

THE DETERMINANTS OF COCOA SUPPLY IN GHANA

Felix Ernst

Ca' Foscari - Master in Economics and Finance

Supervisor: Prof. Zolin

Class of 2019



Abstract

This master thesis researches the determinants of the yearly cocoa supply in Ghana between 1980 and 2011. To introduce the reader to the opaque world of cocoa trade a detailed and wide-ranging review of the agronomics of cocoa beans, its history and trade as well as the current market is undertaken. Based on these discoveries a linear regression model is employed to select national and international factors that impact local cocoa bean production in Ghana. A strict model selection process led to the exclusion of variables that other authors have found significant in explaining export of cocoa beans. The results show the expected impact of variables that are strictly connected to the usage of land and its efficient usage. Moreover, the yearly oil price and the global stock among others are significant showing a clear impact on global supply-side variables. The thesis closes with a literature analysis and general recommendations for global and local policy to improve and stabilize the cocoa bean supply.

Index

Introduction.....	page 05
Global Cocoa Market.....	page 07
The Ghanaian Cocoa Production.....	page 47
Conclusion.....	page 71
Bibliography.....	page 78

Introduction

In the ever-increasing global trade of today there are a few markets that are mostly beyond the public eye although the final product is very dear to many people. The market of cocoa beans is one of these opaque markets. Although the final product, chocolate, is a craving for many, very few people know about the complex supply chain of chocolate and more specifically about the supply chain and the production of cocoa beans. Indeed, the production of cocoa beans takes place in the developing world and is often beyond the consumers' awareness. It is my goal to contribute to the rising awareness of the general public with respect to the cocoa supply chain. Specifically, I concentrate on the supply of cocoa beans in Ghana, the second biggest producer in the world, and analyze the determinants that have an impact on the production of cocoa beans.

Current and past studies have concentrated on the determinants of cocoa beans' export in different countries around the world. To my best knowledge this thesis is the first attempt to analyze the determinants of local cocoa bean production. Past research and its focus on the export of agricultural commodities investigates a slightly different question and aims at providing insights into policies that are globally relevant. The question of trade barriers and trade policies is more prevalent than in this thesis. Consequently, the global market for agricultural commodities is of deeper interest while the local market is considered a given. In contrast, this thesis closely looks at the internal market of Ghana and its development over time. A potential advantage could be the identification of factors that drive cocoa beans' production on a local level and that are not present as factor in the decision to export cocoa beans. Additionally, the analysis of the drivers of cocoa supply is highly relevant on different levels: it can help to shape internal policy decisions that concern the farmers but also global policies regarding trade and price controls.

On a local level, the increase in productivity and sustainability can be driven more convincingly forward when these factors are known. In the end these factors shape part of the livelihood of many poor farmers that rely on the production of cocoa beans. Income security is the main concern of all cocoa farmers every crop season. There are at least 800,000 people in Ghana that rely on the cocoa bean sector as their main source of income. (World Bank, 2016) As Ghana has identified cocoa as one of the key sectors for its continued development it is important to gain deep insights in the functioning of the cocoa bean production. The improvements in productivity and marketing on a local and international level shall contribute to the ambitious goals of retaining a higher share of the value chain in the country and at the same time increase production itself.

This thesis is built on two separate chapters: the first part covers the cocoa market on a global level. The general overview also includes the necessary background information on the agronomics of cocoa beans, the history of cultivation and consumption, and an extensive overview of the current supply and demand structure. This chapter is crucial to understand the dynamics that unfold on a local level. Indeed, the second chapter hones in on Ghana and its cultivation of cocoa trees. It concentrates on the unique history of cocoa cultivation in Ghana and the economic and socioeconomic history of Ghana between 1950 and 2015. I develop the key results of thesis based on this deep understanding of the workings of the Ghanaian cocoa market. The linear regression model contains eleven independent variables which seek to understand changes in the yearly Ghanaian cocoa production. The data is taken from various public sources such as the World Bank's and the Food and Agriculture Organization corporate statistical's databases as well as non-public sources such as the International Cocoa Organization (ICCO). The combination of all my sources forms a complete set of available data for the Ghanaian cocoa sector.

The Global Cocoa Market

The first chapter of this master thesis will introduce the reader to the world cocoa market and its characteristics. The following arguments will be considered: the various typologies of cocoa and the characteristics of the plant, the cocoa market and its history, and the structure of suppliers and users worldwide. Treating all these arguments in detail enables the second part of the thesis to be more specialized and focused on the Ghanaian cocoa production.

The Agronomics of Cocoa

To fully understand the drivers of supply in the cocoa market and understand the various policies that can be applied on national and international level it is important to have a solid understanding of the agronomics of the international cocoa production. Firstly, the cocoa tree has some specific requirements that limit the area where growing is feasible and profitable. The cocoa beans are grown by three different species of cocoa trees which are varyingly susceptible to various diseases and plagues that will be further discussed here. The last part of this subchapter will focus on the harvest of cocoa.

The production of cocoa is confined to the area of the world that lies within 20 degrees north and south of the equator. This band around the world encompasses the following countries which are producing a significant amount of cocoa: Côte d'Ivoire, Ghana, Nigeria, Cameroon, Ecuador, Peru, Indonesia, Dominican Republic, Colombia, Brazil and Papua New Guinea. Other countries such as Togo, Mexico, Venezuela, Liberia, India and Sao Tome and Principe are producing no more than 30.000 tons a year (in 2014/2015) according to the ICCO (2017). Most of the yearly crop is found between 8° north and south of the equator. The cocoa trees are especially productive up to 300m above sea level although cocoa is grown in small quantities up to 1200m above sea level in countries like Uganda.

All these countries have a similar climate that is needed by the cocoa tree: humid conditions with high temperatures while optimal growth can only be obtained by providing shade for the trees. The maximum temperature to grow cocoa is around 32°C while the temperature should not fall below 18°C. The annual rainfall should remain between 1250mm and 3000mm. None of the production areas in the countries has a prolonged dry season (above 3 months) or experiences less than 100mm of rainfall in any month. (Dand, 2011) The amount of water available to the tree is especially important for the quality of the cocoa beans and the size of the crop. The cocoa trees need enough water at two points of the growing cycle: when the trees flower and when the pods that contain the cocoa beans are developed. The rainfall in the first period influences the size of the pods and the number of beans contained in each pod while a dry spell during the pod development could lower the amount of fat contained in each bean.

In any case, the rainfall is not the only deciding factor. Weather in general is important to the growth of the trees and each crop. Much rain with a lot of sun afterwards actually produces a lower humidity of the soil and thus lowers the availability of water to the trees with respect to less rain and cloudy weather. A study undertaken in 1994 by Mora et al. implies that the more important aspect of the rainfall is the distribution and not the quantity. Continued rainfall increases the flowering period of the cocoa trees. The temperature affects the fat content of the beans instead. Higher temperatures produce harder cocoa butter that is often preferred by the processing industry. As mentioned above, the cocoa trees need shade from the sun. Especially young trees need shade to form the canopy that prevents weeds to grow around the base of the tree and extract valuable humidity from the soil. The protection from higher trees against the sunlight is needed until the trees have reached an age of around two to three years when the shade can be reduced or removed completely. The complete removal of shade can lead to better yields but needs to be balanced by

extra water and nutrients to be added to the soil. The protection provided by banana trees, mango trees etc. against wind is necessary because even a small, constant breeze can damage cocoa trees and especially the leaves. Naturally, the need for protection very much varies with location of the plantation. Lastly, the type of soil is important: generally, the soil should be able to retain humidity but also drain excess humidity without problems. Dand (2014) proposes a composition of 50% large particles of sand with good drainage capabilities, 30-40% clay that has good retention capability and contains nutrients while the rest should be up of middle-sized particles.

The cocoa tree, in Latin called *Theobroma Cacao*, has various species but only two of them are of interest here: Criollo and Forastero. While the first and some other sub-species like Nacional, are able to produce very interesting beans that can be used in delicately flavored chocolate of outstanding quality, only the second species is economically viable. Nevertheless, the retention of a genetically diverse gene pool is important for the survival of the plant. The Criollo type also has a historical relevance because it was the only type grown until the mid-18th century. The origin of various subspecies can be found in Figure 1. Afterwards it was substituted by the more resilient Forastero species that also exhibits higher yields. There are three important sub-species for the Forastero type: firstly, the Amelonado is the economically most important type of cocoa and is still grown in Brazil and West Africa. The main part of each yearly crop is produced by Amelonado trees. This sub-species produces a hard pod with a shape that resembles a melon, hence the name, and that contains up to 40 beans which are darker and smaller than the beans of the Criollo type. The beans and their derivatives have a stronger flavor than the Criollo beans. A discovery, made in the 50s, are the hybrids that emanate from the Amazonian region and these types slowly replace the Amelonado type due to some improved characteristics: the newer tree type has higher yields and is more resistant to different diseases and pests.

Another type is the Trinitarios sub-species which is a cross of the Forastero and Criollo types. This type was most likely created by humans through the introduction of the Forastero type to the plantations of Trinidad, Venezuela, West Cameroon and Java. The crop is less uniform than the Amelonado type and more similar to the Criollo type with less beans and different coloring.



Figure 1: Origins of different species of Cocoa in Latin / South America. Source: Motomayor, 2008

A detailed description of a cocoa tree is useful to better understand the impact of environmental factors on the crop. The cocoa tree of each species and sub-species has the same three development stages when grown from a seed: after the initial germination, the cocoa tree grows some cotyledons to about an inch above the surface. Building on this initial epigeal germination, the tree grows its first real leaves. The second step is characterized by vertical growth until the first fan branches are built. The final number of fan branches depends on the species. The Amelonado sub-species i.e. normally grows 5 fan branches which then form a jorquette. (s. Figure 2) Any further growth is mainly determined by the amount of light available to the tree.

Light is also the deciding factor for the point in time when the jorquette is formed and whether one or more chupons will grow beyond the first set of fan branches and form another set of fan branches with its own jorquette. A cocoa tree usually reaches a height between eight and ten meters but for harvest purposes is normally restricted to a growth of four to five meters.

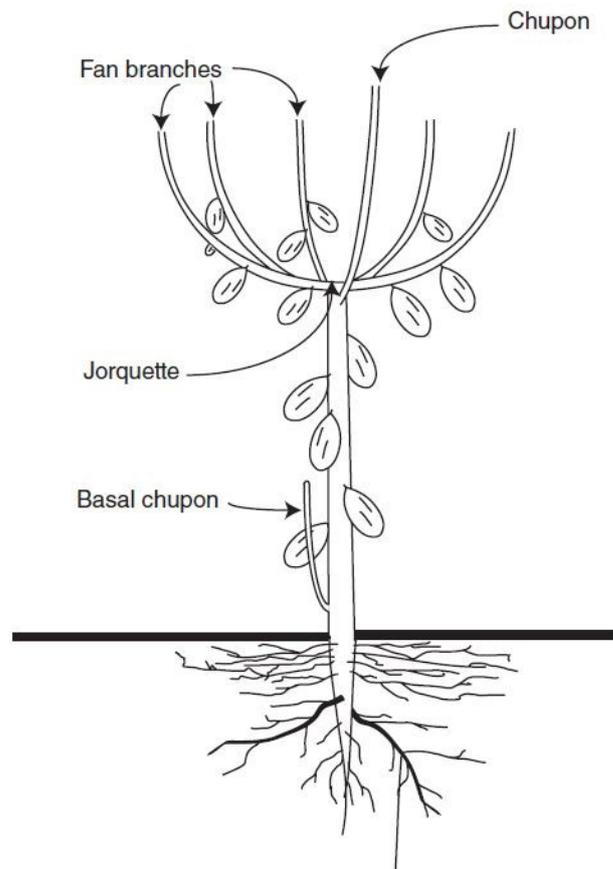


Figure 2: Schematically representation of a cocoa tree. Source: Dand, 2011

The root system of a cocoa tree consists in a main tap root and a number of fine lateral roots which do not reach as deep in the soil. The main tap root is prevalently responsible for the stabilization and reaches up to 1,5m deep. Under normal conditions it is not involved in absorbing nutrients and water which is the main function of the smaller roots. Only in a particular dry setting, the main tap root will absorb water from the deeper parts of the soil which the smaller roots cannot reach.

The leaves form in bursts and start out with a reddish color that changes towards green when the leaves hard off.

The main determinants in leave production are moisture, light intensity and nutrients. The flowering period of the cocoa tree has a rare characteristic as it is cauliflorous, which means that the flowers grow on the trunk and the branches of the tree instead of the leaf nodes. Naturally, successful pollination by insects results in pods growing directly out of the trunk and the branches. A tree can have up to 10.000 flowers a year but only 10-50 will be pollinated successfully and by natural selection only some these will continue to grow and mature into pods that contain the precious cocoa beans.

A cocoa tree reaches maturity and starts to produce a viable number of pods after three to five years. On a plantation, the cocoa trees are often planted in thinned forest or under shade trees as mentioned above. Especially in West Africa, the use of thinned forest is common because it requires less initial capital investment but it also has two significant disadvantages: the soil will not be used to its fullest potential due to other plants and weeds extracting nutrients and some of the shade trees could be host to diseases and pests that affect the cocoa trees. Additionally, the shade that is created by the thinned forest might not be ideal, either too dense or too light, for the cocoa trees. The substitution of forest for a well-planned plantation with appropriate shade trees is more costly endeavor but can produce a higher yield later. It also offers the possibility to grow other crops such as palm oil, bananas, coconuts and melons. The advantage of interplanting is clear for the farmer: he would be less reliant on the price of cocoa and can expect a less volatile income with other fruits or resources to sell as well. For this higher revenue certainty, the farmer must sacrifice some of the efficiency that a single crop plantation can deliver. In any case, the yield can be maximized by eliminating the shade trees by the time the cocoa trees have matured but this has drawbacks that must be considered: very few areas are suitable for this intensive

growing because the soil needs to be extra rich in nutrients and water. The farmer also often needs to add more insecticides because the cocoa trees without shade are no longer protected against capsids, which are sap-sucking insects. Generally, shaded cocoa trees live longer and have a reduced need of nutrients, water and insecticides. To reach the optimal tree growth and yields, pruning is a very important aspect, especially in the yearly years of the cocoa tree. The farmer must assure that the first joquette reaches a sufficient height and cut any choupous at the base and fan branches. The height of the joquette depends, as mentioned above, on the amount of light and thus the pruning of the shade trees is important.

As outlined above, the cocoa tree is particularly sensitive to small changes and is susceptible to various diseases and pests. A significant part of the crop is lost due this vulnerability of cocoa. The estimates vary wildly and range from 15% to 40% of the whole annual crop in the 1950s and 1960s. (Flood 2007, BCCCA 1997) The most important and deadly disease for cocoa trees is the black pod rot (*Phytophthora* spp.). It is estimated by Murphy and Flood (2002), that nowadays black pod rot is responsible for at least 40% loss of crop annually. The black pod rot is a created by four different species of fungus and in all growing areas at least one of the four species is present. This disease colors the pods black and renders the cocoa beans inside the pods useless. The economically most damaging species are *P palmirova* and *P karya*. At least the damage of three species can be reduced by disease control while the fourth, *P megakarya*, is not affected by the fungicides which are usually sprayed. The spread of the infection often revolves around water: water that drips from infected pods contains zoospores or sporangia of the fungus and will encounter healthy pods. The fungus is able to penetrate the healthy pod and this way the disease spreads from pod to pod. The best protection against black pod rot is the pruning of shade trees to allow for more sunshine and airflow that reduces the humidity and the residues of rainfall. Obviously, the infected pods must be removed by the farmer.

If the rotten pod is left attached to the tree, the disease could spread to the trunk and result not only in crop loss but also in tree loss. As the fungicide must be reapplied every time rain has fallen, the cost for protection against black pod rot is high but the potential losses in case of no protection are much higher.

Another species of fungal infection results in the so-called frosty pod rot (*Moniliophthora roreri*). This disease is restricted to growing areas in Middle and Southern America, i.e. Peru, Colombia, and especially Ecuador. The control of this disease is particularly challenging because an infected pod produces billions of spores that are easily transported by a slight breeze. The signs for an infection of a pod develop only one month or even three months after the actual infection has taken place. First, brown lesions appear on the pod until it is fully covered in them and then the pod is covered in white dust due to the fungus sporulation. An infected pod does not produce any cocoa beans and the disease can wipe out nearly the whole annual crop of a plantation. There is no effective fungicide and the only recommendation given to farmers is reduction of humidity by pruning and very careful removal of the infected pods. These methods must be adopted by all farmers in the area to be effective and prevent a return of the disease.

Another disease that is currently not present in West Africa or Asia but is found exclusively in Middle and South America is called witches' broom (*Moniliophthora perniciosa*). The name derives from the branches' deformed growth when the disease has infected a still growing cocoa tree. Normally, the disease affects only the tree but it can also spread to the pods and cause severe losses up to total loss of crop. In any case, the disease does not necessarily lead to a loss of trees. The disease control can only be undertaken by pruning and burning the infected material. Chemical control is not overly effective and has only limited success against witches' broom. Generally, cocoa trees, that enjoy more shade during the growing period up to the age of 19 months, are better prepared to withstand the disease but naturally grow slightly slower and form

their joquette at a lower altitude which could result in reduced yield. The farmer must thus strike a balance between faster growth with potentially higher future yields and less growth with cocoa trees that resist witches' broom better. As noted above, some diseases actually prefer shade which renders the decision between more and less shade during the growing phase of new cocoa trees even more difficult.

On the other hand, the CSSV (Cocoa Swollen Shoot Virus) is present only in West Africa and it causes significant losses in Ghana, Togo, Nigeria and Côte d'Ivoire each year. There are various forms of the virus and some are more aggressive than others. The aggressive types kill the infected cocoa tree within 3 years while the less aggressive forms only induce the roots and shoots of the tree to swell. The best policy that has been employed since the middle of the 20th century is cutting down the infected trees and sometimes even the surrounding trees to avoid a spread of the virus. The virus is transmitted primarily by mealy bugs that cannot be controlled with insecticides or any other method. Unfortunately for growers in West Africa, the Amelonado species of cocoa seems to be particularly susceptible to CSSV. There are some sub-species of the upper-A Amazonas region that are immune to the virus but these sub-species alone are not able to produce an economically viable crop. A cross between an economically viable cocoa species and a resistant one could resolve the problem of CSSV in West Africa.

As the last disease treated here, the vascular-streak dieback (VSD) is present only in Asia, i.e. the Philippines, Malaysia, Indonesia etc. A branch will exhibit a brown streak inside when split in half. The disease actually spreads quite slowly, and the spores die under the impact of light. The fungus can be controlled by frequent pruning and removal of dead branches for growing trees and the addition of fertilizers with nitrogen for mature trees that can withstand the disease this way.

Problems that can affect all plantations around the world are pests. Insects can harm cocoa trees in two ways: they can either directly attack the tree or they can

cause a secondary infection by wounding or weakening the tree. As mentioned before, the biggest direct threat to cocoa trees are capsids that suck the sap of the trees and can cause up to 75% damage in yields. The wounds created by the insects are easy entry points for fungi. The CSSV is transmitted by mealy bugs that are also considered a pest for cocoa plantations. The main measures to control pests are of chemical nature. Their use is controlled by the rules set by important countries for food and environmental safety. These rules are periodically tightened by the authorities in the consumption countries. Integrated measures such as biological measure that are less hazardous are still under development and often are not effective enough to control an outbreak. Examples are the introduction of ants that eradicate some insects or the use of fungi and viruses to control pests.

The harvest normally occurs two times a year: the main crop is harvested between October and March while the midseason crop is collected between May and August each year. Generally, the main crop is considered to be of superior quality but often some of the midseason crop is carried over to the main crop to be sold at a better price. The total annual crop is divided into ca. 80% in the main crop and 20% in the midseason crop. (Conacado, 2018) The preparation of the newly cropped cocoa in the origin countries involves at least three steps: harvesting, fermentation and drying. All three of the steps are important in obtaining a quality product. The crop must be taken in without wounding the tree which requires significant concentration while manually cutting the pods with a knife. The ripe pods are recognized by their color which can differ according to the type of cocoa grown. It is important that the pods are harvested at correct time to avoid beans with low fat content (cropped too early) or beans that have already germinated (harvested too late). After being harvested, the beans can profit from up to 10 days of rest in the pods that is not always respected because growers have various incentives to start the process of fermentation immediately. For example, during the rest period, which is generally respected throughout

Ghana but only sporadically in other countries, the pods could be attacked by diseases, stolen or eaten by animals. Finally, the growers often would also like to sell the crop as fast as possible. On the other side, pod storage makes the resulting chocolate less acid, bitter and generally smoother than chocolate from not-stored pods. The next step is fermentation where big piles of cocoa beans and the mucilage are positioned on the leaves of the banana or the plantain trees and covered with more leaves. Industrial fermentation uses boxes instead. The pile is left for three to five days with some mixing after one or two days to guarantee a steady fermentation among all beans. A good fermented bean has a fully developed color and flavor but still contains too much humidity to be transported. Under-fermented cocoa beans are bitter and astringent, while over-fermented beans have off-flavors described as hammy or smoky. The third step that is necessarily undertaken before export is the drying of the cocoa beans. The cocoa beans still contain around 60% moisture by the time they are removed from the fermentation process and this humidity should ideally be reduced to around 7.5%. There are two options to dry the beans: the simpler one involves only the sun where the growing area is free of rain during the harvest period. This is the case for West Africa but not necessarily for all other producing areas around the world. Sun dried cocoa beans usually are superior in flavor and quality to artificially dried cocoa beans. A very good artificial drying can only be obtained with sophisticated methods and machines that are not widely available in the growing countries. The drying can take between five and ten days. After drying the beans are ready to be transported and exported. As experienced personally, the dried cocoa beans do not deteriorate in quality for at least 25 years and can thus be stored for quite some time before usage in the chocolate making process.

To summarize the chapter of agronomics of cocoa: cocoa is grown exclusively in a narrow band around the equator and requires a very specific climate and characteristics of the soil. The cocoa trees are best planted with other shade trees around

them and need constant caring with respect to pruning and protection against diseases and pests. The diseases and pests that can affect the cocoa tree are of many types and can have a devastating impact on a single plantation while they surely have a significant impact on the cumulative annually crop. Finally, the harvest is undertaken twice a year and includes at least three steps: harvest, fermentation and drying. All of them are important in developing the flavor and color of the cocoa beans and thus the quality of the chocolate. As will be shown later, the agronomics of cocoa has a significant impact on the supply side of the cocoa trade. It makes up a large part of the fundamental determinants of the cocoa trade.

Cocoa Production and Consumption through History

Cocoa was likely discovered between 1500 and 600 BC by the Olmecs in Central America. The initial use in Equatorial America most likely consisted in drinking the crushed cocoa beans mixed with various species, chilies and herbs. The regular usage and its divine status as 'drink of the gods' lead to the cultivation of cocoa trees. Following the Olmecs also the Mayans and the Aztecs grew cocoa trees to obtain the precious cocoa beans. There must have been a trade in cocoa beans as the cocoa tree is believed to originate in the upper Amazonas area. The trade linked the original growing area in Peru, Colombia and Brazil with Mexico and other areas in Middle America where the Aztecs grew the trees. To prepare the drink, the harvested beans were dried and afterwards their content was crushed resulting in a brown and fatty liquid. The taste of this drink mixed with various herbs, species and other ingredients such as honey was unlike the modern taste of cocoa products: it was rather herb and salty and not sweet at all. By adding a fermented maize, an alcoholic version of the sought-after beverage was known to the Aztecs. As the discovery to mix the crushed beans with milk was still some centuries away, the drink was generally prepared by mixing the brown liquid with cold or hot water. The drink was often reserved for the

upper class and soldiers in battle due to its scarcity and its stimulating effect. Apart from the strengthening impact, the drink was thought to have an aphrodisiac property. The dried cocoa beans had other usages, that were of different importance to the various cultures and peoples: it was partly used as a monetary unit and/or as a measuring unit. Some societies also levied taxes that had to be paid in cocoa beans. Generally, the cocoa bean was considered a symbol of abundance and was used in religious rituals dedicated to various gods of the peoples cultivating the tree. It is thus fitting that the Greek word 'Theobroma', chosen in the 18th century, for the cocoa tree means 'food of the gods'. Although the drink made of cocoa, called 'xocoatl', was likely already seen by Columbus, the value of the cocoa beans was only discovered during the expedition of Hernán Cortés. He decided to set up the first plantation that would generate income for the Spanish Crown and could partly finance his expedition. The legend says that he shared the drink with the Aztec emperor Montezuma and then brought the bean and the necessary tools to brew the drink back to Spain. Only with the return of Cortés in 1528, the drink gained a foothold in Europe and especially at the Spanish court. The initial way of consumption was very similar to the beverage enjoyed by the Aztecs. An early recipe was described by Colmenero in 1631 (p.15f) and is supposed to mimic the standard Aztec recipe:

Take seven hundred cacao nuts, a pound and a half white sugar, two ounces of cinnamon, fifteen grains of Mexican pepper called Chile or pimento, half an ounce of cloves, three little straws or vanillas de Campecho or want thereof, as much aniseed as will equal the weight of a shilling, of archiot² a small quantity as big as a filabead, which may be sufficient only to give colour, add thereto almonds, filabeards and the water of orange flowers.

The usage of sugar was later added and made the drink even more enjoyable. The beverage was known to banish tiredness and have a waking effect making it a good drink for breakfast.

Already a very famous and sought-after commodity in the New World, the cocoa bean was cultivated even more after the fall of the Aztec Empire to establish a flourishing trade with Spain. The Spanish crown was able to retain the value of the cocoa beans and the recipe to brew the drink a trade secret and for roughly 100 years the trade with cocoa beans from Middle and South America remained a Spanish monopoly. Outside of the Spanish court only a few monks tasked with the preparation of the beverage knew of its existence. There are various reports that due to initial unconsciousness as to the value of the cocoa beans to the Spanish court, English privateers threw the fruits away when found on boarded Spanish ships. In any case, the drink made from crushed cocoa beans was not of great interest in other European countries if known at all. (i.e. Gage, 1648) The secret about the drink was spilled only in the beginning of the 17th century when it got to Italy and to the French court in Paris where it fast gained traction. The demand for cocoa beans steadily rose during the century but its consume was still limited to the royal courts. Shortly after, the cocoa bean arrived in England and its arrival coincided with the arrival of coffee and tea. By 1660, coinciding more or less with the marriage of the Spanish princess Maria Theresia to Louis XIV, the Spanish monopoly was completely broken, and the cocoa beans became available to all people affluent enough. They were still very expensive and considered a luxury. The increased demand from various countries in Europe lead to an increase in plantation and growing in Spanish and French colonies. All along the equator, plantation owners started to grow the cocoa trees and export the dried beans to Europe. Of special future importance were the trees grown in Trinidad because many of the later plantations were based on these Criollo cocoa trees. The first setback in the plantation and growing efforts arose in the beginning of the 18th century when

a 'blast' eradicated much of the cocoa trees in the Caribbean region. It is not clear of which type the blast was, but it is speculated that it must have been either a hurricane, droughts or a fungal attack. The Criollo type of the cocoa tree was and still is particularly fragile and often subject to fungal attacks. The recovery efforts undertaken by the Dutch countries and the Spanish crown thus focused on a hardened cross of the Venezuelan Forastero with the well-known type of Criollo. The resulting hybrid was called 'Trinitario' and went on to become the standard for plantations that had to be rebuilt after the 'blast'.

For more than one hundred years the areas, where cocoa was grown, did not change much. The fruit was still mainly imported to Europe from the Spanish and French colonies in the Caribbean (i.e. Jamaica, Martinique) and some Dutch and Spanish colonies in Asia (i.e. Malaysia, Indonesia) while Africa was left out. The colonialization of Africa during the 19th century opened up the possibility for the French, German and English Empire to set up plantation of cocoa trees in the new territories near the equator, mainly in West Africa. The colonies located in current-day Cameroon, Ghana, Côte d'Ivoire and Nigeria all started commercial plantations of cocoa trees around or after 1880. Cocoa was originally introduced first to the two islands of Príncipe and São Tomé around 1830. In the first half of the 20th century the African countries started to rapidly increase production and not soon after started to dominate the world cocoa market. The domination by the three countries Côte d'Ivoire, Ghana and Nigeria still holds today as they produce around 70% of the global crop any year. Unlike the cocoa trees used in earlier plantations, the African plantations often used a Forastero variety of the cocoa tree that is much less suspect to fungal attacks and other types of illnesses than the Criollo variety.

To understand the change in consumption from the liquid drink towards the eatable chocolate and the shift of production towards African countries it is important to review the early consumption habits in Europe and how they evolved over time:

apart from the royal consumption, the affluent public could enjoy drinks made from cocoa in drinking houses. Aside from the beverage itself, these houses had an atmosphere of a private club often with an entrance fee and special purpose: some were used for gambling while others focused on business or politics. The growth of the consumption was strictly linked to the alleged properties: therapeutic benefits were to be obtained by a regular consumption of a beverage made of cocoa beans. These unfounded claims were especially made in Spa towns all around Europe. Together with this rise of unfounded claims of health benefits, a major improvement towards the taste of the drink was made in the middle to late 17th century: the drink was no longer consumed as a mix of water and the brown, fatty liquid but the cocoa liquid was mixed with milk to create a better tasting beverage. After the inclusion of sugar in the recipe, it was the second major improvement of taste with respect to the original Aztec recipe that was brought to Europe by Cortés. The eatable milk chocolate, as we know it today, was not invented for another 200 years. In the meantime, improvements in technology were needed to better use all the parts of the cocoa bean and make the resulting products more homogeneous.

The most difficult and arduous part of the production process, aside from plantation work, was the grinding of the cocoa beans. Made by hand in the drinking houses or by servants for the royal courts, the quality was very heterogeneous and the product was of dubious quality and taste. The first impulse to improve the grinding process by introducing machinery and newly developed engines, either powered with water (beginning of 18th century) or powered with steam (end of 18th century), came from doctors and apothecaries which specialized in medicinal chocolate. As it was the case for all other production sectors, the industrialization of chocolate making started in England. By the late 18th century, the grinding of cocoa beans with the help of machinery was established all over Europe and substituted the grinding by hand. Around this time the consume started to gain traction in the United States of Ame-

rica as well and as in Europe the first water- and steam-powered mills were established. The mills inspired another development in treating the chocolate beans: in 1828, the Dutch cocoa producer CJ van Houten discovered the possibility of pressing the ground-up cocoa nibs, also called cocoa liquor, on an industrial level, which extracted a significant part of the fat. This fat, also called cacao butter, is the base for eatable chocolate which was not discovered immediately however. This new method was a significant improvement for the cocoa drink, still the only form of consumption known: the product resulting from the pressing is called cacao powder and is much easier mixable with milk and water. It also contains less fat and thus improves the finesse and taste of the beverage. Not only was the beverage much better with the discovery of cocoa powder but the taste could be further improved by adding alkali during the processing. It makes the characteristics of the flavor mellow and the chocolate drink was much smoother and more homogenous. These two improvements to the cocoa drink resulted in an initial waste of ca. 30% of the beans' content. The cocoa butter had no use for now although it was a rich vegetable fat that was extremely flavored. This significant amount of byproduct created a strong incentive to find a use and make it commercially viable. In fact, its addition to the tablets used for drinking chocolate gave the previously hardly eatable chocolate a much mellow and softer consistency that was very well eatable. This sweet eating chocolate was first offered in 1847. This new offering spread quickly through Europe for two simple reasons: the cocoa butter could be used in a commercially viable way and the consumers slowly but surely took to the new way of consuming chocolate. The new eatable chocolate superseded the old way of drinking chocolate in popularity in just a few years. The consumers unknowingly made a decision that would affect the whole industry: the cocoa powder was now less demanded than the cocoa liquor and the once unwanted cocoa butter because it was not needed as much. The new preferences also gave rise to a division in the chocolate industry that exists up to the current day: manufactures that bought

the beans and processed them into the various derivatives that were needed such as cocoa powder, cocoa liquor and cocoa butter and on the other side, manufactures that use these intermediate products to produce the final chocolate confections.

The two last, very important discoveries were made in Switzerland: firstly in 1876, the addition of condensed milk in the chocolate making process to make the taste ultimately smooth. The addition of milk reduced the need for cocoa butter that was relatively expensive and had the effect that the chocolate flavor becomes milder and more likeable for the wide public. Secondly in 1879, when the manufacture of Rodolphe Lindt smoothed the texture by repeatedly rolling the chocolate with a grinding stone. This process is called 'conching' and it results in a reduced particle size of cocoa and sugar. It also guarantees that the added cocoa butter evenly covers all particles and removes some flavors and acids that might be distributed unevenly among the used cocoa inputs. At this point, the 'modern' chocolate was born and the production techniques and methods have not fundamentally changed since then. The scale has increased exponentially with higher demand and wealth in the world but the techniques that were discovered during the 18th and 19th century have held up and still produce the best chocolate available.

Price control mechanism in the origin countries

Aside from the consumption markets in the more developed countries, also the export markets and their organization are of crucial importance for the cocoa trade. I will limit the overview on the time after the Second World War. This roughly covers the period of interest for the regression analysis in the next chapter.

Over time, various countries have tried different approaches to marketing the export of cocoa products. The contracts, that are signed with the importers and merchants are very similar, so the differences between the countries is due to the internal organization of the cocoa market within each country. In the view of a government of

an exporting country, the three options of regulating the export market fundamentally differ in one aspect: the amount of control over prices and quantity that the policy gives to the government. The decision which policy and institutions to pursue thus depends on the degree of control the governments want to exert over the cocoa market. The first option and the most controlling type of institution is a marketing board. Installed by the British authority after the Second World War in its colonies, only one country still uses this setup for marketing its crop of cocoa beans. The public Ghana Cocoa Marketing Board, setup in 1947 after long and persistent protests by farmers against low prices and little power in the trade of cocoa, still wields extensive powers. Every year before the crop year starts in October, the board sets the farm gate price that is paid to farmers and then buys up the complete harvest. Only the official Ghanaian Cocoa Marketing Board is allowed to export cocoa beans. The farmers are not allowed to sell their crop to other parties. The board also grades the beans in terms of quality and sets high standards that has lead Ghanaian cocoa to be considered the best bulk cocoa. The quality control process is twofold and has two advantages: the first assessment is made at the point of sale from the grower to the marketing board and the second is made at export. This process enables an immediate feedback to the farmers regarding the quality of the cocoa and lower quality beans are bought at a discount to the farmer-price. Secondly, the quality control before export reduces the probability to deliver inferior coca to the counterparty than stipulated in the sale contract. Additionally, the centralized structure of the internal trade encourages the government to provide better infrastructure throughout the rural production areas and improve the provision of services to the farmers. The main disadvantage of this setup is the high cost of quality controls and the extensive man power required for a twofold quality assessment. After the quality controls, lower quality beans are usually processed locally and not exported as cocoa beans but used in local chocolate production or exported as cocoa.

The case of Ghana will be examined in greater detail in the second part of the thesis. Similar marketing boards also exist in the Oceania and in Malaysia, where the power regarding the market is much more restricted. In the case of Malaysia, the marketing board is focused on supervising internal cocoa operations and research into cocoa production, consumption and processing. It does not interfere with local or export pricing.

A second option is the *Caisses de Stabilisation* which is similar to the marketing boards but is less powerful with respect to the export of the cocoa beans and processed products. These institutions were mainly used in the French speaking countries Côte d'Ivoire and Cameroon but are now abandoned. The existence up to 1999 in Côte d'Ivoire is particularly important to understand the current situation, where farmers often believe that the government still fixes the prices while the agencies that are now buying the beans on local level are without power. This is a consequence of the long-lasting government control over farm gate prices.

Aside from controlling the market with a marketing board or a *Caisse de Stabilisation* there is also the option to leave the market to the participants. The free market approach is practiced in Nigeria, Indonesia, Malaysia and Brazil. The exporting countries safeguard some their vital interest from the trade in cocoa by controlling either the quality of the export or the foreign exchange received for the export and, in some cases, both. Only Indonesia adopted the free market system from the onset of its cocoa production while Nigeria, Côte d'Ivoire and Cameroon adapted the free market system only after abandoning a different setup earlier.

The system to use free enterprise to market the cocoa production has been strongly advocated by the IMF and the World Bank to foster development and to increase international trade. A good example for the adoption of the free market is Nigeria. It is of particular value to look at the Nigerian case in more detail because it shows the differences between a free market approach and the marketing boards.

After the Second World War, the Nigerian cocoa market was singlehandedly regulated by the Nigeria Cocoa Marketing Board, established in 1947 by the British colonialists, until 1954 when it was superseded by four regional boards that were responsible for multiple commodities in their respective areas. These four marketing boards (Central, North, East, and West) could set the producer prices independently but the goal was to cut the ties between the local price paid to farmers and the fluctuating world price for cocoa and the other commodities. Another goal was the elimination of local middlemen in the unregulated market who left producers at a disadvantage. (Williams, 1985) Nevertheless, the various (regional) marketing boards set producer prices, that were totally out of line with the world market price. The real goal of the government was to obtain funds to finance the various development programs. (Kolawole, 1974) This distortion had clear results:

the indications show that the [marketing board] system as presently operated discourage increased efforts and production by farmers. The stagnation in the output and export of some cash crops is attributed to the marketing board system. (Nigeria, n.d., p.66)

The marketing boards were also a potential source of corruption due to the high bureaucracy and high tax income. (Kolawole, 1974) The system of regional marketing boards was replaced in 1974 with the old system of commodity boards where each marketing board was responsible only for one commodity but in the whole territory of Nigeria. The results were not significantly different than before and Williams (1985, p.13) summarizes the period of marketing boards in Nigeria as follows:

Marketing boards have not eliminated 'middlemen', 'advances' or the other 'abuses' [...]. They have [...] shaped [the buying system] to serve the needs of ruling parties, government and the Northern aristocracy to expand and consolidate their network of patronage. [...] Impoverished by the board's policies farmers, especially cocoa farmers with

little opportunity to earn money from other crops, found themselves more dependent on credit to meet the claims of the declining resources.

With the introduction of Structural Adjustment Policies (SAP) at the behest of the IMF and the World Bank in 1986 and the abolishment of the marketing boards, the cocoa market in Nigeria changed completely. The goals were the following: increased competition, reduction of bureaucracy and obtain higher share of world price for farmers. (Gilbert, 2009) The initial state can be described as chaotic due to the entrance of many new exporters. (Gilbert, 1997) Afterwards, the conditions reigning in the years after 1986 can be best described as laissez-faire and resulted in worse quality of beans for export and cocoa being used as a vehicle to launder money and circumvent capital controls that were still in place. Rich businessmen with no long-term interest in cocoa used cocoa export to exchange the local currency Naira into hard foreign currency and then invest the returns overseas. The lack of long-term interest in cocoa lead to the sale of low quality beans to increase the capital flight and exchange of local currency into foreign exchange. The cocoa export had become a vehicle for other purposes and the Nigerian cocoa quality still suffers from this period. Quality remains average at best and trees are not replanted due to costs resulting in smaller harvests with low quality. (Dand, 2010) Another aspect to be mentioned is the successful rent seeking by international cocoa processors: Wilcox and Abbott (2004) make the convincing argument that the liberalization of the cocoa market in Nigeria led to the capture of rent by multinational companies. Before the opening of the market, these rents were paid to the government in form of taxes.

Diagram 1 summarizes the above-described timeline: the internal organization of cocoa marketing in Nigeria had four periods which were distinct from each other. To conclude the story of the Nigerian cocoa market structure with some numbers of production: in 1964, the world production of cocoa was around 1.5 million tons and Nigeria contributed around 20% of the annual production. (Ajetomobi, 2014) By 2016,



Diagram 1: Timeline of Nigerian Marketing Systems for Cocoa

Nigeria had fallen to sixth place in annual crop and supplies only around 4% of the annual worldwide production of cocoa. (ICCO, 2017)

A second interesting example is the already-mentioned transition in Côte d'Ivoire: its government was aware of the impact of the cocoa production on public revenue and votes in electoral campaigns and thus remained closely involved by adjusting taxation as needed. Even after the liberalization of the market, the government continued to issue 'indicative prices' which were considered by farmers to be the official prices although they were not enforceable. Another problem arose from the different sale of the harvest. Without the Caisse de Stabilization the cocoa beans were not sold forward anymore and the farmgate prices were no longer guaranteed. The farmers were thus paid a varying amount which was naturally unsatisfying. The issue was raised to the awareness of the government in 2001 but the structural change was completed only in 2015 and the cocoa harvest is now again sold forward via an online

auction process that is administered by 'Le Conseil du Café-Cacao'. The proceeds from this auction stabilize the farmgate prices and guarantee a payoff for the farmers that is set by the government.

The Cocoa Trade

The market for cocoa can be split in two different submarkets: the physical trade and the future trade of cocoa beans and its derivative products. There are important distinctions in the functioning and in the purpose between the two markets: the physical, or cash or forward, market consists in private agreements between two parties that agree to buy or respectively sell cocoa products on private terms. The purpose of this market could simply be the import of cocoa beans to supply intermediate manufactures. All cocoa imported from the various production countries goes through this market as does most of the intermediate chocolate products that are used to produce confections. The future market instead has the main purpose of hedging. The various actors in the physical market are able to hedge their outstanding positions on the future market to avoid holding the price risk. The two markets are linked through supply and demand changes that occur in the physical market and then feed back into the price of the future market, and the fact that the agreed upon price in the physical market is often based on the future market prices. It is important to bear in mind that the cocoa beans can be stored for at least 20 years without losing quality and thus there practically is no due date on bagged cocoa beans. The implications for the market and the price are obvious: supply can be carried and stocks of older cocoa beans can dampen volatility when a supply shock occurs. The International Cocoa Organization (ICCO) managed a buffer stock between 1980 and 1993 but with its small size and especially lacking financing and facing high costs it was not as effective as hoped. The wind-down in the beginning of the 90s was thus a logical consequence. (Gilbert, 1995)

The two types of markets (future and physical market) share a common hi-

story in the so-called spot market where the cocoa beans were sold on the spot. Early overseas trading was characterized by the lack of information: the cargo of the merchant vessel was unknown to the owner awaiting the return of the ship. Without the knowledge of the goods that would be returning with the ship, the merchant was not able to sell the goods advance. Consequently, the cocoa beans were sold when they physically arrived at the port of destination in Europe. The merchant sold the cargo either via auction or privately to apothecaries, manufactures or any other interested party and the cocoa beans sold were deliverable immediately as they had already arrived at the port. This spot market continued during the 17th and 18th century as the only type of market as the quantity of cocoa beans traded was comparably small to the 19th century. The production of chocolate beverages did not yet require highly industrialized factories and was done mainly by hand. Regular supply of high quality and homogenous cocoa beans was not crucial yet. On the other hand, in the 19th century the supply of cocoa beans with a consistent quality became of high importance. Factories required a stable supply of cocoa beans to avoid shortages of ingredients and machine stoppages. This stable supply could only be guaranteed with new technology in shipbuilding because sailing ships were not reliable enough in terms of voyage time. New steam ships instead could nearly guarantee a stable voyage time table and secure enough supply from overseas on time. The merchant could expect his cargo on time and sell it in advance to his clients. This was the beginning of the forward market. The timely delivery of cocoa beans was thus not only advantageous to the manufactures but also to the merchant himself. The merchant became less dependent on local demand and supply determinants and volatile auctions. The stable voyage time table made the price less volatile, guaranteed better quality of the cocoa beans and a stable supply. All these are factors that drove the prices down for merchants to import cocoa beans, for manufactures to produce the (intermediate) products and for the final customer to buy the chocolate confections. Another factor that made the forward market

more attractive to the merchants was its privacy. Auctions were public and competing merchants would know what kind of product would be sold and bought by other market participants. All merchants valued their privacy in their business dealings over the knowledge of the competing businesses and preferred forward contracts that were not public over the spot market and its auctions. Indeed, standardized clauses became common and facilitated the negotiations and simplified the contracts. Most of the contracts adhered to one of the standards that were set up by trade associations. These trade associations were founded in the main trade cities for cocoa in the early 20th century: London, New York and Paris each hosted one trade association. The choice of standard contracts and regulation depended on the cocoa's destination and country of origin. The trade patterns were defined by the colonialization: cocoa was shipped from the French colonies to France and from English colonies to the United Kingdom and accordingly regulated by the associations in Paris and London. These links still endure up to now although France and the UK are no longer major importers of cocoa. The viability of the trade associations is ensured by the offered arbitration services and the contract terms agreed upon by many parties in the industry.

An aspect that is rarely considered is the local processing of cocoa beans in the countries of origin. Apart from Brazil, the consumption of chocolate products in the cocoa producing countries is very low. The rationale for processing the cocoa beans directly at origin should lie thus in increased profits for the exporting countries and increased market power. Theoretically, the removal of unwanted humidity, hulls and other particles would reduce the weight of the product shipped to consumption countries and consequently reduce the freight rate. The industry also attracts skilled labor and additional capital while producing added value that is taxed at higher rate than the original raw export. There are nonetheless factors that oppose the otherwise sensible approach of origin processing. Firstly, the chocolate industry often requires on-time delivery of cocoa products such as butter and cocoa liquid which is virtually

impossible when delivered from overseas and additionally, the cocoa product needs to be in solid state to be exported in a commercially viable way from overseas. This creates problems at some factories as they are no longer ready to accept solid cocoa butter and melting the cocoa butter often eats up the advantage of cheap labor.

From a general perspective, the processing of cocoa is a capital-intensive industry. The developing countries have a competitive advantage in labor but not in capital which makes it less appealing for global producers of cocoa products to invest in developing countries. In the always developing and innovating chocolate industry, new flavors, colors, textures and mixtures are of crucial importance for the producers of confectionary, and processors in developing countries have found it difficult to offer the range needed. The cocoa powders for example differ in fat content, degrees of alkalization, aromas and have added stabilizers and lecithin. Another aspect is the missing import of cocoa beans from other countries that could be used to blend various origins to create a homogeneous mixture that is favored by the chocolate industry. The local beans limit the processors in origin countries in the number of final products they can offer. Similarly, a bad harvest in the origin country would make the products uncompetitive on the world market due to its prohibitive costs of inputs. Unlike producers in consuming countries, there is little choice for the input and no option to source from the cheapest producer of cocoa beans worldwide. Finally, health regulations by the consuming countries are often hard to follow in origin countries as they are very strict and adapted to the level of industrialization prevalent in the consumption countries. This especially concerns the number of bacteria which are more common in the hot and humid climate of the origin countries. The production process must be followed with more care and precision which naturally raises its costs. These disadvantages are met by an extra effort by the origin countries' governments to incentivize company in setting up processing factories.

Côte d'Ivoire and Malaysia offer good examples for two different strategies that are employed by governments: the first one is lowering the export tax on cocoa liquid. By lowering the export taxes and providing a credit per ton, the government of Côte d'Ivoire is able to make to origin processing viable. In Malaysia, the government provides a multiyear tax-break for companies that set up a cocoa processing factory. Often, these industries in origin countries are only profitable exactly because of the local governments' intervention. Without them their offer would not be competitive on the world market.

After looking at the history of the cocoa trade, a look at export and import markets and local processing, a look at the market participants is warranted. The number of participants has reduced drastically over the last decades. For example, the number of brokers in Europe and North America shrank from 192 to 88 between 1970 and 1990, of which only 10 can be considered internationally relevant. (Dand, 2011) To understand the market segmentation, one can generally assume that producers of cocoa are not processing it and are rarely ever making chocolate from cocoa products. This offers the possibility for market intermediaries to facilitate the trade in cocoa. Therefore, the producer of cocoa has generally no contact with the users of the cocoa beans or any subsequent cocoa-based product. The reasons are threefold and explain the existence of market intermediaries such as traders and brokers. The first reason is common to all markets: a seller might not be able to find a buyer or a buyer might not be able to find the right product to buy. The presence of dealers, that are always ready to hold a position, is thus necessary in the cocoa trade. Their presence decreases the volatility of the cocoa market and offers an important service to buyer and seller satisfying both sides' needs. The dealers with proprietary position provide liquidity to the market. They also contribute to price discovery in the market. Different views on the market by various dealers create trades that define the forward price. The third reason for the existence of intermediaries is based on the preferences of the manufacturers:

they would rather have their supply secured by third parties than do so themselves. The manufactures' expertise lies in the production and not in the sourcing of the needed cocoa. Additionally, the manufactures can better distance themselves through an intermediary from the original cocoa and any claim regarding unethical production.

The first intermediary of particular interest is the traditional role of a broker. The broker does not have a market position but introduces seller and buyer to each other. A broker will be paid a commission for his services which are ranging beyond simple introduction of the two counterparties. He offers advisory services, financing and hedging options to the counterparties. The role of broker has declined over time and the remaining brokerage firms often specialize in particular cocoa origins, varieties or quality. As mentioned before, a dealer is ready to hold a position in the second-hand market. These companies will trade on their own account and sell or buy cocoa according to respective market outlook, either physically or on the futures market. The dealer is ready to assume risk that other parties would rather not assume. This risk taking by the dealers helps the market with its liquidity and its price discovery as explained above. The class of dealers, also called merchants, has been enlarged by hedge funds, some of which are also prepared to trade cocoa physically and not only financially. Some of the merchants are also offering transportation, financing and other services to the manufacturers and processors. This level of service is more common in the United States than in Europe.

The other class of market participants is characterized by its immediate exposure to and need for cocoa: the processors and chocolate manufacturers. The processors will be the primary buyer of cocoa beans to manufacture the cocoa products that are used by the confectionary industry.

Suppliers and Users of Cocoa

So far, we have considered the history of cocoa and its usage, the trade in cocoa and how it evolved over time and the agronomics of cocoa production. These arguments are important to understand the trade flows that will be uncovered now. The chapter will explain where the cocoa trade happens and in what direction the trade flows. Additionally, some comparisons between supplying and using countries are useful to interpret the trade flows and underline the imbalances in market power.

As mentioned before in the chapter of agronomics of cocoa, the area where cocoa can be grown efficiently is confined to a band of eight degrees north and south of the equator. This band does not contain industrialized countries but only developing countries. The trade flows are quite similar in their direction: cocoa and its products are exported from the developing world to the developed world where chocolate is consumed.

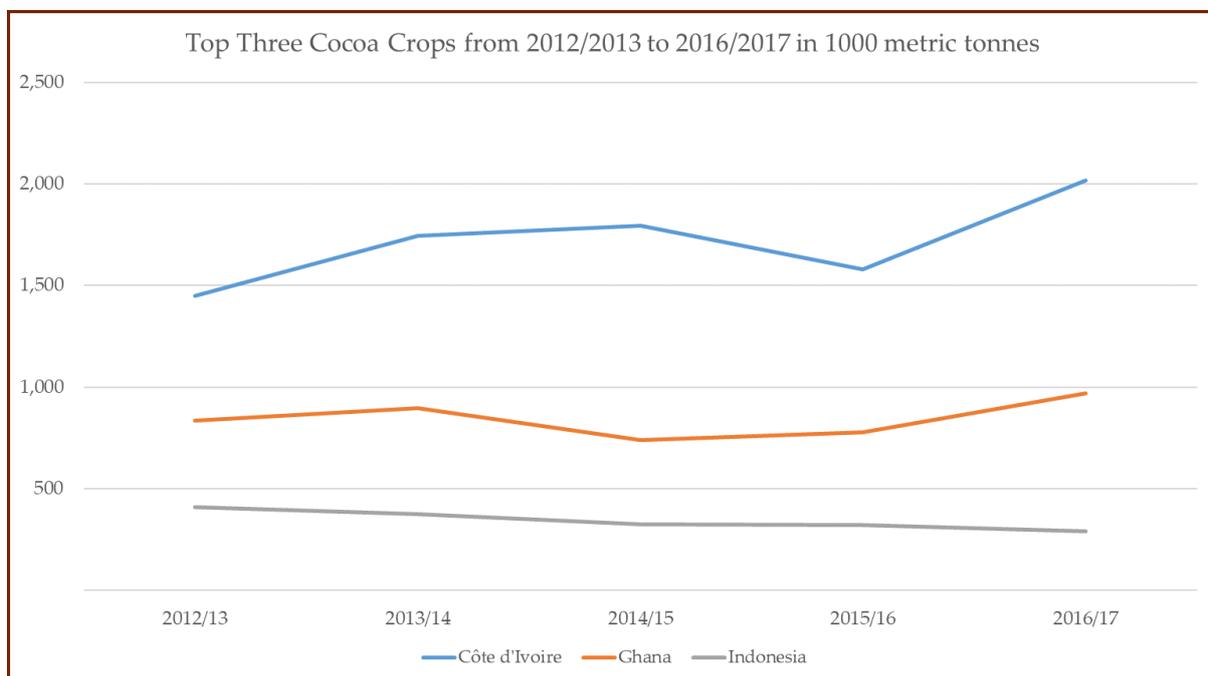


Figure 3: Top Three Cocoa Crops from 2012/2013 to 2016/2017 in 1000 metric tons,

Source: ICCO, 2017

We will first look at the export statistics and then turn our attention to the imported quantities. Starting out with the total crop of cocoa of 2016/2017 one can clearly identify patterns: Figure 3 and 4 make it obvious that West Africa has a dominating position in the supply of cocoa beans. The two top producers, Côte d'Ivoire and Ghana, have had an estimated, combined 2016/2017 crop of over 2,900,000mt and thus supply around 63% of the world crop. The world crop of 2016/2017 is estimated to be 4,733,000mt and the share of Africa is equal to 76%, while the Americas produce around 16% and Asia and Oceania just around 8% of the world crop.

Looking back at the last five crop years we can see a slightly neutral to positive trend for the big producer countries of cocoa. The year 2016/2017 exhibited especially good weather and it explains the overall increase in crop to a large degree. Noteworthy is the missing increase in Indonesia's production: the trees are too old and no new trees are planted so that Indonesia's cocoa production will likely fall in the future. In-

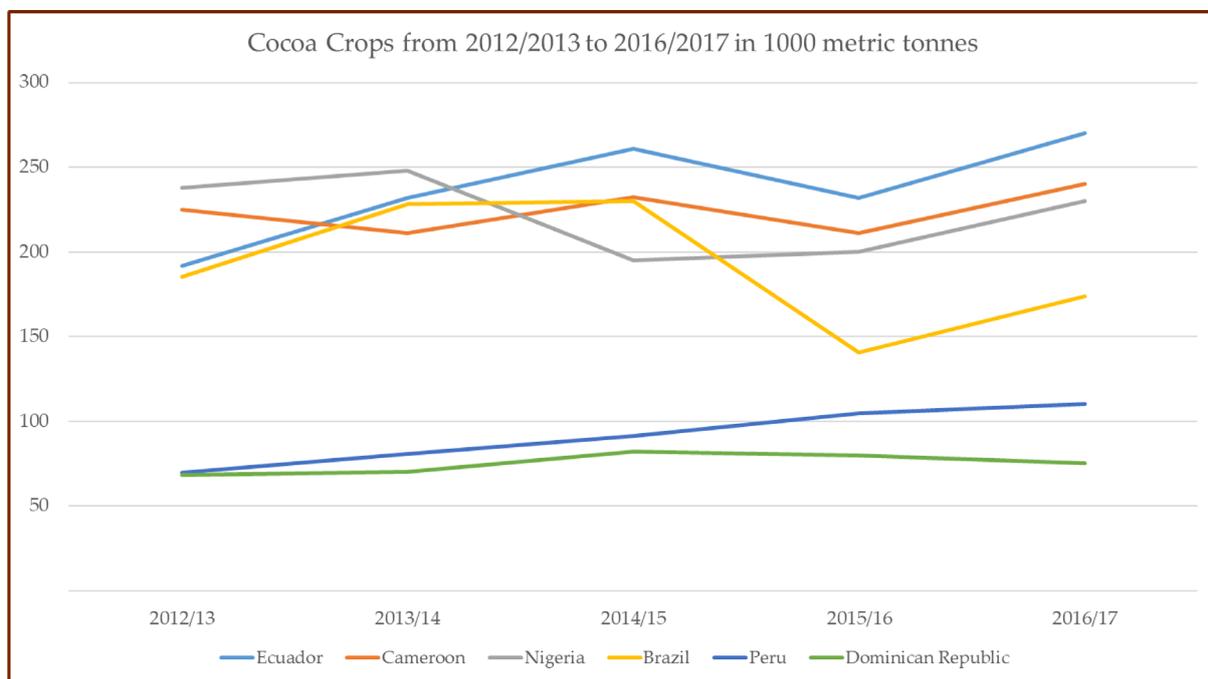


Figure 4: Cocoa Crops from 2012/2013 to 2016/2017 in 1000 metric tons, Source: ICCO, 2017

Indonesia also struggles with cocoa pod borer (CPB), vascular streak dieback (VSD) and blackpod. (Confectionerynews, 2015) Another notable fact is the steep drop in Brazil from 2014/2015 to 2015/2016: a severe drought was the main reason for this disappointing crop year. A year after the Brazilian cocoa crop recovered in fact.

Generally, one could assume that the export figures are quite similar to the crop quantities any given year. In Figure 5 we can nevertheless detect interesting patterns for the annual export quantities that cannot directly be derived from the crop quantity: as expected the biggest producer of cocoa beans are also the biggest exporters but the quantity exported is much smaller than the produced quantity in each year. For the two Asian countries Malaysia and Indonesia the export/import balance of cocoa beans is even negative, meaning that they import cocoa beans on top of their local production of cocoa beans. The reason for this phenomenon are the local grindings of cocoa beans to powder and cocoa butter which we will analyze later. Another reason for the difference is origin chocolate production but this argument is only relevant for Brazil, Malaysia and Indonesia. Two more important factors are the smuggling of

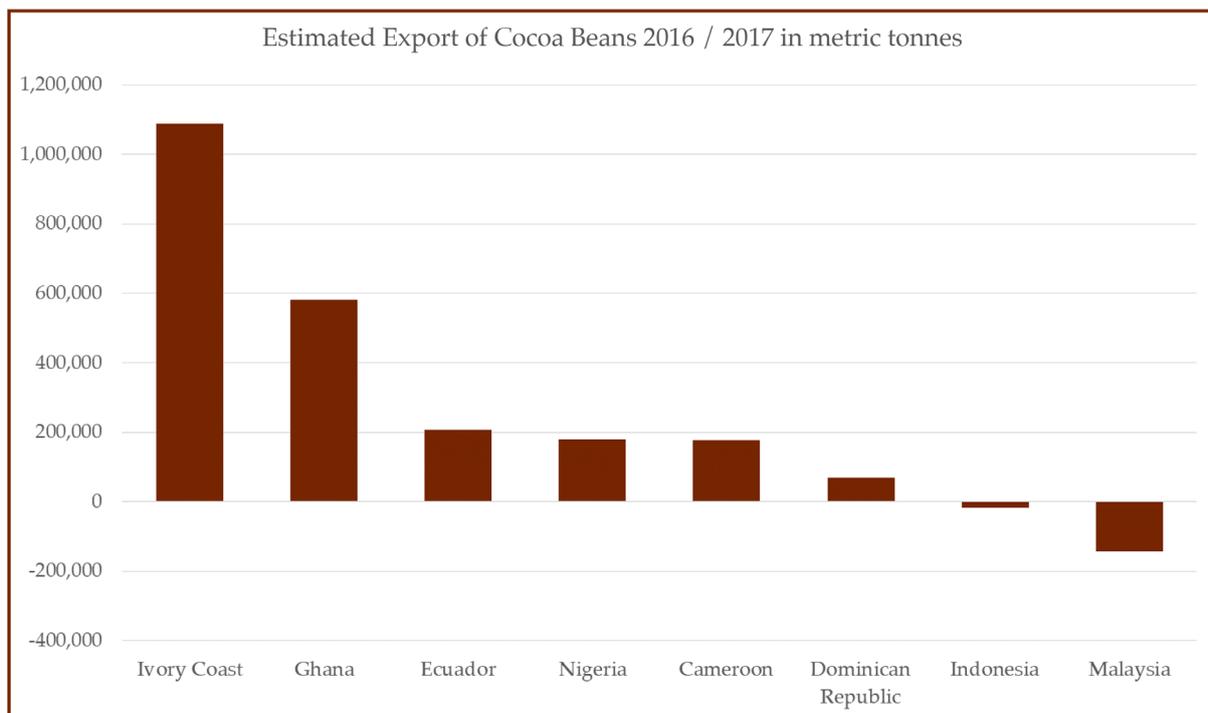


Figure 5: Estimation of Gross Export of Bean Equivalents 2016/2017, Source: ICCO, 2017

cocoa from one African country to another depending on the minimum price paid to farmers by the authorities or private exporters and the carry-over from the last crop that is shipped after the new crop year begins in October. The quantity of carry-over often depends on the public minimum price that is expected for next crop season. A higher expected minimum price incentivizes farmers to store cocoa until the next crop begins. Declaring old cocoa to be new is then rewarded at the higher minimum price. Carry-over can also occur when the mid-crop has started very late and lasts into the beginning of the main crop.

With the increase of grinding capacities in the origin countries and especially in Asia, the trade in cocoa powder and cocoa butter has changed in the last 30 years. This trade accounts for the major part of the difference between crop and export quantity of cocoa beans each year. Figure 6 sheds light on the quantity of grinded beans in 2016/2017 and not surprisingly Indonesia and Malaysia are in the Top 5 worldwide in bean grindings. As noted above, both countries are not able to sustain the grindings with their own cocoa bean production and thus they import beans from other parts of the world.

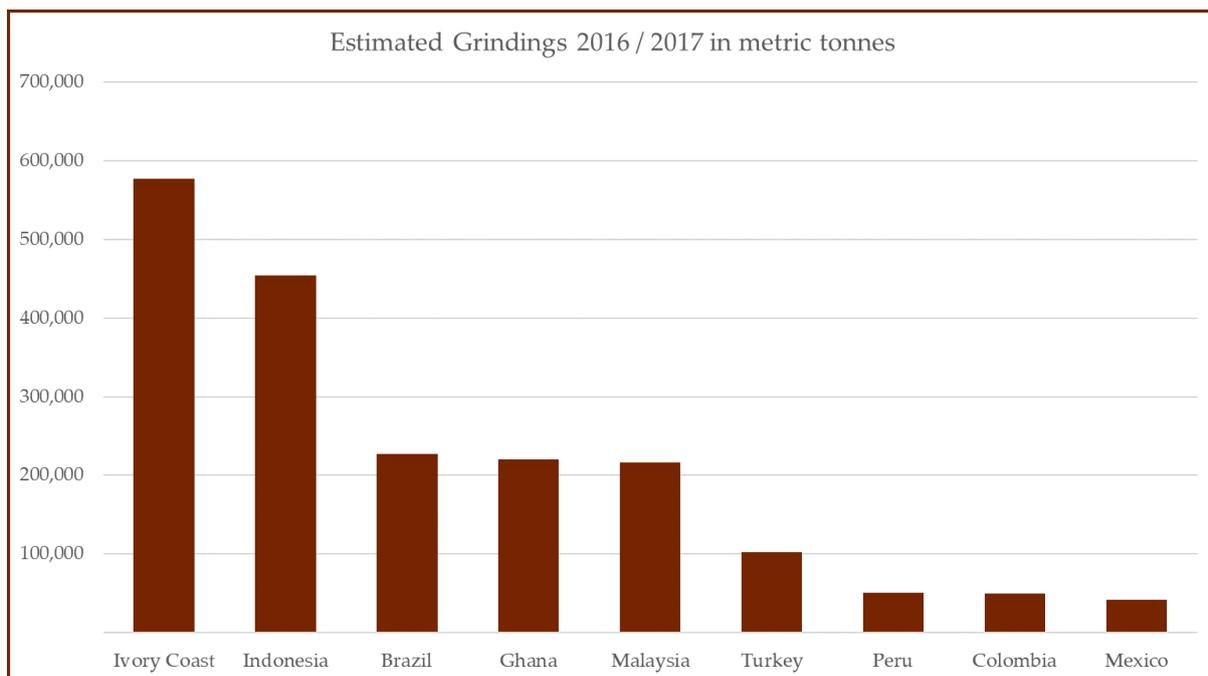


Figure 6: Estimation of Grindings 2016/2017, Source: ICCO, 2017

Figure 6 explains the major part of the difference between crop quantity and export quantity for the big producers of cocoa beans. It is noteworthy that some of the bigger producers and nearly all of the smaller producers of cocoa beans have virtually no origin processing. For example, Nigeria, Ecuador and Cameroon as bigger producers have no relevant capacity for origin grindings and export virtually all of their cocoa bean crop each year.

To understand what the countries are producing from the grinded cocoa beans, a look at their export of cocoa products is warranted. All following data in this chapter is referring to the cocoa season of 2015/2016 and are taken from ICCO, 2017 if not otherwise stated. Figure 7 provides an overview over the cocoa related exports by origin countries that have a significant grinding industry. Brazil is not included in the figure as the local grindings are fully needed in Brazilian production of chocolate and are not available for export with the exception of small quantities of cocoa butter. Anyhow, we have a very interesting distinction between the two continents: the two

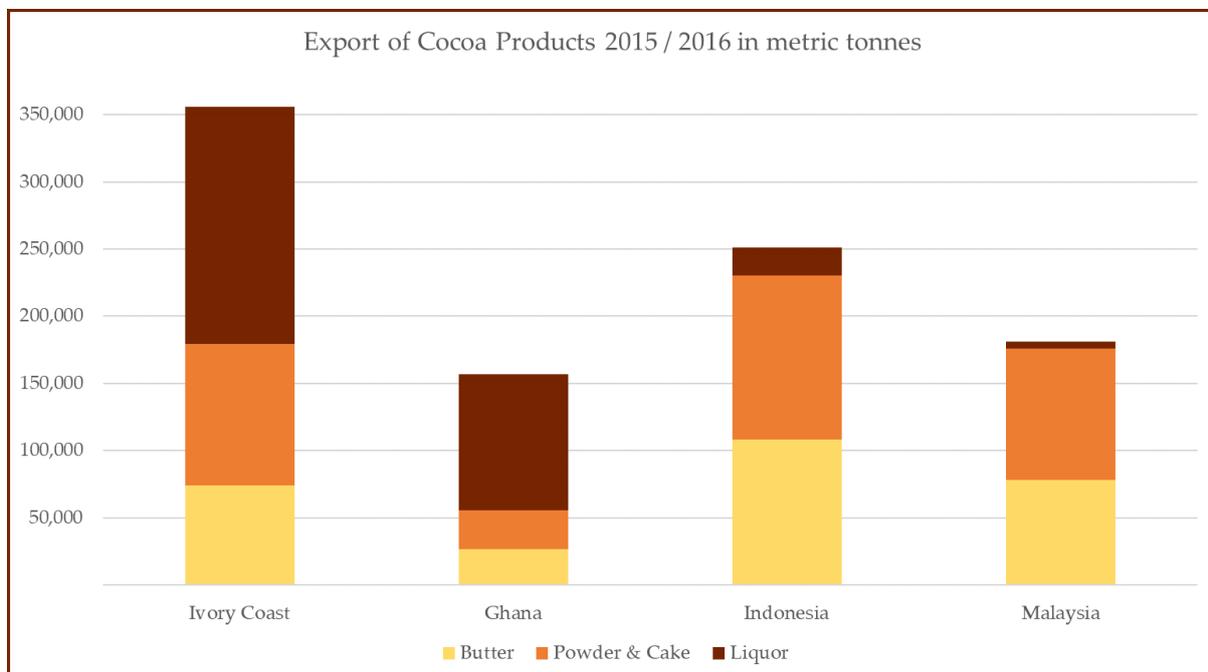


Figure 7: Export of Cocoa Products 2015 / 2016, Source: ICCO, 2017

African countries Côte d'Ivoire and Ghana are exporting relatively more cocoa liquor than the two Asian countries Indonesia and Malaysia which are more focused on cocoa powder and cocoa butter. A reason for this specialization is found in the import taxation by industrialized nations that we shall see later. Another factor in the different composition of exports is the quality of beans that is superior in Africa and thus the beans lend themselves better to the production of cocoa liquor while Asian beans are often used for deodorized cocoa powder and butter. Aside from quality differences, the Indonesian government also established an export tax on cocoa beans that made local grinding much more attractive. This pattern results in nearly 50% of all Ivorian cocoa exports having the form of cocoa liquor while Indonesia exports nearly 50% of its total cocoa product export as cocoa powder and around 43% as cocoa butter.

We have covered the current export of the international cocoa trade enough to look at the import. As we have seen above, chocolate is mainly consumed in industrialized nations and much less in developing countries.

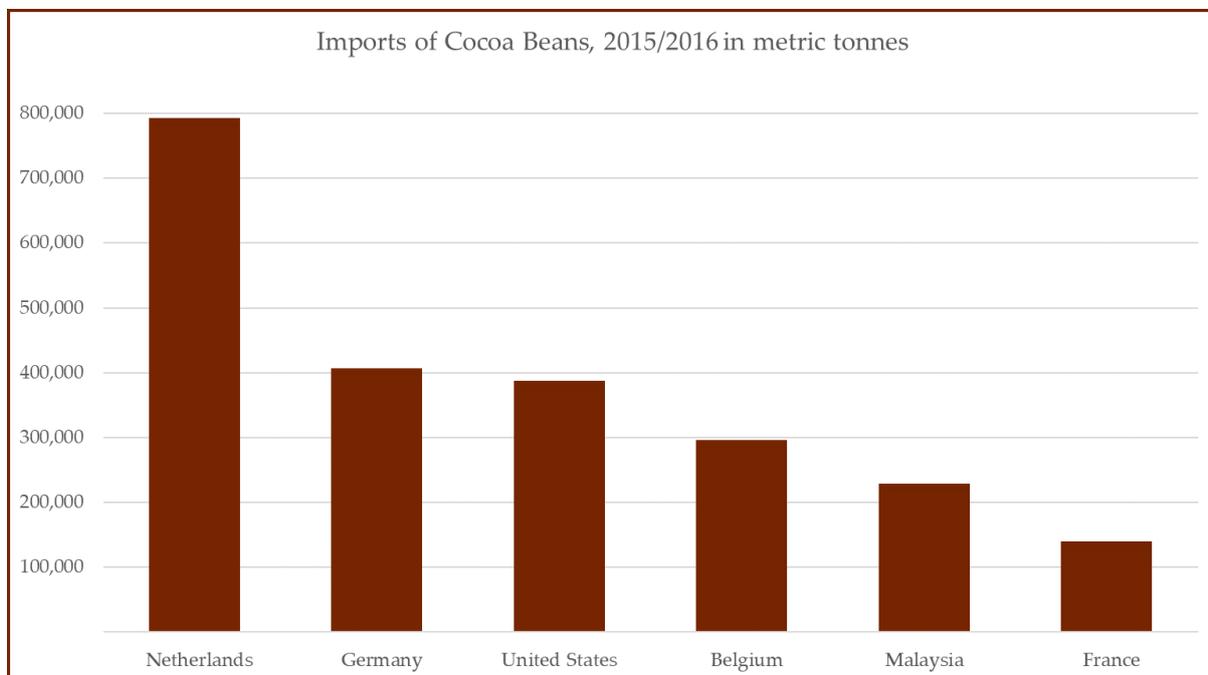


Figure 8: Imports of Cocoa Beans 2015 / 2016, Source: ICCO, 2017

Naturally, this pattern defines the trade flows of cocoa beans and products as the main importers are industrialized nations that either process the cocoa beans or use the imported cocoa products. Figure 8 depicts the six biggest importers of cocoa beans worldwide. There are two interesting facts hidden in the data: first, the Netherlands is traditionally and historically the biggest processor of cocoa beans in the world. A good indication for the relevance of the Netherlands in cocoa trade and chocolate production is the historical name 'dutching' for the addition of alkalizing agents to modify the color and change the taste of cocoa powder. The other interesting point validates the argument before: the origin grindings in Malaysia are mainly sustained by the import of cocoa beans from different origins. This production of intermediate products makes Malaysia the fifth biggest importer of cocoa beans although there is little local chocolate consumption. The other five countries in Figure 8 have a considerable amount of chocolate consumption and were thus no surprise to be among the biggest importers of cocoa beans.

Turning towards the imports of cocoa products we can explain a fact that has been mentioned before: the specialization of Malaysia and Indonesia in the production of cocoa powder. Figure 9 depicts six of the biggest importers of cocoa products worldwide. The most obvious aspect of Figure 9 is the high import of cocoa powder and cake into the United States of America. Around 15% of the worldwide exports of cocoa powder and cake are transported to the United States and the reason is simple: The United States do not charge an import tax on cocoa powder and cake while the European Union has import taxes that make imports of cocoa products from Malaysia and Indonesia often unfeasible. The other countries depicted in Figure 9 have a similar relationship between cocoa butter, cocoa powder and cocoa liquor import in terms of percentages of total imports. As mentioned above, Figure 8 sustains the argument that the imports of cocoa and cocoa products for chocolate production in Asia is quite small.

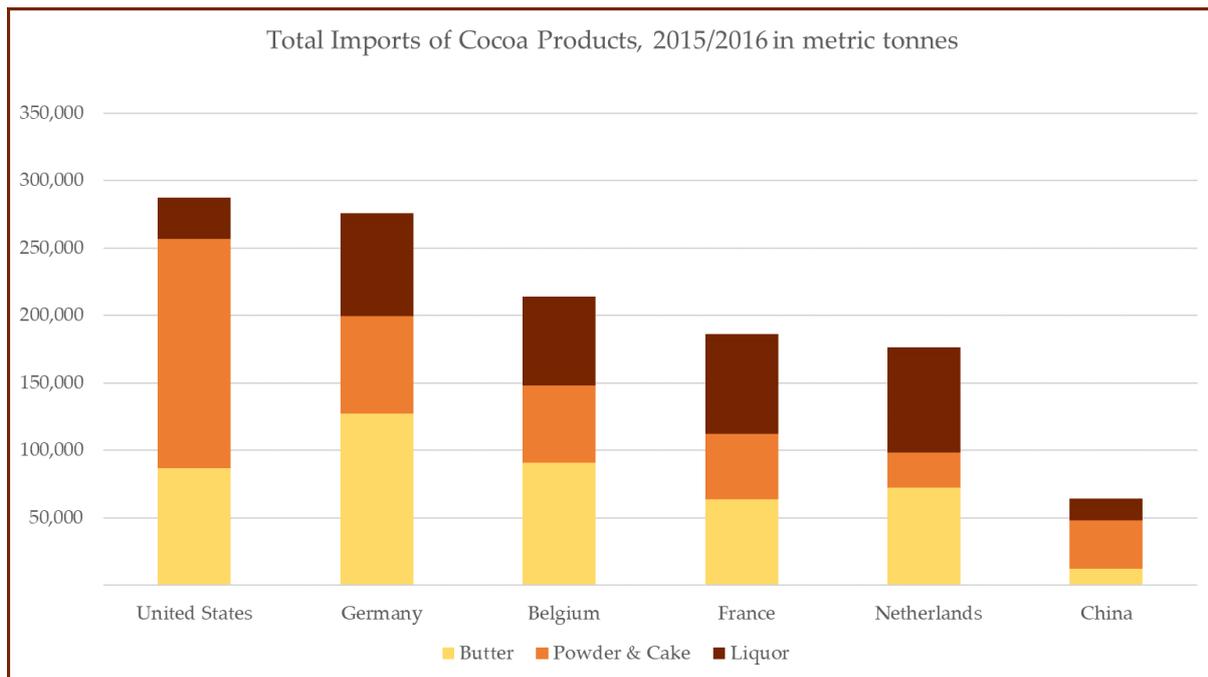


Figure 9: Total Imports of Cocoa Products 2015 / 2016, Source: ICCO, 2017

The biggest Asian importer is China and the total quantity of around 64,000mt is very small compared to the imports of cocoa products of the much smaller country Belgium (around 210,000mt). To complete the picture, Europe imports around 65% of the total cocoa beans imports, while the Americas and Asia each have a share of around 14%. As expected, the European imports for cocoa butter reach 70% while the Americas import only 16% and Asia even less at 11% of the worldwide imports. For cocoa powder, we have to consider the fact that cocoa products are often imported and exported within the European Union which can inflate the quantity that is reported. For 2015/2016, European countries imported 45% of the worldwide cocoa powder imports while the Americas and Asian countries imported each around 25%. Finally, the import percentages of cocoa liquor are similar to the percentages for cocoa butter: around 70% are imported into Europe, 11% to the Americas and 16% to Asia.

We have analyzed the current export and import patterns for cocoa beans and cocoa products. For the scope of this thesis, one has to enlarge the focus and also consider past values and the development over time.

The first historical data set of interest is the development of the cocoa crop over the years. Figure 10 depicts an upward sloping curve for the worldwide crop from 1960 to 2016. One can identify a general positive trend over the last 55 years. Although the worldwide crop increases decade-over-decade, the speed of the increase varies and within all decades there are decreases year-over-year. Hence, the worldwide cocoa trade is not immune to negative supply shocks due to lower crops. Figure 10 shows the different speeds at which the world wide cocoa crop grows: the increase is significantly faster after the beginning of the 80s which is represented by a much steeper positive trend from 1985 to 2016. For the moment it is enough to know that the general direction of the crop yields is pointing upwards and has done so for at least the last 60 years. We will cover some of the events and trends with respect to Ghana later.

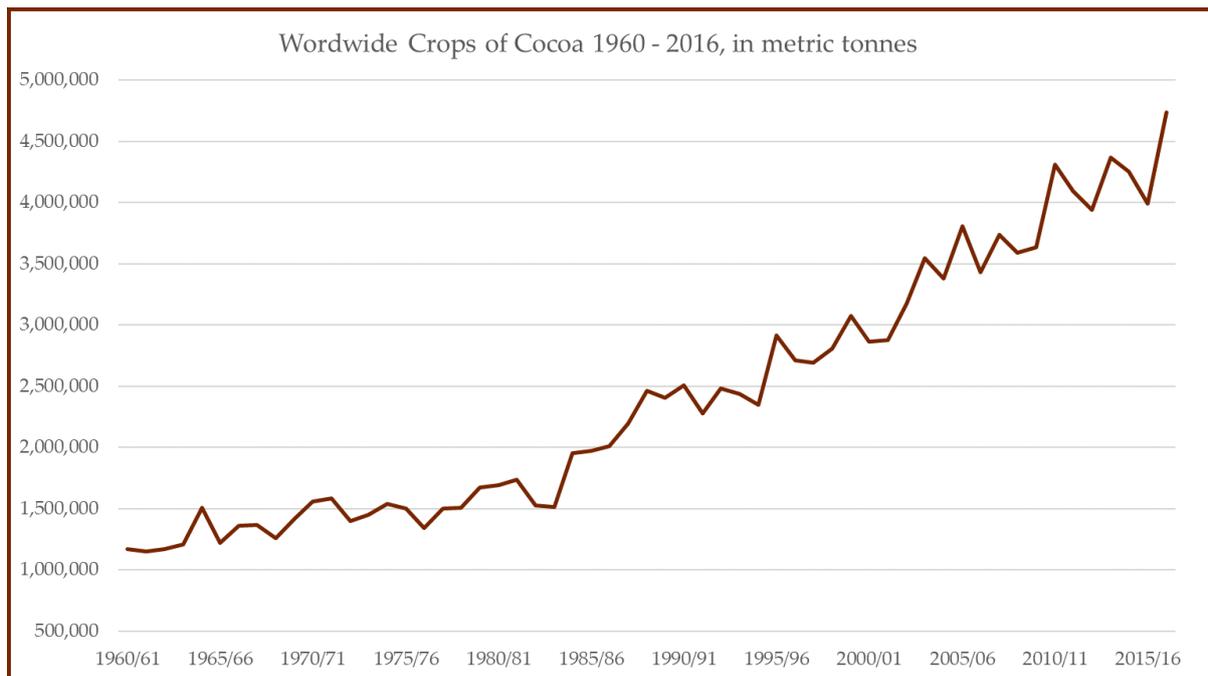


Figure 10: Worldwide Crops of Cocoa 1960-2016, Source: ICCO, 2017

We will close out this chapter with a look at the nominal and real price movements of cocoa beans. Generally, the observation must be made that the real and nominal prices move together but the nominal price seems to have a much higher volatility. One can easily detect various long-lasting up and down movements in the nominal cocoa price. (Figure 11) A short but steep upward movement in the 1970s is followed by a long downward trend until the beginning of 2000 when a steady upward trend has gripped the market and continues up to 2016. A big spike in prices occurred between 1975 and 1977 because the supply was severely limited by bad crops in two consecutive years. The high prices induced Asian countries such as Malaysia to invest into cocoa plantations and thus the prices started to drop. The drop accelerated when the first Asian crops were ready for the international market in the beginning of the 1980s.

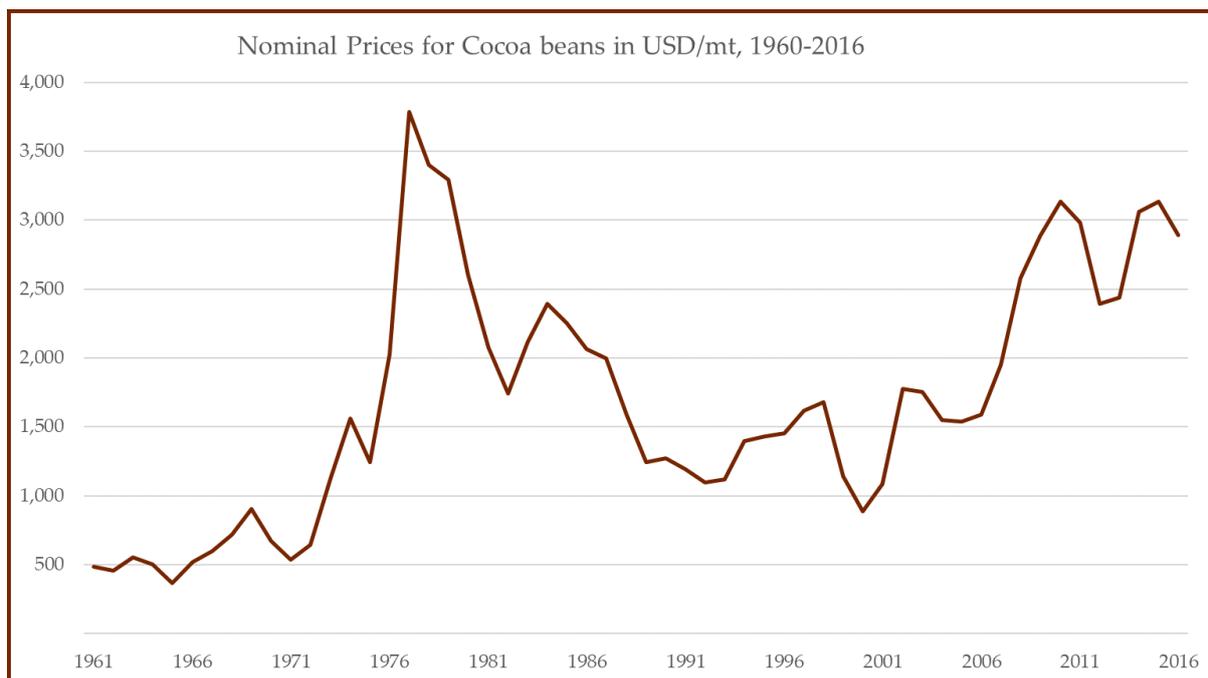


Figure 11: Nominal Prices for Cocoa beans in USD / mt, 1960-2016, Source: ICCO, 2017

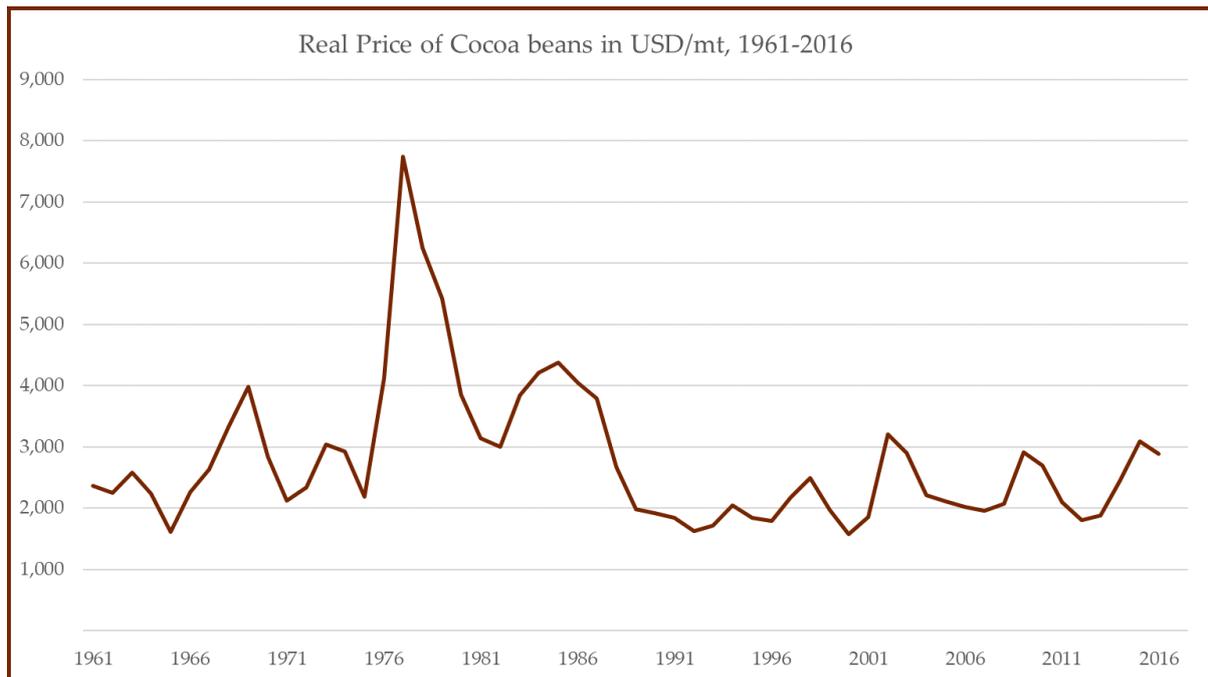


Figure 12: Real Prices for Cocoa beans in USD/mt deflated to 2016 levels, Source: ICCO, 2017

As outlined above due to the agronomics of cocoa, some years had to pass before the first crop could enter the cocoa market. The famous Cobweb model that would suggest that the cycles of high and low prices in agricultural commodities are due to the time lag between planting the crops and availability in the market, could have been at work in this case.

The Ghanaian Cocoa Production

This chapter is the central part of the thesis. It is setup to identify the determinants of supply of cocoa beans in Ghana. To accomplish this goal the chapter will be divided into subchapters: the arguments for the first subchapter are the Ghanaian demographics and economic development over the period of interest from 1960 to 2015, the history of cocoa production from the onset and its importance for the local economy as well as the local institutional setup. This part will underline why Ghana is a good choice to evaluate the impact of different determinants of cocoa production and will deepen the understanding of the following regression.

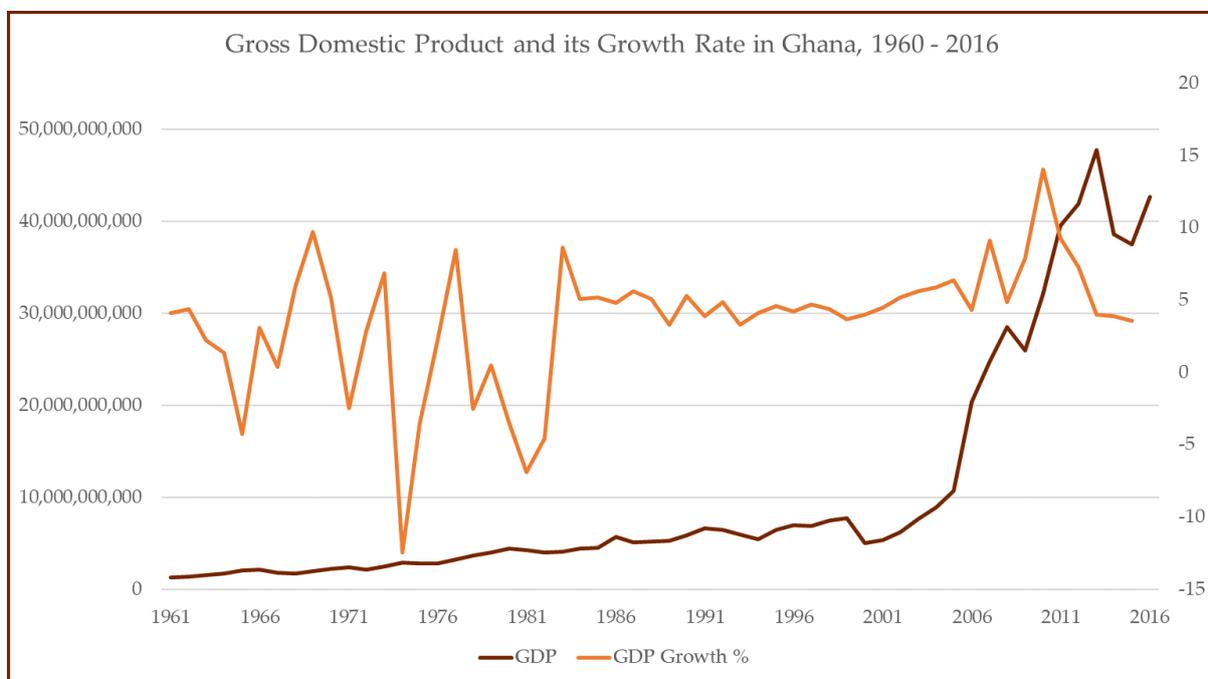


Figure 13: GDP and GDP Growth Rate of Ghana, 1960-2016, Source: World Bank (2016)

Afterwards I will shine light on the supply & demand variables of cocoa beans, that will be used in the regression, and the regression model will be presented. Finally, the results are discussed and put into context.

Ghana and its cocoa production through time

Before focusing on cocoa, which has traditionally been the most important cash crop in Ghana since its introduction in the late 19th century, a general introduction of the Republic of Ghana with respect to its main economic and demographic key data over time is needed. I will start out by looking at the development of the GDP and the realized growth rate between 1960 and today.

According to the World Bank (2016) and as we can see in Figure 13, the general trend of the Ghanaian GDP is positive for the last 50 years. The acceleration has started in earnest only after 2000. Constant growth rates above 5%, even reaching the heights of 14%, let the GDP grow eightfold in just 15 years since. While the years between 2000 and 2016 are generally considered a success story for Ghana, the two decades between 1960 and 1980 were rather dreadful in economic terms. From Figure 13 it is immediately visible that the growth rate was very volatile in this period.

After gaining independence from the United Kingdom in 1957, Ghana was in good shape as the biggest exporter of cocoa beans in the world and endowed with a solid infrastructure and a comparatively advanced education system. (Berry, 1994) Under the first president Kwame Nkrumah, Ghana followed the path of a fast, socialistically driven industrialization that was underpinned by the foreign exchange income generated from cocoa beans' export. With the rapid decline of the world cocoa price during the 60s (s. Figure 11), the financial burden of the rapid expansion in the form of international debt weighted heavily on Ghana and its budget. This explains the negative turn of the real growth rate. Higher taxes and forced savings as well as protests and strikes by urban workers aggravated the situation and the reduction of the price paid by the government's marketing board to the cocoa farmers further strengthened the opposition to the rapid industrialization. The government of Nkrumah was overthrown shortly after but the following, more democratic, government was not able either to solve the problems that hampered Ghanaian growth. Growth

remained unstable, although it exhibited a more positive trend up to the beginning of the 70s. Nevertheless, various policies alienated cocoa farmers that provided up to 50% of the foreign exchange income. (Berry, 1994) The dependency on the cocoa income at national level was painfully felt when a combination of different factors reduced the cultivation and marketing significantly: persistent corruption, misguided international and local market policies, stronger foreign competition (Côte d'Ivoire i.e.) and smuggling of crop into other countries. In 1971, these factors combined with the inherited high international debt and austerity measures recommended by the IMF lead to a coup d'état by the military and the installation of a military dictatorship. The new government had no success in improving the living conditions in Ghana and the oil crisis of 1974 resulted in strong negative growth due to the lack of fuel for transportation and industry. Oil and its derivatives of fuel were too expensive for Ghana because it lacked foreign exchange and credit. Negligence towards the cocoa trees in the previous decade was the main reason why Ghana was not able to profit from the rising cocoa prices towards the end of the 70s. More specifically, the low productivity of the old trees prevented higher yields and the low farm gate prices lead to increased smuggling into neighboring countries that paid higher prices to farmers. High international debt and an overvalued currency resulted in rampant inflation throughout the 70s. To summarize the economic downturn from the late 50s to the early 80s we can turn to Berry, 1994 (p. 135f):

By the early 1980s, Ghana's economy was in an advanced state of collapse. Per capita gross domestic product (GDP) showed negative growth throughout the 1960s and fell by 3.2 percent per year from 1970 to 1981. Most important was the decline in cocoa production, which fell by half between the mid-1960s and the late 1970s, drastically reducing Ghana's share of the world market from about one-third in the early 1970s to only one-eighth in 1982-83. At the same time, mineral production fell

by 32 percent; gold production declined by 47 percent, diamonds by 67 percent, manganese by 43 percent, and bauxite by 46 percent. Inflation averaged more than 50 percent a year between 1976 and 1981, hitting 116.5 percent in 1981. Real minimum wages dropped from an index of 75 in 1975 to one of 15.4 in 1981. Tax revenue fell from 17 percent of GDP in 1973 to only 5 percent in 1983, and actual imports by volume in 1982 were only 43 percent of average 1975-76 levels. Productivity, the standard of living, and the government's resources had plummeted dramatically.

The point was reached where the internal and external problems lead the new government of officers and civilians under President Jerry John Rawlings to apply for aide from the IMF and the World Bank in 1983. The strict concentration on repaying foreign debt and increasing exports that was encouraged by the neoliberal policies of the IMF and the World Bank resulted in a more stable economy with less inflation. The cocoa sector was able to regain some of its lost strength.

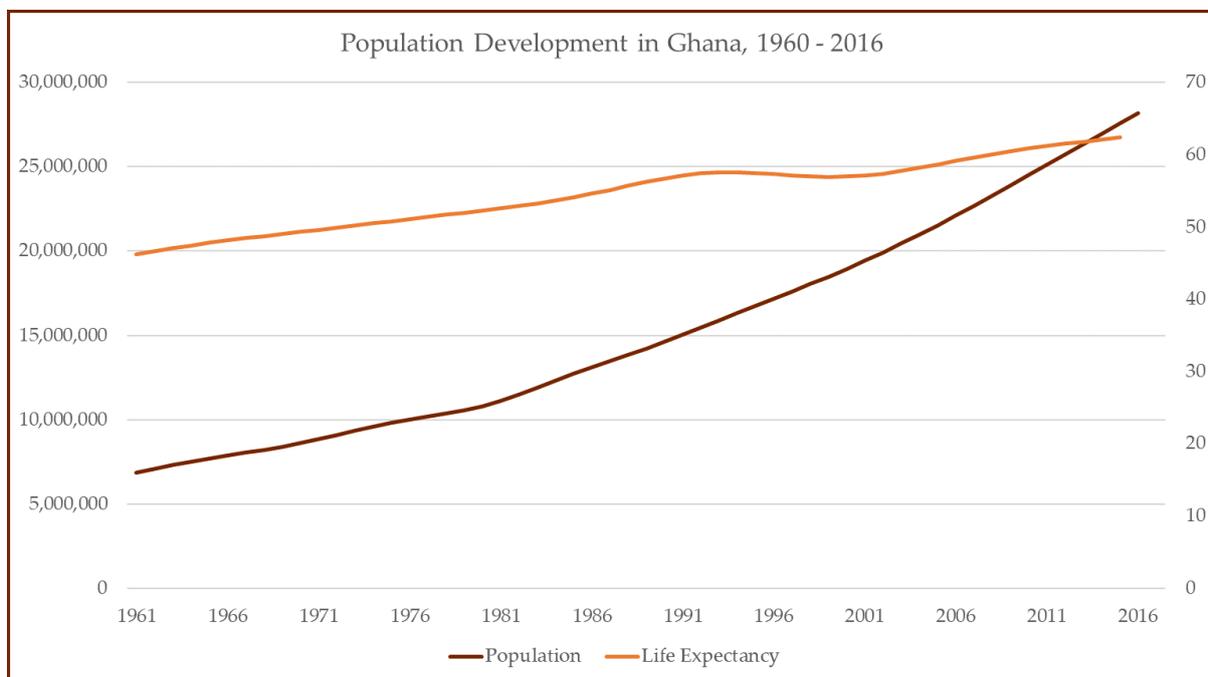


Figure 14: Population and Life Expectancy in Ghana, 1960-2016, Source: World Bank (2016)

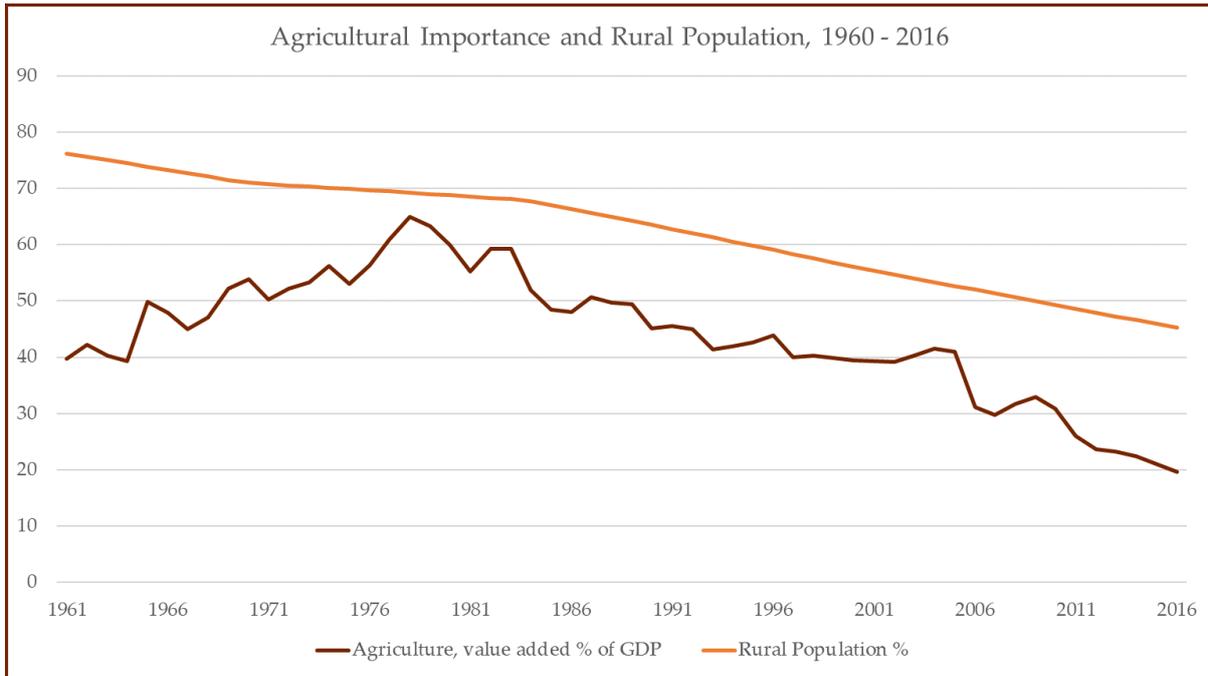


Figure 15: Agricultural Importance and Rural Population, 1960-2016, Source: World Bank (2016)

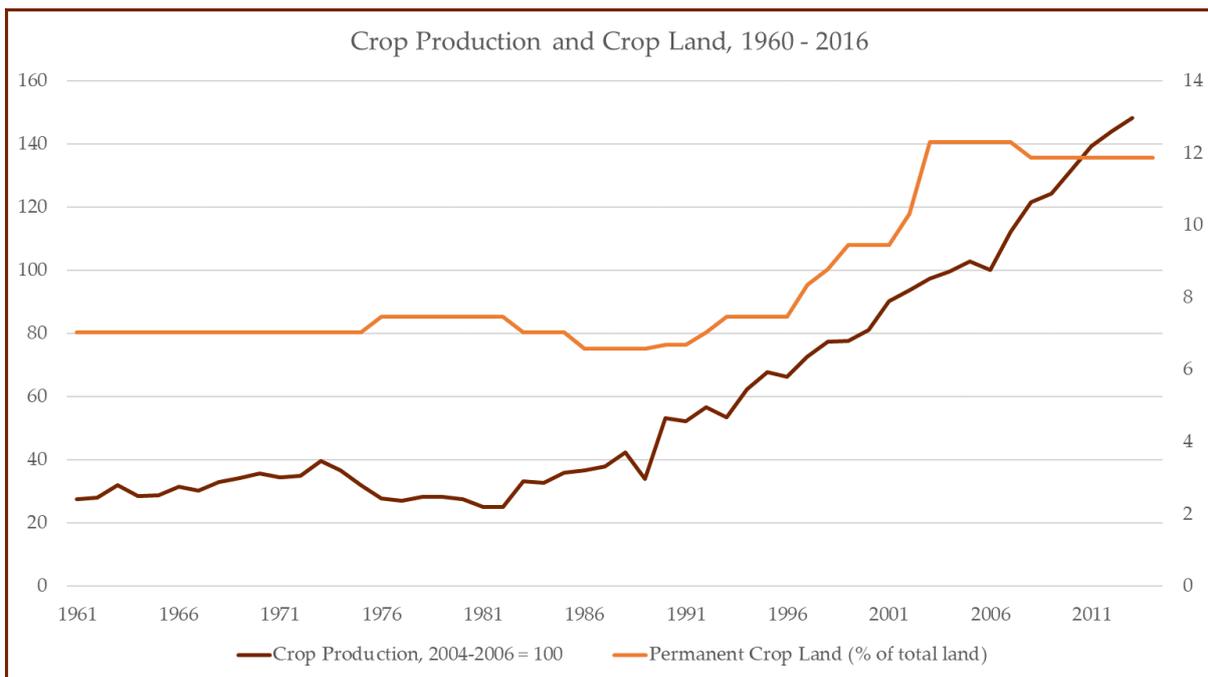


Figure 16: Crop Production and Crop Land, 1960-2016, Source: World Bank (2016)

As we can see in Figure 13, the GDP growth stabilized at ca. 5% per year from 1983 onwards. According to Berry (1994), the recovery program nevertheless entailed a generally 'lowered standard of living for most Ghanaians'. (p.136) Since the first successful and peaceful passing of power from Jerry John Rawlings to his successor in the presidential elections in 2000, Ghana is considered a stable multi-party democracy. With its democracy the Ghanaian economy and its GDP started a strong rally that has been covered above. Interestingly, the GDP growth rate dropped significantly after the boom in commodity prices ended in 2011. It shows the dependency of the Ghanaian economy on cocoa once more.

Continuing the analysis of Ghana to understand the local cocoa supply better, we can turn to the Ghanaian population over time. Figure 14 shows a steady increase in population and life expectancy without any significant break between 1960 and 2016. At most, one could argue that a slight increase in the population growth happened after 1980 and continued up to now. The positive population growth is in line with the higher expected life span of Ghanaians. We would expect that the labor supply within Ghana increased over time and thus reduced the cost to produce cocoa with a slight impact on the world price, but we must look at the rural population to validate this hypothesis. In fact, Figure 15 shows the rural population and the share of Ghanaian GDP that is attributable to the agricultural production. The figure contradicts our earlier idea that higher population would lead to lower costs. Quite the opposite has happened in Ghana: with the ever-increasing industrialization, the Ghanaians preferred, not unexpectedly, to migrate towards the cities. The decline in rural population is staggering: from around 75% in 1960 of all Ghanaians to just 45% in 2016. Equally interesting is the lower contribution of the agricultural sector to the Ghanaian GDP: with the industrialization and the development of the service sector the share of GDP fell from a high of ca. 65% in 1979 to around 20% in 2016 as it is typical for developing countries.

We can conclude that the agricultural sector, thus also cocoa, has declined in importance over time but played and still plays an important role in the Ghanaian economy of the past and today.

As we have seen before, one input factor for the agricultural sector, labor, has decreased dramatically in the last 60 years. We can analyze the other factor looking at Looking at the percentage of permanent crop land of total land in Ghana, we can deduce that the percentage remained steady from 1960 through the early nineties when it started to increase and nearly doubled in less than 10 years. From around 7% to 13% is a surprising increase in terms of total land used in agriculture and in terms of speed of the increase. Since then the crop land percentage has held steady again. Turning towards the second data series represented in Figure 16, we can draw some conclusions concerning the effectiveness of the usage of both factors of agricultural

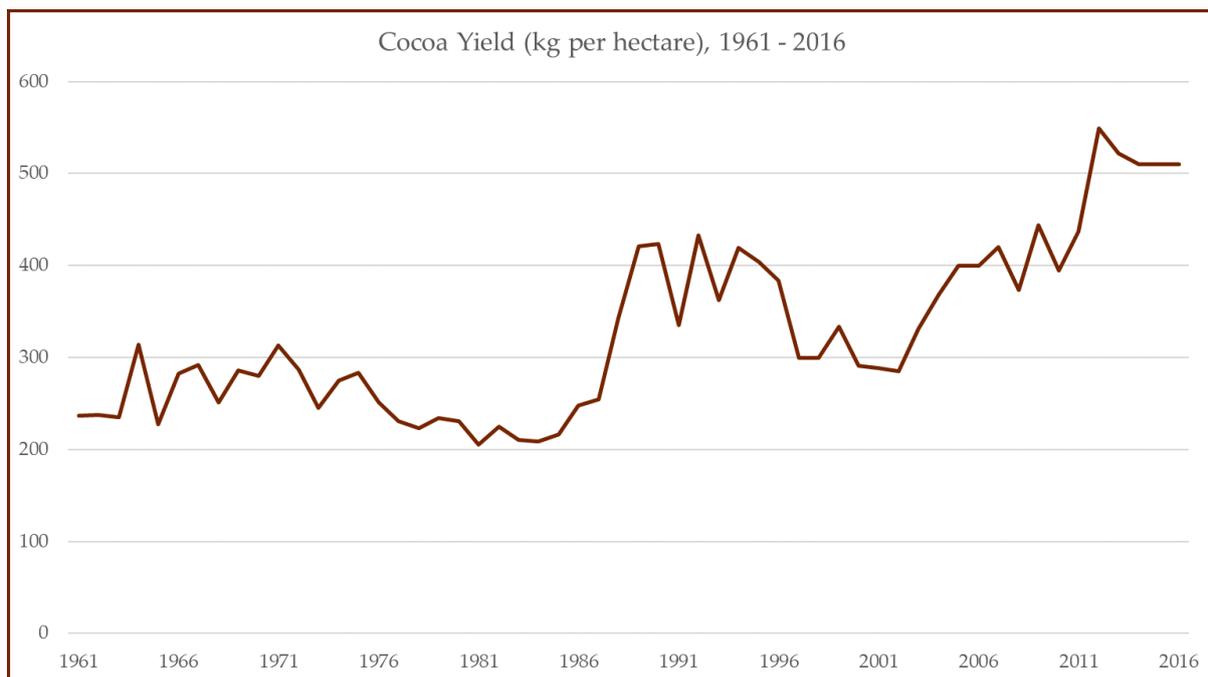


Figure 17: Cereal Yields in kg per hectare, 1960-2016, Source: World Bank

production: although the availability of labor decreased significantly over the years and the land remained steady for a long time, the crop production showed a clear positive trend from the 1980s onwards. Taking the period between 2004 and 2006 as a baseline, the crop production has risen from 1980 at around 25% of the 2004-2006 level to ca. 140% in 2015. Putting the three aspects together, we are left with the question where the higher production came from. Labor input has been reduced and land usage has doubled but not to the extent to explain the increase in crop production. To answer that question, we can turn to the yields that the crops have produced. Naturally, the yields are highly dependent on the weather for each singular crop but the general trend since the beginning of the 2000s is positive and the sharp drops for single years are usually recovered in the next year. We can conclude from the Figures 15, 16 and 17 that the increased production of crops is most likely due to the sharp increase in yields. The higher usage of fertilizers, the better understanding of agricultural techniques and other factors have most prominently contributed to this rise. We will follow this lead more closely for cocoa in the next subchapter about the history of cocoa in Ghana.

To summarize the Ghanaian economy from 1960 to 2016, we can state that the period from 1960 to 1985 was mostly bleak in terms of growth and quality of life for nearly all Ghanaians. The period between 1985 and 2016 was defined by higher and more stable growth in GDP and general political stability. The GDP made significant strides in absolute terms and many Ghanaians were able to profit from the sustained economic growth.

With the economic background in mind, we will turn our attention now to the history of cocoa production in Ghana since its inception. First, it must be noted that the cocoa tree is not a local plant. The cocoa tree was imported in 1876 by a blacksmith called Tetteh Quarshie who considered farming his hobby. A voyage to the territories that are now Equatorial Guinea between 1870 and 1876 gave him the opportunity to

bring back some cocoa pods of the Amelonado type to Ghana that would grow to be the first cocoa trees in Ghana. (Sampson, 1969)

From thereon onwards, the history of cocoa in Ghana can be divided into four periods according to Kolavalli and Vigneri (2011): the first period is defined by the rapid growth of the planted area and endures from 1888 to 1937. After the before mentioned arrival of the cocoa plant, the farmers moved westwards to buy forest land from local chiefs to establish cocoa plantations. (Hill, 1963) There are a few reasons that led farmers to invest into the new plant: the fall of the global palm oil prices after 1885, newly available capital due to the rubber price boom in 1890 as well as population pressure and the new establishment of European buying companies in West Africa. (Gunnarsson, 1978) The second wave of labor, necessary to expand the frontiers of cocoa plantation further to the west, was divided into three distinct classes: land-owning farmers, peasants and laborers. Many of the new arrivals from neighboring regions did not have sufficient funds to buy own land. The distinct salary arrangement between the second wave farmers and the earlier farmers with land, called 'abusa', provided for one-third of the crops' sales price as wage for the work on the farms. (Kolavalli & Vigneri, 2011) The profits gained from the new plantations were mostly reinvested in new frontier plantations further west. Ghana was the world leader in cocoa production between 1910 and 1914. Kolavalli & Vigneri (2011) state that 84% of Ghana's total export in 1929 was cocoa and that a yearly production of 300.000mt was reached in the mid-1930s.

The second period, that was characterized by stagnation and post-independence growth, began in 1938 and finished in 1964 when a strong downturn occurred. During the Second World War, the occurrence of various pests and diseases (i.e. swollen shoot virus) and the coinciding downturn in demand had a profound negative impact on the cocoa production in the original eastern part of Ghana. (Gunnarsson, 1978) The cultivation moved further west towards unoccupied forest land. (Amanor, 2010)

To concentrate the marketing and export effort of cocoa beans in the Gold Coast, which is roughly present-day Ghana, the British colonialists established the Cocoa Marketing Board (CMB) in 1947. This marketing board held the monopoly of buying beans for export and its profits were initially held as reserves which then were used to carry out public works and investment. (Brooks, Croppenstedt & Aggrey-Fynn, 2007) To put the initial success story after the Second World War into perspective: According to Beckham (1976), the government was able to collect about one-third of the whole cocoa export revenues as taxes between 1947 and 1965 while the farmers at least during the 1950s were paid at least twice as much as before the Second World War. The government was able to raise these taxes only through higher export tariffs, established in 1950, and through an ad valorem tax and later a flat tax that was levied on the producers of cocoa beans. The United Ghana Farmers' Council (UGFC), founded in 1953, was used to unite the farmers politically behind the Nkrumah government and exert influence by being the monopoly buyer of cocoa. After successful re-elections in 1954 and 1957 the government tried to raise the export tariffs (1954) and lowered the producer prices (1957) to increase the government's revenue share. However, the regime was also forced to increase the producer prices for the 1956/1957 crop to quell political unrest after they had not been increased for four consecutive years when world market prices were rising quickly. The share of government revenue in the cocoa export dropped from 60% in 1954/55 to 13% 1956/1957. Kolavalli & Vigneri (2011) have analyzed that both, the UGFCC and the CMB, were acting on the behalf of the government by the late 1950s and were principal financiers of the socialist development plans. They were considered 'an instrument of public finance'. (p. 203) Due to the windfall profits from the cocoa export and internal marketing, the government's expenditure of overall GDP rose from 7% to 18% in the 1950s which is a dramatic increase and shift in public finance. (Kolavalli & Vigneri, 2011) The exports nevertheless continued to grow and reached the record level of 430,000mt in 1964

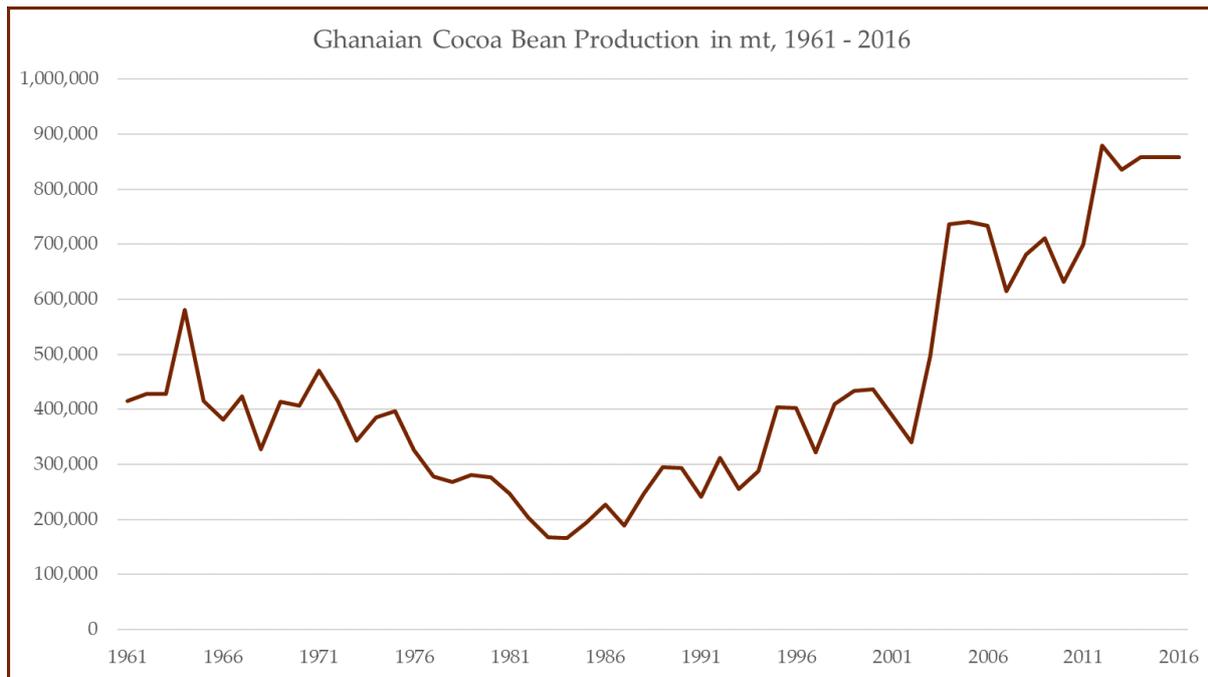


Figure 18: Ghanaian cocoa bean production in mt, 1961-2016, Source: FAOSTAT

although the price of cocoa had fallen significantly between 1960 and 1962. (ICCO, 2017)

The third period according to Kolavalli and Vigneri (2011) coincides with the start of my time series analysis and the public availability of data. Figure 18 depicts the Ghanaian cocoa production from 1961 to 2016 and the downturn, that took hold of the Ghanaian cocoa industry in the beginning of the 60s up to the mid-80s, is clearly visible. In more detail, the fall in world prices between 1960 and 1962 hit the Ghanaian public finances hard and the reserves of the CMB were exhausted by 1964. The last resort of printing money and, thus inducing inflation, led to a further decrease in producer prices. Policies to control foreign exchange, to increase taxes and to introduce import licensing did not stop the budget deficit from exploding and the foreign exchange reserves from dwindling. The final blow was delivered by the unprecedented bumper crop of 538,000mt in 1964 which led the world prices to collapse. Stryker (1990) argues that the further fall in world prices in 1965 aggravated the situation and the government of Nkrumah was overthrown in 1966 as described above.

An important factor was the constantly decreasing producer prices which had not seen a lift since 1957. The countermeasure of overvaluing the local currency, the Ghanaian Cedi, led to another problem: the local Ghanaian harvest was smuggled into nearby Côte d'Ivoire to be sold at the higher local prices there. Bulir (2002) estimates that at least 20% of the Ghanaian cocoa bean crop was sold in Côte d'Ivoire between 1970s and early 1980s.

The past hardship and missing income for the farmers resulted in the logical depletion of the cocoa plantation: the tree stock aged, and diseases decimated the plantations. The farmers with their low income were not able to adequately replace the trees that were planted during the initial boom after the Second World War. The change from cash crop to food crop was thus a logical step for many farmers in the old plantation areas in the east of Ghana. (Amanor, 2005) The result was clear: Ghana lost its once dominant position on the world market in terms of total export of cocoa beans. The export reached a low of 159,000mt in 1982/1983 which represented only 17% of the world production and had fallen significantly from 36% in 1964/1965. During the downturn period until 1982, many different governments tried their hand in resurrecting the cocoa industry, but none succeeded.

The internal marketing system was reorganized by the National Liberation Council when the UGFCC was dissolved and a subsidiary of the CMB, the newly founded Producing Buying Company, was instructed to buy the local cocoa crop. The results were bleak nevertheless as the real producer prices remained on 1950s level which deterred new investments and any increase in production. (Kolavalli & Vigneri, 2011) Windfall profits in the beginning of the 1970s due to the rising world cocoa price were happily accepted by the governments in charge but the worsening balance of payment gave rise to high inflation that eliminated any increase in producer prices, real wages and any other incentives for cocoa plantation. As we have seen, the world cocoa price determines a significant part of the fate of the Ghanaian economy and the

fall in the mid-1970s led to the final collapse of the Ghanaian cocoa sector. The budget deficit increased, and the inflation grew stronger. The overvalued Cedi eliminated any potential gains from the cocoa export and thus the CMB started to weigh on the government's budget even if it was a net contributor to the budget before. Kolavalli & Vigneri (2011) have shown that the situation worsened enough that in 1980/1981 'the world price at the official exchange rate was lower than the producer price plus the marketing costs.' (p. 204) An additional disadvantage was the increased competition in the late 1970s and early 1980s: new producer countries such as Malaysia, Brazil and Indonesia were entering the market and the higher total production reduced the price of cocoa beans substantially. Aside from the smuggle of Ghanaian cocoa beans, also cheap labor from Burkina Faso and Côte d'Ivoire, which had come to Ghana after the Second World War for the initial boom period, now decided to travel to the Ivorian plantations that were offering better pay and higher efficiency. The Ivorian government also offered favorable terms for new plantations setup by immigrants.

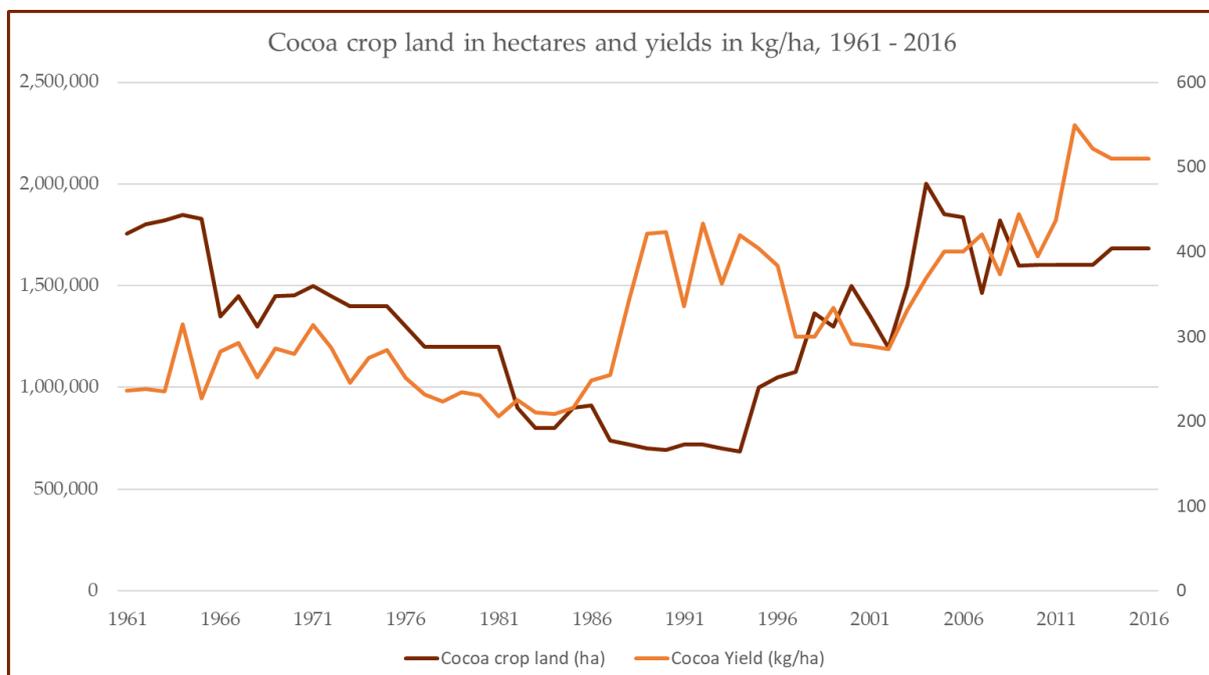


Figure 19: Cocoa crop land in hectares and yields in kg/ha, 1961-2016, Source: FAOSTAT

The upswing started with the introduction of policies aimed at increasing the farm gate price to locally comparable levels and devaluing the Cedi to avoid the indirect tax that was levied on the farmers. (s. Figure 18) The so-called Cocoa Rehabilitation Project was a cooperation by the government of Jerry John Rawlings and the World Bank and the IMF. It included compensation for the elimination of infested trees and monetary help to plant newly developed types of the cocoa tree to increase yield and protection against new infestation. The results were soon visible: the cocoa bean crop rebounded to 400,000mt in 1995/1996 and the productivity increased from 210 to 404 kilograms per hectare. (Kolavalli & Vigneri, 2011) This is visible in Figure 19. Expectedly, the cocoa crop land declined from the beginning of the 60s towards the middle of the 90s as described above. Afterwards the trend turned positive and the last few years have seen a steady size of cocoa crop land. On the other side, without significant outside help and technology, the yields of the Ghanaian cocoa plants remained mostly steady until the mid-80s. However, they increased rapidly afterwards up to the mid-90s, which is in line with the general cereal yields (s. Figure 17).

The higher yields were a result of the elimination of infested trees and the higher expertise in farming and pesticides brought to Ghanaian farmers through the cooperation with the IMF and the World Bank. The strong yields certainly incentivized the plantation of new cocoa trees and the cocoa crop land grew accordingly with a delay of 5-6 years according to the graph. After a considerable slide until the early 2000s, the yields exhibited a strong positive trend again. In total, the yields more than doubled from around 230 kg/ha to 510 kg/ha from 1961 to 2016.

Meanwhile, a change in the internal marketing system resulted in more efficiency: the Cocobod (the new name for the CMB, since 1984) ceded control over the local buying process to six private and licensed buying companies (LBC) but retained the monopoly of exporting cocoa beans. The years after 2001 have been especially successful for the Ghanaian cocoa production. (s. Figures 18 & 19) The world cocoa

beans prices were high, and the farmers were able to participate to higher degree. The Cocobod took it up to dispense good farming practices and promote the use of fertilizers and mass spraying programs to protect the cocoa plants. (Vigneri & Santos, 2008) A final sign of a well-functioning cocoa industry was the smuggling activity that had turned on its heels: Brooks, Croppenstedt and Aggrey-Finn (2007) estimated that 120,000mt to 150,000mt of Ivorian cocoa beans had been smuggled into Ghana in the crop season 2003/2004.

We can conclude that cocoa in Ghana has played an important role in the development of the economy and the society. We have seen that many of the policies and the governmental decisions are linked to the state of the cocoa sector and that it is of high importance for the Ghanaian people and government to foster a strong cocoa sector in the country. This policy focus on the cocoa production sector was visible throughout all the four periods that were identified by Kolavalli & Vigneri in 2011 and has not changed since. With this background information about the economic history of Ghana and especially the history of the cocoa market, we can start building the model that tries to explain changes in the supply of Ghanaian Cocoa supply between 1960 and 2011.

The Econometric Model

To undertake the analysis of the yearly Ghanaian cocoa production, I have employed the widely used multivariate ordinary least squares regression model. It will give an inside into the impact of the independent variables on the yearly supply of cocoa beans in Ghana. The basic theory of the model will be presented in the following part to give the reader a starting point. The deduction is taken from Johnston & DiNardo (1996).

The analysis of a simultaneous equation system that considers k variables can be broken down to a single equation and can be specified as follows:

$$Y_t = \beta_1 + \beta_2 X_{2t} + \beta_3 X_{3t} + \dots + \beta_k X_{kt} + u_t$$

Clearly, the dependent variable Y is the cocoa supply in Ghana and the independent variables X are the determinants of this supply of cocoa beans.

To simplify notation matrix algebra is used and the $k+1$ unknown parameter (all β and the disturbance variance σ^2) can be estimated in this form as well. The error term is assumed to be of white-noise:

$$y = X\beta + u$$

where

$$\mathbf{X} = \begin{bmatrix} 1 & X_{21} & \dots & X_{k1} \\ 1 & X_{22} & \dots & X_{k2} \\ \vdots & \vdots & \ddots & \vdots \\ 1 & X_{2n} & \dots & X_{kn} \end{bmatrix} \text{ and } \boldsymbol{\beta} = \begin{bmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_3 \end{bmatrix}$$

The unknown vector β can be estimated using the algebra of Least Squares. Replacing this vector by an estimate b results in a vector of residuals, e

$$e = y - Xb$$

The guiding principle in estimating the unknown vector is to minimize the residual sum of squares, $e'e$ (RSS):

$$\begin{aligned} RSS &= e'e \\ &= (y - Xb)'(y - Xb) \\ &= y'y - 2b'X'y + b'X'Xb \end{aligned}$$

The first-order condition for minimization is thus:

$$\frac{\partial(RSS)}{\partial b} = -2X'y + 2X'Xb = 0$$

Which results in the normal equations which relates the estimate b to the data

$$(X'X)b = X'y$$

As we are mainly interested in the value of the estimations and their significance, the interference in the OLS regression model can be done as follows:

$$b = (X'X)^{-1}X'y$$

Substituting in for the variable y :

$$b - \beta = (X'X)^{-1}X'u$$

So that:

$$E(b) = \beta$$

which proves that the estimate of β is unbiased. The variance for the estimator b is easily found by taking expectations of the square:

$$\begin{aligned} E[(b - \beta)(b - \beta)'] &= \sigma^2(X'X)^{-1} \\ \text{var}(b) &= \sigma^2(X'X)^{-1} \end{aligned}$$

An estimator for the unknown variance of the error term, σ^2 , can also be found:

$$s^2 = \frac{e'e}{n - k}$$

The linear estimation of the regressor is based on the Gauss-Markov Theorem that states that no other linear, unbiased estimator of the regressors will have a smaller

sample variance than the one above. The proof is readily available in various sources, i.e. Johnston & DiNardo (1996).

The hypothesis whether a certain regressor is significant, can be expressed and tested as follows:

$$H_0: \beta_i = 0$$

The general linear framework can be written as:

$$R\beta = r$$

Where R is a q x k matrix with known constants, and r is a vector of known constants. Obviously, the hypothesis H_0 determines the make up of R and r:

with 1 in the i-th position.

$$R = [0 \dots 0 \ 1 \ 0 \dots 0], r :$$

Combining the matrices and the linear framework we can use the simple:

$$H_0: R\beta - r = 0$$

as the hypothesis for significance that needs to be tested.

It can be proven that the following holds for the distribution of above framework:

$$b \sim N[\beta, \sigma^2 (X'X)^{-1}]$$

$$Rb \sim N[R\beta, \sigma^2 R(X'X)^{-1} R']$$

$$R(b - \beta) \sim N[0, \sigma^2 R(X'X)^{-1} R']$$

If we consider the linear framework of above to be true, that is: $R\beta = r$

We can derive the following distribution:

$$(Rb - r) \sim N[0, \sigma^2 R(X'X)^{-1} R']$$

From which we can easily derive a χ^2 variable in turn:

$$(Rb - r)' [\sigma^2 R(X'X)^{-1} R']^{-1} (Rb - r) \sim \chi_q^2$$

As we have seen before, the missing variable σ^2 can easily be substituted by a proper statistic so that a combined statistic arises which has a F distribution under H_0 :

$$\frac{(\mathbf{Rb} - \mathbf{r})' [\sigma^2 \mathbf{R}(\mathbf{X}'\mathbf{X})^{-1} \mathbf{R}']^{-1} (\mathbf{Rb} - \mathbf{r})/q}{e'e/(n - k)} \sim F(q, n - k)$$

Naturally, the test for significance is applied by computing the F value and comparing it to a preselected critical value. The null hypothesis is rejected if the computed F value exceeds this threshold.

As we have sufficiently, yet succinctly, shone light on the theory that allows us to establish significance of one variable or another, we also need to look at a phenomenon that can blur this significance. This occurrence is called multicollinearity and a closer look at the characteristics and the impact of it is warranted because it will be an issue in the model selection.

First, let us define collinearity: it is the presence of a dependency between the explaining or independent variables within the regression model. Practically it means that a change in an explaining variable does not only affect the variable that is sought to be explained, but also the other independent variables. From the setup of the regression model, that roughly describes the impact of a one-unit change in the independent variable on the dependent variable holding all other independent variables constant, we can easily identify the problem. The other independent variables cannot be held constant when the intended one changes because they change with the one unit change of the independent variable that was intended to be changed. In this regression, I encountered the problem of data multicollinearity meaning that the observed data as such is dependent on each other. I do not encounter structural multicollinearity because no variable is a transformation of another variable.

Independent of the type of multicollinearity, it causes two distinct problems for the regression and the analysis of its results:

- 1) The estimates of the coefficients can vary wildly depending on the included variables. The estimates are reacting sharply to a small change in the regression.

Bank (2016), the percentage of international trade of the Ghanaian economy (World Bank, 2016) as well as the percentage of worldwide international trade of the global economy (World Bank, 2016) and the yield in kg per hectare in Ghana (FAO, 2017). Additionally, I had the world population, world GDP (both World Bank, 2016) and the volume of the cocoa crop (ICCO, 2018) on a global level at my disposal. This is a list of seventeen variables that have a yearly frequency from 1980 to 2011 and are continuous so that they can be used in linear regression. Different variables from above can be defined as either supply or demand variables while others belong both realms. Area harvested, production of cocoa beans in Côte d'Ivoire and globally, yield, stocks, oil price as a dummy for the production costs, terms of trade, real exchange rate, real producer prices would be traditionally seen as supply side determinants of the Ghanaian cocoa beans production. Classic demand side variables would be the grindings of cocoa beans, the world population and GDP as well as the real cocoa price. None of the independent variables are stationary in levels so that I took the first difference of each.

The model selection required the usage of a matrix that showed the correlation between the variables to eliminate some of them. The elimination process was instrumental to identify significant variables and improve the validity of the regression. Before conducting the first regression I have eliminated three variables of the demand side as they were highly correlated with each other: world population, world GDP, grindings in mt and the global crop of cocoa beans showed similar behavior and characteristics so that an inclusion of all of them would only hinder an efficient estimation of the model. The correlation between every single pair exceeded the threshold of 0.90 significantly. I have decided to keep the variable world GDP and discard the other three highly correlated variables. To counteract any other potential correlation, I have then standardized all remaining independent variables, meaning that I have subtracted the respective sample mean from each observation and divided by the

standard error of the observed sample. For the second regression I have also lagged the variable of the cocoa price by one year to see whether the agents took decisions based on the past values of the cocoa price. Only in the third regression I have accounted for the strong change in behavior in the dependent variable that occurred around the year 2002. These changes were discussed in depth in the chapter before. A dummy variable that divides the sample between the time before 2002 and after 2002 stabilized the regression significantly. In the next step I have eliminated the insignificant and correlated variables that describe the percentage of trade in the global and Ghanaian economy as well as the export of cocoa in tonnage and its values. For a similar reason as in the previous step, I decided to lag the producer price once. To arrive at the fifth iteration of the model I replaced the variable of world GDP to the narrower variable that describes the GDP in high income countries which are defined to have at least 12,234 USD per capita of income per year according to the World Bank (2016). This better reflects the consumption of cocoa and the subsequent products which mainly takes place in high income countries. I undertook the last change by adding an explaining variable: a lag of 5 years of the producer price would reflect the time a cocoa tree needs to grow and become efficient in producing cocoa beans.

Regression results and discussion

The regression yields some interesting results. The dependent variable for the final regression iteration is the Ghanaian cocoa production per year in metric tons for the period between 1980 and 2011. The dependent variable was regressed on the following variables to arrive at the final and most stable regression: area harvested in hectare, the cocoa beans productions by Côte d'Ivoire, the once lagged price for cocoa beans as stipulated by the ICCO (2018), a dummy to account for the structural break in production in 2002, the yearly average oil price in USD per barrel, the producer price lagged by five years to account for the natural cycle, the real exchange rate of the

Ghanaian Cedi with respect to a basket of international currencies, the globally available stock of cocoa beans in metric tons, the terms of trade as reported by the World Bank for Ghana, the yield per hectare of the Ghanaian cocoa tree plantations and finally the GDP of high income countries that make up the vast majority of the demand for chocolate.

Variable	Coefficient	Std. Error	t-Statistic	Probability
Area Harvested	125500	9845	12,75	0,00
Cdl Cocoa Production	-2919	10991	-0,27	0,79
Cocoa Price (-1)	22626	8196	2,76	0,01
Dummy 2002	-35140	29665	-1,18	0,25
Oil Price	28355	7770	3,65	0,00
Producer Price (-5)	-4417	8900	-0,50	0,63
Real Exchange Rate	8385	6368	1,32	0,20
Global Stock	-19224	8201	-2,34	0,03
Terms of Trade	-2851	7295	-0,39	0,70
Yield	806039	7988	10,09	0,00
High Income GDP	-296588	8440	-35,14	0,00

Table 1: Final Regression Results

The results in Table 1 can be interpreted in different ways. There is a clear relationship between the area harvested and the cocoa beans supply which is not surprising at all. The significance of the estimator is high with a very low probability of erring. The same holds true for the yield. Also, this independent variable seems to explain the changes in the Ghanaian cocoa bean production quite well. Both are significant on a 1% confidence level. On the demand side, the two variables high income countries' GDP and the available stock worldwide are similarly significant and important in describing changes in the dependent variable from year to year. Although the stocks available is only significant on a 5% confidence level, it has a profound impact on the Ghanaian cocoa beans production. At the same time the GDP variable for high

income countries exhibits a significance at the 1% level but has a negative sign. The most logical explanation is the changing diet and nutritional adjustments in high income countries: the elimination of chocolate products to improve the health and to strive for longevity has turned the sign on the variable. The initial expectation of a positive sign, meaning higher income means higher production, cannot be confirmed.

Interestingly, the oil price has a positive impact on the dependent variable meaning that a rise in oil prices is connected to a higher production in cocoa beans in Ghana. This relationship is significant on a 1% level. It can be assumed that the common denominator is the investment into the commodities basket. Institutional and private investors have discovered commodities as an alternative investment opportunity and the cocoa beans and oil are lumped together. The positive sign can likely be explained by this common movement. A similar result is found for the price of cocoa beans lagged by one year. It seems that producers are basing the decisions on last year's prices. Finally, there are variables that are insignificant and thus can be neglected in explaining the cocoa bean supply from Ghana in any given year: the terms of trade are irrelevant as is the production in the neighboring country Côte d'Ivoire. The producer price lagged five times is equally not helping in explaining the changes in the production of cocoa beans in Ghana and neither is the real exchange rate.

It is useful to set the results into context with other literature that has focused on the determinants of production or export of commodities and cocoa beans in particular. There are no papers that treat the determinants for the cocoa beans production in any country as far as I have researched. Nevertheless, some of the literature regarding export determinants exhibits some interesting links to above results and thus should

not be neglected. Boansi (2013) researches in his paper the determinants for the cocoa export in Ghana. He discovers that the market price has a significant impact on the export. Unsurprisingly, also the lagged cocoa bean production affects the export. Furthermore, the author finds evidence that the real producer price has a significant

impact on export while this regression indicated that the real producer price does not have an impact on the cocoa bean supply. In similar fashion, the real producer price in the neighboring country Côte d'Ivoire has an impact on the exports in Ghana which could not be confirmed for the production of cocoa beans in this analysis. The significant impact of the real exchange rate and lagged export on current export of cocoa beans cannot be traced back to the production of cocoa beans but remains present only further up the supply chain. Other papers are more in line with the results of this regression: In 'Determinants of Liberian Farmgate Cocoa Price' by A. English (2008) shows supportive evidence, that the world cocoa price affects the farmgate prices, and thus, that the farmers are receiving and adjusting to price signals from the global market for cocoa beans. She concludes that the signal transmission is not perfect but cannot be neglected either. As a novelty, the paper looks at the quality component and shows, that the quality of the cocoa beans is relevant for the farmgate price. Amoro & Shen (2012) focused especially on the impact of the local cocoa beans production in Côte d'Ivoire and the domestic consumption for grind. They are also able to include weather related data such as rainfall. The results show that the exports of cocoa beans from Côte d'Ivoire are significantly affected by all three variables mentioned above. For the Cameroon specific case, Gbetnkoum and Khan (2002) identified similar drivers of cocoa exports: the producer price in terms of domestic price index and the agricultural export credits assigned to exporters take center stage in their regression results. Additionally, they are able to show a significant relationship between cocoa export from Cameroon and the rainfall as well as the quality of the road network. Ifeanyi and Ndubuto Nwachukwu (2014) analyzed the determinants for the cocoa export in Nigeria and found differences between the short-run and long-run determinants of cocoa export: short-term export drivers were the cost of export and the rainfall while long-term determinants were output, cost of production and previous export.

Conclusion

This thesis set out to discover the determinants of cocoa beans supply in Ghana using a linear regression model. As the cocoa market and trade is rather opaque and little known to the wider public, I described its characteristics and features in more detail to give the reader a solid background. As a matter of fact, the agronomics of the cocoa market is most important to understand the supply of cocoa beans. The cocoa bean is after all a product of nature and is dependent on the natural cycles. The agronomics of cocoa beans takes this into account.

As the cocoa tree requires special climatic features it only grows between 20 degrees north and south of the equator so that the production countries are limited. The most important countries can be found in West Africa and South America with a small production also located in South East Asia. The countries share a humid climate that exhibits high temperatures and a rainy season as well as a dry season which however cannot be too long. The availability of water is crucial to the healthy development of the tree and the yield that it generates yearly. Aside from the impact of rain, cocoa trees need shade to be able to form a healthy canopy that protects them from pests and plagues. Sometimes there are other crop trees planted around cocoa trees to provide the necessary shade and optimize the yield and the development. More often, cocoa trees are planted in thinned forest which contributes to deforestation in the countries which leads in turn to undesirable consequences. Cocoa is harvested from the *Theobroma cocoa* tree which has different species but only one is commercially viable for the general market. This variety is a mixture of other species and combines the best features: it is more pest resistant, grows faster and more efficiently and is not so influenced by extreme weather. The tree needs up to five years to develop its full yield potential, but the first cocoa pods are available after 3 years. The tree is between eight and ten meters high but is usually restricted to make harvesting easier.

An important challenge for the farmers is controlling pests and diseases that can ravage a harvest season. In the 1950s and 1960s the diseases destroyed up to 40% of the yearly harvest but with better farming and knowledge about remedies the impact of the different diseases has been substantially reduced. Additionally, pest control has been improved over the last decades and although pests can still ravage areas at a time they are mostly controlled now. The farmers are now to better estimate the yield of the harvest and their income depending on the weather without accounting for the unforeseeable occurrence of a disease or pest. The cocoa tree can be harvested twice a year: the main season extends from September to March depending on the region and the second harvest starts in May and ends in August, again depending on the region. The main season accounts for around 80% of the yearly crop and is generally of superior quality. The countries of origin only undertake a few steps in the supply chain between harvest and final consumer product: the cocoa pods which contain the cocoa beans are harvested after which the beans are fermented and then dried. The dried cocoa beans are packed in jute or plastic bags and shipped as containerized freight to the industrialized countries. The exception is the production of cocoa products in Côte d'Ivoire where a significant part of the crop is used in local factories to produce cocoa butter and cocoa powder.

The next part of this paper concerned the usage and consumption of cocoa throughout history. The beans were already known to the old South American and Middle American civilizations and used in various forms. Cocoa beans were i.e. crushed and then stirred to a drink or even used as a payment method or as a measuring unit. The value of the cocoa bean for consumption was discovered in the 16th centuries by the Spanish and it took another 200 years for the drink to spread across Europe. The English Kingdom was an early adopter and the 19th century brought the industrial tools and methods to mass produce a product that was accessible and affordable to the wider public. This increase in consumption sparked the first cultivation

attempts in Africa and led to publicly controlled farming in the colonies in West Africa. Technological developments allowed for the creation of the chocolate bars in the 19th century and increased plantation made the beans cheaper and better available. Early in the 20th century the African countries overtook the South American and Middle American countries in total production and thus paved the way for a change in the supply chain. The new central hub for the supply of cocoa beans was West Africa from there onwards.

After the Second World War the various origin countries developed different systems to control the price of the supply of cocoa beans. The goal was to optimize income and, in some cases, guarantee quality supply. The first option was the establishment of a marketing board that buys the crop from the farmers and then sells it on to the industrialized countries. The board also grades the beans and supervises quality control. A second option is a structure similar to a marketing board but with less power. It is called Caisse de Stabilisation and was used in French speaking countries of West Africa.

The impact was mostly negative and thus this system was abandoned before 2000. The third option is a free market where the participants are free to trade and produce at their own will. It is the preferred system for international organizations such as the IMF and the World Bank who associate the most welfare gain with this liberal market structure. The example of Nigeria shows the advantages and disadvantages of a free market that is poorly regulated by the government.

The next step in the supply chain is the trade in cocoa beans. There is a strong distinction between the physical market and the futures market. The physical market is determined by private agreements between suppliers or marketing boards and the respective buyers, either trade houses, processors or other actors. The goal is the import of physical cocoa to the countries where the product is used. On the other side, the futures market is used to hedge price or time exposure.

The futures are traded on different exchanges and are used to determine the price of cocoa beans and products in the future. The two markets are linked by the supply and demand in the physical market which feeds into the futures' curves. The numbers of participants in the physical market decreased substantially over the past decades as the physical demand market consolidated at an always increasing pace. The actors on the futures market instead increased as speculators and hedge funds discovered commodities as a viable alternative to equity and debt markets.

Concentrating on the physical flow of cocoa beans, one can identify distinct trade patterns. Generally, the flow of cocoa beans originates in West Africa and South America and flows towards Europe and Northern America and for South America towards Asia. West Africa produces about 75% of the world crop in a give year and Europe is the main destination. Big processing facilities are located in Asia and many products that are used in American chocolate making are produced there so that the flow of cocoa beans towards Nord America is smaller than the one going towards Europe. These trade flows have changed little of the past 50 years although Asia has come on strong and the generally the crop has increased significantly on a world level. In terms of price, cocoa beans have been very volatile and were heavily influenced by policy decisions and new plantation areas in Asia. In the late 2000s there was also a speculative bubble that lifted all commodities to new heights and collapsed soon after.

As the focus of this paper lies on the Ghanaian cocoa market and more specifically on the determinants of supply of the Ghanaian cocoa beans, I described it in extensive detail for the period between 1960 and 2016. Cocoa beans have been the most important cash crop for the Ghanaian population since the late 19th century. Much of the economy is connected to the cocoa bean crop and its growth rates have often mirrored crop size and world market prices. As a matter of fact, when Ghana gained independence from the United Kingdom, its economy was in good shape. The next 20 years between approx. 1960 and 1985 were characterized by economic upheaval and

turbulences that left Ghana much worse off. Ghana was hampered by common problems that many ex-colonial states had to face: instable governments and policies as well as civil unrest, high corruption and other problems left Ghana reeling before an intervention by the IMF and the World Bank at the end of the 1980s. However, starting in the 1990 and continuing more rapidly after 2000, the economy has been expanding. While the importance of agricultural produce between 1960 and 2015 declined when viewed as a share of total output the Ghanaian population grew strongly. This increase in population was met by a steady increase in yield and land usage from the 1990s onwards. At the same time, the rural population decreased as Ghanaians increasingly sought work in cities moving away from the traditional agricultural farming of previous generations. These three factors combined to increase the production of cocoa beans significantly over time to reach the current levels.

The history of cocoa production in Ghana is long and went through the usual ebbs and flows. Starting just before the turn of the 20th century, it was a success story right up to the Second World War. Around 1940 the sector entered in a stagnation period that saw steady yields and production up to the independence from the United Kingdom. The period of economic downturn coincided with the downturn in cocoa beans production between 1960 and 1985. By that time Ghana had lost its once dominant position in the cocoa market and had to start anew. Together with the economic and financial help, the IMF and the World Bank provided agricultural expertise and support which helped the Ghanaian farmers to recover all the lost production and yield and increase them significantly over the next 20 years. On an institutional level, the original marketing board imposed by the British colonial government was replaced various times with different systems but the final iteration under the supervision of the IMF and World Bank led to an institutional setup that mostly supported and enhanced the farmers and the Ghanaian cocoa beans' market.

With this background information regarding the agricultural and economic si-

tuation and history of cocoa production in Ghana and worldwide, I gathered data that would be able to explain changes in yearly Ghanaian cocoa bean production between 1980 and 2011. Most of the data was available publicly but the extensive list of potential independent variables needed to be reduced due to correlation between the variables. The final linear least square estimation of the model contained only eleven independent variables. Of these variables five were significant at a 5% confidence level: the area harvested, the once-lagged price of cocoa beans at a world level, the oil price, the globally available stock of cocoa beans, the yield and the GDP of high-income countries. Setting my results in context with other literature that covers the cocoa bean trade, there are some small differences that need further investigation but generally they are in line with current and past research.

To improve the production of Ghanaian cocoa beans, the situation of the farmers and the economy in general there are a few recommendations that can be followed: the local processing capacities need to be increased to retain a higher share of the value chain within the country. A positive example is the neighboring Côte d'Ivoire where the local processing capabilities propelled the country to one of the biggest processors in the world. The retention of a higher share of the value chain leads to higher employment and higher GDP as well as higher taxes. Another area that is crucial to improvement is price control: the very recent cooperation with Côte d'Ivoire to establish a minimum price for the sales of cocoa beans is a step towards selling cocoa beans at a higher price. If this courageous project holds strong and doesn't succumb to low financing strength, it gives the two biggest producing countries a strong hand in negotiations with the international processors of cocoa beans. On a base level, the farmers need continuous support from the government and improved access to infrastructure and especially education and good agricultural practices. It is important to reduce deforestation and support natural ecosystems that allow for long-term cocoa tree plantation outside protected areas. It might be of value to open the very bureau-

cratic internal marketing system up to more competition.

The current setup favors international processors that can act as intermediaries between farming communities and export agencies of the state. An internal marketing system that is minimized increases the value for farmers and government alike.

This paper is based on publicly available data that is not privy of all doubt or interference by governments and institutions. A more detailed research needs better data and more sources that can be validated against each other. The next step in the analysis of the determinants of cocoa bean supply can likely only be taken when there is a reliable variable available for weather changes and especially for rain and humidity in the soil. Furthermore, a new framework needs to establish that accounts for the technological advancement in the light of changing climate. It is hard to decipher the real impact of climate change when technological advancement cannot be measured efficiently. The efficiency gains often mask the climate impact and cocoa bean production in Ghana is in danger of being unviable in the near future if the climate change is not being tackled effectively.

Bibliography

- Ajetomobi, J. O. (2014). Post-Liberalization Markets, Export Firm Concentration, and Price Transmission along Nigerian Cocoa Supply Chains, *AGRODEP Working Paper 0005*.
- Amanor, K. (2005). Agricultural Markets in West Africa: Frontiers, Agribusiness and Social Differentiation, *IDS Bulletin*, 36(2), pp. 58-62.
- Amoro, G., & Shen, Y. (2012). The Determinants of Agricultural Export: Cocoa and Rubber in Cote d'Ivoire, *International Journal of Economics and Finance*, 5(1), pp. 228-233.
- Bccca (1997). *Cocoa diseases and pests [Video]*, London / Brussels: International Cocoa Organization / International Pesticide Application Research Consortium.
- Boansi, D. (2013). Competitiveness and determinants of cocoa exports from Ghana, *International Journal of Agricultural Policy and Research*, 1(9), pp. 236-254
- Brooks, J., Croppenstedt, A. & Aggrey-Fynn, E. (2007). Distortions to Agricultural Incentives in Ghana, *Agricultural Distortions Working Paper 47*, World Bank.
- Bulř, A. (2002). Can Price Incentive to Smuggle Explain the Contraction of the Cocoa Supply in Ghana?, *Journal of African Economies*, 11(3), pp. 413-439.
- Colmenero, A. D. L. (1631). *Curioso Tratado de la Naturaleza y Calidad del Chocolate*, Madrid: Francisco Martinez.
- Conacado Agroindustrial (n.d.). Cocoa Process, Retrieved May 5, 2018, from <http://www.conacado.com.do/?agroindustrial=comercializacion/proceso-del-cacao&lang=en>.
- English, A. (2008). Determinants of Liberian Farmgate Cocoa Price, Knoxville, TN: University of Tennessee.

- Food and Agriculture Organization Corporate Statistical Database (2018), Retrieved online May 5, 2018, from <http://www.fao.org/faostat/en/>.
- Flood, J. (2007). Meeting threats of pest and disease globalization, *Global Research on Cocoa (Gro-Cocoa)*, 12(1), pp. 3–5.
- Gage, T. (1648). *The english-american, his travail by sea and land: Or, a new survey of the west-indies, containing a journall of three thousand and three hundred miles within the mainland of america . . . by the true and painfull endeavours of Thomas Gage. Now preacher of . . . London, London: Printed by R. Coates, and are to be sold by Humphrey Blunden at the Castle in Cornhill, and Thomas Williams at the Bible in Little Britain.*
- Gbetnkom, D., & Khan, S.A. (2002). *Determinants of Agricultural Exports: The Case of Cameroon*, AERC Research Paper 120, Nairobi: African Economic Research Consortium.
- Gilbert, C.L. (1995). *International Commodity Control: Retrospect and Prospect*, World Bank Policy Research Paper, No. 1545 (November).
- Gilbert, C. L., & Varangis, P. (2003). *Globalization and International Commodity Trade with Specific Reference to the West African Cocoa Producers*, NBER Working Paper, No.W9668 (May).
- Gilbert, C.L. (2009). *Cocoa Market Liberalization in Retrospect*, *Review of Business and Economic Literature*, KU Leuven, Faculty of Economics and Business, 0(3), pp. 294-312.
- Gunnarsson, C. (1978). *The Gold Coast Cocoa Industry 1900–1939. Production, Prices and Structural Change*, PhD thesis, Department of Economic History, Lund University, Lund, Sweden.
- Hill, P. (1963). *The Migrant Cocoa Farmers of Southern Ghana. A Study in Rural Capitalism*. Cambridge, UK: Cambridge University Press.

- International Cocoa Organization (ICCO) (2017). *Quarterly Bulletin of Cocoa Statistics*, Vol. XLIII(1), Côte d'Ivoire: Abidjan.
- Ifeanyi and Ndubuto Nwachukwu (2014). Dynamics of Agricultural Exports in Sub-Sahara Africa: an Empirical Study of Rubber and Cocoa from Nigeria, *International Journal of Food and Agricultural Economics*, 2(3), pp. 1-14.
- Johnson, J., & Di Nardo, J. (1996). *Econometric Models*, New York, New York: McGraw-Hill/Irwin.
- Kolavalli, S., & Vigneri, M. (2011). Cocoa in Ghana: Shaping the Success of an Economy. In P. Chuhan-Pole & M. Angwafo (Eds.), *Yes, Africa can: success stories from a dynamic continent* (pp. 201-207). Washington, D.C.: World Bank.
- Kolawole, M.I. (1974). The Reform of Commodity Marketing Boards in Nigeria: An Analysis of New Producer Price Policy, *The Developing Economies*, 12(2), pp. 155-168.
- Mora, A., Morera, J., & Lainez, J. (1994). Evaluation of the Cacao Interclonal Cross 'Pound 12 x catongo' At Catie, Costa Rica: Its phenology, In J. de Lafforest (ed.), *Proceedings of the 11th International Cocoa Research Conference*, Hertford: Stephen Austin and Sons, pp. 473–482.
- Murphy, R., & Flood, J. (2002). World's worst diseases and pests, *Global Research on Cocoa (Gro-Cocoa)*, 1 (1), pp. 1–3.
- Nieburg, O. (2015). 'We cannot let Indonesia fail': Mars stresses Asia's importance in meeting future cocoa demand, Retrieved May 5, 2018, from <https://www.confectionerynews.com/Article/2015/04/29/What-is-the-future-of-cocoa-growing-in-Asia>.
- Nigeria, Federal Ministry of Economic Development and Reconstruction. (n.d.) *Second National Development Plan 1970/1974, First Progress Report* (Lagos).
- Sampson, M.J. (1969). *Makers of Modern Ghana: From Philip Quarcoo to Aggrey*, vol. 1. Ghana: Anowu Educational Publications.

- Stryker, J. D. (1990). Trade, Exchange Rate, and Agricultural Policies in Ghana, World Bank Comparative Studies, World Bank.
- Vigneri, M., & Santos, P. (2008). What Does Liberalization without Price Competition Achieve? The Case of Cocoa Marketing in Rural Ghana, IFPRI-GSSP Background Paper 14, International Food Policy Research Institute.
- Wilcox Jr., M. D., & Abbott, P. C. (2004). Market Power and Structural Adjustments: the Case of West African Cocoa Market Liberalization, 2004 Annual meeting, Denver, CO, American Agricultural Economics Association.
- Williams, G. (1985). Marketing without and with Marketing Boards: The Origins of State Marketing Boards in Nigeria, *Review of African Political Economy*, 12(34), pp. 4-15.
- World Bank Open Data (2018), Retrieved Online May 5, 2018, from <https://data.worldbank.org/>.