, which undoubtedly has negative economic effects, was aggravated by colonialism. Furthermore, Sachs (2001: 26) states that the dominance of the Old World over the New World nations and the backwardness of the poor countries continues. In the post-colonial era, the economically relatively successful countries had more international political influence. For example, as the rich countries have a voting majority in the International Monetary Fund, they are able to enforce their profit-orientated interests by delaying and blocking the relief of the debts of heavily indebted Third World countries (Sachs 2001: 25-26). Furthermore, table 12 shows that regions which were colonized for a long time are linked to a decrease in GDP (NTLGDP) p.c. by 0.83% (-1.05%). A short colonial experience, however, is significantly linked to an increase in NTLGDP by 0.51%. In conclusion, these important results suggest that the observed correlation between geographic variables and per capita income is probably not primarily due to direct effects of geography on productivity. Instead, the geography had an indirect effect by causing long-term changes in non-geographic variables (Spolaore and Wacziarg 2013: 332). These changes still have an influence on current economic and political institutions, thus affecting economic growth.

# 5 Concluding Remarks

All things considered, both the geography hypothesis and the institutional hypothesis have a high relevance as determinants of growth.The previous sections have shown that, with respect to the geography hypothesis, non-temperate climates are directly correlated with a low agricultural productivity, a low health status due to a high disease burden, and the absence of energy resources. Furthermore, the geography affects tropical economic outcomes through its negative effect on the diffusion of technolo-

gies, by hampering the demographic transition, and by complicating the integration into world trade in the case of landlocked countries. Additionally, with respect to the institutions hypothesis, institutions can inhibit or foster growth by being extractive or inclusive. Moreover, as the colonialism hypothesis highlights, institutions can counteract the negative effect of adverse geographic conditions or induce a negative reversal effect by being extractive. The usage of NTL data has shown, that regressing geographical and institutional variables on the NTLGDP published instead of the GDP, published by the World Bank, results in higher adjusted $R^2$. Therefore, the usage of the NTLGDP might be the better choice for future research. However, even though the correlation between the geographic and institutional variables and the per capita income, as well as the adjusted $R^2$ are convincing, no one-directed independent causal effect can be guaranteed. In consequence, economic failure due to geography is not a predetermined destiny, which also applies to economic success. Whether the backward nations will catch up with the successful nations of the Global North remains to be seen.

# 6 Appendix

## Overview

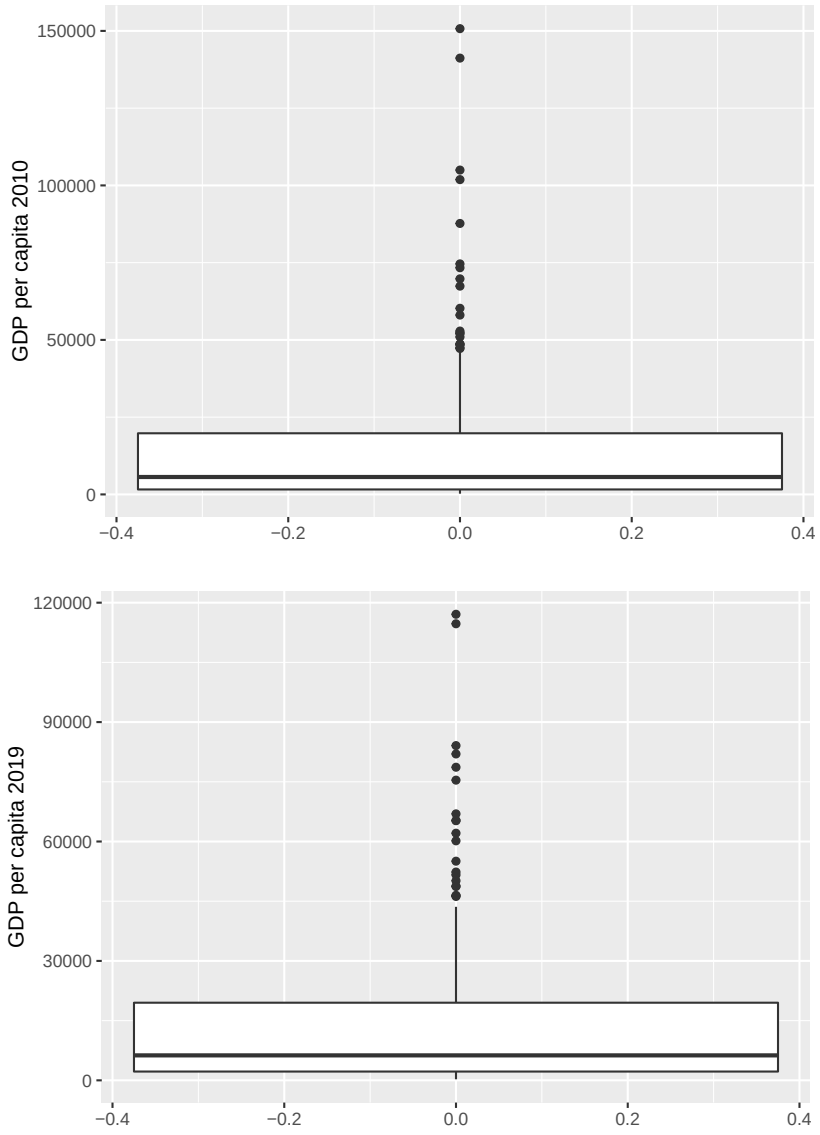


Figure 1: GDP p.c. (PPP) in 2010 & 2019; Data: Data: The World Bank (*Indicator: NY.GDP.PCAP.PP.CD*), and The World Bank (*Indicator: SP.POP.TOTL*)

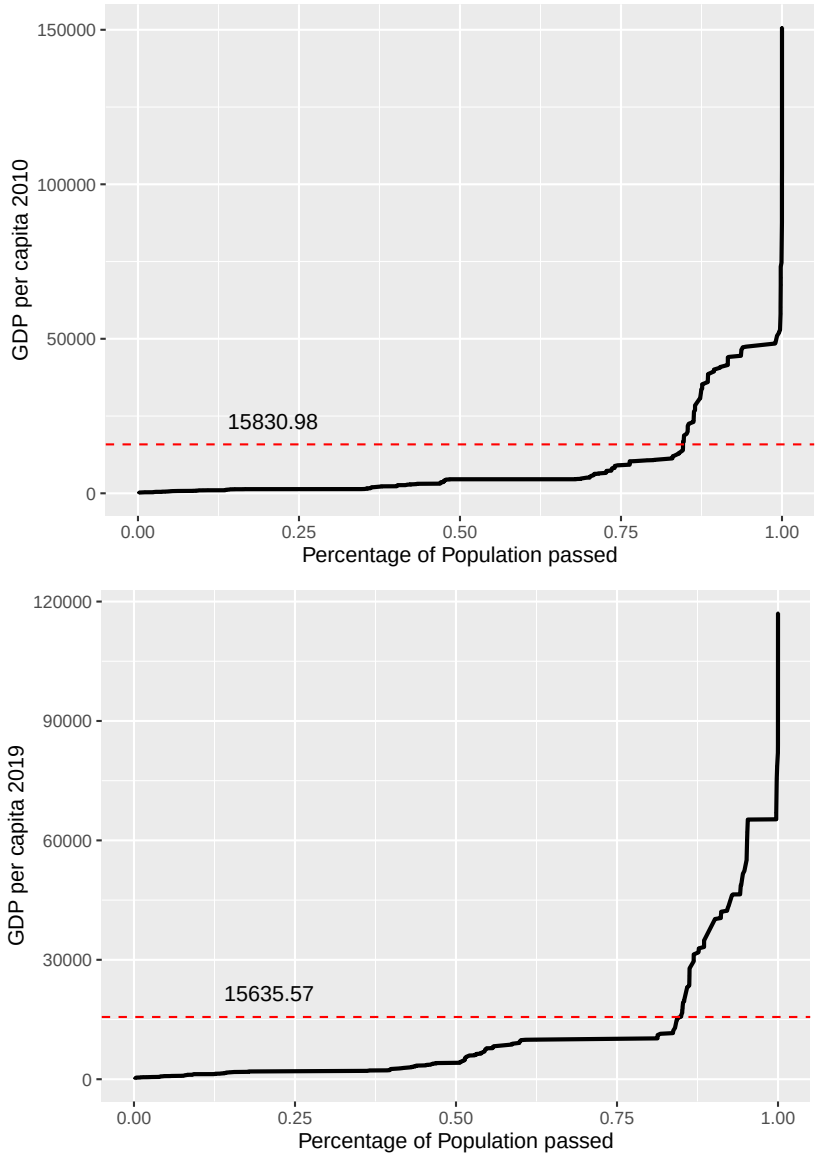


Figure 2: GDP p.c. (PPP) in 2010 & 2019 by percentage of global population passed, the red line indicates the mean GDP per capita; Data: The World Bank (*Indicator: NY.GDP.PCAP.PP.CD*), and The World Bank (*Indicator: SP.POP.TOTL*)

**Comment on Usage of NTL GDP Estimates** The usage of GDP measured at PPP, which controls for the different price levels, mostly relative to the US dollar, is controversial. Most research with respect to the *fundamental determinants* of economic growth do not give attention to informal markets, which account for a large share of actual production, especially in developing countries. Furthermore, developing economies are characterised by a large share of self-service and subsistence economy, which are obviously not included in the GDP. This leads to an underestimation of the actual economic development and to an overestimation of the relevance of the geography and institutions. An alternative approach uses NTL Data to estimate the economic development and income of a region. Even though Bickenbach et al. (2016) highlight that the NTL is a reliable indicator of GDP at the national level but inaccurate at the sub-national level, I assume here that the underground economy is taken into account by the NTL as an indicator, based on the findings by Hu and Yao (2019) and Henderson (2009). As table 1 shows, the GDP and NTLGDP are highly correlated. Thus, similar outcomes might be possible. In addition, the spatial distribution of income illustrated in fig. 5 and fig. 4 is similar to the distribution illustrated in fig. 3.

Table 1: Cross-correlation table

| Variables | NTLGDPp.c.2010 | GDPp.c.2010 |
|---|---|---|
| NTLGDPp.c.2010 | 1.000 | |
| GDPp.c.2010 | 0.817 | 1.000 |

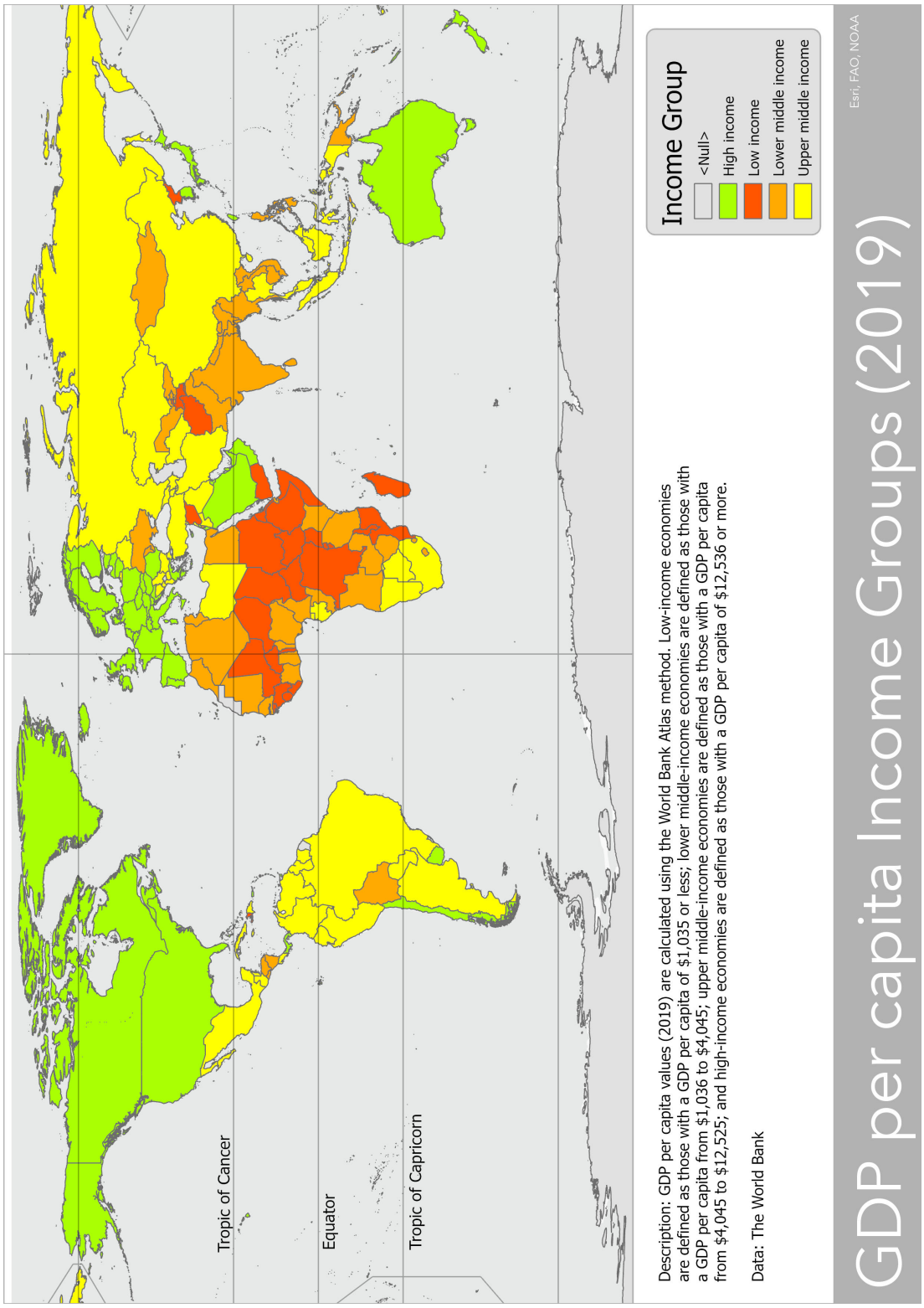


Figure 3: Map of GDP per capita (2019) by income groups; Data provided by The World Bank (*World Bank Country and Lending Groups*).

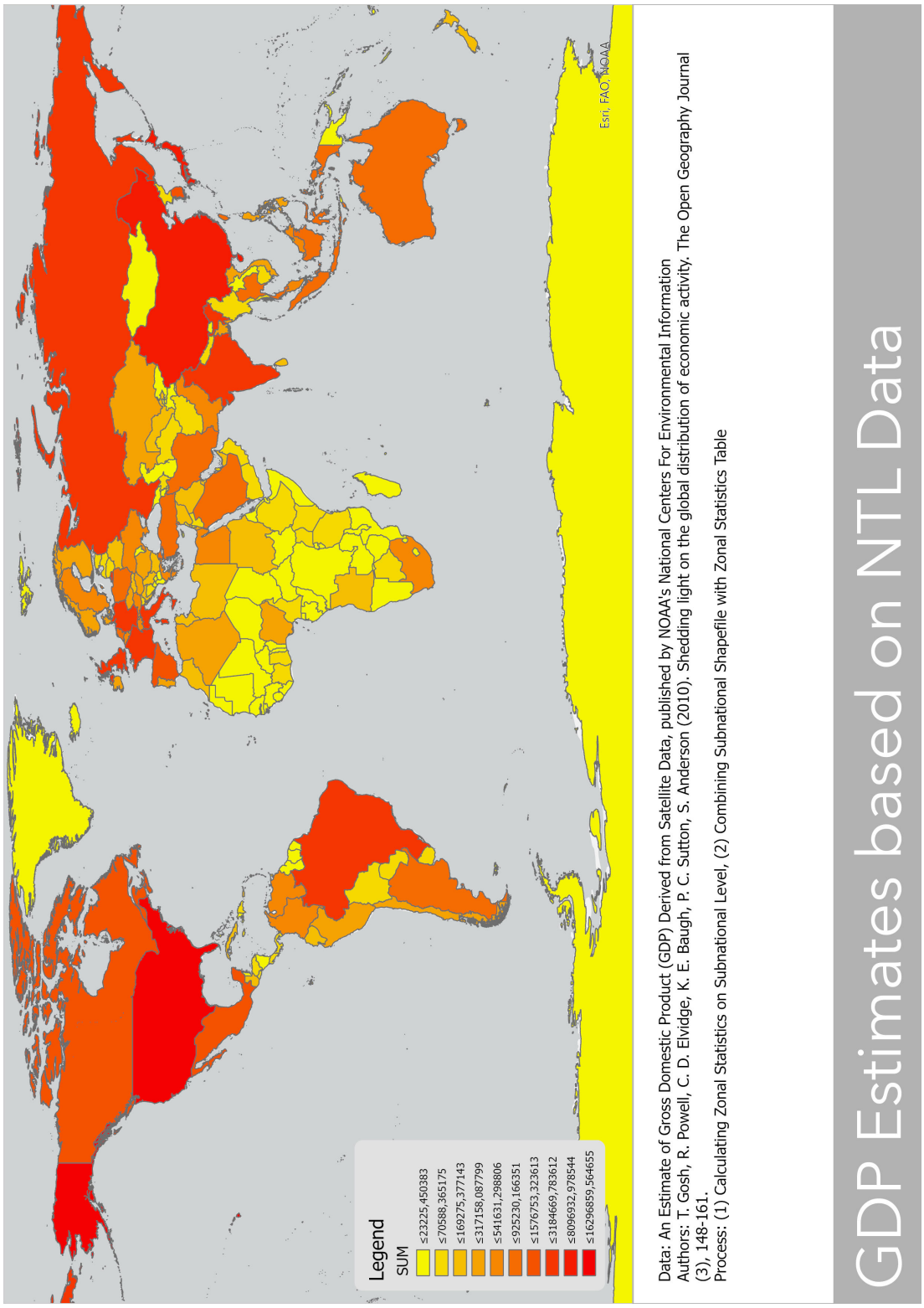


Figure 4: GDP estimates based on Night Time Light Data; Data provided by Lazar (2010).

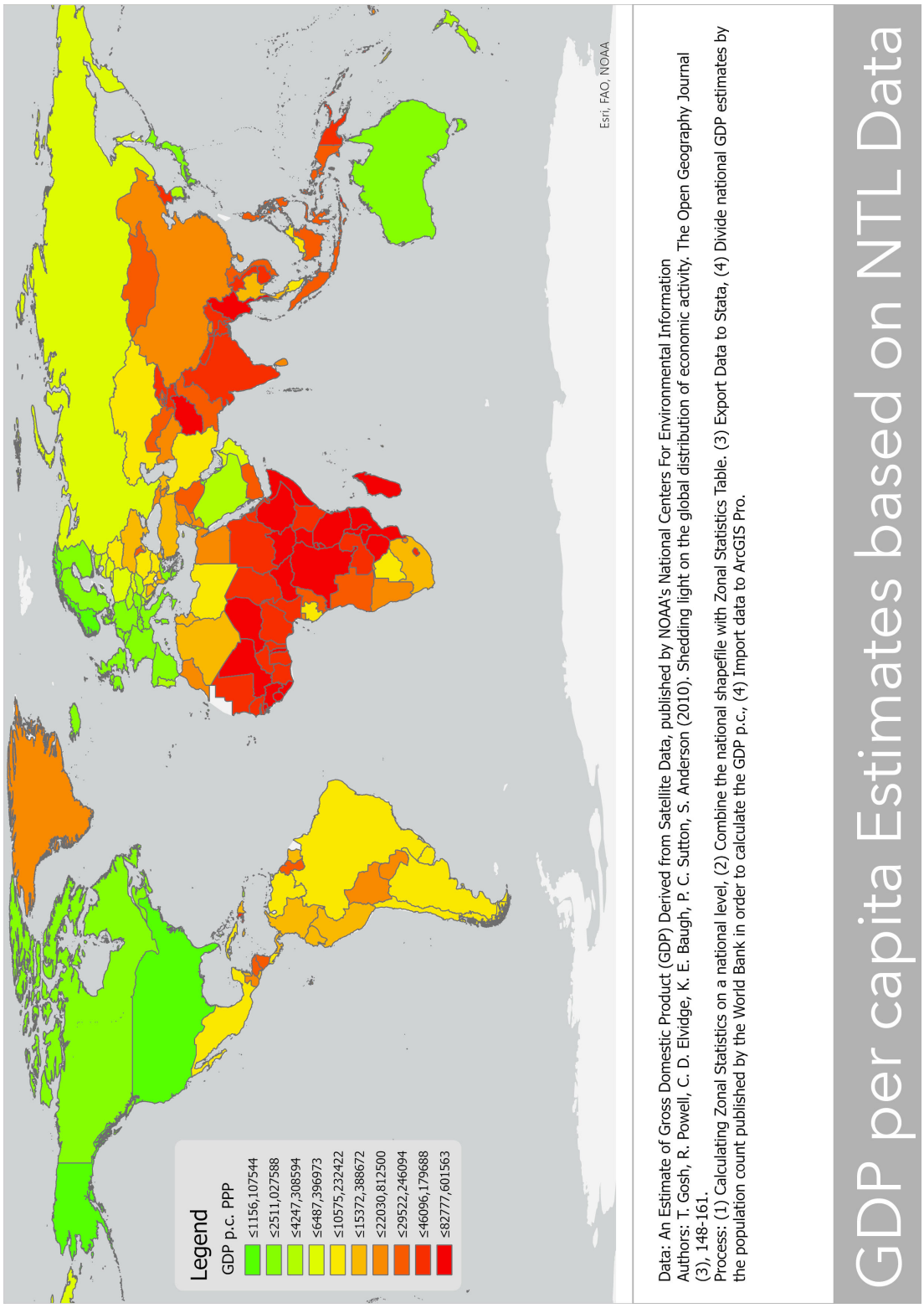


Figure 5: GDP p.c. estimates based on Night Time Light Data; Data provided by Lazar (2010).

## Fundamental Determinants of Growth

### Geography Hypothesis

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| VARIABLES | NTLGDP | GDP | NTLGDP | GDP | NTLGDP | GDP |
| percentage_sum_A | | | -1.38*** | -1.68*** | | |
| | | | (0.22) | (0.24) | | |
| percentage_sum_B | | | -0.75*** | -1.27*** | | |
| | | | (0.28) | (0.30) | | |
| dummy_temperate | 1.07*** | 1.37*** | | | | |
| | (0.21) | (0.23) | | | | |
| percentage_sum_A_B | | | | | -1.20*** | -1.55*** |
| | | | | | (0.21) | (0.23) |
| Constant | 8.91*** | 8.44*** | 9.86*** | 9.68*** | 9.89*** | 9.71*** |
| | (0.10) | (0.11) | (0.16) | (0.17) | (0.16) | (0.17) |
| Observations | 158 | 162 | 158 | 162 | 158 | 162 |
| Adjusted R-squared | 0.13 | 0.17 | 0.19 | 0.23 | 0.17 | 0.22 |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 2: Linear Regression of climatic variables with the log GDP and log NTLGDP per capita (PPP) in 2010. Variable *percentage_sum_A* is the percentage of tropical land and *percentage_sum_A* is the percentage of arid land. The *dummy_temperate* is equal to one, if the cumulative percentage of *percentage_sum_A* and *percentage_sum_B* is smaller than *percentage_sum_C*, the latter being the percentage of temperate land. The variable *percentage_sum_A__B* is the sum of the percentage of tropical and arid land.

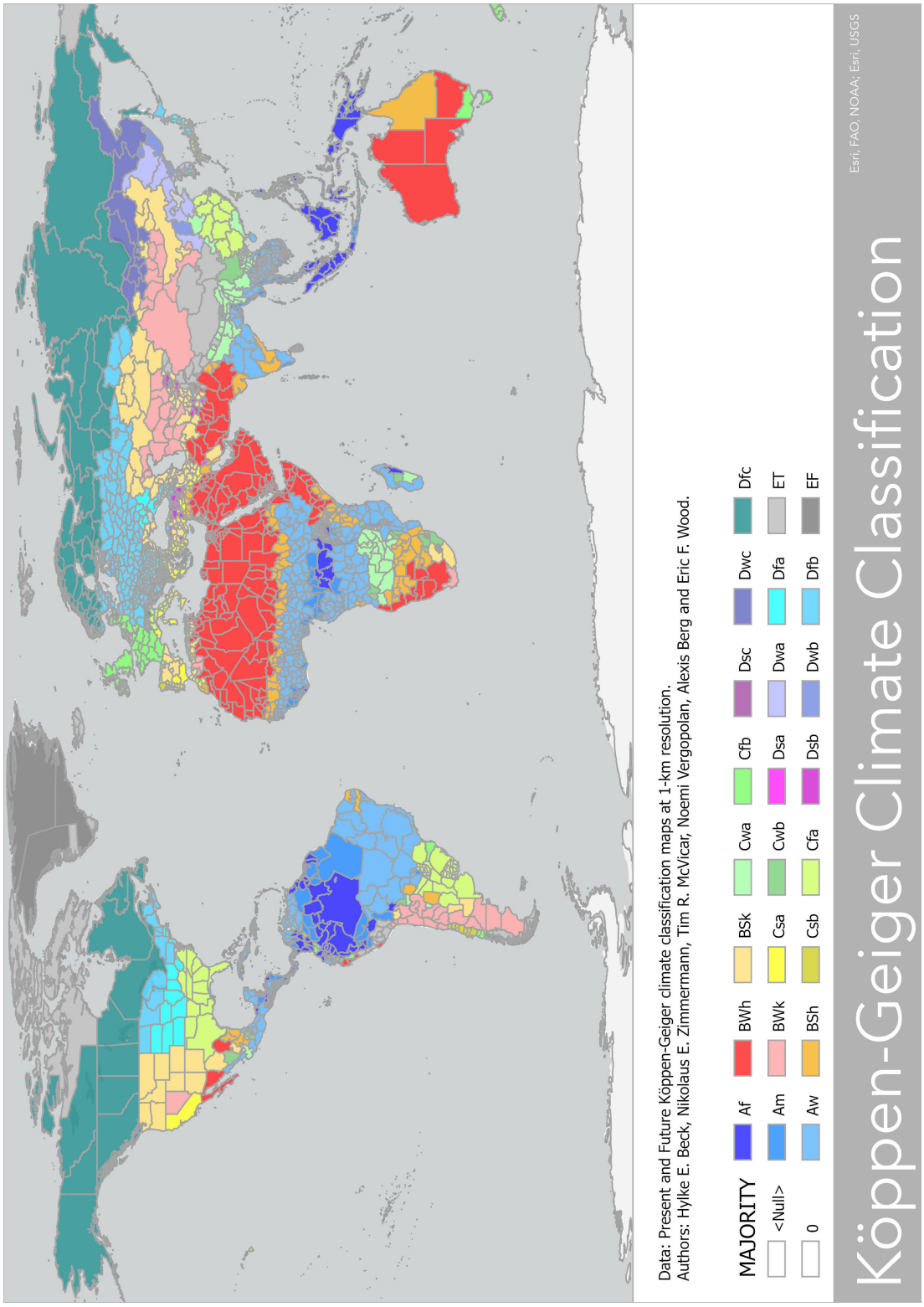


Figure 6: Köppen-Geiger climate classification map by subnational regions; Data provided by Beck et al. (2018). The first letter indicates the highes category. *A* is tropical climate, *B* is arid climate, *C* is temperate climate, *C* is cold climate, and *E* is polar climate.

### Malaria Incidence: *Plasmodium falciparium*

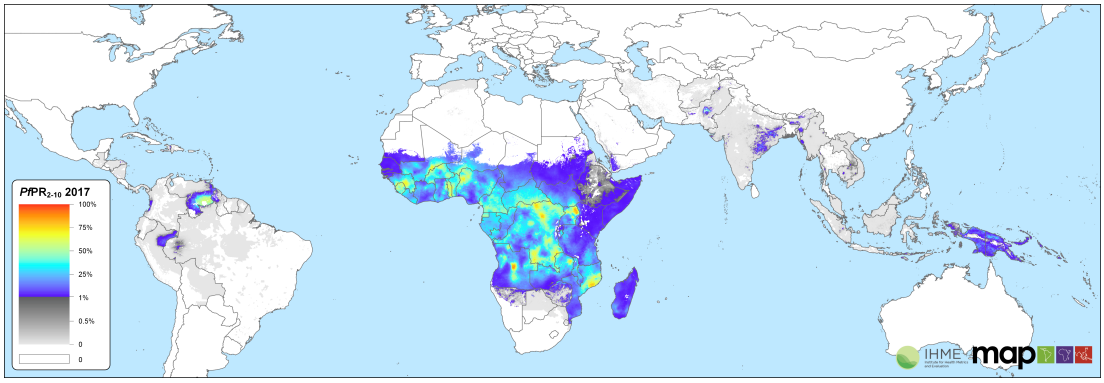


Figure 7: Malaria Plasmodium falciparium incidence; published by Weiss et al. (2019).

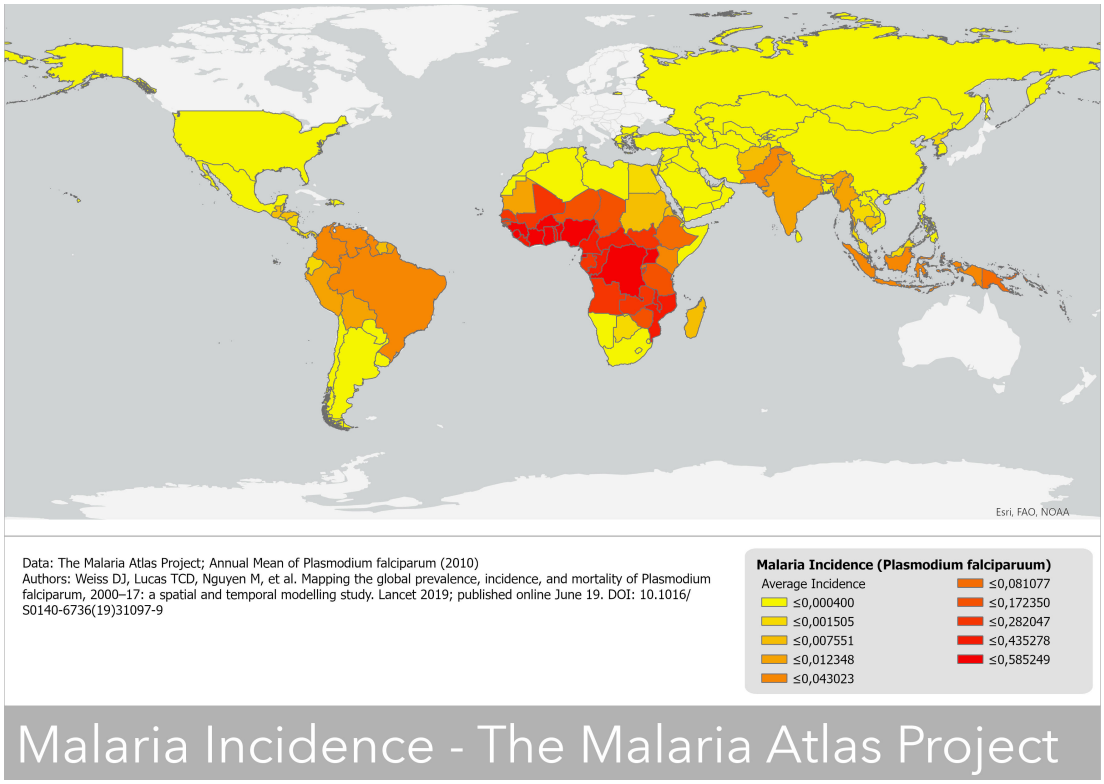


Figure 8: Map of the national mean incidence of Plasmodium falciparium; Data provided by Weiss et al. (2019).

## Malaria Incidence: *Plasmodium vivax*

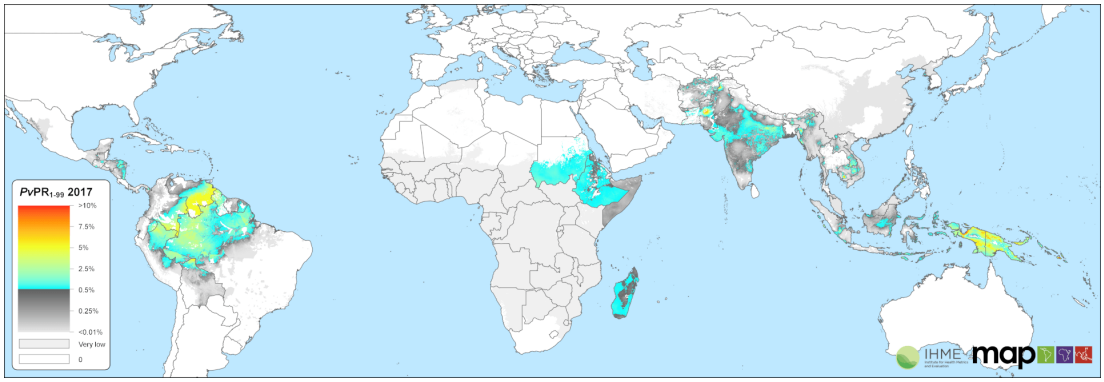


Figure 9: Malaria Plasmodium vivax incidence; published by Battle et al. (2019).

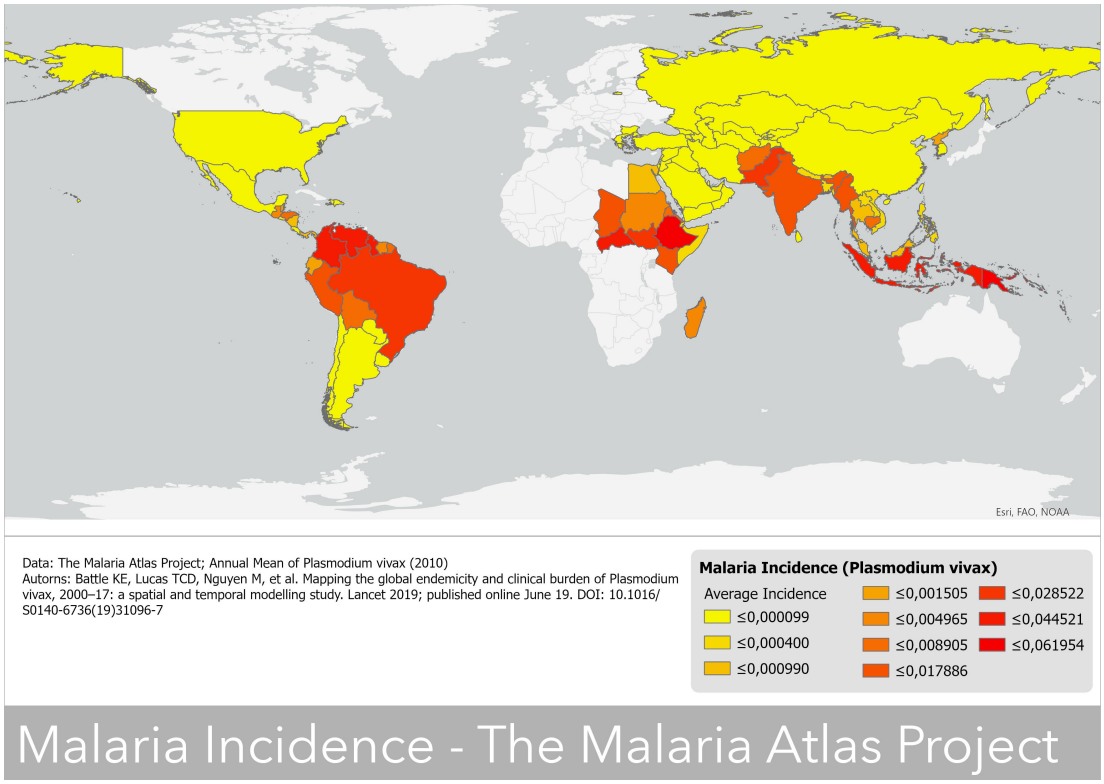


Figure 10: Map of the national mean incidence of Plasmodium vivax; Data provided by Battle et al. (2019).

**Malaria Incidence: *Plasmodium falciparium* and *vivax***

| | (1) |
|---|---|
| VARIABLES | GDP |
| malaria_dummy | -0.69*** |
| | (0.26) |
| Constant | 9.72*** |
| | (0.23) |
| Observations | 158 |
| Adjusted R-squared | 0.04 |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3: Linear Regression of the Colonizer Dummies with the log GDP and log NTL-GDP per capita (PPP) in 2010.

**Economic Integration, Openness and Trade**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| VARIABLES | GDP | NTLGDP | GDP | NTLGDP | GDP | NTLGDP |
| (mean) lat | 0.02*** | 0.03*** | | | | |
| | (0.00) | (0.00) | | | | |
| (mean) lng | -0.00 | -0.00 | | | | |
| | (0.00) | (0.00) | | | | |
| 2010 outclosenness | | | 4.24*** | 5.64*** | | |
| | | | (0.58) | (0.60) | | |
| 1 if landlocked | | | | | -0.94*** | -0.98*** |
| | | | | | (0.23) | (0.26) |
| Constant | 8.75*** | 8.26*** | 5.75*** | 4.23*** | 9.34*** | 8.93*** |
| | (0.12) | (0.13) | (0.47) | (0.49) | (0.10) | (0.11) |
| Observations | 158 | 162 | 158 | 162 | 158 | 162 |
| Adjusted R-squared | 0.16 | 0.20 | 0.25 | 0.35 | 0.09 | 0.08 |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4: Linear Regression of the with the log GDP (NTLGDP) per capita (PPP) in 2010.

### Institutions

**Recitation of the definition given by the World Bank**

- CC.EST is the Control of Corruption Estimate. Control of Corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.

- GE.EST is the Government Effectiveness Estimate. Government Effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.

- PV.EST is the Political Stability and Absence of Violence/Terrorism Estimate. Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism.

- RQ.EST is the Regulatory Quality Estimate. Regulatory Quality captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.

- RL.EST is the Rule of Law Estimate. Rule of Law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.

- VA.EST is the Voice and Accountability Estimate. Voice and Accountability captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.

All estimates give the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5. All data were collected with an annual periodicity.

| VARIABLES | (1) GDP OverallScore | (2) GDP CC_EST | (3) GDP GE_EST | (4) GDP PV_EST | (5) GDP RL_EST | (6) GDP RQ_EST | (7) GDP VA_EST |
|---|---|---|---|---|---|---|---|
| GI_OverallScore2010 | 0.94*** | | | | | | |
| | (0.08) | | | | | | |
| CC_EST YR_GOV_2010 | | 0.79*** | | | | | |
| | | (0.07) | | | | | |
| GE_EST YR_GOV_2010 | | | 0.91*** | | | | |
| | | | (0.06) | | | | |
| PV_EST YR_GOV_2010 | | | | 0.71*** | | | |
| | | | | (0.08) | | | |
| RL_EST YR_GOV_2010 | | | | | 0.85*** | | |
| | | | | | (0.07) | | |
| RQ_EST YR_GOV_2010 | | | | | | 0.88*** | |
| | | | | | | (0.07) | |
| VA_EST YR_GOV_2010 | | | | | | | 0.56*** |
| | | | | | | | (0.09) |
| Constant | 9.22*** | 9.22*** | 9.16*** | 9.26*** | 9.23*** | 9.15*** | 9.21*** |
| | (0.07) | (0.07) | (0.06) | (0.08) | (0.07) | (0.07) | (0.09) |
| Observations | 158 | 158 | 158 | 158 | 158 | 158 | 158 |
| Adjusted R-squared | 0.49 | 0.45 | 0.56 | 0.31 | 0.50 | 0.48 | 0.20 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Linear Regression of the Worldwide Governance Indicators with the GDP per capita (PPP) in 2010. Data: *Worldwide Governance Indicators*

| VARIABLES | (1) GDP OverallScore | (2) GDP CC_EST | (3) GDP GE_EST | (4) GDP PV_EST | (5) GDP RL_EST | (6) GDP RQ_EST | (7) GDP VA_EST |
|---|---|---|---|---|---|---|---|
| GI_OverallScore2010 | 1.12*** | | | | | | |
| | (0.08) | | | | | | |
| CC_EST YR_GOV_2010 | | 0.95*** | | | | | |
| | | (0.07) | | | | | |
| GE_EST YR_GOV_2010 | | | 1.08*** | | | | |
| | | | (0.06) | | | | |
| PV_EST YR_GOV_2010 | | | | 0.81*** | | | |
| | | | | (0.09) | | | |
| RL_EST YR_GOV_2010 | | | | | 1.01*** | | |
| | | | | | (0.07) | | |
| RQ_EST YR_GOV_2010 | | | | | | 1.03*** | |
| | | | | | | (0.07) | |
| VA_EST YR_GOV_2010 | | | | | | | 0.74*** |
| | | | | | | | (0.09) |
| Constant | 8.86*** | 8.84*** | 8.78*** | 8.88*** | 8.86*** | 8.78*** | 8.84*** |
| | (0.07) | (0.07) | (0.06) | (0.09) | (0.07) | (0.07) | (0.09) |
| Observations | 162 | 162 | 162 | 162 | 162 | 162 | 162 |
| Adjusted R-squared | 0.57 | 0.51 | 0.63 | 0.33 | 0.57 | 0.57 | 0.30 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Linear Regression of the World Bank Governance Indicators with the NTLGDP per capita (PPP) in 2010. Data: *Worldwide Governance Indicators*

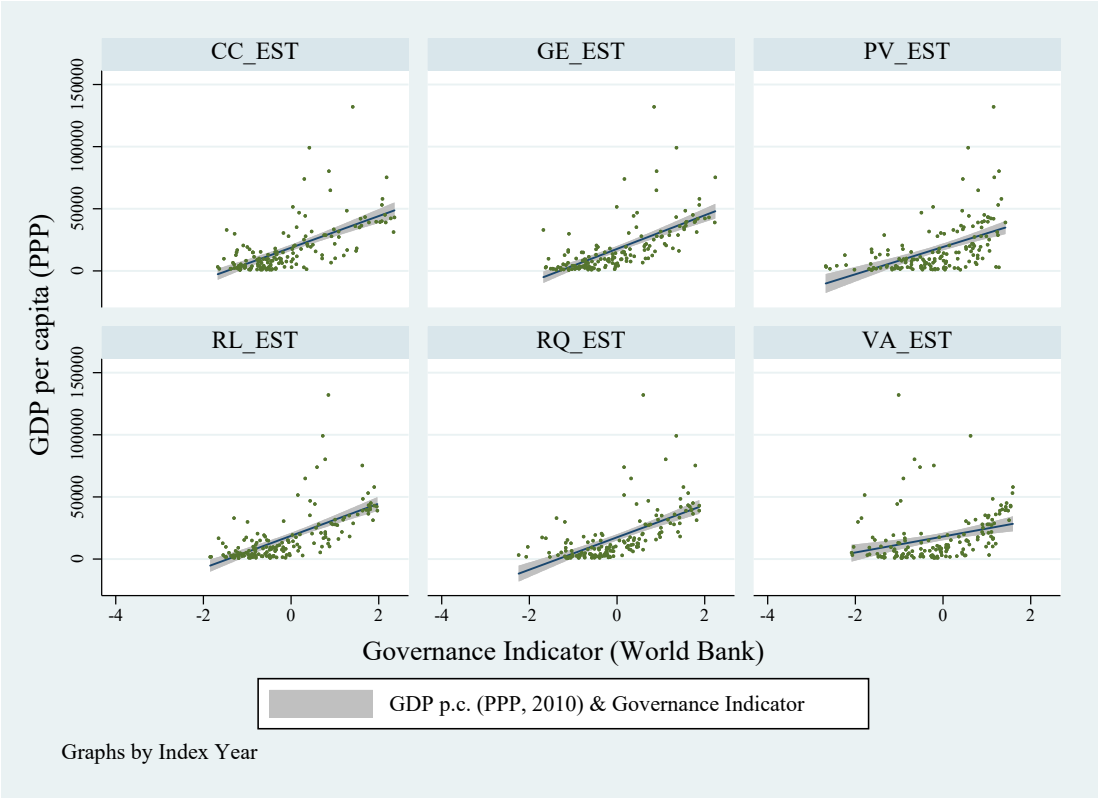


Figure 11: Correlation of the Worldwide Governance Indicators with the GDP per capita (PPP) in 2010; Data provided by Kaufmann and Kraay (*Worldwide Governance Indicators*)

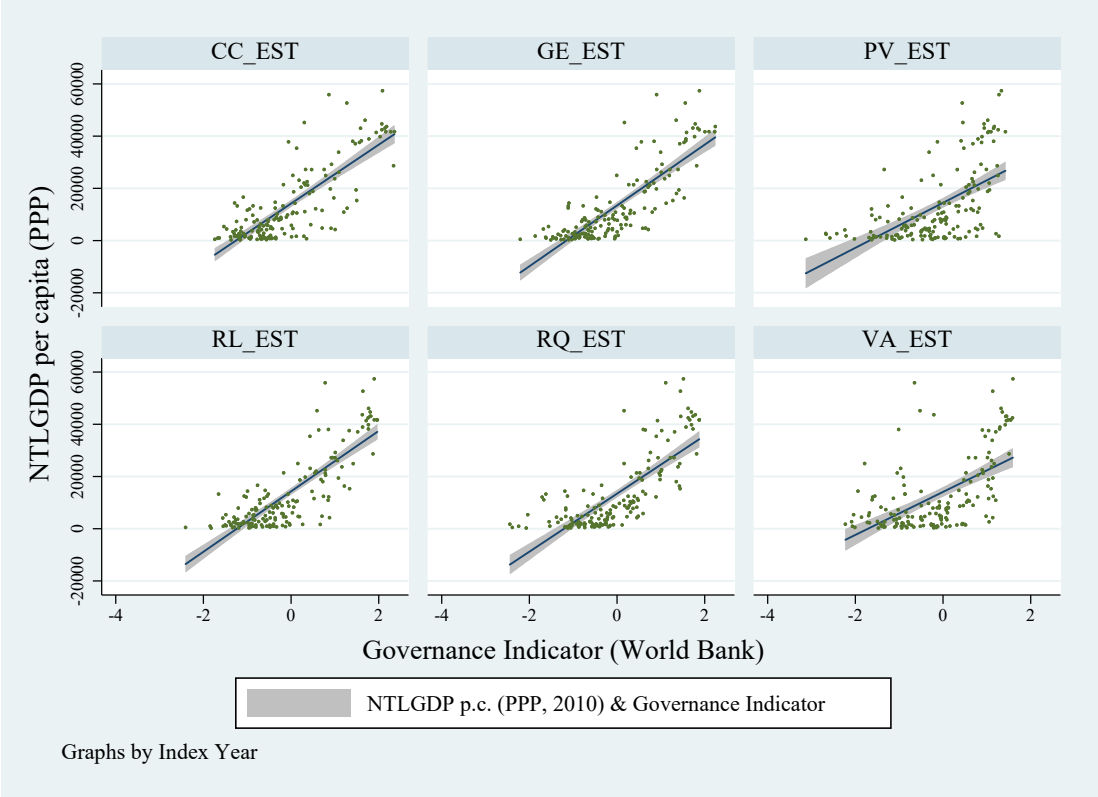


Figure 12: Correlation of the Worldwide Governance Indicators with the NTLGDP per capita (PPP) in 2010; Data provided by Kaufmann and Kraay (*Worldwide Governance Indicators*)

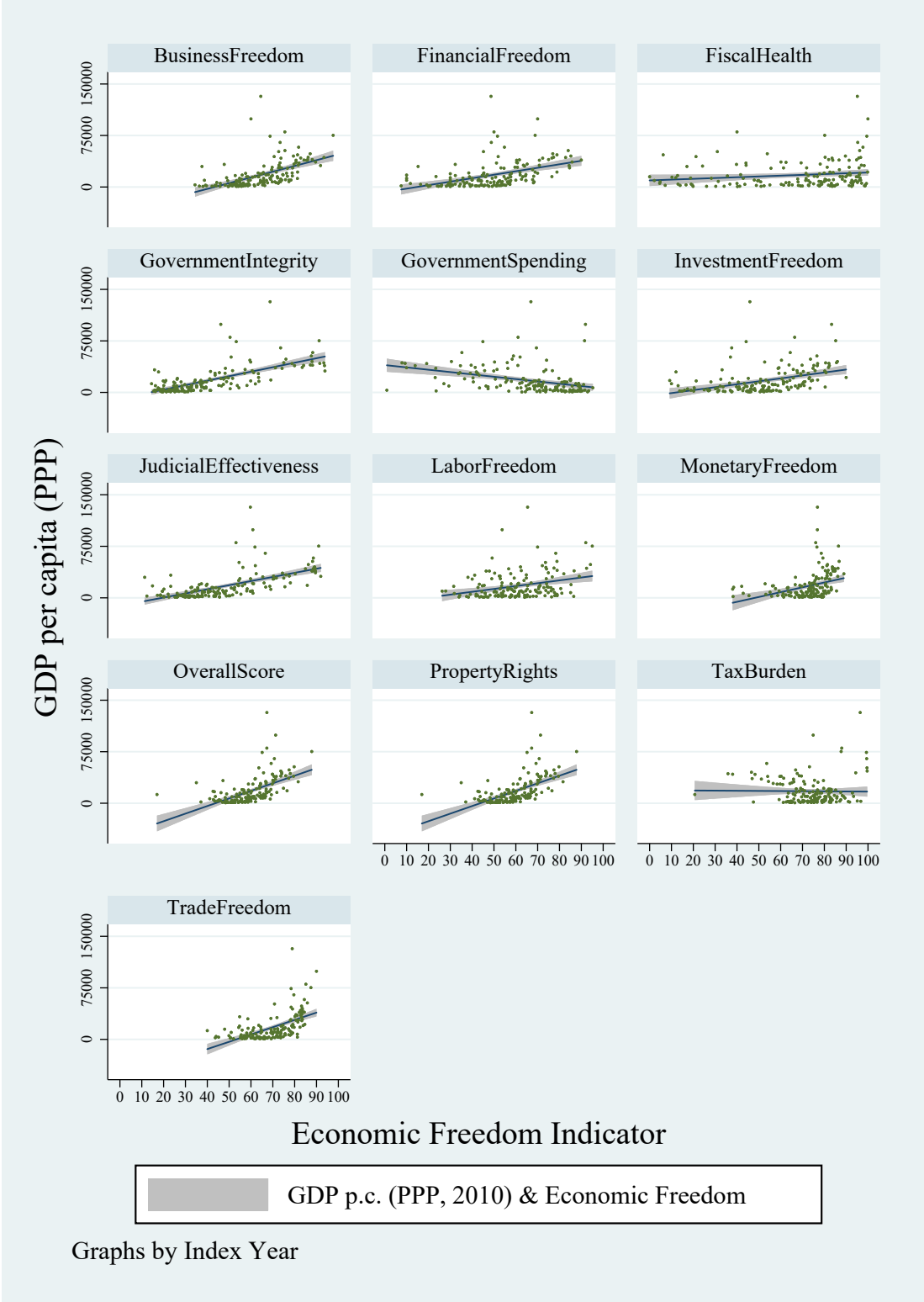


Figure 13: Correlation of the Economic Freedom Indicators with the GDP per capita (PPP) in 2010.

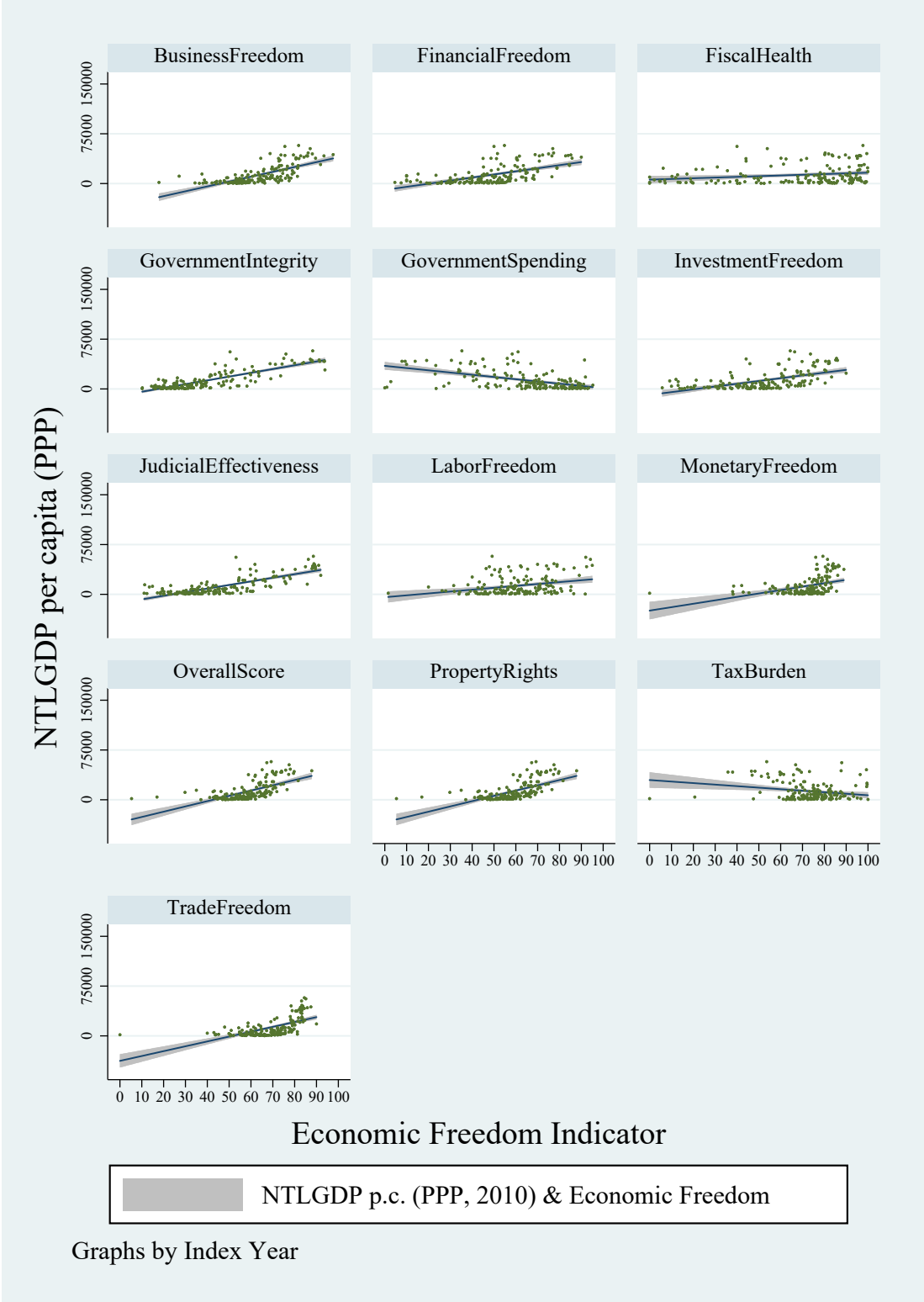


Figure 14: Correlation of the Economic Freedom Indicators with the NTLGDP per capita (PPP) in 2010.

### Rule of Law

| VARIABLES | (1) GovernmentIntegrity GDP_PPP_pc_2010 | (2) JudicialEffectiveness GDP_PPP_pc_2010 | (3) PropertyRights GDP_PPP_pc_2010 |
|---|---|---|---|
| EcoFrMEAN | 652.9*** | 600.0*** | 1,104*** |
| | (56.59) | (61.61) | (132.2) |
| Constant | -8,996*** | -11,590*** | -48,270*** |
| | (2,576) | (3,239) | (7,979) |
| Observations | 158 | 158 | 158 |
| R-squared | 0.460 | 0.378 | 0.309 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 15: Linear Regression of the Rule of Law Indices with the GDP per capita (PPP) in 2010; Data provided by The Heritage Foundation

| VARIABLES | (1) GovernmentIntegrity GDP_NTL_PPP_pc_2010 | (2) JudicialEffectiveness GDP_NTL_PPP_pc_2010 | (3) PropertyRights GDP_NTL_PPP_pc_2010 |
|---|---|---|---|
| EcoFrMEAN | 569.8*** | 541.6*** | 795.3*** |
| | (29.32) | (32.93) | (78.91) |
| Constant | -9,878*** | -12,948*** | -33,883*** |
| | (1,321) | (1,713) | (4,731) |
| Observations | 162 | 162 | 161 |
| R-squared | 0.702 | 0.628 | 0.390 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 16: Linear Regression of the Rule of Law Indices with the NTLGDP per capita (PPP) in 2010; Data provided by The Heritage Foundation

### Government Size

| VARIABLES | (1) FiscalHealth GDP_PPP_pc_2010 | (2) GovernmentSpending GDP_PPP_pc_2010 | (3) TaxBurden GDP_PPP_pc_2010 |
|---|---|---|---|
| EcoFrMEAN | 115.0** | -340.0*** | -20.11 |
| | (57.23) | (71.09) | (129.5) |
| Constant | 9,648** | 39,845*** | 18,949* |
| | (4,197) | (4,913) | (9,697) |
| Observations | 158 | 158 | 158 |
| R-squared | 0.025 | 0.128 | 0.000 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Linear Regression of the Government Size Indices with the GDP per capita (PPP) in 2010; Data provided by The Heritage Foundation

| VARIABLES | (1) FiscalHealth GDP_NTL_PPP_pc_2010 | (2) GovernmentSpending GDP_NTL_PPP_pc_2010 | (3) TaxBurden GDP_NTL_PPP_pc_2010 |
|---|---|---|---|
| EcoFrMEAN | 104.7*** | -336.0*** | -229.8*** |
| | (38.15) | (43.63) | (79.23) |
| Constant | 5,916** | 34,829*** | 29,744*** |
| | (2,767) | (2,997) | (5,913) |
| Observations | 162 | 161 | 162 |
| R-squared | 0.045 | 0.272 | 0.050 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8: Linear Regression of the Government Size Indices with the NTLGDP per capita (PPP) in 2010; Data provided by The Heritage Foundation

### Regulatory Efficiency

| VARIABLES | (1) BusinessFreedom GDP_PPP_pc_2010 | (2) LaborFreedom GDP_PPP_pc_2010 | (3) MonetaryFreedom GDP_PPP_pc_2010 |
|---|---|---|---|
| EcoFrMEAN | 836.2*** | 416.1*** | 704.0*** |
| | (104.3) | (107.5) | (152.8) |
| Constant | -36,164*** | -7,865 | -33,973*** |
| | (6,823) | (6,719) | (11,266) |
| Observations | 158 | 158 | 158 |
| R-squared | 0.292 | 0.088 | 0.120 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 17: Linear Regression of the Regulatory Efficiency Indices with the GDP per capita (PPP) in 2010; Data provided by The Heritage Foundation

| VARIABLES | (1) BusinessFreedom GDP_NTL_PPP_pc_2010 | (2) LaborFreedom GDP_NTL_PPP_pc_2010 | (3) MonetaryFreedom GDP_NTL_PPP_pc_2010 |
|---|---|---|---|
| EcoFrMEAN | 732.0*** | 284.4*** | 516.0*** |
| | (58.77) | (69.59) | (90.64) |
| Constant | -33,604*** | -4,291 | -24,464*** |
| | (3,817) | (4,337) | (6,655) |
| Observations | 162 | 162 | 161 |
| R-squared | 0.492 | 0.095 | 0.169 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 18: Linear Regression of the Regulatory Efficiency Indices with the NTLGDP per capita (PPP) in 2010; Data provided by The Heritage Foundation

**Market Openness**

| VARIABLES | (1) FinancialFreedom GDP_PPP_pc_2010 | (2) InvestmentFreedom GDP_PPP_pc_2010 | (3) TradeFreedom GDP_PPP_pc_2010 |
|---|---|---|---|
| EcoFrMEAN | 506.3*** | 428.0*** | 1,063*** |
| | (81.60) | (80.66) | (122.0) |
| Constant | -7,401* | -5,227 | -56,659*** |
| | (4,256) | (4,523) | (8,607) |
| Observations | 158 | 158 | 158 |
| R-squared | 0.198 | 0.153 | 0.327 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 19: Linear Regression of the Market Openness Indices with the GDP per capita (PPP) in 2010; Data provided by The Heritage Foundation

| VARIABLES | (1) FinancialFreedom GDP_NTL_PPP_pc_2010 | (2) InvestmentFreedom GDP_NTL_PPP_pc_2010 | (3) TradeFreedom GDP_NTL_PPP_pc_2010 |
|---|---|---|---|
| EcoFrMEAN | 466.3*** | 419.4*** | 732.0*** |
| | (49.57) | (49.44) | (71.94) |
| Constant | -9,596*** | -8,961*** | -37,619*** |
| | (2,562) | (2,748) | (5,048) |
| Observations | 161 | 161 | 161 |
| R-squared | 0.358 | 0.312 | 0.394 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 20: Linear Regression of the Market Openness Indices with the NTLGDP per capita (PPP) in 2010; Data provided by The Heritage Foundation

| VARIABLES | (1)<br>Model 7 | (2)<br>Model 8 | (3)<br>Model 9 | (4)<br>Model 10 |
|---|---|---|---|---|
| 2010 OverallScore | 822.45*** | | -14.71 | -252.68** |
| | (70.73) | | (91.61) | (116.78) |
| CC_EST YR_GOV_2010 | | | | 3,492.16* |
| | | | | (2,109.55) |
| GE_EST YR_GOV_2010 | | | | 2,726.99 |
| | | | | (2,398.61) |
| PV_EST YR_GOV_2010 | | | | -229.45 |
| | | | | (965.64) |
| RL_EST YR_GOV_2010 | | | | 6,205.26** |
| | | | | (2,791.97) |
| RQ_EST YR_GOV_2010 | | | | 5,834.50** |
| | | | | (2,406.07) |
| VA_EST YR_GOV_2010 | | | | -3,340.55*** |
| | | | | (1,039.40) |
| GI_OverallScore2010 | | 12,921.74*** | 13,445.26*** | |
| | | (700.41) | (1,193.77) | |
| Constant | -35,892.56*** | 14,450.52*** | 14,928.35*** | 28,737.96*** |
| | (4,318.88) | (647.73) | (5,572.41) | (6,982.67) |
| Observations | 171 | 176 | 171 | 171 |
| Adjusted R-squared | 0.44 | 0.66 | 0.68 | 0.74 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 21: Regression of estimated Night Time Light GDP p.c on institutional characteristics

## Conclusion: Geography and Institutions

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Model 1: Geography | Model 1: Geography | Model 2: Institutions | Model 2: Institutions | Model 3: Both | Model 3: Both |
| VARIABLES | GDP | NTLGDP | GDP | NTLGDP | GDP | NTLGDP |
| Pf_Pv_MEAN | -3.02*** | -3.45*** | | | -1.90*** | -2.30*** |
| | (0.55) | (0.59) | | | (0.43) | (0.44) |
| 1 if landlocked | -0.77*** | -0.60*** | | | -0.64*** | -0.52*** |
| | (0.19) | (0.20) | | | (0.14) | (0.15) |
| percentage_sum_A | -0.58*** | -0.38* | | | -0.36** | -0.29* |
| | (0.20) | (0.21) | | | (0.15) | (0.15) |
| 2010 outclosenness | 1.98*** | 3.72*** | | | 0.61 | 1.50*** |
| | (0.58) | (0.60) | | | (0.55) | (0.56) |
| GE_EST YR_GOV_2010 | | | 0.85*** | 0.87*** | 0.49*** | 0.39** |
| | | | (0.17) | (0.17) | (0.15) | (0.16) |
| PV_EST YR_GOV_2010 | | | 0.22** | 0.16* | 0.35*** | 0.34*** |
| | | | (0.09) | (0.09) | (0.08) | (0.08) |
| RQ_EST YR_GOV_2010 | | | 0.29* | 0.37** | 0.23 | 0.35** |
| | | | (0.17) | (0.18) | (0.15) | (0.15) |
| VA_EST YR_GOV_2010 | | | -0.44*** | -0.31*** | -0.39*** | -0.25*** |
| | | | (0.10) | (0.11) | (0.09) | (0.09) |
| Constant | 8.15*** | 6.26*** | 9.15*** | 8.78*** | 9.08*** | 7.97*** |
| | (0.53) | (0.54) | (0.06) | (0.06) | (0.47) | (0.47) |
| Observations | 158 | 162 | 158 | 162 | 158 | 162 |
| Adjusted R-squared | 0.47 | 0.52 | 0.61 | 0.65 | 0.71 | 0.76 |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 9: Linear Regression of 2010 log GDP and log NTLGDP per capita (PPP) on geographical and institutional variables.

# Discussion

## Colonialism

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| VARIABLES | GDP | GDP | GDP | NTLGDP | NTLGDP | NTLGDP |
| dummy_GBR_long | 0.07 | | | -0.16 | | |
| | (0.21) | | | (0.23) | | |
| dummy_ESP_long | | 0.12 | | | 0.29 | |
| | | (0.29) | | | (0.32) | |
| dummy_FRA_long | | | -1.01*** | | | -0.98*** |
| | | | (0.24) | | | (0.27) |
| Constant | 9.12*** | 9.13*** | 9.33*** | 8.78*** | 8.70*** | 8.91*** |
| | (0.11) | (0.10) | (0.10) | (0.13) | (0.11) | (0.11) |
| Observations | 158 | 158 | 158 | 162 | 162 | 162 |
| Adjusted R-squared | -0.01 | -0.01 | 0.10 | -0.00 | -0.00 | 0.07 |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 10: Linear Regression of the Colonizer Dummies with the log GDP per capita (PPP) in 2010.

| | (1) | (2) |
|---|---|---|
| VARIABLES | GDP | NTLGDP |
| dummy_FRA_long | -0.31 | -0.14 |
| | (0.22) | (0.23) |
| Pf_Pv_MEAN | -3.62*** | -4.08*** |
| | (0.61) | (0.66) |
| percentage_sum_A_B | -0.69*** | -1.04*** |
| | (0.20) | (0.21) |
| Constant | 9.88*** | 9.68*** |
| | (0.14) | (0.15) |
| Observations | 158 | 162 |
| Adjusted R-squared | 0.36 | 0.39 |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 11: Linear Regression of the Colonizer Dummies with the log GDP per capita (PPP) in 2010.

| VARIABLES | (1) Model 1.1: GDP long | (2) Model 1.2: GDP short | (3) Model 1.3: GDP long and short | (4) Model 2.1: GDPNTL long | (5) Model 2.2: GDPNTL short | (6) Model 2.3: GDPNTL long and short |
|---|---|---|---|---|---|---|
| dummy_long | -0.83*** | | -0.78*** | -1.05*** | | -0.99*** |
| | (0.25) | | (0.25) | (0.28) | | (0.28) |
| dummy_short | | 0.41 | 0.27 | | 0.51* | 0.35 |
| | | (0.26) | (0.25) | | (0.28) | (0.28) |
| Constant | 9.84*** | 9.08*** | 9.76*** | 9.61*** | 8.65*** | 9.51*** |
| | (0.23) | (0.10) | (0.24) | (0.25) | (0.12) | (0.27) |
| Observations | 158 | 158 | 158 | 162 | 162 | 162 |
| Adjusted R-squared | 0.06 | 0.01 | 0.06 | 0.08 | 0.01 | 0.08 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 12: Linear Regression of the Colonialism Dummies with the log GDP per capita (PPP) in 2010.

## Procedures

This section describes briefly the procedure for processing and analysing data.

### Procedure: Administrative Boundaries Shapefile[1]

1. Import the Shapefile provided by the GADM to ArcGIS Pro (**GADM**).
2. Use the "Dissolve" tool to generate different levels of administrative zones, reaching from GID_0 to GID_5.

### Procedure: GDP per capita Income Groups (2019)[2]

1. Import the xls.-file provided by the The World Bank (*World Bank Country and Lending Groups*) to ArcGIS.
2. Add the xls.-file to the national administrative boundary GID_0.

### Procedure: GDP per capita Estimates based on NTL (2010)[3]

1. Import the GeoTIFF provided by Lazar (2010) to ArcGIS Pro.
2. Usage of "Zonal Statistics to Table" in order to calculate the summary statistics for a given administrative boundary (here: GID_0, which is the national level)
3. Export data to Stata and calculate NTLGDP per capita using the total population count provided by The World Bank (*Indicator: SP.POP.TOTL*)

### Procedure: World Cities Database[4]

1. Import the Basic World Cities Database .csv-file provided by simplemaps.com to Stata (**Simplemaps.WorldCitiesDatabase**).
2. Calculate the weighted latitude and longitude using the most prominent cities population (large, capitals etc.).

### Procedure: Köppen-Geiger Climate Classification Map by Subnational Regions[5]

1. Import the GeoTIFF provided by Beck et al. (2018) to ArcGIS Pro.

2. To create the map, use "Raster to Polygon" in order to convert the raster into polygon features with the same categorical value. Afterwards use the tool "Intersect" in order to create subregions of the countries, thus taking into account the climatic composition of a nation.

3. To create to data, use "Tabulate Area" in order to count the raster cells of each category in a certain area.

4. Export table and import to Stata.

**Procedure: Malaria Incidence**[6]

1. Import the GeoTIFF provided by *malariaatlas.org* to ArcGIS Pro (Twohig et al. 2019, Weiss et al. 2019, Battle et al. 2019).

2. Usage of "Raster to Point", which convert each raster cell into a point feature, whereby the values are not included.

3. Usage of "Extract Values to Points", which extracts the raster values into the point features

4. Usage of "Summarize Within", which adds the point feature values to the polygon feature, which represents each individual country.

5. Export table and import to Stata.

**Procedure: Network Trade**[7]

1. Download the data provided by Luca et al. (2013).

2. Import to Stata and add GID_0, which is the country code.

**Procedure: GeoDist**[8]

1. Download the data provided by Thierry and Soledad (2011).

2. Import to Stata and add GID_0, which is the country code.

**Economic Freedom Indicator**[9]

1. Download the data provided by The Heritage Foundation (21.02.2021)

### Worldwide Governance Indicators[10]

1. Download the data provided by Kraay and McKenzie (2014)

2. Import to Stata and add GID_0, which is the country code.

## Notes

1. Data: https://gadm.org/download_world.html
2. Data: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending
3. Data: https://ngdc.noaa.gov/eog/dmsp/download_gdp.html
4. Data: https://simplemaps.com/data/world-cities
5. Data: https://figshare.com/articles/dataset/Present_and_future_K_ppen-Geiger_climate_classification_maps_at_1-km_resolution/6396959/2
6. Data: https://malariaatlas.org/malaria-burden-data-download/
7. Data: http://www.cepii.fr/cepii/en/bdd_modele/presentation.asp?id=27
8. Data: http://www.cepii.fr/cepii/en/bdd_modele/download.asp?id=6
9. Data: https://www.heritage.org/index/explore?view=by-region-country-year&u=637484344180733842
10. https://info.worldbank.org/governance/wgi/

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Ich versichere, dass ich die vorliegende Bachelor Thesis selbstständig und ohne Benutzung anderer als der angegebenen Quellen und Hilfsmittel angefertigt und die den benutzten Quellen wörtlich oder inhaltlich entnommenen Stellen als solche kenntlich gemacht habe. Die Arbeit hat in gleicher oder ähnlicher Form noch keiner anderen Prüfungsbehörde vorgelegen.

Herborn, den 21.02.2021

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