The societal metabolism and resource curse of developing economies: a comparative study of Ghana and Ivory Coast

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The candidate confirms that the work submitted is his own and that appropriate credit has been given where reference has been made to the work of others.

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Abstract

This thesis proposes a new analytical framework to analyse the relationship between material and energy use with indicators of well-being and economic growth in developing countries, conducted in the context of debates around the resource curse and development theories. By combining the societal metabolism approach with a historic and political context, this methodology explores the social metabolism and resource curse over time, relying on biophysical indicators of resource abundance.

The analytical framework developed in this thesis identifies different aspects that have shaped the development trajectories of currently developing countries. It demonstrates that in order to understand present and future development paths of developing countries, a holistic approach that can combine different sets of data is needed, as it can inform about possibilities and trade-offs of development pathways such as those envisioned by the Sustainable Development Goals. Therefore, the approach developed in this thesis provides the basis to carry out developmental research utilizing a metabolic approach in developing countries where data issues prevent societal metabolism research. In this thesis two case studies are presented to test the methodology, finding that: (1) socio-political stability plays an important role shaping the metabolism of an economy and avoiding the resource curse; (2) well-being can improve without growth in economic activity or resource consumption; (3) international governance has had major impacts shaping the present economic structure of the selected economies.

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1. Introduction

Understanding the biophysical metabolism of societies has been one of the main focus of sustainability studies since work undertaken by Lotka and later on by Georgescu-Roegen (Lotka, 1922; Georgescu-Roegen, 1971). Societal metabolism is the study of an economy from a biophysical perspective, using energy and mass quantities, rather than solely economic activity, such as GDP. Therefore, societal metabolism is a multidisciplinary subject approached by scientist from varied backgrounds with a critical view of economic growth (Fischer-Kowalski, 1998).

In order to study the development path followed by Ghana and Ivory Coast, it is relevant to explore how economic and social development rely upon the consumption of energy and materials, as these are the inputs to all economies. In any economic process, energy and mass are conserved, but only a very small fraction of these conserved quantities is recycled (Ayres and Kneese, 1969). Society extracts and uses high-quality low-entropy inputs from the environment (energy and material inputs), and emits low-quality high-entropy wastes back into the environment in the form of pollution and heat. Hence, in thermodynamic terms, societal consumption refers to the irrevocable entropic degradation of energy and matter (Georgescu-Roegen, 1971). Understanding these processes is highly relevant to develop environmental policies, especially policies concerning pollution control, reduction of energy and material consumption, and natural resource depletion (Fischer-Kowalski and Hüttler, 1998).

Societies can be categorized by their level and composition of material and energy consumption: their metabolic profile (Schandl et al., 2008). Historically, societies have been categorized as hunter-gatherer, agrarian or industrial societies (Krausmann et al., 2008; Schandl et al., 2008). Developing countries, currently in a mostly agrarian socioecological or socio-metabolic regime, will tend to transition towards industrialization to avoid the limits to growth imposed by agricultural regimes (Krausmann et al., 2008; UNCTAD, 2012). This transition enables societies to achieve economic growth and provide greater living standards for a growing population.

In metabolic terms, the industrialization process has been historically linked with high increase in resource use as well as longer and wealthier life (Schandl et al., 2008). Therefore, in the current international climate set by the Sustainable Development Goals (UN, 2015),

environmental concerns of consumption patterns and economic growth are becoming relevant. Consequently, understanding if these countries can develop and achieve greater levels of well-being, measured as an increase in life expectancy and decline in infant mortality, without equivalent increase in biophysical standards, is important.

Developing countries face scarcity of certain resources due to high competition for resources in international markets and ever decreasing or degraded waste sinks, which pollute the environment (Baer et al., 2007; Daly, 2008). These factors increase the need for developing countries to understand how society–nature interactions occur (Haberl, 2006a), as societies are sustained by nature for their functioning and growth (Manrique et al., 2013). Furthermore, developing countries are subjected to international governance through the Bretton Woods Institutions: the IMF and the World Bank. These institutions have intervened in developing countries affecting their productive structure, their industrialization process and their overall development path (Konadu-Agyemang, 2000; ILRF, 2004; UNEP, 2006; Eisenmenger et al., 2007; Kingston et al., 2011). Consequently, it is important to understand how international intervention has influenced the development path of Ghana and Ivory Coast.

1.1. Overview of West Africa

West Africa stands out as one of the least developed regions in the world, although some of its countries possess vast amounts of natural resources (ICCO, 2010b; USGS, 2012; Bazilian et al., 2013). High demand for raw resources in international markets should increase raw resource prices, and consequently, revenues of raw material exports. However, high international demand prevents local populations in extractive countries from using those resources themselves (Schaffartzik et al., 2014). It is therefore important for developing countries to understand how the consumption of biophysical inputs relates with their socio-economic performance.

Mapping the metabolic path of West African countries is quite a challenging task. As an initial survey showed, data on energy and material use is scarce in the region. Furthermore, very different recent socio-political events have shaped each country's present situation, resulting in the need to narrow down the scope of this thesis. The countries that comprise the Economic Community of West African States (ECOWAS), shown in Figure 1, have very distinct characteristics, as Table 1 illustrates.

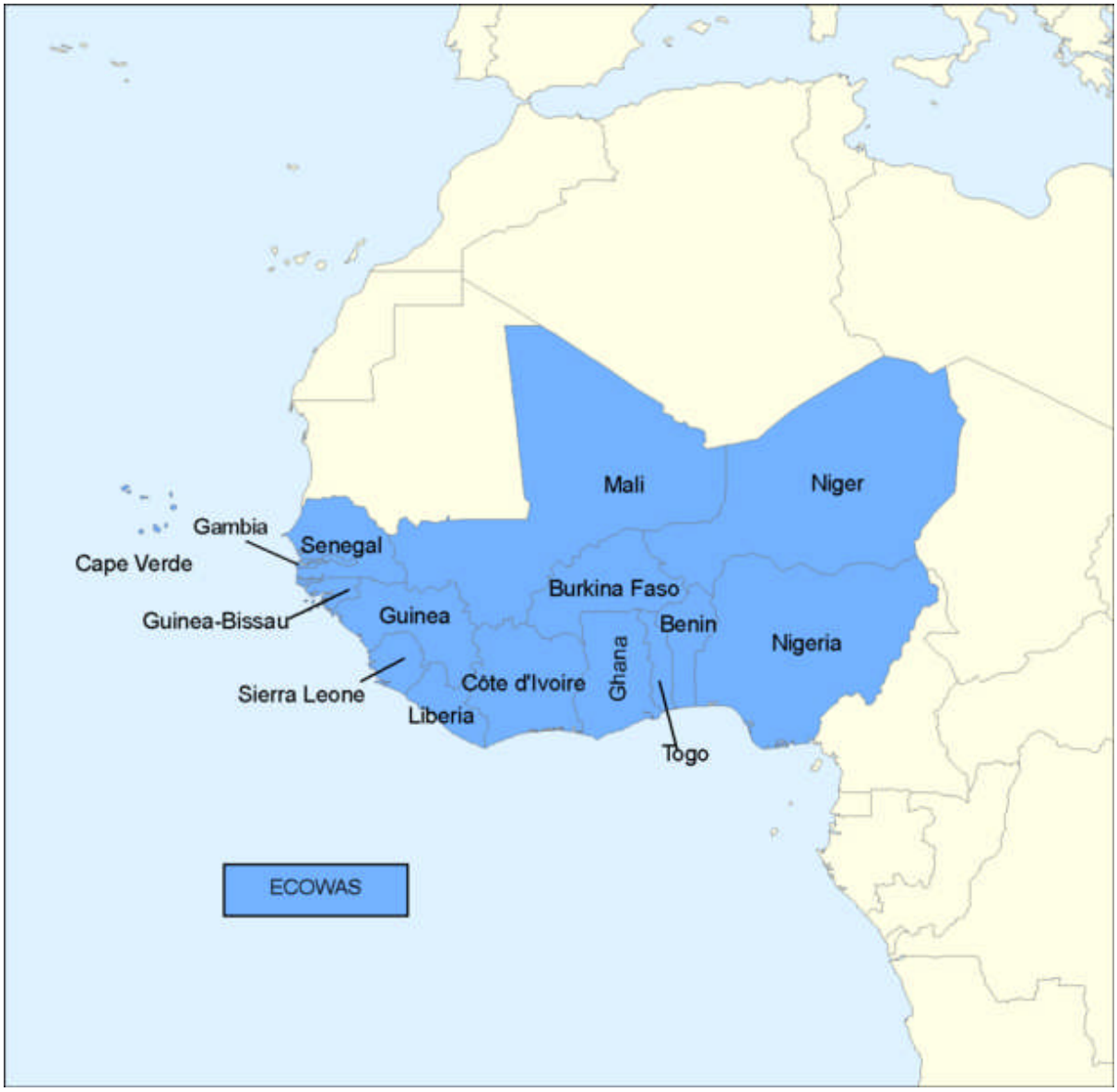

Figure 1.Map of the Economic Community of West African States (ECOWAS).
Source: epp.eurostat.ec.europa.eu

The population density in West Africa varies in between 12 people per km^2 in desert covered Mali to 173 people per km^2 in the most populous country in the continent, Nigeria (UNDESA, 2015). Income per capita highly varies in the region too. By income level, West African countries are divided between low income ($1,045 or less) and lower-middle-income countries ($1,046 to $4,125) (World Bank, 2012a). Despite West African nations falling in the two lowest income brackets, the disparity between incomes in the region is high. For instance, the Cape Verde Islands and Nigeria have several times as much income per capita as countries such as Liberia or Niger.

Table 1.Overview of West Africa in 2010.

Country	Population	Size (Km^2) (Person per Km^2)	GDP* (Billions) (GDP CAP)	Total primary Energy supply (Peta Joules) (Per Capita in Giga Joules)	Material consumption per capita (Kt) (Per capita in tonnes)	Independent since (From)
Benin	9,509,798	112,622 (84.4)	12.6 (1,325)	153 (16.1)	44,488 (4.7)	1960 (France)
Burkina Faso	15,632,066	274,200 (57)	18.6 (1,187)		73,760 (4.7)	1960 (France)
Cape Verde	490,379	4,033 (121.6)	1.7 (3,515)		3,283** (6.7)**	1975 (Portugal)
Ivory Coast	20,131,707	322,463 (62.4)	33.6 (1,670)	305 (15.2)	53,921 (2.7)	1960 (France)
The Gambia	1,693,002	11,295 (149.9)	2.2 (1,292)		5,969 (3.5)	1965 (United Kingdom (UK))
Ghana	24,317,734	238,533 (101.9)	36 (1,479)	388 (15.9)	148,254 (6.1)	1957 (UK)
Guinea	11,012,406	245,857 (44.8)	9.8 (886.8)		58,631** (5.3)**	1958 (France)
Guinea-Bissau	1,634,196	36,125 (45.2)	1.6 (987)		6,890** (4.2)**	1973 (France)
Liberia	3,957,990	111,369 (35.5)	1.5 (379.1)		12,056** (3)**	1847
Mali	15,167,286	1,240,192 (12.2)	14.7 (967.8)		82,017 (5.4)	1960 (France)
Niger	16,291,990	1,267,000 (12.9)	10.1 (621.8)		80,242 (4.9)	1960 (France)
Nigeria	159,424,742	923,768 (172.6)	341 (2,139)	5,023 (31.5)	489,303 (3.1)	1960 (UK)
Senegal	12,956,791	196,722 (65.9)	21.6 (1,666)	164 (12.7)	60,786 (4.7)	1960 (France)
Sierra Leone	5,775,902	71,740 (80.5)	4.4 (753.5)		17,132** (3)**	1961 (UK)
Togo	6,390,851	56,785 (112.5)	5.4 (844.4)	130 (20.4)	21,103 (3.3)	1960 (France)
Total	304,386,840	5,112,704 (59.5)	514.6 (1,691)	6,164	1,157,835 (4)	

***GDP in Constant 2005 International Dollars. ** Incomplete data on domestic extraction and or trade data.**

Scarce available data for West African countries demands the conducting of a data survey for the region. Based on data availability, it can be established which country's metabolism can be analysed.

Data on energy supply can be obtained from the International Energy Agency Energy Balances (IEA, 2015b) and from the United Nations Energy Balances (UNSTATS, 2012). Data from IEA ranges from 1970 to 2012, but is only available for six countries, as Table 1 shows. The United Nations dataset is available for all ECOWAS, but for a short period of time, 2006-2009. In 2016, the time span of the United Nations dataset was expanded to cover from 1990 to 2013. For the purpose of this study, data from IEA will be used, as IEA is the most widely used source in the metabolism literature and it covers a longer time span.

Data on material flows for the region is available from the Sustainable Europe Research Institute (SERI, 2014), from the Institute of Social Ecology (Iff Vienna) (Schaffartzik et al., 2014), and recently from the United Nations Environment Programme (UNEP, 2015). Data from SERI is available from 1980 to 2013, but this source does not possess consumption and trade disaggregated data per material group. Data from Iff is on decadal intervals from 1950 to 2010 and is available for all the countries in aggregated and disaggregated form, but certain disaggregated data is missing. Data from UNEP is available from 1970 to 2010 with consistent disaggregated data for different material groups. However, UNEP's material group disaggregation differs from the other two datasets. UNEP dataset separates materials in four groups: biomass, metal ores, fossil fuels and non-metallic minerals. Yet, the literature on societal metabolism commonly groups materials into five categories: biomass, fossil fuels, ores, industrial minerals and construction minerals, coinciding with Iff. The analysis carried out in this thesis was done before UNEP dataset was available in 2016, utilizing the Iff dataset, which was selected based on the literature and available data. The UNEP dataset will not be used in the interest of time. A preliminary analysis shows that results obtained using UNEP dataset do not always coincide with the results obtained using Iff dataset. In the case of Ghana, a preliminary analysis indicates that the general trends of material consumption are quite similar between UNEP and Iff datasets, as well as how material consumption composition per capita relates with income. Therefore, in the Ghanaian case, results would not be highly affected by selecting one dataset over the other. However, in the Ivorian case, both datasets do not follow matching general trends. Consequently, at the per capita level, utilizing the UNEP dataset, income and DMC per capita are only moderately coupled. The effects of the discrepancies

between both datasets would affect the results concerning the relationships between material consumption and income in Ivory Coast. At the national level, the relation between GDP and DMC does not highly vary utilizing one dataset or another.

Socio-economic data is available from the United Nations (UNDESA, 2015) and the World Bank (World Bank, 2015). These two sources have accessible data for all West African nations from 1950 to 2010 and from 1960 to 2013 respectively.

The presented survey reduces the number of available countries that can be analysed to six countries, Benin, Ivory Coast, Ghana, Nigeria, Senegal and Togo. These six countries do not follow a uniform development path, which for instance is reflected in the differences between income per capita and energy supply. An example can be seen in Table 1; Togo, with almost half of the income per capita of Senegal has an energy supply per capita that is 61% greater. Similarly, Niger, with under a third of Nigeria's income per capita, consumes 58% more materials.

After conducting a preliminary analysis for the six remaining countries, a notable fact that emerges is the lack of a clear West African development path. Greater levels of economic wealth are not reflected by greater levels of material and energy use. There is not a clear evidence that greater economic wealth translates into greater levels of construction and industrial mineral consumption, as it could have been expected from greater incomes (Steinberger et al., 2010; Schaffartzik et al., 2014). Thus, due to the great disparity between socio-economic status and metabolic profile of the six remaining countries, the scope of the study has to be reduced further to enable an in-depth research.

In order to narrow down the scope of the study to two countries that can be researched in detail, the main differences between West African nations needs to be explored. West African countries can be divided into resource-rich and resource-poor, politically stable or unstable. Moreover, based on colonial rulers that set the present frontiers and main languages spoken in the region, West Africa can be divided between Anglo-Saxon and Francophone countries. Not all West African nations are resource-rich: for instance, Cape Verde islands are resource poor but had the highest income per capita in 2010 (World Bank, 2012a). Some countries have had recent conflicts, such as Liberia, Ivory Coast, Nigeria and Sierra Leone (Nnoli, 1998; Ukiwo, 2003; Boafo-Arthur, 2008). To the contrary, Ghana and Benin have been mostly stable

democracies through the last decades (Pellow and Chazan, 1986; Boafo-Arthur, 2007; BBC, 2013a; CIA, 2014).

From the six countries for which there is data on primary energy, Ghana and Nigeria are Anglo-Saxon resource-rich countries. Nigeria has suffered ethnic and religious tensions since independence (Imobighe et al., 2003; Guichaoua, 2010; CIA, 2014). Benin, Ivory Coast, Senegal and Togo are francophone countries. Whereas Benin and Senegal have been mostly stable countries during the last decades (Amin, 1973; Den Tuinder, 1978; BBC, 2014; CIA, 2014), Ivory Coast and Togo have suffered internal political unrest in recent decades (Amin, 1973; BBC, 2013b).

Ghana is an example of an English-speaking nation, endowed with a variety of natural resources such as gold, cocoa and bauxite, and recently discovered oil (Hilson, 2002a; Williams, 2009; World Bank, 2009b; UNIMTS, 2014), resembling other resource-rich Sub-Saharan countries such as Ivory Coast or Nigeria. In comparison, Ghana can serve as example to other African nations. The country has shifted from an unstable country after independence to an economically and politically stable country, with a respected rule of law and an active civil society (Minion, 2004; Boafo-Arthur, 2008; Throup, 2011). These achievements, and the political capacity to manage material and energetic resources effectively (Turkson, 1990; Kemausuor et al., 2011), should set the country apart from other West African nations. Therefore, Ghana's success story is an interesting case to study and compare it with other West African nations.

Ivory Coast is a French-speaking resource-wealthy country. Ivory Coast is the world's largest cocoa exporter, but further produces a diverse set of agricultural products, such as coffee, cotton and natural rubber, besides oil and natural gas (Arias et al., 2003; ICCO, 2010b; Amoro and Shen, 2012; UNIMTS, 2014). Ivory Coast was regarded a politically stable and economically prosperous country after independence in 1960 (Wallerstein, 1964). However, since the early 1990's the country's path change. Internal turmoil, a coup and a civil war, as well as increased corruption, shaped a country in decline (Bowden, 2007; Hennemeyer, 2007), resembling other West African countries that have experienced recent turmoil, such as Guinea-Bissau, Nigeria, Niger, Liberia and Togo.

Ghana and Ivory Coast are relevant countries to study and compare (Wallerstein, 1964; Amin, 1973). Both countries obtained independence at almost identical times, both countries have

similar climates (Oppong-Anane, 2001; Martin Aregheore, 2009), export similar raw resources, have suffered internal conflicts since independence, and both countries have been influenced by international governance (Konadu-Agyemang, 2000; Riddell, 2008). However, differences in the socio-political structure that emerged after both countries became independent -Ghana gaining stability through the 80's and Ivory Coast losing its stability through the 90's, can provide this study with an in-depth understanding on how differing socio-political developments in both countries, visible through their opposing recent paths, can shape economic and biophysical dynamics.

The importance of understanding the relation between metabolism, economic development and socio-political history in Ghana and Ivory Coast relies upon the need to identify the underlying factors of their current level of development. By combining different sets of data composed by biophysical, as well as economic and well-being indicators, this thesis intends to uncover the patterns that underlie in their recent development path. The proposed country-level analysis, which combines both economic and biophysical measures, may warrant a finer reading: the socio-political and global context of a country should also be taken into account to fully understand the metabolism of a society (Redclift and Woodgate, 1997).

1.2. Societal-metabolism research background

Societal metabolism is understood as the material and energy use of countries (Fischer-Kowalski, 1998). There is extensive research available on societal metabolism. There are theoretical studies (Haberl, 2001a; Sorman and Giampietro, 2013), empirical studies on a worldwide scale (Haberl, 2006a), studies centred on industrialised economies (Haberl et al., 2006b; Krausmann et al., 2008) and on transition economies such as China, Mexico, India, Brazil and Chile (Eisenmenger et al., 2007; Gonzalez-Martinez and Schandl, 2008; Pachauri and Jiang, 2008; Russi et al., 2008; Singh et al., 2012).

The metabolism of Africa has been mapped as a whole (UNCTAD, 2012); different types of analysis have been done to observe Ghana's energy and material use (Turkson, 1990; Hilson, 2002a; Kankam and Boon, 2009; Wolde-Rufael, 2009; Obeng and Evers, 2010; Kemausuor et al., 2011; Ayelazuno, 2013). The relation between energy and GDP in Ivory Coast has been studied (Wolde-Rufael, 2005, 2009; Kouakou, 2011), as well as crop production and resource conflicts (Gbetibovo and Delgado, 1984; Cheyns et al., 2001; Woods, 2003; Globalwitness,

2007; Guesnet et al., 2009; Kouakou, 2011; Amoro and Shen, 2012). The study of societal metabolism and its relation with socio-economic development has not yet been done for both countries, thus constituting a research gap. Studying the socio-economic-metabolic relationship within the overall context faced by both countries should increase the explanatory potential of this thesis; providing insights not only on the biophysical needs of development in these countries, but also contribute to the understanding of how national and international governance influenced development outcomes in these countries.

1.3. Research purpose

The purpose of this research is to understand how socio-economic performance and biophysical consumption are connected in Ghana and Ivory Coast, observing and analysing the interdependencies that exist over time in both countries. This thesis will focus on the period in between 1980 and 2010, where there is the most consistent data for selected countries.

This is a challenging task, as one of the problems that arises when trying to analyse both countries is the data to be obtained. Data availability is scarce, unreliable, and not always continuous over time. This entails difficulties understanding the metabolism of these countries.

Both countries are underdeveloped resource wealthy countries, endowed with a variety of natural assets that should play an important role in providing energy and materials needed to develop. Understanding how socio-economic development relates with biophysical inputs to both economies is necessary towards comprehending the role that energy and materials play in the development path and well-being in both countries, as low living standards and population growth are likely to increase future environmental pressure in these countries. Additionally, obtained results could be used in future research to model possible development paths.

Ghana's domestic material consumption per capita in the year 2010 was of 6 tonnes per capita, below of the world's average consumption of 10 tonnes per capita (Schaffartzik et al., 2014). In Ivory Coast, material consumption was 3 tonnes per capita. Such levels of material consumption may not be sufficient to provide some of the basic societal needs, as these consumption levels are a fraction of the consumption levels of western countries of 15 tonnes per capita. In the Ivorian case, these levels are even below the 5 tonnes per capita consumption average in Sub-Saharan Africa.

Primary energy supply in both countries is below the African average of 28 gigajoules (GJ) per capita in the year 2010, and far behind the 78 GJ per capita global average. Revealing that through their developing process, both countries will likely increase the consumption of energy and materials to build and maintain much needed infrastructure, such as hospitals and schools among others. As observed in Steinberger et al. (2013), most countries that have successfully developed have had high economic-material coupling. Thus, future development in both countries might be material intensive in the mid-term.

As neighbouring lower-middle-income countries (World Bank, 2012a) with low levels of biophysical consumption, it is interesting to study if relatively small differences in biophysical consumption and income are reflected in different levels of well-being. Moreover, other factors such as socio-political stability could play an important role affecting differing well-being dynamics in both countries.

This research will additionally analyse the informal economy in both countries, which represents an important share of economic activity for both economies (Gërxhani, 2004; Schneider et al., 2010; Osei-Boateng. C, 2011). By using available published data, this study's results could be enhanced by understanding if obtained results could be extrapolated to the overall economy -measured as the official GDP plus the informal economy.

To deeply comprehend the current situation both countries face, I observe the need of going beyond the metabolism-development relation. Therefore, in order to understand their present situation, I will map Ghana's and Ivory Coast's historical trajectories. This task is to be done by researching recent historical events, such as armed conflicts, policies and international relations. These type of events can shape the development path of a country, and consequently, affect their metabolism, as for instance, armed conflicts can displace population and reconfigure economic activities (Le Billon, 2001). This step of the research can be expected to increase the explanatory potential of quantitative data analysis.

Both countries have not reached a level of income to study the environmental Kuznets curve (Stern et al., 1996; Chimeli and Braden, 2005) due to their lower-middle-income status. The environmental Kuznets curve hypothesizes that environmental degradation increases in early stages of income growth, but when high-income levels are achieved environmental degradation will be reduced. This hypothesis has been studied in the social metabolism literature for developed countries and has been disproved (Steinberger et al., 2013). However, these two

countries can be tested to observe if the intensity of use hypothesis, developed by Malenbaum (1978), holds in these countries. I will investigate if during their process of economic development, income can be identified as the main factor explaining biophysical consumption (the intensity of use hypothesis), entailing that future economic growth will be tied to increased consumption. Additionally, this study will look at the relation between the composition of energy consumption and income dynamics in both countries. This will be done investigating the energy ladder model (Hosier and Dowd, 1987; Leach, 1992; Masera et al., 2000), which states that increased income will be paralleled by an increase in the consumption of non-biomass based energy carriers –an energetic transition.

Ghana and Ivory Coast are equally heavily reliant on production and exports of raw resources. Therefore, these two countries are susceptible to suffer the resource curse (Sachs and Warner, 1995). The resource curse, also known as the Dutch disease, hypothesizes that there are a range of potential negative effects that a resource boom can have in a country. The resource curse theory states that after raw resources are discovered –or experience a great increase in price, economies will focus their economic activity on the primary sector. Increase exports of raw resources will increase national exchange rates, therefore undermining the international competitiveness of national industries, as well as diverting resources such as labour, from manufacturing to the primary sector, causing deindustrialization (Bulte et al., 2005; Stevens and Dietsche, 2008). Moreover, rent-seeking behaviours and low institutional quality can mismanage resource rents towards enriching local elites, maintaining political power and investing raw resource rents to control resource rich areas, which can lead to armed conflicts (Ross, 2004; Collier and Hoeffler, 2005; Vicente, 2010).

In this dissertation, the resource curse will be examined utilizing a societal metabolism approach, therefore mass quantities will be examined in combination with economic proxies of resource endowment -similar to those used in the resource curse literature. Moreover, the international context in which both countries lie in will be analysed to comprehend if this context has determined how raw resources relate with the Ghanaian and Ivorian economies. Consequently, this thesis will be able to study if the channels behind the appearance, or absence, of the resource curse can be attributed to raw resource endowment, resource management, the overall global context faced by the selected countries, or a combination of these. This point becomes crucial to comprehend if the recent Ivorian conflict -which has highly influenced the

country's present state, can be attributed to raw resource dependency, or if the conflict is unrelated to Ivorian raw resources.

This thesis aims to contribute to the understanding of the metabolic patterns of Ghana and Ivory Coast by applying a multidisciplinary mixed method approach that combines different datasets, including energy balances, material flow accounts, national income and well-being indicators. This will be done by measuring data correlations in combination with historical and political analysis in order to understand the present development stage of selected countries. Furthermore, understanding the overall path that has led selected countries to their current development stage could be used to provide policy recommendations that could lead selected countries into a path of increased well-being and living standards.

1.4. Research aim and research questions

How can the concepts of societal metabolism and the resource curse help us understand historic and potential development trajectories of Ghana and Ivory Coast?

1) What are the interdependencies between the physical economy and socio-economic performance in Ghana and Ivory Coast?

2) How have historical events and political development shaped the biophysical, economic and social development of Ghana and Ivory Coast?

3) What can be learned by expanding the metabolism approach to study the resource curse for these two countries?

4) How has the interaction between studied countries and global governance affected their development paths?

2. Literature review

Ghana and Ivory Coast are developing nations, which face a number of challenges towards achieving higher levels of income, better living standards, increased infrastructure, in short, greater development levels. These challenges can be summarised in four aspects:

- In order to develop, both countries will need to increase energy and material consumption to build and sustain needed infrastructure, as economic growth in developing countries is strongly coupled with the development of physical infrastructure (Steinberger et al., 2013).

- As they integrate further in international markets these countries will face an ever increasing competition for scarce resources, which will increase resource prices. Hence, access of poorer countries to certain materials might be hindered due to international competition (Boserup, 1983; Young, 1991; Daly, 1992). This can be expected to worsen with the anticipated rapid population growth, expected to double by 2050 in both countries (UNDESA, 2015).

- Both countries face a conflict between development and sustainability. To achieve resource and energy efficient development, both countries need to acquire the latest most efficient technology to avoid a carbon intensive development pathway. As described by Unruh and Carrillo-Hermosilla (2006), it is a difficult task. Developing countries are likely to replicate successful established technologies that are less resource and energy efficient rather than leapfrogging carbon-intensive technologies

- As resource-wealthy nations, both countries face the challenges derived from resource extraction and exports, such as channelling resource revenues into other sectors that need governmental support to secure their economic future away from exhaustible resources (Hartwick, 1977; Arthur, 2006).

These points underline the importance of understanding the three core literature themes that will be reviewed in this chapter. The first section will examine social and metabolic development transitions. The second section will revise the literature on the relationship between energy consumption and economic growth. The third section will cover the literature

on material consumption and economic performance. Finally, the fourth section presents a summary of the literature, highlighting the main hypotheses and theories that will be explored thought this thesis.

2.1. Socio-metabolic development and transitions

Ghana, Ivory Coast and other West African nations are mainly agricultural societies (CIA, 2013; UNDESA, 2013b; FAOSTAT, 2015a; UNSD, 2015) aiming to develop and achieve greater levels of industrialization. The transition towards an industrial society will modify the society-nature interaction (Haberl et al., 2006b; Krausmann et al., 2008). In order to comprehend how the interaction between a society and its environment will change through this transition, there is a need to study their societal metabolism. The societal metabolism approach studies societies as systems that withdraw energy and materials from their environment to maintain their internal functioning and emit wastes back to the environment (Fischer-Kowalski and Haberl, 2007; Muradian et al., 2012). Therefore, there is a need to understand if the current metabolic path followed by these countries is leading them towards industrialization, or if these countries are going to continue being raw resource producers.

In order to comprehend if the current metabolic path of Ghana and Ivory Coast is leading them towards greater developmental levels, it is important to examine the literature exploring socio-metabolic transitions and development. This section introduces how societies have transitioned throughout history from hunter-gatherer societies to industrialized societies through a metabolic lens, especially focusing on the transition from an agricultural to an industrial society.

The literature that examines socio-metabolic transitions is divided in two major groups; literature that studies socio-cultural and environmental relations that enabled industrialization (Cottrell, 1955; Sieferle, 2001; Fischer-Kowalski and Haberl, 2007; Schandl et al., 2008; Krausmann and Fischer-Kowalski, 2013), and the literature that focuses on analysing the metabolism of the different socio-ecological regimes (Haberl, 2001b, 2006a; Krausmann et al., 2008; Schandl et al., 2008). In order to talk about socio-metabolic transitions, it is necessary to define what a socio-ecological regime is. A precise definition is given by Schandl et al. (2008):

> ‘Socio-ecological regimes can be regarded as dynamic equilibriums that are integrated across scales and allow for certain change and growth processes and feature specific

environmental impacts. They are characterized by certain institutional arrangements, demographic features, and spatial patterns of land use and of socio-economic organisation, infrastructure networks and technology clusters.

A socio-ecological regime shows a distinct structure and level of material and energy use (metabolic profile) and typical patterns of use of human time and labour (time allocation profile).' Schandl et al (2008, p.2).

There are three major socio-ecological regimes that can be distinguished in human history, where societies have transition over time from one to another depending on the historical events that have defined their path. These three regimes, described in Fischer-Kowalski and Haberl (2007), Haberl (2001b), Sieferle (2001) and Schandl et al. (2008), are:

- Hunter-gatherer societies, based on an uncontrolled solar energy system.
- Agrarian societies able to control solar energy systems (agriculture and farming).
- Industrial societies with an energy system based on the exploitation of large stocks of fossil fuels.

Industrialization is the transition process responding to the growth needs of agricultural societies (Schandl et al., 2008). The agricultural socio-metabolic regime is constrained by the amount of energy that can be extracted from a limited amount of land. This constraint imposes limits over the number of individuals and area that a society can control. Social and technological change based on the use of new types of energy carriers, fossil fuels, extends the growth limits that constrained growth in the agrarian regime, leading to industrialization of a society.

Fossil fuels allow an expansion of the agricultural land and the transport of crops from distant rural areas to big urban areas. The process of industrialization changes the way a society interacts with its surrounding environment. There is an increase of the energy that is used in crop production, predominantly mechanization, fertilization and transportation. This process of energy subsidisation increases yields in agriculture, transforming it from an energy-providing sector to an energy-subsidized sector (Schandl et al., 2008; Smil, 2008). New energy carriers used in agriculture increase labour productivity as fewer workers are needed to cultivate the land, consequently shifting labour and added value from agriculture to industry and later on to services, ultimately causing migration from rural to urban areas.

Industrialization of agrarian societies encompasses an increase in population growth to unprecedented levels. There is an increase in per capita energy and material consumption, leading to increased environmental pressure that generates wastes that the environment cannot always absorb (UNCTAD, 2012). England was the first country to transition from an agricultural to an industrial society. The industrialization process occurred as a unique combination of institutional change, population growth, improvements of land use practices and by the discovery and exploitation of large reserves of coal (Cottrell, 1955; Schandl et al., 2008). Smil (2008) and Sieferle (2001) agree that coal alone did not make the transition, but has been deemed as fundamental to achieve industrialization (Cottrell, 1955). England industrialized in the 19th century; however, other modern societies, such as the Netherlands, were already using peat by 1550 but were unable to industrialize. The necessary preconditions to industrialize did not take place in the Netherlands. In words of Sieferle (2001) :

> 'Holland was a mature, i.e. a stationary capitalist mercantile economy. No technical and economic dynamic unfolded, it had exhausted the potential that was available to an advanced agrarian society with a highly developed mercantile and commercial sector. The transition to a new kind of system dynamic in the sense of the Industrial Revolution was not initiated. This leap remained a unique phenomenon that took place in Britain alone.' Sieferle (2001, p.37).

Therefore, discoveries of vast quantities of fossil fuels, in combination with other factors, triggered the transition in England. Factors such as limited available wood, river systems that did not facilitate North-South transportation, in combination with colonization and the socio-political context of the country, favoured the necessary ingredients for the industrialization to take place in England, expanding later to the rest of Europe. In the United States, discoveries of oil reserves and the availability of vast land areas had a positive effect that enabled industrialization (Cottrell, 1955; Sieferle, 2001).

At present, rising affluence in developed countries is accompanied by a decline in the share of industrial energy consumption in overall societal consumption, which is moving towards an increase on the residential, commercial and transportation energy demand (Smil, 2008). Smil (2008) points out that, even if discovery of fossil fuels helped shifting work from agriculture to industry, what really liberated people from drudgery, exertion and child labour was electricity, which in combination with automobiles saved time, hence enabling leisure.

Countries that are transitioning from the agricultural regime, or aiming to industrialise in modern times, do not have the advantage that first industrialized countries had. There are no vast areas of land to be conquered, and there is not an abundance of cheap fossil energy reserves which makes present context different than the one experienced by early industrialized countries (Cottrell, 1955; Smil, 2008). Transition from an agricultural to an industrial society is different depending on the time and region that is transitioning. However, industrialization, contrary to agriculture, once developed tends towards homogenization.

The present industrialization process in Asia is occurring under different circumstances to those that enabled the first waves of industrialization. Their process is taking place in a context of large populations that provide large amounts of cheaper labour than that of already industrialized countries. As mentioned in Norton (1955), Ayal (1992), Glassman and Sneddon (2003), as cited by Schandl et al. (2008) for Asia:

> 'The late industrial development of Asia happened in a context of large populations, a great importance of agriculture and under the hegemony of a few cities which often had established closer links to the outside world than to their agricultural hinterlands resulting in an uneven distribution of income and standards of living among the Asian people.' Schandl et al (2008, p.17).

Some of these factors were due to the effects that European colonialism had on the area. Therefore, a similar transition could evolve in developing African countries with a colonial past. In developing countries of South Eastern Asia, labour and added value are moving from agriculture to the industrial sector, repeating the economic and labour shift experienced by previously developed countries. Yet, in developing Asian countries, agriculture still plays a major role (Schandl et al., 2008), contrary to already developed economies.

2.1.1. The metabolism of the three main socio-metabolic regimes

The three main socio-metabolic regimes show distinctive metabolic rates, measured here as resource use per capita. Haberl (2001b) describes hunter-gatherer societies as societies that performed a basic metabolism, remaining within the carrying capacity of their environment. These societies extracted the amount of resources needed for subsistence and produced wastes that were easily absorbed by the ecosystem. Food intake per capita was estimated to be 10

megajoules per capita per day, 3.5 GJ per capita per year, amounting to around 7GJ per capita per year of final energy considering not digestible parts plus firewood.

Agricultural societies emerged with increased populations, knowledge about natural world and domestication of plants and animals. These changes increased environmental pressure; the main source of energy remained solar-based. However, environmental degradation and resource depletion emerged as problems in some areas (UNCTAD, 2012). Increased control over surrounding environments increased the appropriation of net primary production. Agricultural societies consumed between 20-70 GJ capita year (where 70GJ capita represents an advanced European socio-metabolic regime), depending on their location and level of advancement (Bárcena-Ruiz and Garzón, 2002; Schandl et al., 2008; Smil, 2008). Population expanded from less than 10 people per square km to 40-50 people per km^2 (Krausmann et al., 2008; UNCTAD, 2012). Yearly material use was estimated to be around 3-6 tonnes per capita which was mainly, around 95%, biomass (Schandl et al., 2008).

With the industrialization of agrarian societies, population, material and energy consumption increased by orders of magnitude. Population grew to in-between 100 and 400 persons per square km (Krausmann et al., 2008; UNCTAD, 2012), with some megacities reaching up to 50,000 people per square km (i.e.: some areas from Hong Kong (Smil, 2008)). This enormous population increase came accompanied by an increase in per capita consumption of energy and materials, causing an overall increase of environmental pressure of orders of magnitude compared with the previous regime. Yearly energy consumption per capita reaches levels in-between 150GJ and 400GJ per capita in the industrial regime. Material consumption follows a similar increase, reaching levels in between 15-25 tonnes per capita (Krausmann et al., 2008; Schandl et al., 2008; UNCTAD, 2012) with biomass representing between 10-30% of total energy and material use. Therefore, the transition from an agrarian to an industrial society will increase biophysical consumption, accompanied by a metabolic switch from biomass consumption to mineral and fossil fuel consumption (Eisenmenger et al., 2007).

Smil (2008) shows that decent levels of physical well-being, longevity, varied nutrition, basic educational opportunities, reduced child mortality and individual freedoms are achieved with an energy consumption of 50-70GJ per capita year. Increases over those levels are hardly accompanied by positive increases on the above mentioned indicators. Steinberger and Roberts (2010) find that the energy required for high levels of development (including nutrition, education and longevity) tend to decrease over time. Hence, present developing countries could

achieve high development levels without having an equal increase on energy consumption, representing an opportunity for sustainable social development in developing regions of the world.

2.1.2. Industrialization in a globalized era

It is important to comprehend if Ghana and Ivory Coast can increased the well-being of their citizens in the near future. Therefore, it is necessary to explore how some development theories envision present transition process, which can aid the understanding of the opportunities and barriers these countries face towards achieving greater levels of development.

Future social development in less developed regions might be constrained by the availability of resources, as well as the power relations in global markets, where certain economies seem to be bound to extracting specific resources mainly for export. As noted by Muradian et al. (2012) the global South has suffered a configuration of resource extraction that has favoured Western transnational corporations. As pointed out by Schaffartzik et al. (2014) and Schandl and Eisenmenger (2006), extracted materials for export are generally not available for domestic use. However, the process that present developing countries are going to follow during their industrialization cannot be stated a priori.

> 'The current regime transition is different from the historic industrial transformation insofar as it is situated in a global industrial context where resources are already scarce and the dynamics of the transition are driven from internal and external forces.'(Schandl et al (2008, p.1)).

This statement exemplifies that the transition from an agricultural to an industrialized society has varied over time and over different regions. Thus, there is not a unique development path all countries must follow, and previous development paths may not be available to newly industrialising countries.

The classic development theory, followed by institutions such as the World bank and IMF (Konadu-Agyemang, 2000; Pieterse, 2010), connects development with economic growth, and economic growth with increased quality of life. This theory favours economic growth through structural changes that encourage free trade, market liberalization, privatization of public enterprises, and reduction of government expenditure in order to increase market efficiency and create economic growth (Nafziger, 2006; Pieterse, 2010). The intervention of international

governance in developing countries has advocated for the implementation of adjustment programmes in the line of the neoclassic economic theory.

Alternative theories of development such as the dependency theory (Furtado, 1971; Chilcote, 1974; Leys, 1996; Nafziger, 2006) and world systems theory (Wallerstein, 1974; Wallerstein, 2011) explore modern development in a global socio-economic and political framework, in which a country's development is embedded. These two theories, similar in their view, divide countries internationally as peripheral countries and core capitalist producing states. Peripheral countries specialize in primary products, and due to neo-colonial social and structural configuration, a small ruling class, or bourgeoisie, with ties to the West, accumulates wealth, restrains local innovations, and transfers high rates of surplus to Western countries (Leys, 1996; Nafziger, 2006). On the other hand, core-producing states control advance production processes, accumulate capital that feeds from satellite states, and have power to impose low prices for raw materials from peripheral nations. Moreover, core states can impose trade barriers, quotas and enforce patents, which some scholars consider to create underdevelopment, keeping peripheral countries underdeveloped, and even fuel wars (Furtado, 1971; Conte, 2005; Fell, 2009; Moseley et al., 2010; Meehan, 2011).

Peripheral countries, in addition, face decreasing terms of trade. Competition among peripheral countries to export raw resources to core producing states reduces raw material prices. Hence, peripheral states need to extract and export greater amounts of resources to continue importing the same quantity of manufactured goods from the West (Vallejo et al., 2011; Dittrich et al., 2012). These two theories see underdevelopment as the effects that colonialism and penetration of capitalist mode of thinking has had on colonial states (Konadu-Agyemang, 2000; Stern, 2004; Nafziger, 2006), following the line of thought of the modernization theory (Stern, 2004).

An extreme thought inside the dependency theory can be seen in Nafziger (2006), citing Frank (1969), stating that third world countries can develop only by withdrawing from the world capitalist system. This, even if an extreme view, demonstrates the believed idea that global capitalism is harming the developing world.

The reviewed development theories demonstrate that different theories understand modern day developmental context and process in very different ways. Present developing countries are embedded in a global context in which their developmental process will not be isolated from the international context (Eisenmenger et al., 2007). Consequently, by studying the sectoral

development of the selected countries, we can gain insights into whether or not Ghana's and Ivory Coast transition aligns with the classic development theory followed by global governance institutions, or with the alternative development theories.

The literature reviewed in this section provides information on the development paths followed by previously industrialized countries. This literature can be used to observe if the path followed by Ghana and Ivory Coast resembles the path followed by previously developed countries, or if on the other hand, their development path is significantly different. Furthermore, selected studies provide context specific information to acknowledge different options Ghana and Ivory Coast have for developing in a globalized world, where the role played by developing countries might be established and efforts to withdraw from those roles could be hindered by the developed world.

2.2. Relationship between energy consumption and economic growth

The literature that examines the relationship between energy and material consumption with GDP and well-being is vast. Hence, this review is not comprehensive; it is focused on the most important and relevant references and arguments in each subject.

The research that examines the relation between energy use and economic performance is diverse. There are three main themes that emerge in the literature: literature that observes the energetic metabolism of societies, studies observing the correlation between energy and GDP, and studies that examine the causality links between both variables.

2.2.1. Energetic metabolism of societies

There are a number of studies on the energetic metabolism of societies or countries. These studies are focused on the energetic metabolism of industrialised countries or on developing Asian or Latin American countries; there is a notable lack of studies that focus on West African countries. Studies on this subject link energy carriers availability and consumption with socio-economic development, revealing the importance of domestic energy supply and historical context needed to enter the industrialization process.

Schandl et al. (2008) study developing Asian countries, comparing the societal metabolism of China, India, Indonesia, Thailand, Philippines and Vietnam. This study observes that in general

terms, countries that consume greater amounts of energy per hour are more economically productive.

Haberl et al. (2006b) research the European (EU-15) and the United States energy flow analysis focusing on the importance of biomass. This study observes that biomass is still an important source of energy in developed economies once its non-commercial uses (food, feed, fodder) are accounted for. This study also emphasizes the importance of using energy flow analysis (EFA), developed in Haberl (2001a), for assessing changes in society-nature interaction during the industrialization process of agrarian societies. The aim to industrialize of West African countries will change society-nature relations throughout the industrialization process. Haberl's studies provide data to compare if the path followed by the selected countries resembles the path taken by already developed countries, where biomass consumption decreases its relevance in the overall energy mix, but does not decrease in its use.

In Haberl (2001b) the energetic metabolism of three different socio-metabolic regimes is studied utilizing EFA method. These three regimes are: a hypothetical hunter-gatherer society; an agrarian society, Sang Saeng in Taiwan; and 1995's Austria as an industrial society. When comparing the role energy plays on society's evolution, the study observes that fossil fuels become the main energy carrier in a society, substituting biomass, during the industrialization process. This observation is confirmed in Haberl (2006a) where worldwide energy metabolism is examined over time.

These studies account for the importance that biomass has in all societies, but also analyse the effect that its uses has on the environment. The implications for developing countries, especially those facing rapid population growth such as Sub-Saharan countries (UNDESA, 2015), is that during the process of industrialization, an increase in biomass consumption will require deforestation or fossil energy subsidies to existing croplands, thus affecting sustainable development.

Ramos-Martin et al. (2007) examine China's energy metabolism from 1990 to 1999 using multi-scale integrated assessment of societal metabolism. In this study, China's metabolism is analysed and compared with OECD countries' metabolism. The study concludes that China's energy consumption is low when compared with the OECD. Yet, the Chinese population structure, and the amount of working hours that the society can provide, has enabled the country

to have a comparative advantage. In addition, available national coal in China (IEA, 2015b) has enabled rapid industrialization by providing a cheap and reliable energetic source.

Available inexpensive coal has played a major role in the industrialization of many countries, such as Britain, the US, France, Belgium and later on in China (Cottrell, 1955; Cameron, 2000; Sieferle, 2001; Schandl et al., 2008; Moe, 2009). West African countries do not possess local coal (IEA, 2015b). Some West African nations such as Nigeria and Ivory Coast possess oil reserves, but extracted oil is mainly exported. Historically, the industrialization process has relied heavily on coal and oil use (Cottrell, 1955; Sieferle, 2001; Schandl et al., 2008). Access to fossil fuels is necessary but not a sufficient condition to industrialize. Social needs and socio-political context are needed to create the need to successfully exploit and use fossil fuels (Sieferle, 2001).

2.2.1.1. Fuel switching in developing countries

Developing countries can benefit from an energy switch from biomass to modern energy carriers. As reported by IEA (2015b), around 60 percent of overall energy use in West African countries comes from biomass. Wilkinson et al. (2007) explore, among other negative effects of biomass use, the negative health impacts of biomass use on population. Due to low combustion efficiencies, a large fraction of burned biomass is converted to products of incomplete combustion (carbon monoxide, methane, volatile organics). These products are a major health risk for population in the region causing premature deaths (WHO, 2008). Therefore, switching to modern fuels would reduce the negative health effects of elements of incomplete combustion in biomass, which could increase well-being (measured by life expectancy and infant mortality) without the need of increasing energy consumption. Additionally, fuel transition would decrease the energy intensity (amount of energy needed to create a unit of GDP) of developing countries that switch to modern energy carriers (UNCTAD, 2012).

United Nations (UNCTAD, 2012) focuses on the energetic and material metabolism of the African continent. When examining the energetic metabolism, the report emphasizes the importance of fuel switching for African countries and the ability of the region to leapfrog over inefficient technologies to industrialize. In the Global Energy Assessment (GEA, 2012) and Access to Modern Energy (Pachauri et al., 2012) reports, a wide range socio-political changes needed in the region in order to achieve development are discussed. Both reports highlight and

recognize the complexity and difficulties of achieving industrialization and electrification in developing countries.

Fuel switching can be viewed in different steps as stated by the energy ladder model (Hosier and Dowd, 1987; Leach, 1992; Masera et al., 2000; Heltberg, 2004), which conceptualizes fuel switching in three phases or steps. The first phase is universal reliance on biomass. In the second step, households are hypothesized to move to transition fuels such as kerosene, coal, and charcoal due to higher incomes, increased urbanization and biomass scarcity. In the third phase, households would switch to LPG, natural gas or electricity for cooking. The major achievement of the energy ladder is to show the income dependence on the choice of fuels, as some empirical work done by Barnes et al. (2005) shows. Heltberg (2004) tests fuel switching at the household level utilizing a probit regression for eight developing countries. His results determine that education, income, household size and electrification influence a reduction on the use of biomass and fuel switching. Hence, it is interesting to examine how Ghana's and Ivory Coast's energy supply composition differs based of the differences in their income. However, in order to avoid the negative health aspects of biomass use, these countries do not only need to move up the energy ladder, but as well need to provide modern biomass burners to increase efficiencies of established biomass.

When studying fuel switching in a country, it is important to understand the crucial roles that policy makers, private companies and international agencies have in promoting new energy carriers, their affordability and reliability (GEA, 2012). This is out of the scope of this thesis, yet it is important to note that many factors are involved in the energy-economy-society relationship. Fuel switching would enable Ghana and Ivory Coast to enter the industrialization process, but vested interest seeking to preserve the status quo (Moe, 2009), in what is termed by Unruh (2000) as the techno-institutional complexes, could result in carbon lock-in of societies.

2.2.2. Correlation between energy use and economic development

The literature that examines the correlation between energy, as in total primary energy supply (TPES), with GDP, or electricity with GDP, agrees on the positive correlation that exists. Ferguson et al. (2000) examine the correlation between electricity and GDP in over a hundred countries, finding stronger correlations between electricity and GDP in developed economies than in developing ones. In the case of West African countries, the study shows a strong

correlation (over 0.7) between electricity and GDP. When examining per capita terms, the correlation disappears in African countries, which is not the case in other regions. This could be related to the amount of per capita electricity used in more developed countries, which is several times greater than that of West African countries.

Cleveland et al. (1984) analyse how in the United States energy use highly correlates with GDP, output per industrial sector and labour productivity with almost perfect correlations (over 0.85). This reflects that energy use and added value have been highly correlated in the USA, which is in accordance with Ferguson et al. (2000).

Steinberger and Krausmann (2011) compile worldwide data on energy and material consumption and correlate them with income. Their findings suggest that energy and material consumption (excluding biomass) correlate with income. Their study demonstrates that fossil fuels have high-income elasticity, which would not facilitate increased fossil fuel consumption for lower-middle-income countries such as Ghana and Ivory Coast. Their findings suggest that biomass has low-income elasticity, which is interesting, as it might indicate that increasing income in selected countries could be accompanied by an increase in fossil fuel consumption while biomass use as a fuel remains constant. Therefore, the share of biomass in energy use would decrease in the selected countries with increased income, which would be in line with the energy ladder.

Studies on correlation demonstrate the agreement on the subject; Moe (2009) exemplifies it citing Smil (2003) and Ayres (2006) that observe the correlation between long-term economic growth and energy use. Nevertheless, Moe (2009) criticizes the approach of neoclassical economics towards energy, criticizing how the neoclassical view depicts energy consumption as an effect, not a cause of growth. This highlights the importance of studying economic growth in conjunction with energy consumption.

2.2.3. Causality between energy consumption and economic growth

The literature that studies the relationship between energy consumption and economic growth is mostly focused on the causality in between energy and GDP. These studies are based on econometric regressions that link GDP and energy consumption over time. The focus on the causality in between these two indicators relies on understanding how increased GDP or increased energy use will affect different societies. In developing countries, it emphasizes the

fact that policy measures affecting energy availably and reliability will affect GDP and income growth.

Studies measuring the causality in between energy and GDP utilize different econometric regressions to observe the relationship between selected variables. Once the relation is observed, Granger causality test are used to observe which variable causes the other. Up to date, no general consensus on the causality has been reached.

Starting with unidirectional causality from energy to GDP, energy use having an effect on GDP and not vice versa, Stern (1993) and (Lee, 2005) find unidirectional causality for the US and 18 developing countries respectively. Warr and Ayres (2010) for the USA find evidence of unidirectional causality from exergy (maximum amount of work that can be obtained from an energy carrier) and useful work to GDP. Lee (2006) observes the causality for 11 developed economies, using a different time span than Stern (1993). Lee's findings suggest that for the USA there is a bidirectional causality, meaning that energy consumption affects GDP and GDP affects energy consumption.

Paul and Bhattacharya (2004), using cointegration and Granger causality test, conclude that in India there is a bidirectional causality between energy and GDP. In contrast, Masih and Masih (1996), using cointegration and error-correction model, find that there is an unidirectional causality running from energy to GDP in India. Shown studies exemplify that the literature on the causality has not reached a consensus on the subject. An extensive literature survey on the energy-growth nexus can be viewed in Ozturk (2010), where a review on the literature demonstrates the lack of consensus on the subject. Additionally, in Ozturk (2010), it can be viewed there is a small number of studies measuring this relation in Sub Saharan Africa.

Akinlo (2008) examines the causality relationship between energy consumption and income in eleven Sub-Saharan economies. Using an autoregressive distributed lag bounds test (ARDL) and the Granger causality test based on vector error correction model, Akinlo (2008) finds with the ARDL test that in Cameroon, Ivory Coast, Gambia, Ghana, Senegal, Sudan and Zimbabwe energy consumption is cointegrated with economic growth. Additionally the study finds that energy consumption has a long run positive effect on economic growth in Ghana, Kenya, Senegal and Sudan. The Granger causality test shows bidirectional relationship between energy consumption and economic growth for The Gambia, Ghana and Senegal, while in Ivory Coast and Cameroon there is no causality.

Akinlo (2009) uses a cointegration error correcting model to observe the relationship between electricity and GDP in Nigeria. The findings suggest that electricity consumption causes economic growth. Wolde-Rufael (2005), on the other hand, examines the relation of energy consumption per capita and real gross domestic product per capita in 19 African countries. By applying the Toda–Yamamoto's Granger causality test, the study finds that the causality runs from energy consumption to GDP in Cameroon, Morocco and Nigeria, which is in agreement with Akinlo (2009).

In contrast to Akinlo (2008), Wolde-Rufael (2005) finds that for Algeria, Congo DR, Egypt, Ghana, and Ivory Coast, GDP Granger-causes energy consumption. This study finds no relation (neutrality hypothesis) in Benin, Congo Rep, Kenya, Senegal, South Africa, Sudan, Togo, Tunisia, Zimbabwe, and bidirectional causality between energy consumption and GDP in Gabon and Zambia, deviating from the results found in Akinlo (2008).

Wolde-Rufael (2009) re-examines the results of Wolde-Rufael (2005). This study adds gross capital formation and labour to the causal relationship between energy consumption and GDP, in order to explore if these variables would alter the results previously obtained. With the addition of capital and labour, this study finds that the causal relation obtained in the previous paper changes in 13 countries. In Benin and South Africa the casual relation runs from energy consumption to economic growth, from not having any relation in the previous study. Senegal, Sudan and Tunisia followed the neutrality hypothesis in the previous study, but in this new study, the causality runs from economic growth to energy consumption. In Togo and Zimbabwe bidirectional causality appears. The causal relation for Ghana becomes bidirectional causality, following results found by Chontanawat et al. (2008). For Ivory Coast, the casual relation remains from economic growth to energy consumption. This re-examination finds that capital and labour had higher contribution rates to growth than energy consumption in Ivory Coast in the short and long run. To the contrary, the new results for Ghana find that energy had a greater contribution to economic growth in the short and long run than capital, but lower than labour, which is related with privatization policies of the power sector.

Kouakou (2011) examines the relation that exists between electricity consumption and economic growth in Ivory Coast, finding that in the short run there is bidirectional causality between electricity consumption and economic growth. In the long run electricity consumption per capita Granger-causes economic growth. This study utilized time series data from 1970-2008 with income per capita measured in current prices, thus not being corrected for inflation,

therefore showing an increase in income. In constant prices, income per capita has decreased in Ivory Coast (World Bank, 2012b), which could modify the results of the study.

More recently, Stern and Enflo (2013) discuss one of the main problems in the causality literature, the short time periods used in most studies that relate energy and economic growth. Stern and Enflo (2013) research the energy-GDP relation for Sweden during a period of 150 years utilizing Granger causality and cointegration tests. The study finds that with a bivariate model, GDP causes energy use, but when utilizing a Divisia index the relation was reversed. This study also utilized a multivariate model including capital and labour, showing that the causation for the 150 years runs from energy to GDP. Interestingly, just observing the causality from 1950 to 2000 reversed the relation, GDP Granger-caused energy consumption. These disparities signal that Granger causality tests are sensitive to variable sample periods.

Bruns et al. (2014) perform a meta-analysis of the literature that tests for causality between energy use and economic output to find if there is a publication bias. The study uses a precision-effect test to test the validity of significant parameters in the literature, and a funnel asymmetry test on the intercept term to search for publication bias. The study finds an effect running economic output to energy use in literature that includes energy prices as a control variable. However, a lower causal effect appears from energy to GDP in studies that control for employment. As mentioned in the study, meta-analysis methods might fail to detect other effects due to shortcomings in the selected studies such as low observation frequency, errors in the measurements or model misspecification. The paper states that controlling for capital reduces the significance of energy causing output, arising the problem mentioned earlier, that model specification does affect results.

A summary of the review studies and their findings can be viewed in Table 2. Reviewed studies exemplify the lack of consensus on the causality debate between energy consumption and GDP, demonstrated by changes in the casual relation between both variables that varied by country, by the same set of countries, based on the indicators used, time span used, or the model used. Thus, in this study, the focus will not be on the casual relation, but rather focus on the general form of the relationship between these indicators.

Table 2.Summary of empirical studies on energy consumption-economic growth nexus.

Authors	Empirical method	Countries	Period	Variables	Causal relationship
Stern (1993)	Multivariate Vector autoregression	USA	1947-1990	GDP, E, K,L	E→GDP
Lee (2005)	Panel Vector correction model	18 developing countries	1975-2001	GDP,E,K	E→GDP
Warr and Ayres (2010)	Vector error correction model, cointegration, Granger causality test	USA	1946-2000	GDP,K,L,Useful work, Exergy	Exergy→GDP Useful work→GDP (only long run effects)
Lee (2006)	Granger causality test	11 developed economies	1960-2001	E,GDP_{capita}	E→GDP_{capita} (Belgium, Netherlands, Canada, Switzerland) GDP_{capita}→E (France, Italy, Japan) E←→GDP_{capita} (Sweden, USA) E---GDP_{capita} (Germany, UK)
Paul and Bhattacharya (2004)	Engle–Granger cointegration, Granger causality test	India	1950-1996	E, GDP_{capita},K,L	E←→GDP (Engle–Granger approach combined with the standard Granger causality) E→GDP (Standard Granger test) GDP→EC (Engle–Granger cointegration)
Masih and Masih (1996)	Cointegration , error-correction	Six Asian countries	1955-1990	GDP_{capita}, E	E→GDP (India) GDP_{capita}→E (Indonesia) E←→GDP_{capita} (Pakistan) E---GDP_{capita} (Malaysia, Philippines, Singapore)
Akinlo (2008)	Autoregressive distributed lag bounds test, Granger causality test based on vector error correction model	11 Sub-Saharan countries	1980-2003	E, GDP, Prices, Government expenditure	GDP→E (Gambia, Ghana, Sudan, Zimbabwe, Congo, Senegal) E---GDP (Cameroon, Cote d'Ivoire, Nigeria, Kenya, Togo)
Akinlo (2009)	Cointegration	Nigeria	1980-2006	GDP, $E_{lectricityCapita}$	Electricity→ GDP
Wolde-Rufael (2005)	Toda-Yamamoto Granger test	19 African countries	1970-2001	GDP_{capita}, E_{capita}	GDP_{capita} → E_{capita} (Algeria, Congo DR, Egypt, Ghana, Ivory Coast) E_{capita} →GDP_{capita} (Cameroon, Morocco, Nigeria) E_{capita}←→GDP_{capita} (Gabon, Zambia) E_{capita}---GDP_{capita} (Benin, Congo RP, Kenya, Senegal, South Africa, Sudan, Togo, Tunisia, Zimbabwe)
Wolde-Rufael (2009)	Toda-Yamamoto Granger test	17 African countries	1971-2004	GDP_{capita}, E_{capita}, K, L	GDP_{capita}→ E_{capita} (Algeria, Egypt, Ivory Coast, Senegal, Sudan, Tunisia) E_{capita}→GDP_{capita} (Benin, Cameroon, Morocco, Nigeria, South Africa) E_{capita}←→GDP_{capita} (Gabon, Ghana, Togo, Zambia, Zimbabwe) E_{capita}---GDP_{capita} (Kenya)
(Chontanawat et al., 2008)	Granger causality	108 Countries	1960-2000 (OECD) 1971-2000 (Non-OECD)	GDP_{capita}, E_{capita}	E_{capita}→GDP_{capita} (Higher in OECD than Non-OECD)
Kouakou (2011)	Cointegration, Granger causality based in error correction model	Ivory Coast	1971-2008	GDP_{capita}, $Electricity_{capita}$, Industry AV	$E_{lectricity\ capita}$← →GDP_{capita} (short run) $E_{lectricity\ capita}$→Industry AV (short run) $E_{lectricity\ capita}$→GDP_{capita} (long run) $E_{lectricity\ capita}$→Industry AV (long run)
Stern and Enflo (2013)	Granger causality and cointegration	Sweden	1850-2000	GDP, E Divisia energy K,L	E→GDP (long run) GDP→E (short run)

E= Energy, L= Labour, K= Capital. AV= added value. → Unidirectional causality. ← → Bidirectional causality. --- Neutrality hypothesis

2.2.4. Externalities of energy use

There are negative externalities to energy consumption; these externalities can affect local environments, such SO_2 and NO_x emissions and deforestation, or externalities that affect the global environment, such as carbon emissions. Sulphur and nitrogen oxide emissions, cause direct negative health impacts and are a major cause of acid rain, directly harming localized environments (Bowman, 1992; Srivastava et al., 2001; Kaminski, 2003). With increased wealth, many nations have taken action to successfully decrease their SO_2, NO_x emissions per capita (Oetting and Schweimer, 1982; EPA, 1990; Lefohn et al., 1999; Stern, 2005). Some environmental and health impacts are hypothesized to decrease with increased income, due to increased environmental awareness, this effect has been termed the environmental Kuznets curve (de Bruyn and Opschoor, 1997; Chimeli and Braden, 2005; Smith and Ezzati, 2005). Many scientists have questioned the environmental Kuznets curve methodology and data (Stern, 2004; Kijima et al., 2010). Empirical studies show that the emissions of certain pollutants have steadily increased with increased economic wealth, especially carbon emissions (Boden et al., 2013; Nejat et al., 2015). Increased carbon emissions and the global warming effects of these emissions have brought up an ever-increasing interest on understanding how carbon emissions relate with economic growth. Consequently, there is growing interest on understanding how economic development has related with pollutant emissions, and if economic growth can be achieved without equal increases in carbon emissions. Therefore, it is relevant to understand not only how economic growth has related with energy consumption in selected countries, but also understand the environmental impact of their energy consumption patterns.

2.3. Material consumption and economic performance

The literature that links resource wealth and economic growth also lacks any type of consensus over resource endowment and its effects over economic performance. Studies on developing economies are centred on the effect that material wealth discoveries have over a developing country. Terms such as the ‘Dutch disease’ and the ‘resource curse’ are well established, but researchers have not yet reached an agreement over the effects that material wealth has on GDP.

This section is divided in three subsections. The first subsection analyses the material metabolism literature, these studies research the effects that material extraction, consumption and exports have in different countries. The second subsection analyses the literature on the resource curse, focused on how resource endowment affects development of different nations due to socio-political management. The last subsection will examine resource use in African countries.

2.3.1. Material metabolism

When revising the literature on material metabolism, it can be seen that there are a number of studies that analyse the global material metabolism. These studies provide evidence that consumption of different materials (not including biomass) correlate with economic development (Steinberger et al., 2010).

Studies such as Krausmann and Fischer-Kowalski (2013) observe the global material metabolism and the importance of new energy carriers on the process of industrialization of developing countries. In Krausmann et al. (2008), changes in the metabolism of a society are analysed, comparing how different parameters increase when a society transitions from an agrarian society to an industrial one. These studies provide important insights to understand how material metabolism changes with socio-metabolic transitions and set thresholds that can be used to understand where Ghana and Ivory Coast can be placed in their present state.

Singh et al. (2012) quantify resource use in India from 1961 to 2008 and the challenges the country faces to achieve sustainable development. Due to India's vast population, supplying citizens with a reasonable material standard of living will impose high levels of environmental pressure on local resources. Thus, India's consumption growth will be dependent on imports.

Gonzalez-Martinez and Schandl (2008) examine material flows in Mexico and the changes in the economic structure from 1970 to the early 2000's. Finding that an increase in construction minerals consumption, used to build infrastructure, has related with economic growth. Mexico's economic policy has influenced structural changes, but Mexican exports are still 50% dependent on oil, making it an economy in between extractive and a productive economy. Bunker (1985), as cited in Russi et al. (2008), states that capitalism polarizes extractive economies from productive economies, with an ever increasing flow of raw materials from extractive to productive economies, which makes extractives economies vulnerable to market

price fluctuations, aligning with alternative theories of development. Industrialization and economic policies have led Mexico's export diversification to move away from raw material exports to manufactured goods, which have higher added value per exported tonne. Both papers agree on the importance that structural changes have had to improve the terms of trade. This is an important aspect for Ghana and Ivory Coast, as both countries aim to transition from raw resource exporters to productive economies.

Recently Steinberger et al. (2013) examined how economic development and growth relate with resource use in different countries. Their findings are that, in the long run, developing countries tend to have a strong coupling between economic growth and material use. Nevertheless, this study acknowledges that developing countries show different development pathways. These pathways need to be explored in combination with national historical context and circumstances.

Estimating the material metabolism of a society helps to understand the socio-ecological regime of a society, which is not only dependent on the material metabolism of a society, but also on its socio-political institutions. Ivory Coast and Ghana are in between an agricultural and an industrial society, but agriculture remains the main labour-intensive economic driver in both countries (FAOSTAT, 2015a). The industrialization process in Ghana is being hampered by unreliable energy access, supply and the vast differences between access to modern energy carriers in urban versus rural settings, among other problems (ADF, 2005). While in Ivory Coast, political and security risks hinder the industrialization process (ADF, 2013).

The actual context Ivory Coast and Ghana are facing during their development is different than the one faced by the first countries that industrialised, for instance there is an ever increasing competition for scarce resources. Such differences would make their transition towards less agricultural dependent societies challenging; in words of Krausmann et al. (2008):

'the preconditions are different than what they used to be in the first and second waves of industrialization. There is no wilderness frontier, no new worlds to be conquered anymore; fossil fuel energy supplies are running low and becoming more expensive. This characterizes the system environment for all developing countries today.' (Krausmann et al (2008), p.652).

Trade is an important characteristic when exploring material metabolism in these two nations, as they export great amounts of their raw materials (Martinez-Alier et al., 2010). Through trade,

importing countries are able to ease the burden that certain materials entail, such as the amount of earth moved to obtain a tonne of gold (Dittrich and Bringezu, 2010). Dittrich et al. (2012) analyse world material flows and the burdens for different countries, showing that African countries face trade burdens due to the composition of their exports.

In 1978 Malenbaum hypothesized that economic development is highly related with resource use, terming this relation the intensity of use hypothesis (Malenbaum, 1978). This hypothesis states that income is the main factor that explains consumption of materials. Hence, in stages of economic growth countries will increase material consumption at the same growth rate of income, up to a certain point upon which there will be a de-linking and further increases of income will not increase energy or material use at the same rate. This hypothesis has later on been called the environmental Kuznets curve (de Bruyn and Opschoor, 1997; Chimeli and Braden, 2005). As Ghana and Ivory Coast are endowed with a variety of natural resources and are on a stage of economic growth, it is interesting to observe if this theory of economic development and resource use holds in the selected countries.

2.3.2. The resource curse

In 1995 Sachs and Warner (Sachs and Warner, 1995) analysed how natural resource abundance related with economic growth. Their findings suggested that resource wealth could be related with lower rates of economic growth, what was termed the Dutch disease. This term was introduced in the 1970's, as a rapid de-industrialization process followed discoveries of gas reserves in the Netherlands. The Dutch disease hypothesizes that raw resource dependency, proxied by the ratio of primary exports to GDP in 1971 in Sachs and Warner's study, would divert a country's resources from industrial activities to material extraction. This would move labour from the manufacturing sector, which was more knowledge dependent, to the resource extraction sector, assumed to be less knowledge intensive, shifting the productive structure of a country. Therefore, a resource boom would divert a country's resources from industrial activities to material extraction, which given the external demand for extractive resources would appreciate the exchange rate. Thus, manufacturing exports would decrease, thereby causing a country's de-industrialization (Ploeg, 2011; Saad-Filho and Weeks, 2013).

Many authors have revised Sachs's and Warner's (from now on SW) study and broaden the scope to study the resource curse. By adding new control variables to SW model and studying qualitative aspects of resource discoveries, factors such as the quality of political institutions

are considered important indicators when investigating the effects of resource discoveries in a country, as institutional quality impacts how resource rents are managed. Education expenditure, corruption, control over raw resources -including armed conflicts to control resources, and infrastructure development are the main topics that have caught the attention of researchers on the resource curse topic.

Gylfason (2001b) discusses the negative effects of resource richness. This study argues that the negative outcomes of resource richness emerge through the neglect of education and human capital formation, identifying the need of examining certain social indicators when studying the relation of a country's metabolism and its economic performance. Cherif (2013) argues that the negative effects of a resource boom would not show up until it has been depleted or until there is a great decline in the resource price. When resource rents drastically decrease, the country that was resource rich will be technologically behind resource poor countries. This will be due to resource allocation into the extractive industries, versus investments on technologically complex industries such as manufacturing. It can be argued that large-scale resource extraction, such as offshore oil extraction, is technologically complex. In words of Gylfason (2001b):

> 'high-skill labour and high-quality capital are less common in primary production than elsewhere, this may help explain why natural resource abundance and the associated preponderance of primary production and primary exports tend to impede learning by doing, technological advance, and economic growth. This linkage reinforces the case for investment in education and training as an engine of growth: more and better education tends to shift comparative advantage away from primary production towards manufacturing and services, and thus to accelerate learning by doing and growth' (Gylfason 2001, p.856)

Bulte et al. (2005) and Moe (2009) consider the curse to have an effect through rent-seeking behaviours and maintenance of the status quo of the elites, which inhibit development away from the resources these elites control. Bulte et al. (2005) add to SW study the inclusion of variables that measure governmental quality and differentiate between point and diffuse resources. These studies assert that point resources, oil or other minerals that are concentrated in an area, or agricultural products such as coffee and cocoa, are drivers of the resource curse, through rent-seeking behaviours of the elites.

Moe (2009) analyses, in a qualitative manner, history and politics behind resource use. Moe (2009) identifies that elites that control resources try to inhibit development outside the resources that elites control, thus showing that the resource curse can be observed in a qualitative manner as a complement of econometric design methods. In the same line, Ross (1999) examines the political economy behind the resource curse, reviewing literature on the subject. Based on the review on the literature, Ross (1999) divides the political aspects of the resource curse literature into three theories that view the curse as a policy failure. The first theory, termed cognitive theory views the curse as short-sighted 'get-rich' mentality by policy makers. The second theory, the societal theory, argues that resource rents empower groups that control raw resources and these groups impede growth related policies. The third theory, the statis theory, states that a rentier state obtains funds from resource rents and not taxes, which makes governments less accountable (Bleischwitz and Stefan, 2011), view shared by Stevens and Dietsche (2008) as one of the structural explanations of the resource curse.

Collier and Hoeffler (2005) and Ross (2004) research the relation between resource abundance and internal conflicts in developing countries. Ross (2004) identifies in the literature that agricultural commodities cannot be linked with conflicts, but oil dependence can. Nevertheless, states with large resource dependency tend to have low taxes and low education rates, which can be associated with state weakness and increased likelihood of conflict. Collier and Hoeffler (2005) agree that agricultural rents are less prone to cause conflicts, as agricultural rents are lower than mineral resource rents. A problem that arises with resource richness is that it can lead to bad institutions, and bad institutions can lead to the formation of rebel organizations in the context of controlling valuable resources. Collier and Goderis (2008), utilizing a panel cointegration methodology, identify that high-rent resources (non-agricultural commodities) cause a short-term economic boom. Yet, in the long run, resource curse signs appear, such as exchange rate appreciation.

These approaches consider resources not only, or necessarily, an economic problem, but also a socio-political problem, expanding the idea that the curse might emerge from social dimensions. Therefore, it is interesting to observe the resource composition in Ghana and Ivory Coast, and understand if mineral products show any signs of fostering the resource curse.

Isham et al. (2004), as well as other studies, identify the necessity of differentiating between point and diffuse resources. Isham et al. (2004) consider that point resources have a negative impact on the economy, while diffuse resources do not. This is quite interesting as exports in

Ghana and Ivory Coast, as in other West African countries, are mainly point resources (UNIMTS, 2014). A priori, Ivory Coast and Ghana have some characteristics to suffer the resource curse. Brunnschweiler and Bulte (2008) model shows that the curse is dependent on the quality of national political institutions, where countries with higher quality institutions will be less resource dependent, thus, less likely to suffer the curse.

On the other side, some studies on the subject that are not in favour of the resource curse. For instance, Brunnschweiler (2008) re-examines the resource curse hypothesis, finding a direct and positive relation from natural resource wealth to economic growth once institutional quality is considered. Following the same line of discussion, Stijns (2005) debates the limitations of SW's study. Stijns (2005) argues that primary export intensity, used as proxy for resource abundance as in SW's paper, has limitations; resource rich countries might export their resources not as primary export, but embodied in manufacturing.

A number of studies examine the resource curse through a quasi-experimental approach to analyse if resource discoveries influence economic development. Michaels (2011) studies the effect of oil abundance in Sothern US from 1940 to 1990. Michaels (2011) finds that oil-rich counties outperformed counties without oil in terms of income, employment and infrastructure development, without experiencing a decrease in manufacturing or service sector employment. The study states that developing countries do not face similar economic channels as those that operate in the US, therefore, the likelihood of resource curse channels appearing in developing countries can be related with weak local institutions. Indeed, this is confirmed by Dube and Vargas (2013) who examine how agricultural and mineral resources relate with conflict in Colombia. Utilizing a two least squares difference-in-difference estimator, Dube and Vargas (2013) show that a reduction in agricultural prices increased armed conflicts in agricultural areas, while an increase in mineral prices increased conflicts in mineral rich areas in Colombia. This study was focused on the oil and coffee sectors in Colombia, but the effects hold when other agricultural and mineral resources were considered. Therefore, as Ivory Coast exports coffee and oil, it is interesting to observe if the dynamics of coffee and oil can be related with the conflict in the country.

Similarly, utilizing a difference-in-difference estimator and triple-difference regressions, Vicente (2010) examines the contribution of oil discoveries in perceived corruption in Sao Tome and Principe. Vicente's study utilizes micro-data in a natural experiment setting to compare oil-rich Sao Tome and Principe with Cape Verde, which does not possess oil, from

1997 to 1999. Vicente's research finds that after the discovery of oil there was an increase in corruption in Sao Tome and Principe to maintain political power. In order to maintain power, the government used resource rents to buy votes, to subsidize consumption of the elites and provide educational scholarships to elites.

In a similar line, Caselli and Michaels (2013) compare Brazilian offshore oil-rich municipalities with municipalities that do not poses oil. Brazil has a legal framework to ensure oil revenue allocation to oil-rich municipalities. However, despite offshore oil-rich municipalities receiving oil revenues, recorded public expenditure of oil rents does not coincide with survey data and recorded administrative data. The results of the paper show that infrastructure development, education expenditure and household income have not benefited from increased municipal revenues. Therefore, using ordinary least squares regressions and instrumental variables estimation, the study finds that municipal spending has hardly increased, or has even declined, in offshore oil-rich municipalities, meaning resource rents are being misused. Contrary to the results found for the US by Michaels (2011), in the Brazilian case, labour did not migrate from other municipalities to oil-rich municipalities, signalling that the effects of oil windfalls were not perceived as beneficial. Brückner and Ciccone (2010), study how raw resource prices relate with conflicts in Sub-Saharan African countries. Their findings suggest that decreased international prices of raw resources exported by Sub-Saharan African countries raised the probability of war and conflicts in the region. Consequently, it interesting to observe if in the selected countries, a decline in export prices can be related with war or conflicts.

These quasi-experimental studies focused on individual countries, indicate that the resource curse channels can be related to the specific context that each country faces. Therefore, these studies highlight the importance of in-depth exploration of each country's context when studying the resource curse.

The reviewed literature exemplifies that there are different ideas on the literature that links resource endowment, economic growth and politics. However, the reviewed literature demonstrates that each country's own context will determine if resource curse channels will appear or not. In words of Saad-Filho and Weeks (2013):

> 'the macroeconomic impact of a resource boom is likely to depend upon circumstances of time and place, and on government policies. It is impossible to say ex ante whether a

boom is likely to lead to sustained economic growth, inflation or Dutch disease. The outcomes are likely to depend on the policy mix, the government's priorities, and its capacity to implement consistent policies' (Saad-Filho and Weeks (2013, p.15)).

Therefore, I will study the resource curse hypothesis from a broad perspective. I will consider not only the direct relation between raw resources and GDP, but also the effects that political institutions and public sector management, measured by the World Bank Development indicators, have in the relation.

The work in this dissertation extends the existing literature in several ways: in terms of the study period, as well as in terms of the combination of economic data with data on mass quantities of produced and extracted materials (since economic data alone does not accurately reflect natural resource wealth of a country). Additionally, I will combine qualitative information concerning socio-historical context and policies directed towards raw resources to unfold the characteristics that might have led or prevented suffering the curse. Moreover, this analysis will innovatively relate raw resource dynamics in these two countries not only with the resource curse per se, but also with development theories, in order to uncover any interconnection between these theories, focused on global political and economic power, and resource curse signs.

2.3.3. Resource use in Africa

Bazilian et al. (2013) analyse the relationship between economic growth and oil wealth in West Africa. Their study concludes that resource rich countries show less economic development than resource poor do. The example of Saudi Arabia (the country with greatest global oil reserves) is presented as an extreme case. Saudi Arabia experienced a decrease in GDP per capita in constant 2000 US dollars, from $15,400 US dollars in 1981 to $9,900 US dollars in 2011. Therefore, it is important for Ghana and Ivory Coast to manage adequately their resource wealth. Similarly, oil rich countries studied by Bazilian et al. (2013) show lower electricity access than resource poor ones. This study also examines how countries such as Nigeria and Chad depleted their oil revenue funds, probably due to corruption, highlighting the importance of transparency and accountability when dealing with resource booms. Indeed, Deaton (1999) examines the literature that studies commodity prices and economic growth in African countries. The findings of Deaton (1999) suggest that in the long run, exported African raw resources lose value in real terms -despite short run price variability. Moreover, Deaton (1999)

identifies that the price of a number of raw resources, such as coffee and cocoa, are correlated. Consequently, export diversification might not have expected positive effects of mitigating raw resource price fluctuations. This point is quite important to understand in this thesis, as for instance both countries export a variety of raw resources, among them coffee and cocoa (FAOSTAT, 2014a).

One of the main difficulties arising when studying the physical economy of West Africa is the available data, its consistency over time and its quality. Dittrich and Bringezu (2010) highlight that African countries often report their trade flows in a very incomplete way to UN, missing trade flows could reach up to 50% of their total trade flow.

UNCTAD (2012) examines Africa's trade in physical and economic terms in the global economy. Their share represented 4.9% in material terms and 3.3% in economic terms in 2008. Over the past 30 years, imports and exports have increased in the continent, but the value of imports has grown at a higher pace than exports, which reflects the reality of their imported manufactured goods over their exported raw materials. This trend is also explored by Dittrich and Bringezu (2010), but their findings suggest that, with the exception of Nigeria, West African countries do not suffer a material burden from international trade even when their exports are raw materials and their imports manufactured goods. Dittrich et al. (2012) revise their previous work to include indirect flows associated with extraction, such as the amount of earth moved to extract minerals, revealing that West African countries suffer an environmental burden from their exports greater than what they ease from their imports, which is to be expected due to the composition of their trade.

Steinberger et al. (2010) discuss the importance of understanding the different environmental implications of the extraction of diverse materials, such as biomass extraction compared to gold. This fact presents one of the problems arising from material flow accounting, the inability to measure environmental consequences of the physical economy. Nevertheless material flow accounting is a standardized useful tool to quantify an economy in mass units.

UN (UNEP, 2011) models future scenarios, using material flow analysis, to examine possible future metabolic paths. UNEP (2011) observes that in scenarios where constraints to material consumption are put in place, developing countries would not have any space to grow in terms of material consumption per capita. Therefore, developing countries, in the current global climate, might need to leapfrog non-material efficient (material/GDP) technologies to become

economies that are more productive. Additionally, UNEP (2011) analyses a business as usual scenario, observing that developing countries would increase their material use. In global terms, this scenario would increase world material consumption from 49 billion tonnes per year in 2000 to 141 billion tonnes per year in 2050, which is not a desired future. African countries in general need space to grow in their consumption to provide all Africans with the necessary material needs (UNCTAD, 2012). However, at the same time, growth has to be combined with productivity gains, calling for a change in current African production patterns.

These studies show that African nations face a new situation, in which economic growth is related to important environmental concerns. Their growth might need to be more material and energy efficient than the growth path followed by previously developed economies. However, their development process does not only face environmental concerns, but also a global context in which their status as raw resource producers hinders their transition to industrial economies. Therefore, combining the metabolic approach with the resource curse and development theories can prove as a useful method to measure the development path followed by selected countries, as well as to implement policies to achieve positive developmental outcomes.

2.4. Summary

The reviewed literature highlights that the development trajectories of different societies have been studied through a number of perspectives. In this thesis I have focused on the literature that examines the role of biophysical inputs in different development trajectories and socio-ecological transitions, as well as the role of resource endowment and international context in the development trajectories of societies. In order to comprehend the socio-metabolic development path of the selected countries it is necessary to understand the different socio-metabolic regimes existent and how different countries transition between those regimes.

There is a vast literature that examines previous transition processes through a metabolic approach (Haberl, 2001b; Haberl et al., 2006b; Singh et al., 2012; Krausmann and Fischer-Kowalski, 2013). However, due to data quality issues, the development path of West African countries has not been studied through a metabolic lens. Therefore, there is an empirical gap in the literature that this thesis can address. Moreover, in order to understand in which socio-ecological regime these countries are in and how these countries are transitioning, hypotheses such as the intensity of use (Malenbaum, 1978) and the energy ladder (Hosier and Dowd, 1987; Masera et al., 2000) become relevant, as these two hypothesis link biophysical consumption

and its transition towards non-biomass based consumption with income dynamics. Consequently, by exploring these two hypothesis, this thesis can explore if there is a link between biophysical consumption and income in the selected countries, which can then be used to comprehend if based on these hypothesis, future income dynamics will be related with a metabolic transition.

Mentioned hypotheses do not explore the overall context faced by a country. The context in which a country is embedded might affect the income-biophysical consumption relation; factors such as access to resources or competition for resources are not investigated. Yet, in order to understand the transition from agrarian to industrial societies, not only access to non-biomass inputs is needed, the overall socio-political context faced by a country is needed to comprehend the transition process (Sieferle, 2001). However, in the present day, understanding the transition of a country involves studying the international context in which a country is embedded, calling to explore development theories. These theories view development from different perspectives. The classical development theory (Nafziger, 2006; Pieterse, 2010) connects development with economic growth, and economic growth can be achieved through neoliberal measures such as reducing the role of the state in the economy and free trade. Alternative theories of development, the world systems theory and the dependency theory (Furtado, 1971; Chilcote, 1974; Wallerstein, 1974; Leys, 1996; Nafziger, 2006; Wallerstein, 2011), explore modern development in a global socio-economic and political framework, in which a country's development is embedded. Understanding and exploring these development theories will provide a view of development that will be useful to explore in this thesis, especially when studying the resource curse.

Ghana and Ivory Coast, as well as many developing nations, are highly reliant on raw resources, which has been considered a curse by the literature (Sachs and Warner, 1995; Ploeg, 2011; Saad-Filho and Weeks, 2013) as it is hypothesized that raw resource wealth creates raw resource dependency. Raw resource dependency is hypothesised to cause a number of negative outcomes for many economies, such as lower economic growth, low levels of industrialization and corruption. The resource curse has been studied for many countries from an economic and political perspective. However, combining the economic and political perspectives with a metabolic lens and development theories can be useful to contextualize resource curse channels, as it can provide a holistic perspective to examine resource curse signs. Through a more holistic perspective, this study will aim to point out if the existence of the curse can be

attributed to resource wealth, national or international context, representing a theoretical gap that can be addressed in this dissertation.

Based on this review, there is a lack of comprehensive in-depth country studies that consider the biophysical, economic and social aspects of development of West African countries within the context of resource curse and development theories. Consequently, by comparing Ghana's and Ivory Coast's development paths with African averages, previously industrialized economies, and with global average development paths, this study should be able to point out the notable characteristics that have shaped Ghana's and Ivory Coast's socio-ecological transitions. Therefore, highlighting if the selected countries are following a distinctive development path, or if their development resembles the global average or the African average development paths. Moreover, exploring the differences that exist between the metabolism of the selected countries and the global average should help pin point factors, such as energetic shortcomings, that can be used to identify routes and policies that could positively affect Ghana's and Ivory Coast's development path.

3. Methodology and framework

This thesis aims to utilise the societal metabolism lens to analyse socio-economic development in Ghana and Ivory Coast, and what can be learnt of their development by utilizing this approach. To respond to the overarching question of this thesis, different aspects that build upon one another need to be explored. By combining different methodological elements from the metabolism approach, the resource curse and development theories, the analytical framework developed in this thesis provides a methodological advancement towards studying the development trajectories of currently developing countries.

This chapter will be divided into six subsections, each one identifying the different research stages that answer the main questions addressed by this thesis. The first section examines how qualitative and quantitative data can be combined when conducting research. The second section will describe the methodology to analyse the paths and interdependencies that exist between the physical economy and socio-economic performance of selected countries. The third section will expand the metabolism approach to explore the resource curse in both countries. The fourth section describes the qualitative approach of unifying the overall historical and political context with the development path taken by Ghana and Ivory Coast. The fifth section will contextualize both countries development with their global context. This section presents the method by which the results obtained for both countries will be compared, which will be done in the context of their interaction with global governance. The final section presents a diagram of the overall framework to present the interconnections between the different methodological sections.

3.1. Integrating qualitative and quantitative research, the research onion

In order to understand how qualitative data can be used in combination with quantitative data analysis the research onion will be introduced. Developed by Saunders et al. (2009), the research onion combines the use of quantitative and qualitative data to answer research questions in social sciences (Saunders et al., 2009; Daum, 2013).

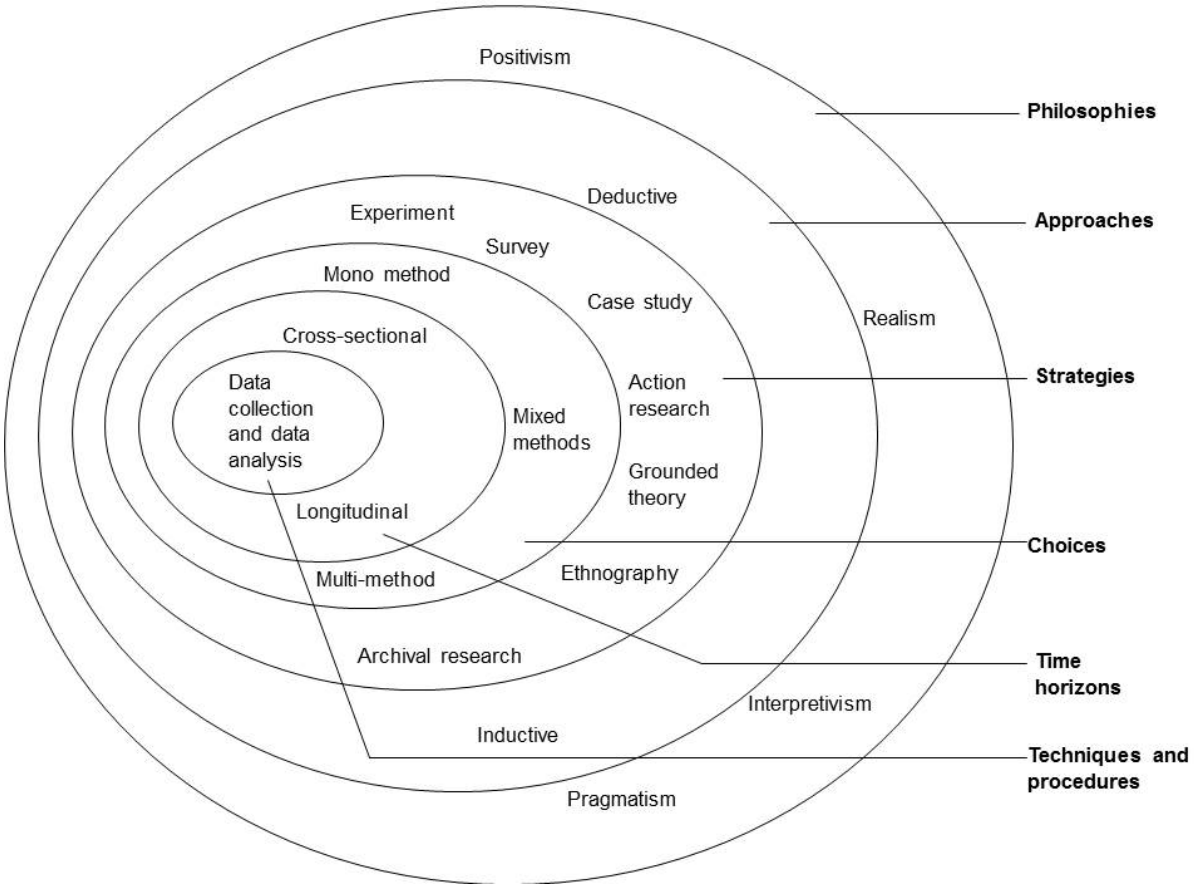

Figure 2. The research onion. Source: (Saunders et al., 2009)

The research onion represents the different choices to be made throughout different steps of developing a research project. Each layer of the onion represents a different step. Each domain inside the different layers represents different options that can be chosen when developing a research project. Each domain in the inner layers is intrinsically related with one or more domains in the outer layers. The analogy with an onion relates with the layers, as the outer layers need to be 'peeled' (evaluated) before reaching the inner layers. This order, however, is not prescriptive, and this dissertation does not follow it exactly.

In order to simplify the 'peeling' of the research onion, only the domains related with this study will be discussed. The first step in the research onion is to choose the research philosophy. The research philosophy relates with the development of knowledge and the nature of that knowledge, it is based on the way the researcher views the world. Research proposals might fit in more than one domain. As noted by Saunders et al. (2009), a particular research question rarely falls neatly into only one philosophical domain. This thesis falls within two philosophical domains:

- Pragmatism: this domain prioritizes the research question, leaving the methodological question as secondary. This domain exemplifies the first step of this research, which is to answer the research question of understanding if the societal metabolism approach can be used to study development in selected countries. The methods to be used are secondary to the research question and dependent on the available data.

- Positivism: this domain deals with observable social realities, the researcher collects and utilizes credible data to develop or test hypothesis, in whole or part, leading to the further development of theory. This thesis also falls within this domain as it intends to observe a measured reality and utilize data to investigate hypotheses such as the intensity of use and the resource curse.

Entering the second layer, the layer of approaches, this research combines the deductive and the inductive approaches. The deductive approach can be understood as a scientific approach where theories are studied after obtaining quantitative data. This approach relates with the positivism philosophy, as one of the points of this thesis is to collect quantitative data and evaluate hypotheses.

On the other hand, this study also follows an inductive approach, which is a flexible approach that permits changes. This approach comprises the collection of data and observes the themes and issues that emerge from analysing the data. Within this approach, qualitative data is collected and used to get a closer understanding of the research context. As opposed to the deductive approach, here the first step is to collect and examine source material to assess which themes and issues emerge, which will help developing a conceptual framework to guide the subsequent work. This represents the research steps followed in this thesis, where the first step has been longitudinal and cross-sectional data collection and analysis, and based on data availability and emerging patterns the framework for subsequent work has been created.

Following into the third layer, strategies, this thesis relates with one domain: case study. A case study involves an empirical investigation of a particular case within a real life context using different and multiple sources of evidence. As highlighted by Yin (2003), understanding the context is important in case studies, as within a case study the boundaries between the phenomenon being studied and the context within which it is being studied are not clearly evident. In this layer, qualitative data provides a context for the period where quantitative data is collected, enabling this study to understand the circumstances behind the numerical data.

Case studies can be single or multiple. Multiple cases can help to establish whether the findings of the first case occur in other cases or not. In order to answer research question four, I will compare if both countries follow a similar development path, or if factors such as different socio-political context make a difference.

The research choice of this project is mixed methods. This category can be separated into mixed methods research and mixed model research (Saunders et al., 2009). Mixed method research uses quantitative and qualitative data but does not combine them. To the contrary, mixed model research combines quantitative and qualitative data, where one type of data can be analysed using the other. For example, in this thesis, qualitative data from a variety of sources (Ousou and Bouabre, 1996; Woods, 2004; Boafo-Arthur, 2007; Globalwitness, 2007; International Business Publications, 2007; Boafo-Arthur, 2008; UNICEF, 2009; World Bank, 2009b; ICCO, 2010a; McGovern, 2011; Amoro and Shen, 2012) will be used to further analyse quantitative data, by contextualizing and explaining the development path taken by both countries. Moreover, data outliers and the relation between socio-economic development and biophysical consumption can be better understood by studying the overall context of the selected countries. Hence, utilizing qualitative data to provide context specific material, this thesis will follow a mix model research choice.

This thesis will examine both countries socio-economic and biophysical development from 1980 to 2010, making the time horizon a longitudinal research. Finally leading to the last layer, techniques and procedures, which is the step where the data is collected and analysed based on the knowledge of the project gained through all the previous layers.

3.2. Interdependencies between the physical economy and socio-economic performance

To answer the first research question presented in section 1.4, a set of indicators that can measure, or proxy, economic and well-being performance, as well as biophysical inputs to the economy, over time need to be selected. Selected indicators will be examined to understand their evolution over time and their interrelation, enhancing the understanding of the present state of Ghana and Ivory Coast.

3.2.1. Indicator selection

The first step is to obtain the most relevant indicators that measure economic, social and biophysical performance in Ghana and Ivory Coast for the selected period of study, 1980 to 2010. In certain cases, there is no available data for the full time span of the study, thus, indicators with shorter time spans are included, with mention made of their temporal coverage. Indicators with data breaks or changes in statistical coverage will also be discussed, as well as methods used to enable consistent usage for the time period of the study.

3.2.1.1. Economic and demographic indicators

To observe the economic performance of the selected countries, I will use GDP converted to constant 2005 international dollars using purchasing power parity (GDP PPP). It is an international comparable measure of total economic activity that is inflation corrected. Analogously, to study the economic wealth of the population, income per capita (GDP per capita constant 2005 US$ PPP) will also be studied.

These economies will be divided into three economic sectors: primary, secondary and tertiary sectors. The primary sector is composed by agriculture, hunting, forestry and mining (International Standard Industrial classification (ISIC) revision 3 (Rev.3) A-C). The secondary sector is composed by manufacturing, utilities and construction (ISIC D-F). The tertiary sector is made up by retail and transport among others (ISIC G-P). By analysing these three sectors and their evolution, this study will be able to unfold if there have been significant structural shifts in selected countries through the study period. Data on total added value per economic sector in constant 2005 international $ at PPP is not available directly. However, data on added value as a share of GDP is available from UNSD (2015). From this dataset, the share of each sector in GDP has been obtained and used to calculate added value of each sector in constant 2005 international $ at PPP.

The World Bank development indicators, 2012 edition World Bank (2012c), will be the dataset used for obtaining GDP, instead of the newest edition, World Bank (2015). The newest edition has updated data on GDP at PPP to constant 2011 international $, with 1990 as its starting year for the selected countries, reason for utilizing the older version in this study.

The informal, or unregistered, economy plays an important role in these economies (Schneider and Enste, 2013). Hence, available estimated data on the informal economy compiled by

Schneider and Enste (2013) for the World Bank from 1999 to 2007, will be used to study an estimate of the overall economy (reported GDP plus informal economy, total economy from now onwards).

Population dynamics will also be examined; population growth, urbanization and the share of active population in agriculture will be studied. Population data has suffered some important changes through the time taken to write this thesis, experiencing two changes with new revisions of population prospects. For instance, estimated population in Ivory Coast in 2010 was of 21.5 million FAOSTAT (2012), while in the revision made by UNDESA (2013b) estimated population in 2010 decreased to 19 million, to later increase to 20.1 million in UNDESA (2015). These changes set drawbacks when conducting this research, as indicators influenced by population, such as GDP per capita, have changed over the course of this research, thus results needed to be re-examined. This is an example of challenges faced when conducting research on this region.

3.2.1.2. Well-being indicators

To examine well-being dynamics of a country a wide range of indicators can be considered. Well-being is a multidimensional composite indicator affected by a number of indicators such as personal security, education, health and interpersonal relations (Rosa et al., 1988; UNEP, 2006). However, based on the ecological economics literature, two indicators will be selected to measure well-being dynamics in this thesis: infant mortality and life expectancy. Moreover, the Human Development Index will be studied alongside these two indicators.

The selection of infant mortality and life expectancy as two indicators that measure well-being in this study is based on Smil (2008), Boserup (1981), UNEP (2006) and Jamison (2006). Infant mortality measures nutrition, healthcare and environmental exposure of the most vulnerable group. For instance, infant mortality has been previously used by Stevens and Dietsche (2008) to study the contribution of natural resource exploitation to the improvement in the living conditions of the population in resource exporter countries. Therefore, it is a good indicator to measure populations health improvements (Reidpath and Allotey, 2003). Life expectancy shows the long-term effects of the measures mentioned for infant mortality, thus, it is a good indicator of the physical quality of life. Consequently, infant mortality and life expectancy represent two indicators that can be used to study health improvements that influence well-being.

The Human Development Index (HDI) is a composite indicator that combines data on income (GDP per capita), education and health (life expectancy), which is useful to observe aggregate human development in a country and compare it with other countries or development groups (based on UNDP's thresholds (UNDP, 2014)). Data for this indicator is available for six years, 1980, 1990, 2000, 2005, 2008 and 2010.

As with population, infant mortality and life expectancy data have experienced changes during this PhD dissertation's research. Revisions have been made in the world bank development indicators dataset, World Bank (2012c) and later on World Bank (2015). These changes have decreased Ghana's life expectancy through the period, but maintained a similar rate of change. In Ivory Coast, life expectancy and its pattern have changed. Similarly, infant mortality figures have faced major changes in both countries. These changes are mainly due to the political instability suffered by these nations, as well as missing reported data. Political instability increases data uncertainty in selected countries, therefore, the estimates of selected indicators change due to adjustments in light of new findings rather than changes in the real parameters.

3.2.1.3. Biophysical indicators

Biophysical indicators used in this thesis can be divided in two types of indicators, biophysical inputs to the economy and emissions. Biophysical inputs are separated into material flows, food supply and total primary energy supply.

Material flows accounts are consistent compilations of economy-wide material inputs to national economies, material accumulation within the economic system and the material outputs to other economies or to the environment (Fischer-Kowalski, 1998; Fischer-Kowalski and Hüttler, 1998; Eurostat, 2001). This type of accounting covers all material inputs except for water and air; it is measured in tonnes per year. It is important to understand that material flow accounting does not measure the environmental impact that an economy possess over the environment. This methodology aggregates different materials; therefore, different environmental implications of different materials cannot be measured. However, it is a consistent methodology to measure the physical scale of an economy and the environmental pressure exerted by society on the environment (EEA, 2002; Schandl and Eisenmenger, 2006). Material flows used in this study are domestic material consumption (DMC) at the national scale, in per capita terms, and physical trade balance (Schaffartzik et al., 2014; UNDESA, 2015). DMC is divided into five categories: biomass, fossil fuels, ores, industrial minerals and

construction minerals; it is calculated by adding to the domestic extraction of materials, imported foreign materials and subtracting exported local materials. The physical trade balance measures the trade surplus or deficit of an economy, calculated as the difference between imported and exported materials (Eurostat, 2001). It differs from monetary trade balance, which calculates trade balance as exports minus imports (Giljum and Hubacek, 2001).

In order to analyse the energetic metabolism of Ghana and Ivory Coast, total primary energy supply (TPES) will be used. Energy balances are chosen over energy statistics. Energy balances report energy data in a common unit with products aggregated by category, simplifying the task of comparing countries with different energy sources. Energy carriers vary between countries, however, energy carriers can be roughly classified in between primary solid biofuels (mainly biomass in selected countries), fossil fuels and hydroelectric power in Ghana and Ivory Coast.

Data on primary energy supply has also experienced updates through the duration of this thesis. From 2013 (IEA, 2013b), to a newer version in 2014 (IEA, 2014a), to the updated version of 2014 in 2015 (IEA, 2015b). In the Ivorian case, primary solid biofuels and charcoal were revised in 2009 for the period 2004-2006 by the IEA based on newly available information. This revision constitutes a large break in the time series of TPES between 2003-2004 (IEA, 2013a). Accordingly, biomass consumption increased 40% from 2003 to 2004: obviously a statistical artefact, not a reflection of reality. In order to smooth the data and create a consistent time series for this study, biomass in TPES in the year 2004 has been matched to the value of 2003, then, inter-annual growth rates of the original biomass time series have been used to obtain new values of biomass use from 2005 onwards. Total final energy consumption (TFC) of gas/diesel in the Ivorian industrial sector doubled from 1982 to 1983 (4.3PJ to 8.7PJ) to decrease 75% from 1983 to 1984 (2.1PJ). Moreover, in 1985 consumption of this energy carrier in the industrial sector increased 50%. Due to the volatility of these years for the dataset, gas/diesel consumption from 1983 to 1985 has been set equal to the value of 1982, and the inter-annual growth rate from 1986 onwards has been used to modify the dataset from 1986 onwards. The resulting new dataset does not highly vary from the original dataset from 1986 onwards.

Similarly, a revision in 2009 in Ghana modified data up to the year 2000, creating a break in certain series. This revision has produced a break in biomass consumption in the industrial sector, which considerably increases biomass consumption in one year, by 118%. Moreover,

agricultural total final energy consumption experienced a decline of 80% from 2001 to 2002 as well as an increase of 41% from 2008 to 2009 in gas/diesel oil consumption. Therefore, the same method has been used to smooth biomass consumption in the industrial sector in Ghana and gas/diesel oil consumption in the agricultural sector.

For the purpose of this study, TFC in both countries has been calculated with the modified dataset, as the sum of agricultural, industrial, service sector and residential TFC. The reason behind this is that IEA dataset does not poses data on mining and quarrying energy consumption for either country. Construction energy consumption is only available for Ivory Coast, representing under 0.2% of TFC, and fishing TFC is only available for Ghana from the year 2000 onwards. Therefore, TFC has been modified to maintain consistency between both countries.

Food supply data (FAOSTAT, 2015c) will be used to observe nourishment levels and to understand quantitative and qualitative changes in dietary patterns. Food supply directly influences infant mortality and life expectancy. Furthermore, it provides information on the resilience of food supply in both countries. Moreover, this indicator can be used to study if there is a relation between dietary patterns and economic development.

As an output of the economy to the environment, carbon emissions will be studied. These emissions will be divided in Carbon Dioxide emissions from fossil fuels, and greenhouse gas (GHG) emissions in carbon dioxide equivalents (Boden et al., 2013; WRI, 2014). GHG emissions include: fossil fuel emissions, agricultural emissions and land-use change emissions equivalents (which measure emissions/sequestration of GHG due to changes in land use, and modified vegetation (IPCC, 2000; Kim et al., 2009)). There are high uncertainties associated with land-use change emissions due to the difficulty of estimating this indicator; therefore, this source of GHG is highly inconsistent. Consequently, GHG emissions will be studied as a whole, and not as a sum of its parts. However, these indicators will inform the study regarding some of the externalities that selected countries have on the environment. GHG emissions in Ivory Coast increased an 84% from 2005 to 2006, which based on the overall GHG trend, is another statistical artefact. Hence, GHG emissions have been smoothed by equalling GHG in 2006 to the levels of 2005 and then utilizing the growth rates of the original dataset. Modified GHG emissions data reduces emissions data in 2010 almost in half, influencing the results obtained for Ivorian GHG intensity and GHG emissions per capita.

Data on energy supply will be combined with economic data for each country and each economic sector, which will derive the energy intensity of the economy (TPES per unit of GDP) and energy intensity of each sector (final energy consumption per unit of added value). Analogously, material flow data combined with economic data will derive the material intensity of the economy (tonnes of material per unit of GDP). By studying energy and material flows in their disaggregated forms alongside economic data will provide an understanding on structural changes in both economies, as well as the dynamics of the energy and material mix of each country (Goldemberg, 1996).

Table 3 and Table 4 summarize used indicators, sources, short description, acronyms and years of selected indicators. Table 3 summarises extensive indicators, indicators that depend on the size of the system (country). Table 4 summarizes intensive indicators, indicators that remain when the size of the system changes.

3.2.1.4. Summary of indicators

Table 3. Summary of selected extensive indicators.

Indicator (unit)	Source	Description	Acronym	Years
Economic and population Indicators Gross Domestic Product (PPP constant 2005 international $)	The World Bank (World Bank, 2012c)	Gross domestic product at PPP is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States.	GDP	1980-2010
Estimate of total economy (PPP constant 2005 international $)	(World Bank, 2012c; Schneider and Enste, 2013)	Sum of GDP plus the estimate of informal economy. Reflects an estimate of total economic activities.	Total GDP	1999-2007
Value added by economic activity (PPP constant 2005 US$)	United Nations (UNSD, 2015)	Gross value added by kind of economic activity.	$VA_{i\ \ i=1,2,3}$	1980-2010
Population (Millions)	United Nations (UNDESA, 2015)	Total population per country.	Population	1980-2010
Agricultural population (Millions)	Food and Agriculture organization (FAOSTAT, 2015a)	Total economically active population in agriculture.	Agricultural population	1980-2010
Biophysical Indicators Domestic material consumption (kilo tonnes)	IFF Vienna (Schaffartzik et al., 2014)	Compiled data on consumed materials at the national scale. Composed by domestic extraction plus imports minus exports of materials.	DMC	1980/1990/2000/2005/2010
Physical trade balance (kilo tonnes)	IFF Vienna (Schaffartzik et al., 2014)	Imports minus exports of materials.	PTB	1980/1990/2000/2005/2010
Total primary energy supply (terajoules)	International Energy Agency (IEA, 2015b)	Total primary energy supply is the sum of all energy inputs to an economy converted to a single unit.	TPES	1980-2010
Carbon dioxide emissions (tonnes of carbon dioxide)	Carbon Dioxide Information analysis Center (Boden et al., 2013)	Carbon dioxide emissions are the most important greenhouse gas emitted to the atmosphere. Carbon dioxide emissions measure fossil-fuel consumption emissions.	CO_2	1980-2010
Greenhouse gas emissions (tonnes of carbon dioxide equivalent)	World Resource Institute (WRI, 2014)	Greenhouse gas emissions sum fossil-fuel emissions with agricultural and land-use changes carbon equivalent emissions.	GHG	1990-2010

Table 4.Summary of selected intensive indicators.

Indicator (unit)	Source	Description	Acronym	Years
Economic Indicators Income per capita (2005 USD PPP per capita)	The World Bank (World Bank, 2012c; UNDESA, 2015)	GDP per person (GDP/pop).	Income per capita	1980-2010
Estimate of total income (2005 USD PPP per capita)	(World Bank, 2012c; Schneider and Enste, 2013; UNDESA, 2015)	Estimate of total GDP per person (Total GDP/pop).	Total income	1999-2007
Well-being Indicators Infant mortality (per 1000 live births)	The World Bank (World Bank, 2015)	Infant mortality rate is the number of infants dying before reaching one year of age, per 1,000 live births in a given year.	Infant Mortality	1980-2010
Life expectancy (years)	The World Bank (World Bank, 2015)	Life expectancy at birth indicates the number of years a new-born infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.	Life expectancy	1980-2010
Human Development Index (0 to 1)	United Nations (UNDP, 2014)	HDI is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living.	HDI	1980/1990/2000/2005/2008/2010
Biophysical Indicators DMC per capita (tonnes per capita)	(Schaffartzik et al., 2014; UNDESA, 2015)	Domestic material consumption per capita (DMC/pop).	DMC per capita	1980/1990/2000/2005/2010
Material intensity (t/1000$)	(World Bank, 2012c; Schaffartzik et al., 2014)	Quantity of materials used to produce a unit of economic value (DMC/GDP).	Material intensity	1980/1990/2000/2005/2010
Energy intensity (MJ/$)	(IEA, 2015; World Bank, 2012)	Energy required to produce a unit of economic value (TPES in MJ/GDP).	Energy intensity	1980-2010
Food supply (Kilocalories per capita per day)	Food and Agriculture organization (FAOSTAT, 2015c)	Food supply represents an estimation of national nourishment and signals changes on eating habits over time.	Food Supply	1980-2010
Carbon dioxide emissions per capita (tonnes per capita)	CDIAC (Boden et al., 2013; UNDESA, 2015)	Carbon dioxide emissions per capita (CO_2/pop).	CO_2 per capita	1980-2010
Greenhouse gas emissions per capita (tonnes per capita)	(WRI, 2014; UNDESA, 2015)	Greenhouse gas emissions per capita (GHG/pop).	GHG per capita	1990-2010

3.2.2. Analysis of biophysical and socio-economic data

The first step towards analysing selected data will be to examine how selected indicators have evolved through the study period. By studying the past dynamics followed by selected indicators, their average percentage growth rates and their standard deviations, this section will provide an understanding of the selected countries' development path. Moreover, it will indicate if the trends followed by selected indicators have been stable or highly variant, and if selected indicators have followed similar or distinctive paths from one other.

Once the overall dynamics of the indicators has been analysed, the next step of analysis is to select key indicators and consider their relationship by observing the coupling that exists between sets of indicators, their elasticity. This is to be done by measuring the '*b*' coefficient of a log-linear least square regression (York et al., 2003):

$$\text{Eq.1.} \qquad \ln(y) = a + b\ln(x)$$

Where *a* is a scaling constant, and *b* is the value of the slope which quantifies the scaling between *x* and *y*. Due to the logarithmic transformation of the variables, *b* is an estimate of the elasticity relating the variables. *b* can be interpreted as the percentage change in *y* corresponding to 1% increase in *x*, quantifying the scaling between *x* and *y*. If $b < 1$, the relation is inelastic, an increase in *x* corresponds to a smaller variation in *y*. If $b>1$, the relation is elastic, *y* increases at a faster rate than *x*. If *b* is negative *y* will decrease when *x* increases. If *b* minus its standard error is equal or lower than one, despite *b* being greater than one, the relation between indicators will be considered unitary or inelastic accordingly.

The correlation coefficient 'r' measures the strength and the direction of a linear relationship between two variables. The correlation coefficient ranges from -1 to 1, 1 meaning a perfect correlation, -1 meaning that both variables perfectly move in opposite directions and 0 that there is no correlation. When conducting the regression in equation 1, the determination coefficient r^2 will be obtained, informing about the goodness of fit in equation 1

The variables *x* and *y* will also be graphically represented alongside their fit (equation 1) in a scatter plot, in order to visualize the exact values and patterns of pairs of interesting variables over time. However, it is not always necessary or informative to conduct a bivariate regression between indicators from time-series data from a single country.

Indeed, if we consider two dynamic variables over time, such as the ones represented by equations 2 and 3, these two variables will always be highly correlated if they have well defined real rates of change (Gujarati, 1995 pp 169-171) 'g'-g being greater than its standard deviation, as both indicators have a common variable 't' (time). In mathematical terms:

$$\text{Eq.2.} \quad x(t) = x_0 \cdot \exp(g_x t)$$

$$\text{Eq.3.} \quad y(t) = y_0 \cdot \exp(g_y t)$$

It worth mentioning that the elasticity between two indicators can be obtained once the rate of change '*g*' (the slope of the fitted line) of selected indicators is known. This means that the elasticity can be derived from the relative change in the dependent variable 'g' of the log-linear fit equation –where a first order approximation to 'g' can be obtained by using the growth rates of the variables selected in this thesis.

If we take the logarithm of equations 2 and 3 we obtain:

$$\text{Eq.4.} \quad \ln(x) = \ln(x_0) + g_x t$$

$$\text{Eq.5.} \quad \ln(y) = \ln(y_0) + g_y t$$

By combining equations 4 and 5, as done in equation 1, we obtain:

$$\text{Eq.6.} \quad \ln(y_0) + g_y t = \text{a} + \text{b}\ (\ln(x_0) + g_x t)$$

Equation 6 can be divided into the time invariant and time dependant parts, equations 7 and 8 respectively:

$$\text{Eq.7.} \quad \ln(y_0) = a + b ln(x_0)$$

$$\text{Eq.8.} \quad g_y t = b g_x t$$

Where equations 7 and 8 can be solved as:

$$\text{Eq.9.} \quad b = \frac{g_y}{g_x}$$

$$\text{Eq.10.} \quad a = \ln(y_0) - b ln(x_0)$$

Equation 9 exemplifies that with 'g' we can derive the elasticity between two indicators.

Certain indicators might not have well defined growth rates. In these cases, it is worth investigating if these indicators are correlated with other indicators. If correlations are measured, it will signal will that these indicators might have other (non-monotonic) time trends in common. Hence, exploring their relation and visually observing scatterplots will aid to understand the time trends and their relation through the study period.

Once the dynamic analysis of single variables and the regression analysis of variables without well-defined time trends has been conducted, it will be possible to discuss the socio-economic and biophysical evolution of each country as whole. Identifying patterns of growth, progress, decline, stagnation, and situating these within the narrative of broader development theories, as well as the resource curse or intensity of use hypothesis (Malenbaum, 1978).

3.3. Investigating the resource curse

This section presents a methodology that uses social metabolism parameters aimed at identifying evidence for or against the resource curse in the selected countries (research question three). This will be done by examining how the physical extraction and exports of certain resources and crops interrelate with economic growth and with different measures of political effectiveness. Available mass quantity data on extraction and exports of raw resources will be combined with the economic value of those resources. Additionally, studies involving policies or frameworks towards studied resources will be investigated. Exploring raw resource data and qualitative studies on those resources alongside each other will provide the necessary information to determine the presence of the resource curse and its possible causes. Additionally, comparing different policies in both countries can highlight how raw resource management policies might prevent or induce the curse. This step of combining qualitative and quantitative data has been acknowledged as relevant when exploring the resource curse, but this practice has not been commonly used in the literature (Stevens and Dietsche, 2008).

The resource curse will be examined following a similar process as in the previous section; utilising available disaggregated data on raw materials physical mass units, such minerals and agricultural crops. This component of the thesis aims to study the path followed by resource extraction, resource use and exports alongside with institutional quality, economic growth and well-being indicators. In order to study if greater levels of material extraction and exports have

emerged in a context of deteriorating institutional quality, decreased economic growth and decreased education expenditure as stated in the literature.

3.3.1. Socio-economic indicators relevant to the resource curse

In order to investigate the resource curse in these two countries, a wide range of indicators will be used, some of which have already been discussed above. From the economic indicators, GDP, total economy, income per capita, total economy per capita, added value of each economic sector and their share in GDP will be studied. Alongside, the growth rates of selected indicators will also be analysed to observe, as mentioned in the literature, if raw resource exports booms relate with periods of lower economic growth. Additionally, indicators that measure governmental quality and education expenditure as percentage of gross national income will be analysed. This would help to understand if the share of national resources devoted to education decreases with increased raw resource exports, as well as help to understand if there is a relation between raw resource exports and governmental quality.

Infant mortality and life expectancy will be studied alongside selected resources. Infant mortality is considered a good well-being indicator that measures improvement of living standards, as it can be used to view if the exploitation of natural resources has contributed to an improvement of the living conditions of the general population of raw resource exporter countries (Stevens and Dietsche, 2008).

3.3.1.1. Political indicators

Four indicators have been selected to measure political effectiveness. These indicators have been developed by Kaufmann et al. (2010) for the World Bank worldwide governance indicators for the years 1996,1998,2000,2002 to 2010. Selected political indicators are:

- Rule of law: measures the perceptions of the extent to which agents have confidence in and abide by the rules of society. In particular, the rule of law focuses on the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.

- Government effectiveness: measures the perceptions of the quality of public services, civil service and the degree of its independence from political pressures. Additionally,

this indicator measures the quality of policy formulation, implementation, and the credibility of the government's commitment to such policies.

- Political stability: reflects the perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism.

- Regulatory quality: reveals the perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.

The scale for these four indicators ranges between -2.5 to 2.5, where -2.5 reflects a weak governance performance versus 2.5 that reflects a strong performance. The selection of these four indicators to measure governmental quality is based on the literature that revises the resource curse hypothesis, studies such as Bulte et al. (2005), Moe (2009) and Stijns (2005) have utilized these indicators when exploring the resource curse.

3.3.1.2. Raw resources

Ghana and Ivory Coast extract and export a variety of raw resources, from agricultural and mineral nature, such as cocoa, coffee, bananas, gold, diamonds and oil among many others (USGS, 2012; FAOSTAT, 2015b). To narrow down the great diversity of crops extracted in both countries, as an arbitrary threshold, agricultural products will be selected on the basis of their economic importance (share) in overall agricultural exports. Agricultural crops that represent at least 5% of total agricultural exports earnings through at least five years during the study period will be selected. Similarly, to narrow down mineral exports, all exported mineral resources that have a similar monetary value to the included agricultural products will be selected in this study.

The motivation for observing extracted quantities in addition to exports, which is the main focus of the resource curse literature, is that resource curse related resources are resources that are predominantly extracted for export purposes (USGS, 2012; EBI, 2013; FAOSTAT, 2014b, 2014a; UNIMTS, 2014). This means that resource extraction patterns and their relation with socio-economic indicators should be similar to the relationship between raw resource exports and selected indicators. Available data on extracted mass quantities is more consistent and

available over longer periods than export data. Thus, results obtained for extracted mass quantities will be useful to complement export data.

3.3.1.3. Raw resource data collection

As mentioned in chapter 1, obtaining data on energy and materials for the region of West Africa is a challenging task. Similarly, obtaining consistent and reliable data on raw resources is a demanding task.

Data on agricultural production, exported quantities and economic value has been obtained from a number of datasets (FAOSTAT, 2014a, 2014b, 2015b). Data on export values in both countries (free on board values) has been converted from current dollars to constant 2005 dollars utilizing the agricultural export value index (FAOSTAT, 2015e). This will reflect exports earnings and prices in constant values, instead of commonly used nominal quantities.

Extracted and exported mineral data in Ghana will be obtained from a variety of sources. USGS (2012) will provide data on extracted mineral quantities from 1990 to 2010. UNIMTS (2014) will provide data on individual resource exports value and weight, with a data span that varies on a per mineral basis. Schaffartzik et al. (2014) will provide data on combined mass quantities of all extracted and exported material quantities from 1980 to 2010 on a decadal basis.

In the Ivorian case, mineral data will be obtained from IEA (2015b), with available data on extracted and exported minerals from 1980 to 2010, and from Schaffartzik et al. (2014). The traded value of exported minerals will be obtained from UNIMTS (2014), where data is available from 1995 to 2010 for a variety of minerals.

In order to convert exported mineral values from constant to current prices, data on producer price index for the mining and quarrying sector in both countries has been searched for, but could not be found. Timmer (2015) provide data on producer price index for 40 countries, none of them Sub-Saharan African, but provides a view of the difference between agricultural and mining producer price index (PPI). Agricultural PPI tends to be below mining and quarrying PPI. However, due to lack of data on average mining PPI for these countries, agricultural trade index values will be used as a proxy to convert mineral export values and prices into constant 2005 dollars.

For crude oil and petroleum products export, two alternative methods have been observed to convert oil exports values from current to constant terms; EIA (2015) adjusts imported oil values utilizing the national consumer price index, while IMF (2015) utilizes indices of market prices utilizing the average spot price of United Kingdom Brent, Dubai and West Texas oil, all equally weighted. Hence, from both methods, the method utilized by the U.S. Energy Information Administration EIA (2015) will be utilized. This method is also utilized by several online oil trading information systems such as Macrotrends (2015a), and CPI and West Texas intermediate crude prices variation have been highly similar for decades (Macrotrends, 2015b).

The resource curse literature utilizes resource exports as percentage of GDP at a point in time as a proxy for resource abundance (Sachs and Warner, 1995; Stijns, 2005; Rosser, 2006b). In contrast to the literature, where this indicator is obtained for one year or as the average over a number of years, in this thesis the evolution of raw resource exports as a percentage of GDP will be studied in a time series form. In Ghana, this indicator will be studied from 1996 to 2010, while in Ivory Coast, this indicator will be studied from 1995 to 2010 (due to data availability). This indicator will be constructed by adding all of the raw agricultural and mineral exports in both countries.

Table 5.Summary of selected resource curse indicators.

3.3.1.4. Data summary

Indicator (unit)	Source	Description	Acronym	Years
Economic indicators Education expenditure (% of GNI)	The World Bank Development Indicators (World Bank, 2015)	Current operating expenditures in education, including wages and salaries and excluding capital investments in buildings and equipment.	Education expenditure	1980-2010
Political Indicators Rule of law (-2.5 to 2.5)	(Kaufmann et al., 2010)	Quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.	Rule of law	1996/1998/2000/2002-2010
Government effectiveness (-2.5 to 2.5)	(Kaufmann et al., 2010)	Quality of public services, 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.	Government effectiveness	1996/1998/2000/2002-2010
Political stability (-2.5 to 2.5)	(Kaufmann et al., 2010)	Likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism.	Political stability	1996/1998/2000/2002-2010
Regulatory quality (-2.5 to 2.5)	(Kaufmann et al., 2010)	Ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.	Regulatory quality	1996/1998/2000/2002-2010
Raw resources Agricultural crop production and exports (kilo tonnes and constant 2005 US $)	(FAOSTAT, 2014a, 2014b, 2015e, 2015b)	Agricultural crop production (cereals, roots and tubers, pulses, treenuts, oilcrops, fibre crops, vegetables, fruits and oilcakes), exported quantities, and exported values.	Agricultural production and exports	1980-2010
Mineral extraction and export weights (tonnes)	(USGS, 2012; Schaffartzik et al., 2014; UNIMTS, 2014; IEA, 2015a; WGC, 2015b)	Extracted and exported mineral quantities. Data span varies on each data source.	Mineral extraction and mineral exports quantities	
Mineral exports value (constant 2005 US $)	(USGS, 2012; UNIMTS, 2014; WGC, 2015b)	Exported minerals economic value. Data span varies between different sources. Different sources might be combined to fill in missing years.	Mineral export value	
Percentage of selected resource curse exports in GDP (% of GDP)	(FAOSTAT, 2015b, 2015d; IMF, 2007; UNIMTS, 2014; USGS, 2012; World Bank, 2015	Combined sum of non-processed agricultural exports values and non-processed mineral exports as a share of GDP.	% Raw resource exports in GDP	1995-2010

3.4. What is the broader context of the links between socio-economic performance and the biophysical economy?

In this section different socio-political and historical events that can be related with previous quantitative analysis will be investigated. Exploring a methodology that can combine qualitative data with quantitative data will be the first step for building the bridges between quantitative data and history. Therefore, this section provides the methodology used to answer research question number two and provide the necessary context to answer question three of this thesis. These bridges will lead to the selection of the qualitative data to be used, leading to the diagram of the developed framework presented in Figure 4. This analysis will be expanded to study the resource curse in both countries, which will be explored utilizing a similar approach that combines qualitative studies on the subject, historical facts and quantitative data.

3.4.1. Qualitative approach: historical and political context of Ghana and Ivory Coast's development

Alongside the quantitative analysis described in section 3.2, secondary qualitative data will be used to gain better insights on the relationship between metabolism and socio-economic development as well as the resource curse. Understanding the socio-political factors that have influenced the development path of selected countries is of great importance to understand the past and present situation each country faces, and to elucidate what the future might look like for these countries.

Qualitative information from a wide range of sources will be contrasted with the previous results to enhance the understanding of the relationships identified. Utilizing qualitative data should provide context and specific circumstances that explain, and better inform, about the evolution of selected indicators and their interrelation, specifically providing answers to any data outliers or unexpected relations that might appear. For example, sudden decreases in food supply might be due to bad weather conditions or due to increased international competition for resources, enriching the interpretative power and validity of quantitative results (Rossman and Wilson, 1985; Carvalho and White, 1997; Bamberger, 2000; White, 2002; Onwuegbuzie and Leech, 2005; Bryman, 2006).

Pattern matching is a widely used method in social sciences that combines quantitative and qualitative data (Trochim, 1985, 1989; Yin, 2003). Social science researchers that use a mixed

methods approach utilize a variety of research designs in order to collect and combine numbers and words (Rossman and Wilson, 1985). These research designs are: triangulation, complementarity, development, initiation and expansion designs (Greene et al., 1989; Onwuegbuzie and Leech, 2005; Tashakkori and Teddlie, 2010). Each design has different characteristics in the way that each design combines quantitative and qualitative data.

Pattern matching links two patterns, usually observed patterns, non-random and describable arrangements or occurrences, and a theoretical one (Trochim, 1989; Yin, 2003). Figure 3 presents the framework used in pattern matching method. The theoretical realm originates from theories, ideas or hunches from the researcher or a combination of these. From the set of theories, there is a conceptualization task, where a theoretical pattern emerges, such as the intensity of use or resource curse theories that will be explored in this thesis. In the observational realm, direct observation and data collection is organized to observe if any patterns emerge from the data.

The patterns that emerge in each realm are matched to provide support, plausible alternatives or refute one another. Hence, if complex patterns are matched in both realms, results yield greater validity. When a theoretical and an observed pattern might not match, this methodology can be used to determine if there might be incorrect observations or incorrect theory specification. In this dissertation, and as observed by Trochim (1989), a theoretical pattern (hypothesis) about what is expected to occur in the data is used; secondly, data is examined to determine if the theoretical model applies in selected countries. Pattern matching differs from hypothesis testing in that it uses a more complex or detailed hypothesis by utilizing a multivariate perspective (data, observations and measures) instead of a univariate perspective. Additionally, pattern matching also provides context by including elements that are more or less related to the object of interest.

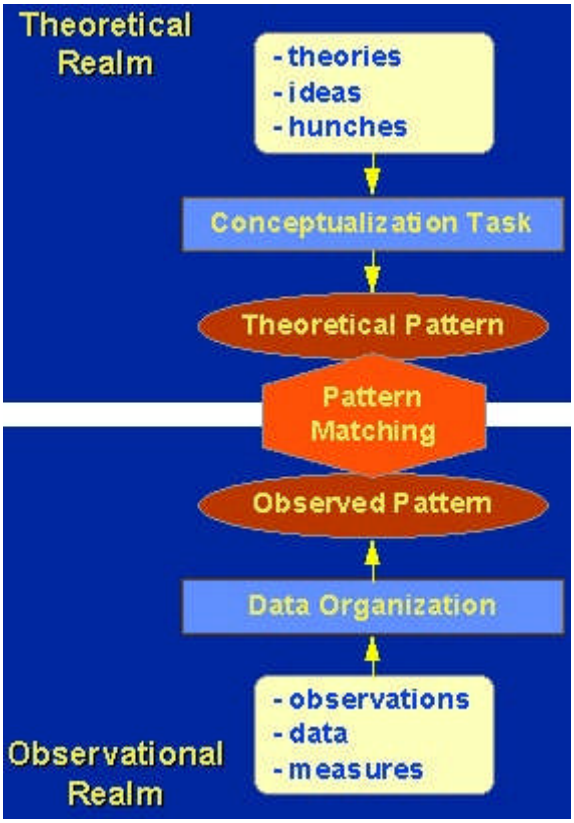

Figure 3. The basic pattern matching model.
Source: http://www.socialresearchmethods.net/kb/pmconval.php

As previously presented, there are five main different mixed-method research designs that can be used to combine quantitative and qualitative data in different ways (Greene et al., 1989; Saunders et al., 2009; Tashakkori and Teddlie, 2010). In this thesis, three research designs will be used: triangulation, complementary and development designs;

Triangulation design converges and corroborates results from quantitative and qualitative data that investigate the same phenomenon to strengthen validity of the results. Within this design, findings of quantitative and qualitative methods can also discriminate one another, as quantitative or qualitative methods may have limitations or biases. Thus, combining both methods should offset or reduce biases and help to eliminate irrelevant sources. This research design will be used to corroborate or contradict the intensity of use hypothesis in chapters 4 and 6.

The complementary design utilizes results of one method to illustrate or clarify results from another. This method differs from triangulation in the fact that different methods are not restricted to assessing an overlapping phenomenon. Different levels of a phenomenon can enrich a study by increasing interpretability and meaningfulness of the results. Within this

design, the role played by policies that relate with studied phenomena, such as agricultural or land use policies, will be examined. Thus, it will highlight important factors that can explain the existence, or non-existence, of the resource curse, which will be investigated in chapters 5 and 7.

The development design is sequential, one method is utilized to help inform the development of the other, and consequently it increases validly of results by capitalizing on the strengths of each method. Development design relates directly with integrating historical events to clarify the socio-metabolic development path of both countries, as well as resource export data. As highlighted by Onwuegbuzie and Leech (2005), qualitative data can be used to explain the relationships discovered by quantitative data. Therefore, it will be used alongside the triangulation and complementary designs in chapters 4 to 7.

The first step in this section will be to review both countries' recent history, analysing relevant political events and policy measures that might have affected the indicators under consideration. Events that could have an impact on crop production or different historical events that might enable to understand the context that these countries have faced will be considered, hence, increasing our knowledge of how the different selected indicators have evolved.

After analysing past events that might have influenced the evolution of selected indicators, qualitative data from reports from different international agencies and think tanks will be drawn upon. These will further explain how the different indicators have evolved and if any relation among them exists. Qualitative data will be obtained from diverse sources, such as books (Pellow and Chazan, 1986; Bowden, 2007; Hennemeyer, 2007; Boafo-Arthur, 2008), reports from international organizations (Den Tuinder, 1978; World Bank, 2009b; UNCTAD, 2012) and think tanks such as the Centre for Strategic and International Studies (CSIS, 2011) or The Africa Centre for Energy Policy (ACEP Ghana; Adam et al., 2013). Thus, enabling to answer the questions that arise in the quantitative sections of this thesis.

3.5. Similarities and disparities between the results obtained for both countries

After analysing the societal metabolism and investigating the resource curse in both countries, the results obtained for both cases will be compared. Firstly, the past dynamics of both

countries will be set side by side, in a similar manner to the systematic comparison of focused comparison (George and Bennett, 2005) and paired comparison (Tarrow, 2010). The most prominent results found in selected countries will be compared alongside to understand how those outcomes were achieved, and why there might have not been achieved in the other country. This comparison would shed light on how different social and political agendas have reflected in the metabolism of these countries, providing an answer to the fourth research question of this thesis.

Secondly, these results will be compared with the global average past dynamics. This will present the bigger picture and evidence if actually these two countries are performing positively, or to the contrary, are falling behind the rest of the world. This is an important step, as comparing just these two countries side by side might wrongly signal positive or negative trends that do not reflect the reality of the worldwide context in which these countries are embedded.

Thirdly, the results of the resource curse analysis, focusing on the political context and policies that have shaped resource management in both countries, will be compared. By directly observing the differences or similarities between raw resource management and policies, including trade and industrialization policies, this comparison will inform if governmental intervention has achieved notable differences in both countries. It is important to note that the social configuration that emerged during the colonial period, as a well as different levels of access to education given by French and British colonist, explains differences in aspects such as governmental accountability and transparency, free media and the legal system (Cooper, 1996; Grier, 1999; Ayittey, 2012). Mentioned differences can also lead to differences in a number of resource curse channels that emerge from the political sphere, mainly corruption. However, the study of the colonial social configuration, despite its importance, is outside of the scope of this thesis.

The last section of the comparison chapter, section 8.3, will consider the role of the global context as considered by development theories. The path followed by selected countries will be compared in the context of the interaction that national governments have had with global governance (the World Bank and the International Monetary Fund), as well as global markets. This will enhance the understanding behind the developmental outcomes in selected countries, as well as their success or failure in avoiding the resource curse.

In this section, understanding the political process and policies towards raw resource production and exports, as well as the role of international players, should highlight the importance that institutions have played in the overall path followed by selected countries. Thus, innovatively combining ideas behind the literature that focuses on the role that institutional quality has in a country's development with the overall global context.

3.6. Framework

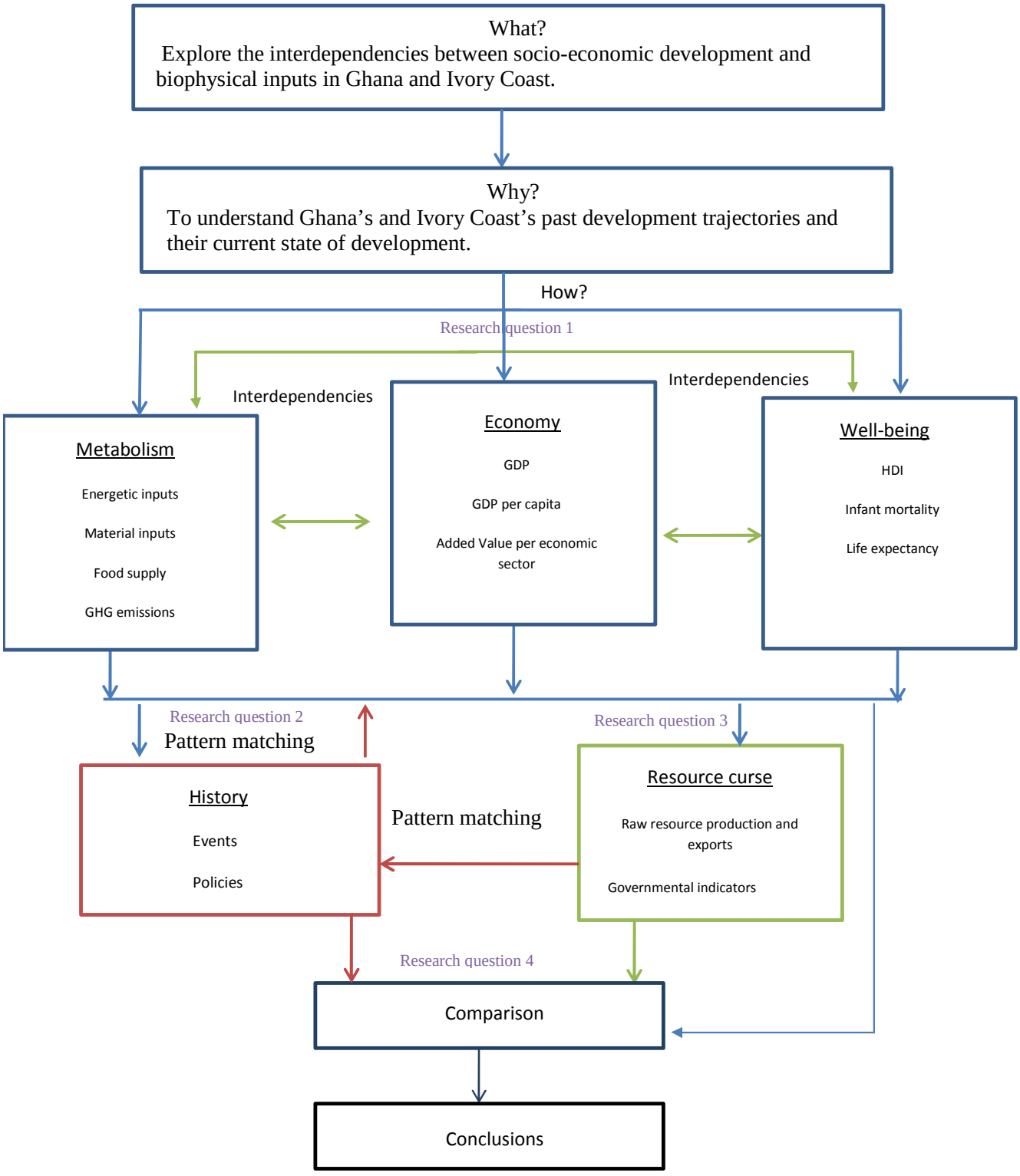

Figure 4. Diagram of the framework used in this thesis.

4. Socio-economic and biophysical metabolism of Ghana

To comprehend the interdependencies that exist between the physical economy and socio-economic performance in Ghana, two steps will be followed. Firstly, in section 4.1, the past dynamics of selected social, economic and biophysical indicators will be examined alongside the interrelation between the most important indicators. This step will serve to visualize how selected indicators have co-evolved through the period by directly studying the interrelations between selected indicators during the study period. Therefore, the intensity of use hypothesis, as well as the energy ladder, will be assessed in this section. The second step will link historical events that can provide context and understanding behind the evolution and relation of socio-economic development and biophysical consumption in the country. Hence, this chapter will answer the first and second research questions of this thesis for the Ghanaian case study.

By studying the development path followed by Ghana through a metabolic lens in combination with the historical context, a focal point that emerges is that the country is achieving greater well-being levels despite its low biophysical consumption and income. Moreover, there is a metabolic transition towards non-biomass inputs with increased income, which favors the energy ladder model. An interesting fact that appears is the importance that the historical context has played in shaping the development path and metabolism of Ghana. Biophysical consumption is mostly dependent on local availability; however, national adversities have highly affected trade of non-locally available energetic inputs and therefore impacted the country's metabolism.

4.1. Past dynamics and interdependencies between socio-economic and biophysical metabolism in Ghana

In this section, I will analyse how socio-economic and biophysical inputs to the economy, depicted in Table 6, have evolved from 1980 to 2010. Table 6, additionally shows the average yearly percentage growth of the selected indicators with their respective standard deviations. The lower the relative standard deviation is, the more stable the annual growth rate. If the standard deviation is on the same order as, or even larger than, the measured average growth rate, it means that the indicator has no steady trend whatsoever over time.

In order to increase our knowledge of the interdependencies between the socio-economic and biophysical indicators in Ghana, the relations between selected indicators will be studied. This

will be done, as described in section 3.2.2, by observing if biophysical and socio-economic indicators have been coupled through the studied period. Furthermore, indicators without well-defined growth rates will be correlated with other indicators in order to enhance our understanding of their evolution. If these indicators are significantly correlated with other indicators it will signal that these indicators might have other time trends in common. Therefore, it will provide a deeper understanding of the path followed by indicators without well-defined growth rates.

Table 6. Selected indicators values for Ghana in 1980 and 2010 with average annual percentage growth rates and standard deviations.

Indicator	Unit	1980	2010	Average annual percentage growth rate ± standard deviation
Extensive Indicators				
Population	Million	10.8	24.3	2.7±0.33
GDP	Billion PPP constant 2005 international $	10.8	36	4.1± 3.4
Estimate of total economy[1]	Billion PPP constant 2005 international $	28	41	4.87±0.9
Total primary energy supply	Petajoules	168.5	387.8	2.9±4.6
Domestic material onsumption[2]	Mt	35.6	148.3	4.9*
Greenhouse gas emissions [3]	$MtCO_2e$	49.2	56.9	0.8± 3.4
CO_2 emissions	Mt	2.6	10.1	5.5±13.3
Physical trade Balance[2]	Mt	0.8	8.6	8.4*
Intensive Indicators				
Income (GDP per capita)	PPP constant 2005 international $ per capita	1,004	1,479	1.4±3.4
Estimate of total income per capita[1]	PPP constant 2005 international $ per capita	1,523	1,818	2.4±0.7
TPES per capita	GJ capita	15.6	15.9	0.2±4.5
DMC per capita[2]	t per capita	3.3	6.1	2.1*
GHG Emissions per capita[3]	tCO_2e per capita	3.6	2.3	-1.7±3.3
CO_2 emissions per capita	t per capita	0.2	0.4	2.7±13
Energy intensity	MJ per $	15.5	10.8	-1.1±4.6
Material intensity of the economy[2]	t/1000$	3.3	4.1	0.78*
CO_2 intensity	tCO_2 per million $	236	281	1.5±13.8
GHGe intensity[3]	tCO_2e per million $	3,668	1,581	-4.1±3.3
Food supply	Kcal/capita/day	1,590	2,976	2.2±5.4
Life expectancy	years	52.3	60.6	0.5±0.4
Infant mortality	per 1000 live births	100.9	50.2	-2.3±0.8
HDI[4]	0 to 1	0.42	0.56	0.92*

1.Data from 1999 and 2007, own calculation based on GDP data from the World Bank (World Bank, 2012b) and estimates of informal economy from (Schneider et al., 2010). 2. Data available for 1980/1990/2000/2005/2010 3. Data starts in 1990. 4. Data available for 1980/1995/2000/2005/2008/2010.*average annual growth rate calculated using compound annual interest rate formula (World Bank, 2011).

Selected indicators show that Ghana has been developing and growing. The extensive indicators, indicators such as GDP, TPES and DMC, have more than doubled. In contrast, per

capita indicators have shown moderate increases in comparison. This disparity signals that extensive indicators have grown driven by increased per capita consumption and especially driven by rapid population growth. GHG emissions have experienced a very low increase compared to economic growth and biophysical inputs consumption, while CO_2 emissions from fossil fuel burning have more than tripled. Physical trade balance has increased by an order of magnitude, meaning that Ghana has been importing greater material quantities than it has exported.

Economic activity and energy supply in the country have decoupled. TPES and GDP follow a similar path up to 2002, year in which GDP growth surpasses the growth of total primary energy supply, as shown in Figure 5. This means that the energy intensity of the economy (TPES/GDP) remained fairly constant throughout most of the period, ranging mostly between 15.5 MJ/$ and 17 MJ/$. After 2002, energy intensity decreased down to 10.78MJ/$ in 2010, which translated into the ability of Ghana to create added value with lower amounts of energy.

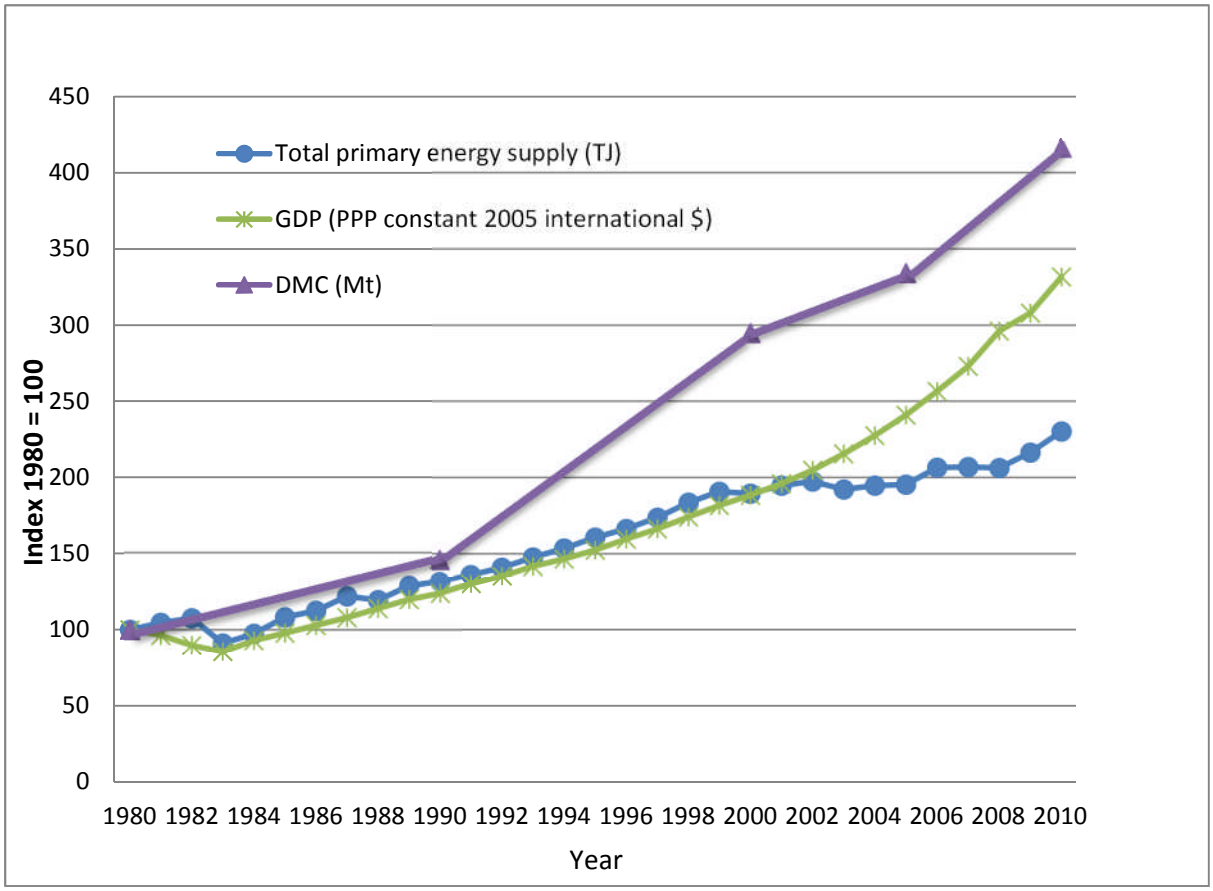

Figure 5.Total primary energy supply, domestic material consumption and GDP of Ghana from 1980 to 2010, index to 1980.TPES in 1980= 168PJ. GDP in 1980=$10.8 Billion 2005 USD. DMC in 1980= 35.6Mt.

The relationship between GDP and TPES in Ghana is inelastic. In the long run, an increase of a percentage point of GDP would be paralleled by an increase of 0.67 percent of TPES, as

Figure 6A shows. In energetic terms, this translates into a less environmentally demanding economic growth. Due to the major role of biomass in the energy mix of the country, over 50% (IEA, 2015b), there is potential to increase GDP without an equal increase of TPES. This can be achieved by transitioning to modern energy carriers. Modern energy carriers have greater efficiencies (in terms of the total heat delivered to the cooking vessel divided by the heating value of the cooking fuel (Golove and Schipper, 1997)) than biomass. Thus, fuel switching from biomass to modern fuels, such as gas or LPG, could further decouple TPES from GDP. This is what has happened through the last years of the study period, where GDP and TPES decoupled; the share of biomass in TPES decreased from 66% in the year 2002 to 55% in the year 2010, being substituted by modern fuels such as crude oil, oil derivatives and natural gas. Therefore, if these trends were to continue in the future, TPES and GDP could decouple in the medium-long run.

Energy consumption has increased in all sectors. The energy consumed by industrial sector has increased by 37%, while energy consumption in agriculture and forestry has almost quadrupled through the study period. Similarly, total final consumption in the service sector has increased by 339%, driven by a threefold increase in transport energy consumption.

The decreasing share of biomass in energy supply goes in hand with a shift in added value in Ghana. The share of the primary sector in GDP has decreased from 46% in 1980 to 33% in 2010 (UNSD, 2015). The service sector (ISIC G-P) has increased its share in GDP from 25% in 1980 to 50% in 2010. This exemplifies that even if a vast majority of Ghanaian working population are employed in agriculture (FAOSTAT, 2015a), added value is shifting towards other activities. This trend follows the development economics literature (Srinivasan, 1988; Eichengreen and Gupta, 2013); with increased income, the share of services in an economy grows with respect to the primary and secondary sectors. The economic growth experienced by the service sector has been greater than its increased energy requirements; this translates into decreased energy intensity of the service sector.

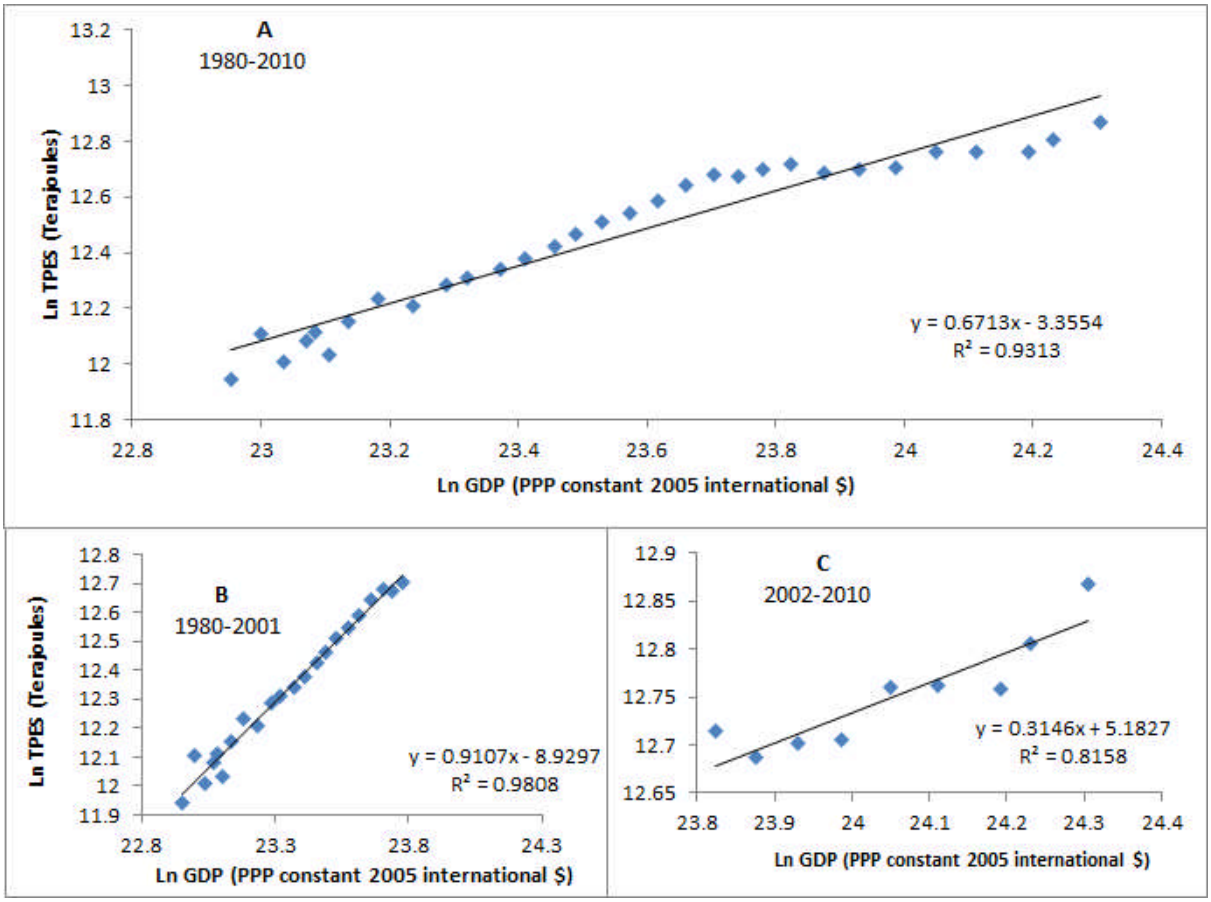

Figure 6.Simple linear regression of the logarithm of GDP and TPES in Ghana from 1980 to 2010 (A). (B) From 1980 to 2002. (C) From 2002 to 2010.

Ghana is becoming a service economy without an established industry. The service sector in Ghana is reliant on raw resource rent expenditure rather than on the surplus generated by the industrial sector; which is a different development trajectory than that followed by the first waves of development (Cottrell, 1955; Krausmann et al., 2008; Schandl et al., 2008). The Ghanaian industrial sector has lost importance in GDP from 30% in 1980 to 17% in 2010, despite not decreasing in overall added value. Similarly, energy consumption has increased from 29 PJ in 1980 to 40 PJ in 2010, but the sector has lost importance in TFC as Table 7 shows. The decreases in the share of GDP of this sector does not coincide with the period in which the share of energy consumption of the sector in TFC decreased. Both indicators followed a similar trend up to 1993, year in which the share of the industrial sector in GDP decreased due to the increased share of the service sector in the overall economy. On the contrary, the share of the industrial sector in final energy consumption remained almost stagnant after 1986. These findings coincide with Jedwab (2011) and Eberhardt and Teal (2010). The disparity between the development path of Ghana towards a service economy

could be due to a range of socio-political factors that hinder industrialization in many developing countries (GEA, 2012; Pachauri et al., 2012), which will be explored in chapter 5.

Ghanaian homes are slowly starting to move up the energy ladder (Leach, 1992; Heltberg, 2004). Despite biomass representing the main energy carrier used in residential consumption, its share has decreased from 93% of residential TFC in 1980 to 84% of energy consumption at the residential level. This is due to the increased use of LPG and electricity, driven by governmental subsidisation of electricity consumption (Kankam and Boon, 2009), which is moving Ghanaian households to the second step of the energy ladder.

Table 7. Energy intensity of Ghana's productive sectors, share of each sector and residential consumption in TFC in 1980 and 2010.

Indicator	Units	1980	2010
Agriculture energy intensity	MJ per $	0.3	0.7
Agriculture share in TFC	Percentage	1	2.8
Industry energy intensity	MJ per $	9	6.6
Industry share in TFC	Percentage	20.6	16.4
Services energy intensity	MJ per $	6.8	4.5
Services share in TFC	Percentage	12.9	32.8
Residential share of TFC	Percentage	65.5	48

In Ghana, the official GDP (without the informal economy) can be used as a proxy of overall GDP. As mentioned in section 1.3, Ghana is a country with a high percentage of informal transactions, which are not accounted for in official statistics. Hence, it is important to investigate if the relation that GDP has with other indicators varies when an estimate of informal economy is added. Analysing the estimate of total GDP, in comparison with the official GDP figures between 1999 and 2007, both indicators have an almost identical evolution. Both economic indicators show very similar relations with selected indicators when the same time span is observed. Consequently, at least in terms of the dynamics studied here, GDP can be used as a proxy of total GDP without a great variation on the obtained results.

DMC growth has surpassed the growth experienced by GDP and TPES, as Figure 5 reveals. All material groups, biomass, fossil fuels, ores, industrial minerals and construction minerals have experienced notable increases. Biomass remained the main material consumed in Ghana, representing 55% of all materials consumed in 2010, down from 63% in 1980. The share of fossil fuels decreased from a low 3% in 1980 to 2% in 2010. Construction minerals decreased from representing 21% of DMC in 1980 to 19% in 2010, while material consumption of ores

increased from 12% of DMC in 1980 to 23% in 2010. Industrial minerals represented under 1% of DMC through the study period. It is important to note that DMC (domestic extraction plus imports minus exports) does only measure apparent consumption and not final consumption, as is does not include unused (indirect) flows, thus it is a proxy of total material consumption (Schandl and Eisenmenger, 2006; UNDESA, 2012).

Material consumption and GDP are highly coupled, as Figure 7 demonstrates. The economy and material consumption have been going hand in hand through the selected study period. The relation between the economy and material consumption is elastic; an increase of a percentage point of GDP would be accompanied by 1.2 percent increase in material consumption. Hence, economic development has been material intensive. Due to the necessity of infrastructure and low levels of material consumption in Ghana, as compared with the global average, this is an expected result.

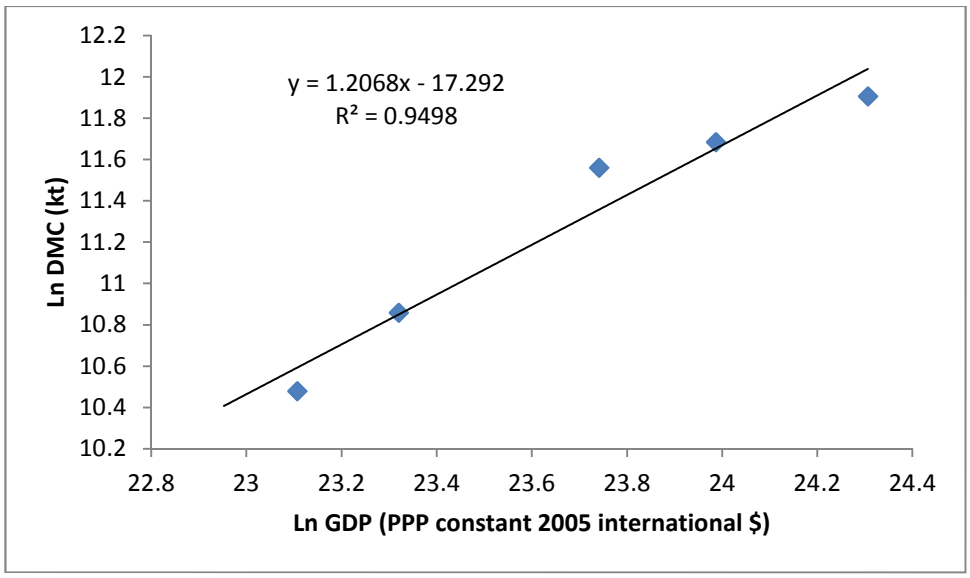

Figure 7. Simple linear regression of the logarithm of GDP and DMC in Ghana from 1980 to 2010.

Material intensity (DMC/GDP) has increased during the study period. Increased material intensity has negative environmental implications; the country needed greater amounts of material resources to create a unit of added value at the end of the period. However, Ghana's material intensity at the end of the period was in line with the African average, 4.1 t/1000$ in 2008 (UNCTAD, 2012). On the same line, fossil fuel CO_2 emissions intensity have increased from 236 tCO_2 per million dollars to 281 tCO_2 per million dollars. These results reflect that emissions from fossil fuels have increased at a higher rate than GDP. To the contrary, GHG intensity has more than halved from 1990 to 2010, indicating that the country's economic

growth has not relied on increasing its overall GHG impact. This is an expected result due to the tertiarisation of the economy.

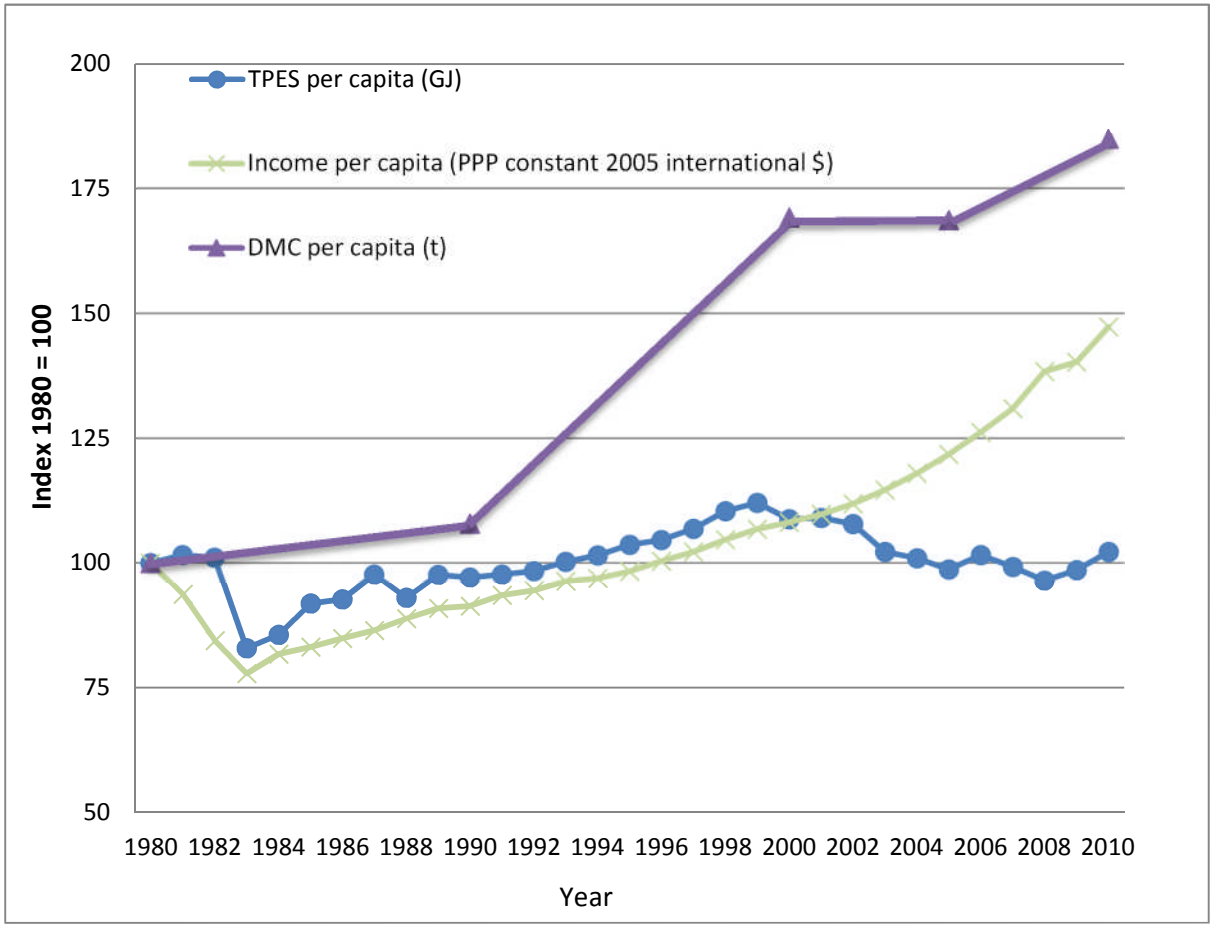

Figure 8. Total primary energy supply per capita, domestic material consumption per capita and income per capita of Ghana from 1980 to 2010, index to 1980. TPES per capita in 1980=15.6GJ. Income per capita in 1980=$1,003 PPP international 2005 USD. DMC per capita in 1980=3.3t.

TPES per capita shows similar path to income per capita up to 2002, as it occurred with the macroeconomic indicators. After 2002, GDP per capita grew while energy supply per capita decreased, as depicted in Figure 8. DMC per capita growth has surpassed income and TPES per capita growth. Per capita consumption of all of the different material groups has increased, especially ores per capita.

The intensity of use in energetic terms does not hold in Ghana, TPES and GDP per capita are not coupled in the long run, as Figure 9 demonstrates. Similarly, during the last eight years of study period both indicators are not related. However, from 1980 to 2001, income elasticity of energy supply was almost unitary. Both indicators decupled as the share of modern fuels increased in overall energy supply. From 2002 to 2010, income increased while TPES per

capita declined. These results could mean that the inclusion of modern fossil fuels into the energy mix decreased energy supply per capita needed to deliver the same amount of final energy, or that the country was unable to supply its citizens with greater amounts of energy despite their increased economic power.

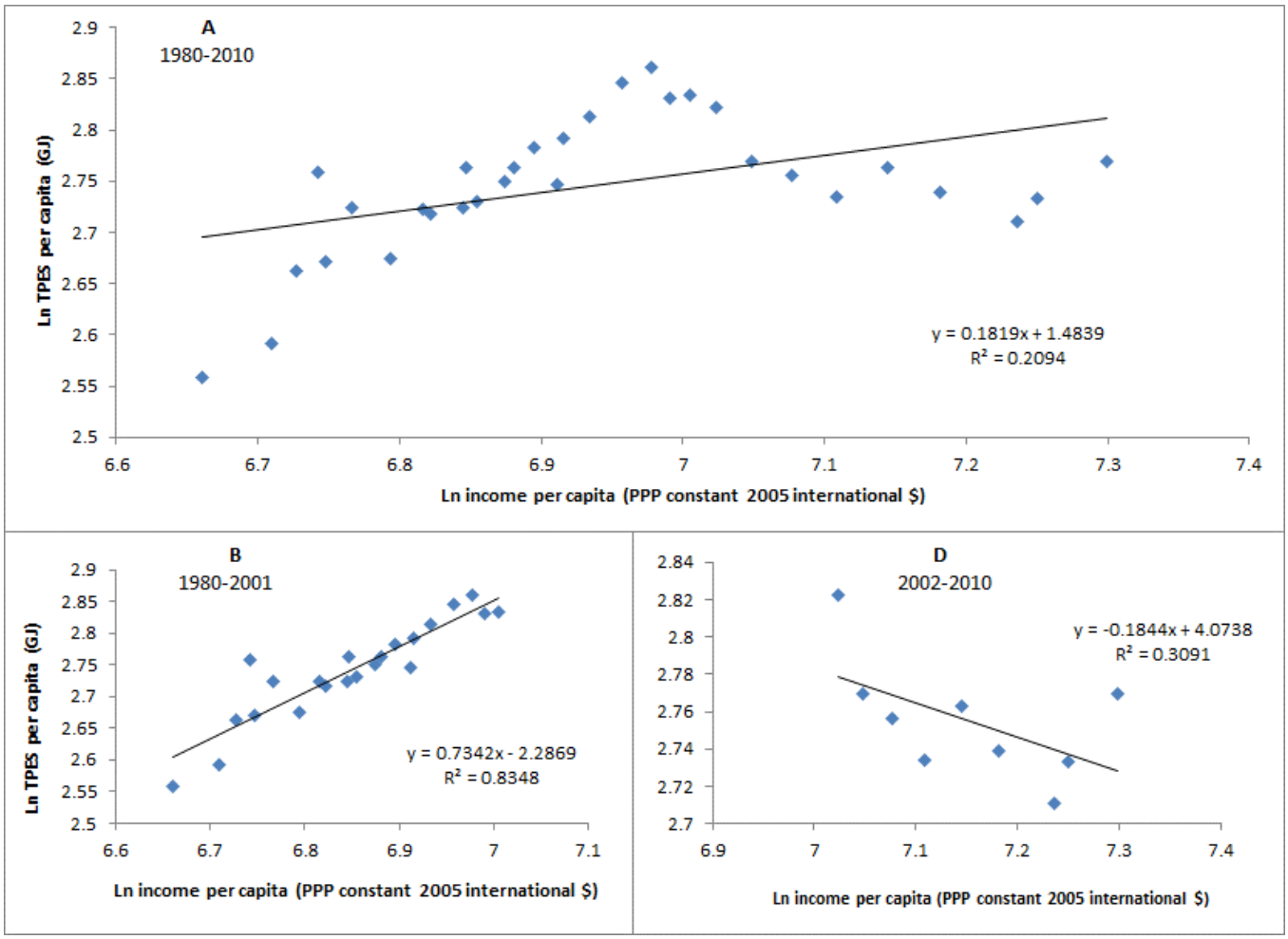

Figure 9.Simple linear regression of the logarithm of GDP per capita and TPES per capita in Ghana from 1980 to 2010 (A). (B) From 1980 to 2002. (C) From 2002 to 2010.

By examining primary energy supply, total final energy consumption in the country and energy consumption at the residential level, there are signs that both have occurred. On the one hand, non-biomass energy carriers per capita in TPES increased from 4.5 GJ in 1980 to 7.2 GJ per capita in 2010, decreasing the gap between modern fuels and biomass consumption per capita (8.8 GJ in 2010). Furthermore, total final consumption of non-biomass energy carriers per capita surpassed biomass in total final consumption per capita in 2002. On the other hand, total final energy consumption per capita has decreased. Therefore, non-biomass energy carriers are gaining importance in the country, but final energy consumption has not increased. This

provides an answer towards understanding the decoupling between TPES per capita and income. TPES per capita did not have a well-defined growth rate and is not strongly correlated with any of the selected indicators. Consequently, other indicators cannot be used to understand this shift. However, analysing the context during the last decade of the study period should shed light on the causes behind the energetic shift towards non-biomass energy carriers while overall energy consumption per capita declined.

The relation between the economy and energy supply is not deterministic (Ang and Liu, 2006). By reviewing Figure 6 and Figure 9 it becomes clear that the relation between both indicators varied through the last years of the study period once fossil fuels increased their share in TPES. This signals that it cannot be assumed a priori that the relationships between biophysical inputs and economic performance will be time invariant in Ghana. In consequence, policies that aim to achieve economic growth through increased energy supply, as well as forecasting studies in Ghana based on extrapolation of the past, should acknowledge that there could be a further decoupling between energy and GDP if modern fuels penetration increased in the country.

Ghana has followed a path as stated by the energy ladder model. With increased income, there has been a substitution of biomass for modern fuels consumption. Income has increased while fossil fuel per capita in TPES increased and biomass consumption per capita decreased (IEA, 2015b; UNDESA, 2015). This can signal that increased income has been spent on modern fuels. However, the continued importance of biomass per capita as a fuel ratifies the main criticism to the energy ladder model (Heltberg, 2004); with increase income, biomass and modern fuels are combined, not completely substituted.

The intensity of use in material terms cannot be disregarded in Ghana. Material consumption and income are highly correlated and strongly coupled in Ghana, as evidenced in Figure 10. Income elasticity of material consumption is almost proportional, increased income has been followed by an almost equal increase in material consumption. When observing income growth and the path followed by the different material groups, biomass and fossil fuel consumption per capita have increased at an almost identical rate to income. To the contrary, income is not significantly coupled with ores or construction mineral consumption.

Previously analysed relations between selected indicators show that Ghana has followed a material intensive but not an energy intensive development path. At the country level,

biophysical inputs and economic growth have followed a similar overall trend, but, at the per capita level, biophysical consumption per capita is not as strongly related with income growth.

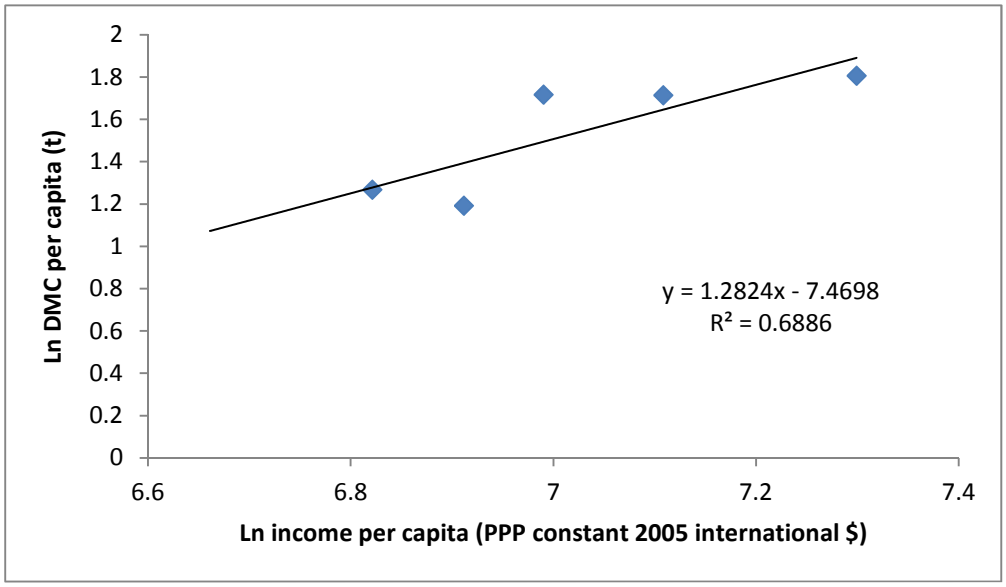

Figure 10. Simple linear regression of the logarithm of GDP per capita and DMC per capita in Ghana from 1980 to 2010.

In developing countries GDP and TPES are highly correlated at the national level, while at the per capita level the correlation is low (Ferguson et al., 2000). Similarly, to the results found by Ferguson et al. (2000) for electricity and GDP, the relation between energy and GDP varies from the national to the per capita level in Ghana. This signals that at the national level economic and biophysical growth have been dominated by the effects of population growth. However, economic growth and energy consumption have decoupled through the last decade of the study period. Consequently, due to the importance of biomass in the energy mix, energy supply and economic growth could further decouple.

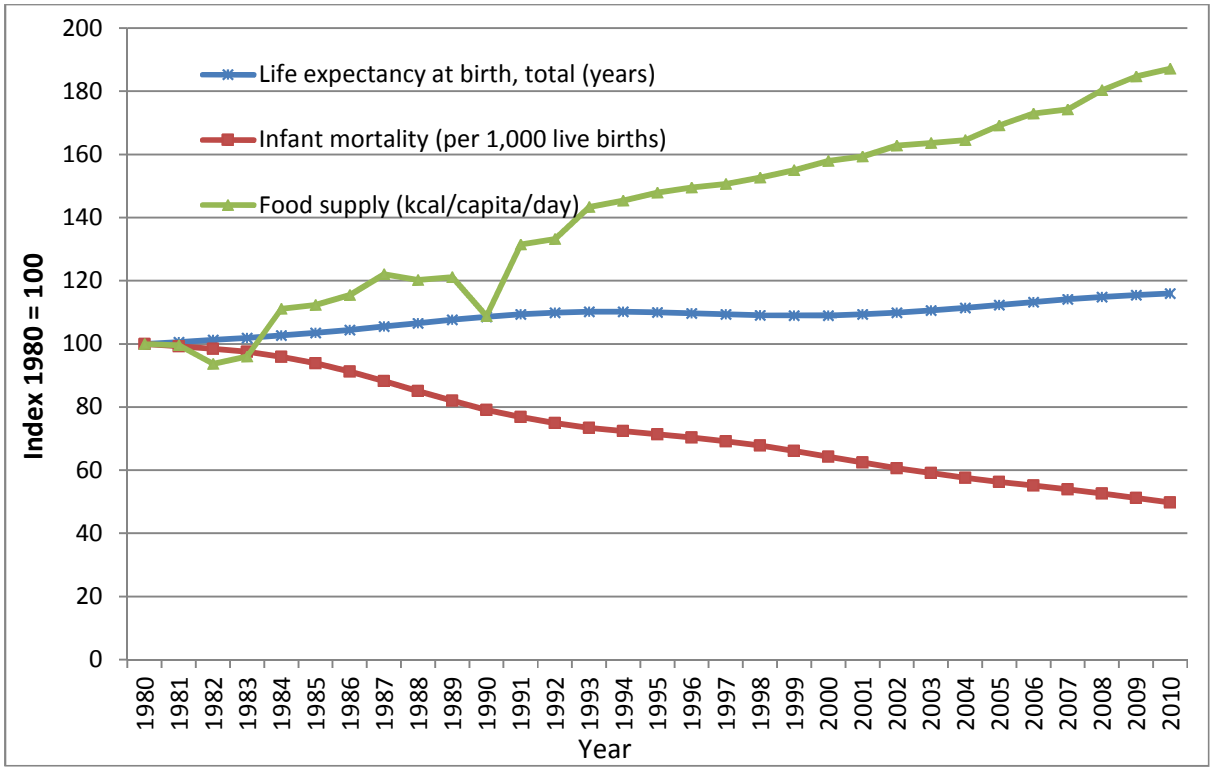

Figure 11. Life expectancy, food supply and infant mortality in Ghana from 1980 to 2010, index to 1980. Life expectancy in 1980=52.3 years. Infant mortality in 1980=100.9 per 1000 live births. Food supply in 1980=1,590 Kcal/capita/day.

Ghanaians have experienced an improvement in their well-being, and increased food supply, despite the modest increase in income per capita and stagnation of energy supply per capita. Infant mortality has halved and life expectancy has increased 16%, while food supply has almost doubled, which has supposed a change in the dietary patterns of Ghanaians. Calorie, fat and protein intake have all increased. Greater incomes, greater material consumption and greater levels of food supply can relate with better nourishment levels for infants and the ability to afford giving birth with professional assistance, corroborated by the increase in births attended by skilled staff and increased access to sanitation (World Bank, 2015).

In between 1994 and 1999, life expectancy slightly declined as it can be seen in Figure 11. During these years, neither did income or energy supply per capita decline or infant mortality increase, which signals that a specific event had an impact on adult population in the country. This point will be further investigated in section 4.2 utilizing the pattern matching framework.

Food supply and income are highly coupled. Yet, there are a number of outliers where food supply increased while income decreased. The four outliers circled in orange in Figure 12 represent four years (1980-1984) in which income declined while food supply just declined in 1981 and 1982. On the other hand, the outlier circled in red, represents a dip in food supply in

1990, while income continued increasing. Therefore, despite these two indicators following a similar trend through most of the period, the overall context is needed to understand the path followed by food supply in the country.

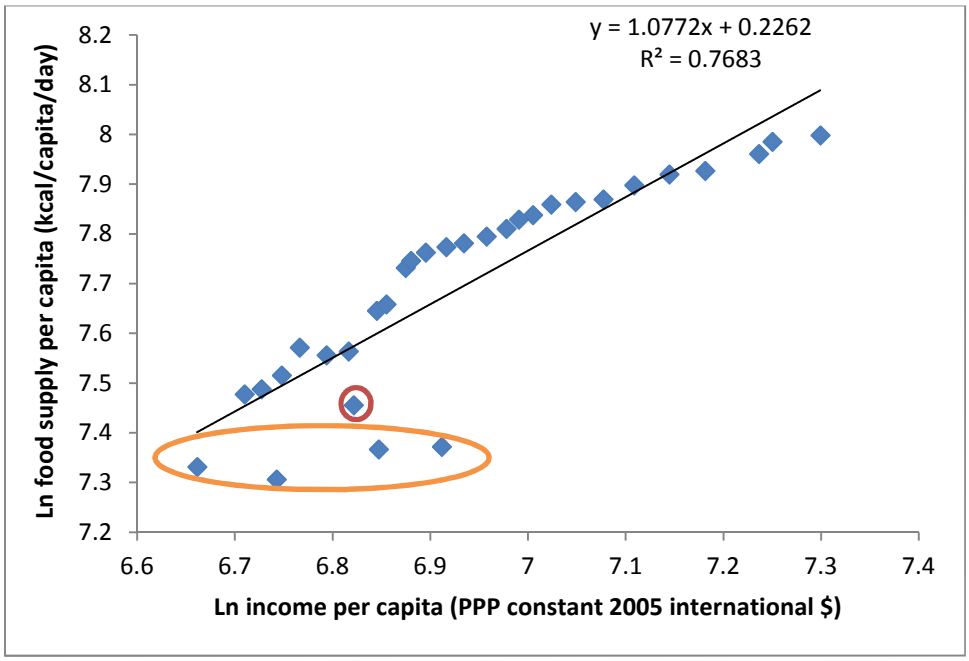

Figure 12. Simple linear regression of the logarithm of income per capita and food supply in Ghana from 1980 to 2010.

In general terms, increased well-being of Ghanaians has been accompanied by a qualitative change in biophysical consumption. There has been a shift towards non-biomass biophysical consumption. Certain factors linked to material build up may also mean build-up of sanitation and health infrastructure, which are positively related with increased life expectancy and decreased infant mortality (Riley, 2001). Hence, as mentioned by Steinberger and Roberts (2010) certain aspects of human development might be obtainable at low energy levels, which appears to be the case for life expectancy and infant mortality in Ghana.

Studied indicators, with the exception of income per capita and energy supply per capita, follow similar general trends. Yet, outliers to the general trends cannot be understood with the previous analysis. Therefore, integrating qualitative data into previously examined results should provide an understanding behind the evolution of Ghana's socio-metabolic and economic development. Consequently, the next section would highlight how socio-political events have shaped or influenced the development path of the country.

4.2. How does qualitative data inform about the evolution of the development path taken by Ghana?

Previously examined indicators and their relations showed some interesting characteristics, such as the instability of energy supply per capita or the decoupling of GDP and income from energy supply from 2002 onwards. In this section, the development path of Ghana's metabolism will be examined alongside historical events. These events will be used to explain how socio-political factors have influenced the evolution of certain indicators over the study period. Hence, this section will answer the second research question of this thesis for Ghana. This is to be done by following pattern matching framework (Trochim, 1985, 1989).

This section will be divided into three subsections. The first section will look at the events that have influenced the relation between income and energy supply. The second subsection will focus on the events that have affected food supply. The last subsection will examine the events that have influenced life expectancy.

4.2.1. Energy supply and income

Energy supply per capita was unstable through the study period. This instability was due to variety of factors that converged in Ghana in 1983, year in which TPES per capita sharply fell. The first decades into Ghanaian independence were characterized by socio-political instability, which materialized in numerous coup's d'état's, failed democratic elections, social unrest and economic instability. The drivers of national instability were: high unemployment rate, common currency devaluation, high inflation and commodity shortages (Girdner et al., 1980; Pellow and Chazan, 1986; Boafo-Arthur, 2008).

The country could not afford to acquire oil in the international markets in 1983. All of Ghana's crude oil was imported at the time. In 1983 a number of misfortunes occurred in Ghana. In 1983 there were widespread bush fires that devastated crop production; there was an influx of a million Ghanaians expelled from Nigeria (which is not reflected in the statistical records used here); the national currency, the Cedi, was devaluated from 2.75 Cedis per dollar to 30 Cedis per dollar (Pellow and Chazan, 1986; World Bank, 1988; Ghana web, 2013). These problems limited the ability of the Ghanaian government, and especially the Ghanaian population, to acquire foreign oil sources due to the impossibility of obtaining foreign currency. Under this climate, oil supply drastically declined from 44 PJ in 1982 to 14 PJ in 1983, to then double to 30 PJ in 1984 (IEA, 2015b). After a military coup of 1981, Ghana's military regime entered

the Structural Adjustment Programmes (SAPs), developed by the World Bank and IMF to acquire loans in 1983. The regime developed the Economic Recovery Programme (ERP) based on the SAPs. After the ERP was put in place in 1983, Ghana was able to vastly acquire international economic assistance in that same year (Ghana web, 2013). Consequently, the country was able to acquire foreign oil in 1984. These adjustment programmes did highly impact Ghanaian GDP and income. The privatization policies from the adjustment programmes led to large influx of foreign income that changed the path of a failing economy.

Moreover, Ghana has faced, and still faces, power shortages. Most of the electricity consumed in the country comes from hydropower, dependent on rainfall, which is one of the reasons that halts industrialization (Throup, 2011). An example can be seen in the declined faced by hydropower from 1982 to 1984 as a consequence of low rainfall in the Volta river, hydropower production decreased from 18 PJ in 1982 down to 6 PJ in 1984 (Amin, 2015; IEA, 2015b). In order to provide a more stable electricity supply, oil was used from 1998 to produce electricity. Thus, the confluence of a prolonged economic crisis, that had its worse effects in 1983, with low crop production, due to fires and low rainfall, can account for the sharp energy supply per capita decline in 1983.

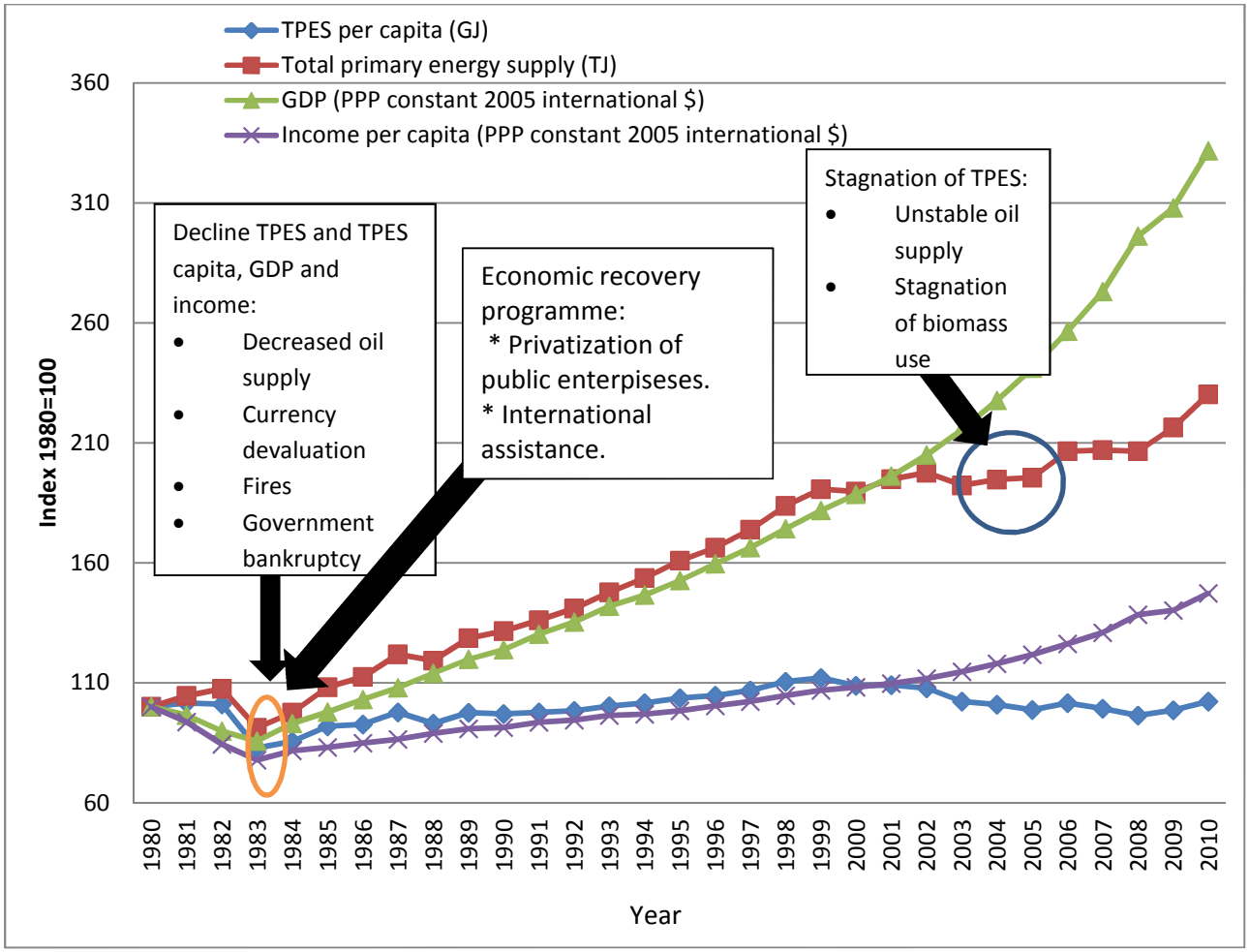

Figure 13. TPES, GDP, TPES per capita and income in Ghana from 1980 to 2010, index to 1980. TPES in 1980 =168 PJ. GDP in 1980= $11 billion PPP 2005 USD. TPES per capita in 1980=15.6 GJ. Income in 1980=$1,004 2005 PPP USD.

The stagnation of energy supply was mainly driven by the stagnation of biomass. TPES began to moderate its growth from 2002 onwards, during the cocoa boom. Furthermore, unstable oil products supply, which rapidly declined between 2002 and 2003 did not recover up to 2006 (IEA, 2015b), induced by an increase in gas/diesel oil and gasoline consumption. This was quite unexpected, as oil prices were higher in 2006 than in 2005 (NPA, 2013).

Many of the selected indicators are of social nature, therefore a wide array of influencing factors complicate to ascertain which exact factors have had an effect on the selected variables (Trochim and Donnelly, 2008). Therefore, analysing historical events ranging from weather patterns, political history or international relations, provides reasoning behind some of the patterns that emerged in Ghana's past dynamics. A good example can be observed in Figure 9, were it could be seen that income and energy supply per capita were not correlated, meaning that there is not much that can be inferred by observing energy supply per capita alongside

income per capita. Moreover, studying the relation between these two indicators during two different periods revealed that during the last years of the study period, income and TPES per capita decoupled. How can this analysis contribute to understand how the selected indicators interrelate with each other?

One of the reasons that can explain the decoupling between income and energy supply can be viewed comparing sources of income and energy use. The main job creation sector in Ghana is agriculture and the main source of energy is biomass. Despite Ghana relying in old farming methods and not having adopted major agricultural innovations to increase yields (Throup, 2011), Ghana's main agricultural product, cocoa, experienced a boom during the last decade of the study period, which relied on increasing the area under cultivation. This translates into less land with available biomass to be used by urban or rural population, which would have to travel further distances to obtain biomass as an energy source or pay higher prices for charcoal. Therefore, energy supply per capita faced difficulties to increase under this cocoa boom.

Placing Ghana on one of the three steps in the energy ladder model, Ghana as a whole would be placed in between the first and the second step. This is due to biomass energy consumption at the residential level only decreasing 10% through the study period. However, due to disparities in modern energy access, and income, between rural and urban areas (UNDP, 2009; WEO, 2012), rural areas are to be placed on the first step of the ladder, universal reliance on biomass for cooking, 96.8% in rural Ghanaian households in 2008 (UNDP, 2009).

4.2.2. Food supply

Food supply did experience a remarkable growth in Ghana, as it could be seen in Figure 11. There are various factors that explain food supply's path. Examining the full time series of available data on food supply for Ghana, starting in 1961 (FAOSTAT, 2015c), food supply ranged in between 1,848 and 2,147 kilo calories from 1960 to 1970. From 1975 food supply commenced to decline, reaching its lowest point in 1982, where food supply was as low as 1,489 kilocalories per capita per day. Decreased food supply occurred within a period of great political instability in the country, and the inability of the different governments to change the Ghanaian system, that under the colonial rule had specialised in monocrops for exports. This led the country to import around half of the population's food requirements (Pellow and Chazan, 1986).

During the mid-70's Ghana faced a decline in crop production, rising inflation and there were commodity shortages, which led to a coup in 1979. As mentioned by Girdner et al. (1980) there were several problems concerning Ghanaian farming, old tools and old production methods, which produced the same yields generation after generation. Without increasing yields, a growing population had to be fed, having a negative impact on food security. Colonial trade history led Ghana to specialise in cash crops, making food production for self-consumption scarce and thus expensive. Food shortages led to the creation of operation "feed yourself" in 1972 to increase self-reliance of Ghanaians (Girdner et al., 1980; Ghana web, 2013). Poor and slow policy implementation, in combination with low rainfall in 1982 (Amin, 2015), led to low levels of crop production. Therefore, the overall increase shown by food supply in the country is due to a gradual recovery from a combined decline in crop production during the mid-70's and early-80's, increased poverty levels, rampant inflation and currency devaluation at the time. These factors deprived Ghanaians from acquiring foreign commodities at the beginning of the study period. However, after the ERP, stable economic growth, as well as increased food crop plantations, enabled Ghanaians to acquire imported food, as income and food supply were highly coupled

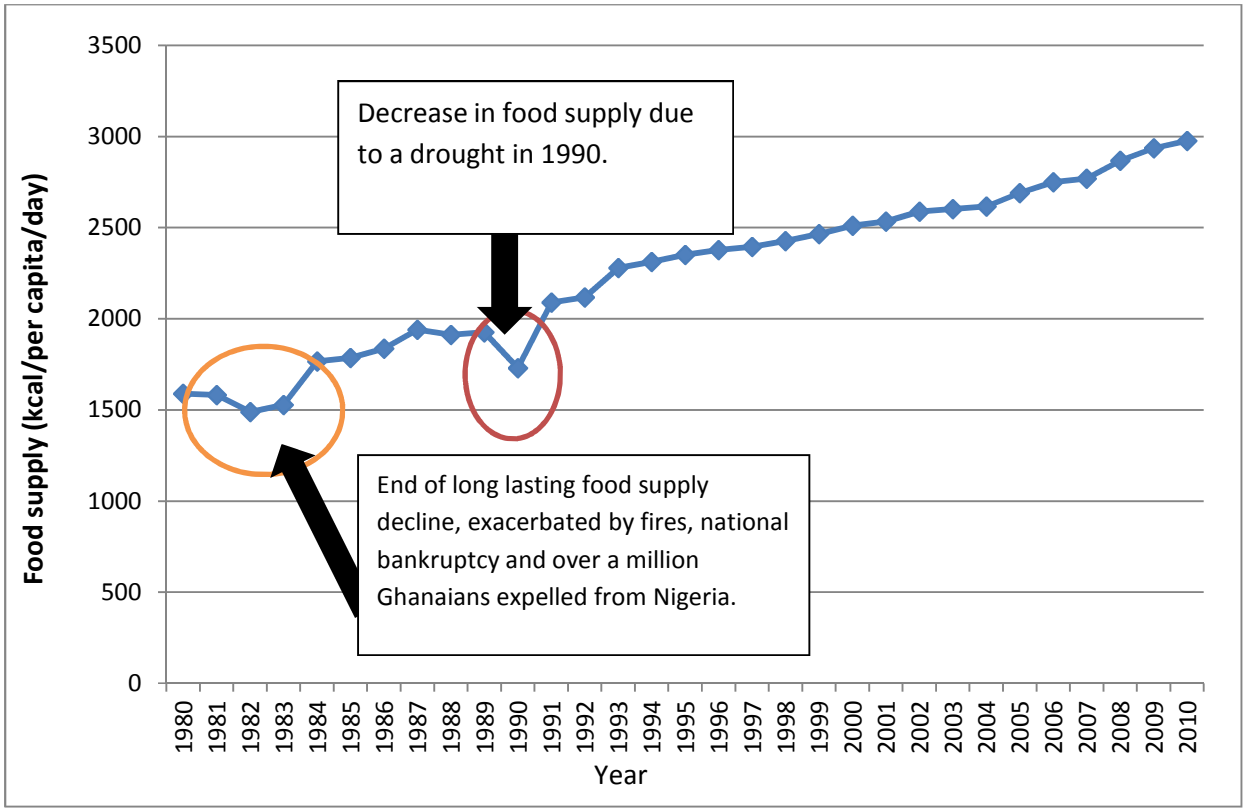

Figure 14. Food supply in Ghana from1980 to 2010.

4.2.3. Life expectancy

Life expectancy experienced a couple of years of slow growth and decline. From 1994 to 1999 the trend followed by this indicator changed, not resembling the path of any other indicator. Utilizing the pattern matching method with complementary method design, isolated conflicts in the country have been reviewed.

In 1994 a conflict took place in north-eastern Ghana, the "Guinea Fowl War", between two ethnic groups that had long lasting tensions, the Konkombas and the Nanumbas (Assefa, 2001; Pul, 2003; Jönsson, 2009; Ghana web, 2013). Other ethnic groups entered into the clash, thus amplifying the effect of the conflict. Through the course of this war, there were high number of casualties, between 2,000 and 15,000 (depending on the source), and between 135,000 and 175,000 people were displaced. During this war, which lasted up to 1996, over 400 villages were destroyed and some towns were 'ethnically cleansed'(Assefa, 2001). This war, and its effects over the mid-term in north-eastern Ghanaian population, provides the context to understand the stagnation and decline of life expectancy in the country. Life expectancy declined from 1994 to 1999. Thus, the aftermath of the conflict, rebuilding entire towns, raising cattle and so on, would have affected tens of thousands for a number of years. Consequently, this conflict had an impact on life expectancy in a country, which, as a whole, was growing economically and in biophysical terms.

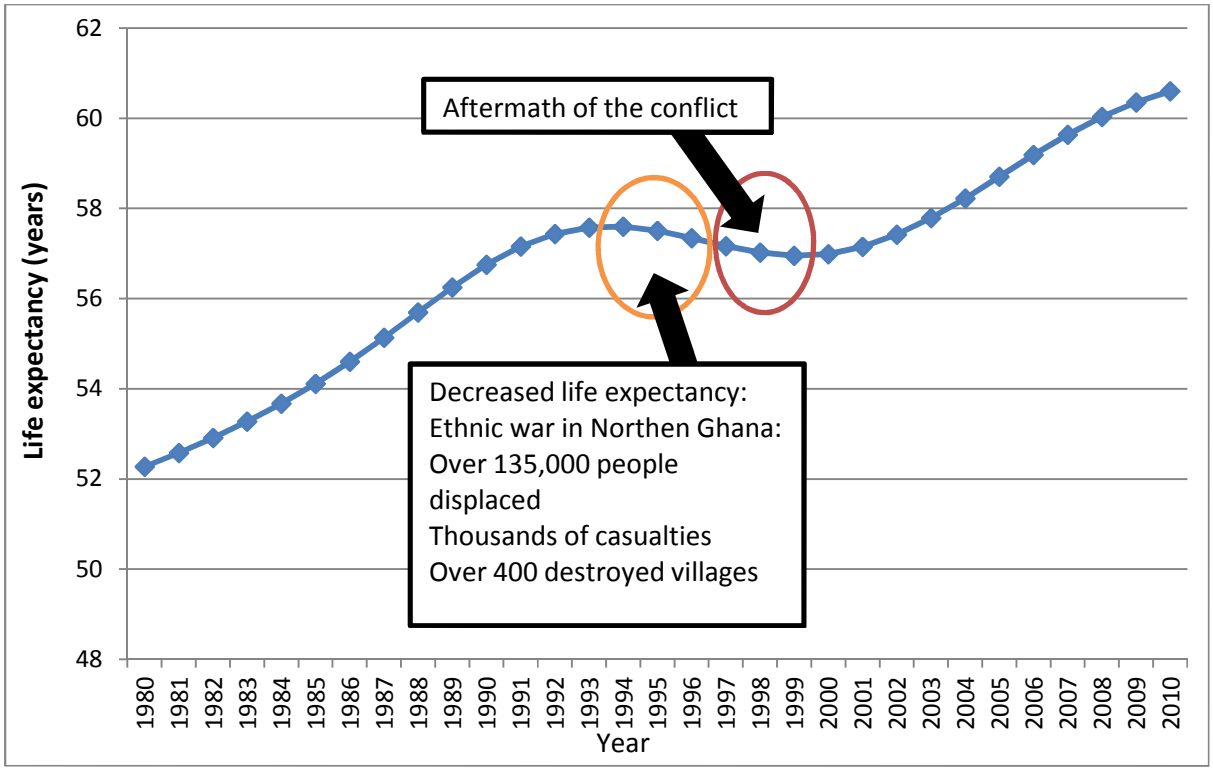

Figure 15. Life expectancy in Ghana from 1980 to 2010.

4.3. Conclusions

This chapter has examined the development path followed by Ghana through the societal metabolism lens. Moreover, by adding historical context to the metabolic path of Ghana, this chapter was able to analyse the relation between biophysical inputs, economic growth and well-being. The results highlight the importance that the socio-political context of the country has played on shaping the dynamics behind Ghana's development.

Ghana has followed a material intensive development path but not an energy intensive path. The material intensive path has been driven by increased consumption of all material groups. However, the main material group, biomass, has lost share in DMC. On the other hand, the energetic path has not been intensive. Modern energy carriers have enabled the stabilization of energy supply per capita, and have decoupled energy supply from economic growth. Therefore, population growth has driven TPES growth in the country. Similarly, economic and material growth at the country level have been dominated by the effect of population growth, as the disparity between extensive and per capita indicators demonstrated.

Understanding the metabolism of the country, and how different historical events have influenced material and energy use, as well as the economy, provides insights towards understanding the interconnectedness that exist between different spheres in Ghana. Therefore, demonstrating that historical events studied in combination with societal metabolism yield a more complete understanding of Ghana's development path.

The Ghanaian case study evidences the role played by policies and context shaping the country's present situation, visible in economic and biophysical trends. Consequently, validating the selected approach of combining the metabolism approach with socio-historical context. The selected approach provides an understanding behind some policies that should be taken towards achieving certain development goals in the country, such as fuel switching to decrease biomass burning health impacts and energy related deforestation. However, comparing Ghana with Ivory Coast will highlight the changes needed in both countries to achieve certain developmental outcomes.

Ghana is becoming a service economy without having achieved industrialization, which does not resemble the socio-ecological transitions explored in section 2.1. It is therefore important to understand the reasons why Ghana, at its low development levels, is 'leapfrogging' the industrialization process followed by already developed countries, which could be due to the heterogeneity of the service sector (Eichengreen and Gupta, 2013). However, by exploring the productive system of the country, as well as how Ghana is integrated in the global economy, this thesis might be able to highlight the reasons behind Ghana's transition process.

5. Investigating the resource curse in Ghana

Ghana is a resource-rich country that extracts and exports a number of agricultural and mineral resources, such as gold, aluminium, diamonds, cocoa and coffee (USGS, 2012; FAOSTAT, 2014b, 2014a; UNIMTS, 2014). These are point resources that could trigger the resource curse. The variety of raw resources produced in Ghana masks the reality of a country that is highly dependent on the foreign income provided by two resources, gold and cocoa. These are by far, the most important exports in economic terms in the country (Hilson, 2002a; Williams, 2009; UNIMTS, 2014).

Ghana is the second largest cocoa producer in the world, just after Ivory Coast (O.B., 2011), the second largest African gold producer, and one of the top 10 global gold producers (WGC, 2015a). Moreover, Ghana is the third largest African aluminium producer, although, monetarily, gold accounts for over 75% of mineral commodity exports (USGS, 2012).

Ghana discovered offshore oil and gas in 2007 and commenced its commercial extraction in 2010 (Adam et al., 2013). These newly found resources have triggered the fear that Ghana might suffer the same fate as other oil-rich West African countries. Ghana's government is aware of the problems that the new cash inflow might bring and it has legislated to avoid falling into the resource curse (Ayelazuno, 2013; Kopiński et al., 2013). The discoveries and extraction of oil are recent and out of the study period of this thesis; therefore, the effects of oil extraction will not be analysed in this thesis. However, a basic exploration (see Appendix II) reveals that Ghanaian experience managing raw resource rents has materialized developing a framework that could help to avoid resource rent mismanagement and invest oil revenues on developing the country.

Ghanaian manufactured goods will not be considered in this study. A failure in the literature that studies the resource curse, as observed by Stijns (2005), is that raw materials can be embedded in exported manufactured goods. Yet, manufactured goods are not considered by the resource curse literature. In the Ghanaian case, manufactured goods represent under 3% of total exports in economic terms through most of the studied period (UNIMTS, 2014). Moreover, mass quantity on Ghanaian manufactured exports is not available. Therefore, manufactured goods would not be included in this study. Given the small contribution of manufactured goods in export composition, this should not affect obtained results.

The resource curse literature utilizes resource exports as percentage of GDP in a given point in time as a proxy for resource abundance (Sachs and Warner, 1995; Stijns, 2005; Rosser, 2006b), proxy which has been critiqued (Brunnschweiler and Bulte, 2008). This section will analyse raw resource exports as a percentage of GDP, from 1996 to 2010, in combination with resource production and exports (in mass and economic value). The relation that exists between the quantities of extracted and exported resources with socio-economic indicators will be analysed. The reason behind utilizing alternative indicators to monetary values is that exported quantities reflect the true 'metabolism' of the country with respect to certain resources. Moreover, resource mass quantities are not directly influenced in the short run by resource prices, which are set in the international markets. Therefore, this approach enables to analyse terms of trade and real variations in extraction patterns, which will be useful to analyse the productive evolution of the primary sector exports in ways that economic indicators cannot account for.

This chapter reveals that the Ghanaian socio-political system has shielded the country from the major resource curse channels. Yet, national and international hurdles have impeded a transition towards an industrial society. However, utilizing the metabolic lens to study the relation that raw resources have with the economy, highlights that shortage of consistent economic data can be moderately eluded by combining easily accessible mass quantity data with national raw resource management frameworks.

In order to study the resource curse in Ghana, this section will extend the metabolism approach utilized in chapter 4 to raw resource production and exports. Firstly, a selection of the resources that could trigger the resource curse is presented. Secondly, the past dynamics of socio-political and economic indicators that can become affected by the resource curse are analysed. Thirdly, past trends of production and export of the main crops and materials in the country will be examined. These resources would then be related with the socio-political and economic indicators previously studied. The specific drivers behind the evolution of selected socio-economic and political indicators cannot be identified. However, this approach can be used to comprehend if there is a significant relation between raw resource export dependency and selected indicators. Therefore, it can be used to assess, and even disprove, the existence of the curse in Ghana.

5.1. Past trends of resource curse related resources in Ghana and their relation with socio-economic and political indicators

This subsection will answer research question three for the case study of Ghana. This section would provide an understanding of how the main resources exported by Ghana can be associated with an increase, or decline, of the socio-political and economic development trajectory followed by the country. This will be done by combining observed trends between selected indicators with policies and qualitative data, utilizing the pattern matching method with complimentary and development research designs.

5.1.1. Resource selection and data issues

Ghana extracts and exports a variety of agricultural and mineral resources. Consequently, as explained in section 3.3.1.2, only resources which represent at least 5% of total agricultural products exports in economic terms for a period over five years would be selected for further study. Cocoa and cocoa derivatives represented between 79% and 99.4% of all agricultural exports value in Ghana (FAOSTAT, 2015b). Hence, in the Ghanaian case study, cocoa will be the only agricultural product studied in isolation.

Mineral resources extracted in Ghana are also diverse, but similarly to the agricultural sector, there is one mineral export that accounted for over 70% of mineral exports revenues through the study period, gold (USGS, 2012). Thus, in the Ghanaian case study, only cocoa and gold will be examined in depth. Alongside gold and cocoa, combined quantities and values of agricultural products (excluding cocoa), and mineral products (excluding gold) will be studied; enabling to observe the role that these resources and their management have played in the Ghanaian economy.

Data on gold extraction and exports in Ghana has been obtained from a variety of sources. Gold extraction data has been obtained from USGS (2012), with available data from the year 1990 to 2010. Exported gold quantities have been obtained from UNIMTS (2014) with available data from 1996 to 2010. Exported gold values have been obtained from three sources: USGS (2012) from 1994 to 2003, IMF (2007) for the year 2004 and 2005, and UNIMTS (2014) for 2006 onwards. The motivation for mixing these three sources is that UNIMTS (2014) data on traded gold value is not consistent with reported exported gold quantities and international gold prices for a number of years; while data from USGS (2012) and IMF (2007) are related with reported exported quantities and international gold prices. The latter two sources have different

time spans. However, through the years where both sources coincide, the values of gold exports match. Hence, although the original data source of these two reports could not be obtained, it is likely to be the same. These three sources measure gold exports values at free on board values, thus utilize the same metric despite the inconsistencies found in UNIMTS (2014).

There is an observed error in exported gold quantities in the year 2004 and there is missing data for the year 2002 in UNIMTS (2014). This issue has been resolved by revising various datasets on gold prices. USGS (2012) provides data on prices paid for Ghanaian gold for certain non-consecutives years. WGC (2015b) provides average annual gold prices, which are the closest in value to the prices reported by USGS (2012) for Ghanaian gold. Therefore, WGC (2015b) prices have been used to convert exported gold values into quantities for the years 2002 and 2004.

Produced and exported mineral quantities for Ghana have been obtained from Schaffartzik et al. (2014) for the years 1980, 1990, 2000, 2005 and 2010. While values of exported minerals - excluding gold, have been obtained from UNIMTS (2014).

5.1.2. Resource curse related socio-political and economic indicators

There are a wide range of channels by which a country can suffer the resource curse. One of the main channels considered by the literature on the resource curse is de-industrialization. It is theorised that resources from an economy would be diverted from industrial activities to primary sector activities (Ploeg, 2011; Saad-Filho and Weeks, 2013). Other channels by which the resource curse is considered to affect resource rich countries are: currency revaluation, neglect of education and human capital formation -as the primary sector is considered to be less knowledge intensive (Gylfason, 2001b; Ross, 2004), corruption and armed conflicts (Vicente, 2010; Dube and Vargas, 2013).

De-industrialization in favour of the primary sector has not occurred in Ghana. Throughout the study period, the primary and secondary sectors have lost importance in GDP. These results do not follow hypothesized signs of the resource curse, as added value of the three main economic sectors has increased in absolute terms. The service sector has experienced the most notable growth, as Figure 16 shows. Jedwab (2011) remarks that rural raw resource rents have been spent in urban non-tradable goods and services in Ghana and Ivory Coast, driving growth of the service sector in cities in both countries. The argument behind Jedwab (2011) encompasses the idea that in the long run, the service sector has been fuelled by raw resource rents. The

overall effect of this transition -transitioning from an agricultural economy to a service economy, has a small long-term impact on income as hardly any processing industry emerges. Yet, this transition drives population growth in the cities. These arguments unravel the dynamics behind the constant urban growth experienced in Ghana (FAOSTAT, 2015a) despite low income per capita growth during the three decades under study (World Bank, 2012c).

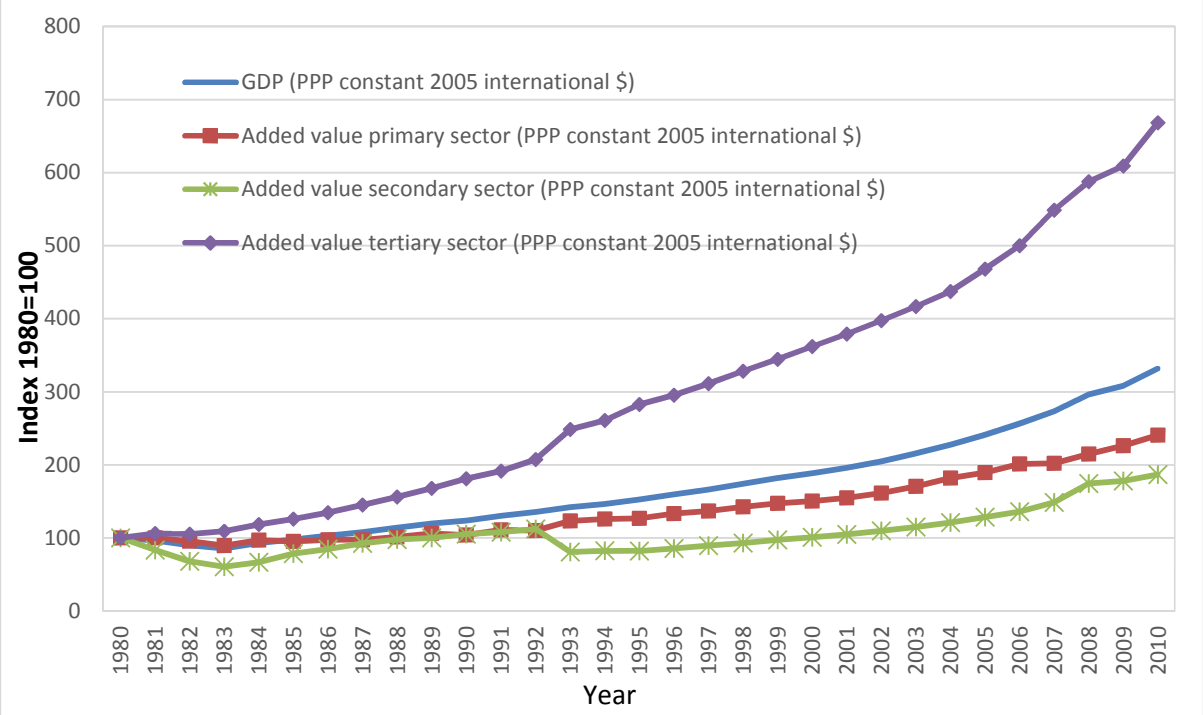

Figure 16.GDP and added value per economic sector in Ghana from 1980 to 2010. GDP in 1980=10.8 billion PPP 2005 USD. Added value primary sector in 1980= $5 billion PPP 2005 USD. Added value secondary sector 1980=$3.3 billion PPP 2005 USD. Added value tertiary sector in 1980=$2.7 billion PPP 2005 USD.

The decreased share of the industrial sector in GDP is a consequence of the Ghanaian specialization in raw resource exports and due to the lack of import substitution industrialization (Gbetibovo and Delgado, 1984). This is verified by the import composition in the country which has been mainly manufactured goods throughout most of the study period (UNIMTS, 2014). In order to understand the evolution of the industrial sector, as well as the agricultural and service sectors, an understanding of the overall context faced by Ghana is needed.

In 1983, Ghana developed the ERP, based on the SAPs, to obtain loans from the IMF and the World Bank. These loans had a number of conditionalities. The most notable conditionalities demanded to reduce government expenditures, the liberalization of the cocoa sector, agricultural diversification and trade liberalization (IMF, 1998; Naiman and Watkins, 1999;

Konadu-Agyemang, 2000; Easterly, 2005; Riddell, 2008). After the implementation of the SAPs, Ghana privatized most of its state owned companies, 212 of a total of 300 companies were privatized by 1998 (Ackah et al., 2014). Moreover, as advised by the Bretton Woods institutions, the country ended state-led industrialization. These adjustments were supposed to balance national budgets and create economic growth, as private participation in industrialization would drive growth. However, foreign capital investment moved towards mining in the country, especially gold. Furthermore, Ghanaian industries were in their infant stage and could not compete against mature industries from industrialized countries. As examined by Ayelazuno (2014), open markets had an effect in Ghana, by which merchandise 'from toothpicks to clothing' were being imported in the country. These adjustments and their effects explain the decreased importance of the industrial sector, which cannot be solely considered a resource curse sign, but the effects of international governance in the country.

Education expenditure has increased, therefore not following a path as hypothesised by the resource curse. Education expenditure decreased driven by governmental bankruptcy and SAPs conditionalities at the beginning of the study period (Abukari et al., 2015). However, between 1985 and 1986 Ghanaian civil society and the government realized that the adjustments put in place in exchange for loans had social cost. In order to mitigate these costs the Programmes of Action to Mitigate the Social Cost of Adjustments (PAMSCAD) were put in place. These programmes as a whole were not very successful, yet, these programmes increased education expenditure above the levels of 1980 (Konadu-Agyemang, 2000; Abukari et al., 2015).

Table 8.Socio–economic indicators considered to be affected by the resource curse in Ghana in 1980 and 2010 with their average annual percentage growth rates and standard deviations.

Indicator	Unit	1980	2010	Average annual percentage growth rate ± standard deviation
Education expenditure	% GNI	2.6	4.7	3.5±19
Added value primary sector	%GDP	45.9%	33.3%	-1±2.7
Added value secondary sector	%GDP	30%	17%	-1.6±7.4
Added value tertiary sector	%GDP	24.7%	49.7%	2.4±3.5
Government Effectiveness	-2.5 to 2.5	-0.11*	-0.04	-29.2±121[1]
Rule of Law	-2.5 to 2.5	-0.34*	-0.06	-570±1046[1]
Regulatory Quality	-2.5 to 2.5	-0.38*	0.12	71±117[1]
Political Stability and Absence of Violence/Terrorism	-2.5 to 2.5	-0.32*	0.02	269±1038[1]

*** Value for 1996. 1. Average annual growth rate and standard deviation from 2002 to 2010.**

Corruption has not increased in Ghana. Governmental quality indicators have all improved, as it can be seen in Table 8. The decline of governmental quality due to rent-seeking behaviours (Ross, 1999; Bulte et al., 2005; Collier and Hoeffler, 2005; Brunnschweiler, 2008; Moe, 2009) is regarded as resource curse channel, perhaps the most important one as policy making has a direct impact on the overall economy. Measures of governmental quality: government effectiveness, rule of law, regulatory quality and political stability have all, to a more or lesser extent, improved, which would a priori indicate that dependence on raw resource exports has not resulted in lower governance performance. However, these values are not at the high range of international governance performance.

Ghana has not experienced currency appreciation throughout the study period. Currency appreciation is considered to cause de-industrialization as national manufactures become less competitive abroad. During the study period, the Ghanaian Cedi has depreciated, steadily losing value against the US dollar (World Bank, 2015). This is a consequence of an economy which highly dependent on imported manufactured goods that have a higher monetary value than Ghanaian raw resource exports (Aryee, 2001; UNIMTS, 2014). Furthermore, with exchange rate deregulation encouraged by the SAPs (Berry, 1994; Minion, 2004; Boafo-Arthur, 2007; Boafo-Arthur, 2008; Ayelazuno, 2013; Ayelazuno, 2014), the Ghanaian Cedi constantly depreciated. However, constant currency depreciation protected local food production from foreign imports after trade liberalization (Braimoh, 2009).

At the macroeconomic level, Ghana does not show signs of the resource curse. In general terms, there has not been a deterioration of political indicators, neglect of education or de-industrialization in favour of the primary sector. However, in order to assess if there are resource curse signs or negative effects from raw resources to the Ghanaian economy, a closer look to into the primary sector is needed. Resource curse channels such as rent-seeking behaviours or resource rent mismanagement, as well as elites inhibiting development, might only be visible when immersing into the study the agricultural and mining sectors.

5.1.3. Agricultural products

5.1.3.1. *Cocoa in Ghana*

Cocoa production represents a small share of agricultural production, as it is mainly a cash crop. However, this crop comprises a lion's share of agricultural exports in weight and

economic terms, as Table 9 shows. Cocoa bean exports represent over 80% of total cocoa exports in weights and in economic terms. Thus, the share of semi-processed cocoa has not increased despite governmental efforts (Essegbey and Ofori-Gyamfi, 2012). Processing is mainly done by cocoa importing countries (World Bank, 2009b).

National and international constraints have halted Ghanaian expressed aims to increase cocoa processing. Ghana has been trying to process cocoa since 1960 (Essegbey and Ofori-Gyamfi, 2012), but has been unable to achieve the self-expressed goal of processing 50% of exported cocoa. There are numerous reasons behind the lack of success of cocoa processing industries, such as higher shipping cost for processed cocoa, tariffs imposed for processed cocoa by importing countries, and lack of access to reliable local supplies for processing (World Bank, 2009b). Henceforth, the failure to process their own raw products prior to export can be related with development theories such the world systems theory and the dependency theory (Furtado, 1971; Chilcote, 1974; Wallerstein, 1974; Leys, 1996; Nafziger, 2006; Wallerstein, 2011). Ghana has become a peripheral country that can only operate in low-skill labour-intensive production and extraction of raw materials, while core industrialized countries process raw resources, adding value to them.

Table 9.Production, exports and price of cocoa and agricultural products in Ghana in 1980 and 2010 with their average percentage growth rates and standard deviations.

Resource	Unit	1980	2010	Average annual percentage growth rate ± standard deviation
Cocoa beans production	kt	277	632	4.6±20.3
Total cocoa products exports	kt	218	316	4.1±26.1
Total cocoa products exports price	Price per tonne (constant 2005 USD)	5,265	2,809	0.8±25
Total cocoa products exports	Million constant 2005 USD	1,071	882	-0.5±4.9
Non-cocoa agricultural production	Mt	5	30	7.2±18.8
Non-cocoa agricultural exports	kt	4.6	272.6	24.2±49.3
Non-cocoa agricultural exports price	Price per tonne (constant 2005 USD)*	1,179	850	11.8±64.5
Non-cocoa agricultural exports	million constant 2005 USD	5.4	231.6	25.1±80.3

*** Unweighted average price.**

Exchange rate deregulation improved agricultural exports. Currency revaluation negatively impacted local production throughout the 1970's (Ghana web, 2013), which could be seen as

a resource curse sign prior to the selected study period. As the ERP was put in place in 1983, exchange rate deregulation benefited agricultural exports (Ghana web, 2013; UNSD, 2015). Moreover, the ERP did prove successful to decrease inflation and achieve high economic growth (Ghana web, 2013). Therefore, raw resource dependency cannot be said to have appreciated the Cedi, as would be expected if the resource curse was present via this channel. Furthermore, due to the lack of strong industries, and as an effect of trade liberalization, imported manufactures can be said to have declined the value of the Cedi. Yet, despite currency depreciation, the Ghanaian industrial sector has not increased its share in GDP. An industrial sector over-reliant on biomass as a fuel, plus mentioned international barriers, impede the industrialization process.

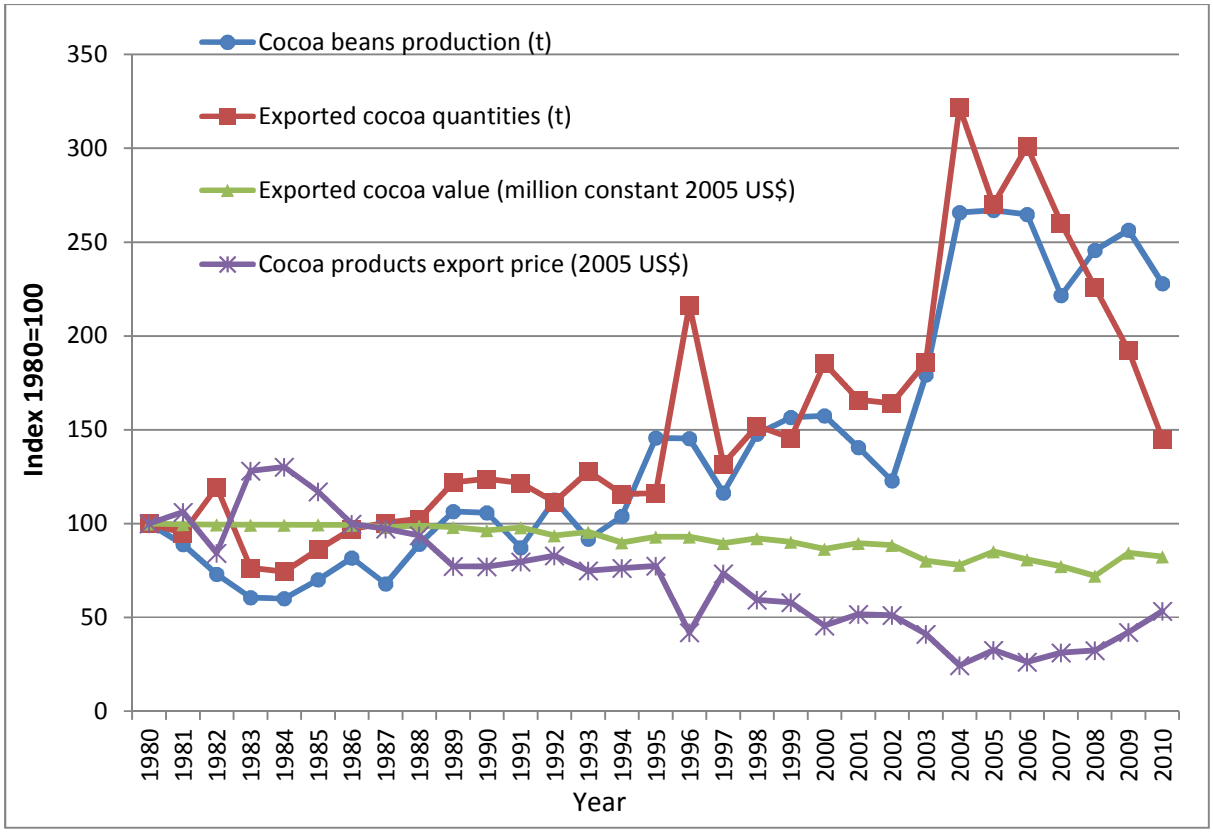

Figure 17. Cocoa, cocoa export weight, value and price in Ghana from 1980 to 2010, index to 1980. Cocoa production in 1980= 277 kt. Exported cocoa quantities in 1980=218 kt. Exported cocoa value in 1980=$1,071 million constant 2005 USD. Cocoa export price in 1980= $5,265 constant 2005 USD per tonne.

Cocoa has suffered from declining international prices. In order to maintain export earnings Ghana needed to increase exported cocoa quantities, as Figure 17 shows. Raw resource prices are set in international markets. In line with alternative development theories (dependency and world systems theories (Leys, 1996; Pieterse, 2010)), Ghana, as a raw resource exporting

country is unable to control prices (Wallerstein, 1974; Nafziger, 2006; Pieterse, 2010; Dand, 2011; Wallerstein, 2011), consequently, cocoa exports have more than doubled while the country has been unable to maintain cocoa exports revenues through the study period.

Global governance has fostered global cocoa oversupply. Decreased cocoa prices were due to new producers entering the cocoa supply market from 1981, such as Malaysia and Indonesia, which oversupplied the international markets with cocoa, thus decreasing prices. Agricultural diversification as an agricultural strategy to avoid raw resource price fluctuation was encouraged by the World Bank and IMF in a number of countries that entered the SAPs (Buira, 2005; J.Hawksworth and S.Nahta, 2014). Consequently, cocoa, as well as a number of agricultural crops, flooded international markets causing a fall in prices. This exemplifies the role that global governance has had in the country, perpetuating raw resource dependency as well as creating a global climate in which a wide number of raw resource producing countries compete to supply core capitalist producing states.

Cocoa overproduction has been a regular phenomenon in Ghana during the study period. Comparing production and exports, as depicted in Figure 18, it becomes clear that there are constant overproductions of cocoa as exports have increased less than production. Cocoa stockpiling is a common strategy followed by numerous cocoa producing countries (ICCO, 2010a). These frequent practices in the cocoa supply markets are hypothesized to be a strategy of cocoa exporting countries, that stock up production in order to serve markets when yields suffer from bad climatic conditions, while maintaining prices on the international markets (ICCO, 2013). Efforts by one country to withhold production to increase international prices cannot succeed with only one country opting for this option to keep prices high (Dand, 2011). However, as a combined strategy it can have an effect on international prices (ICCO, 2010b). World cocoa stocks through the selected study period have remained on average over one megaton per year (Segal, 2015), representing up to 61% of gross crop production through the study period.

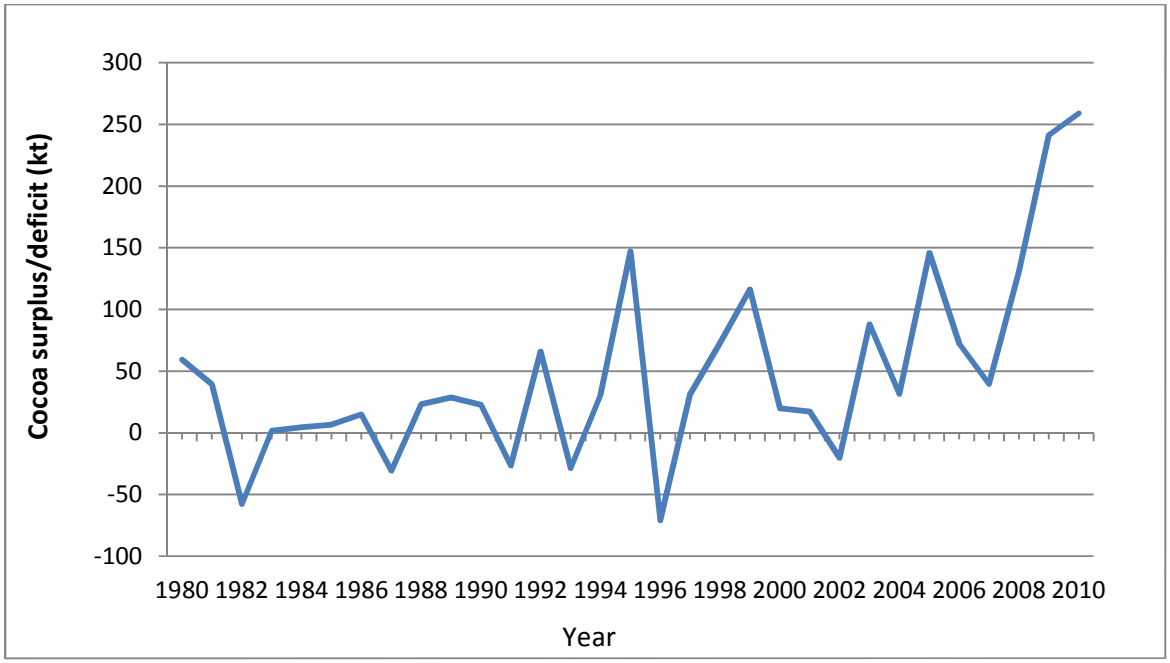

Figure 18.Cocoa surplus/deficit in Ghana from 1980 to 2010 (production-consumption-exports). Source: Own elaboration from FAO datasets. When accounting for cocoa exports, all products containing cocoa are included (cocoa butter, cocoa paste and cocoa powder & cake).

Cocoa stockpiling is a strategy that also serves to tackle bad environmental conditions. Cocoa production and exports have suffered a high variability through time. Droughts and pests have affected crop harvest (Elmasoeur, 2012; EBI, 2014), consequently, stocked cocoa can serve the market when production falls.

5.1.3.2. *The Ghanaian Cocoa board*

Ghana is the only country that has not fully liberalized the cocoa sector. As recommended by international organizations, cocoa exporting countries liberalized their national cocoa sectors (Williams, 2009; EBI, 2014). To the contrary, Ghana only liberalized national cocoa purchasing, but exports remained controlled by the state (Williams, 2009; Essegbey and Ofori-Gyamfi, 2012; EBI, 2014).

The cocoa marketing board, the Cocobod, is the public enterprise that controls cocoa plantation, regulation, disease and pest control, prices paid to farmers, as well as quality of exported cocoa (Williams, 2009; Dand, 2011). The Ghanaian system provides an advantage to farmers who know at the beginning of each year the price that will be received for cocoa (Woods, 2004).

The Cocobod has increased farmers incomes. The Cocobod was restructured after the reforms put in place after the coup. The coup intended to create a context that ensured that Ghana would become a stable democracy, in which corruption would be eradicated and the power would be given back to the people (Pellow and Chazan, 1986; Ghana web, 2013). Therefore, the political restructuration of Ghana restructured the cocoa system. The restructuration of the Cocobod gradually increased state guaranteed price paid to farmers. These prices increased from 30% of cocoa free on board (FOB) price prior to 1983 to a state guaranteed minimum 70% of FOB price from 2005, which despite declining cocoa prices, it has increased farmers' revenue per produced tonne.

Farmers get paid for their production, not for exported quantities. Therefore, to understand farmers income, produced mass quantities are needed. Decreased exports revenues would indicate a decrease of the cocoa sector due to decreased international prices. However, the restructuration of Cocobod has protected the farmers from declined international prices.

Cocobod controls the quality of exported Ghanaian cocoa, making it the best of bulk cocoas (Williams, 2009; Dand, 2011; Essegbey and Ofori-Gyamfi, 2012). Consequently, Ghanaian cocoa receives a premium over other cocoa from other countries. By comparing the price fluctuation experienced by Ghanaian Cocoa, with the price fluctuation experienced by the liberalized cocoa sector in Ivory Coast, this study should be able to assess if state control over the sector can shield a country from suffering negative consequences from raw resource export dependency.

So far, it is clear that in the Ghanaian case, cocoa exports have followed an almost continued growth to fairly maintain similar earnings from this crop. This relates with theories of development; countries specialized in raw resource exports face ever-decreasing terms of trade due to competition with other raw resource exporters. However, state control over cocoa has provided certain benefits to the Ghanaian cocoa farmers, such as quality controls that add value to Ghanaian cocoa.

5.1.3.3. ***Agricultural crops relation with socio-economic development***

The results of the previous sections of this chapter highlighted that international governance and internal constraints have shaped a country that is dependent on raw resource exports. Therefore, internal and external forces have shaped an economy in which raw resource reliance is being perpetuated.

Agricultural production and exported quantities have increased in a context of increased economic growth, increased education expenditure and increased added value in all three economic sectors. Analysing the trend followed by GDP and exported cocoa -mass quantities and economic values, it is clear that mass quantities share a general growing trends with GDP, while cocoa revenues follow completely opposite trend. However, as it can be seen in Figure 19, sudden changes in exported cocoa quantities or values have not related with sudden changes in GDP -orange circles in Figure 19. Hence, despite cocoa mass exports following a general increasing trend similar to GDP, and an almost an opposite trend followed by cocoa exports value, neither metric of cocoa can be used to understand the full evolution of GDP. Despite economic and mass quantity data not being able to account for variations in GDP, utilizing qualitative data provides an understanding of the role that cocoa plays in the country.

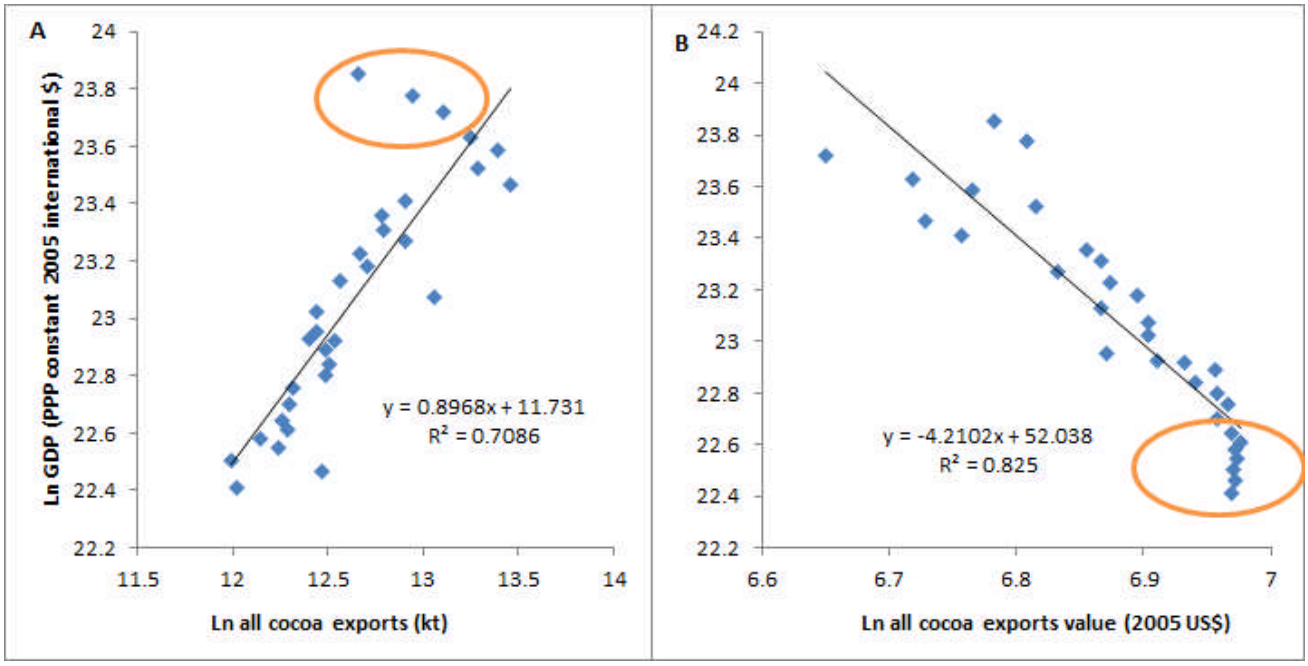

Figure 19. Simple linear regression of the logarithm of Ghanaian GDP and cocoa exports weights (a) and value (b) from 1980 to 2010.

In order to understand how agricultural resources relate with the Ghanaian economy a qualitative approach that examines agricultural frameworks is needed. The resource curse theory suggest that dependency on cash crops to obtain foreign income will halt a country's ability to achieve higher rates of economic growth (Caselli and Ii, 2006; Rosser, 2006b; Stevens and Dietsche, 2008), especially in developing countries with weak institutions (Michaels, 2011). However, in the Ghanaian case, raw resource exports dependency requires the understanding of national and international dynamics. Nevertheless, by comparing Ghanaian

and Ivorian export composition and economic growth, we can understand if greater importance of raw resources in economic terms can be related with slower economic growth in the selected countries, or if other factors influence GDP growth disparities.

Ghana has been positively performing on decreasing corruption, as shown by political indicators. Despite not achieving high levels of governance, the country has been positively performing on decreasing corruption. Corruption is considered to inhibit industrialization by blocking the use of resource rents for growth-led activities (Gylfason, 2001a; Collier and Hoeffler, 2005). Nonetheless, as previously mentioned, the Ghanaian cocoa board is not considered a majorly corrupt organization (Williams, 2009; EBI, 2014), as the Ghanaian government has been trying to combat corruption in the country (Adom and Kwakwa, 2014).

Ghana has been at the forefront of industrial policy through the last decade of the study period (Zakari, 2013). The country has addressed demand and supply side factors. However, the country faces a bottleneck at the national level, such as lack of stable input supply to the industrial sector (40% of the sector's energy needs are met utilizing biomass, and unstable electricity supply which is mostly hydroelectric), obsolete equipment and lack of experience on industrial policies. Similarly, at the international level, international competition, tariffs and the effects of SAPs halt Ghanaian industrialization. Asamoa (1996) highlights that Ghanaian industrialization has been halted by industrialized economies, not only through terms of trade, but also through the brain drain (Carrington .W.J, 1999; Commander et al., 2004; Nullis-Kapp, 2005). Therefore, a combination of national adjustments that can provide stable energy sources to the industrial sector, as well as international measures that do not halt Ghanaian industries, such as allowing certain industrial protectionism (Arthur, 2006) and state-led industrialization, will be needed to break the bottleneck the country faces to industrialize.

It is important that Ghana can create an industrial sector to process local goods, which is considered necessary to increase income and living standards (Ayelazuno, 2014). Newly discovered oil and gas reserves could be partly used to provide stable energy for local processing industries in the future (World Bank, 2009b). But, up to 2012, the country did not provide local industries with locally extracted fossil fuels as a stable energy source (IEA, 2015b).

Agricultural exports earnings have remained stagnant. Therefore, with increased active population in agriculture, overall agricultural income per farmer has not increased. However,

the Ghanaian system after the ERP increased FOB prices paid to cocoa farmers, but farmers from liberalized sectors faced declining prices and incomes. Moreover, state control over the whole agricultural sector permitted the Ghanaian government to provide fertilizer subsidies up to the liberalization of the agricultural sector in 1991. As it happened with education and health expenditure, the government realised the effects SAPs in agriculture and by 2008 the government re-instated these subsidies in order to increase agricultural productivity (Banful, 2011; Norman et al., 2016). Further, the government has implemented a number of subsidies to increase agricultural mechanization and reduce post-harvest losses -creating an agricultural insurance system and providing income to the poor (FAO, 2015). These recent measures indicate that the government is addressing some of the problems that liberalization policies brought to the sector. By comparing the Ghanaian approach with the Ivorian approach, it can be assessed if state intervention in the agricultural sector has been positive for farmers or negative. However, in the Ghanaian case, it cannot be stated that state intervention has perpetuated raw resource dependency, as state intervention in non-cocoa crops was discontinued for two decades.

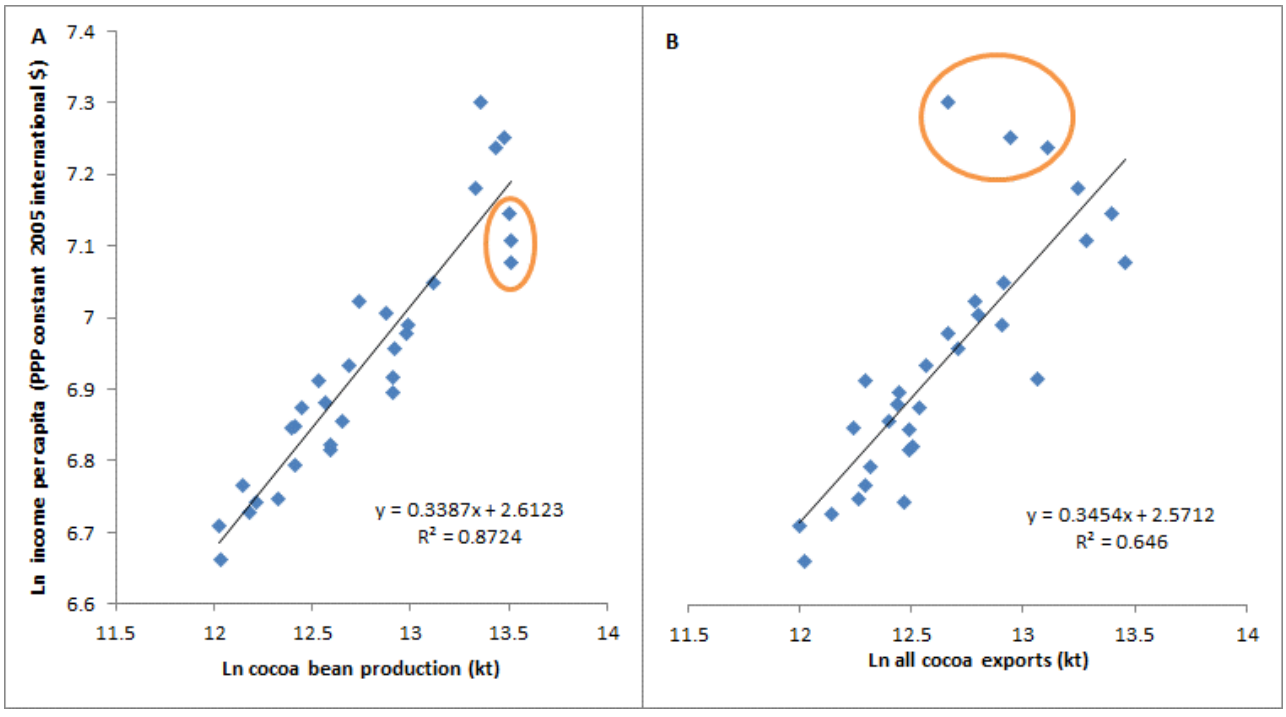

Figure 20. Simple linear regression of the logarithm of income and cocoa production (A) and exports (B) from 1980 to 2010.

Income and cocoa share a general trend, but are not coupled, as Figure 20 shows. This is explained by the system by which cocoa is produced and exported in Ghana. The Ghanaian system creates a shield for cocoa farmers. Therefore, production of cocoa is not as coupled at

the per capita level with income as cocoa exports are with GDP. This is a consequence of the 'shield' provided by the cocoa board. The cocoa board ensures that farmers receive a state guaranteed minimum wage, and has strong policies protecting cocoa production, such as pest control programmes, bonuses paid to farmers and agricultural insurances (Essegbey and Ofori-Gyamfi, 2012) -even if sometimes those programmes fail (EBI, 2014). Farmers income is directly dependent on their production and indirectly dependent on worldwide supply and demand (ICCO, 2010b). Therefore, to understand the relation between the cocoa sector and income, produced mass quantities are needed. Variations in export revenues in a given year might not directly influence farmers income due to the shield provided by the Cocobod.

The differences between the relation of the cocoa sector with GDP and income are interesting to compare with Ivory Coast, which has liberalized the cocoa sector. Hence, the relation between cocoa production and exports with income might differ from the Ghanaian case study as Ghanaian intervention in the cocoa sector might have been beneficial, or detrimental, to farmers compared to the Ivorian approach. Therefore, comparing both countries should provide a clearer view of the effects that governmental intervention can have in an economy, and if full liberalization of the cocoa sector can achieve greater levels of industrialization, or cocoa processing, in a country.

Based on these results, there is no clear evidence that shows that the cocoa sector, or agriculture, has had a negative impact in the economy, or has fostered resource curse signs. The elements that relate with alternative theories of development seem to be affecting the country's economic structure and evolution. Cocoa is the main agricultural export due to colonial specialization. The continuation of the country as an agricultural exporting nation emerges from local constraints and international governance that has impeded state-led industrialization. The overall effect has been a decrease in the importance of the industrial sector, which could a priori appear as a resource curse sign. Yet, it does no stream from corruption or elites that have impeded the creation of an industrial sector.

5.1.4. Mineral products

Gold has been mined and traded for centuries for economic and cultural reasons in Ghana (Hilson, 2002a, 2002b). Gold extraction has increased fourfold from 1990 to 2010. Despite representing a small fraction of material exports in weight, gold represented up to 97% of the

economic value of exported minerals through the study period (Aryee, 2001; USGS, 2012; UNIMTS, 2014).

Table 10. Production, exports and price of gold and minerals in Ghana in 1980 and 2010 with their average percentage growth rates and standard deviations.

Resource	Unit	1980	2010	Average annual percentage growth rate ±standard deviation
Gold extraction	t	16.8[1]	76.3	9±16
Gold exports	t	65.6[2]	96	4.5±21
Gold exports	Price per kg (constant 2005 USD)	13,073[2]	32,021	9.6 ±27
Gold exports	Million constant 2005 USD	857[2]	3,075	9±34
Industrial, construction minerals and ores extraction	Mt	12	59	5.39*
Industrial, construction minerals and ores exports	kt	664	579	-0.46*
Metals and ores (without gold) exports	Price per tonne (constant 2005 USD)	181.6[3]	335.5	6.3*
Metals and ores(without gold) exports	Million constant 2005 USD	379.7[2]	194.2	-4.7*
Percentage of selected raw resource exports in GDP**	% GDP	18.1%[2]	18.35%	1.2±15.8

1. Dataset starts 1990. 2. Dataset starts 1996. 3. Dataset starts 2000. *average annual growth rate calculated using compound annual interest rate formula (World Bank, 2011). Agricultural exports values without processed cocoa exports, plus metals and ores exports value as a share in GDP.**

Recorded gold, not including smuggled extraction to Ivory Coast and unreported artisanal extraction (USGS, 2012), has almost steadily increased, as Figure 21 shows. Such an increase is attributed to the opening of several new mines in the country and to the Small-Scale Gold mining law of 1989. As previously mentioned, after Ghana entered the SAPs, foreign investments were made in the extractive industries in Ghana (Arthur, 2006; Ayelazuno, 2014). Moreover, the Small-Scale law was established to voluntarily regularize small-scale miners, by directly buying gold from miners and to increase tax collection. Production slightly declined after 1999, the closure of a number of mines and decreased gold prices in the year 2000 led companies to rationalize production. Moreover, some mines were depleted by 2002. However, major foreign investments boosted gold extraction in the country (USGS, 2012).

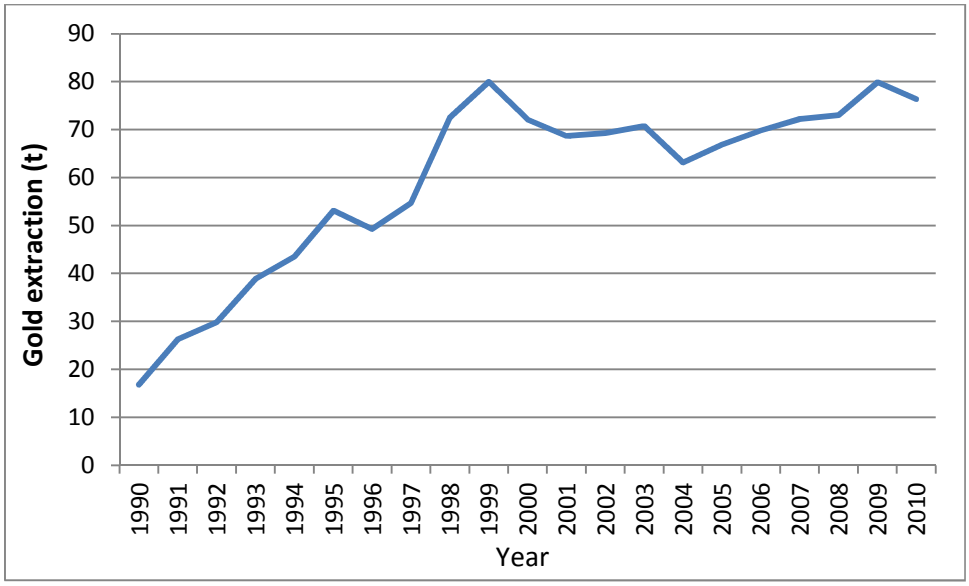

Figure 21. Gold extraction in Ghana 1990 to 2010.

Gold extraction has followed a similar trend to GDP for a number of years, as it can be seen in Figure 22A, while exported gold mass quantities and values have not followed a trend similar to GDP, as Figure 22B and C evidence. This brings out the question of why the most economically important export of the country does not follow a similar trend to that of GDP (or of any other the selected indicator). In order to answer this question, the Ghanaian gold revenue management framework needs to be reviewed.

Gold extraction directly benefits the Ghanaian economy, while exports contribution is indirect. Gold mining companies pay a number of taxes to the country -which have been reduced through the study period. Mining companies paid in between 3% and 12% of taxes over their gross revenue, gold royalties (levy on production), as minerals in the country belong to the state (Hilson, 2002b, 2002a). However most companies pay only 3% due to loopholes in regulation (Gajigo et al., 2012). Exported gold values benefit the Ghanaian economy through corporate tax, hence indirectly, as it is based on each company's profits. This tax has decreased from 45% to 30%. The mining industry contributed on average to a 5% of GDP during the first lustrum after the year 2000 (USGS, 2012), mostly from gold extraction. Consequently, understanding the tax system is important to measure the impact of gold in the country.

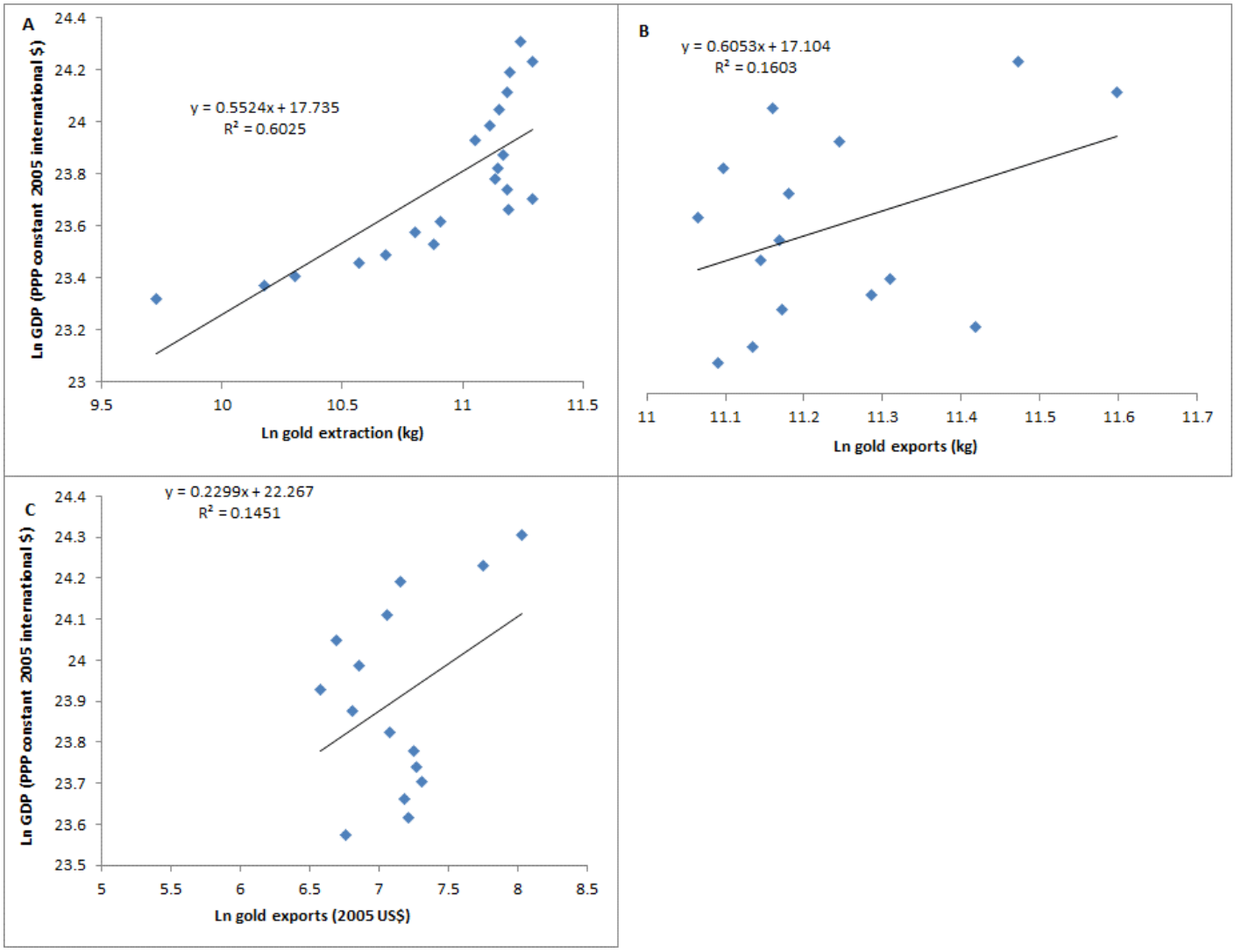

Figure 22. Simple linear regression of the logarithm GDP with gold extraction (A)1990-2010 and exported gold (B) mass quantities and (C) value (1996-2010) in Ghana.

Mining taxation policies explain the stronger relation of Ghana's GDP with gold extraction than gold exports. It should be noted that gold extraction does not include undocumented extraction and some artisanal mining (USGS, 2012). Small-scale mining is highly linked with job creation and local income as it is not mechanised (Teschner, 2012). To the contrary, large-scale gold mining is mechanised and proportionally creates less jobs.

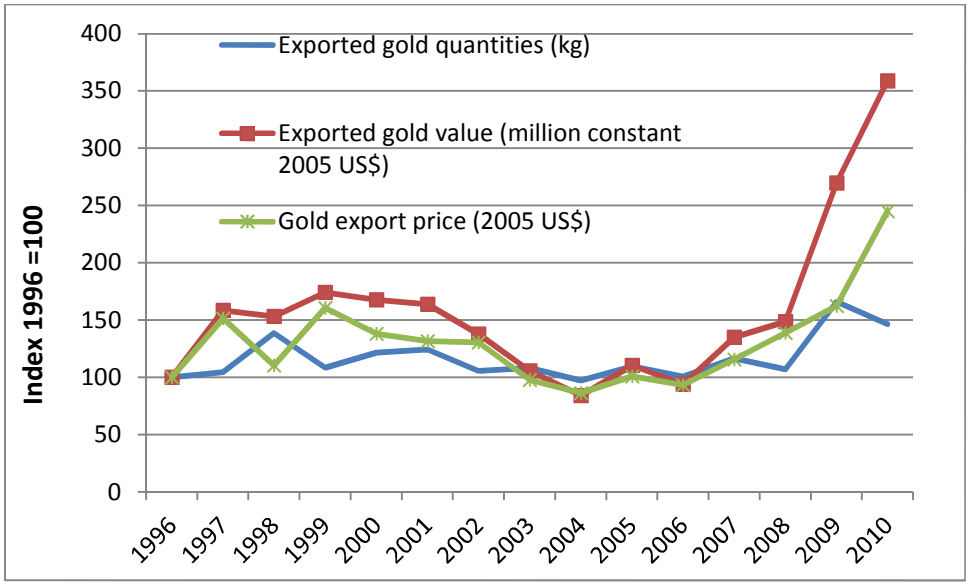

Figure 23. Exported gold quantities and value in Ghana from 1996 to 2010, index to 1996. Gold export quantity in 1996=65.6t. Gold export value in 1996= $857 million 2005 USD, Gold price in 1996=$13,073 2005 USD per tonne.

Labour in the mining industry is mostly informal. During the 90's, it was estimated that there were approximately 60,000 small-scale miners, increasing up to an estimated 600,000 in 2006. However, under 1% of these workers were registered as artisanal miners (USGS, 2012). On the other hand, large-scale mining employed about 20,000 Ghanaian nationals in 2010. Thus, in terms of labour, mining remains mainly an informal sector that despite increasing its exports revenues it does not benefit the working population as much as the agricultural sector. The difference between extracted gold quantities and exported gold reveals that unreported mining represents on average 12% of exported gold quantities. Hence, decreased agricultural prices cannot be counterbalanced by increased exported gold.

5.1.4.1. *Gold revenues management*

Based on how the cocoa and gold sectors are managed, it is clear that the cocoa sector is highly linked with the Ghanaian economy and income per capita. On the other hand, gold, despite being the most important export in economic terms during the last years of the study period, does not have such a strong relation with GDP nor income per capita. Which calls for an investigation of gold management framework to comprehend how gold contributes to the country.

The gold management framework put in place in Ghana prevents wide resource rent mismanagement, and therefore prevents resource curse signs. The Ghanaian Mineral

Development Fund, put in place in 1992, saves 20% of mineral royalties collected in Ghana to be used in development projects to improve conditions of mining areas and research projects in the mineral sector. Furthermore, in 2003, Ghana announced its commitment to comply with the Extractive Industries Transparency Initiative (EITI) and was a compliant country in 2010. The effects of these frameworks provide local communities with mining revenues –local governments receive up to 40% of their budget from mining (Ashiadey, 2014). Ghana being a compliant country means that through disclosure of earnings it decreases corruption levels in the sector (Bleischwitz, 2013; Kopiński et al., 2013; EITI, 2015b; Kumah-Abiwu et al., 2015).

Ghana has been disclosing gold revenues received by the state since 2007 (Nguyen-Thanh and Schnell, 2009), with a three year time lag that has prevented government accountability. Moreover, this lag has contributed to the shortcomings of mining benefits to the local communities (Nguyen-Thanh and Schnell, 2009; Ashiadey, 2014). This posed initial difficulties for Ghana to become an EITI compliant country until 2010. However, the country has increased its level of transparency to disclose gold rents received by the government. Gold revenues to the government are only available from 2004 to 2010, yet are acknowledged to be incomplete. Based on available data (EITI, 2015b), the Ghanaian government received 3.3% of gold export revenues in 2004, 5.9% in 2006, 2.8% in 2009 and 5.9% in 2010, indicative that reporting has varied. Therefore, as mentioned by Van Alstine (2014), the implementation of transparency does not always achieve desired results, as produced data can be incomplete or unreliable. Consequently, understanding the tax system, extracted gold quantities can be used as a proxy of gold revenues to the state for the years where reported data is incomplete.

Despite the lack of strong relationships between gold with most of the selected economic indicators, regulatory enforcement put in place after 1983 has positively benefited the Ghanaian economy (Aryee, 2001; USGS, 2012). It is to note that the Ghanaian gold sector has shown signs of the resource curse prior to 1983. However, the socio-political climate that emerged after 1981, reformed different aspects of the Ghanaian economy and avoided suffering further resource curse signs by good regulatory enforcement and good governance to control raw resource exports revenues.

5.1.5. Share of raw resource in GDP

Ghana as whole has maintained its dependency on raw resource exports. However, the share of raw resource exports in GDP has fluctuated between 10.5% and 21% of GDP influenced by the value of gold exports -which have been dominated by international market prices. Increased

gold earnings from 1996 to 2010 have been over ten times greater than revenue lost from cocoa exports, but the share of raw resource exports in GDP has just slightly increased. However, as previously analysed, the context faced by Ghana has perpetuated raw resource dependency.

As previously mentioned, quantitative studies on the resource curse focus on the share of raw resource exports in GDP as a measure of raw resource dependency of an economy, in order to compare if countries with greater shares of raw resource exports in their GDP show lower economic growth compared to their resource poor counterparts (Sachs and Warner, 1995; Ploeg, 2011; Saad-Filho and Weeks, 2013). By comparing Ghana and Ivory Coast, we can observe if the country that possess the largest share of raw resource exports on its economy has experienced lower economic growth, which would be in favour of the resource curse literature.

Infant mortality is considered a good well-being indicator that measures improvement of living standards, as it can be used to view if the exploitation of natural resources contributes to improved living conditions of the population of raw resource exporter countries (Stevens and Dietsche, 2008). A link between infant mortality and raw resources can be established, as for instance revenues from the Cocobod and from the mineral development fund are utilized in the development of health facilities, schools and electrification projects. Therefore, raw resource dependency in Ghana cannot be linked with a deterioration of well-being. However, the lack of long-term resource curse signs in the country streams from the political climate that emerged after 1981, coinciding with the literature that states that the effects of raw resource dependency and raw resource booms are dependent on governmental quality (Ross, 1999; Brunnschweiler, 2008; Saad-Filho and Weeks, 2013).

5.2. Conclusions and relation to development theories

Ghana has followed liberal economic policies since 1983. However, an active civil society, as well as strong political parties in the opposition and free media, have all helped to control governmental activities and avoid the major resource curse channels (Minion, 2004; Boafo-Arthur, 2007; Boafo-Arthur, 2008; Ayelazuno, 2013; Ayelazuno, 2014). Yet, after decades of following neo-liberal policies and opening markets to foreign investors as advised by international organizations, Ghana has been unable to develop a strong industrial sector, as foreign manufactured goods from developed economies have predated nascent Ghanaian industries.

Therefore, in the Ghanaian case, it is difficult to ascertain that the lack of a strong industrial sector is due to the resource curse. These results seem to confirm that the combined effect of unstable local inputs to the industrial sector and the SAPs decreased the importance of the industrial sector in the economy. Ghana's development path is in a global context in which processing Ghanaian raw resources prior to export reduces the competitiveness of those processed goods through protective tariffs in industrialized countries. Yet, the country has been advised to remove trade barriers to foreign goods (World Bank, 2009b; Ayelazuno, 2014). As mentioned by Dooley et al. (2007), gains from trade are not enough to ensure mutually beneficial trade between importing and exporting countries, leaving Ghana to suffer the lack of competitiveness against mature industries from other countries.

The results found in this chapter show that the Ghanaian political system has been able to regulate and prevent the resource curse channels studied by the literature. This has been due to the socio-political system that emerged in Ghana after the successive coups; successive governments after the coup in 1981 have strived for increased transparency of agricultural and mining sectors. This is one of the main ideas behind the literature on the resource curse, good governance and transparency are the main keys to avoid the resource curse during resource booms and achieve economic gains from raw resources (Rosser, 2006b; Stevens and Dietsche, 2008; Bleischwitz, 2014; Kumah-Abiwu et al., 2015). Additionally, a minimally diversified export structure has protected the country from further experiencing negative effects of relying in only one resource.

The literature on resource management in Ghana, revised utilizing pattern matching framework, to a certain extent shows consensus with alternative development theories. The country is stuck in a point where it needs to further process its own resources in order to achieve greater levels of economic growth that can potentially reach the population in order to increase living standards.

However, the global context in which Ghana is embedded has perpetuated raw resource export dependency in Ghana, making the country a peripheral, or satellite state, which exports raw materials to core capitalist states that export their high-valued manufactured goods back to Ghana. The main consequence of this development path, which has been influenced by international governance, is that the country competes with many other developing countries to provide international markets with raw resources, which reduces prices of agricultural products. This further damages the Ghanaian economy that has to increase exported quantities

to be able to obtain foreign income to afford manufactured imports. Consequently, it is important to understand if Ivory Coast suffers a similar global context, which will imply that both countries, and perhaps all ECOWAS, suffer from international barriers to development.

A clear result that comes out from this analysis is the difference between the relation of monetary exports and physical quantities of selected resources with political and economic indicators, which is a novelty when studying the resource curse. Agricultural exports have had to increase to maintain exports revenues, while in the cocoa sector, despite increased exported quantities, cocoa export revenues have decreased. A priori this would entail declining cocoa farmers standards. However, understanding the overall context faced by these farmers and that they are paid based on their production, not exports, provides the understanding that their standards have not declined.

This chapter provides an understanding of the relation that has existed in the country with raw resource production and exports. Providing context and management frameworks to the past dynamics and relations examined in this chapter, provides a more complete understanding of the importance of different actors and their actions over produced and exported raw resources. This type of analysis is lacking in most studies on the resource curse, but is considered essential to capture overall dynamics of socio-political agenda (Rosser, 2006a; Stevens and Dietsche, 2008).

In order to understand the evolution of selected indicators, the combination of these results with global averages will provide a better picture on the performance of the country. Yet, no clear signs of the resource curse in the overall Ghanaian economy have been found so far.

It is clear that only one method, be it quantitative or qualitative in nature, does not bring clear answers on the relation or effects that raw resources have in an economy, thus the lack of consensus of many studies that examine the resource curse. By combining both types of methods, and additionally including views from the societal metabolism (mass quantity data), a number of questions are left unanswered, as causation can in no case be determined. Nevertheless, new insights towards understanding the differences in the relation that exists between mass quantities and economic values produced in the country helps to recognize the different relations between raw resources and the economy and raw resources and income. Furthermore, observing the relation between resources, export structure and acknowledging the forces at play at the national and international levels, sheds light over what could a priori seem like a resource curse sign, such as decreased importance of the industrial sector in GDP.

This analytical approach can be applicable in other developing contexts to study the how the economy relates with raw resource exports.

6. Socio-economic and biophysical metabolism of Ivory Coast

In order to answer the first and second research questions of this thesis for the Ivoirian case study, and hence comprehend the interdependencies that exist between biophysical consumption and socio-economic development in Ivory Coast, two steps will be followed. Firstly, the past dynamics of selected indicators will be studied alongside their interrelation, in order to visualize how selected indicators have jointly evolved through the period, as done in section 4.1. Moreover, to further comprehend the relation that exists between selected indicators and the economy, the second section will examine the historical context in which selected indicators have evolved, which should provide an understanding behind the dynamics previously studied.

The Ivorian development path seen through the metabolism approach highlights that the country has been in decline. It is following a 'retroceding' transition towards biomass inputs, which is falling back the energy, and material, ladder. The decline of Ivory Coast is reflected in all spheres of the country. Therefore, biophysical consumption and its composition, as well as well-being and economic dynamics, cannot be understood without an in depth exploration of the country's overall context.

6.1. Past dynamics and interdependencies between socio-economic and biophysical metabolism in Ivory Coast

Ivory Coast shows many characteristics of a developing economy, as Table 11 shows. Selected biophysical and socio-economic indicators reveal the difficulties Ivory Coast has faced to provide greater living standards to Ivoirians.

Population growth has dominated economic and biophysical growth in Ivory Coast. Population has experienced a huge increase, more than doubling, at an average annual growth rate ahead of most developing countries and other West African nations (Soubbotina, 2004; UNDESA, 2015). Such high rates of population growth hinder the possibility of achieving many millennium development goals (MDGs) in the country (UNDP, 2012). In contrast, GDP has increased on average 1.4% per year; economic activity has not been able to keep up with population growth. The estimate of total economy slightly increased, with an average yearly growth of 0.3% from 1999 to 2007, far behind population growth through those years of 2% per year.

TPES has doubled, surpassing economic growth and not far from population growth. Greenhouse gas emissions have decreased. Within this category, carbon dioxide emissions from fossil fuels have also decreased. This would indicate that the increase in TPES is not driven by fossil fuel use, as liquid fuels in carbon emissions have decreased from 2002 (Boden et al., 2013). Indeed, biomass use has more than doubled, but crude oil supply has experienced just a moderate increase (IEA, 2015b). Moreover, increased energy needs have also been met by utilizing natural gas from 1995 onwards, which has a lower carbon content than oil (Marland, 1983; IEA, 2015a). Therefore, despite using greater amounts of fossil fuels, emissions from this source have decreased.

Domestic material consumption has increased slightly above GDP. By viewing biophysical inputs to the economy and GDP in comparison with population dynamics in the country, it is clear that in per capita terms, Ivoirians have decreased their material and energetic standards simultaneously with reduced economic power. Thus, Ivory Coast is a case of a growing, some might say developing, country in terms of macro-level indicators, but in per capita terms, it is hard to see how this growth has benefited the population. The term developing country here only applies at the macro level, not in terms of material progress for the population.

In terms of traded mass quantities, physical trade balance has decreased. Imports have increased more than exports, which would indicate that in physical terms Ivory Coast does not suffer a great burden from trade. Trade balance data has to be taken with care. Trade data is incomplete, and due to the composition of traded products, non-accounted indirect flows from raw material exports would have higher amounts of unused materials as compared to some semi-manufactured and manufactured imported goods (Dittrich et al., 2012). These material exports are mainly cocoa, petroleum and petroleum products, vegetables and crude rubber, while imports are mainly oil, machinery and chemicals, and health related products (UNIMTS, 2014).

Table 11. Selected indicators values for Ivory Coast in 1980 and 2010 with their average annual percentage growth rates and standard deviations.

Indicator	Unit	1980	2010	Average annual percentage growth rate ± standard deviation
Extensive Indicators				
Population	Million	8.3	20.1	3±0.9
GDP	Billion PPP constant 2005 international $	22.3	33.6	1.4±2.9
Estimate of total economy[1]	Billion PPP constant 2005 international $	44.1	45	0.3±1.6
Total primary energy supply	Petajoules	149.6	305.3	2.6±5.8
Domestic material consumption[2]	Mt	35	54	1.4*
Greenhouse gas emissions[3]	$MtCO_2e$	24.6	18.2	-1.1±8.6
CO_2 emissions	Mt	6.2	5.9	1.8±20.8
Physical trade Balance[2]	Mt	-0.3	-0.07	-4.4*
Intensive Indicators				
Income (GDP per capita)	PPP constant 2005 international $ per capita	2,695	1,670	-1.5±2.9
Estimate of total income per capita[1]	PPP constant 2005 international $ per capita	2,732	2,396	-1.6±1.6
TPES per capita	GJ capita	18.1	15.2	-0.4±5.6
DMC per capita[2]	t per capita	4.2	2.7	-1.5*
GHG Emissions per capita[3]	tCO_2e per capita	2	0.9	-3.6±8.5
CO_2 emissions per capita	t per capita	0.8	0.3	-1.2±20
Energy intensity	MJ per $	6.7	9.1	1.2±5.7
Material intensity of the economy[2]	t/1000$	1.6	1.6	0.07*
CO_2 intensity	tCO_2 per million $	279	175	0.4±20.2
GHGe intensity[3]	tCO_2e per million $	1,031	541	-2.8±1.7
Food supply	Kcal/capita/day	2,918	2,737	-0.2±1.7
Life expectancy	years	50.7	49.7	-0.06±0.9
Infant mortality	per 1000 live births	113.7	76.9	-1.3±1.1
HDI[4]	0 to 1	0.38	0.44	0.5*

1.Data from 1999 and 2007, own calculation based on GDP data from the World Bank (World Bank, 2012b) and estimates of informal economy from (Schneider et al., 2010). 2. Data available for 1980/1990/2000/2005/2010. 3. Data starts in 1990. 4. Data available for 1980/1995/2000/2005/2008/2010. * average annual growth rate calculated using compound annual interest rate formula (World Bank, 2011).

Economic growth has been energy intensive in Ivory Coast, as it can be seen in Figure 24. TPES growth surpassed economic growth from 1985. The rapid increase experienced by energy supply has been mainly driven by increased biomass use. Economic growth has been strongly coupled with TPES in the long run, but as it can be seen in Figure 25 it has been a time variant relation. Looking at different time spans, economic growth and TPES were

coupled from 1980 to 1998, prior to the conflict, and decoupled thereafter. This evidences that the Ivoirian conflict had stronger effects over GDP than on TPES.

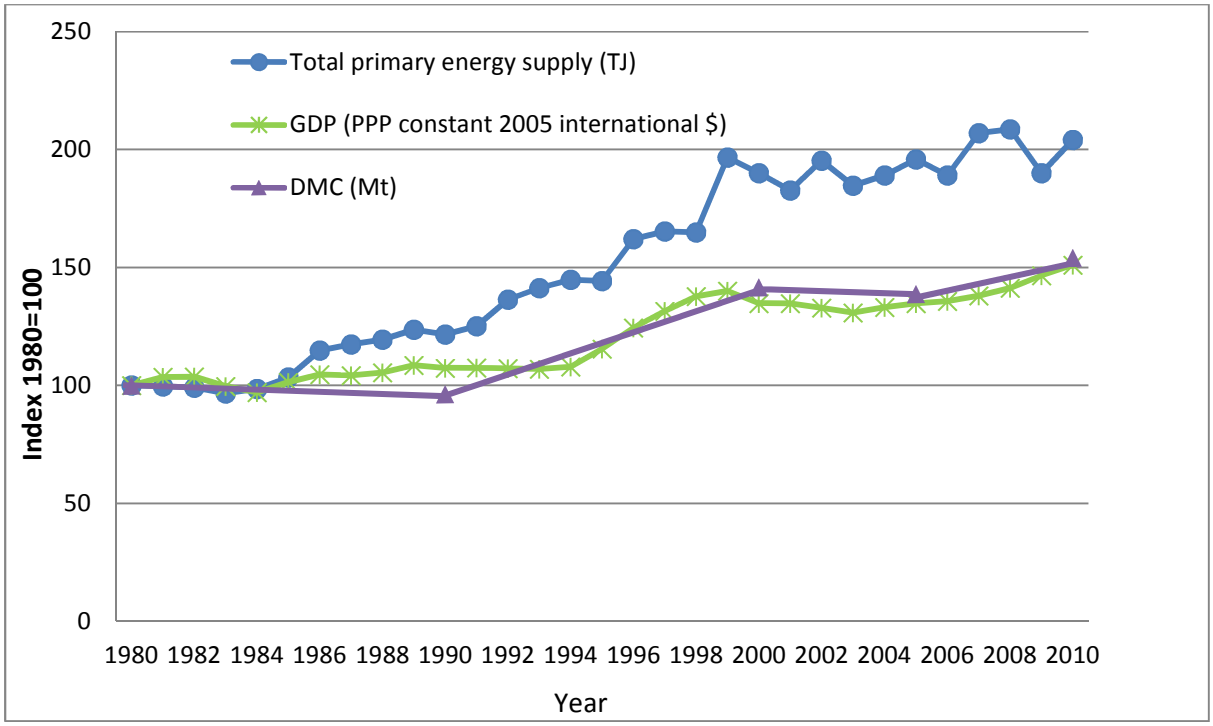

Figure 24. Total primary energy supply, domestic material consumption and GDP in Ivory Coast from 1980 to 2010, index to 1980. TPES in 1980=150 PJ. GDP in 1980=$22 Billion 2005 USD. DMC in 1980=35 Mt.

Biomass is the main energy carrier used in Ivory Coast. Despite having a diverse energy mix mainly composed by hydropower, crude oil and gas, biomass represents mostly over 60% of the energy mix through the study period. Moreover, biomass has increased its share in TPES from 62% in 1980 to 67% in 2010. Hence, Ivory Coast's energy intensity has increased due to the increased share of biomass, which increases the energy intensity of nations due to the lower efficiencies as compared with commercial sources (Goldemberg, 1996; Steinberger and Krausmann, 2011).

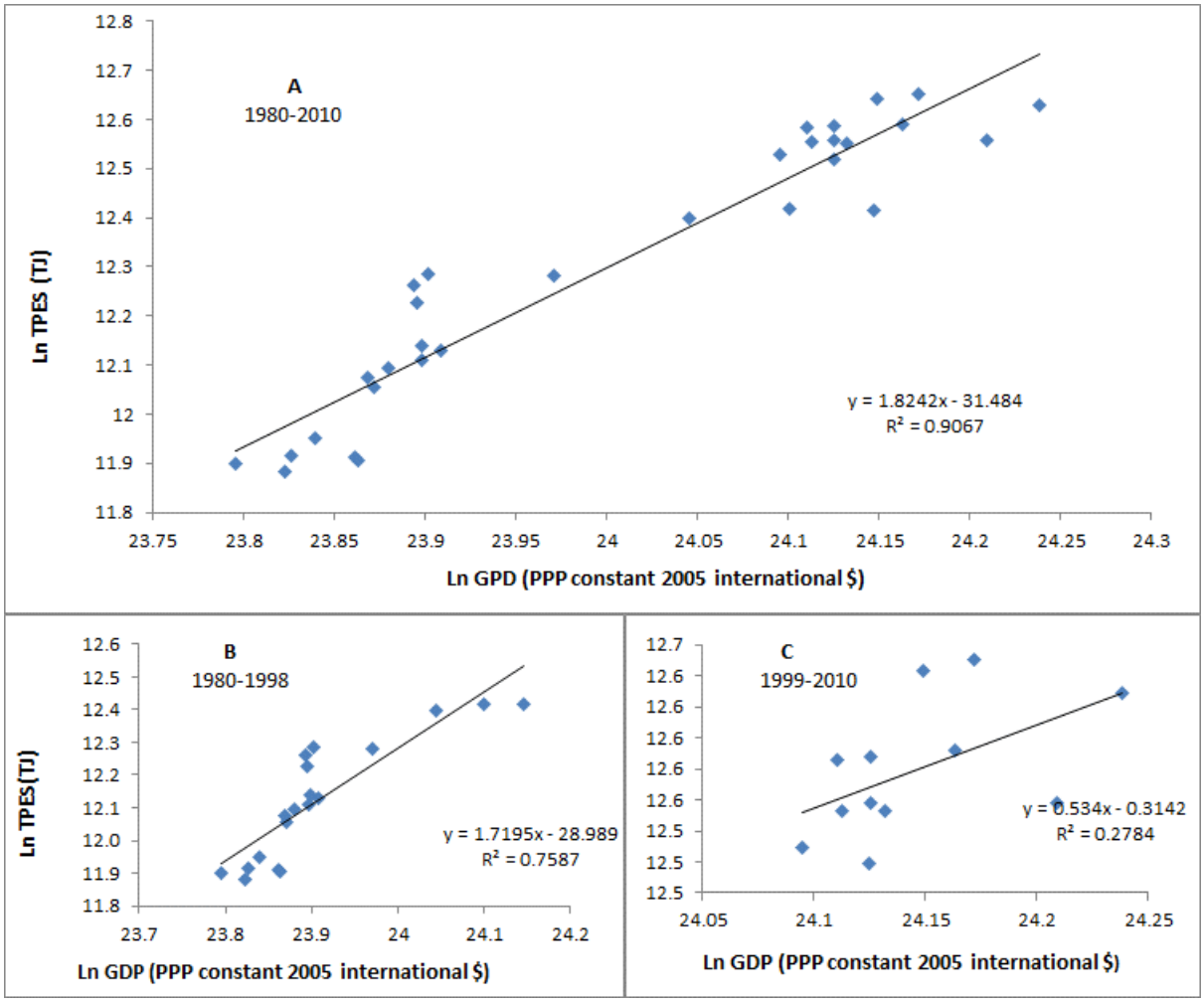

Figure 25. Linear regression of the logarithm of GDP and TPES in Ivory Coast from 1980 to 2010 (A). (B) From 1980 to 1998. (C) From 1999 to 2010.

In order to fully understand past dynamics followed by TPES and GDP, it is fundamental to analyse how the different economic sectors in the Ivoirian economy have evolved. Starting with the most important sector in economic terms, the tertiary sector, its share in overall GDP has decreased. Development economics literature states that as income increases in a society the share of services grows with respect to other sectors (Srinivasan, 1988; Eichengreen and Gupta, 2013). However, the exact opposite has happened in Ivory Coast, income has decreased as well as the share of the service sector in GDP.

The primary and secondary sectors have increased their importance in economic terms and as a share in GDP. To the contrary, the share of the active population in agriculture has decreased from 65% of total active population in 1980 to 38% in 2010, but increased from 2 million to 3.1 million workers (FAOSTAT, 2012). The paradox behind these trends is resolved by considering Ivory Coast's huge population increase. The number of active workers in agriculture has increased by 54% during the study period, leading to increased agricultural

production of 106% (FAOSTAT, 2014b). However, with an overall population increase of 143% through the study period, food security in the country might be at risk, due to the importance of cash crops in expanded plantations, as decreased food supply through the period shows.

Increased production in the agricultural sector has been achieved by increasing labour and not mechanization. Energy consumption in the agricultural sector has fluctuated through the study period. However, as decreased energy intensity in agriculture shows, increased production has not been achieved through mechanization.

The industrial sector has experienced an increase in added value and energy consumption. Increased industrial added value (127%) has surpassed increased energy needs of the sector (91%). Based on the evolution of the industrial sector added value and energy consumption, these two indicators have been closely linked through the three decades under study. Therefore, energy intensity of the industrial sector has just slightly decreased.

The service sector has lost share in economic and energetic terms. The service has experienced a moderate increase in overall added value and energy use. Yet, this increase has been below than GDP and TFC growth; consequently, the sector has lost importance in economic and energetic terms. These results show that added value in the different sectors has been linked with the energetic consumption of each economic sector. Hence, as it can be seen in Table 12, all the economic sectors present almost stagnant energy intensities. These results highlight that there has not been major productive changes in any economic sector. Therefore, increased energy consumption at the non-productive sector of the economy, the residential sector, has increased the energy intensity of the economy.

Table 12.Energy intensity of Ivory Coast's productive sectors, share of each sector in TFC and residential consumption share in TFC in 1980 and 2010.

Indicator	Units	1980	2010
Agriculture energy intensity	MJ per $	0.6	0.4
Agriculture share in TFC	Percentage	2.6	1.3
Industry energy intensity	MJ per $	3.9	3.4
Industry share in TFC	Percentage	9.8	8.2
Services energy intensity	MJ per $	2.1	2.3
Services share in TFC	Percentage	32.4	18.9
Residential share in TFC	Percentage	55.3	71.6

Economic growth has been material intensive. DMC and GDP have been highly coupled through the study period. Increases in GDP have been accompanied by greater increases in

DMC. Per material groups, biomass and fossil fuels are highly correlated with GDP, resembling the results found by Steinberger et al. (2010). But, contrary the results found in Steinberger et al. (2010), construction minerals are not related to GDP. Surprisingly, this would imply that GDP growth has not been accompanied by an increase in the built-environment or road infrastructure in the country.

DMC decreased from 1980 to 1990, driven by the decrease of construction minerals consumption but increased thereafter, as biomass consumption increased. The consumption of all material groups has increased, with the exception of construction minerals. These results are to be taken with care, as Ivory Coast's urban population has tripled through the study period from 3 million in 1980 to 9.6 million in the year 2010 (UNDESA, 2015). A priori, increased urban population should have increased the consumption of construction minerals. Biomass and construction minerals represented most of Ivory Coast's DMC, the former increased from 41% of total DMC in 1980 to 64% in 2010, while construction minerals decreased from 54% to 29% of total DMC (Schaffartzik et al., 2014).

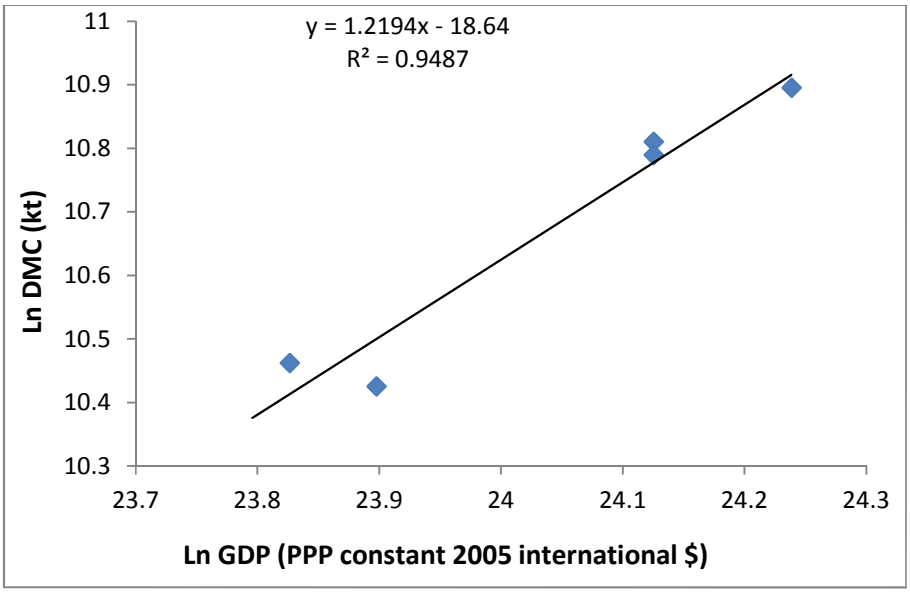

Figure 26. Linear regression of the logarithm of DMC and GDP in Ivory Coast for the years 1980,1990,2000,2005 and 2010.

The results obtained with official GDP cannot be extrapolated to the estimate of total economy. GDP and the estimate of total economy in Ivory Coast are significantly correlated. However, both indicators do not always similarly correlate with selected indicators when utilizing the same span for both indicators, from1999 to 2007. Therefore, the relationships between official

GDP and other extensive indicators cannot be entirely extrapolated to the estimate of total economic activity.

Most intensive indicators have decreased, as Figure 27 demonstrates. Income per capita, total income per capita, TPES per capita and domestic material consumption per capita have all decreased. In the same line, food supply has also decreased at a moderate pace, while CO_2 emissions per capita from fossils fuels have more than halved; reflecting the slow growth of fossil energy supply.

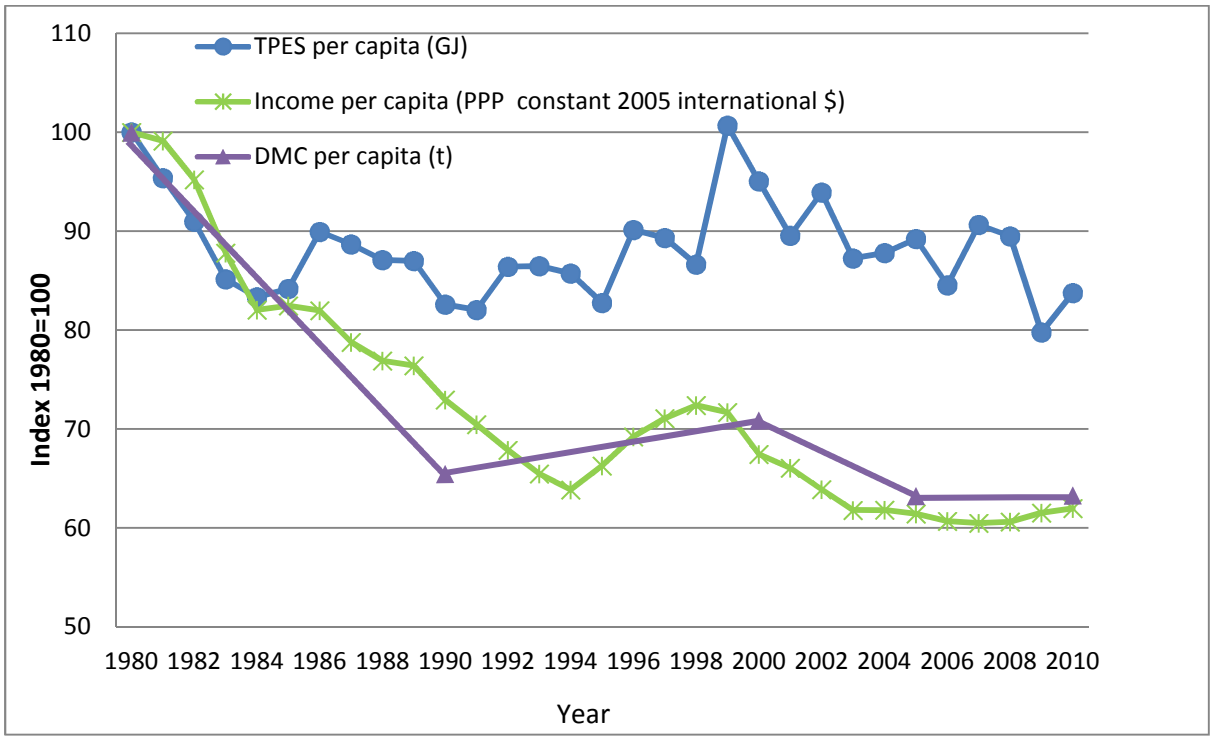

Figure 27. TPES per capita, DMC per capita and income per capita in Ivory Coast from 1980 to 2010, index to 1980. TPES per capita in 1980= 18 GJ. Income per capita in 1980=$2,695 PPP 2005 USD. DMC per capita in 1980=4.2 t.

The intensity of use hypothesis in energetic terms does not hold in the country. Income and TPES per capita are not coupled in the long run. Income elasticity of energy supply per capita in Ivory Coast is almost completely inelastic. These results do not coincide with the findings of Ferguson et al. (2000) for the period 1971-1995, as evidenced in Figure 28A. By studying this relation prior, and during the conflict, as well as during the aftermath, both indicators were not coupled prior to the conflict years, as TPES per capita highly fluctuated. However, during the conflict years and the aftermath, both indicators coupled. During the conflict, the share of biomass in energy supply per capita increased, while fossil fuel consumption decreased. Similarly to the previous case study, when the share of biomass was high in the energy mix,

income and energy supply per capita were coupled. As income decreased, biomass use at the residential level increased from 91% to 93% of TFC (IEA, 2015b). Its increased consumption can be related with the fact that biomass is cheaper and easier to collect for locals as advance techniques are not required for its harvest (Hall et al., 2013). This is an example that follows the relation stated by the energy ladder model backwards (Heltberg, 2004).

Energy supply per capita follows a similar path to income up to the year 1984. After 1984, energy supply per capita mostly ranged below 1980's levels. Thus, Ivoirians have seen their energetic standards decrease during the three decades under study. This fact reflects the difficulties of providing such a fast growing population with even sustained quantities of energy in a country where population already consumed low levels of energy -even compared with least developed economies (UNCTAD, 2012).

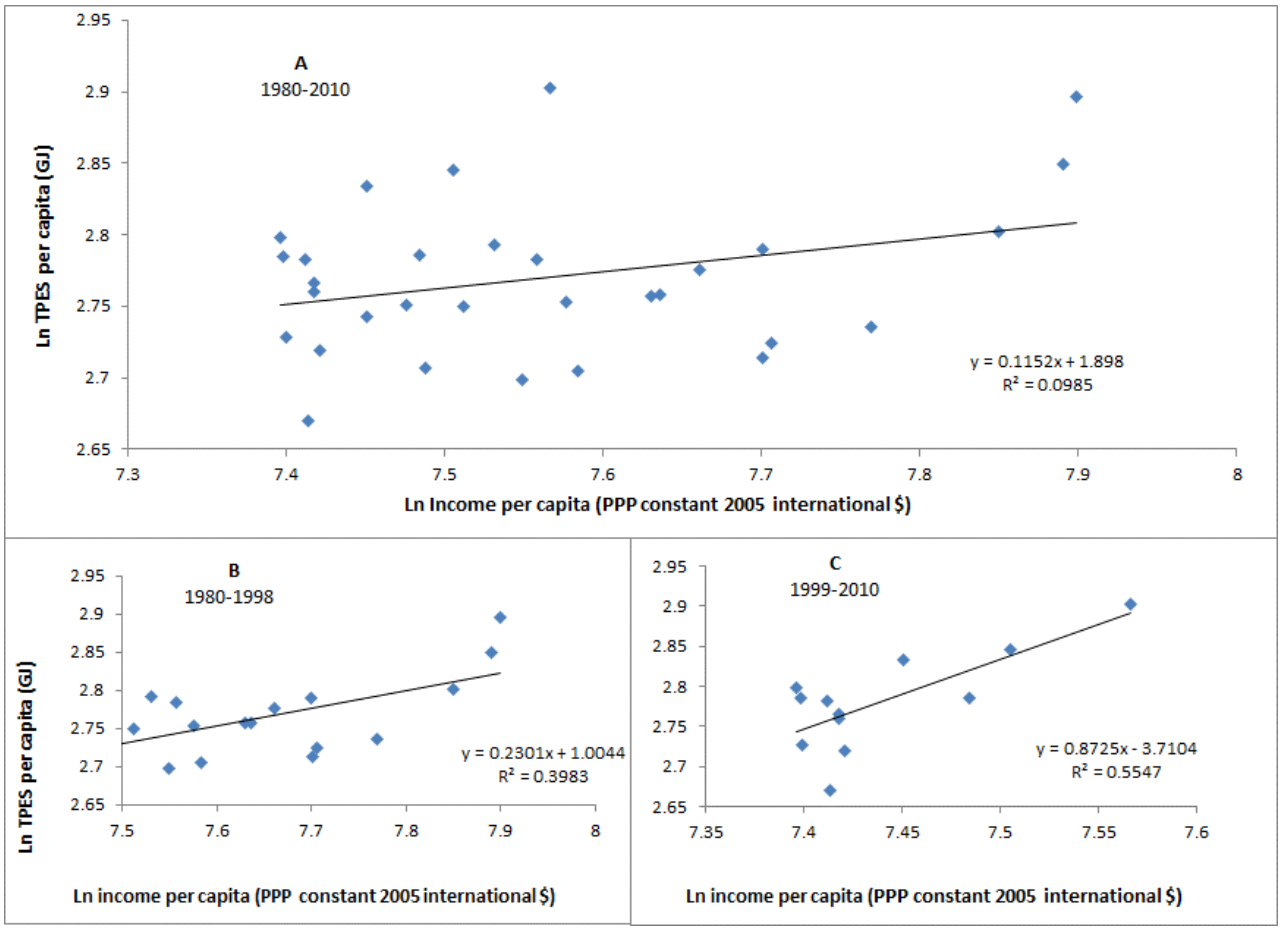

Figure 28. Linear regression of the logarithm of income per capita and TPES per capita in Ivory Coast from 1980 to 2010 (A). (B) From 1980 to 1998. (C) From 1999 to 2010.

The intensity of use hypothesis in material terms holds in the country. As it can be seen in Figure 29, DMC per capita and income per capita strongly correlate; it is in fact the strongest

correlation that income has with any intensive indicator. Focusing on the three material groups for which there is data for the whole period, income only is significantly coupled with construction minerals *b*=2.48. Income is moderately coupled with fossil fuels *b*=0.5 and is not coupled with biomass consumption per capita *b*=-0.09. These three components of DMC per capita have decreased at different rates than income. For instance, construction minerals per capita decreased at a much faster pace than income per capita, given the non-vital need of construction minerals consumption. To the contrary, biomass consumption, which is used as source of food and energy, did barely decrease despite lower income, corroborated by the lack of coupling between income and food supply.

Urbanization has not relied on consumption of construction minerals. In a country in which urban population has increased, almost equalling the global trend (51.6% of the population living in urban areas), it is somehow surprising. The reasons why the urbanization process has not been followed by building infrastructure, which relies on construction minerals, can indicate that data on construction mineral use is incomplete, or that increased urban population is not relying on increased infrastructure. However, comparing the metabolism of Ghana and Ivory Coast with the global trend might highlight the reasons behind construction mineral decline.

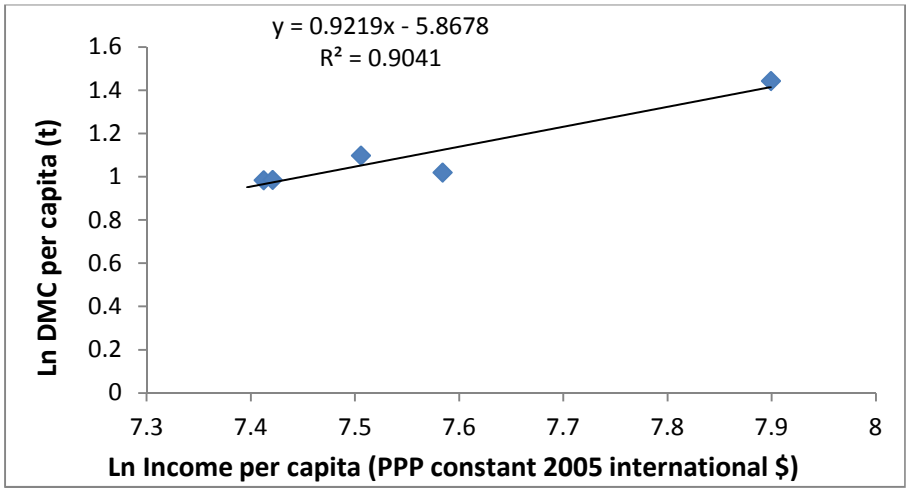

Figure 29.Linear regression of the logarithm of income per capita and DMC per capita in Ivory Coast for the years 1980,1990,2000,2005 and 2010.

The lack of progress in economic and physical living standards has counterparts in the lack of progress in human development and health. As depicted in Figure 30, life expectancy has decreased by slightly over one year through the study period. However, life expectancy dynamics are not coupled with any biophysical indicator. These results highlight that other

occurrences have affected Ivoirians life expectancy, such as conflicts or illnesses; hence these will be explored in the next section. Life expectancy has decreased in Ivory Coast while the global average life expectancy has been increasing. Life expectancy moderately grew from 1980 to 1988, but from 1989 to 2002 life expectancy decreased. There are wide array of factors that need to be explored in order to understand why Ivory Coast has been unable to increase, or even maintain, life expectancy, contrary to the global trend.

In contrast, infant mortality has moderately improved. In the global context, Ivory Coast is falling far behind the world as whole, infant mortality has moderately decreased compared to the global average decrease (World Bank, 2015). This makes it important to understand the reasons behind Ivory Coast's decreased prosperity. However, the dynamics of infant mortality do not relate with the dynamics followed by other intensive indicators. Infant mortality has almost steadily declined despite the declining biophysical standards. Different factors that do not affect the country's metabolism, such as increased access to medical treatment, decreased HIV prevalence among young women, increased percentage of births attended by skilled health staff and increased infant immunization (World Bank, 2015) have played a role in decreasing infant mortality. Therefore, metabolic changes in the country cannot be used to understand the dynamics behind infant mortality.

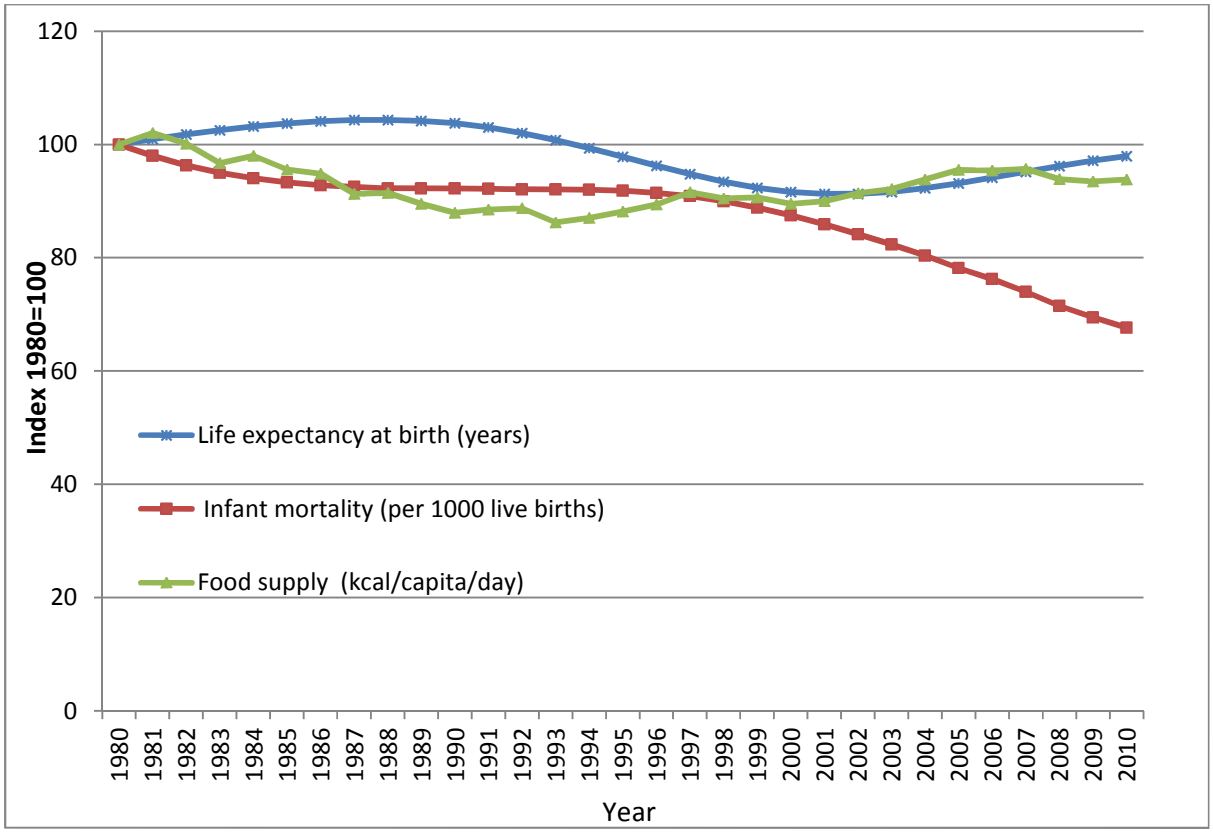

Figure 30.Life expectancy, food supply and infant mortality in Ivory Coast from 1980 to 2010, index to 1980. Life expectancy in 1980=50.7 years. Infant mortality in 1980=113.7 per 1000 live births. Food supply in 1980=2,918 Kcal/capita/day

Food supply has moderately declined throughout the study period, reaching the lowest point in 1993. Yet, food supply per capita has been above the average Sub-Saharan African average food supply and near the world average levels during the period of study. As income declined, there has been a switch in dietary patterns. Protein and fat intake decreased, driven by a decreased in animal product consumption. However, protein intake remained in the safe levels of daily protein intake for adults under 70 kg (FAO et al., 1985). Pulses, roots and cereals consumption were barely affected. Hence, the share of vegetal product consumption in overall food intake has increased. These results are in line with findings Erb et al. (2009), in which by a cross-country comparison, the study finds that countries with lower income per capita consume greater amounts of cereals, pulses and roots as share of the total diet, and the share decreases with increased income. Declining life expectancy happened through the period where food intake reached its minimum, but did not immediately increase when food supply increased; therefore, both indicators are not related.

Based on the presented analysis there are a number of questions that remain. Presented relations between indicators show that in the Ivorian case, there is not a deterministic relation between

socio-economic indicators and biophysical inputs to the economy as the intensity of use hypothesis would suggest (Steger and Bleischwitz, 2011). As it occurred in the Ghanaian case study, the relations presented in this chapter are not time invariant (Ang and Liu, 2006), which has important implications for forecasting in Ivory Coast. Selected indicators are of social nature, therefore a wide range of factors affect their dynamics (Trochim and Donnelly, 2008). Thus, including secondary qualitative data and utilizing pattern matching (Trochim, 1985, 1989) would increase the explanatory potential of the evolution of selected indicators in Ivory Coast.

The analysis shown provides insights of the development trajectory followed by Ivory Coast and the role of different material and energetic inputs. Moreover, obtained results can disregard the validity of the intensity of use hypothesis in energetic terms for Ivory Coast, but not on material terms. To further comprehend the implications of these results, a more detailed national and international context is needed.

6.2. How does qualitative data inform about the evolution of the development path taken by Ivory Coast

Following the pattern matching framework, historical events will be related with previously analysed data. By combining historical events from secondary data sources, this section will increase the overall understanding of previous results. This section will be divided into two different subsections based on the nature of the indicators explored. This is in contrast to section 4.2, which was divided based on specific indicators, as a greater number of questions remain unanswered after section 6.1 than after section 4.1. The first subsection will focus on the events that have shaped the economic indicators in the country. The second subsection will analyse some of the factors that have influenced the path followed by well-being indicators, life expectancy and infant mortality.

6.2.1. Economic indicators

Economic indicators in Ivory Coast have not followed a stable path, as it could be seen in Table 11. One of the implications of the instability of economic indicators was that the results obtained for GDP could not be extrapolated to the estimate of total economy. By exploring the growth model followed by Ivory Coast, we can explore the path followed by GDP and the estimate of informal economy, therefore, the path of the overall economy.

There are to two differentiated periods on the trend of total economy. During the first period, from the year 2000 to 2003, official GDP experienced four years of continuous decline, averaging 1.7% per year. During those four years, informal transactions increased on average 0.9% per year, but the aggregate of informal economy plus official GDP experienced an overall yearly decline of 0.9%. During the second period, between 2004 and 2007, the estimate of total economy grew on average 1.5%.

To understand the fluctuations experienced by the informal economy, the decline faced by GDP between the year 2000 and 2003, the historical events throughout those years have been researched utilizing the triangulation design method (Onwuegbuzie and Leech, 2005; Saunders et al., 2009). Ivory Coast has suffered a number of conflicts through the second half of the study period. In 1999, Ivory Coast suffered a military coup due to popular discontent. The coup was fuelled by a number of factors such as increasing poverty and rising income disparity between the rich and the poor (Bédia and Souleymane, 2011; McGovern, 2011). Despite the coup being welcomed by Ivoirians (Bowden, 2007), the decline of the Ivorian economy began with this coup (McGovern, 2011). After the coup, a declining economy, popular discontent and failed elections contributed to an inter-ethnic and religious civil war. Rebel groups were formed in Northern Ivory Coast gaining control of the northern territories. These events displaced over 850,000 people in Ivory Coast: 250,000 migrated and 600,000 were displaced internally (Bowden, 2007; McGovern, 2011). As discussed by Le Billon (2001), population in conflict areas tend to regroup in the safest areas, resulting in a reconfiguration of economic activities which shifts formal activities to informal activities.

In 2004, despite the stabilization efforts by the ECOWAS, the UN and France, the country was still suffering internal tensions, but with increased exports of the country's largest commodity exports in economic terms (UNIMTS, 2014); official GDP, which had dropped 1.6% from 2002 to 2003, increased 1.8% in 2004 during the internal crisis situation. This shifted the negative trend followed by GDP and thus the estimate of total economy grew, changing the pattern followed from 1999 to 2003 and explaining the high fluctuation of this indicator.

6.2.1.1. Agricultural led growth

The Ivorian Government encouraged agricultural expansion to increase agricultural production, especially cocoa. To boost cocoa production, the Ivorian government implemented policies to encourage migrants to exploit forests to increase overall cocoa production (Woods, 2003). These policies led to short-term cocoa production and yields increase but caused major

deforestation. Planting cocoa on cleared forests had lower associated cost for farmers than planting cocoa on grasslands. Furthermore, higher rents could be obtained by intercropping food crops in cocoa plantations (Angelsen and Kaimowitz, 2001; Woods, 2004). These practices account for increased agricultural production without increased energy use in the agricultural sector. Moreover, these policies, directed towards cash crop production, provide the context behind the increased importance of the agricultural sector in overall GDP, as well as declining food supply.

Agricultural expansion towards cleared forest, contradicted forest conservation policy objectives defined in the late 70's and early 80's. These policies were meant to protect Ivorian forests (Ehui and Hertel, 1989). However, from the 16 million hectares of forest cover in Ivory Coast in 1960, forest cover decreased to less than 3 million hectares in 2010 (Hansen, 2013; EU-REDD, 2016), which casts doubts on GHG emission data –due to the importance of land use change and forestry in GHG emissions.

Labour in the agricultural sector is mainly composed by migrant workers and the poor, including labourers in rebel controlled areas during the conflicts. Labour in the agricultural sector is highly informal (Herrera et al., 2012), an estimated 19% to 25% of total population in 2006 worked on cocoa plantations, including forced child labour (Schrage and Ewing, 2005; Globalwitness, 2007; Hawksley, 2011; OBG, 2013; FAOSTAT, 2015a). Henceforth, the effects of increased agricultural plantations can be directly linked with informal work and with the informal economy. With increased population, increased deforestation rates, decreased income levels and policies encouraging forest use for cash crop plantation (Jedwab, 2011), it is clear that demography and politics have played a role shaping a metabolism heavily reliant on biomass.

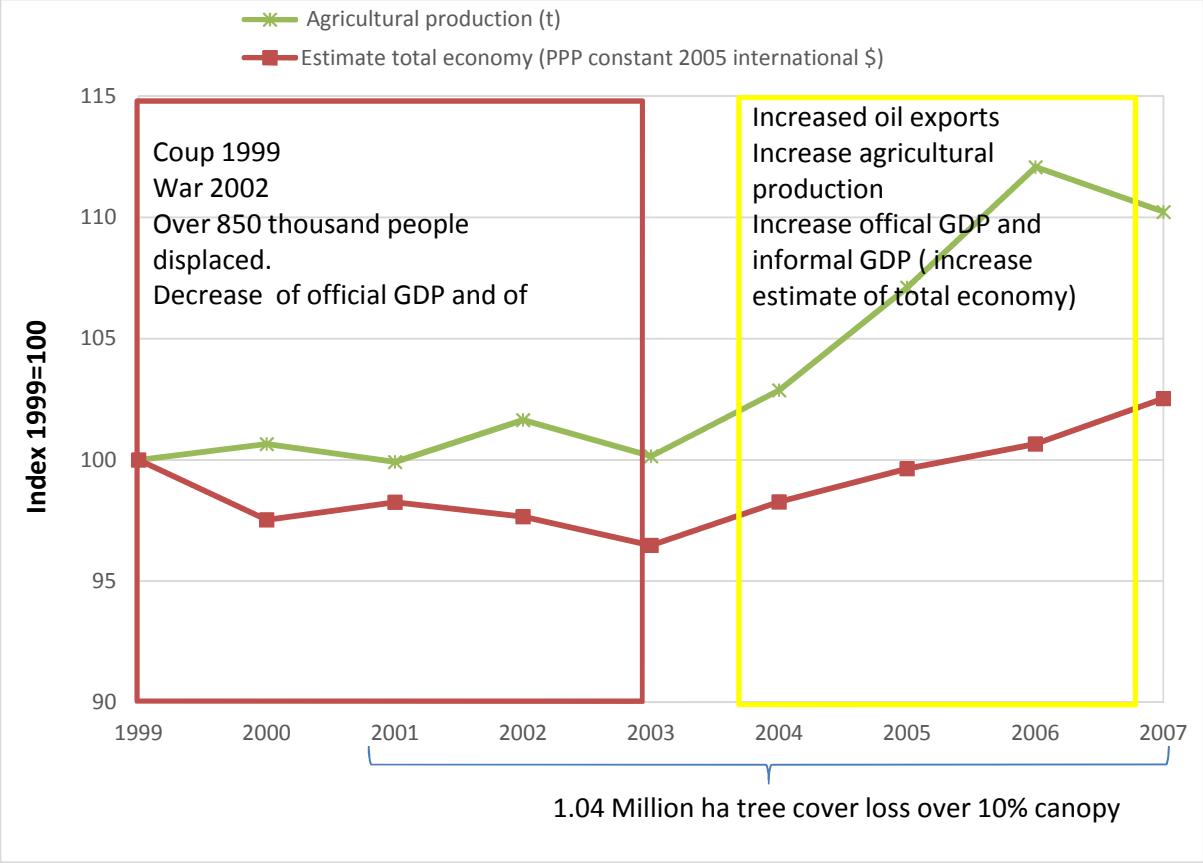

Figure 31. Agricultural production and estimate of total economy in Ivory Coast from 1999 to 2007, index to 1999. Agricultural production in 1999=11.7 Mt. Estimate of total economy 1999=$44 billion 2005 USD.

6.2.1.2. Income per capita

Income per capita has experienced an almost constant decline in Ivory Coast. With the exemption of four consecutive years, economic growth has not been able to keep up with population growth. Ivory Coast's income per capita constantly fell through a period where agricultural prices almost constantly declined. In a country where most of the population was employed in the non-mechanized agricultural sector, it meant that production had to increase driven by increased labour. However, the lack of innovation could only permit to increase production by deforesting forested areas, limiting increases in production. Moreover, during the 80's, the Ivorian government halved state guaranteed prices paid to cocoa farmers (McGovern, 2011).

In 1994, the Ivorian government entered the SAPs. The government implemented a number of adjustments in exchange for loans, which boosted economic growth. Furthermore, following a devaluation of the CFA franc by 50% (Bédia and Souleymane, 2011; McGovern, 2011), cocoa exports boosted. These factors ended the decline of income per capita. Income per capita grew

from 1995 to 1998 with an average yearly growth of 3.2%. Yet, in 1999, income commenced a period of almost steady decline lasting up to 2007. This second period of decline commenced the same year in which the military coup divided the country (Bowden, 2007). In 2008 the disarming process of rebel forces began; rebel forces and the government started working towards a common goal (McGovern, 2011), initiating a period of increasing internal stability. Hence, from 2008, GDP growth accelerated and income decline ended.

This subsection provides an example of the importance that the historical context has played in shaping Ivory Coast's economic development. The internal situation has had almost immediate counterparts in the economy of the country. Mentioned events exemplify the relevance of studying the socio-political context in order to understand the path of certain indicators, and the reasons why the Ivorian economy has been performing poorly.

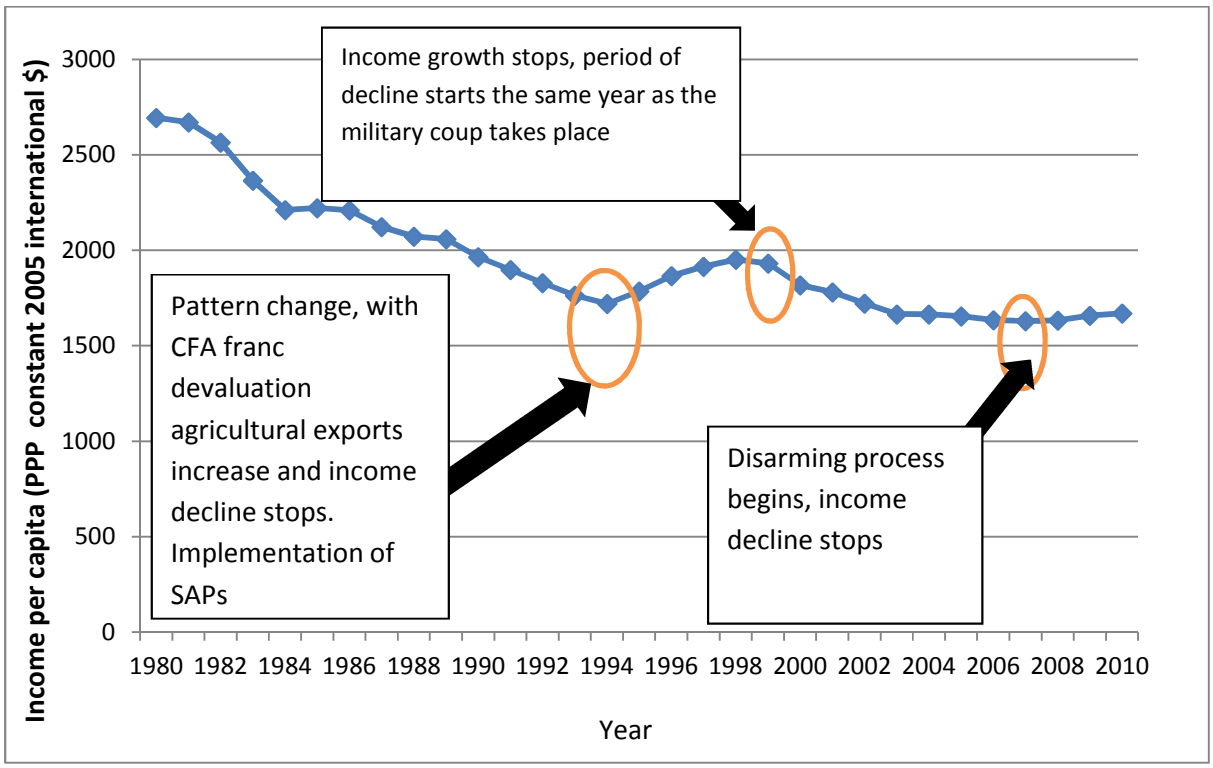

Figure 32. Income per capita in Ivory Coast from 1980 to 2010.

6.2.2. Life expectancy and infant mortality

Well-being indicators could not be matched with any indicator described in section 6.1. It is hard to pin point the specifics behind the dynamics followed by these indicators. For instance, an indicator such as life expectancy is influenced not only by present events, but also by a combination of long-term effects on health (Smil, 2008). Researching possible reasons behind

the dynamics of life expectancy, it is interesting that life expectancy is significantly coupled with number of undernourished people in the country (*b*=-3.2), which grew from 1990 to 2003 (FAOSTAT, 2015d). Moreover, life expectancy commenced its decline in 1989, year in which Ivory Coast became involved with the IMF and commenced the period of structural adjustments to obtain loans (ILRF, 2004).

Combining the complementary and development research designs, I can explore certain causes that could have led to reduced life expectancy by examining non-overlapping phenomena in a sequential matter.

In 1989, Ivory Coast started a period of adjustment reforms in order to obtain loans from international lenders. These adjustments liberalized the coffee and cocoa sector, reduced government expenditures (including healthcare and education), and devaluated the CFA franc. The effects of these adjustments were: increased poverty, decreased in the quality of healthcare and education, increased healthcare private cost, increased agricultural exports and decreased imports of necessary goods (ILRF, 2004; Bédia and Souleymane, 2011; McGovern, 2011). Moreover, HIV prevalence among population in between 15-49 years of age increased from 2.9% in 1990 to 5.5% in the year 2000 (UNAIDS, 2014; World Bank, 2015) to then decrease. Thus, a country that was viewed as a healthy economy with strong economic growth through the 70's and 80's (Bowden, 2007; World Bank, 2012c), implemented a number of policies that not only were unable to decrease malnutrition, but increased it. These events would have influenced increased malnutrition levels and impacted life expectancy, as well as living standards.

In 2002, the civil war commenced, but the number of casualties did only slightly increase from the previous year (World Bank, 2015). However, the conflict displaced population. During the conflict, population growth rates decreased to an average growth rate just under 2% per year between 2001 and 2010 (UNDESA, 2015). Hence, during those conflict years population growth slowed, food supply increased and thus undernourishment decreased -which is surprising due to the conflict context. Henceforth, better nourishment levels, despite the conflict related context, provide circumstances that explain the dynamics behind life expectancy during the last decade under study. Between 2007 and 2010 undernourishment figures increased to the same levels as those in 2001-2003, 2.8 million people, due to increased global food prices -almost 50% in one year, which increased undernourishment in Sub-Saharan Africa (SOFI, 2008), including Ivory Coast (FAOSTAT, 2015d). Increased global prices only

reflect on a small decline in food supply, depicted in Figure 30, which could be due to increased income through the last years of the study period or a statistical artefact. However, life expectancy did not decline, which exemplifies that there are a wide range of issues that affected life expectancy in Ivory Coast.

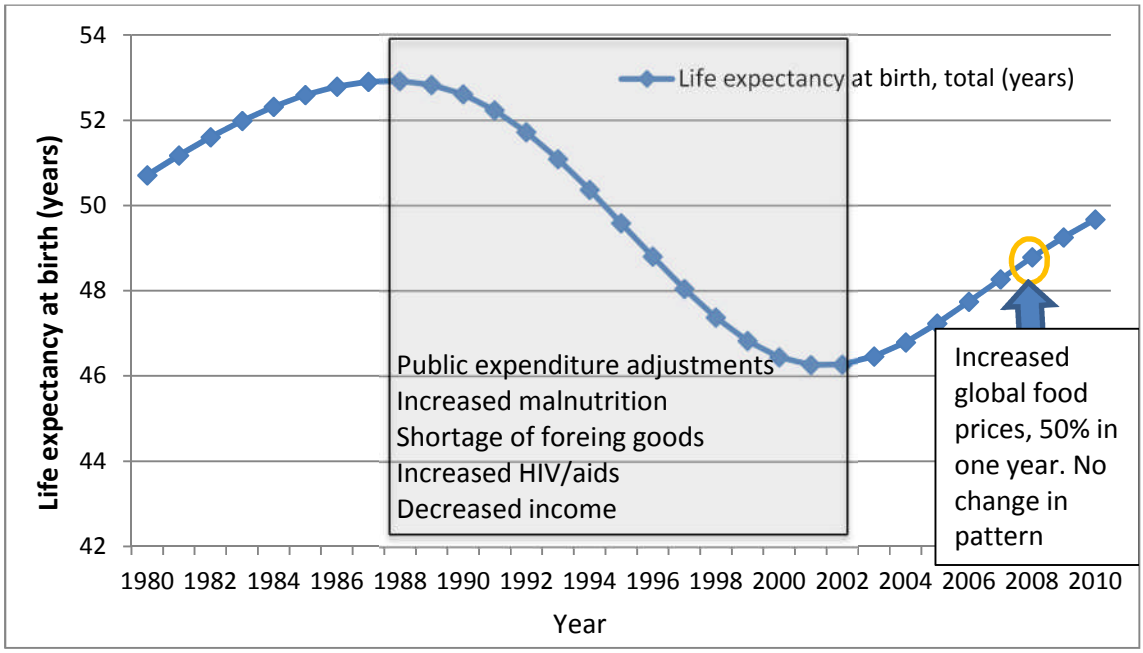

Figure 33. Life expectancy in Ivory Coast from 1980 to 2010.

Infant mortality decreased through the whole period, but at different rates. Infant mortality rate decreased from 2% inter-annual reduction in 1981, to stagnation in 1989, 1990 and 1993. Therefore, inexpensive measures such as maternal nutritional support, immunization against childhood infectious diseases and having skilled attendants at birth – which could prevent great number of childhood deaths (Andrews et al., 2008), seem to have become affected by the adjustments. However, from 1999, infant mortality decreased at yearly rates between 1.3% and 3.3% per year. Coinciding with the years where population growth was lower -the number of births rates and children per woman declined, thus facilitating the number of births that could be attended by skilled staff (World Bank, 2015). Thus, despite decreased income and increased undernourishment, infant mortality almost constantly declined through the study period.

6.3. Conclusions

Having analysed the societal metabolism and socio-political history of Ivory Coast has provided an understanding behind the past dynamics followed by the country, enhancing our knowledge behind Ivory Coast's development. The approach taken to investigate the country's

metabolism and relations between indicators has explained to a greater detail Ivorian past dynamics by providing context to the period under examination. Solely looking at numerical data would have proved unsuccessful towards understanding the whole development path followed by the country, as a wide array of events have shaped a very unstable development path.

Certain questions remain unanswered. Data quality issues might affect the results of this chapter, such as construction mineral consumption. Nevertheless, it is clear that utilizing a method that combines quantitative and qualitative techniques provides a useful tool to study the societal metabolism in countries where data quality and availability issues discourage this kind of research. Furthermore, despite not providing an answer to how can Ivory Coast develop, this research reinforces the idea that there is not a single recipe to achieve development, nor are the paths and the relations between biophysical inputs and socio-economic development time invariant. For instance, Ivory Coast has followed an energy and material intensive development that does not resemble the path followed by Ghana, which has not been energy intensive. Moreover, Ivoirians have experienced a decline in their living standards, not solely manifested through declining biophysical consumption, but by a change in the composition of Ivorian consumption. Through the development process, biomass consumption loses importance in biophysical consumption, yet, in the Ivorian case, Ivoirians have increased their consumption of biomass, which represents a step back in development. Therefore, an overall view of the Ivorian and global context is needed to better understand the lack of progress faced by Ivory Coast. This might provide a clearer view of the failures of the Ivorian model, and perhaps enable policy recommendations to ameliorate the country's path.

It becomes clear that politics and conflicts have had direct impacts in the country's past and present state in a way that societal metabolism alone cannot account for. This could be due to low biophysical consumption levels of the Ivorian economy. Hence, this chapter confirms the validity of the selected approach towards the study of societal metabolism in the context of developing West African countries.

Chapter 7 and 8 will provide not only benchmarks that can be used to assess the overall trends found for Ivory Coast, but also provide a global context to further comprehend the dynamics followed by the Ivorian economy. Moreover, analysing how the dynamics of Ivory Coast compared to the Ghanaian dynamics can be used to comprehend if small differences in biophysical consumption can be directly linked with different socio-economic development

levels, or if policies and the overall context play a major role in shaping the differences that exist between both nations.

7. Investigating the resource curse in Ivory Coast

Ivory Coast is a resource rich country, which has a diversified composition of agricultural and mineral exports. The country extracts and exports oil, gold, diamonds, bananas, cotton, rubber, coffee and cocoa among others, which are volatile commodities (Bogetic et al., 2007; O.B., 2011; USGS, 2012; FAOSTAT, 2015a). Similarly to the Ghanaian case study, manufactured goods would not be studied, with the exception of semi-processed cocoa and petroleum products, which account for an important share of Ivorian exports.

Some interesting results emerge in this chapter. The Ivorian approach towards agricultural expansion deforested large shares of the country, which had an overall positive effect on agricultural yields, but imposed limits to further agricultural expansion. Reliance on oil revenues in the primary and secondary sectors has economically benefited both sectors due to increased oil prices. However, by combining mass quantities with economic data the lack of industrialization in productive terms becomes clear. Moreover, diminishing farmers standards can be examined by combining economic, mass quantity and qualitative data, which present a different picture to the one presented solely by the economic data from the sector.

This chapter will be divided into two sections. In the first section, a selection of the most relevant resources in the country will be made and their past dynamics will be investigated. These resources will be analysed in combination with socio-political and economic development context, as well as with indicators that could be affected by the resource curse. In the second section, obtained results will be researched in a context related with hypothesis informed by development theories, providing the conclusions of this chapter.

7.1. Past trends of resource curse related resources in Ivory Coast and their relation with socio-economic and political indicators

This section will explore if the main resource curse channels have affected Ivory Coast. By exploring raw resource management frameworks in Ivory Coast, and how these relate raw resources with the Ivorian economy, this section aims to answer research question number three for the Ivorian case study.

7.1.1. Resource selection and data issues

In Ivory Coast there are a number of economically important agricultural products. Therefore, as explained in section 3.3, only crops that represent at least 5% of total agricultural exports earnings through at least five years during the study period will be selected. In this case study those resources are cocoa, coffee, rubber and cotton lint. Selected agricultural crops represent a combined share of 76% to 90% of total agricultural exports value. The combined sum of remaining agricultural crops provided the country with significant revenues, between $280 and $713 million 2005 USD. Thus, the total sum of all agricultural products exports will also be examined to explore if the sector as a whole shows a different relation with the selected socio-political indicators compared to the individual main resources. In Ivory Coast, the diversity of economically important crops has shaped an agricultural sector dominated by cocoa, but where other resources have played important roles in terms of labour shift from one crop to another or different policies for each crop. Hence, the overall dynamics of the agricultural sector might differ from the individual evolution of each of the selected crops.

Similarly, Ivory Coast exports a number of mineral products, but there is a main mineral export, crude oil and its derivatives. Other exported mineral resources such as gold and diamonds, monetarily account for less than some of the excluded agricultural crops, hence, as a result, these are excluded from this study. Data on extracted and exported oil quantities have been obtained from the IEA (2015b) in TJ and converted into tonnes utilizing IEA (2014b) conversion factors. Crude oil exports and petroleum products traded values are obtained from UNIMTS (2014), where data is available from 1981 to 1983, 1985 and 1995 to 2010.

7.1.2. Resource curse related socio-political and economic indicators

Selected socio-economic and political indicators in Ivory Coast show a picture of a country in decline. Education expenditure as share of GNI has declined, the importance of the service sector has declined and so have all the governmental quality indicators.

Table 13. Socio–economic and political indicators considered to be affected by the resource curse in Ivory Coast with their average annual percentage growth rates and standard deviations.

Indicator	Unit	1980	2010	Average annual percentage growth rate± standard deviation
Education expenditure	%GNI	6	4.3	-0.7±8.8
Added value primary sector	%GDP	21.6%	27%	1.16±9.7
Added value secondary sector	%GDP	11.3%	17.1%	1.94±11.2
Added value tertiary sector	%GDP	68.7%	58%	-0.32±7.2
Government Effectiveness	-2.5 to 2.5	-0.06*	-1.26	-4.4±12.4[1]
Rule of Law	-2.5 to 2.5	-0.82*	-1.24	1.2±6[1]
Regulatory Quality	-2.5 to 2.5	-0.48*	-0.91	-12±29.8[1]
Political Stability and Absence of Violence/Terrorism	-2.5 to 2.5	0.01*	-1.57	1.58±17.1[1]

***Value for 1996. 1. Average annual growth rate and standard deviation from 2002 to 2010.**

In order to understand the evolution of the different economic sectors, as well as declined education expenditure, an overview of the Ivoirian context through the study period is needed. Ivory Coast's recent history has been unstable. After obtaining independence in 1960, the country experienced a number of years with steady economic growth, with a government that aimed to diversify agricultural exports, raise education levels and create a successful light industrial sector that could process Ivorian raw resources. The main aim of the government was to reduce import dependency of certain processed goods and achieve sustained economic growth (Wallerstein, 1964; Amin, 1973; Den Tuinder, 1978). Policies directed towards export diversification and the establishment of light industries in the country shielded the country from the major economic effects of international recessions, oil crisis and droughts during the mid-1970's and mid-1980's (Den Tuinder, 1978; Appiah, 2005), therefore not experiencing resource curse channels mentioned by Deaton (1999) through those years.

The 'Ivorian miracle' (Den Tuinder, 1978; Guesnet et al., 2009) was based on the governmental understanding of the limitations behind an agrarian growth system, and the potential that the country had of attracting foreign labour and capital to achieve growth. These policies positively influenced Ivory Coast's productive system. Yet, as examined in the previous chapter, implemented policies attracted great numbers of foreign workers, caused major deforestation and did not create a self-sustaining light industrial sector. In the long run, the Ivorian model created tensions between foreigners and locals, which exploded after the coup. Therefore, the

Ivorian growth model and political stability that were praised during the country's first decades into independence, suffered some devastating effects during the war years. Mentioned circumstances make the Ivorian case study interesting to explore, as the literature on the resource curse acknowledges the importance that agriculture, and especially cocoa, has played during the conflict years (Woods, 2003, 2004; Globalwitness, 2007; Guesnet et al., 2009).

Structural adjustments explain the decline of education expenditure. Similarly to Ghana, Ivory Coast had to implement a number of structural adjustments, such as reducing budget spending, privatization of state controlled companies, liberalization of agriculture -which reduced tax earnings (Bédia and Souleymane, 2011), agricultural diversification and so on. Adjustments began in 1989, when Ivory Coast engaged with the IMF and the World Bank to obtain aid and loans, which led the country to enter, in 1994, the Enhanced Structural Adjustment Facility (ESAF) -which is a Structural Adjustment Programme.

Education expenditure increased up to 1992, to then decline. In 1992, education expenditure reached 7.7% of GNI, however, when the SAPs were put in place, education expenditure declined, remaining in between 3.5% and 5% of GNI. Therefore, decreased education expenditure relates directly with the adjustment programmes. As stated by Ross (2004), countries with taxation systems highly dependent on large resource exports tend to have lower education levels. However, in Ivory Coast decrease education expenditure did not occur until neoliberal policies were put in place. Therefore, it cannot be stated that it is a resource curse sign.

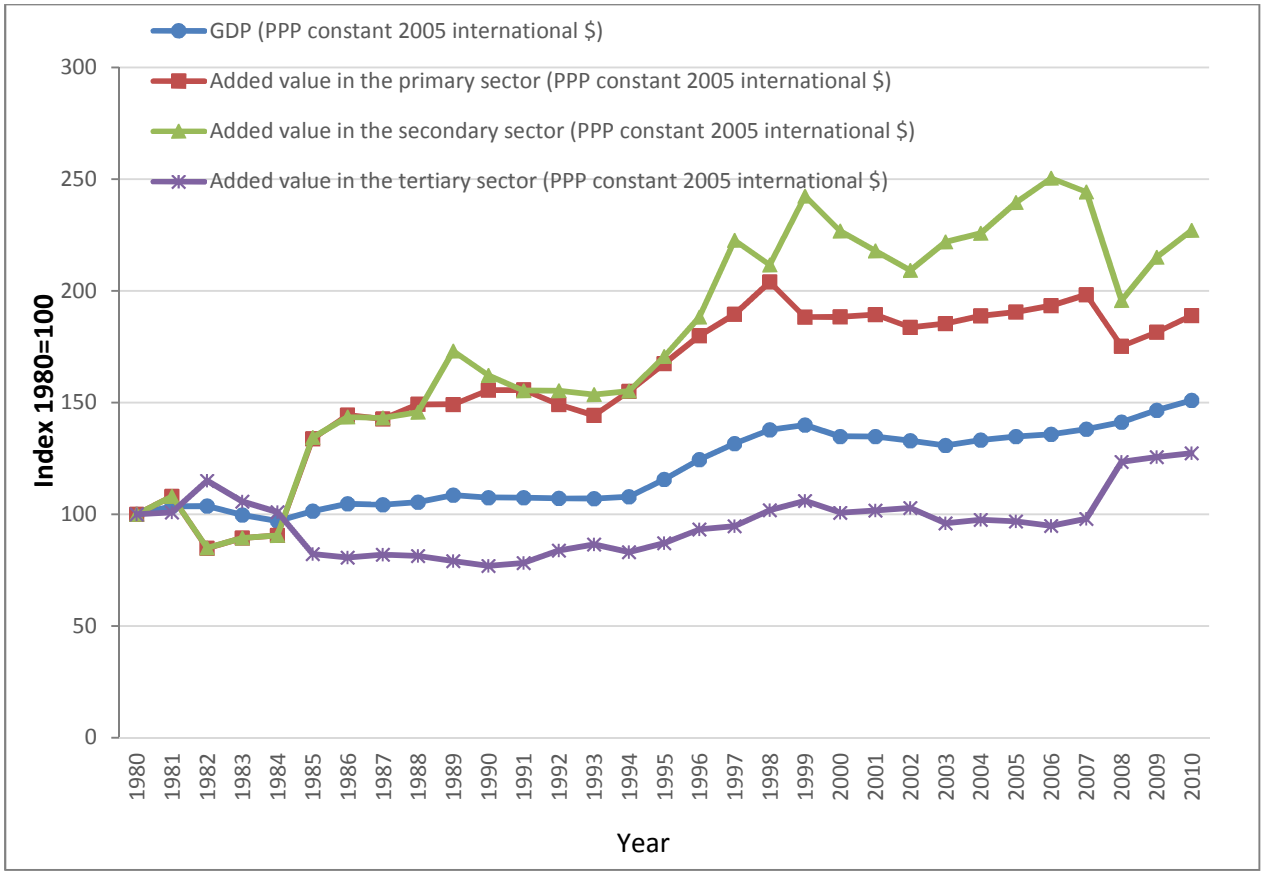

Figure 34. GDP and added value per economic sector in Ivory Coast from 1980 to 2010 index to 1980. GDP in 1980=22.3 billion PPP 2005 USD. Added value in the primary sector in 1980=4.8 billion 2005 USD PPP. Added value in the secondary sector in 1980=2.5 billion PPP 2005 USD. Added value in tertiary sector in 1980= 15 billion PPP 2005 USD.

Increased importance of the primary sector in the economy has been driven by increased petroleum exports. Agricultural exports values have been maintained through the study period due to a sharp increase in exported quantities. Increased oil extraction and increased oil prices have increased the importance of the primary sector in the economy (UNIMTS, 2014; FAOSTAT, 2015b, 2015e).

The secondary sector has increased its importance in the economy, which does not follow the resource curse hypothesized signs. The Ivorian government stated its commitment to increase food and raw resource processing in the country and to a certain extent it could appear to have succeeded (OECD/AfDB/ECA, 2010; OECD/AfDB/UNDP, 2014). Nevertheless, the conflicts in the country through the study period hampered the achievement of greater industrialization levels (OECD/AfDB, 2006). Contrary to cited sources, utilizing a metabolic approach, a different picture appears. Since 1995, year for which there is data for petroleum products exports economic value, the secondary sector has grown driven by international petroleum

prices, not increased refinement. Moreover, in 1995 added value of the secondary sector, without including petroleum products exports, was greater than in 2010, therefore, it could be said that the country has suffered a decline on its non-petroleum related industries. This could be regarded as a resource curse sign. Yet, examining the Ivorian context, it could be seen that the country had to end state led-industrialization, which had been financed with resource rents, in order to obtain international assistance. Consequently, it cannot be stated that low quality industrial investments are the sole cause of the industrial decline, as mentioned by Deaton (1999). As mentioned by Besada (2009), the foundations of the Ivoirian miracle were undermined with these adjustments.

The tertiary sector is the sector that contributes the most to GDP, despite experiencing a decline on its share in GDP and experiencing lower growth than the other two economic sectors (depicted in Figure 34). The Ivoirian service sector is mainly composed by financial and property services as well as a public administration services (INS, 2013). Therefore, declined incomes, and war damages, which forced the closure and relocation of companies (OECD/AfDB, 2006) such as the African Development Bank (Besada, 2009) -which was one of the biggest employers in the country, account for the decline of this sector.

All the selected political indicators have declined. This could be regarded as a resource curse sign; however, this decline goes beyond the curse. Ivory Coast has suffered turmoil in recent times. A coup, fail elections and a civil war took place in Ivory Coast during the study period. Moreover, the SAPs reduced governmental salaries, which increased corruption, and therefore opacity, of the state managed raw resource revenues, which is a clear sign of the resource curse. However, due to the context faced by the country, a more complete view of these indicators is needed.

The role played by the primary sector in the civil war in Ivory Coast will be examined in depth. A number of studies (Woods, 2003; Schrage and Ewing, 2005; Globalwitness, 2007; Hawksley, 2011; McGovern, 2011; OBG, 2013) have examined the role of cocoa, land regulation, child labour and slavery in Ivory Coast towards fuelling and financing the conflict in the country. A priori, this would indicate that despite mentioned catastrophes faced by the country, the decline of institutional quality is also related with resource curse channels. Consequently, this subject will be studied in depth when analysing the relation between selected resources, economic sectors and governmental quality indicators.

A preliminary analysis of the past dynamics followed by some of the selected indicators shows a country that has faced a context that increased the likelihood of suffering the resource curse. Therefore, by investigating the evolution of political and economic indicators in the context of selected resources, this study should shed light over the presence of the resource curse or if other occurrences have shaped the decline of the examined indicators.

7.1.3. Agricultural products

In order to increase our understanding behind the dynamics of resource curse related indicators, the main raw resources in Ivory Coast will be examined. Resource rent management and conflicts behind cocoa, coffee, rubber and cotton will be analysed in order to comprehend if resource curse channels have been related with these resources.

The results found in this section verify that there are signs of the resource curse in Ivory Coast that have had an effect on mentioned resources. However, examining in depth the four main crops is not as informative as it was previously expected. Resource curse channels that manifest in the country and relate with different agricultural resources stream from the same context and sources. Therefore, this analysis will be focused on cocoa. An analysis of the three remaining crops can be found in Appendix III.

7.1.3.1. Cocoa and its relation with selected resource curse indicators

Production and exports of the main agricultural product in the country have tripled. Cocoa exports have remained below production levels through most of the study period, following the pattern of cocoa surplus mentioned in ICCO (2010a). On the other hand, cocoa export revenues have not surpassed 162% of 1980 levels. Exported cocoa quantities peaked in 2004, while cocoa export revenues peaked in 2002.

Table 14.Production, exports and price of cocoa in Ivory Coast in 1980 and 2010 with their average annual percentage growth rates and standard deviations.

Resource	Unit	1980	2010	Average annual percentage growth rate ± standard deviation
Cocoa bean production	kt	417	1,301	4.7±13.9
Total cocoa products exports	kt	327	1,032	6±23.1
Total cocoa products exports	Price per tonne (constant 2005 US$)	4,402	1,859	-2±12.7
Total cocoa products exports	Million constant 2005 US $	1,367	1,881	1.9±13.9

Increased cocoa production deforested large areas of the country, reaching agricultural expansion limits (Woods, 2004; Jedwab, 2011; Hansen, 2013). Cocoa plantations, as well as agricultural plantations in general, have not widely benefited from innovations. Largely, increased production has been obtained by planting on previously forested areas. Past deforestation patterns have left the country without large shares of forest remaining that can be used for planting purposes. Nutrient rich deforested areas enabled Ivory Coast to have very high cocoa yields compared to other major cocoa producing countries (Kolavalli and Vigneri, 2011; FAOSTAT, 2014b). In order to maintain high yields and avoid the burst of the cocoa sector with aging trees, the low fertilization (FAOSTAT, 2014b) and mechanization levels in the country would need to increase. Semi-processed cocoa products had a minimum mark up of 35% over cocoa beans price, but composed a maximum of 23% of total cocoa export value -which represents the highest share for any West African cocoa exporter (Kolavalli and Vigneri, 2011; FAOSTAT, 2015b). Therefore, cocoa processing would need to increase in order to maintain export earnings without increasing cultivated area.

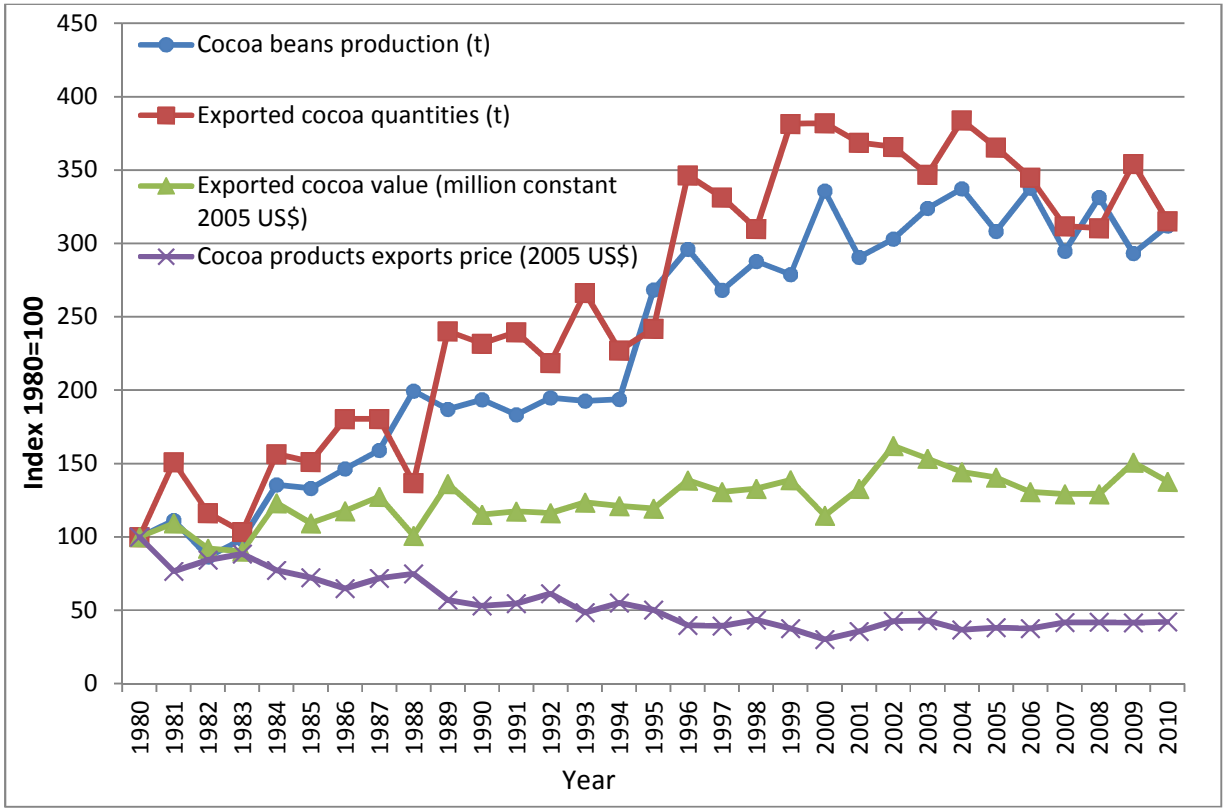

Figure 35. Cocoa production, exports quantity, export value and export price in Ivory Coast from 1980 to 2010, index to 1980. Cocoa production in 1980=417 kt. Exported cocoa quantities in 1980=327 kt. Exported cocoa value in 1980=$1.37 billion 2005 USD. Average cocoa products export price in 1980=$4,402 2005 USD per tonne.

Processing of cocoa has increased through the last years of the study period. This is a positive sign towards avoiding the resource curse, adding value prior to export of Ivoirian resources. However, as previously examined, once petroleum product prices are omitted, the Ivoirian industrial sector has not been growing through the study period. Increased processing might have been limited to cocoa products.

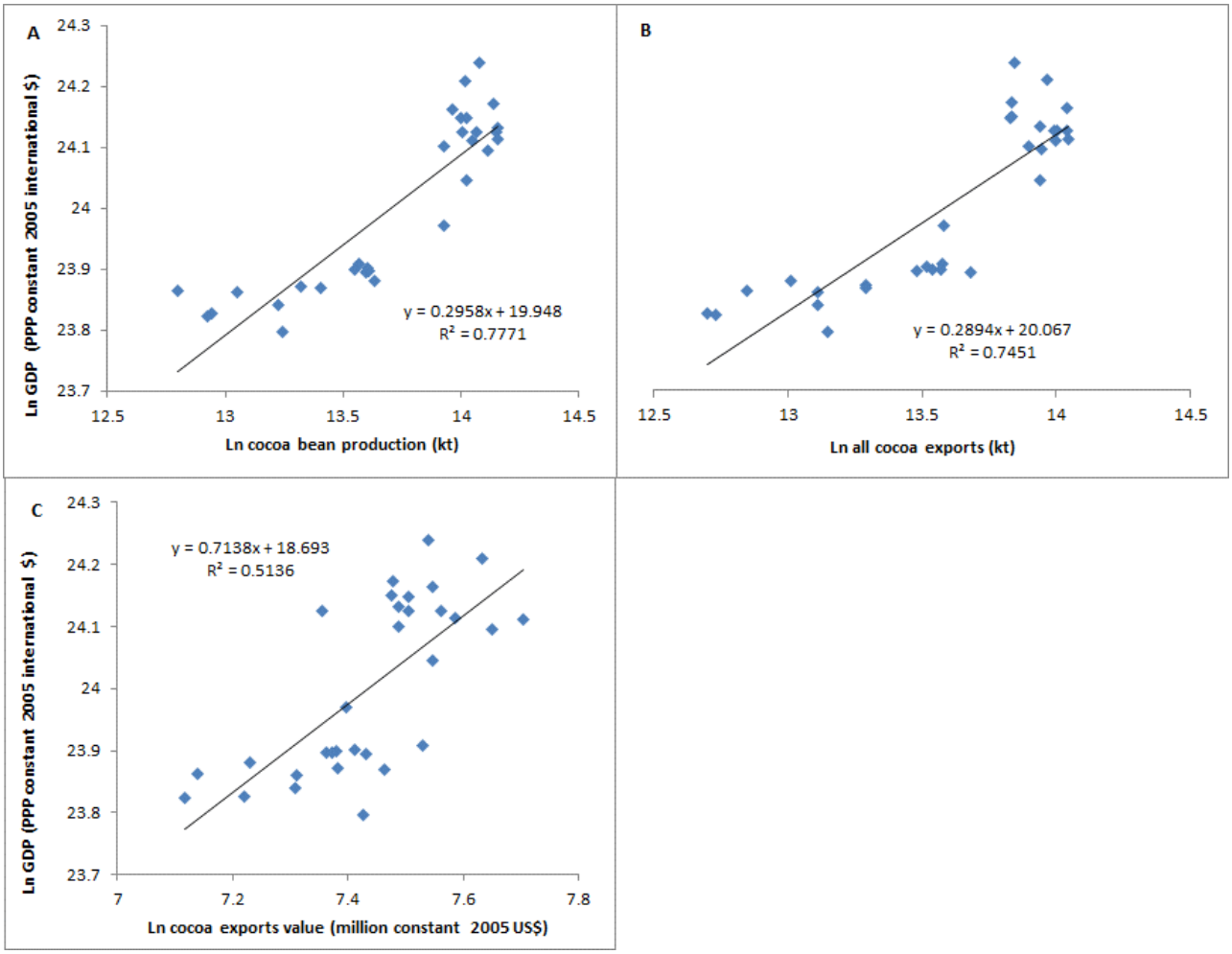

Figure 36. Simple linear regression of the logarithm of GDP with (A) cocoa production, (B) cocoa export quantities (C) and cocoa export value in Ivory Coast from 1980 to 2010.

Exported cocoa values have been moderately coupled with GDP, as Figure 36 shows. Both indicators have followed a positive path, it cannot be stated that GDP, or GDP growth, have declined driven by increased cocoa production and exports. However, cocoa exports value and the tertiary sector have not followed a similar path. As previously stated, Jedwab (2011) studied the impact of resource rents in service sector growth, stating that raw resource rents drove urban tertiary sector growth. Yet, the importance of financial services in the Ivorian tertiary sector would limit the impact that raw resource rents would have in the overall service economy. Interestingly, with decreased importance of financial services due to the conflict, a moderate

increase in cocoa prices from 2007 –as well as most agricultural products prices, was accompanied by an increase on income per capita and added value in the tertiary sector. Consequently, with decreased importance of the financial sector in the country, income and the service sector dynamics might have become connected. Hence, as other services have lost importance in the tertiary sector, non-tradable urban services might have gained importance in the service sector. Disaggregated data on the service sector subsectors cannot be obtained, yet, if the service sector has become more reliant on raw resource rent surplus, it would indicate that the Ivorian economy has become highly vulnerable to resource price volatility, therefore prone to suffering the resource curse.

Cocoa production and exports follow an inverse path to income per capita. Cocoa has played a major role in the country through the past decades, thus in depth exploration of the socio-political context and the influence of cocoa in the country has to be analysed to fully understand these relations.

Building upon the discussion of the cocoa sector in Ivory Coast in section 6.2, cocoa is the main agricultural product in a country where active population in agriculture represented 65% of total active population in 1980 and 38% in 2010. Although the overall share of labour has decreased, in economic terms the importance of the sector has increased. The reasons behind the inverse path followed by cocoa revenues and income per capita are due to the effects of cocoa sector liberalization under the SAPs, which affected farmers' income and declined cocoa prices.

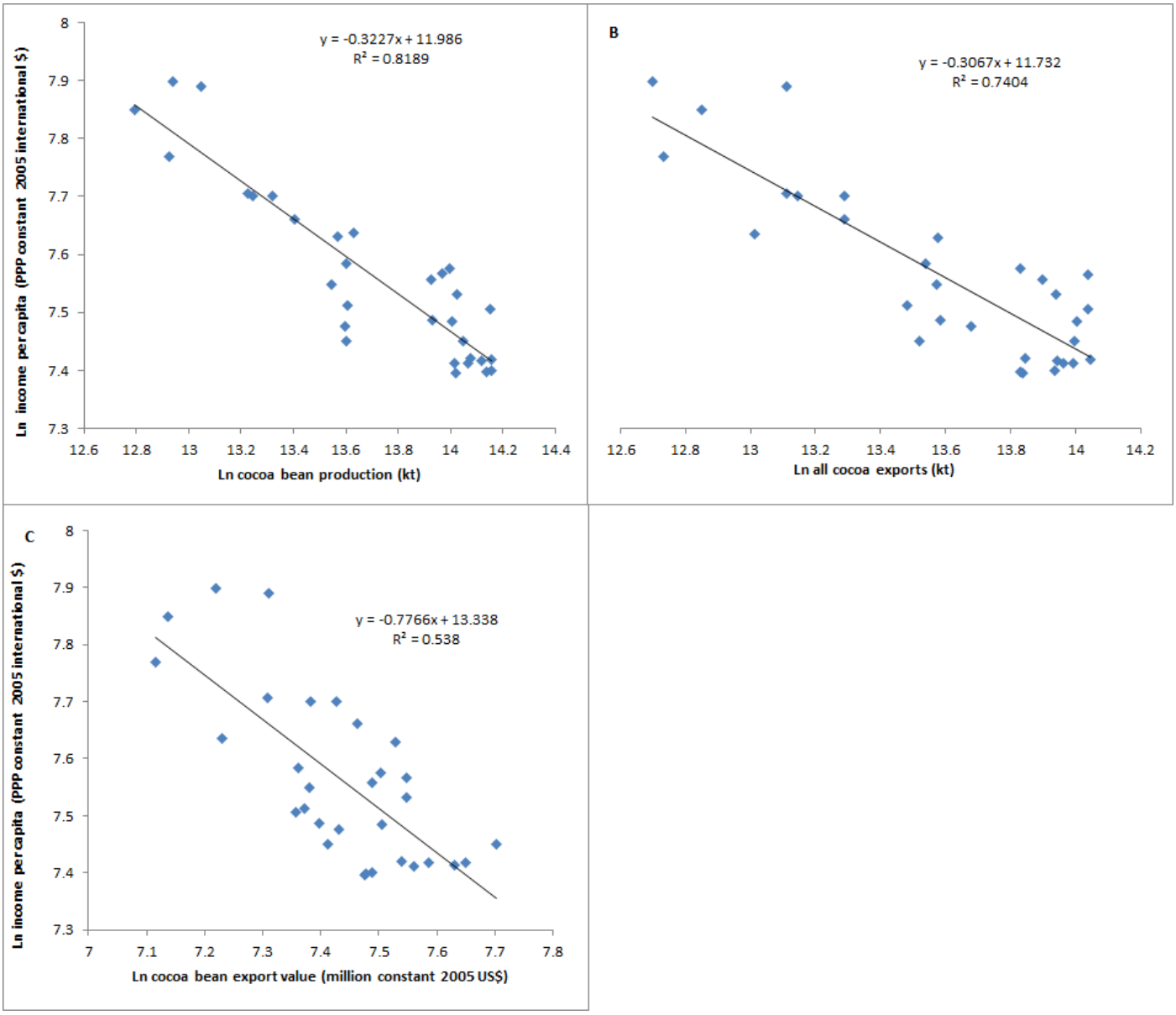

Figure 37. Simple linear regression of the logarithm of income per capita with (A) cocoa production, (B) exported quantities and (C) exported value in Ivory Coast from 1980 to 2010.

Cocoa management has influenced the decline of income per capita in Ivory Coast. Income per capita has almost steadily declined through the study period. Ivory Coast has been mostly an agricultural economy in terms of labour through the study period. During the 80's, continued decrease of cocoa prices led the Ivorian president to stockpile all the Ivorian cocoa in 1987, in order to increase cocoa prices. However, as new cocoa producers emerged, the move was unsuccessful, despite Ivory Coast producing almost a third of global cocoa. Consequently, guaranteed price paid to farmers were cut in half. A vast number of Ivoirians saw their income halved almost overnight (leading to protest that fuelled the climate prior to the conflict

(McGovern, 2011)). Moreover, cocoa liberalization under the SAPs further decreased farmer's salaries through the study period.

7.1.3.2. Cocoa management in Ivory Coast

The cocoa sector and its management have followed an intriguing path in the country. The Ivorian government developed policies that encouraged increased cocoa production by expanding production to forested areas. During the 1980's, the country faced the economic consequences of stagnant commodity prices, which continued during the 90's. Stagnation of agricultural prices incentivized the adoption of structural adjustments in exchange for loans (Woods, 2003; Conte, 2005; Fell, 2009; Gergely, 2010; Moseley et al., 2010; Amoro and Shen, 2012). This could be seen as a resource curse sign. A country highly specialised in raw resource exports could not achieve sustained economic growth, as the productive structure, highly sensitive to volatile international prices, faced declining terms of trade (Woods, 2004; Besada, 2009; Amoro and Shen, 2012). This had an impact over income, living standards and well-being of the citizens (Woods, 2003; Besada, 2009; World Bank, 2015).

The Ivorian government controlled agriculture in the country prior to the SAPs. Ivory Coast's Caisse de stabilisation et de soutien des prix des productions agricoles (CSSPPA) was the state controlled marketing board of Ivory Coast which controlled fixed price paid to farmers. Fixed prices paid to farmers used to increase above inflation up to the end of the 1980's, when an almost bankrupt CSSPPA was forced to reduce fixed price paid to farmers (Woods, 2003; McGovern, 2011).

Cocoa revenues were used to construct infrastructure and finance import substituting industrialization, but it was not enough to create a self-sustaining industrial sector in the country (Woods, 2004). The SAPs and the end of the cocoa boom reduced public investment, government salaries, and state-led industrialization (Besada, 2009; Bédia and Souleymane, 2011; McGovern, 2011). Moreover, the liberalization of the cocoa sector between 1995 and 1999 (OECD/AfDB, 2002) led to lower prices paid to cocoa farmers (Globalwitness, 2007) - which after the liberalization of the cocoa sector were estimated to be the lowest in the world (Kireyev, 2010). Consequently, it discouraged farmers to take care of their fields, reducing the quality of Ivorian cocoa and further reducing the price paid for Ivorian cocoa (Woods, 2004; Guesnet et al., 2009). Therefore, a sector that in economic terms seemed a healthy and growing sector can be seen as a sector in decline once the management framework is explored. Moreover, as cocoa production did not grow driven by increased production per farmer, but by

increasing the area under cultivation and the number of cocoa farmers, income per farmer decreased.

Mentioned adjustments decreased tax earnings from trade, which represented a large share of governmental revenues, leading to an increase of income tax and governmental budget cuts. The effects of these programmes, as previously mentioned, led to a decrease in education and health expenditure, decreased salaries and so on.

Consequently, the inverse relation that exists between cocoa and the selected socio-economic indicators cannot be solely attributed to the resource curse. The neoliberal policies introduced to achieve economic development were unsuccessful.

7.1.3.3. Cocoa and the Ivorian Conflict

Cocoa, as well as agriculture, played an important role prior and during the conflict. The literature on the resource curse, generally agrees that there is a relation between raw resource abundance and conflict in developing countries (Ross, 2004; Collier and Hoeffler, 2005). However, the literature agrees that agricultural rents are less prone to cause conflicts than mineral rents, which does not reflect the Ivorian case.

Short-sighted policies increased agricultural production and were a precursor of the conflict. The Ivoirian government aimed to increase agricultural production through the 70's and 80's. To achieve increased production, the government encouraged large numbers of migrants to settle in the country, making Ivory Coast to bear over a third of all immigrants in Western Africa (UNDESA, 2013a). The focal points of encouraging mass immigration were to increase agricultural exports to obtain resource rents that could be used to industrialize the country, as well as to maintain political power in certain areas (McGovern, 2011). Immigration policies made Ivorian's a minority in certain areas, which created social polarization that exploded during the conflict.

Short-term effects of these policies were increased agricultural production and prosperity. Yet, long-term effects of these policies were great deforestation and socio-political division between the northern Muslim migrant populated Ivory Coast and the most prosperous South (Woods, 2003; Besada, 2009; Fell, 2009; Meehan, 2011; Wickberg, 2013). Therefore, the downturn of the Ivorian economy cannot be solely associated with the resource curse channels such as rent-seeking behaviours, but the interlinkage in between short-sighted agricultural policies, a

resource curse sign (Bazilian et al., 2013), failed industrialization attempts, and national discontent fuelled by the adjustment programmes.

Cocoa production and exports follow a complicated pipeline between production, transportation, grinding, manufacturing and exports. Export prices are determined based on cocoa futures in international markets, prices paid to farmers varies on a yearly basis, determined by location inside Ivory Coast and affected by price differentiation between Ghanaian and Ivorian cocoa (Kireyev, 2010).

Cocoa also played a central role over the war. Rebel groups and the government fought for the control of cocoa producing areas. Rebel groups took control of Northern Ivory Coast, where a small share of cocoa and cotton were produced. Rebel groups imposed road levies to agricultural product North to South transport to finance their war campaign. Moreover, rebel groups, as well as farmers, smuggled cocoa to Ghana, Togo, Mali and Burkina Faso in order to obtain higher prices for cocoa (OECD/AfDB, 2006; Globalwitness, 2007; Besada, 2009; Guesnet et al., 2009). Declined cocoa prices, the effects of the liberalization policies and cocoa earnings being used to finance war efforts by rebel groups and the government, directly relates with rent-seeking behaviours and corruption as stated by the literature that studies the resource curse (Gylfason, 2001b; Bulte et al., 2005; Globalwitness, 2007; Moe, 2009; Dube and Vargas, 2013). As mentioned by Harford and Klein (2005), the natural resource curse can damage institutions, provoke rent-seeking behaviours and fights to control resource rents, as it has happened in Ivory Coast.

Moreover, slavery and child labour in cocoa fields in Ivory Coast have not been uncommon, and became aggravated during the conflict years, as law enforcement declined (Schrage and Ewing, 2005; Hawksley, 2011; CNN, 2012; BBC news, 2013; OECD/AfDB/UNDP, 2014; World Bank, 2015). Cocoa, and other agricultural products per se, have not only financed military weaponry, but also created ethnic tensions (Woods, 2004; Globalwitness, 2007; Besada, 2009), which all relate with resource curse channels. Based on obtained results and literature, these consequences seem to derivate from a political framework that promoted a productive system and a social context that concluded with a divided state in civil war and the consequences derived from that division. Hence, as mentioned by Stevens and Dietsche (2008) institutions have a mediating effect in between the impact of resource endowment and development outcomes. In this case, the lack of good institutions and political decisions fostered decreasing development outcomes.

In summary, the combination of national policies and international governance led to a decline of farmers' wages, and overall incomes, as well as causing social polarization, being some of the precursors of the conflict. The fight to control agricultural rents between the government and the rebel groups to finance war is a clear sign of the resource curse. However, obtained results highlight that the study of the resource curse cannot be separated from the intervention of international governance in the country. Hence, the resource course channels present in the country are not only bound to raw resource dependency per se, as raw resource dependency was in fact also perpetuated by international governance.

Based on studied data, the cocoa sector shows signs of the resource curse, driven in part by policies that ultimately have had socio-economic consequences. It is clear that the cocoa sector has followed a different path than in Ghana. Ivorian mismanagement, and its effects, has negatively affected Ivoirians economically, politically and socially by fuelling the conflict. Therefore, the liberalization of the Ivorian cocoa sector is considered to be a disastrous liberalization (Globalwitness, 2007; Fold and Nylandsted Larsen, 2008; Guesnet et al., 2009; EBI, 2014). The different paths followed by Ghanaian and Ivorian cocoa sectors are interesting to explore and compare. Understanding the effects of institutional quality and approach towards the main agricultural crop in both countries, as well as different SAPs implementation, can provide a clear view of the effect of governance over how raw resources can benefit or damage a country. This is not to be mistaken with the idea that implementing the Ghanaian system in Ivory Coast would have yielded matching results. Similar sets of institution might not yield the same outcomes, as there a number of factors, such as national transparency (Stevens and Dietsche, 2008), that influence how resource rents are managed. However, it can be used to compare the individual outcomes that different policy implementations have had in both countries. It is worth mentioning that the new coffee and cocoa board established in Ivory Coast after 2010 has been modelled based on the Ghanaian Cocoa Board. This signals that the effects of the diverted strategies that both countries have followed during the agricultural liberalization process (IIC, 2015) are also being understood at the political level.

7.1.3.4. Total agriculture and its relation with selected resource curse indicators

Agricultural crops in general have faced declining international prices. As depicted in Table 15 and Figure 38, exported agricultural quantities have more than doubled while the value of exported agricultural products has remained almost stagnant. Therefore, as it happened with

cocoa, this disparity remarks the importance of further processing of agricultural resources prior to export.

Table 15.Production, exports and price of agricultural exports in Ivory Coast in 1980 and 2010 with their average annual percentage growth rates and standard deviations.

Resource	Unit	1980	2010	Average annual percentage growth rate ± standard deviation
Total agricultural production	kt	6,612	13,638	2.5±4.3
Total agricultural exports	kt	1,200	2,800	3.3±9.7
Total agricultural exports*	Price per tonne (constant 2005 USD)	2,426	1,085	-2.2±9.2
Total agricultural exports	Million constant 2005 USD	2,911	3,038	0.15±0.9

*Unweighted price.

At the aggregate level, the agricultural sector is strongly coupled with GDP and negatively coupled with income. Consequently, this sector as a whole has expanded, while agricultural rents received by farmers have decreased. The agricultural sector has been throughout most of the study period the sector with the highest percentage of workforce in the country (FAOSTAT, 2015a) and provided over 50% of overall export earnings (UNIMTS, 2014). Thus, the Ivorian economy is highly dependent on this sector.

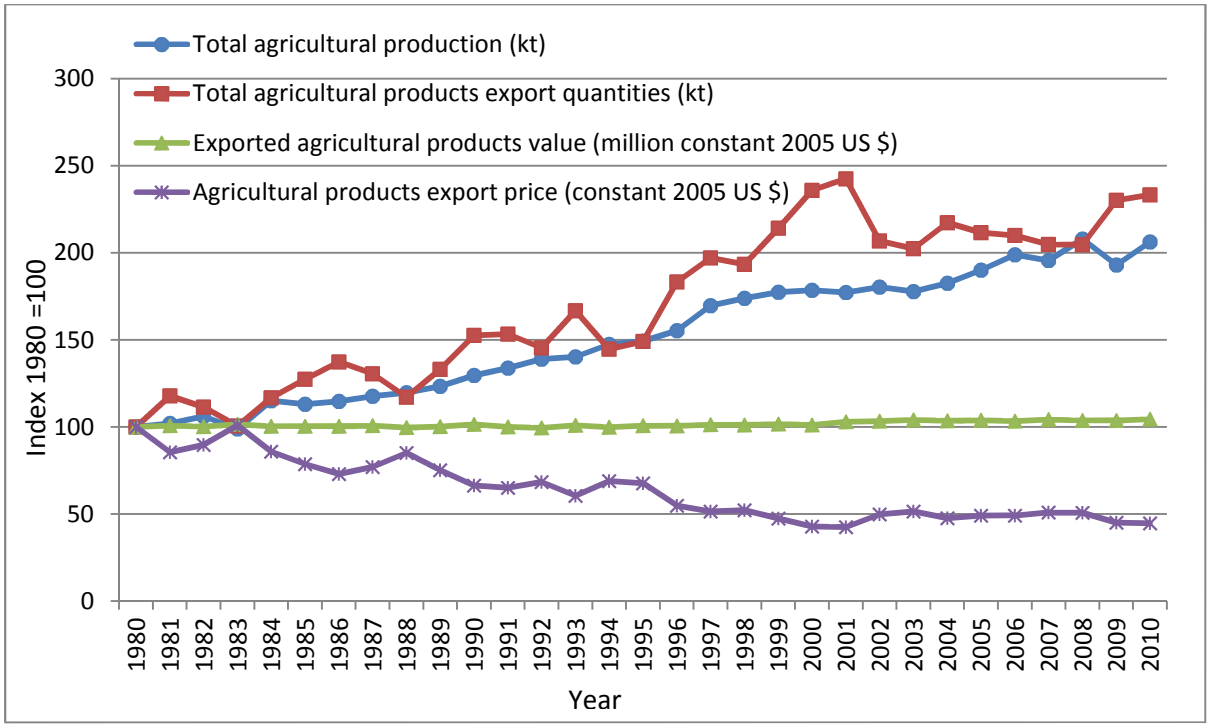

Figure 38.Agricultural production, exported quantity, export value, and export price in Ivory Coast from 1980 to 2010, index to 1980. Agricultural production in 1980= 6.6 Mt. Agricultural export quantities in 1980= 1.2 Mt. Exported agricultural products value in 1980= $2.9 billion 2005 USD. Unweighted average price of agricultural products in 1980=$2,426 2005 USD per tonne.

The agricultural sector as a whole shows a similar relation with the selected socio-political indicators presented in section 7.1.2 as cocoa. Policies proposed by global governance aiming at boosting the agricultural sector, such as agricultural liberalization to increase producer prices, had similar effects on the whole of the agricultural sector as they did with the cocoa sector. Hence, as mentioned by Conte (2005), Fell (2009), Amoro and Shen (2012) and Meehan (2011), the role played by the neoliberal adjustment programmes was important on shaping some of the negative consequences experienced by the country. However, in terms of production and added value of the agricultural sector, these policies appeared to have achieve agricultural growth rather than agricultural poverty.

Providing bridges between economic data, mass quantity data, and these two with the overall context, provides a genuine view that the resource curse channels are present in Ivory Coast. Nevertheless, these mainstream transmission channels do not necessarily have to be inherent to resource booms, but are strongly related with the failed development trajectory envisioned by decision makers in the country and global governance institutions.

7.1.4. Petroleum

Crude oil extraction and exports have highly increased during the study period. Similarly, petroleum products export have highly increased. By observing Table 16 it seems that Ivory Coast exported all of its extracted petroleum, but Ivory Coast has imported more crude oil through the whole study period than it has extracted.

Table 16.Crude oil extraction and exports, petroleum products exports in Ivory Coast with their average growth rates and their standard deviations in 1980 and 2010.

Resource	Unit	1980	2010	Average annual percentage growth rate and standard deviation
Crude oil extraction	kt	74	1,972	36.6±11.8
Crude oil exports	kt	120	1,921	38.6±163
Crude oil exports	Price per tonne (constant 2005 USD)	155*	498	0.2±0.4
Crude oil exports	Million constant 2005 USD	13.8*	957	97.6±287
Petroleum products exports	kt	540	2,076	6.6±21.7
Petroleum products exports	Price per tonne (constant 2005 USD)	254*	566	0.14±0.4
Petroleum products exports	Million constant 2005 USD	477*	1,174	15.7±58
Percentage of selected raw resource exports in GDP[1]	% GDP	21.7%*	22.3%	0.6±7.3

*** Dataset starts in 1995. 1. Agricultural products exports, without processed cocoa, plus crude oil plus gold exports as a share of GDP.**

Oil extraction has been highly linked with international oil prices. Ivorian oil extraction was unstable prior to 2002, as its extraction was only economically viable with high international oil prices. Therefore, with increased international petroleum prices, oil and petroleum products exports highly increased (USGS, 2012; EBI, 2013).

State controlled Ivorian oil refinement capabilities reached their peak capacity through the study period. Consequently, exported crude oil highly increased, reaching similar levels to refined exports. This is due to Ivory Coast's petroleum refinement structure, composed by a single oil refinery in Abidjan since 1965, controlled by stated owned Societe Ivoirienne de Raffinage (SIR). SIR has expanded through the years, but faced difficulties to obtain funds during the war period. Expansion investments were halted and oil refinement stagnated, diminishing potential revenues from increased petroleum products exports (EOE, 2008; Wild, 2010). Hence, reducing the share of processed petroleum products in overall oil exports.

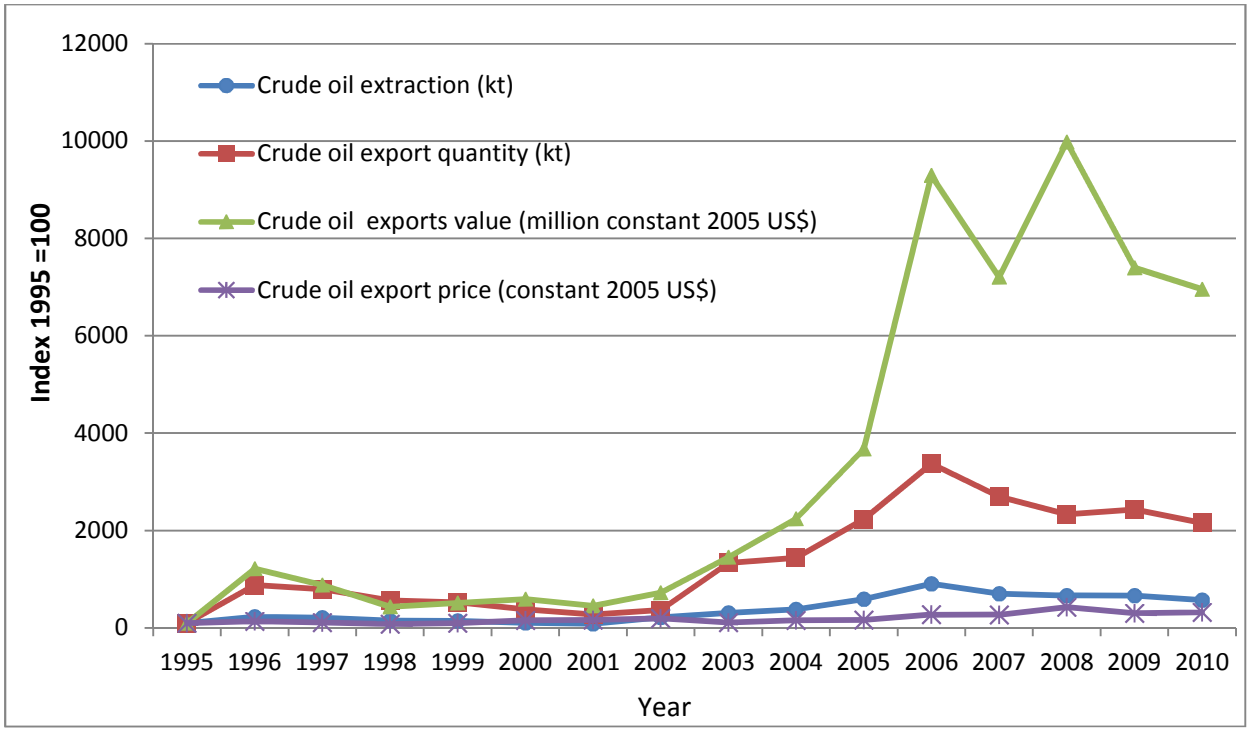

Figure 39. Crude oil extraction and exports, and petroleum products export from Ivory Coast from 1995 to 2010, index to 1995. Crude oil extraction in 1995=345kt. Exported crude oil in 1995= 89kt. Crude oil export value in 1995=$13.7 million 2005 USD. Exported crude oil price in 1995= $155 2005 USD per tonne.

The Ivorian government has expressed its commitment to increase raw material processing activities in the country to increase the share of the industrial sector in the country (OECD/AfDB/UNDP, 2014). If positive results were to be achieved, it could help the country to decrease its raw resource dependency. It is clear that a greater number of refineries will be needed to increase refinement capability in a country with rapid population growth which requires greater amounts of petroleum products (EBI, 2013). Nevertheless, processed petroleum products export revenues have been highly sensitive to international oil prices, as well the internal Ivorian situation.

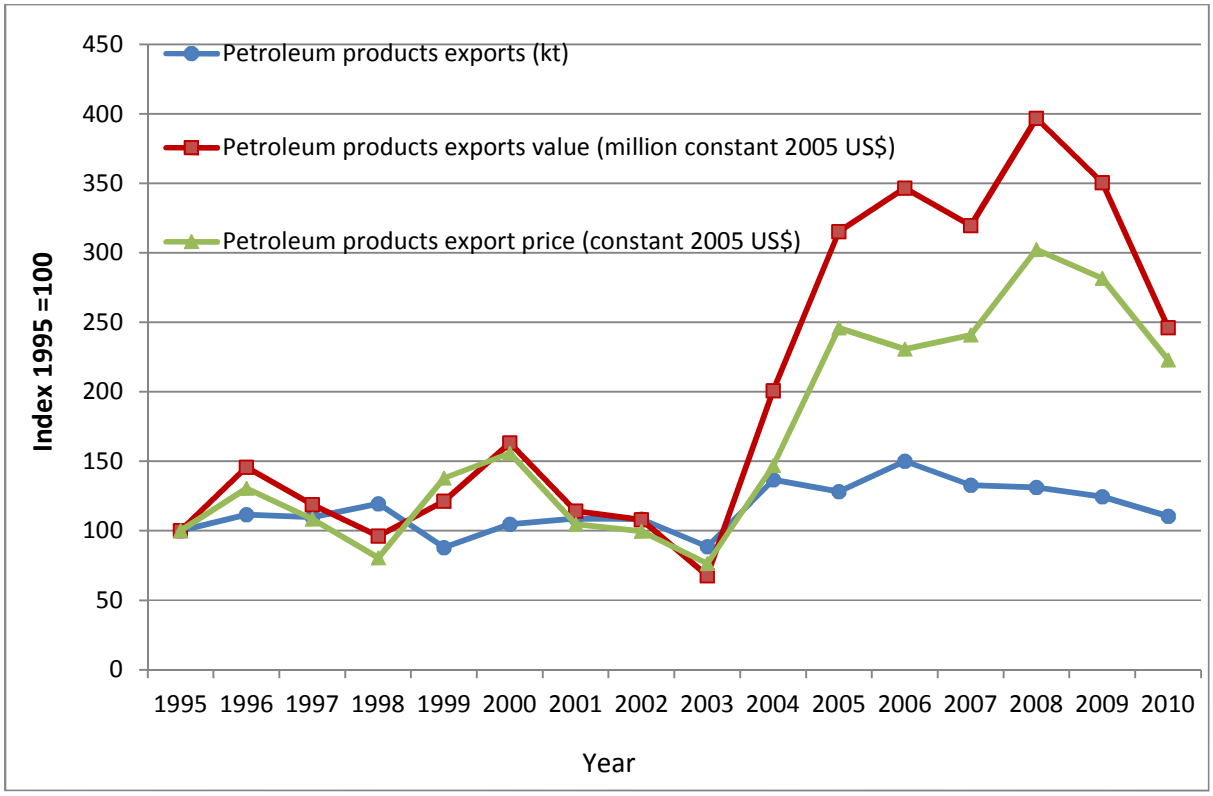

Figure 40. Petroleum products exports quantities, export value and price from Ivory Coast 1995 to 2010. Petroleum product exports in 1995=1880 kt. Petroleum products export value in 1995=$477 million 2005 USD. Petroleum products price in 1995=$254 2005 USD per tonne.

Crude oil and petroleum products have experienced a boom through the last decade of the study period, surpassing the economic value of exported cocoa from the year 2005 onwards, signalling the economic importance of this sector for the Ivorian economy. Ivory Coast mostly refines imported Nigerian oil, which is lighter than Ivorian oil and thus provides better yields than locally extracted oil (USGS, 2012; EBI, 2013). In the Ivorian context, most extracted crude is exported as crude petroleum, which has been considered negative. Ivorian offshore oil can be directly be exported from the wells to other countries, which fosters corruption in the sector. This is certified by the pipelines followed by petroleum in West Africa. In the region there is a significant volume of unregistered intra-regional petroleum trade, 80% of those unregistered petroleum products originate from Nigeria and the remaining 20% from Ivory Coast (EBI, 2013).

Petroleum products are the main energy carriers used in the primary and secondary sectors, which implies that the functioning of SIR has not only economic implications for export revenues, but also for future growth in the primary and secondary sectors, deeming important to understand how SIR and the oil sector function. However, it is to note, that based on

quantitative data, crude oil and oil products are not significantly coupled with mentioned economic sectors.

Corruption in Ivory Coast is endemic, and due to the opacity of the petroleum sector it is difficult to know how much oil is produced and exported (Guesnet et al., 2009; Beggs and Kitchen, 2013; Wickberg, 2013). Many complementary and incomplete components of information are necessary to gain insights in the processes at play.

Ivory Coast obtains direct economic earnings from extracted oil and refined foreign crude by SIR. Conversely, the country does not directly benefit as much from exported crude oil. There are a wide variety of taxes that extracting companies pay and are dependent on a per contract basis. The main taxes paid by extracting companies are extraction taxes, income tax, surface rent tax and corporate tax -which some companies are exempt of paying (Ernst & Young, 2015).

Oil products exports and imports related with oil extraction activities, are exempt from taxation (Ernst & Young, 2015). Therefore, due to the Ivorian oil tax system, the nation benefits directly from extracted quantities, and indirectly from oil export revenues –from the companies that are not exempt from corporate tax. Rent-seeking behaviours complicate obtaining accurate data on oil extraction, exports and payments made by extracting companies (Guesnet et al., 2009). Only the inflows paid to the national treasury are known. It is to be noted that Ivory Coast discloses oil revenues since 2010, with data from 2006 onwards (EITI, 2015a). However, disclosure of payments has highly varied and is inconsistent (Berger, 2015; Andreasen, 2016). Therefore, it cannot be used to analyse the economic impact of oil extraction in the country. As described by the pattern matching framework (Trochim, 1985), by utilizing the triangulation and complementary designs (Greene et al., 1989; Onwuegbuzie and Leech, 2005; Tashakkori and Teddlie, 2010), qualitative data has been useful to omit some results of the quantitative data due to incomplete observations, but unfortunately, accurate data cannot be obtained. However, data on extracted and exported oil quantities have been more consistent than oil revenues, therefore, for the period under study, mass quantities in combination with international oil prices, might provide a clearer view of the economic impact of oil in the country for studies focused on this sector.

7.1.5. Share of raw resources in GDP

The share of selected raw resource exports in GDP has slightly increased as a consequence of increased estimated crude oil revenues. The share of raw resources in GDP has been highly linked with the effects of the SAPs and international petroleum prices. Based on the resource curse literature, if the curse was to be present through the economic channel, GDP and the share of raw resources in GDP should be negatively coupled, however both indicators are not significantly related.

In Ivory Coast, there are signs that can relate the oil sector and its boom to corruption, but the opacity of the sector complicates understanding the whole system. Evidence suggests that mainstream bureaucratic corruption increased with the conflict (Wickberg, 2013). Similarly to agricultural revenues, the literature that explores the Ivoirian oil sector links oil rents with financing the war (Guesnet et al., 2009), which can be related to the rapacity effect discussed in Dube and Vargas (2013) for Colombia. However, due to the obscurity of the petroleum sector in the country, considered to be more opaque than the cocoa sector, it is hard to bring out more than indicative conclusions from the obtained data. Nevertheless, resource rents opacity and rent mismanagement are certainly resource curse signs, as the government cannot be held accountable for mismanaging unknown rents.

Ivory Coast has not suffered an increase in the exchange rate of the CFA franc, despite gaining greater amounts of foreign income from exports than expenditure on imports. Thus, it can be said that the country did not experience the resource curse from this channel. Despite the large amount of revenues that Ivory Coast obtains from the oil sector, the country as whole did not experience a significant decline in GDP growth with decreased oil prices and decreased oil production in the country in 2014 (World Bank, 2015). This implies that the country might not suffer the resource curse through oil price volatility (EIA, 2016).

7.2. Conclusions and relation to development theories

The results obtained in this chapter highlight the overall importance that national and international regulation has had in shaping the decline faced by the country. National policies incentivizing economic growth through agricultural expansion, and massive immigration, increased agricultural production, with mid-term overall effects on sustaining economic growth through agricultural diversification. Revenues from agricultural exports were used to finance

light industries in the country: this was then called the Ivorian miracle. However, in the long run, declining agricultural prices constrained public expenditures and declined income. These hardships led the Ivorian state to engage with the Bretton Woods institutions. By following neoliberal policies, in line with the classic development theory (Nafziger, 2006; Pieterse, 2010) in exchange for loans, the Ivorian model collapsed. Trade liberalization, privatization of public enterprises, reduction of government expenditure and the end of state financed industrialization eroded the model that made Ivory Coast a strong economy in West Africa. Ivory Coast faced decreasing terms of trade, falling incomes and decreased biophysical standards in a context of increased corruption and war. Therefore, as stated by the dependency theory and world systems theory (Furtado, 1971; Leys, 1996; Wallerstein, 2011), Ivory Coast has been relegated to become a raw resource exporting country.

Agricultural policies of the past brought economic growth but created a social structure that would explode once the economic situation worsened, and the SAPs created that context. Once agriculture reached its expansion limits and income declined, tensions between Ivoirians and foreigners became rampant. Moreover, division between the North and South of the country increased, reaching the political sphere, motivating the military coup of 1999 (Bowden, 2007; McGovern, 2011) which led to the ethnic war.

In the Ivorian case, the failure to industrialize cannot be solely understood by examining development theories. Declined institutional quality, and the emphasis to increase agricultural production and diversification, as well as the conflict, did not only halt the country's ability to increase the processing industry, but did also disrupt the industrial and service sector present in the country.

Infant mortality has been highly related with governmental revenues in the country. After the liberalization of the agricultural sector, government revenues decreased, but with the expansion of the oil sector from 2002, the government was able to compensate for some of the losses of agricultural taxes. Greater internal stability achieved after 2005 translated into greater ability to collect income tax, averaging 12.6% annual increase of the taxpayer's base. Combined with increased oil tax inflows, tax revenues helped Ivory Coast to increase imports of medicines into the country to tackle infant mortality, making it the third largest import (OECD/AfDB, 2006).

The resource curse appears in the country mainly through governance and rent-seeking behaviours channels, which spread negative outcomes to all the economy. Good governance is key to avoiding the curse, but poor governmental decisions can strengthen the decline of the

system. Corruption and the SAPs have halted national expressed aims of increasing local product refinement. The country has been able to increase the share of processed cocoa in overall cocoa exports, but has decreased the share of processed petroleum products in overall oil exports, as well as not being able to increase added value from non-oil manufactures.

Traded mass quantities and economic values show different paths. Quantities have grown much more than the modest increase in overall agricultural export values, while socio-economic and political indicators have declined. In the Ivoirian case study, the metabolism approach provides an understanding of the past dynamics of selected resources and it can be matched with the overall context faced by the country. Yet, to understand the interconnection between resources and selected indicators to study the resource curse, it is clear that national and international context and policies have played a major role shaping the evolution of the country. Hence, despite combining quantitative and qualitative data, the utilized methodology heavily relies on qualitative data. The instability and war context experienced in the country clearly shaped past dynamics in a way that the metabolism approach alone cannot explain.

The method utilized in this chapter highlights two aspects previously mentioned when studying the resource curse. One aspect is that mass quantities need to be combined with export revenues, as it provides a clear view of how terms of trade affect a country's trade structure. The second aspect is that in the Ivorian case, produced agricultural quantities are what provide income to farmers, and extracted petroleum quantities income to the state.

In the case of an economy highly reliant on agriculture such as Ivory Coast, there are serious implications when avoiding the study of mass quantities and just focusing on resource rents. At the macroeconomic level, Ivory Coast has been able to maintain export revenues despite decreasing terms of trade. However, understanding that lack of innovations to increase yields per farmer, observing that the number of farmers working in agriculture has increased while agricultural exports earnings have stagnated, means that agricultural population faced declining salaries for their production. Moreover, studying the dynamics of production and exports with indicators that can inform about the development path faced by the country provides a view on how the primary sector relates with socio-economic development. But, opposed to studies that claim direct causality through quantitative data, incorporating qualitative data to comprehend socio-political evolution provides a clearer view of the system in the country, and therefore, this study can more accurately relate the benefits or negative effects of one sector to the economy. For instance, in Ivory Coast, by studying oil revenues with selected economic and

socio-political indicators it might seem that there is a positive relation between this economically important resource and the economy. However, by incorporating qualitative data, it becomes clear that corruption has gone hand in hand with the oil sector; consequently, oil revenues are not accurately known.

This method does not provide an answer to how to avoid the resource curse. As it has been explored in chapter 5 and in this chapter, each country faces a different context and hence answers cannot be extrapolated, obtained results are context dependent. However, it provides knowledge of the failure of classic development theory to achieve development everywhere through a defined set of measures. It provides the basis to prove that there are resource curse signs in the country, but these are not inherently endogenous to raw resource dependency. As it was mentioned in chapters 5 and 6, in Ivory Coast and Ghana, policies, their implementation and the context in which they are surrounded, have played a major role in both countries. Which means that regulatory quality and good regulatory frameworks need to improve to achieve greater development levels, instead of focusing on concrete quantitative aims that target certain level of economic growth, industrialization and so on, instead of prioritizing the overall regulatory context in which these measures are being implemented.

8. Comparison between the development path of the selected countries; the role of global governance

Ghana and Ivory Coast have followed different development paths through the study period, as chapters 4 to 7 revealed. The aim of this chapter is to unfold and comprehend those differing paths. Both countries will be compared by utilizing the approach developed throughout this thesis, which is a methodological advancement to previous studies, as highlighted in chapter 3. To comprehend the differences between both nations, national and international forces (policies and context) need to be compared, as these forces have shaped the development path followed by the selected countries.

The goal of this chapter is to investigate if based on analysed past trends, there is an overall link between biophysical consumption, income and well-being in the selected countries, or if policies and context have shaped the differences between both countries. This will help to understand if variations in biophysical consumption can be related to differing levels of income and well-being, or if the interaction between national and international governance has had a stronger role determining differences in living standards, income and well-being. Understanding this point will prove important towards envisioning how greater levels of well-being can be achieved in the future, as perhaps policies that aim to improve well-being might not need to rely on greater biophysical resource use.

By incorporating global averages into this comparison, I can explore how the development path followed by the selected countries compares to the average global development path, therefore comprehending if the selected countries are performing positively or if they are falling behind the global average. Furthermore, as examined in chapters 5 and 7, the role that raw resources have played in each country has been determined by policies and frameworks put into place by national and international powers; consequently, it is important to understand how the local-global interaction has shaped the success or failure of these economies.

It is only by combining the metabolism of both countries, policies concerning raw resource management, as well as their international context that we can comprehend the process that has led both countries to their present development state. The results synthesized in this chapter demonstrate that the interaction between local policies, the international context and international governance has determined the different evolution of well-being in both countries.

However, the results found in this chapter do not ascertain that development outcomes in both countries would have been better or worse without the local-global interaction, as the lack of consistent data, and the limitations of the method, difficult reaching unambiguous conclusions.

This chapter highlights that there is not a homogenous development path that has been followed by these two neighbouring countries. The differences observed between the development path of these two countries and the global average are manifold. Both of the selected countries, as well as SSA, face a global context in which their role as raw resource providers has been determined by the international sphere. The transition towards industrialization in both countries faces local and international constraints. Lack of stable energy sources that can sustain local industries, as well as external tariffs to manufactured products from both countries and international competition have hindered industrialization.

The findings of this chapter will be discussed in the context of Sustainable Development Goals (SDGs)(UN, 2016). These were announced partway through this dissertation, and though they did not shape the research design and analysis carried out in this thesis, they provide an appropriate context to discuss the policy-relevance of the method and findings. The SDGs provide a more comprehensive approach towards different aspects of development needed in developing countries than previous Millennium Development Goals. These new goals, set for 2020 and 2030, acknowledge the importance that access to modern energy carriers has to increase well-being in developing countries, as well as reducing deforestation and health issues related with biomass use as a fuel. Therefore, these goals provide a global context in which understanding the metabolism of developing countries, as well as the interaction between resource use and well-being, becomes relevant in the international political agenda (Allison et al., 2015; Pongiglione, 2015; Costanza et al., 2016; Gupta and Vegelin, 2016). For instance, the SDGs envisage the importance of access to modern energy carriers, as stable modern energy access can increase developmental levels by fostering industrialization, improving the healthcare system, education and so on. However, in selected countries, greater energy access is, and will be, constrained by a number of factors, such as population dynamics (an important factor not considered by the SDGs (Pongiglione, 2015)), calling for an approach that can relate energy use and composition with national well-being and development where possible (Nilsson et al., 2013).

For instance, the approach of this thesis can be used to comprehend the relation between economic and well-being dynamics with energy use. Consequently, this approach can be used

to provide insights on aspects such as deforestation for energetic and agricultural needs (SDGs 7 and 15). Additionally, topics relevant to this research become important towards achieving a number of the SDGs; subjects such as decreased corruption, increased industrialization, and participation of developing countries in global governance, may provide an ideal context to test the methodology developed here.

This thesis and the SDGs aim to integrate socio-economic development with environmental concerns. While the SDGs are ends to be achieved, the method developed in this thesis can measure the progress towards those ends and evaluate the means employed. Ends such as energy transition, deforestation or decoupling economic growth from material consumption (SGD 8.4) can be measured utilizing the metabolism approach used in this thesis. The results found in this thesis can therefore inform possibilities and trade-offs of development in these countries. Moreover, the methodology developed in this thesis can be adapted to other case studies of developing economies. Hence, the contribution of this thesis can prove significant towards understanding different aspects to consider at the national and international levels to achieve a number of SDGs.

This chapter is divided into four sections that will provide complementary information answering research questions one and three, as well as addressing research question number four. The first section will compare the metabolism of both countries, as well as the global and African trends. This section will complement sections 4.1 and 6.1 answering research question one. The second section will analyse how different policies and frameworks towards raw resources in each country have affected both economies. Therefore, section 8.2 will supplement chapters 5 and 7 answering research question number three, while providing the foregrounds to answer research question four. The third section will analyse the broader context for each country. This will be done by analysing the role that global institutions have had in the development path of selected countries, which will provide an answer to research question number four. Finally, the fourth section will provide the concluding remarks of the results found in this chapter.

8.1. Comparison of the metabolism of Ghana and Ivory Coast in relation with the global trend

The biophysical metabolism of the selected counties shows that there is a link between composition of energy supply, and the quantity and composition of consumed materials with national economic dynamics. However, in order to compare both countries, a range of other factors needs to be considered. Factors such as resource endowment, population growth and policies, which through trade or subsidies ensure reliable and affordable access to resources, all play important roles in shaping the differences observed in the metabolism of selected countries. Therefore, the metabolism approach alone proves insufficient to comprehend biophysical and developmental differences between Ghana and Ivory Coast.

Population dynamics have played an important role shaping the evolution of living standards in the selected countries. High population growth constrains achieving per capita economic growth, providing greater material standards and sustained energy supply to the population, and hindered the achievement of a number of MDG's in both countries (NDPC, 2015). A clear example can be seen in Ivory Coast, where at the national level, economic and biophysical growth have been dominated by the effect of population growth. Global trends show a picture of global development, where income and biophysical consumption have increased while well-being has steadily improved, as evidenced in Table 17. Ghana and the SSA region have experienced faster than average population growth, yet have been able to decrease the gap with global average life expectancy while maintaining lower biophysical standards. This gap has decreased, driven by policies that promote child and maternal health measures. Ivory Coast, on the other side, with an even faster population growth, has been unable to maintain biophysical standards or follow the global average well-being trend.

Table 17. Selected indicators global averages with average annual percentage growth rates and standard deviations in 1980 and 2010.

Indicator	Unit	1980	2010	Average annual percentage growth rate ± standard deviation
Population	Million	4,440	6,930	1.5±0.25
Income	PPP constant 2005 international $ per capita	5,934	9,848	1.7±1.4
TPES per capita	GJ capita	68	77.9	0.5±1.6
DMC per capita[1]	t per capita	7.8	10.2	0.9*
Food supply	Kcal/capita/day	2,489	2,851	0.5±0.5
Energy intensity	MJ per $	11.5	7.9	-1.2±0.9
Material intensity of the economy[1]	t/1000$	1.3	1	-0.8*
GHGe intensity[2]	tCO_2e per million $	936.8	670.3	-1.7±1
CO_2 intensity	tCO_2 per million $	739.5	491.1	-1.3±1.4
Life expectancy	Years	62.9	70.5	0.4±0.1
Infant Mortality	per 1000 live births	80	37.5	-2.5±0.9
HDI [3]	0 to 1	0.56	0.69	0.7*

1. Data available for 1980/1990/2000/2010. 2. Data starts in 1990. 3. Data available for 1980/1995/2000/2005/2008/2010. * Average annual growth rate calculated using compound annual interest rate formula.

Economic development has been paralleled by a shift in the composition of biophysical consumption. In Ghana, as well as in Africa and the global average, there has been a shift towards increased share of non-biomass energy carriers and non-biomass material consumption. This shift has occurred alongside increased income. Indeed, in Ivory Coast, income has decreased, while the share of biomass in energy and material consumption has increased. In energetic terms, perhaps energy composition, rather than levels of consumption, are coupled with economic growth. The fact that this phenomenon is seen in both countries, during phases of economic growth and decline, makes it one of the more compelling findings of this thesis.

Table 18. Selected indicators African or Sub-Saharan African (SSA) averages with average annual percentage growth rates and standard deviations in 1980 and 2010.

Indicator	Unit	1980	2010	Average annual percentage growth rate ± standard deviation
Population Africa	Million	478	1,044	2.6±0.15
Population SSA	Million	371	840	2.76±0.07
Income SSA	PPP constant 2005 international $ per capita	1,788	1,987	0.4±2.2
TPES per capita Africa	GJ capita	23.8	27.8	0.5 ±1.3
DMC per capita SSA[1]	t per capita	5.6	4.6	-0.7*
Food supply Africa	Kcal/capita/day	2,232	2,595	0.5±0.8
Life expectancy SSA	Years	48.2	56.3	0.5±0.5
Infant Mortality SSA	per 1000 live births	119.6	66	-2±1.2
HDI SSA[2]	0 to 1	0.38	0.49	0.8*

1. Data available for 1980/1990/2000/2010. 2. Data available for 1980/1995/2000/2005/2008/2010.
*** Average annual growth rate calculated using compound interest rate formula.**

Greater income levels alone do not translate into greater energy or material consumption. The composition of TPES per capita, as well as DMC per capita, at the national level, is not only related with the level of income, but with the access citizens have to different energy carriers and materials. Access is partly dependent on governmental policies (e.g. electricity subsidisation in Ghana to connect houses to the electricity grid) and locally available energy carriers and materials (e.g. oil in Ivory Coast or construction minerals in Ghana).

Selected countries follow the energy ladder in opposite directions. Increased income in Ghana has been accompanied by a moderate decrease in biomass consumption, while the consumption of modern energy carriers has increased in absolute terms and as a share of TPES per capita. Greater income provides a wider range of available cooking fuels, or cooking strategies, to the population, which are combined. This result is in line with the findings of Heltberg (2004) and Masera et al. (2000) for a number of countries and Kankam and Boon (2009) for Northern Ghana.

Ivoirians have experienced a combined decrease in income and energy consumption (modern fuels and biomass). With decreased energy consumption, biomass has increased its share in overall energy consumption per capita. Consequently, Ivory Coast is regressing down the energy ladder. Decreased TPES per capita has to be understood in the context of agricultural expansion and high population growth that reduced available forests for biomass use, and the difficulties faced by local refineries to expand their refinement capacity during the conflict.

Consequently, the backslide of Ivory Coast in terms of modern energy carriers use is highly related to the context faced by the country. Ivory Coast, with greater income and stability than Ghana, consumed more energy per capita and had a lower share of biomass in TPES per capita and at the residential level than Ghana in 1980. By 2010, with decreased income in Ivory Coast, despite income being greater than in Ghana, Ivorian energy consumption was below the Ghanaian consumption levels, and the Ivorian energy mix had a greater share of biomass than the Ghanaian energy mix. By comparing these two countries, it is evident that income alone has not determined differences in energy composition.

At the global and African levels, increased use of modern energy carriers has not led to a decrease in biomass consumption. However, the share of biomass in TPES per capita in Africa and the global average has decreased, coinciding with the findings of Haberl et al. (2006b). Therefore, the selected countries, with lower TPES per capita than the global and their continental averages, are not following a similar energetic transition to the World or Africa. These results confirm that energetic composition, dependent on locally available energetic resources and infrastructure, is linked to income dynamics despite the level of consumption not being related with income.

The intensity of use hypothesis in energetic terms does not hold in selected countries in the long run. Nevertheless, when the share of biomass in TPES per capita was high, energy supply and income were coupled in both countries. This is due to the greater impact of biomass on increasing or decreasing TPES per capita, compared with modern energy carriers -due to low biomass efficiency. Therefore, energy supply per capita and income decoupled when more efficient modern fuel consumption increased, as lower energetic inputs were needed to supply the same amount of final energy. At the global level, income and TPES per capita have not been coupled through the study period.

The varying relation between income and TPES per capita in the selected countries has been shaped by their differing historical contexts. Ghana faced fluctuations of oil supply at a time when agricultural expansion was taking place, decreasing available biomass and its consumption, which was in part substituted by modern fuel consumption. Therefore, while income was increasing driven in part by agricultural policies, biomass energy supply was constrained by agricultural practices. In contrast, in Ivory Coast, due to the internal conflict, SIR could not expand its refinement capabilities; consequently, increased population, and the large numbers of displaced population, had to rely on the few pristine forests in the country for

biomass consumption. Moreover, the conflict put an end to the only four consecutive years of income growth. Studying the societal metabolism of the selected countries highlights that their metabolism has evolved in a different manner. Nevertheless, to understand their differing paths, the historical context faced by these two countries explains how Ghana was able to surpass Ivory Coast's biophysical standards despite having lower income.

Income might be the main driver of material consumption in selected countries, in accordance with the intensity of use hypothesis. This implies that in Ghana and Ivory Coast, variations in material consumption relate with the national evolution of income, coinciding with the results from Steinberger et al. (2013) for developing countries. To the contrary, at the global and SSA levels, income is not coupled with DMC per capita. Similarly to TPES per capita, the share of biomass in DMC per capita in the selected countries is related to income dynamics. Yet, it cannot be stated that this is a common trend in the developing world; as presented in section 1.1, West Africa has not experienced a homogenous metabolic path.

Greater income levels do not reflect in greater material consumption. Greater income in Ivory Coast or the SSA average, compared to Ghana, did not translate into greater consumption of materials. Therefore, despite economic growth being dependent on continuous development of physical infrastructure in developing countries, domestic access to construction minerals, which in every global region is mostly dependent on local extraction (Schaffartzik et al., 2014), has determined consumption levels of construction minerals. Furthermore, in the selected countries, the consumption of this material group has been influenced by governmental infrastructure development policies. This is exemplified in Ivory Coast, where income is highly coupled with consumption of construction minerals, as in the Ivorian case resource rents were used to finance infrastructure development. However, with decreased governmental infrastructure investment and decreased income, construction mineral consumption decreased. In Ghana, income is not coupled with construction minerals consumption, but public infrastructure development during the study period increased construction mineral consumption above the Ivorian levels of consumption, through a period of economic growth. These results partly resemble results found by Gonzalez-Martinez and Schandl (2008) for Mexico, where an increase in construction minerals used to build infrastructure happened alongside economic growth. These results have to be taken with care, as data quality issues concerning material consumption might distort obtained results.

8.1.1. The metabolism approach, the SDGs and well-being

The SDGs are 17 goals that aim to increase development in a sustainable way. Measures to increase access to affordable modern energy services (SDG 7.1), increase renewable energy use (SDG 7.2), decouple economic growth from environmental degradation (SDG 8.4) and protect forests (SDG 15) relate with topics of this thesis. By understanding the metabolism of these countries, policies and frameworks to achieve these goals could be rightfully developed and implemented, as the uniqueness of local development paths are understood. The framework developed by the SDGs utilizes traditional measurements such as energy intensity and access (IEA and World Bank, 2015) to address energy related goals. The method developed in this thesis explores how the socio-economic context relates to the use of different fuels, which provides further insights to traditional measurements used in the SDGs framework.

Obtained results for Ghana reveal that economic growth, at the national level and the per capita level, has been strongly linked with energy supply in the past. However, with increased modern fuels in the energy mix, economic growth decoupled from energetic growth, as biomass was partly substituted by modern fuels. Modern fuels present high-income elasticity in Ghana; therefore, based on these results, policies that aim at increasing income in the country, such as increasing farmer's income and industrialization policies, would continue the process of decoupling income and TPES per capita in the country. The main deterrents of energy transition in developing countries have been considered to be modern fuel stove prices and modern fuels bulk prices (Leach, 1992; Pachauri et al., 2012). Hence, subsidisation programmes will be needed in combination with policies that can increase incomes. On the other hand, in Ivory Coast, modern fuels are refined in the country; thus, supply has been constrained by SIR's capabilities. In order to increase modern fuel supply and avoid further deforestation in Ivory Coast, firstly, modern fuel supply will need to increase, for example by expanding SIR or through trade. Furthermore, to reduce agriculturally led deforestation, governmental programmes will be needed to increase, or even maintain, agricultural yields without expanding arable land to forested area. These results signal that SDG 7, 8.4 and 15 are intrinsically related to one another in the selected countries. Therefore, to successfully achieve the ends of a number of SDGs in selected countries, means from different SDGs will need to be combined.

The selected countries do not show signs of leapfrogging carbon intensive technologies. Ghana and Ivory Coast have not increased their use of non-biomass based renewable energy sources (data quality issues have to be taken into consideration), therefore suffering a carbon lock-in

(Unruh, 2000; Unruh and Carrillo-Hermosilla, 2006). Governmental subsidies have focused on traditional modern fuels, not in low-carbon renewable technologies (Kankam and Boon, 2009). These technologies would decrease the urban-rural energy access divide in both countries as well as improve the chances of both countries to achieve previously mentioned SDGs.

Studying the biophysical side of these economies signals that well-being can improve and follow a similar path to the global average with much lower biophysical standards. This is evidenced by comparing the Ghanaian case with the global average presented in Figure 41. Ghana has been able to experience a higher growth in life expectancy, and similar levels of decreased infant mortality, than the global average, with a fifth of the global energy supply per capita and lower material standards. This can be regarded as the effects of policies such as education and health investment policies, which might not necessarily affect metabolism. These results show that greater consumption levels, or incomes, do not directly translate into greater well-being. In Ghana and Ivory Coast, policies and internal context have played a role shaping current well-being levels in ways that cannot be solely explored studying income and biophysical dynamics.

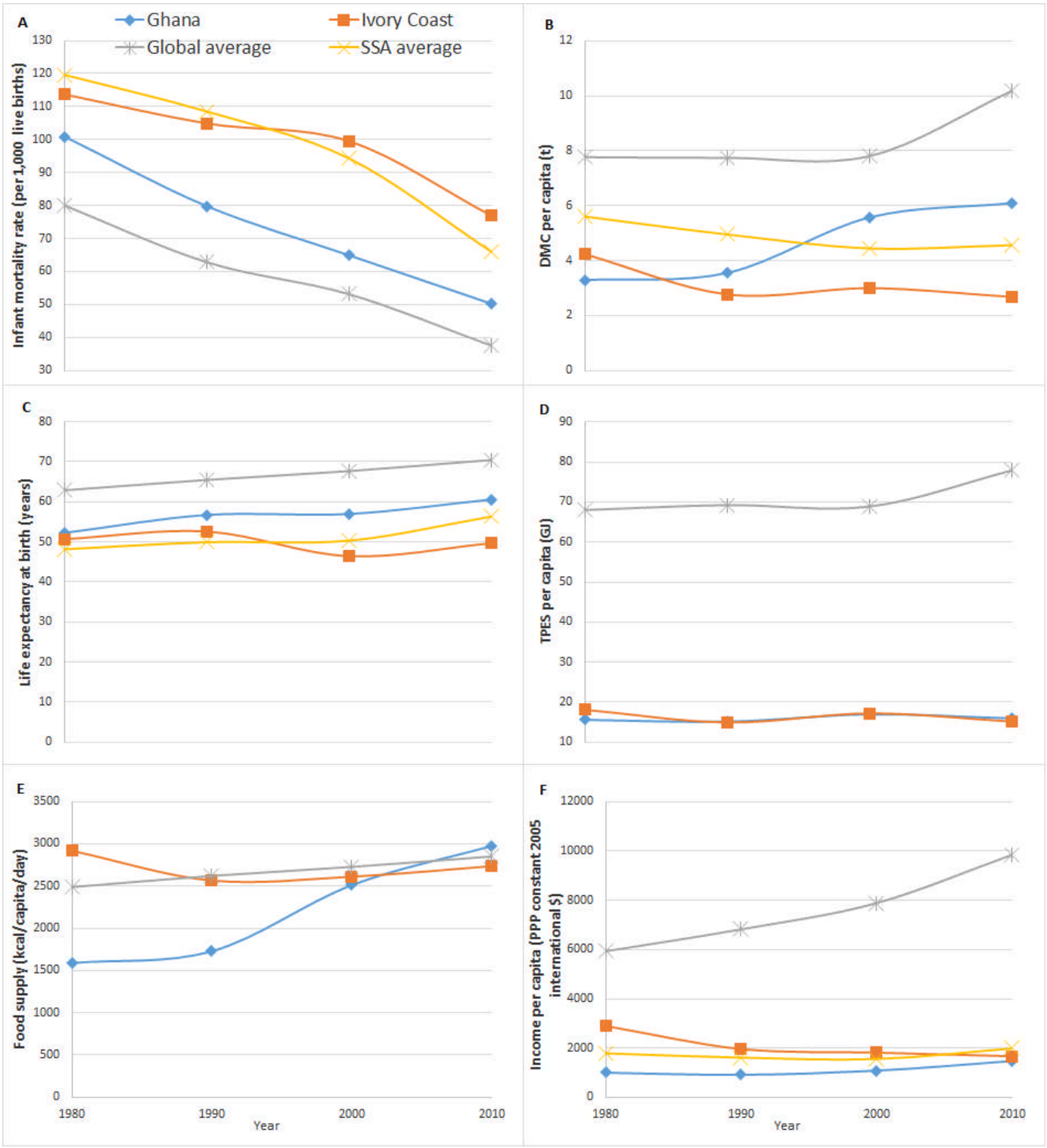

Figure 41.Ivory Coast's, Ghana's, Sub-Saharan Africa and global average (A) infant mortality, (B) DMC per capita, (C) life expectancy, (D) TPES per capita, (E) food supply and (F) income per capita in decadal intervals from 1980 to 2010.

Examining one of the principal externalities of biophysical consumption from an economy, GHG emissions, Ghana has high emissions relative to its level of economic output, as Figure 42 shows. The high GHG intensity of Ghana is mostly due to the large importance of

agriculture in the economy and biomass use as a fuel compared to the global average. In contrast, Ivory Coast has a GHG intensity similar to the global average, which could be due to greater combined importance of services and industry in the Ivorian economy, or GHG data quality issues. Both countries have been able to decrease their GHG intensity over time. Ghana especially has decreased GHG intensity at a faster rate than the Ivoirian and the global average. GHG intensity in both countries, as well as globally, has decreased due to the increased importance of the secondary and tertiary sectors in the economy from 1990 to 2010. However, with expected population increase in both countries, and its importance on emissions (see Appendix I), overall national emissions are not likely to decrease in both countries. Moreover, population growth could as well as decrease biomass availability, which could lead to an energy crisis if remaining Ivorian forests were depleted, hindering achieving SDG 7 and SDG 15. Understanding these processes is highly relevant to develop coherent social, economic and environmental policies, especially policies concerning pollution control, energy and material consumption reduction and natural resource depletion. Unfortunately, precise disaggregated data on deforestation due to energetic and agricultural needs is challenging to obtain; therefore, policy recommendations can only be in line with decreasing the combined impact of both causes, energetic and agricultural.

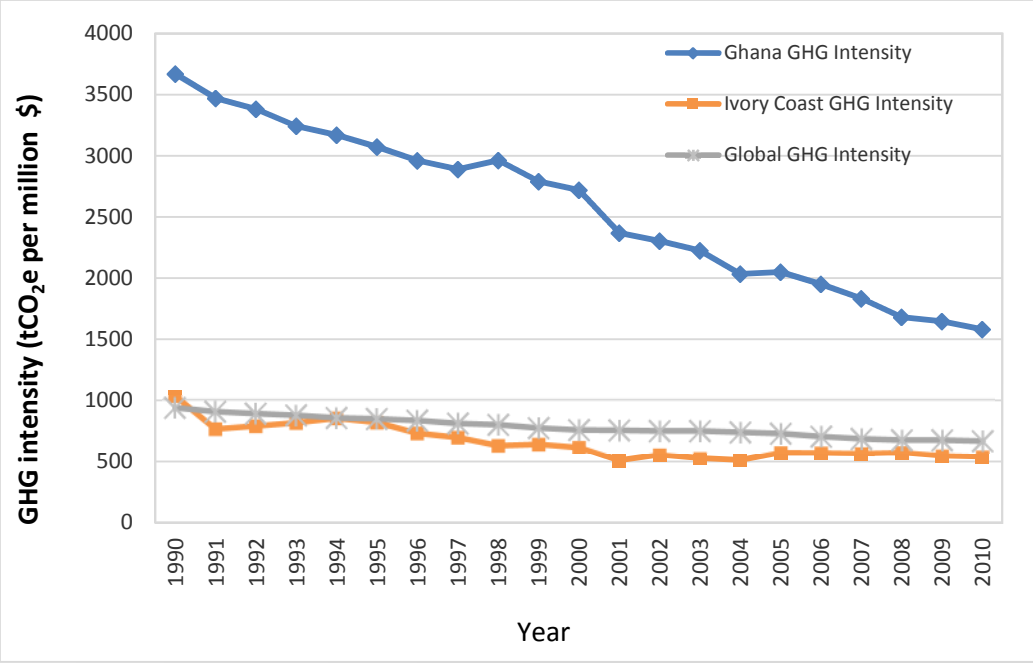

Figure 42. Ghana's, Ivory Coast's and global average GHG intensity from 1980 to 2010.

The previous analysis indicates that identical set of measures in both countries would not yield similar results, as both economies have not followed a unique linear path. Consequently,

international governance organizations that aim to aid the development process of these two countries, as well as the developing world, need to envisage the heterogeneity between countries in order to achieve the SDGs (Allison et al., 2015). Data quality issues, as well as national differences, warrant taking into account the national and international socio-political context in which both countries have developed.

8.1.2. Sectoral comparisons and trends

Based on previously presented thresholds, Ghana's and Ivory Coast's material consumption, represents that of an agrarian society, 3t to 6t per capita (Schandl et al., 2008), where biomass is the main material consumed. In industrialized countries DMC per capita lies in between 15t and 25t per capita, where the share of biomass in DMC represents under 30%. Similarly, at the global level, biomass in DMC decreased to 30% in 2010, while remaining over 50% in selected countries and SSA. Therefore, selected countries, as well as SSA, are not near the consumption levels or the composition of consumption of the global average. Hence, despite Ghana and Ivory Coast being service economies in economic terms, in biophysical terms the selected countries remain as mainly agrarian economies.

Socio-metabolic transition in Ghana and Ivory Coast differs from that followed by previously industrialized countries and the global average. These differences can be observed by comparing the economic structure and the energy intensity of both countries and comparing it with the process followed by the global average. Globally, the service sector remains the most important sector in terms of added value and energy consumption, while the primary and secondary sectors have lost economic and energetic importance. Indeed, the selected countries, as well as the continent, have become service economies where the primary sector maintains a large share in GDP that has not shifted towards the industrial sector; therefore, both countries are 'leapfrogging' the industrialization process followed by developed economies before becoming service economies. However, the service sector is highly heterogeneous (Eichengreen and Gupta, 2013). While in Ghana transport and financial services activities are the main service sector subsectors, in Ivory Coast, the service sector is mainly composed by financial and property services as well as a public administration services. Consequently, becoming service economies does not mean that services in these countries do resemble the service sector of developed economies.

Table 19. Share of each economic sector in global GDP and in global total final energy consumption, and energy intensity of each economic sector in 1980 and 2010.

Indicator	Units	1980	2010
Agriculture share in TFC	Percentage	3	2
Primary sector	% GDP	11.5%	9.4%
Agriculture energy intensity	MJ per $	7	3.2
Industry share in TFC	Percentage	33.8	28.2
Secondary sector	% GDP	24.1%	22.8%
Industry energy intensity	MJ per $	12	6.6
Services share in TFC	Percentage	31	36.1
Tertiary sector	% GDP	64.2%	68.1%
Services energy intensity	MJ per $	4.1	2.8
Residential share of TFC	Percentage	23.7	23.6

The energy intensity of the main economic sectors can be used to understand productive differences and explain the differing socio-metabolic transition between the selected countries and the global average. By comparing the energy intensity of both countries with the global trend, it can be seen that at the global level the agricultural sector is much more energy intensive than in selected countries, highlighting the low mechanization levels in both nations. Agricultural energy intensity has decreased at the global level as electricity consumption in the sector, which is more efficient than fossil fuels, has increased from 9% of agricultural energy consumption to 23%. Similarly, in Ghana, governmental subsidisation programmes have modestly increased modern fuel consumption through the mechanization of the sector, and therefore increased agricultural energy intensity. This is in contrast to the Ivorian case, where the end of agricultural subsidisation has decreased agricultural energy intensity, exemplifying the role of the state affecting the metabolism of the selected countries.

Table 20.Share of each economic sector in African GDP and in African total final energy consumption 1980 to 2010.

Indicator	Units	1980	2010
Agriculture share in TFC	Percentage	1.5	2
Primary sector	% GDP	39.6	31.1
Industry share in TFC	Percentage	21.3	16.2
Secondary sector	% GDP	17.5	16.2
Services share in TFC	Percentage	15	20.3
Tertiary sector	% GDP	41.8	54.4
Residential share of TFC	Percentage	57.8	56

In contrast, the energy intensity of the Ghanaian industrial sector is similar to the global average, and both are above the Ivorian industrial energy intensity. This could imply that the industrial sector in Ghana relies on similar technologies to the global average. However, this is due to the reliance of Ghanaian industrial sector on manual labour for the semi-processing

of local resources, as the main energy carrier used by the industrial sector in Ghana is biomass, while in industrialized economies, and during the process of industrialization, modern fuels become the main energy carriers (Haberl, 2001b, 2006a). Ivory Coast's low energy intensity in this sector is related with the country utilizing only modern fuels for the functioning of the sector, which is due to this sector being mostly reliant on oil refinement for added value creation. Despite the country benefiting from increased petroleum prices that have increased the importance of the secondary sector in the economy, industrial production more broadly has not increased, which appears to be a resource curse sign. Therefore, there has not been a transition towards greater industrialization levels. The energy intensity of the service sector is similar in Ivory Coast to that of the global average, as financial services are the main services in the country, while in Ghana, the importance of transport energy consumption increases the service sector energy intensity.

Ghanaian material intensity is much larger than the Ivorian and the global material intensity. This is due to sectoral composition of both countries. In Ivory Coast, as well as the global average, the greater share of the service sector in GDP, when compared to Ghana, explains this disparity. Unfortunately, the lack of sectoral material consumption does not enable us to further explore material intensity or draw conclusions from observing material intensity. It is to be noted that studies such as Steinberger and Krausmann (2011), Bringezu et al. (2004) and Steinberger et al. (2010) question the use of material intensity as an indicator of environmental performance, as an N shaped material intensity appears in many countries.

8.2. Relation of the main raw resources with selected economies, the importance of national policies

The resource curse is a complex issue that needs a multidisciplinary methodological approach to be understood. By combining the study of raw resource exports in mass quantities, a metabolic approach, with economic data, as well as with national context (social and political context), a more complete picture of the relation that raw resources have with an economy can be painted to previous studies. Raw resource management frameworks put in place in both countries, such as their taxation system or farmers FOB prices, provide the basis to understand that extracted mass quantities are needed to comprehend how raw resources contribute to the selected economies. On the other hand, exported economic values of the main raw resources indirectly contribute to both economies. Exports do benefit both countries through corporate

taxes, which are based on companies' profits, with the exception of cocoa in Ghana, which exports are managed by a public institution.

In order to understand the differences between the agricultural sectors of both countries, agricultural policy frameworks need to be understood in combination with an approach that combines mass quantities and energy consumption. The cocoa sector in both countries provides the best example of comparison, as differing frameworks were established after each country implemented their respective adjustments during the 80's and 90's, with diverging outcomes for farmers in each country.

To compare the cocoa sector of these two countries, observing exports in economic terms or mass quantities separately proves insufficient to understand the sector as a whole, including farmers' standards. In Ghana, the cocoa sector has experienced a decrease in export revenues in constant terms, despite doubling cocoa production. However, the framework put in place in Ghana after 1983 increased farmers income per produced tonne. Moreover, the funds obtained by the Cocoa board enabled the Cocobod to ensure cocoa quality and provide a number of subsidisation programmes, which permitted Ghanaian farmers to increase modern energy consumption. To the contrary, the Ivorian cocoa sector as a whole has grown in monetary terms through the study period, but farmers have experienced a decrease on their income per produced tonne. The privatization of the cocoa sector in Ivory Coast led to a halt in state subsidisation programmes to farmers, which could be observed by the declining energy intensity of the sector. Therefore, what might initially appear as a positively performing Ivoirian cocoa sector is in fact not a sector that is delivering prosperity for its working population.

Mineral management frameworks and opacity in both countries necessitates the use of mass quantities to understand, to a certain extent, the impact that mineral resources have in each country. Economic benefits of mineral exports are not always easily accessible, or dependent on individual contracts that each mining company has with the state, which difficult obtaining accurate data. Therefore, extracted mass quantities can be used as a proxy for the economic impact of a resource in the selected countries when economic data is not available. For example, in Ghana, as explored in chapter 5, only extracted gold quantities were related with GDP due to the national taxation system. Consequently, without direct reliable economic data on gold contribution to the state, mass quantities can provide clues about the impact of gold in Ghana. By analysing mass quantity data, non-reported artisanal mining can be estimated.

Studying the disparities between reported extracted gold and exported gold signals that gold has mostly benefited big corporations, as exported quantities are just slightly above reported extraction figures. Therefore, increased added value in the primary sector has not directly benefited working population, as large-scale mining employs under 1% of the population employed in agriculture.

In Ivory Coast, the resource curse channel of corruption has affected the oil sector. One clear example is that through the study period, part of exported Ivorian oil has been in the informal economy of West Africa. Furthermore, the government obtains funds from extraction taxes and locally refined oil, but not exported crude oil. Reduced government salaries after the adjustments increased corruption, and therefore opacity concerning oil revenues. Therefore, exploring mass quantities with available economic data and the framework put in place by the country, can inform about the evolution of the secondary sector, as previously explored. The potential contribution of oil to the national economy can be proxied by combining international oil prices with extracted oil quantities.

Governmental intervention in the selected economies can provide positive outcomes. The Ghanaian model of governmental intervention and resource rent management has proved more successful than the Ivorian model. Ghana and Ivory Coast are both on the low side of development and maintain the primary sector as the engine that fuels the economy. Both economies are highly dependent on agriculture, but in Ghana, the primary sector contributes more to the economy, as share of GDP and share of working population, compared to Ivory Coast. Yet, governmental intervention in the Ghanaian economy has provided advantages to the population in a way that free-market forces have not achieved for Ivoirians, such as increasing incomes and agricultural subsidisation programmes. The instability and conflict in Ivory Coast have certainly further damaged the country in unmeasurable ways, but, the conflict was not isolated from the policies implemented by the Ivorian government (ILRF, 2004; Kingston et al., 2011).

The social context of both countries determined the differing outcomes of governmental intervention. By analysing the differences between the Cocobod and SIR, it becomes clear that, while Cocobod was restructured under the post-coup climate that intended to ensure government accountability and transparency, SIR did not experience that type of restructuration. Since the creation of SIR, Ivory Coast did not experience a major social change that demanded accountability and transparency, as the Ivorian economy did not face major

negative outcomes that sparked social change until the coup in 1999. Consequently, the social context faced by Ghana led the Cocobod to tackle corruption after the coup. To the contrary, in Ivory Coast, the lack of social movements and decreased governmental incomes during the adjustments period increased corruption in SIR.

The results obtained in the selected countries coincide with the literature that acknowledges that the negative outcomes of raw resource dependency in a country are dependent on the quality of the institutions (Ross, 1999; Brunnschweiler, 2008; Saad-Filho and Weeks, 2013). Therefore, the resource curse is not necessarily an economic problem but a policy failure. This is reflected through the internal context and political indicators, which have deteriorated in Ivory Coast but not in Ghana. The overall evolution of the most common indicators explored by resource curse literature: education expenditure, de-industrialization (the main resource curse channel in Sachs and Warner (1995) study) and exchange rate appreciation, have been influenced by specific policies put in place, which have ultimately reflected in distinct dynamics of well-being indicators.

The lack of a strong industrialization process in both countries can be explained by the interaction of national and international governance, not as a resource curse sign. In Ghana, the results confirm the role of international barriers as well as the lack of stable local resources have impeded the creation of an industrial sector that can add value to local raw resources. In a different manner, Ivory Coast was able to create a light industrial sector after its independence, but was unable to create an industrial sector that could surpass the agricultural sector or grow under the SAPs. As examined in the previous section, economic data provided a picture of increased industrialization in Ivory Coast, being this a different picture to the one presented by mass quantity data. By combining mass quantities with economic data, it could be viewed that industrialization in economic terms was exogenous to the country's productive system.

Universal recipes for development have not worked in both countries. The different implementation of similar neoliberal policies (reduced government expenditure and privatization of state owned companies) did not deliver universal increased prosperity. The Ghanaian approach was able to reduce agricultural poverty and receive a price premium over Ivorian cocoa, but was not able to increase the importance of the industrial sector in the country. While on the contrary, the Ivorian approach did increase agricultural poverty and led to decreased national income, despite benefiting from increased petroleum prices. Therefore, by

comparing both countries, this study concludes that most of the researched facts confirm that resource dependency alone is not inherently negative for a country, as raw resource management frameworks can provide a climate in which resource rents can be used to fuel industrialization. However, in Ghana and Ivory Coast, adjustment programmes modified the political will to foster industrialization utilizing resource rents.

8.3. A call for a more holistic approach: The importance of socio-political and international context

The previous analysis shows that the recent development path of Ghana and Ivory Coast has been strongly tied to the effects of the implemented structural adjustments. Both countries are embedded in a global context in which international governance can intervene in national politics in exchange for loans. The lack of power of the selected countries in international organizations, and the financial difficulties that these countries have faced, has led them into the global economy to acquire loans and trade local products. By acquiring funds from international donors, these countries have had to implement a number of adjustments designed by the Bretton Woods institutions, which as previously analysed, did not lead them towards greater development levels.

Adjustments tied to international loans did foster a climate of economic growth, but not a climate of increased development. By entering the SAPs, the selected countries were able to halt economic decline, but Ivory Coast's income growth only lasted four years. As advised by international loan donors these countries diversified their agricultural structure to buffer both economies against resource price volatility. International donors encouraged a number of developing countries in need of loans to diversify their agricultural composition (Riddell, 2008), with the global impact of increasing the global supply of a number of agricultural products. The effect of this recommendation was a decrease in global agricultural resource prices. The prices of a number of agricultural products are correlated, crops such as coffee and cocoa follow similar price fluctuations through time (Deaton, 1999). Therefore, agricultural diversification as a strategy to combat resource price volatility can fail. The SAPs polarized the selected countries from the productive economies. Consequently, Ghana and Ivory Coast needed to export an ever-increasing flow of raw materials to productive economies to obtain funds to acquire foreign manufactured goods, making them vulnerable to market price

fluctuations. These results align with the world systems and dependency theories, as well as with results from Bunker (1985) for the Amazon.

The adjustments proposed by the Bretton Woods institutions increased agricultural dependency and affected the industrialization of the selected countries. Mentioned adjustments did not only promote agricultural diversification, SAPs ended state-led industrialization policies. International governance institutions envisioned that ending state-led industrialization would encourage private investment into industrial activities in the selected countries. Additionally, trade liberalization would permit local industries to compete based on their comparative advantages. To the contrary, the effects were decreased industrialization. Foreign capital was not invested in industrial activities; it was invested in extractive industries, mainly gold in Ghana and petroleum in Ivory Coast. Consequently, local industrial sector declined as local infant industries could not compete against mature industries from developed economies. Both countries have faced declining agricultural export prices, but the overall primary sector export revenues did increase driven by mineral export revenues. Mineral extraction in both countries did not require as much labour as the agricultural sector, therefore, increased mineral revenues could not counterbalance income losses faced by working population.

International loans and the implementation of adjustment programmes immediately ameliorated macroeconomic imbalances in both countries, but did not immediately benefit local population. Some adjustments decreased expenditure in health services and education. Therefore affecting life expectancy in the selected countries, as these adjustments had effects such as increased HIV prevalence in Ivory Coast (UNEP, 2006). Ghana implemented the economic recovery programme when the country was facing a near governmental bankruptcy, hyperinflation and food shortages. These ‘one size fit all’ (ILRF, 2004) reforms implemented by the Ghanaian government, provided long-term economic growth. However, these macroeconomic adjustments did not directly benefit the population, as these reforms decreased some of the basic services in the country and had a central focus on the cocoa sector. It was the recognition of some of the failures of the adjustments that led to changes that were able to increase well-being in the country, despite not achieving industrialization or high economic growth.

Ivory Coast did not tackle the social costs of the SAPs, therefore, Ivoirians faced harsher outcomes from the adjustments than Ghanaians. Ivory Coast entered the ESAF, and later on the SAPs, with the consequent liberalization of the cocoa and coffee sectors, reduced public

spending and so on. The effects of the Ivorian approach were increased agricultural poverty, increased child labour, decline education and health expenditure, while only contributing to four years of income growth. Without major governmental willingness to ameliorate the social costs of these programmes, the country did not tailor the adjustments to fit local needs. Therefore, mentioned resource curse channels present in Ivory Coast are not only directly related with national policies and corruption, but also with the role played by international organizations. Consequently, in order to examine the resource curse a holistic approach that examines national and international context in which these countries are embedded is needed.

8.3.1. Implications of global governance in Ghana's and Ivory Coast's development

A predefined set of policies cannot be used worldwide to achieve development. Despite being recommended a similar set of policies, different implementation strategies followed by both countries yielded divergent effects on well-being. Yet, these policies had similar effects on maintaining dependence on agriculture. However, based on the classical development literature (Konadu-Agyemang, 2000; Pieterse, 2010), Ivory Coast, with a slightly stronger industrial sector in terms of share in GDP, should have been able to provide greater living standards to its citizens. Nevertheless, previously mentioned measures declined Ivorian standards, exemplified by decreased life expectancy. These results demonstrate the need for context specific development strategies, such as decreasing healthcare cost, or continuation of state–led industrialization financed with raw resource rents.

The resource curse presence in Ivory Coast stems from a combination of internal policies and the effects of SAPs. Analysed policies concerning agricultural expansion, the liberalization of the agricultural sector and the national conflict, increased corruption of the national agricultural and oil sectors. Consequently, the resource curse per se cannot explain the decline of the country. A more comprehensive view of local policies, and their interaction with global context in which the country is embedded, is necessary to understand the downturn of the nation. Consequently, as mentioned by Brunnschweiler and Bulte (2008), poor institutions would unlikely develop production sectors outside of non-primary production, but in the case of these two economies the role of poor global governance needs to be incorporated.

SSA, Ghana and Ivory Coast have become service economies that mainly rely on the surplus of the primary sector, which is a different development path to that followed by present day

developed economies. Why is the sectoral evolution of Ghana and Ivory Coast different to that of previously developed countries and the world average?

In order to answer this question, an approach that binds together development theories with previous analysis is needed. It provides the necessary tools to understand the existing interconnection between internal and external factors that have influenced the present situation and the development path followed by both countries.

By studying the global context of both countries, and the domestic context each country faces, the reasons behind the lack of a strong industrial sector can be examined and compared. The selected countries are peripheral countries that despite following the classic development neo-liberal 'remedies' to achieve economic growth, have not been able to develop an economic structure that enables them to produce high-valued manufactured goods. Moreover, their efforts to create import substituting light industries were halted by the SAPs, which as mentioned by Bunker (1985), capitalism polarizes extractive economies from productive economies. Local constrains and international governance have blocked the creation of a self-sustaining industrial sector, and therefore perpetuated raw resource dependency. Consequently, raw resource dependency has not halted industrialization; raw resource dependency is the result of national and international political decisions. The results obtained by studying the metabolism of both countries, as well as the relation of raw resources with both economies, highlights that the international sphere has had an unexpectedly high influence on different aspects of these economies. Development and its benefits, have been, and will certainly be, linked to the global context these countries face (loan conditionalities and international competition), as well as the influence that global governance has in both countries.

8.3.2. Implications of a holistic approach towards the SDGs

The SDGs become an opportunity for both countries, as well as the developing world, to achieve greater industrialization levels, decrease rent mismanagement and implement development measures that are tailor made for each case. However, the fragmentation of SDGs and the lack of certain indicators to measure progress towards certain SDGs, such as considering material consumption composition to measure progress towards industrialization, means that the SDG's (which are still developing a number of indicators to measure SDGs progress) can be improved.

Different SDGs need to be combined in order to be successfully implemented in Ghana and Ivory Coast, as well as in other countries (Nilsson et al., 2013; Weitz et al., 2014; Pongiglione, 2015). SDG 9 focuses on achieving greater industrialization levels that can process local goods, for instance agro-industries, as well as knowledge transfer and use of local skills. To achieve SDG 9, other SDGs need to be achieved simultaneously. SDG 16.8 aims to strengthen the participation of developing countries in global governance institutions. By combining these two SDGs, the selected countries, in combination with the developing world, can have their voices heard and promote the creation of an international context that facilitates loans that suit their needs. For example, loans without conditionalities that can have detrimental effects on the economy of developing countries. Based on obtained results, without accomplishing SDG 16.8, SDG 9 would likely would not be achieved, as loan conditionalities have previously halted industrialization. Similarly, SDG 7.1 (universal access to affordable, reliable, and modern energy services) does not measure access to reliable energy sources for local industries, but should. Reliable energy supply is needed to create and sustain an industrial sector in both countries. By doing so, the industrial sector could grow in the selected countries and provide greater incomes. Successfully achieving SDG 16.8 would decrease some of the difficulties faced by selected countries, such as decreasing trade tariffs to processed goods from the developing world. Consequently, if the energy ladder continues to hold in the future, industrialization could increase incomes and therefore decrease biomass consumption in Ghana and Ivory Coast.

The metabolism approach can be used to understand effects of SAPs on agriculture, and how future structural adjustments could affect the achievement of a number of SDGs. For instance, increased global cocoa production, driven by SAPs, decreased global prices. Consequently, global producers increased cocoa stockpiling to avoid further price declines. Increased cocoa production in selected countries was achieved by planting on cleared forests. Hence, without the effects of SAPs on increasing global production, the selected countries would not have faced such declining agricultural prices. Therefore, both countries would have not needed to constantly expand production to maintain raw resource rents. These results agree with UNEP (2006), which acknowledges the role of SAPs increasing deforestation for agricultural purposes in Ivory Coast and other African countries. Moreover, with fewer international cocoa producers, both countries would have had greater bargaining power in international cocoa markets, which might have permitted both countries to increase the amount of exported

processed cocoa. Understanding these interactions will be important towards achieving SDGs 7 and 15 in the future.

These results highlight the importance of understanding the interconnections that exists between economic development, biophysical consumption, national and international context, towards achieving greater developmental levels. These interconnections will need to be incorporated into the SDGs. The dynamics behind the development path followed by the selected countries is a clear example that their transition is different to the transitions presented in section 2.1. The development path followed by Ghana and Ivory Coast cannot be disconnected from the rest of the world; their agricultural products compete in a global market with a number of developing countries, which decreases prices of their products. At the same time, these countries rely on manufactured products from developed economies, as their manufacturers cannot compete with manufacturers from developed economies. Therefore, Ghana and Ivory Coast face a bottleneck in which they need to increase local processing in their productive structure to avoid a never-ending need to increase agricultural exports to acquire foreign goods. Yet, loan conditionalities have impeded the protection of nascent local industries. Consequently, without certain protectionism from the state, nascent industries in the selected countries will not be able to compete in international markets, which coincides with results of Ayelazuno (2014). Hence, to achieve the SDGs, and especially to develop in the future, both countries need a global framework that understands the heterogeneity of these countries and the global context they face – a sort of bottom up approach. Understanding these points will be crucial to aid their future development away from raw resources, which could provide long lasting economic growth that can benefit the population, contrary to the present context. Productive sectors are needed to fuel the consumption sector, the service sector. Therefore, with an agricultural sector that cannot grow indefinitely, the industrial sector will need to increase its role in both economies to create added value that can increase income and avoid a future decline of the service sector.

8.4. Conclusions

This section has compared the development path of Ghana and Ivory Coast and has matched it against the global and African averages. By comparing the metabolism of the selected countries, it could be observed that metabolically Ghana and Ivory Coast are evolving in

different ways. However, differences in their metabolism, such as greater biophysical consumption or income, have not determined greater well-being levels.

Overall results show that in the selected countries, biophysical consumption has been conditioned by access to different material and energetic inputs, which have been dependent on domestic extraction and governmental policies. Neither of the selected countries have followed the intensity of use hypothesis in energetic terms, but results confirm that both countries are following the energy ladder. This is an important aspect towards understanding future energetic transitions in both countries. If the energy ladder holds in the future, energy use for cooking purposes would move away from biomass as income grows. However, constraint access, and reliability, to modern energy carriers could halt this transition. Similarly, the composition of material consumption will move away from biomass with increased income. Yet, material consumption has been highly influenced by the internal context and local availability, therefore, constraint access to different materials might modify the current material transition in both countries. Contrary to energy, the intensity of use hypothesis in material terms holds in both countries, consequently overall material consumption and income will likely follow a similar path in the future.

Combining quantitative and qualitative data to explore the resource curse can be used to understand if economic data misguides the perception of industrialization in a country. It is only by combining different methods that we can understand that the industrialization process in both countries has not only been halted by endogenous factors (Konadu-Agyemang, 2000). As results from this thesis demonstrate, exogenous factors play a very important role in national politics. An energetic transition will be needed to sustain local industries. However, without a context that facilitates the creation of local industries that can mature, these countries will not industrialize. Therefore, in order to develop, Ghana and Ivory Coast will need to have their voices heard at the international level. The metabolism approach, in combination with a holistic view of these countries, becomes relevant in order to implement and monitor the progress of SDGs that focus on energy supply, industrialization, global context and deforestation in both countries.

Results found in this chapter, prove the usefulness of the developed methodology. In order to understand the development path of the selected countries, a wide array of issues need to be explored. The novel approach developed in this thesis highlights that in order to understand present and future development paths of these countries a holistic view that can combine

different sets of data is needed. Due to present globalized context, the development of the selected countries is shaped by national and international decisions and context, which are dependent on international governance and trade (international competition). These results exemplify that developmental issues cannot be studied in isolation. To understand the success, or failure, of policies and frameworks pun in place in the selected countries, a holistic analysis is required.

9. Conclusions

This thesis intended to comprehend the development path followed by two developing West African nations through the societal metabolism lens. To do so, this thesis proposed a multidisciplinary analytical framework that integrates different types of indicators: economic, biophysical and well-being indicators combined with historical context and the concepts, and narratives, of the resource curse and development theories. By combining these, this thesis unfolded the intricacies behind Ghana's and Ivory Coast's complex development path.

The availability of recent biophysical data enabled this thesis to break new grounds in empirical terms by studying the metabolism of two countries that had not been studied before. In methodological terms, this thesis innovated in various ways. By combining quantitative and qualitative data in a mixed method approach, this thesis was able to innovatively study the societal metabolism in countries where data quality and availability issues had prevented the study of development utilizing the societal metabolism lens. To study the resource curse, this thesis addressed a theoretical gap in the resource curse literature using the metabolic approach together with development theories. By combining these approaches, this research uncovered the interconnections between the resource curse channels and the global context both countries are embedded in, as well as highlighting the role that biophysical factors have played shaping the resource curse channels that relate to the different economic sectors.

The framework developed in this thesis, and the results obtained, can contribute to implement and monitor a number of SDGs. The SDGs have provided this thesis with an opportunity to translate obtained results into policy recommendations, which have been prescribed to achieve the goals envisioned by SDGs 7, 8.4, 9, 15 and 16.8. Furthermore, the results of this thesis highlight that the SDGs linked with the topics discussed in this dissertation can benefit from utilizing the societal metabolism approach to measure progress towards those SDGs, such as considering material consumption composition to study the industrialization process. As discussed in section 8.3.2, to successfully achieve the ends of a number of SDGs in both countries, the interlinkages between the different SDGs need to be researched. In the case of Ghana and Ivory Coast, the results found in this research indicate that the SDGs related to industrialization, modern energy access, deforestation, and global governance, need to be implemented synchronously to achieve the desired goals. Therefore, calling for a holistic approach, as the one developed in this thesis, which can combine different disciplines.

This chapter is comprised by three sections. The first section will re-examine the research objectives, highlighting the contribution of this thesis as well as summarizing the main results obtained. The second section will discuss the limitations of the methodology as well as the limitations of the obtained results. The last section will present further steps for future research development.

9.1. Revisiting research objectives

The purpose of this research was to understand the development trajectories of Ghana and Ivory Coast to comprehend their current state and potential development pathways. The multidisciplinary analytical framework developed in this thesis was used to answer this dissertation's overarching question: How can the concepts of societal metabolism and the resource curse help us understand historic and potential development trajectories of Ghana and Ivory Coast?

In metabolic terms, development is envisioned as the transition from an agrarian socio-metabolic regime to and industrial one. This transition entails an increase in biophysical consumption –increasing environmental pressure, increased economic wealth, better living standards, and well-being. Both countries are highly dependent on raw resource exports, which could make both countries prone to suffering the resource curse. Suffering the resource curse would slow the socio-metabolic transition of Ghana and Ivory Coast. In order to answer the main research question of this thesis, a holistic approach that could examine the development trajectories of these countries through different perspectives was needed.

The overarching research question was answered by studying different concepts and hypothesis behind the societal metabolism approach, the resource curse hypothesis and development theories. Consequently, this thesis explored the development path of the selected countries by mapping their biophysical, economic and well-being dynamics in conjunction with the role that raw resource exports have played in both economies, and the impact of international governance in both countries. This exploratory approach enabled this thesis to study the intensity of use hypothesis, the energy ladder model and the resource curse, together with the context -national and international, that has shaped obtained results.

The metabolism approach permitted this study to assess the intensity of use hypothesis (Malenbaum, 1978). The results obtained in this thesis support that this hypothesis holds in both

of the selected countries in material terms. Furthermore, this thesis was able to understand the context dependency behind the development paths followed by Ghana and Ivory Coast through a deeper examination of biophysical consumption, as well as the utilizing pattern matching to study the context faced by both countries (Trochim, 1985; Greene et al., 1989; Trochim, 1989; Yin, 2003; Saunders et al., 2009; Tashakkori and Teddlie, 2010). As a result, I was able to prove that the intensity of use hypothesis might not hold in the future due to material access constraints. Moreover, studying the intensity of use in energetic terms showed that the intensity of use hypothesis only holds when biomass consumption grows or is high, as occurred in both countries. These results would imply that decreased income, or constraint access to non-biomass fuels, could lead to an energy intensive economic growth.

Examining the metabolism of both countries, this study could also investigate the energy ladder (Hosier and Dowd, 1987; Leach, 1992; Masera et al., 2000; Heltberg, 2004), the link between fuel switching and income. Both countries have followed an energetic and material ladder, meaning that with increased income, there has been a switch towards the use of non-biomass sources. Yet, the continuation of these trends in the future will be constrained by national biophysical stock availability, international competition, and high population growth in both countries.

Combining historical context with the metabolic approach helped counterbalancing data quality issues. This approach highlights that socio-metabolic transitions are dependent on a combination of biophysical inputs and socio-political context, as it happened with previously industrialized countries (Sieferle, 2001). However, the transition followed by Ghana and Ivory Coast has been constrained by international governance. Moreover, contrary to previously industrialised countries and the global average, Ghana and Ivory Coast have become mainly service economies in economic terms, without an established industrial sector, leapfrogging the industrialization process. Yet, in labour and biophysical terms, these countries are still agrarian economies.

Both countries have experienced high rates of population growth. Population dynamics in both countries led the path followed by extensive indicators: GDP, TPES, and DMC. Consequently, extensive indicators have grown driven by increased population, especially in Ivory Coast, where, income, energy and material consumption at the per capita level have all declined. Therefore, it is important to study the role that population dynamics plays in the development path of a country as done in this research.

The study of the resource curse in this thesis has benefitted from using a metabolic approach and the context provided by development theories (Furtado, 1971; Chilcote, 1974; Wallerstein, 1974; Leys, 1996; Nafziger, 2006; Wallerstein, 2011). By researching the resource curse in the context of development theories and socio-metabolic transitions –flows of raw resources in mass quantities, I was able to study the development path followed by both countries through a holistic approach, providing a topical contribution to the resource curse literature. The resource curse is rarely studied in physical terms neither incorporating global governance, its study is mostly confined to narratives that consider the economic or national political aspects behind the resource curse (Sachs and Warner, 1995; Ross, 1999). Therefore, the method developed in this research provided new grounds to study a number of issues that have shaped the development path of the selected countries in the context of the resource curse. Such as lack of industrialization, production patterns, farmers' salaries and the perpetuation of raw resource dependency in both countries. These points could not have been analysed without combining mass quantities and the perspectives of development theories into the resource curse.

In the case of economies highly reliant on agriculture such as Ivory Coast and Ghana, utilizing a metabolic approach towards studying the agricultural sector becomes essential for understanding the evolution of the sector (especially where data on harvested area is not consistent). This method helps to comprehend that increased agricultural production has relied on increased labour and the expansion of cultivated area. In Ghana and Ivory Coast there has not been a strong mechanization and fertilization process. Therefore, by studying the energetic composition of the agricultural sector, it could be understood that agricultural expansion has been mainly achieved at the expense of increasing cultivated areas, causing deforestation. Moreover, at the sectoral level, Ivory Coast has maintained agricultural export revenues. However, the combined effect of lack of innovations to increase yields per farmer and new agricultural policies, have decreased farmer's salaries. While in Ghana farmers have seen their income slightly increased despite the sector's decreased economic output. These results illustrate the benefit of merging different approaches to understand the evolution of the agricultural sector and farmers standards in both countries.

The method developed in this thesis provides the basis to carry out developmental research through the metabolic lens in developing countries where data issues have prevented this type of research in the past. The new international agenda set out by the Sustainable Development Goals, evidences the increased relevance of this type of research. Countries that aim to achieve

the SDGs can benefit from using the approach developed in this thesis, which can be used to develop and monitor progress towards achieving SDGs that relate to biophysical consumption and industrialization.

9.1.1. Summary of the main results and development implications

The most interesting results of this research are summarized below:

- Well-being has not been related with the absolute level of biophysical use or economic growth of the selected countries. Differences in the metabolism of both countries, such as greater biophysical consumption or income, have not determined greater well-being levels. Therefore, the metabolism approach alone does not inform about differences in well-being between both countries. However, well-being in both countries has increased, often unaccompanied by high economic and biophysical growth, which can be considered green well-being growth. Factors related to internal context, such as investment policies in healthcare and education, which might not necessarily affect metabolism, have in fact shaped differing well-being paths in both countries. Indeed, by comparing Ghana with the global average, it could be seen that well-being can improve at a similar rate to the global average without biophysical consumption reaching average global levels.

- Material consumption is connected to the internal economic dynamics, confirming the intensity of use hypothesis in each country. Yet, by comparing both countries, it is clear that the differences in material consumption and composition are connected to locally available materials and the internal context that each country faces, but not to differing income levels.

- Energy use and income are not coupled in any of the selected countries. Nonetheless, the composition of energy consumption is related to national income dynamics, confirming the energy ladder in both countries. This indicates that alongside increased income, the importance of modern fuel consumption would increase –income dependence on the choice of fuels. In terms of consumption, this implies a transition away from being agricultural economies.

    - Both countries are heavily reliant on biomass as a fuel at the national level. Therefore, they can decrease their energy intensity by leapfrogging carbon

intensive technologies used during the first waves of industrialization. Renewable energy sources would help both countries increase the penetration of modern energy carriers, achieve SDG 7, and specially decrease the rural-urban energy access gap. Consequently, achieving a carbon efficient socio-metabolic transition.

- The energetic metabolism of the three main economic sectors indicates the existence of differing production technologies in both countries, which have been dependent on their national resource availability. Moreover, obtained results demonstrate that the industrialization process of each country is currently facing different challenges. For example, Ghana's industrialization process will require greater amounts of modern fuel supply for its industry, which currently is mostly reliant on biomass. On the other hand, Ivory Coast's industrial sector relies mostly on fossil fuels refined locally, but its energy requirements are dependent on SIR's expansion capabilities.

- Socio-political stability has played a key role in shaping the metabolism of these countries, as well as avoiding resource curse signs. The overall internal context faced by both countries has shaped contrasting metabolic paths in both countries. During the Ivorian conflict, there was switch towards biomass energy use in Ivory Coast. In Ghana, when agricultural policies increased farmers' income there was a switch towards increase modern fuel use in the country. Moreover, the opposing paths of agricultural policies, liberalization of Ivorian agriculture, and the maintenance of certain level of governmental control in Ghana, led to opposing paths of the agricultural energy intensity. Context-dependent differences led Ghanaians to have greater biophysical consumption than Ivorian's with lower income at the end of the study period.

- International governance has had major impacts shaping the present economic structure of selected economies. Development paths envisioned by global governance have shaped the economic structure of both countries, as well as influenced internal policymaking, which has ultimately affected the metabolism and well-being of both countries. Policy recommendations from international governance have shaped a development pathway in both countries that does not resemble the development pathway followed by previously industrialized countries. Therefore, the industrialization process of both countries will not only be influenced by local

constraints, but also by the interaction between local industrialization policies and global governance.

Some interesting results emerged from examining the relationship between raw resources in both countries and their development path utilizing a metabolic approach:

- Resource curse channels, as mentioned by Sachs and Warner (1995) and Gylfason (2001a), such as de-industrialization, lower economic growth, exchange rate appreciation and neglect of education, cannot be directly associated to raw resource dependency in the selected countries. The continued importance of raw resource exports in both economies streams from the local-global interaction.

- The study of the resource curse through the metabolic lens can be used to distil the particularities behind the industrialization process of a developing country, as it could be seen in the Ivorian case. In Ivory Coast the industrial sector grew in economic terms, however, the sector just benefitted from increased petroleum products international prices, not from a production increase.

- The comparison of both case studies demonstrated that the resource curse signs have not been inherent to raw resource dependency or resource booms. The combined effect of the socio-political evolution of both countries with the conditional ties of acquired international loans perpetuated raw resource dependency, entrenching their status as peripheral countries, in line with the world systems and the dependency theories.

- The SAPs modified local agricultural and industrial policies in both countries, halting their industrialization process. Ivory Coast was able to create a light industrial sector after independence, but this sector was not able to flourish under the SAPs. In the Ghanaian case, the lack of stable inputs to the industrial sector impeded the creation of an industry that could surpass agriculture without governmental intervention. Therefore, resource curse signs stream from endogenous and exogenous sources, aligning with the literature on the resource curse that considers that the course is dependent on the context faced by different countries and the quality of their institutions, rather than on resource booms per se (Ross, 1999; Brunnschweiler, 2008; Saad-Filho and Weeks, 2013).

- The share raw resource exports in GDP has not determined lower economic growth. None of the indicators examined in the resource curse chapters has a significant relation with lower rates of economic growth.

The selected countries, as well as the developing world, present heterogeneity in their development paths (Steinberger et al., 2013). This heterogeneity is due to a wide number of differences such as cultural and socio-economic configurations that emerged during and after colonialism, their international role and available local resources. Therefore, neither can these countries, nor developing nations, be considered as entities in which neoclassical measures of development will work for all. Development should not be considered as a straight path towards a unique end. Consequently, neoclassical development measures might not be suitable for countries developing in the present context, as these measures were not designed for the current climate developing countries face, neither to account for differences between developing nations.

Ghana and Ivory Coast will certainly need to increase their level of industrialization in order to avoid the limits that their agricultural system imposes to local population standards, as well as to reduce their dependency on foreign manufactured goods. However, as this study has confirmed, through their recent history, well-being has not been directly linked with income, level of industrialization or biophysical consumption, but by the combined effect of a number factors such as local policies, internal stability and international governance.

These results indicate that global governance institutions need to understand development as a way to tackle local constraints towards achieving greater well-being and prosperity. This probably cannot be achieved through ‘one size fits all’ measures. Different countries face different constraints.

In order to achieve the developmental outcomes designed by a number of SDGs, the approach developed in this thesis is a tool that can be used to implement and monitor the progress towards these goals. For instance, the metabolism approach provides an understanding behind the difficulties that increased population imposes on providing modern energy access to all, and the effects that increased population can have on deforestation for energy needs. Consequently, despite not being directly addressed by the SDGs, population dynamics would affect progress to achieve SDGs 7 and 15. This implies that there is a trade-off between fuel switching and population growth. If population growth surpasses the rate of fuel switching, overall

deforestation for energy needs will not decrease. In order to achieve greater developmental levels, as well as a mentioned SDG's, multidisciplinary approaches, such as the one developed in this thesis, will be needed.

9.2. Limitations

While this research represents a significant contribution to the field, it also suffers from inevitable limitations. The analysis carried out in this thesis has relied on composite indicators. Most of the selected indicators are simplifications of aggregated data and therefore miss the complexities behind a number of indicators. For example, DMC only measures apparent consumption and does not reflect indirect flows from different material sources. Similarly, life expectancy measures the long-term effects of a number of factors such as health care, environment, education among others. However, despite the limitations of utilizing composite indicators, these indicators are needed to measure and simplify complex problems to provide us with the ability of making decisions based on aggregated information. It simplifies the task of monitoring hundreds of non-composite indicators, especially to policy and decision makers not familiar with the complexities behind aggregated indicators.

The results obtained in this thesis, as well as the policy prescriptions provided to achieve a number of SDGs are context dependent. This thesis has demonstrated that to understand the development paths of Ghana and Ivory Coast and to provide policy prescriptions, the specificities that each country faces need to be considered (conflicts, policies, international relations and available national resources). Therefore, while policy recommendations cannot be extrapolated to other case studies, the method developed in this thesis can be extended to other case studies and could be useful to provide context-based policy recommendations.

Data quality issues have severely limited this type of research in the selected countries in the past. Consequently, wherever possible, some datasets were corrected when inconsistencies were found. Even though it is difficult to ensure that corrected datasets accurately represent the reality that the original dataset inaccurately reflected, by exploring the historical context of both countries, a concerted effort has been made to verify that corrected datasets reflect the reality faced by both countries as accurately as possible.

Corruption and opacity in Ivory Coast's oil sector have influenced the lack of reliable data. Likewise, credible direct economic impact of gold in Ghana could not be obtained. Consequently, the direct relation that mineral extraction and exports have with both countries could not be studied with the same rigour as the relation of agriculture with both economies.

The relation between the economy and energy supply has been time variant in both countries. Hence, the energy-income relation in the future could vary due to numerous reasons. Bearing this in mind, the best efforts were made to prescribe recommendations to achieve energy transitions or decreased energy related deforestation based on obtained results. Due to the lack of strong correlations that could be used to forecast future scenarios, I cannot forecast that certain level of income or biophysical consumption will have a quantifiable impact on one another. Nevertheless, based on obtained results, this study provided plausible outcomes as certain patterns that emerged in both countries, such as the energy ladder, offered a view of probable future energy-income dynamics.

Global governance has influenced both countries, as well as many developing countries, with loan conditionalities. Yet, the method developed in this thesis cannot be used to ascertain that these countries could have achieved better or worse outcomes without global intervention. However, by comparing Ghana and Ivory Coast, it can be concluded that bottom-up approaches –such as the local solutions implemented to counterbalance the effects of the SAPs in Ghana, can provide benefits for the well-being of local citizens of developing countries that a top-down approach might not be able to achieve.

The results found in this thesis do not show that the share raw resource exports in GDP has determined lower economic growth, as the resource curse theory would suggest. However, it has to be acknowledged that during the years for which there is comparable data between Ghana and Ivory Coast, the SAPs and war affected the dynamics of GDP in Ivory Coast, which could influence obtained results. However, in Ghana, there has not been a direct relation between the share of raw resource exports in GDP and GDP growth.

9.3. Next steps/future directions

This study provides a number of research paths that could be further investigated. Future research should continue the path started by this study. By expanding the method developed in this thesis, the development path of other countries, such as those where data quality and availability restrains analysing their development dynamics utilizing a metabolic approach,

could be studied. The analytical method used in this thesis is not constrained to analysing any particular policy area or historical moment, based on data restrictions or historical events relevant to a given case study, the method developed in this research can be adapted to explore other countries' development paths utilizing a biophysical perspective that can be combined with relevant available information.

Further research should extend this method to analyse the development path of other ECOWAS. Analysing the metabolism and development trajectories of the countries that compose the region would provide the basis to assess if there are a number of distinctive development paths in the region, or, if as Table 1 seemed to indicate, each country is following a path of its own. If the development paths of ECOWAS could be clustered into a small number of different development paths, it would provide the foregrounds to study which factors contribute towards achieving positive developmental outcomes in the region and which factors do not. Therefore, those results would prove useful towards developing the right policies to uplift the region, improve living standards and well-being.

Further study on the role that socio-political context has played in the development path of West African countries, would provide interesting benchmarks to assess governmental intervention in the region. Moreover, it would enhance the understanding of the policies that have a positive effect on well-being and development, and how policies could be applied in order to improve well-being in the region.

It has been recognized that different synergies and trade-offs between SDGs are related to the different needs and circumstances of each country (Griggs et al., 2013; Weitz et al., 2014; Allison et al., 2015; Costanza et al., 2016; Delzeit et al., 2016), coinciding with the results found in this thesis. Future studies could analyse each country's structure from a bottom-up approach prior to developing strategies towards the SDGs, which could then be used to assess if each country needs specific measures to achieve the SDGs, or if a number of countries can use similar approaches (top-down approach). Consequently, analysing each country's structure from a bottom-up approach prior to developing strategies towards the different SDGs would provide a better understanding of the actions needed at the national and international sphere to achieve the desired outcomes.

Future work could additionally forecast plausible future scenarios. These could be in line with the SDGs. Forecasting methods should be combined with a qualitative approach that can assess

the feasibility of the designed paths. It is not to be forgotten that the SDGs have been developed from a UN process, which despite being an inclusive process as far as UN processes are concerned (Spijkers and Honniball, 2014; Deacon, 2016), the SDGs have been developed from a top-down approach (Weitz et al., 2014). Therefore, the local context of each country is not considered, and as demonstrated in this thesis, the complexities of each country can constraint or improve the chances of achieving these goals.

Appendix I : Externalities of socio-economic activities, the Kaya identity

Biophysical consumption produces negative externalities: among others, the most commonly measured are carbon dioxide emissions (CO_2). CO_2 is one of the major negative externalities that anthropogenic consumption of energy and materials has over the environment (Ayres and Kneese, 1969). Developing countries face a current situation in which their development will have to be less climate intensive than that taken by previously industrialised countries (Baer et al., 2007). For this reason, it is important to understand if the development path followed by developing countries is carbon -or GHG- intensive or if the development path followed by these countries is decoupling from carbon emissions. That being said, it is to be clarified that the developing world needs space to grow in order to provide decent levels of human development, security and well-being to their citizens.

Carbon dioxide is the most important emitted greenhouse gas globally (IPCC, 2007, 2014a). In 1971, Ehrlich and Holdren (1971) described how the environmental impact of a society could be described as a non-linear relation between impact and population growth, theoretically describing how impact was dependent on a variety of causes. Environmental impact (I) was described as the multiplicative product of (P) population and a function of population (F(P)). This function was developed as the multiplicative product of population, affluence (A) -income- and (T) technology (impact/GDP), creating the IPAT identity (Commoner, 1972; Ehrlich, 1972) where known values of I, P and A are used to solve for T.

Impact, which is usually pollutant emissions, can be proxied by resource use indicators. Goldemberg (1996) uses this approach and observes that trends of resource productivity vary over time. The IPCC uses the IPAT identity with projections of population and economic growth to measure future scenarios of impacts (IPCC, 2007, 2014a, 2014b). However, the IPAT identity assumes unit elasticity (Rosa and Dietz, 2012), therefore its use to test hypotheses about the relative contribution of each driving force has been questioned. Yet, for the purpose of this thesis, it is a useful and simple tool to observe the drivers behind emissions.

A variant of the IPAT identity has been used in order to study past trends of carbon emissions, the Kaya identity (Kaya 1990):

Eq.11. CO_2 emissions = Population x (GDP/Population) x (energy/GDP) x (CO_2/Energy)

It is to be noted that, due to due to the relatively small contribution of CO_2 emissions from fossil fuels to overall GHG emissions in the selected countries (Boden et al., 2013; WRI, 2014), a modified version of the kaya identity, shown in Eq.12, was analysed. This was done with the purpose of observing if the results obtained with Eq.11 would vary once consumption and emissions of non-fossil fuels were considered –especially the role of population growth in emissions. Indeed, utilizing Eq.12, population growth was still the most important driver of GHG emissions. However, due to difficulties of estimating GHG emissions and the inconsistencies found in Ivorian GHG emissions, the Kaya identity will be explored utilizing CO_2 emissions from fossil fuels, which is the only alternative measure of emissions available for both countries.

Eq.12. GHG emissions = Population x (GDP/Population) x (DMC/GDP) x (GHG/DMC).

Appendix I a: The Kaya identity for Ghana

The different components from the Kaya identity show that income, population and carbon intensity of energy have grown, while energy intensity is the only driver of CO_2 emissions that has decreased in Ghana. Fossil fuels CO_2 emissions have increased almost 400% during the 30 years of the study period, which is related with increased importance of fossil fuel consumption that has been substituting biomass consumption. This increase has been driven mainly by increased population and by an increase in the carbon emitted per unit of energy -due to the increase use of crude oil in Ghanaian energy mix. Consequently, economic growth has not decoupled from CO_2 in Ghana. With prospects of population almost doubling by 2050 in Ghana (UNDESA, 2015), carbon dioxide emissions are expected to continue rising under the current path.

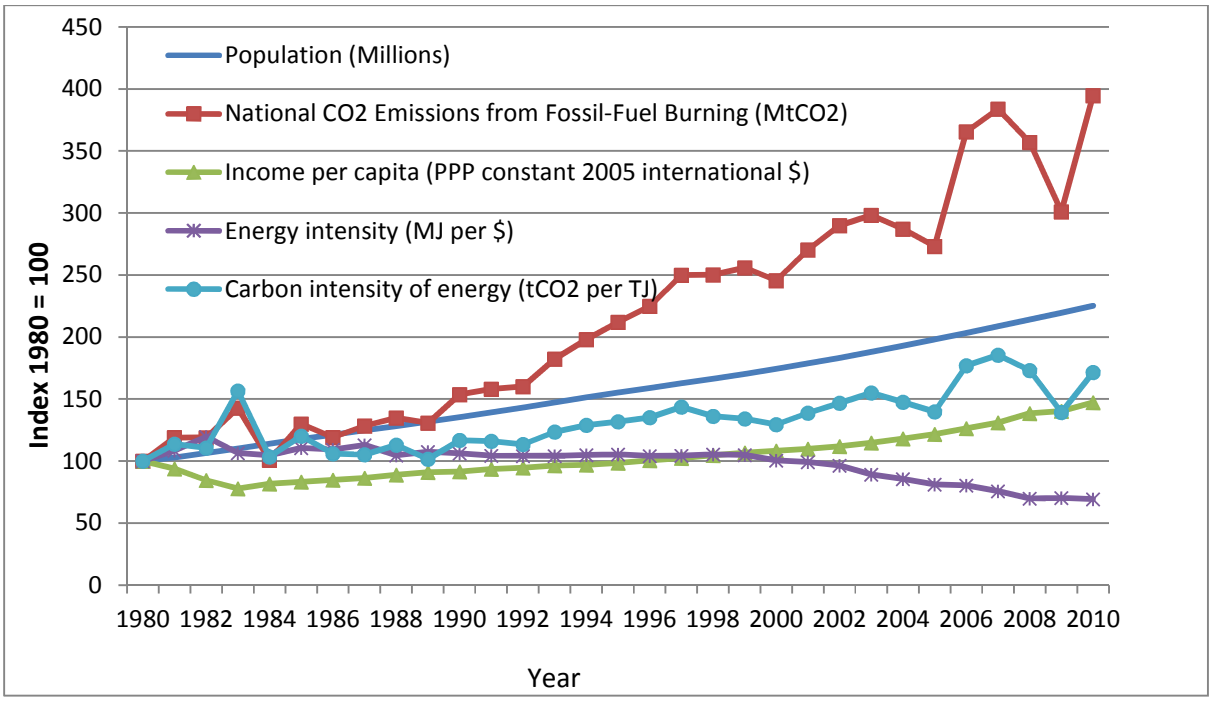

Figure 43. Kaya identity factors for Ghana from 1980 to 2010, index to 1980. Population in 1980=10.8 million. CO2 emissions from fossil fuels in 1980=2.6 Mt. Income per capita in 1980=1,004 $. Energy intensity in 1980=15.5 MJ per $. Carbon intensity of energy in 1980=15.2 tCO_2 per TJ.

Appendix I b: The Kaya Identity for Ivory Coast

Fossil fuel CO_2 emissions have slightly declined in Ivory Coast. Income and carbon intensity of energy are the two drivers of the decline experienced by CO_2 emissions, as these are the only factors that have decreased. Similarly to Ghana, population has been the main driver of fossil fuels CO_2 emissions; however, it has been counteracted by declining carbon intensity and income.

The Ivorian case, declined CO_2 emissions from fossil fuels are clearly explained by the context in which Ivorian income declined. As hypothesized by the energy ladder, with decreased income the share of fossil fuel in the energy mix has decreased. It is to note that carbon intensity of energy and energy intensity of the economy are affected from 2005 onwards by smoothed biomass data in TPES, decreasing energy intensity values and increasing carbon intensity of energy values when compared with original dataset.

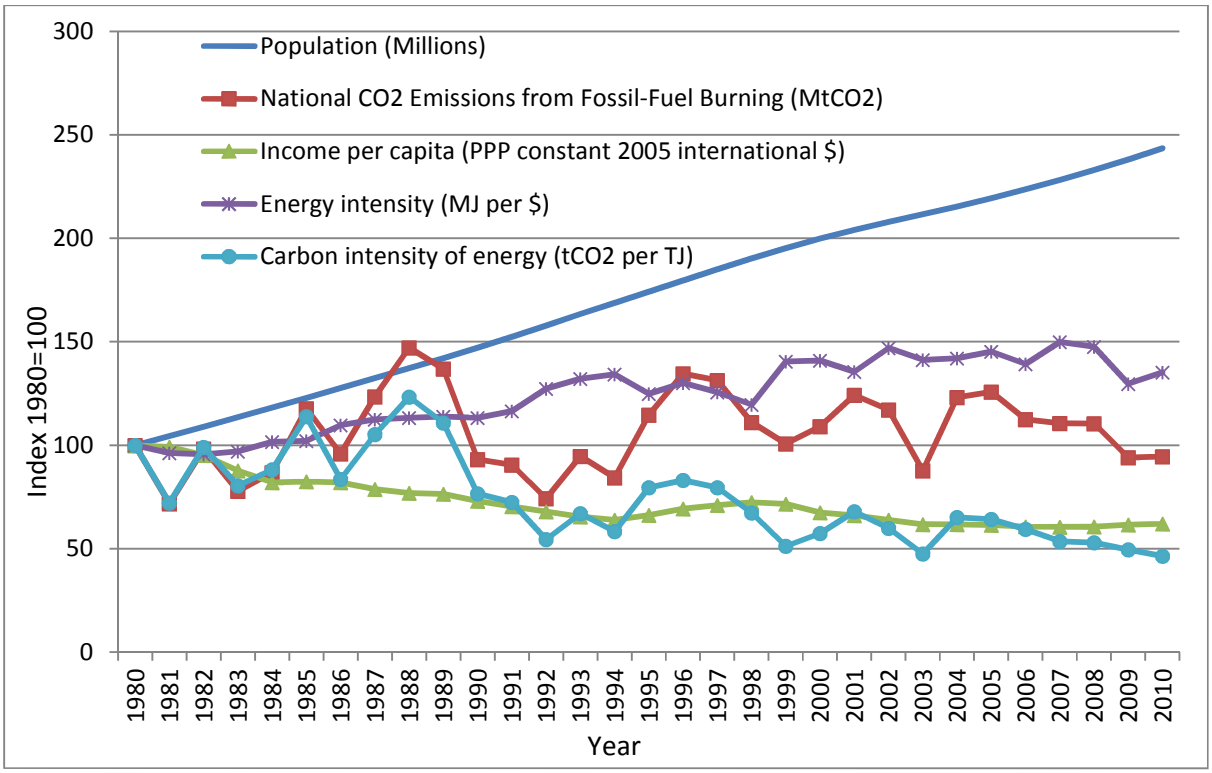

Figure 44. Kaya identity for Ivory Coast from 1980 to 2010, index to 1980.
Population in 1980=8.3 million. CO_2 emissions in 1980=6.2 Mt. Income per capita in 1980=2,695 PPP 2005$. Energy intensity in 1980=6.7 MJ per $. Carbon intensity of the economy in 1980=279 tCO_2 per million $.

Appendix II: Ghana's oil, the petroleum revenue management law

In 2007, offshore oil in commercial quantities was discovered in Ghana, triggering the fears that some of the effects of the resource curse could appear in the country. However, oil could bring a large inflow of resource rents to the country, modify the trade balance of Ghana, as well as decreasing the need for energy imports. But up to date, national oil has not been used as an energetic source (IEA, 2015b).

Theoretical work has been done to examine if the resource curse could be avoided in Ghana after recent oil discoveries. Kopiński et al. (2013) identify the key factors that could make Ghana a success story in managing revenues from recent oil and gas discoveries. The most important factor is the time of the discovery, which sets Ghana as a late comer to the oil industry. Being a late comer gives Ghana the ability to benefit from the experience and policies of success stories such as in Norway and Trinidad and Tobago. The stable democratic process, fiscal framework put in place to manage the oil revenues and consensus between the civil society and political parties to control the overall process, should help Ghana to avoid the curse. Therefore, it is considered that if the curse was to appear it should it be perceived as a treatable disease (Kopiński et al., 2013).

In addition, prior experience in managing other raw rents such as gold and cocoa, which diversify export composition, and the knowledge of the existence of the resource curse, are some of the main points shared by the literature to avoid the curse. Export diversification in an economy as well as transformation of natural resource revenues into other forms of productive capital (being examples of measures implemented by the Dutch government to tackle the Dutch disease) is what is considered by Bazilian et al. (2013) as the Dutch Cure. Nevertheless, we have to remember the effects that global governance has had in preventing state-led industrialization financed with resource rents in Ghana.

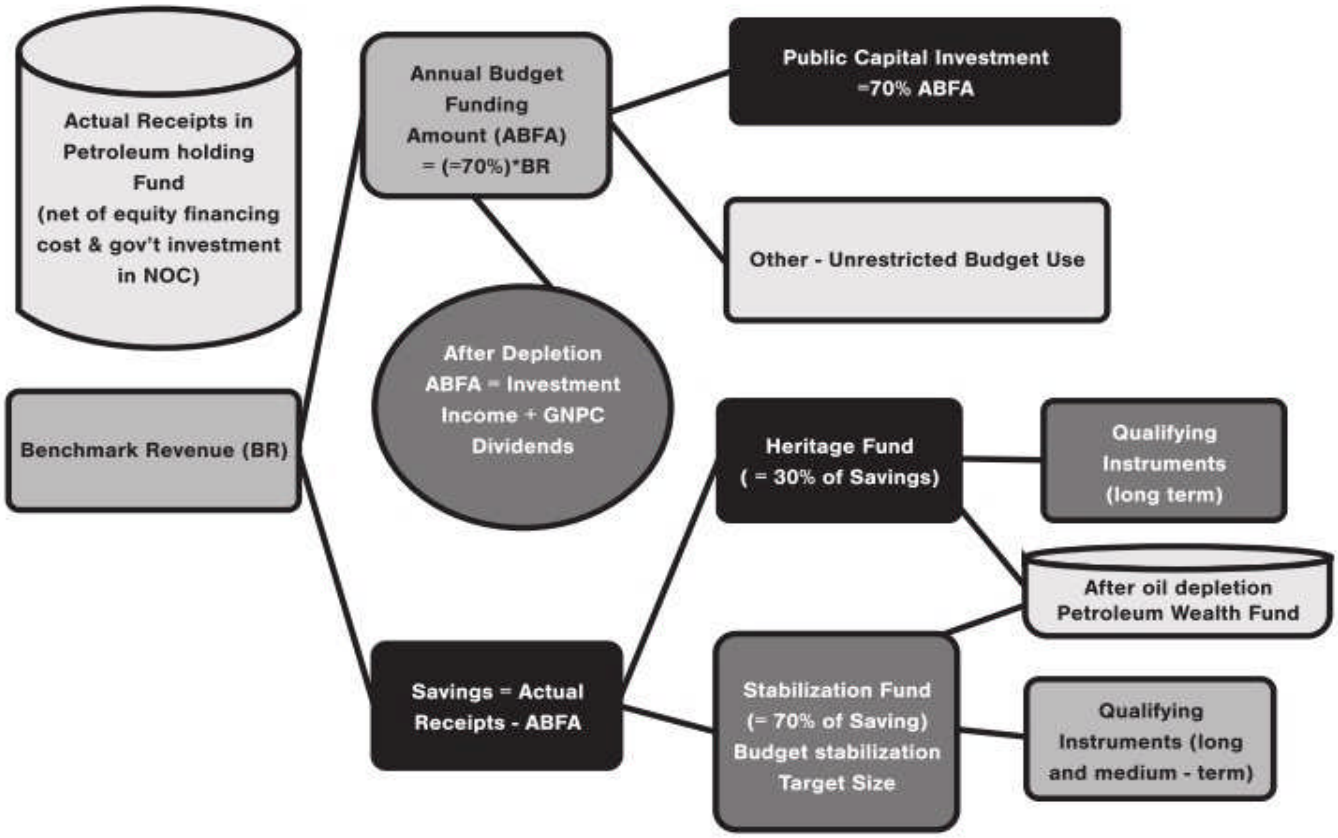

Figure 45. Ghana's Petroleum Revenue Management Law framework. Source: Adam et al. (2013).

Figure 45 shows the framework put in place by the Ghanaian government to invest oil revenues in capital investments and to create funds to avoid discretionary political decisions, ensuring long-term savings for the future. The Annual Budget Funding Amount allows the government to support its budget and can be used as a collateral for loans. The Heritage Fund is to endow future generations with oil wealth, while the stabilization fund has created to cushion for unanticipated petroleum revenue shortfalls. This framework has been established in the Petroleum Revenue Management Law, which was modelled based on the Norwegian experience and with Norway's support (Kumah-Abiwu et al., 2015), which was ratified in 2011 (Bazilian et al., 2013).

To a certain extent, in economic terms the framework has worked. For instance, in 2014 GDP at constant 2005 USD, GDP grew from 19.7 billion 2005 USD in 2013 to 20.5 billion USD in 2014 (World Bank, 2015), while oil prices declined. This is a decrease is in the rate of economic grow from the previous years, but it demonstrates the ability of the country to withstand international oil price volatility. It is to be noted that exported oil quantities for

2013 and 2014 are not yet available to observe if oil exports greatly increased to counterbalance declining prices.

Creating a legal framework to manage oil and gas revenues is an important step to avoid the resource curse. Adam et al. (2013) examine the legal fiscal framework put in place to manage oil revenues and observe how it has been implemented. Ghanaian government enabled a Public Interest Accountability Committee to observe how the law was being implemented. According to Bazilian et al. (2013) the framework requirements were met in 2011, as reported by the committee report for the petroleum management of 2011. Adam et al. (2013) observe some violations of the legal framework, which are deemed to operational challenges of the first year of implementation, politically motivated project selection and incapacity to invest revenues efficiently. As mentioned by Ayelazuno (2013) it is of crucial importance to respect the framework put in place, as other resources such as gold have not directly benefited the well-being of the population due to the neo-colonial orientation of the extraction industries.

Mentioned studies agree on the effort the government has done to increase infrastructure, agricultural development to benefit rural population and building an energy infrastructure. On the other hand, education and health improvements are not getting enough political attention (Adam et al., 2013). Neglect of education is a sign of the resource curse. However, based on World Bank (2015) data on education expenditure, education expenditure as a share of GNI has not decreased, but has remained stagnant since oil extraction began, which is not common in the trend of education expenditure and therefore could be a statistical artefact.

Not everything about Ghana's petroleum management seems positive. A major problem the country faces are the stabilization clauses signed by oil companies prior to development of environmental or other laws. These clauses establish compensation for any substantial change in circumstances that prevailed at the time the contracts were signed. Therefore, these clauses limit the government's power to ensure environmental protection in the present and the future.

Natural resources can be a blessing when high-quality institutions are in place at an advance stage of development, as it happened in Norway (Gylfason, 2001b; Saad-Filho and Weeks, 2013). Norway discovered its oil wealth when the country was well developed, enabling policies to manage revenue windfall from oil, involving three administrations to control oil

operations, policy related issues, regulatory and technical issues (Kumah-Abiwu et al., 2015). However, in the Ghanaian case, civil society organizations have deemed that the model of oil revenue management of Norway, where collateralization of oil related money is not allowed, cannot be successfully implemented in Ghana (Kopiński et al., 2013). This exemplifies that regulations have to be adapted to each country depending on its needs. Consequently, the framework put in the place by the country and the fact that oil is the third most important export, means that Ghana is on a solid track to avoid oil related resource curse signs.

Appendix III: Continuation of Ivory Coast's main agricultural crops evolution: coffee, rubber and cotton

Appendix III a: Coffee

Coffee has been the crop that has suffered the most from agricultural liberalization policies. At the beginning of the study period, coffee was the second most important agricultural crop in Ivory Coast, almost equalling cocoa in export revenues. However, the combined effect of weather patterns, price volatility, liberalization of the sector, reduced price paid to farmers and increased export taxes during the war period (OECD/AfDB, 2002, 2006) destroyed the coffee sector. Can this be regarded a resource curse sign? The coffee sector was regulated by the coffee and cocoa board. This board has been linked with political corruption and considered to foster the crisis in the country (Globalwitness, 2007; Guesnet et al., 2009; BBC news, 2013). Despite being other reasons behind the crisis, most studies coincide on the importance that corruption in the coffee and cocoa sector management has played in the conflict. Thus, cocoa and coffee, the two main agricultural resources in Ivory Coast, have been affected by the resource curse via mismanagement and rent-seeking behaviours, such as increasing coffee export taxes during the war period exemplifies.

Table 21.Production, exports and price of coffee in Ivory Coast in 1980 and 2010 with their average annual percentage growth rates and standard deviations.

Resource	Unit	1980	2010	Average annual percentage growth rate ± standard deviation
Green coffee production	kt	250	94	5.7±51.6
Total coffee products exports	kt	210	103	4.8±44.7
Total coffee products exports	Price per tonne (constant 2005 USD)	5,293	1,975	-0.9±22.5
Total coffee products exports	Million constant 2005 USD	1,009	123	-1.8±31.8

Decreased coffee prices decreased farmers income and subsequently decreased internal consumption (OECD/AfDB, 2002). However, coffee farmers moved to more profitable crops, not resembling the Colombian case, in which reduced coffee prices led to conflict (Dube and Vargas, 2013). Consequently, decreased coffee production and exports have not had a long-

term effect on the economy. When the Ivorian conflict ameliorated, the government increased fixed price paid to farmers to boost the sector, but low governmental credibility did not encourage farmers back to coffee plantations (OECD/AfDB, 2006). The case of coffee signals the importance that good governance and government credibility have to implement successful policies.

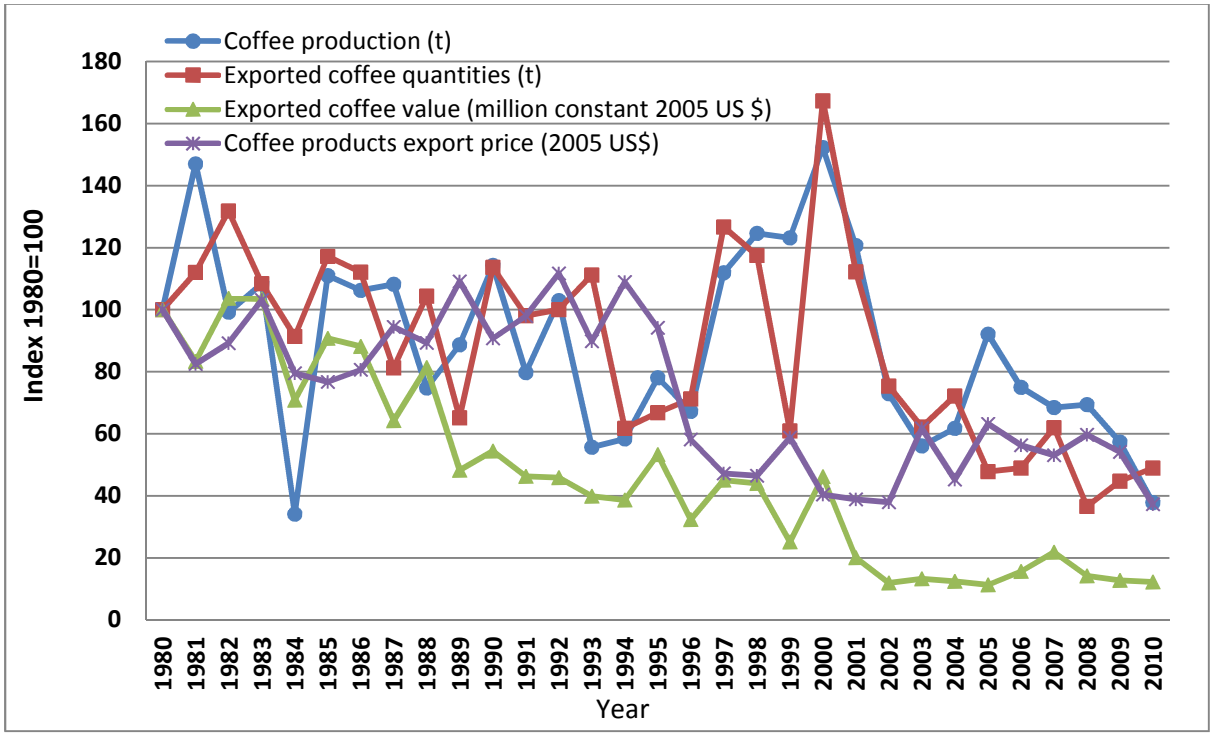

Figure 46. Coffee production, exported quantity, export value, and export price in Ivory Coast from 1980 to 2010, index to 1980. Coffee production in 1980= 250 kt. Exported coffee quantities in 1980=210 kt. Exported coffee value in 1980= $1 billion 2005 USD. Average coffee products export price in 1980= $5,293 2005 USD.

In 2012 the government realised the role it played in the coffee sector and reinstituted locally guaranteed prices and expressed its commitment to improve transportation between production, consumption and export areas (OBG, 2013; OECD/AfDB/UNDP, 2014). However, governmental credibility has to increase to convince farmers to move back to the crop.

Appendix III b: Rubber

Natural rubber production and exports have steadily increased. Good climatic conditions for production of this crop have boosted Ivory Coast's global position, making the country one of the five global countries with higher rubber yields (FAOSTAT, 2014b). Rubber exports values have steadily grown, increasing the share of rubber in total agricultural exports value from

1.4% in 1980 to 11.9% in 2010. Rubber prices have not decreased as much as coffee prices and the sector has not been as regulated. Therefore, planters have moved from other crops to rubber plantation (OECD/AfDB/ECA, 2010), consequently increasing production.

Table 22.Production, exports and price of rubber in Ivory Coast in 1980 and 2010 with their average annual percentage growth rates and standard deviations.

Resource	Unit	1980	2010	Average annual percentage growth rate and standard deviation
Natural rubber production	kt	22	235	8.7±10.1
Natural rubber dry exports	kt	21	239	8.7±8.7
Natural rubber dry exports	Price per tonne (constant 2005 USD)	1,956	1,513	2.7±23.7
Natural rubber dry exports	Million constant 2005 USD	42	361	11.4±30

Rubber production has experienced the most notable increase from all of the examined agricultural products (Amoro and Shen, 2012; FAOSTAT, 2014a; UNIMTS, 2014). The expansion of this crop is largely due to the attractive producer prices. Moreover, companies that produce intermediate rubber products for export have established in the country through the last decade of the study period. This is in line with the governmental aspirations to develop the rubber processing industry and a positive move towards avoiding the resource curse on a crop that is growing in importance in the country driven by an increasing international demand (OECD/AfDB/UNDP, 2014).

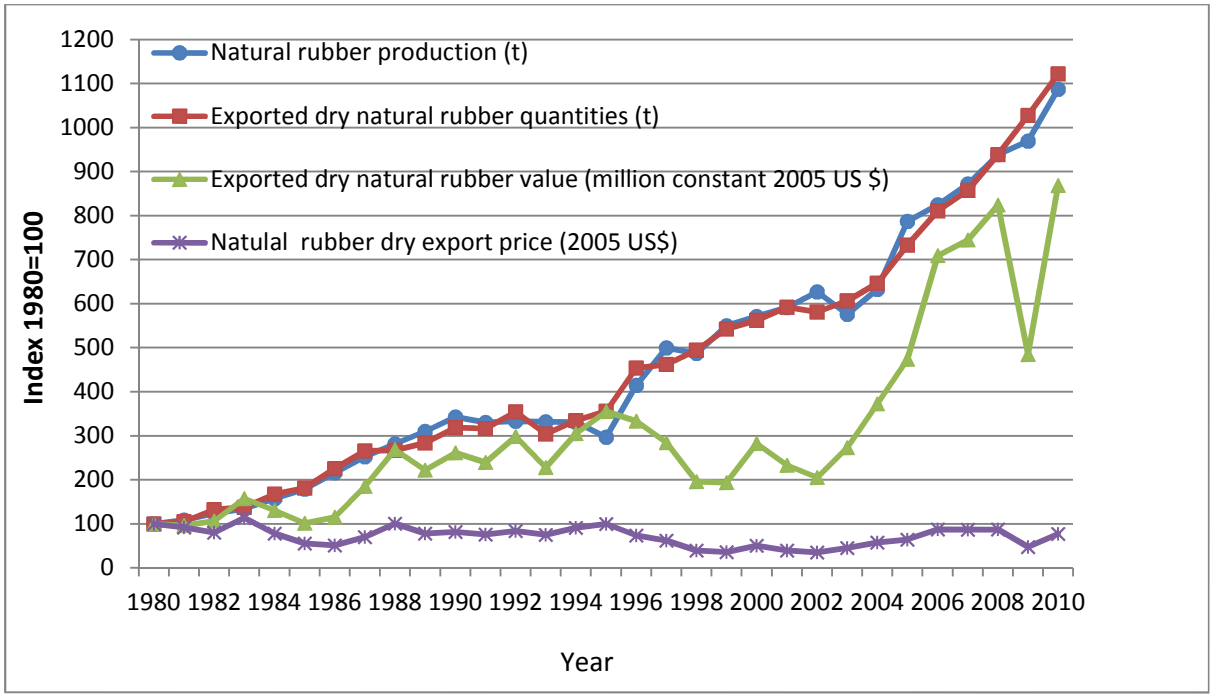

Figure 47. Natural rubber production, exported quantity, export value, and export price in Ivory Coast from 1980 to 2010, index to 1980. Natural rubber production in 1980=22 kt. Exported dry natural rubber in 1980= 21 kt. Exported dry natural rubber value in 1980= $42 million 2005 USD. Natural dry rubber export price in 1980= $1,956 2005 USD per tonne.

The Ivorian government liberalized the prizing and marketing system of rubber (FAO, 2003), which consequently stimulated rubber exports, making rubber Ivory Coast's third mayor export from the year 2003 onwards (UNIMTS, 2014). Liberalization policies benefited rubber as a crop, but had an opposite impact on other crops such as coffee. Therefore, compared to the previously examined resources, rubber has not experienced resource curse channels.

Appendix III c: Cotton

Cotton has suffered the resource curse channel of rent-seeking behaviours through the war years. Cotton is mainly produced in the north of Ivory Coast, which was controlled by the rebel group Forces Nouvelles (FN), but processing and export routes are in the south, which was controlled by the government during the conflict period. Transported cotton from the North had to pay road levies to FN, which reduced cotton farmers' profits. In addition, Burkina Faso and Mali had better producer prices, which encouraged cotton producers in Ivory Coast to divert over half of total local production (OECD/AfDB, 2006). Together, with decreasing international cotton prices, the cotton sector was highly affected by these events (OECD/AfDB/ECA, 2010).

Table 23.Production, exports and price of cotton in Ivory Coast in 1980 and 2010 with their average annual percentage growth rates and standard deviations.

Resource	Unit	1980	2010	Average annual percentage growth rate and standard deviation
Cotton lint production	kt	59	82	5±28.1
Cotton lint exports	kt	39	85	5.8±26.6
Cotton lint exports	Price per tonne (constant 2005 USD)	2,615	798	-1.3±23.7
Cotton lint exports	Million constant 2005 USD	102	67	3.2±33.6

Cotton production and exports have experienced high variability due to the structure of the cotton industry in the country, which, as it happened with previously analysed crops, this crop faced major challenges due to governmental intervention in the sector affecting producer prices (Bassett, 2006; OECD/AfDB, 2006). Prior to the liberalization period, production, producer prices and processing of cotton were controlled by the Compagnie Ivoirienne de Developpement du Textile (CIDT), which subsidized fertilizer and pesticide use (Bassett, 2006). Producer prices have been declining in the country, and have been far below export prices despite cotton being subsidized by the government to incentivize growers not to move away from cotton (Gbetibovo and Delgado, 1984; Bassett, 2006). However, with the liberalization of the sector and the conflict, the cotton sector has been in decline, especially after 2006 (OECD/AfDB, 2006; OECD/AfDB/ECA, 2010) when new middle men started to buy cotton from farmers at very low prices to resell the crop in other countries and to cotton manufacturers. Therefore, farmer's income decreased.

The cotton sector has been influenced by governmental actions concerning producer prices, liberalization of the sector and privatization of CIDT. Combined with the instability that divided production and manufacturing centres, it has all shaped a sector that has suffered under the national conflict. After 2010, the government understood the role that its policies had on this sector, and as it did with other crops, it tried to amend previous policies.

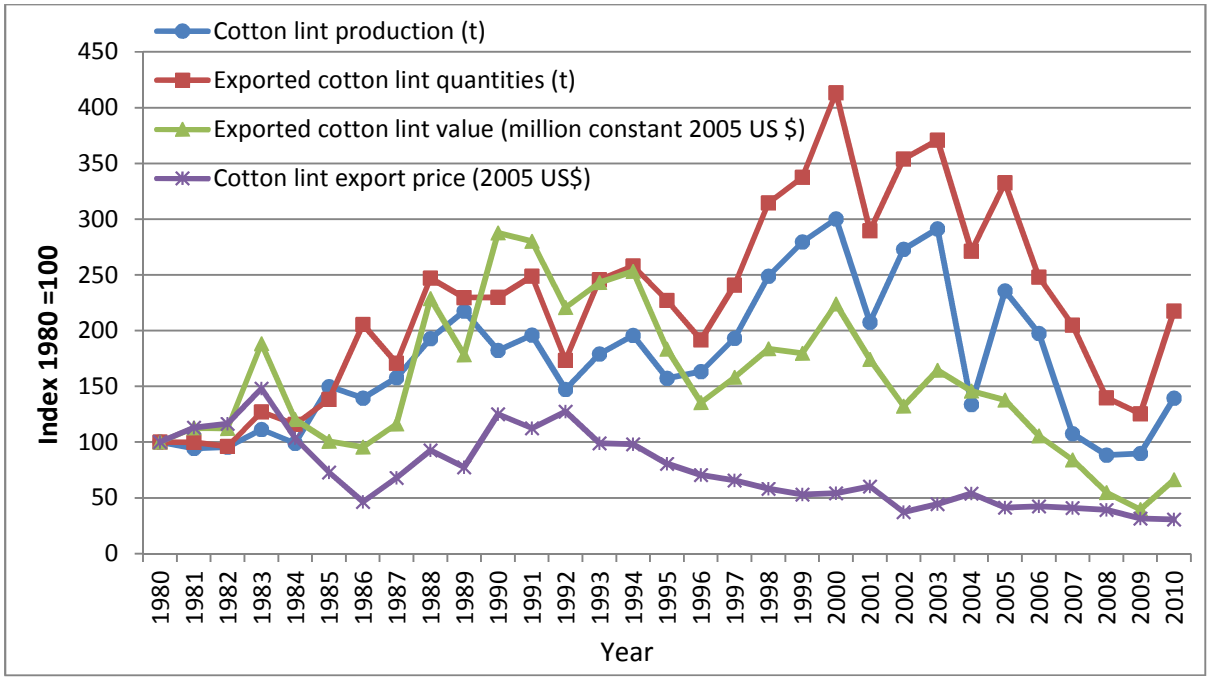

Figure 48.Cotton lint production, exported quantity, export value, and export price in Ivory Coast from 1980 to 2010, index to 1980. Cotton lint production in 1980=59kt. Exported cotton lint quantities in 1980= 39kt. Exported cotton lint value in 1980=$102 million 2005 USD. Cotton lint price per tonne in 1980=$2,615 2005 USD.

These crops, as well as cocoa, exemplify that Ivory Coast's agriculture has experienced the resource curse through rent-seeking behaviours and rent mismanagement. Therefore, farmers' incomes, which were already decreasing due to declining international prices, were further reduced due to mentioned resource curse channels –with the exception of rubber farmers. Consequently, these crops demonstrate that national frameworks towards agricultural rent management are important to avoid the decline of the agricultural sector, and especially to ensure farmers standards.

Acronyms and abbreviations

ACEP	Africa Centre for Energy Policy
ADF	African Development Fund
BAU	Business as usual
CDIAC	Carbon dioxide information analysis center
CIA	Central Intelligence Agency
CIDT	Compagnie Ivoirienne de Developpement du Textile
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CPI	Consumer price index
CSIS	Center for Strategic International studies
CSSPPA	Caisse de stabilisation et de soutien des prix des productions agricoles
DCs	Developing Countries
DMC	Domestic material consumption
ECOWAS	Economic Community of West African States
EFA	Energy flow analysis
EITI	Extractive Industries Transparency Initiative
ERP	Economic Recovery Programme
ESAF	Enhanced Structural Adjustment Facility
EU-15	European Union (member countries previous to 2004)
FAO	Food and Agriculture Organization

FN	Forces Nouvelles
GDP	Gross Domestic Product
GEA	Global Energy Assessment
GHG	Greenhouse gasses
GJ	Gigajoules
HDI	Human Development Index
IEA	International Energy Agency
IMF	International Monetary Fund
IPCC	Intergovernmental panel on climate change
Kcal	Kilo (Thousand) calories
Kg	Kilo (Thousand) grams
Km^2	Square kilometer
Kt	Kilo (Thousand) tonnes
Ktoe	Kilo (Thousand) tonnes of oil equivalent
LDCs	Least Developed countries
LPG	Liquefied Petroleum Gas
MDGs	Millenium Development Goals
MFA	Material Flow Accounting
Mt	Mega (Million) tonnes
$MtCO_2e$	Million tonnes of carbon dioxide equivalent
OECD	Organization for Economic Co-operation and Development
PPI	Producer price index
PPP	Purchasing Power Parity

SAPs	Structural adjustment programmes
SDGs	Sustainable Development Goals
SERI	Sustainable Europe Research Institute
SIR	Societe Ivoirienne de Raffinage
SW	Sachs and Warner
t	Tonne
TJ	Terajoules
TPES	Total primary energy supply
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNIMTS	United Nations International Trade Statistics
UNSD	United Nations Statistics Division
USGS	United States Geological Survey
USD	United States Dollars
WEO	World Energy Outlook
WHO	World Health Organization

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